Identifying FDI Spillovers

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Abstract

This paper improves on the strategy used in the literature to identify the spillover effect of horizontal foreign direct investment (FDI) by taking advantage of the plausibly exogenous relaxation of FDI regulations on China's World Trade Organization accession at the end of 2001. In addition, to understand the (aggregate) FDI spillover effect, the paper evaluates two underlying explanations (the agglomeration effect versus the competition effect, the former of which is further moderated by the absorptive capacity of domestic firms) by distinguishing different types of FDI along various dimensions. Finally, the analysis uses an array of performance measures, including total factor productivity, exporting performance, wages, R&D investment, and firm survival, with one single data set to offer a fuller and more nuanced picture of the impact of FDI on domestic firms.

Keywords: FDI Spillovers; Difference-in-Differences; Agglomeration Effect; Competition Effect; Absorptive Capacity; China
JEL Classification: F2, O3, R1

1 Introduction

Over the past few decades, developing countries around the world have heeded advice from developed countries and international organizations (such as the World Bank and the International Monetary Fund) in removing restrictions on foreign direct investment (FDI) and even adopting policies to attract FDI, in the belief that domestic firms can benefit from the presence of FDI. However, empirical studies using firm-level panel data from developing countries have failed to uncover conclusive evidence that domestic firms benefit from the presence of FDI in the same industry (referred to as *horizontal FDI*), and some have even found that FDI has a negative effect on domestic firms.[1] The lack of consensus in the academic literature on the *FDI spillover effect* prompts us to reexamine this research question.

Our study contributes to the literature on three grounds. First, the decision by foreign multinationals to enter developing countries and their particular industries is an endogenous one, which partially explains why it is difficult to identify the FDI spillover effect. We improve on the identification strategy used in the literature (which generally relies on the inclusion of industry or firm fixed effects) by taking advantage of the plausibly exogenous relaxation of FDI regulations on China's World Trade Organization (WTO) accession at the end of 2001. Specifically, upon its WTO accession, China opened up 112 of its 424 four-digit manufacturing industries for FDI, and these industries have indeed experienced a surge of FDI inflows since 2002. Using this shock as an instrument for the presence of FDI, we are able to compare firm performance in our treatment group (i.e., industries that encouraged FDI entries) with firm performance in our control group (i.e., industries that did not have any change in FDI regulations) before and after China's WTO accession at the end of 2001. Section 2 provides the details of China's FDI regulations and our empirical identification strategy. Our regression analyses and a battery of identification checks, provided in Section 3, show that horizontal FDI has a negative spillover effect on the performance of China's domestic firms.

Second, to further understand the negative (aggregate) FDI spillover effect, we examine the relevance of two explanations proposed in the literature (namely, agglomeration versus competition effects). Specifically, Aitken and Harrison (1999) argue that although domestic firms may enjoy a positive *agglomeration effect* from the presence of foreign multinationals

[1] Studies reporting the negative effects of horizontal FDI on domestic firms in developing countries include, for example, Haddad and Harrison (1993) for Morocco; Aitken and Harrison (1999) for Venezuela; Djankov and Hoekman (2000) for the Czech Republic; Konings (2001) for Bulgaria, Romania, and Poland; and Hu and Jefferson (2002) for China. However, most studies using data from developed countries report that FDI has a positive effect on domestic firms, e.g., Haskel, Pereira, and Slaughter (2007) and Keller and Yeaple (2009). See Görg and Strobl (2001), and Görg and Greenaway (2004) for recent surveys of this literature.

through channels such as knowledge spillovers, input sharing, and labor pooling (see Blomström and Kokko (1998) for a more discussion), they may lose market share to the more productive foreign multinationals, thereby suffering from the negative *competition effect*. To disentangle these two opposite effects, in Section 4, we distinguish different types of FDI along various dimensions, such as FDI source countries (developed versus developing countries; e.g., Javorcik and Spatareanu (2011)), linkages (horizontal FDI versus FDI in upstream or downstream industries; e.g., Javorcik (2004); Bwalya (2006); Kugler (2006); Blalock and Gertler (2008); Liu (2008); Barrios, Görg, and Strobl (2011); Gorodnichenko, Svejnar, and Terrell (2014)), location of investment (within versus outside a city; e.g., Bwalya (2006); Halpern and Muraközy (2007)), and the time horizon of the FDI spillover effect (static versus dynamic; e.g., Liu (2008); Kosová (2010)). Consistently, we find that the negative spillover effect of horizontal FDI is stronger in scenarios where the competition effect is more pronounced, but that it is either smaller in magnitude, albeit negative, or even positive in cases where the agglomeration effect is more prominent.

Relatedly, the positive agglomeration effect hinges on the absorptive capacity of domestic firms, and so does the (aggregate) FDI spillover effect. Using a panel data set of Indonesian manufacturing firms for the 1988 to 1996 period, Blalock and Gertler (2009) find that firms with more R&D investment benefit more from the presence of foreign multinationals. Following this line of the research, we investigate whether the negative FDI spillover effect on domestic firms can be explained by the differences among the domestic firms in their R&D investment and ownership structure (state ownership versus private ownership); we find weak support for the latter but not the former, suggesting that absorptive capacity plays a limited role in attenuating the negative FDI spillover effects in the setting of China.

Finally, compared with the studies in the literature, each of which focuses on a subset of indicators for firm performance with a particular data set, we explore a long list of indicators with one single data set to depict a comprehensive picture of the impact of FDI on domestic firms. Specifically, we examine exporting performance (i.e., probability of exporting and export intensity), wage rate, R&D investment, and firm survival. We find that the presence of foreign multinationals has no significant effect on the exporting performance or R&D investment of domestic firms in the same industry, leads to significant increases in the wage rate paid by domestic firms in the same industry, and decreases the exit probability of domestic firms in the same industry. Combined with the negative effect of FDI on the total factor productivity (TFP) of domestic firms, these results confirm that there is limited evidence that domestic firms benefit from the presence of foreign multinationals; our finding casts doubt on the policy orientations of many developing countries.

2 Estimation Strategy

2.1 Regulation of FDI in China

From 1949 to 1978, China was a closed economy under rigid central planning, and there was an almost complete absence of foreign-invested enterprises (FIEs) in the country. However, the situation changed dramatically in December 1978, when the then leader of China, Deng Xiaoping, initiated an open-door policy to promote foreign trade and investment. A "Law on Sino-Foreign Equity Joint Ventures" was passed in July 1979 to attract FDI, and from the 1980s to the early 1990s, a series of laws on FDI and implementation measures were further introduced and revised.[2] Specifically, the central and local governments of China granted preferential policies on taxes, land usage, and other matters, often in the form of policies for special economic zones, to FIEs, as these FIEs were expected to bring advanced technologies and management know-how to China, and to promote China's integration with the world economy. As a result of these laws and implementation measures, China experienced rapid growth in FDI inflows from 1979 to 1991 (Figure 1).

[Insert Figure 1 here]

Despite of the open-door policy and the removal of barriers to inward FDI from the late 1970s to the early 1990s, FIEs operating in China still faced significant obstacles. For example, FIEs had to meet local content requirements in manufacturing and exporting products, and were required to transfer advanced technologies and management know-how to local partners.

In July 1986, China inaugurated the bid to the General Agreement on Tariffs and Trade (GATT, the predecessor of the WTO) for resumption of its status as a GATT contracting party. The plan was temporarily suspended between 1987 and 1992, when China was debating the direction of its economic reforms. It was after Deng Xiaoping's tour of Southern China in 1992 when the momentum resumed, and in July 1995 China officially submitted the application to join the WTO. The negotiations for China's WTO accession lasted 15 years, during which China introduced and substantially revised a large number of laws and regulations on trade and FDI in accordance with its WTO commitments. Specifically, there were large-scale tariff reductions between 1992 and 1997: the average tariff dropped from 35% in

[2] In September 1983, the "Regulations for the Implementation of the Law on Sino-Foreign Equity Joint Ventures" was issued by the State Council of China; it was revised in January 1986, December 1987, and April 1990. In April 1986, the "Law on Foreign Capital Enterprises" was enacted, and in October 1986, "Policies on Encouragement of Foreign Investment" was issued by the State Council of China. In April 1988, the "Law on Sino-Foreign Contractual Joint Ventures" was enacted, and in October 1990, the "Detailed Rules for the Implementation of the Law on Wholly Foreign-Owned Enterprises" was issued.

1994 to around 17% in 1997. Service sectors such as banking and insurance were gradually opened through the elimination of restrictions on market access. In terms of foreign investments, China committed to comply fully with the "Agreement on Trade-Related Investment Measures" upon the WTO accession, and laws on FDI and implementation measures were enacted and amended accordingly.[3]

Most significantly, there were policies designating which industries were permitted to receive FDI. In June 1995, the central government of China promulgated the "Catalogue for the Guidance of Foreign Investment Industries" (henceforth, the Catalogue), which, together with the modifications made in 1997, became the government guidelines for regulating the inflows of FDI. Specifically, the Catalogue classified products into four categories: (i) FDI was supported, (ii) FDI was permitted, (iii) FDI was restricted, and finally, (iv) FDI was prohibited. To comply with China's accession commitments for entry to the WTO, the central government of China substantially revised the Catalogue in March 2002, and made minor revisions in November 2004. In this study, we use the plausibly exogenous relaxation of FDI regulations upon China's WTO accession at the end of 2001 to identify the spillover effect of horizontal FDI on domestic firms.[4]

2.2 Data

Panel data on industrial firms. The main data used in this study are from the *Annual Survey of Industrial Firms* (ASIF), conducted by the National Bureau of Statistics of China for the 1998–2007 period. These surveys cover all of state-owned enterprises (SOEs) and non-SOEs with annual sales over 5 million Chinese yuan (about US$827,000). The number of firms covered in the surveys varies from approximately 162,000 to approximately 270,000. The data set has more than 100 variables, including the basic information for each surveyed firm, such as its identification number, location code, industry affiliation, and ownership structure (including ownership by foreigners and the state, which can be used to calculate the foreign equity share and the state share, respectively), and the financial and operational information extracted from accounting statements, such as sales, employment, materials, fixed assets, and total wage bill.

For our study, we need precise industry information about our sample firms. In 2003,

[3]Specifically, in August 1995, "Detailed Rules on the Implementation of the Law on Sino-Foreign Joint Cooperative Ventures" was enacted. After that, three laws on FDI were amended: the "Law on Foreign Capital Enterprises" and the "Law on Sino-Foreign Contractual Joint Ventures" in October 2000, and the "Law on Sino-Foreign Equity Joint Ventures" in March 2001. In addition, "Detailed Rules for the Implementation of the Law on Wholly Foreign-Owned Enterprises" was revised in April 2001, and "Regulations for the Implementation of the Law on Sino-Foreign Equity Joint Ventures" was revised in July 2001.

[4]The National Development and Reform Commission and the Ministry of Commerce jointly issued the fifth and sixth revised versions of the Catalogue in October 2007 and December 2011, respectively.

a new classification system for industry codes (GB/T 4754-2002) was adopted in China to replace the old classification system (GB/T 4754-1994) that had been used from 1995 to 2002. To achieve consistency in the industry codes over our entire sample period (1998–2007), we use the concordance table constructed by Brandt, Van Biesebroeck, and Zhang (2012).[5]

Table 1 shows the distribution of foreign equity share (measured by the output-weighted average of foreign equity share across all the firms in an industry) across the two-digit industries over the entire sample period (1998–2007), the pre-WTO period (1998–2001), and the post-WTO period (2002–2007). There were substantial variations in the extent of FDI across these industries in China, with the average foreign equity share ranging from 1.4 to 55.6%. The Electronic and Telecommunications Equipment industry had the highest percentage of FDI (55.6%) in the 1998–2007 period, followed by the Garments & Other Fiber Products industry (42.6%), and the Furniture Manufacturing industry (41.8%). The industries with the lowest percentage of FDI were Tobacco Processing (1.4%), Smelting and Pressing of Nonferrous Metals (6.4%) and Smelting and Pressing of Ferrous Metals (6.7%), all of which were monopolized and resource-intensive.

