# Does FDI increase product innovation of domestic firms? Evidence from China

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# Does FDI Increase Product Innovation of Domestic Firms? Evidence from China*

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**Abstract**

Exploiting a change in policy governing the entry of foreign direct investment (FDI) in 2002, we apply the difference-in-differences model to estimate the effect of FDI on the product scope of domestic Chinese firms. In industries that experienced relaxation in FDI regulations, the average product scope increased by 5% which indicates a rise in product innovation. FDI's spillovers along vertical linkages are also important, as we find that the product scope of firms is positively affected by FDI in upstream industries, but negatively affected by FDI in downstream industries. Further analysis shows that the negative effect of FDI in downstream industries is mainly concentrated in industries with a high level of processing trade, as firms in those industries rely more on imported inputs and have less contact with domestic suppliers. The main channels of effect are firm-level R&D and industry-level technological distance, as the entry of FDI leads to an improvement in these variables. Positive effects are found in medium- and low-tech industries but not in high-tech industries, indicating that indigenous effort is important for product innovation in high-tech industries.

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# 1 Introduction

Foreign direct investment (FDI) is an important force in the world economy as it helps move physical capital, technology, managerial practices, and high-skilled workers across country borders. Extensive literature has been devoted to answering the important question of whether FDI generates positive spillover effects in the host country. In addition to influence on productivity and employment, the effect of FDI on innovation is of particular interest. Although it is well understood that product innovation is a crucial aspect of economic growth (Kuznets, 1973; Romer, 1990), the analysis of the effects of FDI on product innovation is unfortunately hindered by the available measures of product innovation. Few studies (Kee, 2015; Javorcik et al., 2018) can directly examine the change in the mix of products produced by firms, but the available evidence remains scant as the estimated effects range from insignificant to positive.

As a high-growth economy with prominent status in both global FDI and the global manufacturing landscape, the Chinese economy presents an ideal background for studying the dynamic relations between FDI and product innovation. Starting from zero foreign investment at the beginning of the era of 'reform and opening up' in 1978, China has actively courted FDI and boasted the fourth largest stock of inward FDI, behind only the United States, the United Kingdom and the Netherlands, by the end of 2021.[1] Simultaneously, China has become one of the largest contributors to world manufacturing, accounting for approximately 29% of world manufacturing value-added in 2021. As China's manufacturing sector grows, it demonstrates a nontrivial ability to upgrade products and innovate.

It is natural to ask whether the vast amount of FDI that China has managed to attract aids product innovation in China. Our study addresses this question using Chinese firm-level data from 2000 to 2007 to estimate the effect of FDI on domestic Chinese firms' product innovation. Exploiting the change in policy governing FDI entry in 2002 that

[1] The ranking is based on the *World Investment Report 2022* published by the United Nations Conference on Trade and Development.

accompanied China's WTO entry in 2001, we apply the difference-in-differences (DID) estimation strategy to identify the causal effects.

Our analysis yields the following main results for product innovation. First, FDI boosts the product scope of domestic firms in the same industry. In industries that experienced relaxation in FDI entry immediately after China's entry into the WTO, the product scope of domestic firms increases by 5% on average. Second, FDI entry also affects product scope through vertical linkages. Domestic firms' product scope is positively related to FDI in upstream industries but negatively related to FDI in downstream industries. The positive effect of upstream FDI is consistent with the theoretical and empirical finding in the literature that foreign firms upstream can exert positive influence by providing better inputs. We show that the negative effect of downstream FDI occurs mainly in industries with more processing trade, the type of trade regime which weakens the link between foreign firms and domestic firms upstream. Third, there is some evidence that a firm-level channel of FDI effects is R&D, as firm-level R&D expenditures increase by 5% following the change in FDI entry policy. As for the industry-level channel, FDI entry leads to a shortening of the technological distance between domestic industry and the world frontier. Fourth, when we distinguish industries by technology intensity, the positive effects of FDI entry on product scope are mainly found in the medium- and low-tech industries. In comparison, FDI does not appear to help domestic firms' product innovation in China's high-tech industries. Finally, the positive effects of FDI on product scope are robust when we include two factors that may help expand the product scope—trade liberalisation and imported inputs, and when we use alternative measures of product innovation, such as the rate of new product addition and the possibility of product innovation.

This study is closely related to Kee (2015) and Javorcik et al. (2018), both of which examine the relationship between FDI and product scope. Kee (2015) finds that FDI increases the product scope in Bangladesh firms and shows that an important effect channel is common local suppliers shared by both foreign and domestic firms. As foreign firms demand better input from local suppliers, the improvement in quality also benefits domestic firms that use the same suppliers. In comparison, Javorcik et al. (2018) does not find a significant relationship between FDI and the introduction of new products by domestic firms in Turkey but finds an increase in the complexity of their products. In the context of China, Ito et al. (2012) and Li et al. (2013) find positive effects of FDI on two variables closely related to product innovation, patent innovation and the share of new products in sales.

Our findings are relevant to the broad literature on the spillover effects of FDI through both horizontal and vertical linkages. Theoretically, FDI can generate positive spillovers in the same industry—through horizontal linkage—because foreign firms demonstrate better technology and train workers who later take up jobs in domestic firms (Teece, 1977; Blomström and Kokko, 1998). It also improves peer domestic firms' access to better inputs as foreign firms help improve the technological capacity of local suppliers (Kee, 2015). Meanwhile, foreign firms naturally want to guard their technology, which mutes spillovers, and an increase in competition can reduce the performance of domestic firms. In empirical studies, the productivity spillovers from foreign to domestic firms are mixed, ranging from positive in Mexico (Kokko, 1994), the US (Keller and Yeaple, 2009), and Bangladesh (Kee, 2015), to insignificant in Turkey (Javorcik, 2004), and to negative in Venezuela (Aitken and Harrison, 1999).

As for vertical channels, the literature posits positive forward spillovers in general (Blomström and Kokko, 1998) but evidence remains limited (Gorodnichenko et al., 2014). In the forward channel, improvements in the availability of better or cheaper inputs brought by foreign firms in upstream industries increase domestic firms' product innovation.[2] As for backward linkage, Rodriguez-Clare (1996) point out that the effects of foreign

[2]Goldberg et al. (2010) show that imported inputs made available by trade liberalisation lead to more new products introduced by local firms in India, which can be viewed as indirect evidence for positive

firms in downstream industries depend on the nature of the linkage. If foreign firms help expand the market for domestic inputs or voluntarily transfer technology to domestic firms upstream, spillover through backward linkages should be positive. Conversely, if foreign firms displace domestic inputs with imported inputs, negative spillovers can occur. Most empirical studies find that productivity spillovers through backward linkages are positive (Javorcik, 2004; Blalock and Veloso, 2007; Girma and Gong, 2008). However, Xu and Sheng (2012) report negative productivity spillovers through backward linkages in the context of China.

Relative to existing studies, we make two contributions. First, to the best of our knowledge, this study is the first to examine the effect of FDI on Chinese firms' product scope. The results indicate that FDI is an important factor that contributes to product innovation of China's manufacturing sector. This finding complements existing studies on FDI spillovers in China, which focus on other outcomes, such as productivity. Nevertheless, we also find that the effect is limited to medium- and low-tech industries, highlighting the importance of indigenous R&D in product innovation in high-tech industries.

Second, we provide a more comprehensive set of results on FDI spillovers from the horizontal and vertical linkages. We find that the horizontal spillover in China to be nuanced as FDI increases the product scope of domestic firms in the same sector but lowers their TFP. As for vertical linkage, the product scope of domestic Chinese firms is positively related to the entry of FDI in upstream industries but negatively affected by FDI in downstream industries. The negative backward spillovers contrast with the findings from other countries, albeit with the caveat that these studies focus on productivity. We argue that the negative effect through the backward channel occurs because foreign firms in industries with prevalent processing trade can weaken the link between these industries with domestic firms upstream. Overall, using a rich set of information from multiple micro

forward spillovers. This is because both FDI entry in upstream industries and trade liberalisation improve the availability of better inputs.

datasets, our study illustrates the complexity of FDI spillovers, and tests the predictions of various theories in the context of China.

The remainder of this paper is organised as follows. We present the empirical research design and describe the data in Section 2 and report the empirical results regarding the effects of FDI on product scope in Section 3. In Section 4, we explore the channels of the FDI effects. The robustness of the results and issues of heterogeneity are discussed in Section 5. Finally, in Section 6, we conclude the paper.