[Insert Table 1 here]

From the pre-WTO period to the post-WTO period, most of the industries experienced increases in the extent of FDI. The Special Purpose Equipment industry witnessed the fastest growth rate in FDI (68.60%), followed by Petroleum Processing & Coking (41.94%), and Raw Chemical Materials & Chemical Products (33.74%). However, some industries experienced decreases in foreign equity share, specifically, Tobacco Processing (declined by 38.89%), and Timber Processing, Bamboo, Cane, Palm Fiber & Straw Products (declined by 13.66%).

Data on China's FDI regulations. To obtain information about changes in FDI regulations upon China's accession to the WTO, we compare the 1997 and 2002 versions of the Catalogue for the Guidance of Foreign Investment Industries. We focus on the 2002 version rather than the 2004/2007/2011 versions for three reasons. First, the revision to China's

[5] One potential problem with the ASIF data is that, for firms with multiple plants located in regions other than their domiciles, the information about the satellite plants might be aggregated to that of the domicile-based plants. According to Article 14 of the Company Law of the People's Republic of China, however, for a company to set up a plant in a region other than its domicile, "it shall file a registration application with the company registration authority, and obtain the business license." For example, Beijing Huiyuan Beverage and Food Group Co., Ltd. has six plants, located in Jizhong (Hebei Province), Youyu (Shanxi Province), Luzhong (Shandong Province), Qiqihar (Heilongjiang Province), Chengdu (Sichuan Province), and Yanbian (Jilin Province). Our data set accordingly counts them as six different observations belonging to six different regions. Thus a firm in our data is essentially a plant.

FDI regulations contained in the 2002 version of the Catalogue was substantial and in strict accordance with the commitments made by China's central government in its negotiations with the existing member countries of the WTO before its WTO accession. This makes the changes plausibly exogenous to China's domestic situations. Second, there were very few changes in the 2004 revision of the Catalogue. Finally, the 2007 and 2011 modifications were not applicable to our sample period, which is from 1998 to 2007.

In the Catalogue, products were classified into four categories: (i) products where FDI was supported (the supported category), (ii) products (not listed in the Catalogue) where FDI was permitted (the permitted category), (iii) products where FDI was restricted (the restricted category), and finally, (iv) products where FDI was prohibited (the prohibited category).

Next, by comparing the 1997 and 2002 versions of the Catalogue, we can identify, for each product in the Catalogue, whether there was a change in the FDI regulations upon China's accession to the WTO. We then assign each product to one of three possible outcomes:

- FDI became more welcome (henceforth, such products are referred to as (FDI) encouraged products). For example, "dairy products" was listed in the supported category in the 2002 Catalogue, but listed in the permitted category in the 1997 Catalogue. We thus designate "dairy products" as (FDI) encouraged products.

- FDI became less welcome (henceforth, such products are referred to as (FDI) discouraged products). For example, "ethylene propylene rubber" was listed in the supported category in the 1997 Catalogue, but listed in the permitted category in the 2002 Catalogue. We thus designate "ethylene propylene rubber" as (FDI) discouraged products.

- No change in FDI regulations between 1997 and 2002. For example, "casting and forging roughcasts for automobiles and motorcycles" was listed in the supported category in both the 1997 and 2002 Catalogues. We designate such products as no-change products.

Online Appendix Table A1 lists a matrix of all the possible changes in product categories (supported, restricted, prohibited, and permitted) between 1997 and 2002 with the corresponding classifications in the changes in FDI regulations (encouraged, discouraged, or no change).

Finally, we aggregate the changes in FDI regulations from the Catalogue product level to the ASIF industry level. As the product classifications used by the Catalogue are different from the industry classifications used in the ASIF data, we convert the product classifications of the Catalogue for the Guidance of Foreign Investment Industries into the four-digit

Chinese Industry Classification (CIC) of 2003 using the Industrial Product Catalogue from the National Bureau of Statistics of China.[6] As the product classifications of the Catalogue are generally more disaggregated than the four-digit Chinese Industry Classifications of the ASIF, it is possible that two or more products from the Catalogue are sorted into the same four-digit CIC industry of the ASIF. The aggregation process leads to four possible scenarios:

1. (FDI) Encouraged Industries: For all the possible Catalogue products in a four-digit CIC industry, there was either an improvement in FDI regulations or no change in FDI regulations. For example, four sub-categories under "Synthetic Fiber Monomer (Polymerization)" (CIC code: 2653) experienced improvements in FDI regulations (listed in the restricted category in the 1997 Catalogue, but the supported category in the 2002 Catalogue): "Pure Terephthalic Acid (PTA)" (CIC sub-code: 26530101), "Acrylonitrile" (26530103), "Caprolactam" (26530104), and "Nylon 66 Salt" (26530299); and there was no change in FDI regulations for the other sub-categories. We thus designate "synthetic fiber monomer (polymerization)" as an (FDI) encouraged industry.

2. (FDI) Discouraged Industries: For all of the possible Catalogue products in a four-digit CIC industry, there was either a deterioration in FDI regulations or no change in FDI regulations. For example, one sub-category in "Food Additives" (CIC code: 1494) experienced a deterioration in FDI regulations (listed in the permitted category in the 1997 Catalogue but in the restricted category in the 2002 Catalogue): "Synthetic Sweeteners" (CIC sub-code: 14940103); and there were no changes in FDI regulations for the other sub-categories. We thus designate "Food Additives" as an (FDI) discouraged industry.

3. No-Change Industries: There was no change in FDI regulations for any of the possible Catalogue products under a four-digit CIC industry. For example, in "Edible Vegetable Oil" (CIC code: 1331), all of the sub-categories were permitted in both the 1997 Catalogue and the 2002 Catalogue. We thus designate "Edible Vegetable Oil" as a no-change industry.

4. Mixed Industries: Some of the possible Catalogue products in a four-digit CIC industry experienced an improvement in FDI regulations, but some other products had worsening FDI regulations. For example, under "Crude Chemical Medicine" (CIC code: 2710), the FDI regulations for one sub-category ("Vitamin B6" (CIC sub-code: 27100404)) improved (listed in the restricted category in the 1997 Catalogue, but

[6] The Industrial Product Catalogue lists each four-digit CIC industry and its sub-categories at the eight-digit disaggregated product level.

the permitted category in the 2002 Catalogue), but the FDI regulations for one sub-category ("Vitamin E" (CIC sub-code: 27100408)) deteriorated (listed in the permitted category in the 1997 Catalogue, but in the restricted category in the 2002 Catalogue). We thus designate "Crude Chemical Medicine" as a mixed industry.

Among the 424 four-digit CIC industries, 112 are (FDI) *encouraged industries* (which is the treatment group in our regression analysis), 300 are *no-change industries* (which serves as the control group in our regression analysis), 7 are (FDI) *discouraged industries*, and 5 are *mixed industries*; the latter two groups are excluded from the analysis. The results (available upon request) remain robust when we include the *discouraged industries* in the analysis.

2.3 Estimation Specification

The benchmark model used in the literature to investigate the spillover effect of FDI on firm performance (e.g., Aitken and Harrison, 1999) is

$$y_{fit} = \alpha_f + \gamma_t + \delta FDI\_Sector_{it} + \mathbf{X}'_{fit}\boldsymbol{\lambda} + \varepsilon_{fit}, \tag{1}$$

where f, i, and t denote the firm, four-digit industry, and year, respectively; y_{fit} measures the performance (e.g., TFP) of firm f of industry i in year t; α_f and γ_t are firm and year fixed effects, respectively; $\mathbf{X}_{fit}$ is a vector of time-varying firm and industry characteristics used to isolate the FDI spillover effect; and ε_{fit} is the error term. Following Bertrand, Duflo, and Mullainathan (2004), we address the potential serial correlation and heteroskedasticity issues by calculating the standard errors clustered at the industry level. While equation (1) considers a linear effect, we also investigate a possible nonlinear effect as in Barrios, Gorg, and Strobl (2005).

FDI_Sector_{it} is our regressor of interest, capturing the extent of FDI in industry i and year t. We use the standard measure in the literature, i.e.,

$$FDI\_Sector_{it} = \frac{\sum_{f\in\Omega_{it}} FDI\_Firm_{fit} \times Output_{fit}}{\sum_{f\in\Omega_{it}} Output_{fit}},$$

where $Output_{fit}$ measures the output of firm f of industry i in year t; FDI_Firm_{fit} measures the foreign equity share of firm f of industry i in year t; and Ω_{it} is the set of firms in industry i in year t.

This standard measure of FDI (FDI_Sector_{it}) may encounter two identification concerns. First, it includes all the output ($Output_{fit}$) each foreign multinational produces, despite that foreign multinationals in China export significant shares of their output. To the

extent that the FDI spillover effect comes mostly from the domestic sales of foreign multinationals, the use of total output in the variable construction may overestimate the presence of FDI in China. To address this issue, we conduct a robustness check by excluding exports from output in the construction of FDI_Sector_{it}. Second, the measure does not distinguish the composition of FDI. Specifically, there are two forms of foreign multinationals in China, wholly-owned firms and joint ventures. If multinationals established after China's WTO accession were of different forms than incumbents, our estimates may capture the composition effect rather than the level effect of the FDI presence. To address this issue, we first examine whether multinationals established after 2002 are different from those before 2002 in composition, and then include an additional control (i.e., the percentage of wholly-owned multinationals) to condition out the composition effect.

As our study concerns the spillover effect of FDI on domestic firms, we exclude from our regression sample all foreign firms (i.e., any firm with more than 25 percent of its equities owned by foreign investors, as such firms are entitled to preferential corporate tax rates offered for FIEs according to the Chinese law). The results obtained using the full sample but controlling for foreign equity share, as is common in the literature, are qualitatively the same and available upon request. The summary statistics of our key variables are presented in Table 2.

[Insert Table 2 here]

A crucial assumption for obtaining an unbiased estimate of δ in equation (1) is that, conditional on all of the control variables, the regressor of interest FDI_Sector_{it} is uncorrelated with the error term. It is reasonable to doubt that this identifying assumption holds in our setting. For example, there could be more FDI inflows to China's comparatively disadvantageous industries, where domestic firms already have lower productivity levels; this would cause bias toward a negative effect of FDI on domestic firms.

To deal with the identification problem, we use variations across industries in the changes in FDI regulations upon China's WTO accession as an instrument for FDI_Sector_{it} to identify the FDI spillover effect on domestic firms. Specifically, we compare firm performance in our treatment group (i.e., the *encouraged industries*) with firm performance in our control group (i.e., the *no-change industries*) before and after China's WTO accession at the end of 2001, a difference-in-differences (DID) based instrumental variable (IV) estimation. The first stage of the IV estimation is

$$FDI\_Sector_{it} = \alpha_f + \gamma_t + \eta Treatment_i \times Post02_t + \mathbf{X}'_{fit}\boldsymbol{\psi} + \zeta_{fit}, \tag{2}$$

where $Treatment_i$ indicates whether industry i belongs to the treatment group; and $Post02_t$

is a dummy indicating the post-WTO period, i.e., $Post02_t = 1$ if $t > 2002$, 3/4 if $t = 2002$, and 0 if $t < 2002$.[7]

One concern with the above IV estimation is that FDI_Sector_{it} is bounded between 0 and 1, but is treated as a linear variable in the first stage. To address this nonlinearity of outcome in the first stage of the IV estimation, we follow the methodology developed by Angrist (2001). Specifically, an appropriate model (i.e., Tobit model) is chosen first to estimate equation (2), from which the fitted value is obtained. Then, the fitted value is used as the instrument for FDI_Sector_{it} in the standard linear IV estimation.

2.4 Identifying Assumption and Checks

Our instrument is valid under the following two conditions: 1) the share of FDI increased more in the *encouraged industries* than in the *no-change industries* upon China's accession to the WTO (or the relevance condition); and 2) variations across industries in the changes in FDI regulations upon China's WTO accession do not affect our outcomes through channels other than the share of FDI (or the exclusion restriction condition). Although the relevance condition can be confirmed by the significance of η in equation (2),[8] the exclusion restriction requires further discussion.

The exclusion restriction means that conditional on all the controls, our instrumental variable ($Treatment_i \times Post02_t$) is uncorrelated with the error term (ε_{fit}) in equation (1), i.e., $cov\left(Treatment_i \times Post02_t, \varepsilon_{fit} | \mathbf{W}_{fit}\right) = 0$ where $\mathbf{W}_{fit}$ summates all of the controls in the regression. There are only two possible sources of violation of this identifying assumption; that is, $cov\left(Post02_t, \varepsilon_{fit} | \mathbf{W}_{fit}\right) \neq 0$ and $cov\left(Treatment_i, \varepsilon_{fit} | \mathbf{W}_{fit}\right) \neq 0$. We examine these two possible estimation biases in sequence.

Estimation bias due to the nonrandom treatment timing. The possible correlation between the post-treatment period indicator ($Post02_t$) and the second-stage error term (ε_{fit}) arises when the timing of the FDI deregulation was nonrandom. Note that we have included year fixed effects in all the analyses, which removes all the difference across years. Hence, this nonrandom selection of timing would have biased our estimates if the Chinese government had chosen to change the FDI regulations in 2002 in anticipation of the treatment and control industries becoming different at that moment.

[7] $Post02_t$ is 3/4 for 2002, as the Catalogue 2002 was implemented on April 1, 2002. The results (available upon request) remain robust when $Post02_t$ equals 1 for 2002.

[8] One issue with the relevance condition is the weak instrument problem. To alleviate this concern, we further report the Anderson-Rubin Wald test and the Stock-Wright LM S statistic, which offer reliable statistical inferences in a weak instrument setting (Anderson and Rubin, 1949; Stock and Wright, 2000; Baum, Schaffer, and Stillman, 2003).

However, as discussed in Section 2.1, the FDI deregulation in 2002 was part of the requirements of China's WTO accession, the negotiation of which was very lengthy and rather uncertain prior to 2001. First, it took more than 15 years of exhaustive negotiations with the 150 WTO member countries for China to join the WTO. Second, although China signed a breakthrough agreement with the United States in November 1999 and an agreement with the European Union in May 2000, several remaining issues, such as farm subsidies, were still unresolved in mid-2001. To check quantitatively whether there was any anticipation of China's WTO accession by the end of 2001, we conduct a placebo test following Topalova (2010). Specifically, we use the pre-treatment sample (i.e., 1998-2001), and assign 1999, 2000, and 2001 as the time of treatment, respectively. Given that no real treatment happened in this sample period, any significant differences between the treatment and control groups around the hypothetical time of treatment (1999, 2000, or 2001) would indicate the possible expectation effect.

Another issue associated with the timing is that other policy reforms that were ongoing at the time of China's WTO accession might affect our outcomes, leading to biased estimates of the spillover effect of FDI on domestic firms. One important policy reform in the early 2000s was the restructuring and privatization of SOEs. To control for the possibility that the extent of SOE restructuring and privatization differed across industries and affected our outcomes, we add the interaction between year dummies and industry SOE share in 2001 into $\mathbf{X}_{fit}$. Furthermore, at the same time as China's WTO accession, there were substantial tariff reductions by China and its trading partners, which affected the use of imported inputs and access to export markets. To condition out the tariff reduction effects, we include the interactions between the year dummies and various tariffs (specifically, China's output and input tariffs, and its export tariffs) in 2001 in $\mathbf{X}_{fit}$.[9]

Estimation bias due to the nonrandom selection of the treatment group. The possible correlation between the treatment status ($Treatment_i$) and the second-stage error term (ε_{fit}) means that our treatment and control groups are not comparable. For example, the selection of which industries to open up to FDI upon the WTO accession was not random; hence, the *encouraged industries* and the *no-change industries* could have been experiencing different trends before the WTO accession, and these differences might have generated differential

[9] The tariff data for Harmonized System (HS-6) products are obtained from the World Integrated Trade Solution (WITS). By mapping HS-6 products to four-digit ASIF industries through the concordance table from the National Bureau of Statistics of China, we can calculate the simple average output tariff at the industry level. The input tariff is constructed as a weighted average of the output tariff, using as the weight the share of the inputs in the output value from China's 2002 Input-Output Table. The export tariff is measured as a weighted average of the destination country's tariffs on China's imports, using China's imports by each destination country as the weight.

trends in our outcomes across the two types of industries in the post-WTO period.

To alleviate this identification concern, we first control for time-varying firm characteristics to balance firms in different industries. Specifically, we include, in $\mathbf{X}_{fit}$, firm output, firm capital-labor ratio, a dummy variable indicating if a firm is an exporter, and a dummy variable indicating whether a firm is a SOE. Then, we conduct an analysis following Gentzkow (2006). Specifically, we first carefully characterize the potential determinants $\mathbf{Z}_{i1998}$ of the changes in FDI regulations upon the WTO accession. As shown in Online Appendix A and Online Appendix Table A2, four determinants are identified at the four-digit industry level: new product intensity, export intensity, number of firms, and average age of firms. We then add interactions between γ_t and $\mathbf{Z}_{i1998}$ in $\mathbf{X}_{fit}$ to control flexibly for post-WTO differences in the time path of the outcomes that are caused by the endogenous selection of industries for changes in FDI regulations.[10]

Meanwhile, China has a unique trading regime, namely, processing trading, which allows some firms to import intermediate inputs duty-free if they export all of their outputs. If the extent of processing trading changed discontinuously upon China's WTO accession and across industries, our estimates of the spillover effect of FDI could simply reflect the changes in this trading regime. To address this estimation concern, we first match the ASIF data to China's Customs data to identify processing traders, and then exclude these firms from the regression sample.[11]

Along with its economic reform in the past decades, China has set up special economic zones to attract foreign investment with favorable policies. If our treatment and control industries were differentially distributed in these special economic zones and policies in these zones changed at the time of the FDI deregulation, our estimates of the spillover effect of FDI may capture the zone effects. To address this concern, we first carefully examined the 2002 Catalogue as well as other FDI policies issued in 2002, and did not find any changes regarding the regional aspects of FDI entry regulations. Actually, on May 4, 1997, the State Council issued "the Termination of Unauthorized Local Examination and Approval of Commercial Enterprises with Foreign Investment," which forbids the location discretions in FDI entry regulations. Further, to alleviate the concern about special economic zones, we include an additional control, the share of industry output from the special economic zones, to isolate the effect of our main variable of interest.

[10] While in the baseline model we measure these determinants in 1998, we also experiment with measures in 2001.

[11] The ASIF data set and the Customs data set use different coding systems of firm identification. To identify processing traders in the ASIF data, we gather as much information as possible from the firm's name, location code, the name of the legal person, phone number, and so on to find a match in the Customs data set, which has information about the types of exporters (including processing traders).

A placebo test. We formalize the identification issues and carry out a placebo test. We decompose the error term into two parts: $\varepsilon_{fit} = \beta\omega_{fit} + \tilde{\varepsilon}_{fit}$, such that

$$\begin{aligned} cov\left(Treatment_i \times Post02_t, \omega_{fit} | \mathbf{W}_{fit}\right) &\neq 0, \\ \text{and } cov\left(Treatment_i \times Post02_t, \tilde{\varepsilon}_{fit} | \mathbf{W}_{fit}\right) &= 0. \end{aligned}$$

In other words, all of the identification issues come from the omitted variable ω_{fit}. Hence, our estimator $\hat{\delta}$ is

$$\hat{\delta} = \delta + \beta\gamma, \tag{3}$$

where $\gamma \equiv \frac{cov\left(Treatment_i \times Post02_t, \omega_{fit} | \mathbf{W}_{fit}\right)}{cov\left(Treatment_i \times Post02_t, FDI\_Sector_{it} | \mathbf{W}_{fit}\right)}$. And $\hat{\delta} \neq \delta$ if $\beta\gamma \neq 0$. To check whether our results are biased due to the omitted variable ω_{fit}, we conduct a placebo test by randomly generating the industry and time variations in the changes in FDI entry regulations. Specifically, we first randomly select 112 industries from the total 412 industries in the regression sample and assign them to the category of *(FDI) encouraged industries*; then, we randomly choose a year from 1999 to 2006 (to make sure we have at least one year before the treatment and one year after the treatment for our DID analysis) as the year of the WTO accession; finally, we construct a *false* instrumental variable from these two randomizations, i.e., $Treatment_i^{false} \times Post_t^{false}$. The randomization ensures that $Treatment_i^{false} \times Post_t^{false}$ should have no effect on FDI inflows (i.e., $\eta^{false} = 0$) and hence the regression of our outcome directly on $Treatment_i^{false} \times Post_t^{false}$ should produce zero effect; otherwise, it indicates the existence of the omitted variable ω_{fit}.[12] We conduct this random data generating process 500 times to avoid contamination by any rare events and to improve the power of the test.

3 Effect of FDI on Firm Productivity

3.1 Graphical Results

We start with total factor productivity (TFP) as a measure of firm performance for our investigation, as it is the most widely used indicator in the literature. We use the control function approach developed by Ackerberg, Caves, and Frazer (2015) to estimate the production function for each of the 29 two-digit industries, and then calculate the TFP for each firm and each year. The details of the production function estimation are provided in Appendix B. For robustness checks, we also experiment with the TFP estimation procedures developed by Olley and Pakes (1996) and Levinsohn and Petrin (2003).

[12] Note that we cannot perform an instrumental variable estimation for this placebo test, as the instrument does not have the predictive power in the first stage.

Table 3, panel A, summarizes the average TFP in 29 two-digit industries for the pre-WTO period (i.e., 1998-2001), the post-WTO period (2002-2007), and their differences. A majority of industries experienced an increase in their average productivity after China joined the WTO. The top three TFP-improving industries are Timber Processing, Bamboo, Cane, Palm Fiber & Straw Products industry (an 86.33 percent increase); Leather, Furs, Down & Related Products industry (a 50.25 percent increase); and Furniture Manufacturing industry (a 42.6 percent increase), in which China has comparative advantage. There are also several industries experiencing declines in TFP after the WTO accession, for example, the Special Purpose Equipment industry, Petroleum Processing & Coking industry, and Smelting & Pressing of Nonferrous Metals industry, in which China mostly has comparative disadvantage.