# 2 Empirical Design

## 2.1 Difference-in-difference estimation

To estimate the effect of FDI entry on product scope, we adopt the DID regression of the product scope of a firm on a policy change that affects FDI entry in some industries in 2002. The regression equation is specified as follows:

$$ln(scope_{fit}) = \beta_0 + \beta_1 treat_i \times post_t + \rho X_{fit} + \gamma_f + \delta_t + \epsilon_{fit} \quad (1)$$

where $f$, $i$, and $t$ are the indices for the firm, the 4-digit industry, and the year, respectively. Following Kee (2015), our dependent variable is the log of a firm's product scope ($ln(scope)$), which is measured as the number of products produced by firm $f$ in year $t$ in industry $i$. The variable $treat_i$ is a dummy variable that equals 1 if industry $i$ becomes more open to FDI entry in 2002 and 0 if the industry experienced no change in entry policy. The group of industries that experienced no policy changes was the reference group. The variable $post_t$ is an indicator, which takes the value of 1 for years after 2002 and 0 otherwise. The parameter of the interaction term, $\beta_1$, captures the effect of the relaxation of FDI entry on a firm's product scope. If $\beta_1 > 0$, then the data support the notion that the policy change in 2002 promotes the development of product scope. Quantities $\gamma_f$ and $\delta_t$ are firm fixed effects and time fixed effects, respectively.

Our control variables are the following: firm size, measured as log output ($lnOutput$); log firm age ($lnAge$); capital intensity, measured as log capital to labour ratio ($lnKL$); financing ability ($FinAbility$); an indicator for state-owned enterprises ($SOE$); an indicator for exporting activities ($export$). The error term was $\epsilon_{fit}$. We clustered the standard error at 4-digit industry level.

### 2.2 Overhaul of FDI policy in 2002

In this subsection, we discuss the overhaul of FDI policy in the revision of the Catalogue of Industries for Guiding Foreign Investment (hereinafter, the Catalogue of Industries) in 2002. Published by the State Council of China, the Catalogue of Industries plays a fundamental role in the approval process of FDI projects by indicating the industries in which FDI is encouraged.[3] Over time, the revisions to the Catalogue of Industries indicate how China has become increasingly open to FDI.

The 2002 revision of the Catalogue of Industries constitutes a substantial relaxation in FDI entry regulations in China. By announcing that FDI was encouraged in a larger number of industries, the 2002 Catalogue of Industries significantly increased the attractiveness of these industries to foreign investors. Crucially, the 2002 revision was part of China's efforts to fulfill its obligations associated with entry into the WTO in 2001.[4] As part of the WTO entry arrangement, China agreed to increase its economic openness significantly and substantially reduce the barrier to inward FDI. The timing of WTO entry and subsequent policy changes was determined by a long and difficult negotiation process punctuated by geopolitical factors and other shocks and hence arguably exogenous to for-

[3]The Catalogue of Industries was first published in 1995 and underwent revisions in 1997, 2002, 2004, 2007, 2011, 2015, and 2017. In 2019 and 2020, the State Council further consolidated the Catalogue and released the Catalogue of Industries for Encouraging Foreign Direct Investment.

[4]During our sample period of 2000 to 2007, China made changes to the Catalogue of Industries in 2002, 2004, and 2007. Of these, the revision in 2002 was the most substantial because it was linked to the obligations associated with China's WTO entry. The revision to the Catalogue of Industries in 2004 was minor, serving mainly to fine-tune industrial policies. Thus, we choose the revision in 2002 as the main policy shock in our sample period and study the effects of the resulting FDI inflow on the product scope of firms.

eign investors. In particular, the revision of the Catalogue of Industries was unrelated to the contemporaneous level of product scope in China.

In the Catalogue of Industries, there is a classification of industries into four categories in descending order of FDI entry: encouragement, permission, hindrance, and forbiddance. In the first step of identifying and coding changes in FDI policy, we compare the Catalogue of Industries of 1997 to that of 2002 and record the change (or the lack of change) in status of an industry's FDI entry policy as encouraged, unchanged, or tightened. Thus, we identify the changes in FDI policies for a large number of industries.

In the second step, to link the changes in FDI policy to other data, we map the manufacturing industries in the Catalogue of Industries to 424 manufacturing industries in the Chinese Industry Classification (CIC) 4-digit industry codes.[5] As the former classification is finer than the latter, our mapping procedure sometimes places two or more industries in the former classification into a single 'umbrella' industry in the latter. However, multiple industries from the former classification that go into the same CIC 4-digit 'umbrella' industry could experience different policy changes. Recognising this complexity, we distinguish three cases. First, if industries from the Catalogue of Industries experienced either relaxation or no change in entry policy, we coded the CIC 4-digit 'umbrella' industry as 'encouraged'. Second, if industries from the Catalogue of Industries experienced either tightening or no change in entry policy, we code the CIC 4-digit 'umbrella' industry as 'tightened'. Finally, if among the industries from the Catalogue of Industries, at least one experienced relaxation and at least one experienced tightening in entry policy, we code the CIC 4-digit 'umbrella' industry as 'mixed'.

After applying the above two-step procedure, among the 424 CIC 4-digit industries, we code 106 industries as 'encouraged'[6], 294 as 'unchanged', 13 as 'tightened', and 11 as

[5]We use the version of CIC codes developed by Brandt et al. (2012), as the authors provide consistent concordance between different vintages of industry classification published by the National Bureau of Statistics of China.

[6]These 106 4-digit industries belong to 23 2-digit manufacturing industries, which account for the

‘mixed’. In the DID estimation, we defined the ‘encouraged’ industries as the treated group and the unchanged industries as the control group.[7] While it is plausible that the revision of the Catalogue of Industries in 2002 was an exogenous policy event, some industry characteristics likely affect whether a particular industry experiences a relaxation in FDI regulation. To address the potential endogeneity problem associated with differences in pre-existing trends, we control for several industry characteristics in 2000 that are related to innovation and productivity. They are the fraction of new products in sales, export-to-sales ratio, average wage rate, and the number of firms in the industry.[8]

### 2.3 Data and measurement

Our sample covers all large and medium-sized manufacturing firms in China from 2000 to 2007. The two main data sources are the *Annual Survey of Industrial Firms* (ASIF) and the *China Product Output Database* (CPOD), both obtained from the National Bureau of Statistics of China (NBSC). ASIF, widely used in research on Chinese firms, covers private firms with sales greater than 5 million RMB (approximately US 760,000 at the market exchange rate) and all SOEs. On average, there were approximately 230,000 unique firm observations each year, from 2000 to 2007. The survey provides rich information on two sets of variables: those related to basic information and those related to financial information. Variables related to basic information include identification code, firm name,

majority of 29 of China’s 2-digit manufacturing industries. They include low-, medium-, and high-tech industries. The six industries that did not experience relaxation in entry, with their 2-digit codes in parenthesis, are the following: the manufacturing industry of textile costumes, shoes, and caps (18), wood processing and manufacturing industry of wood, bamboo, rattan, palm, and straw-made articles, (20), furniture (21), printing and reproduction of record media (23), plastic product (30), and ferrous metal smelting and extrusion (32).

[7] The results remain essentially unchanged if we use industries coded as ‘unchanged’, ‘tightened’, and ‘mixed’ as the control group.

[8] If the selection of industries into the control and treatment groups is not random—the two groups of industries have pre-existing differences in the tendency to experience relaxation in FDI regulation before the revision of the Catalogue of Industries in 2002—our DID estimation will be inconsistent. Presumably, the government is likely to ease or retain FDI regulation in selected industries to suit the development goals. For instance, the government may want to limit high-pollution industries and promote high-tech industries. To account for the non-randomness in selection into treatment, we follow Lu et al. (2017) to control for industry characteristics that likely affect FDI regulation.

industry, and geographical location. Important examples of financial variables are output value, sales, exports, employment, and sources of paid-in capital (state, foreign, and domestic private).

We obtained product scope information from CPOD data, which covers more than 200,000 industrial firms per year in China from 2000 to 2007. For each firm, the database provides information on the number of products produced, the 5-digit product codes, product names, and quantities. A product is identified using a 5-digit product code. As ASIF and CPOD share the same firm identification codes issued by the NBSC, linking the two databases is straightforward. The merged CPOD and ASIF data accounted for 90.90% of the CPOD and 37.60% of the ASIF.[9]

Following standard practices in the field (Chor et al., 2021), we exclude observations unusable or unreliable for the following reasons: (1) reporting zero or negative firm age, industrial output, sales, fixed assets, and industrial value added; (2) employing fewer than eight employees; (3) reporting negative export value or an export value greater than sales. After these adjustments, we were left with 615,416 firm-year observations covering the period from 2000 to 2007.

We exclude foreign firms to examine the spillover effect of FDI entry on domestic firms. We define a firm as foreign if foreign capital (including capital from Hong Kong, Macau, and Taiwan) accounts for more than 25% of the paid-in capital. Subsequently, to avoid the extreme values problem, we winsorised the continuous variable at the 1st and 99th percentiles.