[Insert Table 3 here]

Panel B in Table 3 compares the changes in TFP before and after the WTO accession for the treatment and control groups, respectively. There is no significant increase in TFP for the treatment industries (i.e., industries in which FDI was encouraged), whereas the control industries (i.e., industries without any changes in FDI entry regulation) experienced a significant increase in TFP.

Figure 2 further shows the differences in TFP changes between the treatment and control groups over time, by plotting a set of estimated coefficients from the regression of TFP on $Treatment_i \times \gamma_t$ along with all of the controls in equation (1). The treatment and control groups were balanced in TFP in the pre-WTO period, indicating a good comparability between our treatment and control groups conditional on our selected controls. However, in the post-WTO period, the treatment group experienced a gradual and persistent decline in TFP compared with the control group, indicating that the relaxation of FDI regulations had a negative effect on firm productivity in the treatment group.

[Insert Figure 2 here]

3.2 Main Results

The instrumental variable estimation results are reported in Table 4, with the first-stage estimates in panel A and the second-stage estimates in panel B. In addition to firm and year fixed effects, we stepwisely include interactions between year dummies and determinants of changes in FDI regulations, interactions between year dummies and tariff reductions, interactions between year dummies and SOE share, and time-varying firm characteristics in columns 1–3. The inclusion of these additional controls allows us to isolate the effect of FDI

spillovers from other confounding factors, such as the endogenous selection of industries for changes in FDI regulations upon the WTO accession and other ongoing policy reforms (SOE reform and tariff reduction) occurring around the same period.[13]

[Insert Table 4 here]

Our instrument $Treatment_i \times Post02_t$ has a positive and statistically significant effect on FDI_Sector_{it}, confirming the argument that the relaxation of FDI regulations triggered inflows of FDI in the post-WTO period and hence the relevance of the instrument.

With respect to our central research focus, we find that, after being instrumented, FDI_Sector_{it} consistently casts a negative and statistically significant effect on firm productivity. These results further confirm the findings in the literature (e.g., Aitken and Harrison, 1999; Konings, 2001) that the presence of FDI in the same industry hurts the productivity levels of domestic firms.

We further report the reduced-form estimation results (i.e., the regression of outcome directly on the instrumental variable along with the same set of controls) in column 4. The estimated coefficient of the instrumental variable is negative and statistically significant, which is consistent with our aforementioned findings and further confirms the relevance of our instrument.

For ease of comparison, we also report the OLS estimation results (i.e., FDI_Sector_{it} without being instrumented) in column 5. Again, we find consistent results: FDI_Sector_{it} is negative and statistically significant. The small magnitude, compared with the IV estimates in column 3, may reflect the issues of omitted variables and measurement errors.

Economic magnitude. To calculate the magnitude of the effect, we rely on the estimate in column 3 in Table 4. We find that if the output-weighted share of FDI in an industry increases by 10%, the average logarithm of the TFP of domestic firms in that industry drops by $0.1 \times 3.407 = 0.3407$, or 34% of the sample mean. This magnitude is much larger than the OLS estimates in the literature (e.g., 0.0267 by Aitken and Harrison, 1999; 0.067 by Konings, 2001; 0.0106 by Lin, Liu, and Zhang, 2009). These results suggest that the OLS estimator is downward biased, possibly due to some omitted variables bias and/or measurement errors in the panel data framework.

[13] As another check, we directly examine whether the presence of FDI affects the privatization of SOEs in China. We first investigate whether the presence of FDI reduces the degree of state ownership. The estimation results in column 1 in Online Appendix Table A3 show that the coefficient of FDI sector is negative albeit statistically insignificant, indicating that the privatization of SOEs is unrelated to the presence of FDI. Second, we check whether the increase in FDI caused by the deregulation went into SOEs or not. To this end, we compare the foreign equity share in SOEs in the treatment and control groups. The estimation results, reported in column 2, show a negative and statistically insignificant effect.

To gain further insights into the economic significance of our estimate, we conduct the following exercise. Note that from 1998 to 2007, the average output-weighted share of FDI increases from 0.2062 to 0.2595. According to our estimate, this increase of FDI share reduces the average logarithm of the TFP of domestic firms by $(0.2595 - 0.2062) \times 3.407 = 0.1816$ during this period. Meanwhile, the overall average logarithm of the TFP of domestic firms increases from 0.90 to 1.14. Hence, if we set the output-weighted share of FDI in 2007 to be the same as in 1998, the average logarithm of the TFP of domestic firms increases a further $0.1816/1.14 = 15.93\%$ from 1998 to 2007.

3.3 Robustness Checks

We provide a battery of robustness checks on our aforementioned results to address various estimation issues.

Nonlinear FDI spillover effect. We model a linear effect of the FDI presence as commonly used in the literature. However, as shown in Barrios, Gorg, and Strobl (2005), the effect of the presence of FDI could be nonlinear. To examine this possibility, we include a squared term in the regression. The estimation results shown in column 1 in Table 5 confirm the existence of the nonlinear effect, consistent with Barrios, Gorg, and Strobl (2005). Specifically, the FDI spillovers become negative after the foreign share is larger than 31 percent.

[Insert Table 5 here]

Exclusion of exports in the construction of the FDI presence variable. The construction of our regressor of interest, FDI_Sector_{it}, uses firms' total output. This may overestimate the presence of FDI, as foreign multinationals export a large portion of their output. To check whether our results are biased because of this measurement issue, we re-do the analysis with the exclusion of exports in the FDI presence measure. The estimation results are reported in column 2 in Table 5. We continue to find a negative and statistically significant effect. And the magnitude becomes even larger. This is consistent with the competition explanation we explore in the next section: foreign multinationals bring positive agglomeration effects, but also cast negative competition effects in the Chinese markets. The negative competition effect from foreign multinationals gets softened with exports; and this explains the larger negative spillover effects when we exclude exports in the construction of the FDI presence variable.

Composition of foreign multinationals. Foreign multinationals established after the changes in the FDI entry regulations could be in different forms (more specifically, wholly owned

versus joint venture) than those incumbents, generating a possible composition effect. To address this issue, we first examine whether new and old multinationals were different. As shown in Online Appendix Table A4, multinationals set up after 2002 were more likely to be wholly-owned than those before 2002, suggesting the possible existence of a composition effect. To condition out this composition effect, we include the percentage of wholly-owned multinationals in all foreign multinationals as an additional control. The estimation results reported in column 3 in Table 5 show that this additional control is statistically insignificant but our regressor of interest (FDI_Sector_{it}) barely changes in its significance and magnitude. These results suggest that our findings are not driven by the composition but the level of the FDI presence.

Nonlinearity of the first-stage outcome. Our first-stage outcome, FDI_Sector_{it}, is bounded between 0 and 1, but is treated as linear in the standard IV regression. To address the possible bias from this misspecification, we conduct a check using the method developed by Angrist (2001). In the first step, a Tobit model is used to estimate equation (2), and the fitted value is obtained. Second, we use the fitted value as an instrument for the first-stage outcome, and conduct a standard IV regression. The estimation results are reported in column 4 in Table 5. We still find a negative and statistically significant effect of the FDI presence, suggesting that our results are not biased by the nonlinear outcome in the first stage.

Alternative values of determinants. In the analyses, to control for the possible nonrandom selection of the treatment and control groups, we include interactions between year dummies (γ_t) and determinants of treatment selection (Z_{i1998}) measured in 1998. For robustness checks, we experiment with the measurement using 2001 values (Z_{i2001}). The results shown in column 5 in Table 5 suggest that our findings are robust to these alternative values of treatment selection determinants.

Exclusion of processing traders. In column 6 of Table 5, we exclude processing traders from our sample to alleviate the concern that our findings may be driven by changes in the trading regime upon China's accession to the WTO. Clearly, our estimates barely change in statistical significance and magnitude, suggesting that a possible change in the trading regime is not the main driver of our findings.

Placebo test with random assignment of treatment. As discussed in Section 2.4, we conduct a placebo test by randomly assigning the timing and the direction of changes in FDI regulations to industries. Figure 3 shows the distribution of the estimates from the 500 randomized assignments. We find that the distribution of these estimates is centered around

zero (mean value of 0.0004), with a standard deviation of 0.0179. Our true estimate (i.e., -0.048), however, lies beyond the 95 percentile of the 500 estimates. Combined, these observations suggest that the negative and significant effect of FDI on the productivity of domestic firms in the same industry is unlikely to be driven by unobserved factors.

[Insert Figure 3 here]

Controlling for the special economic zone effect. To examine whether our findings can be explained by the special economic zones that China set up to attract FDI, we first carefully examined the 2002 Catalogue and other FDI policies issued in 2002, and did not find any changes regarding the regional aspects of FDI entry regulations. We then include the percentage of industrial output from the special economic zones as a control to isolate the effect of the FDI presence. The results reported in column 7 in Table 5 show that adding this control barely changes our main results; that is, FDI_Sector_{it} remains negative and statistically significant. These results suggest that our findings do not come from the special economic zone effect.

Alternative measurement of TFP. In the baseline analysis, we use Ackerberg, Caves, and Frazer's (2015) method to estimate firm productivity. To check whether our results are sensitive to this method, we use two alternative TFP estimation methods, i.e., one developed by Olley and Pakes (1996) and the other by Levinson and Petrin (2003). The estimation results are reported in columns 8-9 in Table 5. We find a consistent message; that is, FDI_Sector_{it} is negative and statistically significant, suggesting that our findings are not driven by a particular method of TFP estimation.

Expectation effect. To examine whether the deregulation of FDI entry (or the WTO accession) in 2002 was expected, we conduct a placebo test following the method by Topalova (2010). Specifically, in Online Appendix Table A5, we use the pre-treatment sample, and alternatively use 1999, 2000, and 2001 as the fake treatment timing. These essentially allow us to compare the treatment and control groups in various periods before the treatment. All the estimates are statistically insignificant and small in magnitude. These results indicate that the treatment and control groups remain comparable in all the pre-treatment periods, implying no expectation effect.

4 How to Explain Negative FDI Spillovers

The previous section establishes that FDI causes a negative spillover effect on the productivity of domestic firms in the same industry. In this section, we explore the relevance of two hypotheses that are widely used to explain the negative FDI spillover effect.

4.1 Agglomeration versus Competition

Aitken and Harrison (1999) provide a framework for understanding the negative spillover effect of FDI on domestic firms. They argue that domestic firms can benefit from nearby foreign multinationals through knowledge spillovers (such as imitation of foreign multinationals' technologies, management practices, and market orientation), labor pooling (such as recruitment of employees who have had working experience at those foreign multinationals), and supply of specialized inputs (for example, obtaining quality inputs from suppliers of foreign multinationals). Such a positive effect is usually referred to in the international and urban economics literature as the agglomeration effect. However, domestic firms may lose market share to the generally more productive foreign multinationals, and consequently experience a fall in firm productivity due to diminishing scale economies. Such a negative effect is often referred to as the competition effect.

To understand how the competition and agglomeration effects determine the overall FDI spillovers on domestic firms, we explore variations along with different dimensions of FDI, and examine scenarios under which these two underlying effects have different relative strengths, leading to possibly different overall FDI spillovers.

4.1.1 Horizontal vs. Vertical FDI

Javorcik (2004) demonstrates the importance of upstream and downstream linkages as potential channels for FDI to have positive effects on domestic firms.[14] Intuitively, we do not expect any direct competition between domestic firms and foreign multinationals that are located in different vertical stages of the same production chain, and such foreign multinationals have more incentives to educate their domestic clients or suppliers. In other words, the agglomeration effect might dominate the competition effect for FDI located in either upstream or downstream industries.

[14] This finding is further confirmed by papers using data from different countries, such as Bwalya (2006) for Zambia; Kugler (2006) for Colombia; Blalock and Gertler (2008) for Indonesia; Barrios, Görg, and Strobl (2011) for Ireland; Liu (2008), Lin, Liu, and Zhang (2009), and Du, Harrison, and Jefferson (2012) for China; and Damijan, Rojec, Majcen, and Knell (2013) and Gorodnichenko, Svejnar, and Terrell (2014) for several emerging and transition economies.

To test this prediction, we follow Javorcik (2004) in constructing a domestic firm's backward and forward FDI_Sector. Specifically, for domestic firm f in sector s in year t, its backward FDI_Sector is

$$FDI\_Sector_{st}^{backward} = \sum_{k \text{ if } k \neq s} \alpha_{sk} \times FDI\_Sector_{kt},$$

where α_{sk} is the ratio of sector s's output supplied to sector k (information compiled from China's 2002 Input–Output Table).[15] Its forward FDI_Sector is

$$FDI\_Sector_{st}^{forward} = \sum_{m \text{ if } m \neq s} \beta_{sm} \times \frac{\sum_{j \in \Omega_{mt}} FDI\_Firm_{jt} \times (Output_{jt} - EX_{jt})}{\sum_{j \in \Omega_{mt}} (Output_{jt} - EX_{jt})},$$

where EX_{jt} is firm j's export at time t; $Output_{jt} - EX_{jt}$ is the size of firm j' output for domestic market; and β_{sm} is the ratio of inputs purchased by sector s from sector m.[16]

Accordingly, the instruments for FDI_Sector_{st}, $FDI\_Sector_{st}^{backward}$, and $FDI\_Sector_{st}^{forward}$ are $Treatment_s \times Post02_t$, $\sum_{k \text{ if } k \neq s} \alpha_{sk} \times Treatment_k \times Post02_t$, and $\sum_{m \text{ if } m \neq s} \beta_{sm} \times Treatment_m \times Post02_t$, respectively.

The second-stage results of the instrumental variable estimation are shown in column 1 in Table 6, while the results from the three first stages are presented in Online Appendix Table A6, panel A. The effect of horizontal FDI on firm productivity remains negative and significant. Interestingly, we find that the effects of both backward and forward FDI on firm productivity are positive and statistically significant. These results are consistent with the findings in the literature (e.g., Javorcik 2004) and confirm the argument that the agglomeration effect dominates the competition effect for FDI located in either upstream or downstream industries.

[Insert Table 6 here]

Barrios, Görg, and Strobl (2011) argue that the measure of backward linkage using α_{sk} from the host country's input-output table in Javorcik (2004) hinges on three underlying assumptions. First, foreign firms use locally produced inputs in the same proportion as imported inputs. Second, foreign firms have input sourcing behavior identical to that of domestic firms, and foreign firms from different countries have the same input sourcing

[15] α_{sk} is calculated by excluding the products supplied for final consumption and the imports of intermediate products.

[16] The industries in the ASIF data are more disaggregated than the sectors in China's Input-Output (or IO) Table. Hence, we compile a concordance table to link four-digit industries in the ASIF data with IO sectors, and to measure the extent of FDI, i.e., horizontal, backward, and forward FDI, at the broad level of IO sectors.

behavior. Third, foreign firms' demand for domestically produced inputs is proportional to the share of locally produced output.

Barrios, Görg, and Strobl (2011) argue that these assumptions may not be valid in practice. They relax the three assumptions as follows. For the first assumption, they measure α_{sk} using domestically sourced inputs α_{sk}^{NIMP} (where $NIMP$ refers to no imported inputs). To deal with the second assumption, they use input-output tables from various countries other than that of the domestic country, by allowing that the extent of input sourcing behavior varies across foreign countries. To relax the third assumption, they use data on foreign firms' input sourcing from domestic firms, that is, replacing the output-weighted FDI share with the ratio of locally sourced to total inputs by foreign firms.

For the measure of forward FDI, only the first and third assumptions are relevant. The first assumption can be relaxed by calculating β_{sm} exclusive of imported inputs, i.e., β_{sm}^{NIMP}. Barrios, Görg, and Strobl (2011) cannot directly test the validity of the third assumption because of missing data on domestic firms' input sourcing from foreign firms.

As a robustness check, we follow closely Barrios, Görg, and Strobl's (2011) method. Specifically, we calculate input-output coefficients using locally sourced inputs only, i.e., α_{sk}^{NIMP} for backward FDI, and β_{sm}^{NIMP} for forward FDI. However, because of the data limitation, we cannot perform the second and third adjustments.[17] The estimation results are reported in column 10 in Table 5. We find consistent results, suggesting that our findings are not driven by the assumptions used by Javorcik (2004) in the vertical FDI construction.

4.1.2 Local vs. Non-Local FDI

The competition and agglomeration effects of FDI exhibit different degrees of attenuation with distance. The agglomeration effect operates through knowledge spillovers and labor pooling, which are more likely to be captured by domestic firms located near foreign multinationals (for a recent literature review, see Audretsch and Feldman (2004)). In contrast, product markets are generally integrated within a country, and thus the competition effect does not decrease substantially with distance (for a recent literature review, see Taylor and Taylor (2004)). As the positive agglomeration effect is relatively more localized than the negative competition effect, it is expected that domestic firms benefit from foreign multinationals in the same industry that are located nearby, but may suffer from FDI located

[17]The second and third assumptions cannot be tested because of data limitations. First, the industry classification of Chinese firm-level data is more disaggregated than that of world input-output tables. The usage of aggregated industry-level classification makes almost no variations between the treatment group and the control group. Second, data on input sourcing by foreign firms from domestic firms are not available. Third, similar to Barrios, Görg, and Strobl (2011), data on input sourcing by domestic firms from foreign firms are unavailable in our data.

in more distant areas. This argument has been supported in previous studies, including Sjöholm (1999), Bwalya (2006), Halpern and Muraközy (2007), and Xu and Sheng (2012).

To test this prediction, we divide the extent of FDI in an industry into two parts: the extent of FDI located in the same city as the concerned domestic firm, and the extent of FDI located outside the city. Specifically,

$$\begin{aligned} FDI\_Sector\_Local_{it} &= \frac{\sum_{f\in\Omega_{ict}} FDI\_Firm_{fict} \times Output_{fict}}{\sum_{f\in\Omega_{ict}} Output_{fict}} \\ FDI\_Sector\_Non\text{-}Local_{it} &= \frac{\sum_{f\in\Omega_{it}} FDI\_Firm_{fit} \times Output_{fit}}{\sum_{f\in\Omega_{it}} Output_{fit} - \sum_{f\in\Omega_{ict}} Output_{fict}} \\ &\quad - \frac{\sum_{f\in\Omega_{ict}} FDI\_Firm_{fict} \times Output_{fict}}{\sum_{f\in\Omega_{it}} Output_{fit} - \sum_{f\in\Omega_{ict}} Output_{fict}}, \end{aligned}$$

where c denotes city. The instrumental variable for $FDI\_Sector\_Local_{it}$ is constructed as $\frac{Output_{ic2001}\times Treatment_i\times Post02_t}{\sum_i Output_{ic2001}}$, reflecting the localized effect of the policy shock, whereas the instrument for $FDI\_Sector\_Non\text{-}Local_{it}$ is constructed as

$$\frac{(\sum_c Output_{ic2001} \times Treatment_i \times Post02_t) - Output_{ic2001} \times Treatment_i \times Post02_t}{\sum_i \sum_c Output_{ic2001} - \sum_i Output_{ic2001}},$$

capturing the non-localized effect of the policy shock. Here, $Output_{ic2001}$ is the total output of industry i in city c in 2001.

The second-stage results of the instrumental variable estimation are shown in column 2 in Table 6, while the results from the two first stages are presented in Online Appendix Table A6, panel B. The productivity effect of FDI located in the same city is positive and statistically significant, whereas the productivity effect of FDI located outside the city remains negative and statistically significant. These results confirm our argument that the two opposite effects of FDI have different degrees of attenuation with distance, and that domestic firms are likely to benefit from horizontal FDI located nearby but to suffer from horizontal FDI located in more distant areas.

4.1.3 FDI from Developed Countries vs. Developing Countries

Foreign multinationals come from different countries with different technologies and know-how, and present different trade-offs to China's domestic firms. For example, FIEs from developing countries with a similar or even a lower level of economic development than China may not possess any advanced technology or sophisticated know-how from which

China's domestic firms can benefit. At the same time, these FIEs might not be competitive enough to grab significant market shares from domestic firms. In contrast, FDI coming from developed countries is expected to generate a significant agglomeration effect; but precisely because of their latest technology and advanced know-how, FIEs from developed countries are in an ideal position to steal market share away from China's domestic firms, as can be seen in many industries (for example, the automobile industry). Hence, the examination of possibly differential effects of FDI from developing and developed countries can reveal the interaction between the negative competition effect and positive agglomeration effect from FDI.[18]

To this end, we decompose the extent of FDI (FDI_Sector_{it}) in industry i at year t into two components: the extent of FDI from developed countries ($FDI\_Sector\_Developed_{it}$) and the extent of FDI from developing countries ($FDI\_Sector\_Developing_{it}$).[19] Specifically,

$$\begin{aligned} FDI\_Sector\_Developed_{it} &= \frac{\sum_{f\in\Omega_{it}} FDI\_Firm\_Developed_{fi2001} \times Output_{fit}}{\sum_{f\in\Omega_{it}} Output_{fit}} \\ FDI\_Sector\_Developing_{it} &= \frac{\sum_{f\in\Omega_{it}} FDI\_Firm\_Developing_{fi2001} \times Output_{fit}}{\sum_{f\in\Omega_{it}} Output_{fit}}, \end{aligned}$$

where $FDI\_Firm\_Developed_{fi2001}$ and $FDI\_Firm\_Developing_{fi2001}$ are the foreign equity of firm f of industry i in 2001 from developed and developing countries, respectively.

Given that we have two potentially endogenous regressors of interest in the estimation, we need two instruments for their identification. The first regressor of interest reflects the variations in the extent of FDI from developed countries across industries, and the second regressor of interest captures the variations in the extent of FDI from developing countries across industries. Although the relaxation of FDI regulations upon China's WTO accession is uniform for developed and developing countries, the effects on FDI from the two different groups of countries could be different because of pre-existing conditions. To this end, we construct two instruments for $FDI\_Sector\_Developed_{it}$ and $FDI\_Sector\_Developing_{it}$: $Treatment_i \times Post02_t$ and $Treatment_i \times Indicator_{i2001} \times Post02_t$, where $Indicator_{i2001}$ equals 1 if industry i's foreign equity share from developed countries is above its median level in

[18] In a similar vein, Javorcik and Spatareanu (2011) study whether foreign investors from different countries (Europe versus North America) generate different spillovers to domestic suppliers, based on the argument that the share of local sourcing is affected by the geographic distance between the host and source countries of FDI and preferential trade agreements.

[19] The Ministry of Commerce Foreign Invested Firms Survey (FIFS) contains information on the country of origin of foreign firms. We use firm name and contact information to merge the FIFS country of origin data with the ASIF data, and classify countries into developed countries (i.e., high-income Organisation for Economic Co-operation and Development members) and developing countries.

2001.