We define product scope as the number of 5-digit CPOD product codes produced by a firm. Our practice is similar to that of Bernard et al. (2010), which uses 5-digit SIC codes to identify products. In the Appendix, we show that the 5-digit CPOD codes we

[9]Changes in FDI regulations, as explained in Section 2.2, are identified at the level of 4-digit industries. As the industry classification in the ASIF data changed from GB/T4754-1994 (2000–2002) to GB/T4754 2002 (2003–2007) in 2003, we ensured consistency of the industry classification by applying the concordance table developed by Brandt et al. (2012).

use can be mapped into the 5-digit codes in the Central Product Codes (CPC version 1.0) published by the United Nations. Thus, the 5-digit CPOD codes can accurately identify products.

As shown in Table 1, 67.83% of firm-year observations correspond to single-product firms. For firm-year observations reporting multiple products, the average number of products is 2.51. Figure 1 shows that the number of multi-product firms increased during our sample period. Figure 2 shows that multi-product firms are superior to their single-product counterparts, reporting, on average, higher output, larger sales volume, more employment, and higher total factor productivity.

As for measures of control variables, we use the logged value of a firm's output as a proxy for firm size (*lnOutput*). Our measure of a firm's age (*lnAge*) is the log of a firm's total number of years in business plus one. We use the interest expenses to fixed capital ratio to measure the financing ability of a firm. This is because firms subject to fewer financial constraints can borrow more funds externally and incur a larger amount of interest rate expenses against the same level of fixed capital. The larger this indicator ($FinAbility$), the less financially constrained is the firm. We define a firm as an SOE if the state accounts for more than 50% of its paid-in capital. Finally, the export indicator (*export*) is equal to 1 if a firm registers positive exports in a given year and 0 otherwise.

# 3 Main Regression Results

## 3.1 Baseline results

We report the DID regression results associated with equation (1) in Table 2. In the first column, we include the treatment variable ($treat \times post$), predetermined industry-level controls, year fixed effects, and firm fixed effects. We then introduce firm-level control variables in the regression in column (2). In column (3) of Table 2, which is our preferred benchmark, we control for two concurrent reforms: China's entry into the WTO in 2001 and the reform of SOEs. China's entry into the WTO ushered in an era of further opening up of the country, which could have affected the product scope through trade liberalisation. With the creation of the China State-owned Assets Supervision and Administration Commission in 2003, existing SOEs underwent significant reforms that allowed them far greater flexibility in deciding the product mix and product scope. To account for the potential effects of these reforms, we include in the regressions the interactions of year dummies and the import tariff of 2001 and those of year dummies and the fraction of SOEs in the number of firms in 4-digit industries in 2001. The estimated effects are significant in all three specifications.

The estimated coefficient of the treatment variable is 0.05 in the benchmark regression in Column (3). The estimate indicates that firms in the treated industries—industries that experienced deregulation in FDI entry—report a growth in product scope that is 5% ($0.05 \times 100\%$) greater than that of firms in industries in the control group. Compared to the mean of the log product scope (0.26), the effect of FDI entry is also significant in the economic sense.

### 3.2 Parallel trend test

When using the DID to evaluate the effect of a policy change, the control and treatment groups must satisfy the parallel trend assumption. Before the policy change, we need to ensure that the two groups have similar trends; hence, pre-existing differences do not confound the effect of the policy. In Figure 3, we plot the trends in product scope for the control group (firms in industries that experienced no relaxation in FDI entry policy) and the treatment group (firms in industries that experienced relaxation in FDI entry). As shown in Figure 3, the trends for the two groups were similar prior to 2003, and the treatment group showed a notable increase in product scope relative to the control group. Evidence suggests that the parallel trend assumption is likely to be satisfied in our application.

### 3.3 Vertical linkage

In addition to the horizontal spillover effects of FDI, we consider spillovers that occur along the supply chain or vertical linkage. To capture the effect of FDI on product scope along the vertical linkage, we follow Javorcik (2004) to construct the following forward FDI linkage measure:

$$treat_i^{forward} \times post_t = \sum_{s \neq i} \alpha_{si} \times treat_s \times post_t$$
$$\alpha_{si} = \frac{input_{si}}{\sum_s input_{si}},$$

where $input_{sit}$ is the input from industry $s$ used in industry $i$, and $\alpha_{si}$ is the share of industry $s$ in cost industry $i$. Similarly, the measure of industry $i$'s backward FDI linkage is defined as

$$treat_i^{backward} \times post_t = \sum_{k \neq i} \alpha_{ik} \times treat_k \times post_t$$
$$\alpha_{ik} = \frac{output_{ik}}{\sum_k output_{ik}},$$

where $output_{ikt}$ is the input from industry $i$ used in industry $k$, and $\alpha_{ik}$ is the share of industry $k$ in the sales output of industry $i$. Input and output data were obtained from the 2002 Chinese Input-Output (IO) table.

In Table 3, we add the measures of forward FDI linkage ($treat_i^{forward} \times post_t$) and backward FDO linkage ($treat_i^{backward} \times post_t$) to the benchmark regression first separately and then jointly. The results show that the horizontal effect of FDI on product scope remains significant, and its magnitude is similar to the benchmark. As for vertical linkage, the coefficient of the forward FDI linkage is positive, indicating that the product scope of a firm is positively associated with the entry of FDI in upstream industries. The finding of positive forward linkages is consistent with the theory of Rodriguez-Clare (1996), as domestic firms' innovation can be boosted by better inputs provided by foreign firms upstream. Our finding of positive spillovers on product scope is also consistent with the previous empirical studies (Ito et al., 2012; Xu and Sheng, 2012), albeit their focus is on productivity spillovers.

The backward FDI linkage is estimated to exert a negative effect, which is contrary to findings based on data from Lithunania (Javorcik, 2004), Indonesia (Blalock and Veloso, 2007), and the UK (Girma and Gong, 2008) but is consistent with Xu and Sheng (2012) in the context of China. Notably, our outcome variable is the product scope, while the aforementioned set of papers examines productivity. While domestic firms in theory can gain technology transferred by foreign firms downstream, Rodriguez-Clare (1996) notes that if foreign firms downstream prefer imported inputs to domestic inputs, they can have negative effects on domestic firms upstream. Because a significant number of foreign firms in China engage in processing trade and hence rely heavily on imported inputs during our sample period, we conjecture that entry of foreign firms in downstream industries with significant processing trade exerts negative effects on domestic firms.

To test the role of processing trade in backward linkage, we create the following treatment variables for backward linkage from industries with above median processing trade and backward linkage from industries with below median processing trade:

$$treat^{backward}_{i,high\ processsing} \times post_t = \sum_{k \neq i} \alpha_{ik} \times treat_k \times 1(high\ processing = 1) \times post_t$$
$$treat^{backward}_{i,low\ processsing} \times post_t = \sum_{k \neq i} \alpha_{ik} \times treat_k \times 1(high\ processing = 0) \times post_t,$$

where $1(high\ processing = 1)$ is an indicator function which takes value of 1 if industry $k$ is an industry with a high level of processing trade. Following Liu and Qiu (2016), we define an industry as a high-processing-trade one if the fraction of processing trade in total trade of the industry is above the median of all industries in the previous year. In column (4) of Table 3, the coefficient on the backward linkage from industries with below median processing trade is insignificant while the coefficient on backward linkage from industries with above median processing trade is negative and significant.[10] Thus, consistent with our

[10]Yu (2015) measures the prevalence of processing trade by the fraction of firms engaged in processing

conjecture, the negative effects from backward linkage is mainly associated with industries with a high level or processing trade.

Finally, the coefficients of both the forward and backward linkages (0.20 and -0.18 in column (3)) are larger than the horizontal linkage (0.06 in column (3)). Therefore, in practical sense the vertical linkage effects appear to substantial and larger than the horizontal effect.

# 4 Analysis of Channels

## 4.1 Firm-level channels

We study two firm-level channels for product scope change: firms' R&D and managerial efficiency. First, we examine whether FDI entry prompts domestic firms to increase their innovation efforts through R&D. To test this channel, we regress the log of the R&D expenditures of local firms on the treatment variable in column (1) of Table 4. The estimates indicate that post treatment, firms in the treated industries experience a 5% increase in R&D expenditure. As the p-value of the coefficient is 0.064, the results provide reasonable support to the R&D channel.

The second firm-level channel that we consider is managerial efficiency. When foreign firms bring advanced management practices with them, domestic firms can improve their management practices and efficiency by mimicking and learning from foreign firms. Nocke and Yeaple (2006) show that the marginal cost of a firm is determined by the managerial efficiency and optimal product scope, and higher efficiency in management enables a firm to overcome a higher marginal cost and increase its product scope. Using firm-level data from China between 2000 and 2006, Qiu and Yu (2020) find that, in response to the foreign country's tariff cut, firms with better managerial efficiency could expand the product scope

trade in an industry. In unreported regression, we use this measure and find the the coefficient on backward linkage from industries with above median processing trade to be -.28 and statistically significant, which is similar to the results reported in column (4).

of exporters, while firms with lower managerial efficiency experienced reductions in product scope.