The second-stage results of the instrumental variable estimation are reported in column 3 in Table 6, while the results from the two first stages are presented in Online Appendix Table A6, panel C. Although both are statistically significant, the negative productivity effect of FDI from developed countries is stronger than that from developing countries. These results suggest that the negative competition effect is more dominant relative to the agglomeration effect for FDI from developed countries than for FDI from developing countries.

4.1.4 Static vs. Dynamic Effects

Kosová (2010) argues that the competition effect could be a short-term effect, whereas the agglomeration effect may take time to become effective; in this case, the spillover effect of FDI on domestic firms could become positive in the growth rate estimations. Using firm-level data from the Czech Republic for the 1994 to 2001 period, she finds that growing foreign sales increases domestic firms' growth. This dynamic positive effect of FDI on domestic firms is also found by Liu (2008) and Merlevede, Schoors, and Spatareanu (2014).

Following this line of research, we investigate whether the presence of foreign multinationals has a positive effect on the growth rate of firm productivity (measured as difference in firm productivity between t and $t+1$). The second-stage results of the instrumental variable estimation are shown in column 4 in Table 6, while the first-stage results are presented in Online Appendix Table A6, panel D. We indeed find a positive effect of FDI on the productivity growth rate of domestic firms in the same industry, consistent with the findings in the literature. In Online Appendix Table A7, we conduct two further experiments. First, we examine the dynamic effect using the difference in firm productivity between $t-1$ and t as the outcome and one-year lagged FDI presence as the regressor of interest along with the same set of controls. We find similar results in column 1 to those obtained by difference in productivity between t and $t+1$ (column 4 in Table 6). Second, instead of examining the one-year dynamics, we examine a three-year effect (i.e., the difference in firm productivity between t and $t+3$; the longest difference in our data). Estimates are reported in column 2. We find a larger effect, suggesting that with longer time of accumulation, the positive dynamic effect becomes larger.

To understand the contrasting results from the level equation and the growth equation, we include lags of FDI presence in the analysis. The estimation results are reported in Online Appendix Table A8. We find that the estimated coefficient of the contemporary FDI presence is -2.602. It drops to -1.956 for the one-year lagged FDI presence, and further to -1.11 for the two-years and three-years lagged FDI presence. These results suggest that the negative effect of the presence of foreign multinationals diminishes over time, but still

persists even after three years. This explains the positive findings in the growth equation, as the outcome is the difference between current TFP and next period's. Presumably it takes time for domestic firms to learn from foreign multinationals. It is also possible that the damages caused by foreign multinationals (loss of market share) dissipate over time, as consumers may switch back to domestic brands. Detailed firm-level data are required to disentangle these two possible explanations, which is beyond the scope of this study.

4.2 Absorptive Capacity

Our analysis in Section 4.1 focuses on how various types of FDI differentially affect the agglomeration effect and competition effect, and hence the overall spillover effect of FDI on domestic firms. In this subsection we examine how the absorptive capacity of domestic firms may affect the FDI spillover effect.

Kokko (1994), using cross-sectional industry-level data from Mexico, tests the idea that FDI spillovers on domestic firms depend on the technological distance between the foreign multinationals and the domestic firms. The hypothesis that the degree of FDI spillover hinges on the absorptive capacity of domestic firms has been further explored in the literature. For example, Blalock and Gertler (2009), using a panel data set of Indonesian manufacturing firms for the 1988 to 1996 period, find that firms with more R&D investment benefit more from the presence of foreign multinationals. Lin, Liu, and Zhang (2009) find that the negative effect of FDI on firm productivity is smaller for Chinese SOEs than for domestic non-SOEs, presumably because SOEs in China are better endowed and more capable of absorbing technology and know-how from foreign multinationals than their privately-owned counterparts.

To investigate the role of absorptive capacity in explaining the negative effect of FDI on domestic firms, we further conduct two exercises: 1) we investigate whether the FDI spillovers differ across firms with different R&D investments; and 2) we examine any differential FDI effects across firms with different ownership structures (i.e., SOEs vs. non-SOEs). We use the changes in FDI regulations at the end of 2001 to instrument the presence of foreign multinationals. To mitigate the estimation bias that may occur because those changes in FDI regulations in turn affected firms' R&D decisions and ownership structure, we measure the R&D investment ratio and ownership structure using information from 2001, one year before the changes in FDI regulations. The second-stage estimation results are reported in Table 7, and the first-stage results are presented in Online Appendix Table A6, panels E and F.

[Insert Table 7 here]

R&D investment. In column 1, we present the instrumental variable estimation results

for whether the FDI spillovers differ across firms with different ratios of R&D investment over total output (denoted by $R\&D\ Intensity$) in 2001. The single term of FDI_Sector_{it} is still negative and statistically significant, but the interaction between FDI_Sector_{it} and $R\&D\ Intensity$ is small in magnitude and statistically insignificant. These results imply that foreign multinationals have a negative effect on firms without R&D investment, but this negative effect does not improve much for firms that have R&D investment.

Ownership structure. We further investigate whether the FDI spillovers differ between SOEs and other domestic non-SOEs in China; the results are shown in column 2. The presence of foreign multinationals has negative and statistically significant effects on both SOEs and domestic non-SOEs, with the difference between these two groups small in magnitude albeit statistically significant.

Taken together, these results suggest that the differences across firms in their absorptive capacity (proxied by R&D intensity and ownership structure) have a limited role in attenuating the negative FDI spillover effects in the setting of China.

5 Other Measures of Firm Performance

The above analyses focus on productivity as the measurement of firm performance. It is possible that domestic firms could benefit from the presence of foreign multinationals in aspects other than production efficiency. In this section, we consider some of the other measures of firm performance used in the studies of FDI spillovers. The second-stage results of the instrumental variable estimation are presented in Table 8, and the first-stage estimation results are available upon request.

[Insert Table 8 here]

Exporting performance. We examine whether the presence of foreign multinationals helps domestic firms in the same industry to export. Presumably, domestic firms could obtain information about the international market from foreign multinationals, thus reducing the entry barriers to the international market. Indeed, Aitken, Hanson, and Harrison (1997) find, using plant-level cross-sectional data from Mexican manufacturing industries, that the export activities of foreign multinationals increase the probability of exporting by domestic firms in the same industry. This finding is further confirmed by other studies, such as Barrios, Görg, and Strobl (2003), Greenaway, Sousa, and Wakelin (2004), and Banga (2006).

Following this line of research, we look at two measures of exporting performance: the probability of exporting and exporting intensity. The regression results are shown in columns

1-2. Domestic firms do not have either a higher probability of exporting or a greater exporting intensity when there are more foreign multinationals in the same industry. These results are in sharp contrast to the findings reported by studies using the OLS estimations, and indicate that export activities may not be an alternative channel for domestic firms to benefit from the presence of multinationals.

Wage rate. Next, we investigate the FDI effect on the wage rate of domestic firms. The premise is that there could be some FDI spillovers on labor productivity (such as human capital, managerial experience, etc.), but not on the overall production efficiency. Aitken, Harrison, and Lipsey (1996) find a positive effect of FDI on the wage rate in the U.S. but negative effects in Mexico and Venezuela. Using matched employer–employee data from Brazil, Poole (2013) conducts a worker-level analysis and finds that workers benefit from colleagues who have some experience at foreign multinationals.

We also examine the effect of FDI on the wage rate in our data set. The regression results are shown in column 3. We find that domestic firms increase their wage rates when there are more foreign multinationals in the same industry. One possible explanation for findings of a positive wage effect but a negative productivity effect is that upon entry, foreign multinationals may compete for the talents with domestic firms in the same labor market, driving up the wage rates. While our firm data do not contain wage information for skilled and unskilled labor, we provide two pieces of indirect evidence supporting this argument. First, anecdotal evidence shows that foreign multinationals did approach skilled workers in the domestic firms. For example, Xinhua News (the lead media associated with the State Council of China) reported on March 10, 2002 that "the biggest competition from the international market, after China's WTO accession, would not be on the domestic product market or the natural resources, but the talents." Second, the Economic Census 2004 contains information for skilled and unskilled labor in each enterprise, from which we compare the composition of labor force between foreign multinationals and domestic firms. As shown in Online Appendix Table A9, we find that foreign multinationals employed higher ratios of skilled labor than domestic firms.

R&D investment. We further investigate whether the entry of FIEs spurs domestic firms in the same industry to engage in innovative activities. Theoretically, the effect of FDI on the innovative activities of domestic firms could be mixed. On the one hand, the R&D productivity of domestic firms may be enhanced by the presence of foreign multinationals through channels such as knowledge spillovers and labor pooling, and this may lead to greater R&D investment. On the other hand, the presence of foreign multinationals may discourage domestic firms from investing in R&D, as they foresee less chance of beating the foreign

multinationals in the race for new products. In the context of China, Cheung and Lin (2004) show in a panel of provincial data for the 1995 to 2000 period that FDI has a positive effect on domestic patent filings.

In our data set, we only have the R&D expenditure data for a few years, and hence we use the ratio of new product revenue as a proxy for firms' innovative activities. The estimation results are shown in column 4. Although the estimated coefficient is positive, it is small in magnitude and not statistically significant, suggesting that domestic firms do not increase their innovative activities when there are more foreign multinationals in the same industry.

Firm survival. Lastly, we examine whether the presence of foreign multinationals increases or decreases the probability of firm survival, the underpinnings of job creation and destruction. Görg and Strobl (2003), studying Irish manufacturing plants, find that the presence of foreign multinationals enhances the survival probability of domestic firms in high-tech industries. Kosová (2010) further confirms the positive effect of FDI on firm survival for firms in the Czech Republic for the 1994 to 2001 period. However, using data from Belgian manufacturing industries, De Backer and Sleuwaegen (2003) find that FDI drives out domestic entrepreneurs.

To test this hypothesis, we first construct a dummy variable (denoted *Exit*) indicating whether a domestic firm exited the data set in the following year or not, and then conduct an instrumental variable estimation using this outcome variable. The regression results are shown in column 5. We find that the presence of FDI in the same industry has a negative effect on the firm exit rate: increasing the output-weighted FDI share in an industry by 10 percentage points increases the survival probability of domestic firms in that industry by 2.6 percentage points; these results are consistent with Kosová's findings (2010).

To understand why the presence of FDI has a negative effect on TFP but a positive effect on firm survival, note that in our analysis on the impact of FDI on firm survival, our identification essentially comes from a DID approach; that is, the difference between the survival rate of treatment industries in year $t+1$ and that in year t relative to the corresponding difference of control industries. Assuming that nothing changed in the control industries, the difference between the survival rate in year $t+1$ and that in year t is then 0. Next, recent works with the setting of heterogeneous firms suggest that firm survival hinges on its productivity (Melitz, 2003). Given the diminishing negative effect of FDI on firm productivity (i.e., the results in Online Appendix Table A8, and the consistent results in column 4 in Table 6), the survival rate of treatment industries in year $t+1$ shall be higher than that in year t; hence, their difference is positive. Combined, the DID identifies a positive coefficient of FDI presence on firm survival rate.

6 Conclusion

It is notoriously hard to identify the FDI spillovers on domestic firms, as the decision by foreign multinationals to enter developing countries and their various industries is obviously an endogenous one. This partially explains why there is no consensus on the effect of horizontal FDI on domestic firms. However, these mixed findings are troubling, as the governments of developing countries have been urged by both developed countries and international organizations to open up their economies to FDI. This paper contributes to the literature by utilizing the arguably exogenous relaxation of FDI regulations upon China's accession to the WTO, under which some of China's manufacturing industries became more open to FDI (the treatment group) while others encountered no change in FDI regulations (the control group). We find that the former group of industries experienced significantly larger inflows of FDI than the latter, although there had been little difference between the two groups prior to China's entry into the WTO. Using instrumental variable estimations, we find that FDI has a negative and significant effect on the productivity of domestic firms in the same industry. In addition, this paper investigates the two underlying explanations (the agglomeration effect and the competition effect) for FDI spillovers on domestic firms. Using variations along dimensions of FDI, and differences in the absorptive capacities of domestic firms, we study various scenarios in which the two underlying effects have different relative strengths, thereby leading to possibly different overall FDI spillovers. Finally, we use an array of measures used in the literature (including TFP, exporting performance, wages, R&D investment, and firm survival) to examine the effect of horizontal FDI on domestic firms, therefore offering a fuller and more nuanced picture of the impact of FDI on domestic firms.

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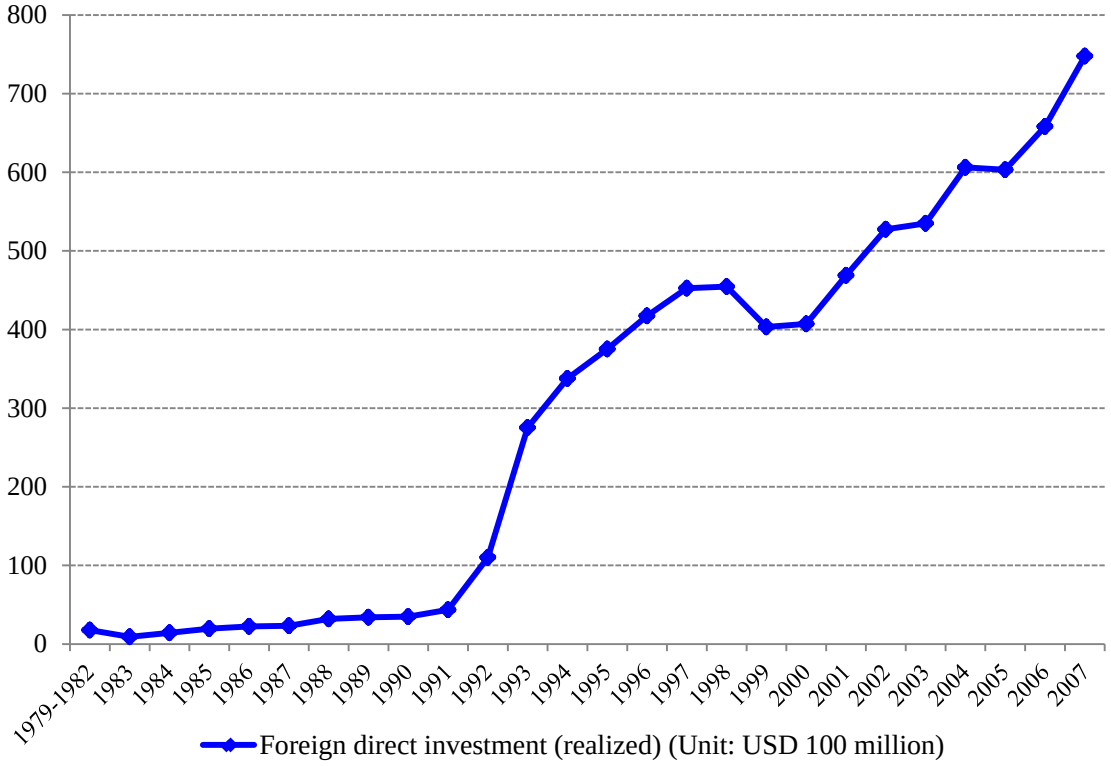
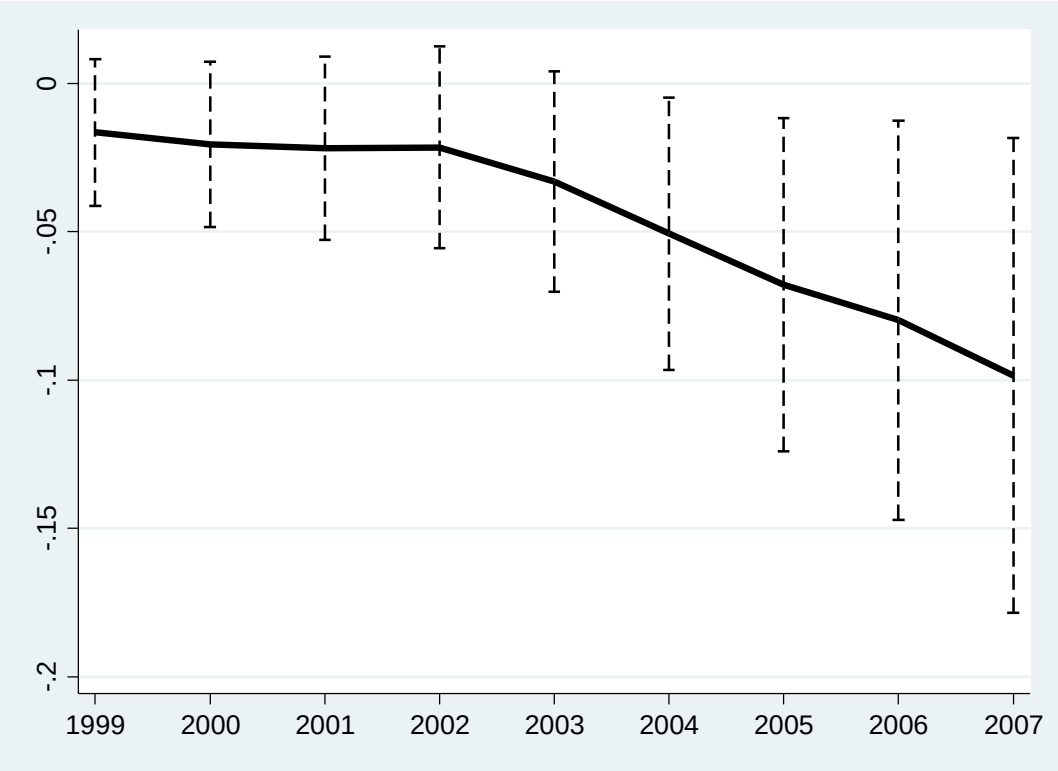
Figure 1: Foreign direct investment (realized), 1979-2007 (USD 100 million)



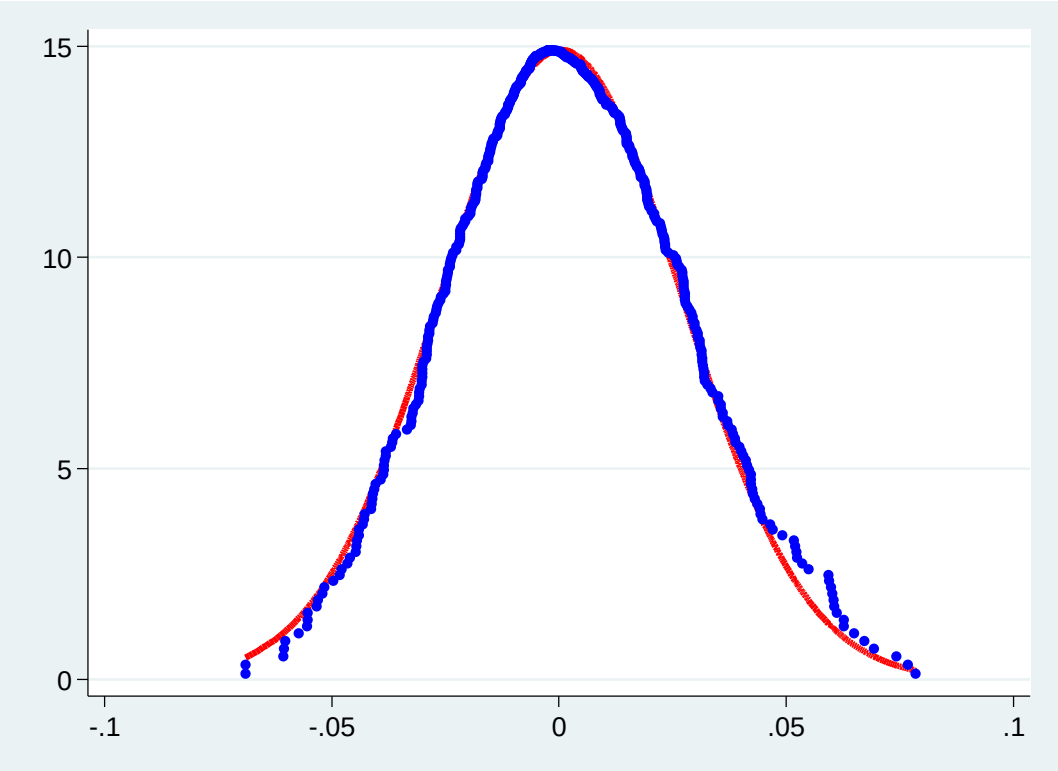
Note: The data on foreign direct investment are obtained from China Foreign Economic Statistical Yearbook (various years).

Figure 2: Effect of FDI regulations on firm TFP



Note: The solid line captures the time course of the total factor productivity difference between industries that were opened up for FDI at the end of 2001 (treatment group) and those that did not (control group). The dashed lines represent the 95% confidence interval of the estimated effect.

Figure 3: Distribution of estimates in the randomization test



Note: In this exercise, we randomly assign the timing and the degree of changes in FDI regulations to industries (false *Post02* and false *Treatment* dummy). We then use equation (1) to conduct regression analysis based on the false *Post02* and false *Treatment* dummy. This is repeated 500 times and the resulting estimated coefficients are plotted. The figure shows the distribution of the estimates from the 500 times of randomization.

Table 1: Foreign equity share at the two-digit industry level

Industry	(1)	(2)	(3)
	1998-2007	1998-2001	2002-2007
Food processing	0.199	0.189	0.206
Food manufacturing	0.276	0.257	0.288
Beverage manufacturing	0.252	0.232	0.264
Tobacco processing	0.014	0.018	0.011
Textile industry	0.209	0.196	0.217
Garments & other fiber products	0.426	0.438	0.419
Leather, furs, down & related products	0.340	0.341	0.339
Timber processing, bamboo, cane, palm fiber & straw products	0.168	0.183	0.158
Furniture manufacturing	0.418	0.386	0.440
Papermaking & paper products	0.225	0.219	0.230
Printing industry	0.259	0.278	0.247
Cultural, educational & sports goods	0.409	0.386	0.424
Petroleum processing & coking	0.077	0.062	0.088
Raw chemical materials & chemical products	0.199	0.166	0.222
Medical & pharmaceutical products	0.181	0.174	0.187
Chemical fiber	0.154	0.149	0.158
Rubber products	0.242	0.213	0.261
Plastic products	0.341	0.341	0.341
Nonmetal mineral products	0.145	0.141	0.148
Smelting & pressing of ferrous metals	0.067	0.062	0.069
Smelting & pressing of nonferrous metals	0.064	0.061	0.066
Metal products	0.255	0.250	0.258
Ordinary machinery	0.177	0.151	0.194
Special purpose equipment	0.171	0.121	0.204
Transport equipment	0.133	0.119	0.142
Electric equipment & machinery	0.318	0.284	0.340
Electronic & telecommunications equipment	0.556	0.508	0.588
Instruments, meters, cultural & office equipment	0.388	0.342	0.418
Other manufacturing	0.333	0.350	0.322

Note: Output-weighted average of foreign equity share across all firms in each two-digit industry calculated over the 1998-2007 period, the pre-WTO 1998-2001 period, and the post-WTO 2002-2007 period, respectively.