To test whether FDI entry is associated with higher managerial efficiency, we use distance to frontier managerial efficiency as the dependent variable in the DID estimation.[11] In the second column of Table 4, we report the regression with distance to frontier managerial efficiency as the dependent variable. The coefficient of the treatment variable is negative but not statistically significant, with a p-value of 0.160. Thus, evidence on managerial efficiency as an effect channel is marginal.

## 4.2 Industry-level channel

We consider two industry-level channels, technological distance and resource misallocation. First, FDI entry can help local firms introduce new products by reducing the industry-level technological distance between China and the world frontier. This is because FDI entry generates technology spillovers through the demonstration effect and human capital training. After receiving the de facto technology transfer, existing firms can choose to upgrade the technology used in current products and start manufacturing new products. To capture the technological distance channel, we modified the benchmark regression model by replacing lnscope with technological distance as the dependent variable. The distance is measured as the industry-specific labour productivity ratio, $dist_{it} = \frac{LP\_US_{it}}{LP\_CN_{it}}$, where $LP\_CN_{it}$ and $LP\_US_{it}$ are the labour productivity of industry $i$ in China and the US, respectively. Here, we follow Aghion et al. (2009) by assuming that US industries are at the world technology frontier. The larger this ratio, the larger the technological

[11] Following Qiu and Yu (2020), we measure managerial efficiency as the residual of the following regression of overhead expenses: $lnManage_{ft} = \beta_1 \times lnL_{ft} + \beta_2 \times lnExp_{ft} + \beta_3 \times markup_{ft} + \gamma_f + \gamma_t + \epsilon_{ft}$, where $lnManage_{ft}$ is the log of overhead expenses, $lnL_{ft}$ is the log of employees, $lnExp_{ft}$ is the log of firm exports, and $markup_{ft}$ is the firm's markups. Quantities $\gamma_f$ and $\gamma_t$ are the firm fixed effects and the year fixed effects, respectively. The larger the overhead residual for firm $f$ in this regression, the lower the firm's managerial efficiency. Subsequently, we define the mean value of the managerial efficiency of firms with managerial efficiency in the top 10% as frontier managerial efficiency. Dividing a firm's managerial efficiency by frontier value, we obtain the measure of distance to frontier managerial efficiency.

distance between China and the world frontier.

Column (1) of Table 5 reports the regression of technological distance. The results confirm our conjecture that FDI deregulation reduces the technological distance between a firm's industries and the world frontier. The coefficient on $treat \times post$ is -2.13, implying that FDI deregulation is associated with a 2.13 drop in technological distance. Relative to the mean technological distance of 19.58, this effect represents a sizable improvement of technology at the industry level.

The second industry-level channel is a potential reduction in resource misallocation, which is often considered an important aspect of the Chinese economy. If the entry of foreign firms improves resource allocation within an industry, then domestic firms are better positioned to introduce new products. We use the standard measure of resource misallocation introduced by Hsieh and Klenow (2009)—the standard deviation of log TFP within an industry—in place of *lnscope* as the dependent variable. However, the results reported in column (2) of Table 5 suggest that FDI entry has no effect on the degree of resource misallocation within an industry.

# 5 Heterogeneity and Robustness Results

## 5.1 Heterogeneity analysis

First, we examine whether the effects of FDI vary with industry-level technology intensity. As industries with high levels of technology intensity are R&D intensive, it is likely to be more difficult and costly for domestic firms to expand their product scope by learning from foreign firms (Sanjaya, 2000; Manova and Zhang, 2009). We follow Sandven et al. (2005) and Lu et al. (2010) in using the definitions of industry-level technology intensity from the Organization of Economic Cooperation and Development (OECD) to define three types of industries: high-tech, medium-tech, and low-tech industries. A detailed classification is presented in Table 6. To check whether the effects of FDI deregulation vary with technology intensity, we divide the sample into high-, medium-, and low-tech industries and rerun the regressions. The results are reported in Table 7. For the medium- and low-tech industries, the effect of FDI entry on firms' product scope is positive and statistically significant. FDI deregulation in medium- and low-tech industries leads to a 5% and 2% increase in the product scope of a firm in these industries, respectively. However, in the high-tech industry, the effect of FDI was insignificant. Therefore, FDI does not uniformly increase product innovation in industries with different technological intensities. Indigenous innovation probably plays a more critical role in high-tech industries than in medium- and low-tech industries.

In the second heterogeneity analysis, we consider whether the effect of FDI entry on product scope differs between SOEs and domestic private firms. In our sample, the mean product scopes of these two types of firms were 1.80, and 1.42, respectively. The product scope of SOEs was notably larger, presumably because they had better access to resources, and their product choices were heavily influenced by the state. To estimate whether the effect of FDI deregulation on product scope differs by ownership type, we ran separate regressions for SOEs and domestic private firms. As indicated by the first two columns of Table 8, FDI deregulation at the industry level is associated with a 4% increase in the product scope of SOEs and a 5% increase in the product scope of domestic private firms. Therefore, FDI entry has a strong positive effect on domestic private firms' product scope, which is the most important force behind China's economic growth. At the same time, SOEs' product innovation is also positively affected by entry of foreign firms.

Third, heterogeneity is the upstreamness of a firm's industry. In studies of global value chains, a notable observation is that the upstream stages of production and downstream stages generate more value added than the midstream stages Mudambi (2008). Thus, we conjecture that FDI may motivate more domestic innovation in upstream and downstream industries, in which the potential return on innovation is higher. We adopt the upstreamness concept of Antràs et al. (2012), in which an industry with a larger average distance from final use is considered to be upstream. After sorting the upstreamness level of 71 manufacturing industries based on the 2002 IO table of China, we define the top third of the industries as upstream, the next third as midstream, and the bottom third as downstream. The classification details are presented in Table 9. Running the regressions by upstreamness level, we obtain the results in columns (3)–(5) in Table 8. Consistent with our conjecture, the coefficients of $treat \times post$ suggest that FDI deregulation increases product scope in upstream and downstream industries but has no significant effect on product scope in midstream industries.

In the final heterogeneity analysis, we distinguish between entrant, incumbent, and exit firms. Following Dunne et al. (1988), for each year $t$, we define firms that appear in the sample in year $t$ but not in the previous period as entrant firms and firms present in year $t$ but not in the next period as exit firms. The remaining firms are incumbents in year $t$. With these definitions, we run regressions for three subsamples of firms (entrants, incumbents, and exit firms) and report the results in columns (1)–(3) of Table 10. To accommodate firm-level dynamics in entry and exit, we replace firm-fixed effects with industry-fixed effects in these regressions. For firms that are entrants and incumbents, FDI deregulation is estimated to have positive effects on product scope, and the coefficient on the treatment variable is considerably similar in magnitude in these two regressions. Finally, to exclude the effects of entry and exit dynamics, in column (4) of Table 10, we retain only firms that operate throughout the sample period of 2000–2007. The estimated effect of FDI deregulation (0.10) is substantially larger than the benchmark effect estimated for the full sample (0.05).

### 5.2 Alternative dependent variables

First, we analyse the radicality of innovation at the firm level by examining whether a firm adds a new product to the current industry, a different industry, or even a new sector.

Here, we define a sector as a 2-digit CIC code and maintain the definition of an industry as a 4-digit CIC code. In the whole sample, 3.58% of the firm-year observations firms report the addition of products. Within this total, in 2.30% of observations, firms add products in a 4-digit CIC industry in which they previously participated. In 1.28% of observations, firms add products in a new 4-digit CIC industry. Decomposing the product addition at the sector level, in 2.93% of observations, firms add products in the 2-digit CIC sector in which they operate, while in 0.65% of observations, firms add products in the new 2-digit CIC sector. Thus, most firms tend to add products in familiar industries and sectors, indicating that product innovation, on average, is more incremental than radical innovation.

Subsequently, we estimated the effect of FDI entry on radical and incremental product innovation using the linear probability model. To this end, we use four binary dependent variables for each firm: whether a firm adds products in a 4-digit CIC industry in which they previously participated, whether a firm adds products in a new 4-digit CIC industry, whether a firm adds products in a 2-digit CIC sector in which they previously operated, and whether a firm adds products in a new 2-digit CIC sector. The results in Table 11 suggest that FDI entry mainly promotes incremental product innovation within the same industry or sector but has no significant effect on radical product innovation at the firm level.

Next, we examine the measures of product dynamics finer than product scope. In general, changes in product scope are the result of the product-switching process, in which a firm chooses to add new products and keep or drop existing products. Following the definition of Bernard et al. (2010), we compute three measures of product switching, the rate of addition ($add\_rate$), the rate of retirement ($retire\_rate$), and the net rate of change ($net\_rate$), to capture the dynamics behind product scope. Specifically, they are defined as follows:

$$add\_rate_{ft} = \frac{product\_addition_{ft}}{total\_product_{ft-1}}$$
$$retire\_rate_{ft} = \frac{product\_retirement_{ft}}{total\_product_{ft-1}}$$
$$net\_rate_{ft} = add\_rate_{ft} - retire\_rate_{ft},$$

where *product_addition* is the number of products added, *product_retirement* is the number of retired products, and *total_product* is the total number of products. Using the three new measures as dependent variables, we rerun our regressions and report the results in columns (1)–(3) of Table 12. The results suggest that relaxation in FDI regulation is associated with a significant increase in the rate of adding new products (*add_rate*) but has no effect on the rate of dropping existing products (*drop_rate*). The effect of FDI on the net rate of product addition (*net_rate*), estimated to be 0.02, is mostly accounted for by the effect of FDI on the addition rate (0.02).

Finally, as TFP is an important measure of firm performance, it is often used as an outcome variable in studies of spillovers from FDI (Aitken and Harrison, 1999; Javorcik, 2004; Keller and Yeaple, 2009; Kee, 2015; Lu et al., 2017). While our focus is on product innovation as measured by product scope, we also ran a regression with TFP as the dependent variable and report the results in Table 13. The results indicate that the TFP of a domestic firm is negatively related to the entry of FDI into the firm's industry, which is consistent with the typical finding in the literature on the horizontal effect of FDI. Combined with our benchmark finding that FDI entry has a positive effect on the product scope of firms in the same industry, our study points to a nuanced picture of the horizontal spillovers of FDI.

### 5.3 Accounting for effects of trade liberalisation and yuan appreciation

During our sample period of 2000 to 2007, trade liberalisation and the appreciation of the Chinese yuan may also have contributed to the increase in the product scope of

Chinese firms. Trade liberalisation affects product scope through price and cost channels. First, after trade liberalisation lowers market prices and markups, firms are forced to give up products with low margins (Baldwin and Gu, 2009; Bernard et al., 2011; Eckel and Neary, 2010; Mayer et al., 2014). Second, as marginal cost increases with product scope, firms choose to reduce product scope and, hence, reduce the marginal cost to meet the competition associated with trade liberalisation (Nocke and Yeaple, 2014).

To account for trade liberalisation at both the industry and firm levels in the regression, we follow the approach of Yu (2015). For industry-level trade liberalisation, we introduce 2-digit industry-year fixed effects. For firm-level differences in tariffs on imported inputs, the measure is constructed as follows:

$$input\ tariff_{f,t} = \sum_{k \in O} \frac{m^k_{f,t0}}{\sum_{k \in M} m^k_{f,t0}} \cdot \tau^k_t \tag{2}$$

where $k, f, t$ and $t0$ are the indices for product, firm, time, and initial period, respectively. $input\ tariff_{f,t}$ is the average tariff level on firm $f$'s imported inputs in year $t$, $m^k_{f,t0}$ is firm $f$'s import of product $k$ in the initial period $t0$, and $\tau^k_t$ is the tariff level for product $k$ in year $t$. $M$ denotes the set of products imported by firm $f$. As the processing trade is exempt from import tariffs, we use information on ordinary trade to compute $input\ tariff_{f,t}$. To prevent the measure of the average tariff from being affected by the endogenous response in import volume to tariffs, we use only the initial import volume as the weight.

As for the measure of the tariff on output, Yu (2015) pointed out that its construction should use the fraction of domestic sales in the total output. Unfortunately, this information was unavailable. We follow Melitz (2003) and posit that an efficient firm should sell to both domestic and foreign markets. Thus, sales to a foreign market imply sales in the domestic market. Subsequently, we follow the practice of Yu (2015) to assume that the fraction of domestic sales is the same as foreign sales and replace the former with the latter. Consequently, the output tariff of firm $f$ in year $t$ can be expressed as

$$output\ tariff_{f,t} = \sum_k \frac{X^k_{f,t0}}{\sum_k X^k_{f,t0}} \cdot \tau^k_t \tag{3}$$

where $X^k_{f,t0}$ is the export of product $k$ by firm $f$ in the initial period $t0$, and $\tau^k_t$ is the export tariff. Similar to the construction of $input\ tariff_{f,t}$, we use the initial export volume as the weight throughout all years.

In the first two columns of Table 14, we introduce the average tariffs on imported inputs and outputs, respectively. All regressions include industry-year fixed effects. The coefficient of the treatment variable remained positive and statistically significant. Overall, after accounting for industry- and firm-level trade liberalisation, we find that FDI entry has positive effects on domestic firms' product scope.

As imported intermediate goods often embody better technology (Blalock and Veloso, 2007), and the import of intermediate inputs can boost the product scope of domestic firms (Kee, 2015), the yuan appreciation starting from July 2005 can increase product scope by making imported intermediate goods cheaper. Thus, we include the log of the number of imported intermediate goods in the regression to verify that FDI spillover effects are not confounded by the import of intermediate inputs.

We apply the Broad Economic Categories (BEC) classification to identify imported intermediate goods from a firm's imports and include the log of the number of intermediate products plus one in the benchmark regression. To be precise, we regard products with BEC codes of '111', '121', '21', '22', '31', '322', '42' and '53' as intermediate goods.[12] For non-importer firms, the number of imported intermediate goods was set to 0. The results, as shown in the last column of Table 14, indicate that the effect of FDI on product scope remains positive and significant, whereas imported intermediate inputs do not appear to

[12] These BEC codes correspond to food and beverages-primary-mainly for industry, food and beverages-processed-mainly for industry, industrial supplies not elsewhere specified-primary, industrial supplies not elsewhere specified-processed, fuels and lubricants-primary, fuels and lubricants-processed-other, capital goods (except transport equipment) and parts and accessories thereof-parts and accessories, and transport equipment and parts and accessories thereof-parts and accessories.

have a significant effect.

### 5.4 Alternative identification strategy

We consider two alternatives to the DID regression used in the baseline results. The first was based on the event study method and the second on the synthetic control method. First, we follow Kline (2012) and Abebe et al. (2022) and employ the event study method to verify the parallel trend assumption. In equation (4), we introduce a set of interactions between the treatment indicator and year dummies $(treat_i \times post_t)^j$ to capture the time trend.

$$ln(scope_{fit}) = \beta_0 + \sum_{j=-2, j\neq 0}^{j=5} \gamma_j (treat_i \times post_t)^j + \rho X_{fit} + \gamma_f + \delta_t + \epsilon_{ft}. \quad (4)$$

The dummy variable $post_t^j$ takes the value of 1 if year $t$ is $j$ years apart from the impact year and 0 otherwise. When negative, the superscript $j$ indicates that year $t$ is $j$ years before the relaxation of the FDI entry policy. By symmetry, a positive value of $j$ indicates that year $t$ is $j$ years after the relaxation of FDI entry policy. After centring the estimates on the year of the policy change (year 0), we summarise the trend of the coefficient on $(treat_i \times post_t)^j$ with their respective 95% confidence intervals in Figure 4.

Clearly, when $j$ is equal to -2 and -1, the coefficients on the dummies are not statistically different from 0. Two years after the policy change—for the $j$ value of 2—the coefficients of the interactions increase sharply and become statistically significant, indicating a strong effect of FDI entry on the product scope. The effect of policy change emerges with a lag, which might appear puzzling. A natural conjecture is that the lag in policy effect is caused by the delayed increase in actual FDI entry post-policy change in 2002. To this end, we plot the inflows of FDI in manufacturing against time in Figure 5 which shows that FDI inflows indeed exhibited notable increase in 2004. In subsequent years, the coefficients on the interaction terms are of similar magnitude, which suggests that the effect of FDI entry on product scope is persistent.

Second, we use the synthetic control DID method of Arkhangelsky et al. (2021) to identify the effect of FDI on product scope. Relative to conventional DID, synthetic DID provides a more robust identification strategy because the use of a synthetic control group reduces reliance on the parallel trend assumption. The regression results reported in the first column of Table 15 confirm that FDI has a significant and positive effect on product scope. As synthetic methods require a balanced panel, the sample size is 49,432, which is significant below 338,203 in the baseline regression. While the size of the coefficient (0.17) is large in a practical sense in the balanced panel, the difference from the baseline estimate (0.05) cannot be attributed to the difference in identification strategy alone. This is because the baseline results are obtained from an unbalanced sample. To see the difference in estimated effects between the baseline DID and the synthetic DID, in column (2) of Table 15, we report the baseline DID regression estimated with the balanced panel. The coefficient of the baseline DID (0.10) was significantly smaller than that of the synthetic DID (0.17). Thus, the estimated spillovers are robust and large for the synthetic DID model.