Table 2: Summary statistics

Panel A. Firm-level variables			
Variables	Obs.	Mean	Std. Dev.
Log firm TFP	1,368,957	1.026	0.432
Export status	1,368,957	0.187	0.390
Export intensity	1,368,957	0.101	0.270
Log wage rate	1,365,869	2.302	0.694
New product intensity	1,197,222	0.031	0.140
Panel B. Industry-level variables			
Variables	Obs.	Mean	Std. Dev.
FDI sector (four-digit industry level)	4,101	0.239	0.185
Backward FDI (IO sector level)	690	0.112	0.101
Forward FDI (IO sector level)	690	0.086	0.071

Note: Panel A reports number of observations, mean, and standard deviation on firm-level variables: firm TFP, export status, export intensity, wage rate, and new product intensity. Panel B reports number of observations, mean, and standard deviation on industry-level variables: FDI sector, backward FDI, and forward FDI.

Table 3: Industry TFP before and after WTO accession

Industry	(1)	(2)	(3)
	1998-2001	2002-2007	Diff (2)−(1)
Panel A. TFP at two-digit industry level			
Food processing	0.733	0.767	0.034***
Food manufacturing	0.582	0.663	0.080***
Beverage manufacturing	0.784	0.896	0.111***
Tobacco processing	0.310	0.247	−0.062
Textile industry	0.927	1.065	0.138***
Garments & other fiber products	0.428	0.517	0.090***
Leather, furs, down & related products	0.101	0.152	0.051***
Timber processing, bamboo, cane, palm fiber & straw products	0.486	0.906	0.420***
Furniture manufacturing	0.607	0.866	0.258***
Papermaking & paper products	1.067	1.295	0.228***
Printing industry	1.021	1.258	0.237***
Cultural, educational & sports goods	1.084	1.235	0.151***
Petroleum processing & coking	0.049	0.009	−0.040***
Raw chemical materials & chemical products	0.621	0.686	0.065***
Medical & pharmaceutical products	0.798	1.030	0.232***
Chemical fiber	0.438	0.445	0.007
Rubber products	0.773	0.938	0.165***
Plastic products	0.866	1.167	0.301***
Nonmetal mineral products	1.166	1.411	0.245***
Smelting & pressing of ferrous metals	0.555	0.534	−0.021
Smelting & pressing of nonferrous metals	0.767	0.631	−0.137***
Metal products	0.434	0.529	0.095***
Ordinary machinery	1.489	1.625	0.135***
Special purpose equipment	1.531	0.848	−0.682***
Transport equipment	0.512	0.640	0.128***
Electric equipment & machinery	0.737	0.767	0.03***
Electronic & telecommunications equipment	1.143	1.456	0.314***
Instruments, meters, cultural & office equipment	1.102	1.273	0.171***
Other manufacturing	0.721	0.802	0.081***
Panel B. TFP for the treatment and control groups			
Treatment	0.921	0.947	0.026
Control	0.889	0.938	0.049***

Note: Output-weighted average of TFP across all firms in each two-digit industry in Panel A, and in the treatment and control groups in Panel B, calculated over the pre-WTO 1998-2001 period, the post-WTO 2002-2007 period, and their differences, respectively. *** denotes significance at the 1% level.

Table 4: Main results

	IV	IV	IV	Reduced-form	OLS
	(1)	(2)	(3)	(4)	(5)
Panel A. First-stage estimation (dependent variable: FDI sector).					
Treatment × Post02	0.014**	0.014**	0.014**		
	(0.007)	(0.007)	(0.007)		
Panel B. Second-stage estimation (dependent variable: Log firm TFP).					
FDI sector	−3.414***	−3.396***	−3.407***		
	(0.115)	(0.114)	(0.114)		
Panel C. Weak instrument test.					
Anderson-Rubin Wald test	(5.45)**	(5.49)**	(5.48)**		
Stock-Wright LM S statistic	(9.87)***	(10.14)***	(10.69)***		
Panel D. Reduced-form and OLS estimation (dependent variable: Log firm TFP).					
Treatment × Post02				−0.048**	
				(0.021)	
FDI sector					−0.182***
					(0.064)
Firm fixed effects	Y	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y	Y
FDI determinants × Year dummies	Y	Y	Y	Y	Y
Tariff reductions × Year dummies	Y	Y	Y	Y	Y
SOE privatization × Year dummies	N	Y	Y	Y	Y
Time-varying firm controls	N	N	Y	Y	Y
Observations	1,368,957	1,368,957	1,368,957	1,368,957	1,368,957

Note: Panels A and B report the results of first and second-stage IV estimation, respectively. Panel C reports the results of the weak instrument test. Panel D reports the reduced-form and OLS estimations. The sample for our analysis is that of domestic firms. Determinants of changes in FDI regulations include new product intensity, export intensity, number of firms, and average age of firms at the four-digit industry level in 1998. Tariff reductions include output tariff, input tariff, and export tariff at the four-digit industry level in 2001. SOE privatization is a ratio of state-owned enterprises in the total number of firms at the four-digit industry level in 2001. Time-varying firm controls include firm output, export status, capital-labor ratio, and SOE dummy. In Panels A and D, robust standard errors are clustered at the four-digit industry level in parentheses. In Panel B, bootstrapped standard errors are clustered at the four-digit industry level in parentheses. *** and ** denote significance at the 1% and 5% level, respectively.

Table 5: Robustness checks

	(1)	(2)	(3)	(4)	(5)
Dependent variable: Log firm TFP	Nonlinear effect	Exports excluded	Wholly-owned FIEs	Nonlinearity of first-stage outcome	Alternative values of determinants
FDI sector	1.051***	−4.714***	−4.079***	−3.407***	−4.722***
	(0.011)	(0.179)	(0.165)	(0.114)	(0.175)
FDI sector, squared	−1.676***				
	(0.016)				
Wholly-owned FIEs ratio			0.801		
			(0.660)		
Observations	1,368,957	1,368,957	1,368,957	1,368,957	1,368,957
	(6)	(7)	(8)	(9)	(10)
Dependent variable: Log firm TFP	Processing traders excluded	Special economic zones control	TFP (Olley-Pakes)	TFP (Levinsohn-Petrin)	Alternative measure of vertical FDI
FDI sector	−3.412***	−3.454***	−3.146***	−1.797***	−3.763***
	(0.124)	(0.116)	(0.094)	(0.198)	(0.074)
Backward FDI					0.271***
					(0.034)
Forward FDI					5.490***
					(0.178)
Observations	1,360,262	1,368,957	1,343,340	1,318,886	1,368,957
Firm fixed effects	Y	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y	Y
FDI determinants × Year dummies	Y	Y	Y	Y	Y
Tariff reductions × Year dummies	Y	Y	Y	Y	Y
SOE privatization × Year dummies	Y	Y	Y	Y	Y
Time-varying firm controls	Y	Y	Y	Y	Y

Note: Determinants of changes in FDI regulations include new product intensity, export intensity, number of firms, and average age of firms at the four-digit industry level. Tariff reductions include output tariff, input tariff, and export tariff at the four-digit industry level in 2001. SOE privatization is the ratio of state-owned enterprises in the total number of firms at the four-digit industry level in 2001. Time-varying firm controls include firm output, export status, capital-labor ratio, and SOE dummy. Bootstrapped standard errors are clustered at the four-digit industry level in parentheses. *** denotes significance at the 1% level.

Table 6: Agglomeration versus competition effects

Dependent variable: Log firm TFP	Horizontal vs. vertical FDI	Local vs. non-local FDI	Developed vs. developing FDI	TFP growth *(t, t+1)*
	(1)	(2)	(3)	(4)
FDI sector (horizontal FDI)	−3.919***			1.213***
	(0.051)			(0.148)
Backward FDI	0.541***			
	(0.040)			
Forward FDI	3.855***			
	(0.078)			
FDI sector (local)		6.644***		
		(1.642)		
FDI sector (non-local)		−6.329***		
		(0.933)		
FDI sector (developed)			−7.318***	
			(0.454)	
FDI sector (developing)			−2.802***	
			(0.157)	
Firm fixed effects	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y
FDI determinants × Year dummies	Y	Y	Y	Y
Tariff reductions × Year dummies	Y	Y	Y	Y
SOE privatization × Year dummies	Y	Y	Y	Y
Time-varying firm controls	Y	Y	Y	Y
Observations	1,368,957	1,347,189	1,368,957	1,119,151

Note: Determinants of changes in FDI regulations include new product intensity, export intensity, number of firms, and average age of firms at the four-digit industry level in 1998. Tariff reductions include output tariff, input tariff, and export tariff at the four-digit industry level in 2001. SOE privatization is a ratio of state-owned enterprises in the total number of firms at the four-digit industry level in 2001. Time-varying firm controls include firm output, export status, capital-labor ratio, and SOE dummy. Bootstrapped standard errors are clustered at the four-digit industry level in parentheses. *** denotes significance at the 1% level.

Table 7: Absorptive capacity

Dependent variable: Log firm TFP	R&D intensity	SOEs
	(1)	(2)
FDI sector	−3.365***	−3.376***
	(0.165)	(0.101)
FDI sector × R&D intensity in 2001	0.148	
	(2.140)	
FDI sector × SOEs dummy in 2001		0.361**
		(0.163)
Firm fixed effects	Y	Y
Year fixed effects	Y	Y
FDI determinants × Year dummies	Y	Y
Tariff reductions × Year dummies	Y	Y
SOE privatization × Year dummies	Y	Y
Time-varying firm controls	Y	Y
Observations	682,451	657,982

Note: Determinants of changes in FDI regulations include new product intensity, export intensity, number of firms, and average age of firms at the four-digit industry level in 1998. Tariff reductions include output tariff, input tariff, and export tariff at the four-digit industry level in 2001. SOE privatization is a ratio of state-owned enterprises in the total number of firms at the four-digit industry level in 2001. Time-varying firm controls include firm output, export status, capital-labor ratio, and SOE dummy. Bootstrapped standard errors are clustered at the four-digit industry level in parentheses. *** and ** denote significance at the 1% and 5% level, respectively.

Table 8: Other measures of firm performance

Dependent variable	Export status	Export intensity	Log wage rate	New product intensity	Exit
	(1)	(2)	(3)	(4)	(5)
FDI sector	0.069	0.055	1.125***	0.053	−0.260**
	(0.080)	(0.042)	(0.193)	(0.033)	(0.103)
Firm fixed effects	Y	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y	Y
FDI determinants × Year dummies	Y	Y	Y	Y	Y
Tariff reductions × Year dummies	Y	Y	Y	Y	Y
SOE privatization × Year dummies	Y	Y	Y	Y	Y
Time-varying firm controls	Y	Y	Y	Y	Y
Observations	1,368,957	1,368,957	1,365,869	1,197,222	1,368,957

Note: Determinants of changes in FDI regulations include new product intensity, export intensity, number of firms, and average age of firms at the four-digit industry level in 1998. Tariff reductions include output tariff, input tariff, and export tariff at the four-digit industry level in 2001. SOE privatization is a ratio of state-owned enterprises in the total number of firms at the four-digit industry level in 2001. In columns 1-2, time-varying firm controls include firm output, capital-labor ratio, and SOEs dummy. In columns 3-5, time-varying firm controls include firm output, export status, capital-labor ratio, and SOE dummy. Bootstrapped standard errors are clustered at the four-digit industry level in parentheses. *** and ** denote significance at the 1% and 5% level, respectively.