# 6 Conclusion

During the era of 'reform and opening up', China has become an important economy in terms of attracting FDI and contributing to global manufacturing output. This study addressed whether and how FDI contributes to product innovation in China. Exploiting the WTO entry-related policy change in 2002 that eased FDI entry for several industries, we used the DID model to estimate the causal effect of FDI entry on domestic Chinese firms' product scope.

Our analysis of product scope leads to four main findings. First, FDI is an important factor in explaining product innovation in China. After the WTO-related policy overhaul on FDI regulation in 2002, the product scope of domestic Chinese firms in industries that enjoyed a relaxation in FDI entry increased by 5% on average. Second, besides the horizontal effects that occur within an industry, FDI also affects product scope along vertical linkages. The product scope of domestic firms is positively (negatively) affected by FDI entry in upstream (downstream) industries. Third, we find two FDI channels that increase domestic firms' product scope. FDI contributes to product innovation by inducing local firms to increase R&D expenditures and shortening the technological distance between Chinese industries and the world frontier. Fourth, the positive effect of FDI on the product scope is found in medium- and low-tech industries but not in high-tech industries. Thus, FDI has limitations in enhancing domestic product innovation. The main findings remain robust when we include alternative factors that may contribute to product innovation and adopt alternative measures of product innovation.

Overall, our study presents strong evidence that FDI entry contributes to product innovation of domestic firms, which has important implications for economic growth and development. However, much remains to be explored in product-scope research. For instance, our identification and estimation are based on a one-time policy change. Future research could exploit better data and alternative identification schemes to estimate the long-term effects of FDI on product innovation.

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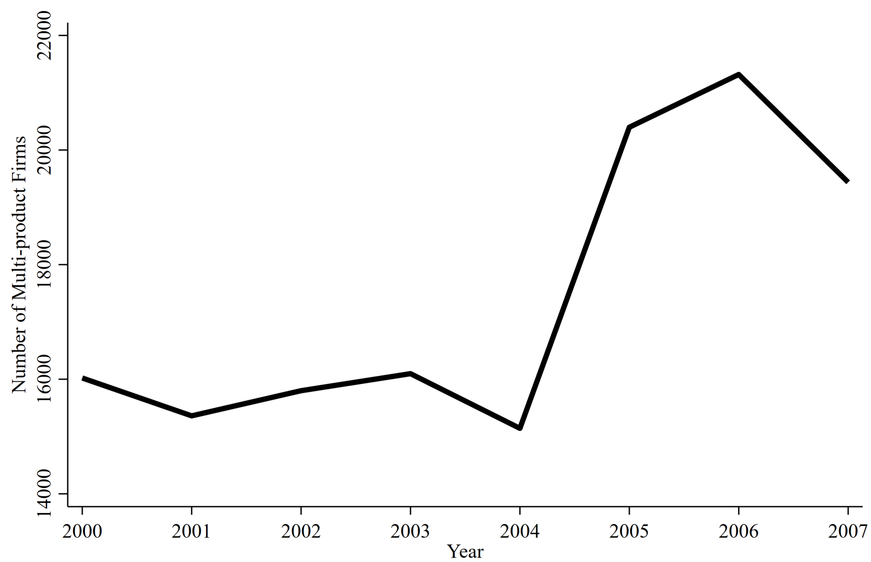
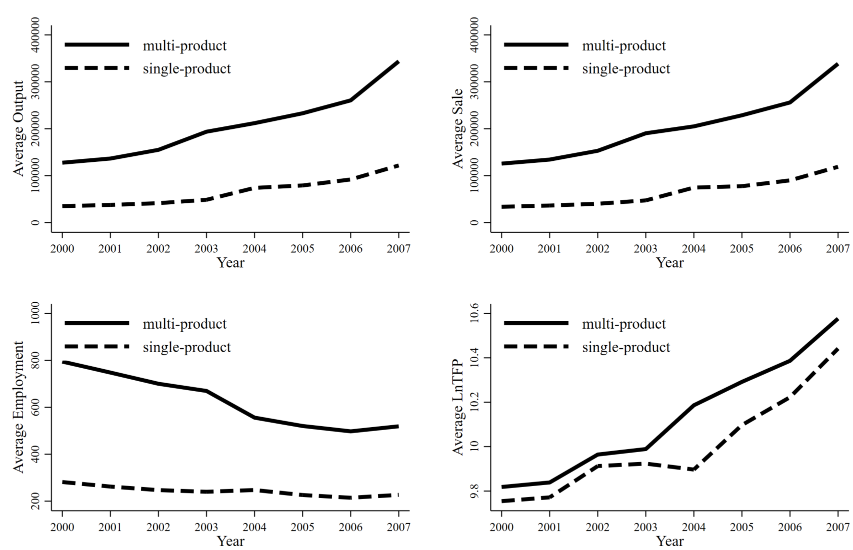


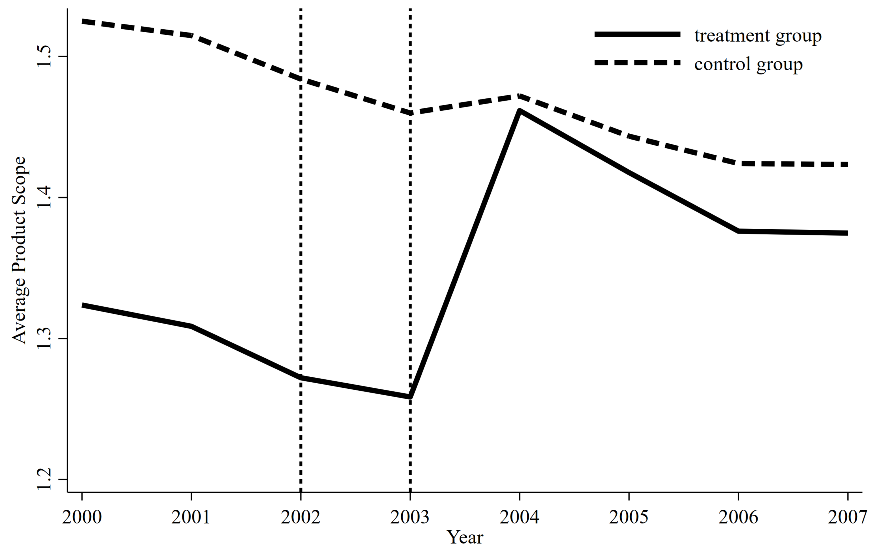

Source: authors' calculation based on the CIPO

Figure 1: Numbers of Multi-Product Firms



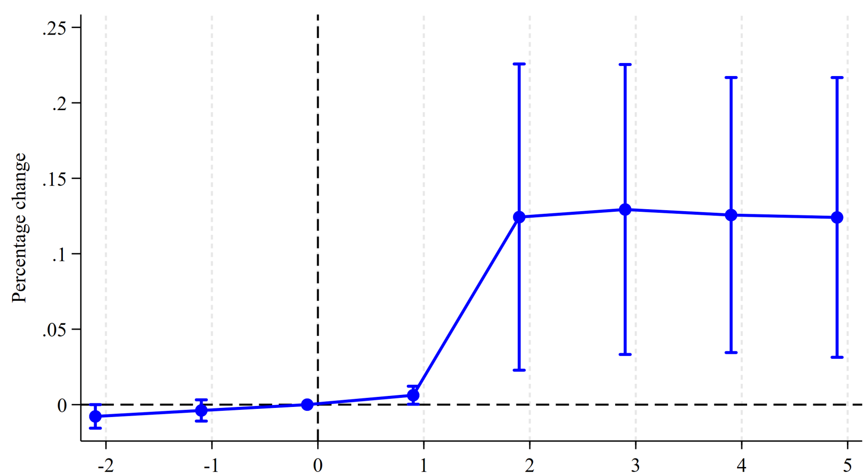

Source: authors' calculation based on the CIPO and ASIF

Figure 2: Performance Differences between Multi-product Firms and Single-product Firms



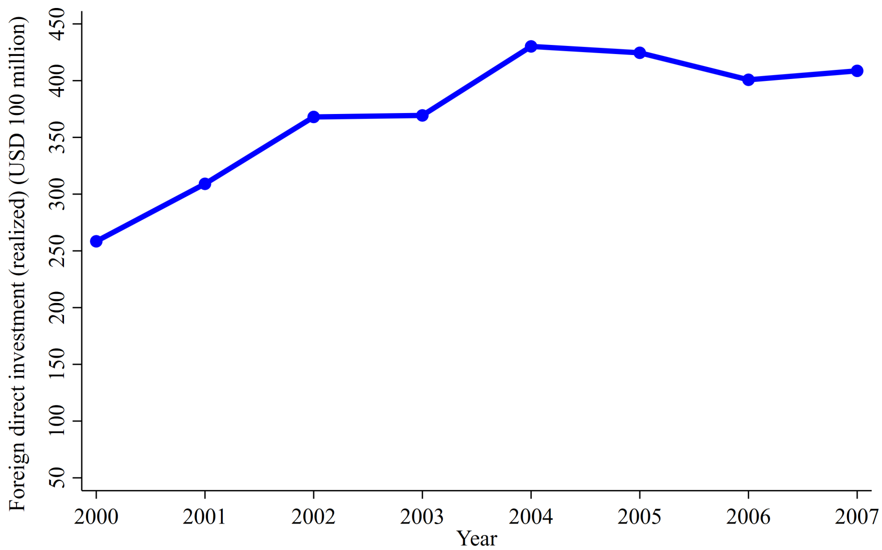

Source: authors' calculation based on the CIPO and ASIF

Figure 3: Trends of Average Product Scope for Treatment Group and Control Group




Source: authors' calculation

Figure 4: Effects of FDI Policy Change on Product Scope Based on Event Study




Source: authors' calculation

Figure 5: Foreign Direct Investment Flows in the Manufacturing Sector in Chian

Table 1: Summary Statistics

| Type of firm | Share of firms average | Average product scope | Share of output | Share of employment | Average TFP |
|---|---|---|---|---|---|
| Single-product firms | 67.83% | 1 | 40.03% | 45.29% | 10.03 |
| Multi-product firms | 32.17% | 2.51 | 59.97% | 54.71% | 10.16 |
| | Mean | Observations | Standard Deviation | Min | Max |
| scope | 1.42 | 338,203 | 0.73 | 1 | 5 |
| lnScope | 0.26 | 338,203 | 0.40 | 0 | 1.61 |
| treat | 0.36 | 338,203 | 0.48 | 0.00 | 1 |
| post | 0.79 | 338,203 | 0.41 | 0 | 1 |
| lnOutput | 10.16 | 338,203 | 1.21 | 6.62 | 14.03 |
| lnAge | 2.18 | 338,203 | 0.90 | 0 | 4.03 |
| lnKL | 0.04 | 338,203 | 0.01 | 0 | 0.06 |
| FinAbility | 0.05 | 338,203 | 0.08 | -0.02 | 0.74 |
| export | 0.20 | 338,203 | 0.40 | 0 | 1 |
| SOE | 0.12 | 338,203 | 0.33 | 0 | 1 |

Note: This table reports the number of observations, mean, standard deviation, minimum and maximum value for the following key variables: firm product scope and its log, the fraction of observations subject to treatment, the fraction of observations in the post policy change period, log of firm output, log of firm age, log of firm capital-intensity, financing ability, indicator for exporter, and indicator for SOEs.

Table 2: Baseline Results for FDI Spillovers through the Horizontal Linkage

| Dependent Variable: lnScope | (1) | (2) | (3) |
|---|---|---|---|
| treat × post | 0.06** | 0.06** | 0.05*** |
| | (0.03) | (0.03) | (0.02) |
| lnOutput | | 0.01*** | 0.01*** |
| | | (0.002) | (0.002) |
| lnAge | | 0.004 | 0.005** |
| | | (0.003) | (0.002) |
| lnKL | | 0.02 | 0.06 |
| | | (0.19) | (0.16) |
| FinAbility | | -0.001 | 0.002 |
| | | (0.01) | (0.01) |
| export | | 0.01*** | 0.01*** |
| | | (0.004) | (0.004) |
| SOE | | 0.01*** | 0.01** |
| | | (0.005) | (0.005) |
| Dependent Variable's Mean | 0.26 | 0.26 | 0.26 |
| Firm fixed effects | Y | Y | Y |
| Year fixed effects | Y | Y | Y |
| Pre-determined industry controls | Y | Y | Y |
| Tariff in 2001×year dummy | N | N | Y |
| Proportion of SOE in 2001×year dummy | N | N | Y |
| Constant | 0.44*** | 0.29** | 0.21** |
| | (0.11) | (0.12) | (0.08) |
| Observations | 338,203 | 338,203 | 338,203 |
| R-squared | 0.89 | 0.89 | 0.89 |

Notes: 1) The variables *treat*, *lnOutput*, *lnAge*, *lnKL*, *FinAbility*, *export*, and *SOE* are the treatment variable associated with the 2002 policy change, log of firm output, log of firm age, log of firm's capital intensity, firm's financial ability, indicator for exporter, and indicator for SOE. Tariff is the 4-digit industry-level ad volorem tariff in 2001.
2) ***, **, * denote significance at the 1%, 5% and 10% level, respectively. The standard errors reported in parentheses are clustered at the level 4-digit industry.

Table 3: FDI Spillovers Along the Vertical Linkages

| Dependent Variable: lnScope | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| treat×post | 0.06*** | 0.05*** | 0.06*** | 0.05*** |
| | (0.02) | (0.02) | (0.02) | (0.02) |
| $\text{treat}^{forward}$ ×post | 0.17** | | 0.20** | 0.22*** |
| | (0.08) | | (0.08) | (0.08) |
| $\text{treat}^{backward}$ ×post | | -0.16*** | -0.18*** | |
| | | (0.06) | (0.06) | |
| $\text{treat}^{backward}_{low\ processing}$×post | | | | -0.05 |
| | | | | (0.13) |
| $\text{treat}^{backward}_{high\ processing}$ ×post | | | | -0.24*** |
| | | | | (0.08) |
| Dependent Variable Mean's | 0.26 | 0.26 | 0.26 | 0.26 |
| Firm fixed effects | Y | Y | Y | Y |
| Year fixed effects | Y | Y | Y | Y |
| Pre-determined industry controls | Y | Y | Y | Y |
| Time-varying firm controls | Y | Y | Y | Y |
| Tariff in 2001×year dummy | Y | Y | Y | Y |
| Proportion of SOE in 2001×year dummy | Y | Y | Y | Y |
| Constant | 0.20** | 0.21*** | 0.20** | 0.20** |
| | (0.08) | (0.08) | (0.08) | (0.08) |
| Observations | 336,827 | 336,827 | 336,827 | 336,827 |
| R-squared | 0.89 | 0.89 | 0.89 | 0.89 |

Notes: 1) The variables *treat* is the treatment variable associated with the 2002 policy change. $treat^{forward}$, $treat^{backward}$, $treat^{backward}_{low\ processing}$ and $treat^{backward}_{high\ processing}$ are treatment variables for forward FDI linkage, backward FDI linkage, backward FDI linkage from industries with below median processing trade, and backward FDI linkage from industries with above median processing trade.
2) The time-varying firm control variables are log of firm output, log of firm age, log of firm's capital intensity, firm's financial ability, indicator for exporter, and indicator for SOE. Tariff is the 4-digit industry-level ad volorem tariff in 2001. Proportion of SOE is calculated by the ratio of SOE in each 4-digit industry in 2001.
3) ***, **, * denote significance at the 1%, 5% and 10% level, respectively. The standard errors reported in parentheses are clustered at the level 4-digit industry.

Table 4: Firm-level Channels

| Dependent Variables: | lnR&D | ME distance |
|---|---|---|
| | (1) | (2) |
| treat×post | 0.05* | -0.08 |
| | (0.02) | (0.06) |
| | | |
| Dependent Variable's Mean | 0.66 | -0.01 |
| Firm fixed effects | Y | Y |
| Year fixed effects | Y | Y |
| Pre-determined industry controls | Y | Y |
| Time-varing firm controls | Y | Y |
| Tariff in 2001×year dummy | Y | Y |
| Proportion of SOE in 2001×year dummy | Y | Y |
| Constant | -1.37*** | 6.21*** |
| | (0.20) | (0.23) |
| Observations | 235,991 | 261,720 |
| R-squared | 0.71 | 0.34 |

Note: 1) The dependent variables are log R&D expenditure at firm level, and the distance between a firm's managerial efficiency and the frontier level, respectively.
2) The variables *treat* is the treatment variable associated with the 2002 policy change. The time-varying firm control variables are log of firm output, log of firm age, log of firm's capital intensity, firm's financial ability, indicator for exporter, and indicator for SOE. Tariff is the 4-digit industry-level ad volorem tariff in 2001. Proportion of SOE is calculated by the ratio of SOE in each 4-digit industry in 2001.
3) ***, **, * denote significance at the 1%, 5% and 10% level, respectively. The standard errors reported in parentheses are clustered at the level 4-digit industry.

Table 5: Industry-level Channels

| Dependent Variables: | Technology distance | Misallocation |
|---|---|---|
| | (1) | (2) |
| treat×post | -2.13*** | 0.01 |
| | (0.81) | (0.03) |
| | | |
| Dependent Variable's Mean | 19.58 | 0.96 |
| Industry fixed effects | Y | Y |
| Year fixed effects | Y | Y |
| Pre-determined industry controls | Y | Y |
| Time-varying industry controls | Y | Y |
| Tariff in 2001×year dummy | Y | Y |
| Proportion of SOE in 2001×year dummy | Y | Y |
| Constant | 43.41*** | -0.01 |
| | (5.23) | (0.25) |
| Observations | 3,035 | 2,907 |
| R-squared | 0.85 | 0.47 |

Note: 1) The dependent variables are the distance between an industry's labour productivity and the world frontier level, and the degree of resource misallocation at industry level which is measured by the standard deviation of log TFP within an industry, respectively.
2) The variables *treat* is the treatment variable associated with the 2002 policy change. The time-varying industry control variables are log of average industry output, log of average industry age, log of industry's average capital intensity, industry's average financial ability, share of exporter and SOE. Tariff is the 4-digit industry-level ad volorem tariff in 2001. Proportion of SOE is calculated by the ratio of SOE in each 4-digit industry in 2001.
3) ***, **, * denote significance at the 1%, 5% and 10% level, respectively. The standard errors reported in parentheses are clustered at the level 4-digit industry.

Table 6: OECD Technolog Classification (GB/T 4754-2002)

| | |
|---|---|
| High-tech industries | |
| Manufacture of medicines | 27 |
| Manufacture of medical equipment and instruments | 368 |
| Manufacture of postal machinery and equipment | 3693 |
| Manufacture of aerospace vehicles | 376 |
| Manufacture of power electronics components | 3924 |
| Manufacture of communications equipment, computers and other electronic equipment (excl. other electronic equipments) | 40 (excl. 4090) |
| Measuring instruments and machinery for cultural activity and office work (excl. special instruments for teaching) | 41 (excl. 4126) |
| Medium-tech industries | |
| Processing of salt | 1493 |
| Manufacture of stationery | 2411 |
| Manufacture of ink | 2414 |
| Processing of petroleum, coking, and nuclear fuel | 25 |
| Manufacture of chemical raw materials and chemical products | 26 |
| Manufacture of chemical fibers (excl. chemical fiber pulp) | 28 (excl. 2811) |
| Manufacture of rubber (excl. rubber boots) | 29 (excl. 2960) |
| Manufacture of plastics (excl. plastic shoes) | 30 (excl. 3081) |
| Manufacture of non-metallic mineral products (excl. waterproof building materials) | 31 (excl. 3134) |
| Smelting and processing of ferrous metals | 32 |
| Smelting and processing of non-ferrous metals | 33 |
| Manufacture of metal products (excl. coins and precious metal laboratory supplies) | 34 (excl. 3491) |
| Manufacture of general purpose machinery | 35 |
| Manufacture of special equipment (excl. manufacture of medical equipment and instruments,and postal machinery and equipment) | 36 (excl. 368; 3693) |
| Manufacture of transport equipment (excl. aerospace vehicles) | 37 (excl. 376) |
| Manufacture of electrical machinery and equipment (excl. power electronics components) | 39 (excl. 3924) |
| Manufacture of other electronic equipments | 4090 |

| | |
|---|---|
| Manufacture of sculpturing handicraft | 4211 |
| Manufacture of metal handicraft | 4212 |
| processing of mirror and similar products making | 4221 |
| Low-tech industries | |
| Processing of food from agricultural products | 13 |
| Manufacture of foods (excl. processing of salt) | 14 (excl. 1493) |
| Manufacture of beverages | 15 |
| Manufacture of tobacco | 16 |
| Manufacture of textiles | 17 |
| Manufacture of textile,apparel, footwear, and caps | 18 |
| Manufacture of leather, fur, feather and related products | 19 |
| Processing of timber, manufacture of wood, bamboo, rattan, palm, and straw products | 20 |
| Manufacture of furniture | 21 |
| Manufacture of paper and paper products | 22 |
| Printing and recorded media | 23 |
| Manufacture of articles for culture, education and sport activity (excl. manufacture of ink) | 24 (excl. 2414) |
| Manufacture of other daily chemicals | 2679 |
| Manufacture of sanitary materials and medical supplies | 2770 |
| Manufacture of chemical fiber pulp | 2811 |
| Manufacture of rubber boots | 2960 |
| Manufacture of plastic shoes | 3081 |
| Manufacture of waterproof building materials | 3134 |
| Manufacture of coins and precious metal laboratory supplies | 3491 |
| Manufacture of special instruments for teaching | 4126 |
| Manufacture of artwork and other manufacturing (excl. sculpturing handicraft; metal handicraft; mirror and similar products making; coal products) | 42 (excl. 4211; 4212; 4221; 4230) |

Note: This table reportes the detailed technology indtensity industry classification based on OECD. Different from the CIC code adjusted based on Brandt et al.(2012) in the empirical regressions, in order to show the industry name and better understand the classification, we show this table with the CIC system of GB/T 4754-2002 version.

Table 7: Effects of FDI on Product Scope by Technology Intensity

| Dependent Variable: lnScope | High-tech (1) | Medium-tech (2) | Low-tech (3) |
|---|---|---|---|
| treat×post | -0.02 | 0.05*** | 0.02* |
| | (0.03) | (0.01) | (0.01) |
| Dependent Variable's Mean | 0.14 | 0.19 | 0.33 |
| Firm fixed effects | Y | Y | Y |
| Year fixed effects | Y | Y | Y |
| Pre-determined industry controls | Y | Y | Y |
| Time-varying firm controls | Y | Y | Y |
| Tariff in 2001×year dummy | Y | Y | Y |
| Proportion of SOE in 2001×year dummy | Y | Y | Y |
| Constant | -0.01 | 0.33*** | 0.17** |
| | (0.12) | (0.11) | (0.06) |
| Observations | 5,590 | 165,921 | 166,272 |
| R-squared | 0.85 | 0.86 | 0.93 |

Notes: 1) The variables *treat* is the treatment variable associated with the 2002 policy change. The time-varying firm control variables are log of firm output, log of firm age, log of firm's capital intensity, firm's financial ability, indicator for exporter, and indicator for SOE. Tariff is the 4-digit industry-level ad volorem tariff in 2001. Proportion of SOE is calculated by the ratio of SOE in each 4-digit industry in 2001.
2) ***, **, * denote significance at the 1%, 5% and 10% level, respectively. The standard errors reported in parentheses are clustered at the level 4-digit industry.

Table 8: Heterogeneity Analysis of SOE vs. Non-SOE Firms, and Firms by Upstreamness of Their Industries

| Dependent Variable: lnScope | Ownership | | Upstreamness | | |
|---|---|---|---|---|---|
| | SOE | Non-SOE Firms | Upstream | Midstream | Downstream |
| | (1) | (2) | (3) | (4) | (5) |
| treat×post | 0.04*** | 0.05*** | 0.04*** | 0.01 | 0.07*** |
| | (0.01) | (0.02) | (0.01) | (0.01) | (0.01) |
| Dependent Variable's Mean | 0.35 | 0.24 | 0.19 | 0.22 | 0.34 |
| Firm fixed effects | Y | Y | Y | Y | Y |
| Year fixed effects | Y | Y | Y | Y | Y |
| Pre-determined industry controls | Y | Y | Y | Y | Y |
| Time-varing firm controls | Y | Y | Y | Y | Y |
| Tariff in 2001×year dummy | Y | Y | Y | Y | Y |
| Proportion of SOE in 2001 ×year dummy | Y | Y | Y | Y | Y |
| Constant | 0.16 | 0.23*** | -0.16 | 0.01 | 0.16* |
| | (0.18) | (0.07) | (0.12) | (0.03) | (0.08) |
| Observations | 38,960 | 294,160 | 84,711 | 129,809 | 123,683 |
| R-squared | 0.90 | 0.90 | 0.88 | 0.92 | 0.90 |

Note: 1) The subsamples contain firms that are SOEs, non-SOEs, in upstream industries, in midstream industries, and downstream industries, respectively.
2) The variables *treat* is the treatment variable associated with the 2002 policy change. The time-varying firm control variables are log of firm output, log of firm age, log of firm's capital intensity, firm's financial ability, indicator for exporter, and indicator for SOE. Tariff is the 4-digit industry-level ad volorem tariff in 2001. Proportion of SOE is calculated by the ratio of SOE in each 4-digit industry in 2001.
3) ***, **, * denote significance at the 1%, 5% and 10% level, respectively. The standard errors reported in parentheses are clustered at the level 4-digit industry.

Table 9: Classification Based on 2002 Input-Output Table of China

| | |
|---|---|
| Upstream | |
| | Manufacture of basic chemical raw materials |
| | Smelting of non-ferrous metals |
| | Waste products |
| | Manufacture of special chemical products |
| | Manufacture of coatings, pigments, inks and similar products |
| | Manufacture of Electronic components |
| | Smelting of ferroalloy |
| | Manufacture of synthetic materials |
| | Coking |
| | Smelting of iron |
| | Manufacture of chemical fibers |
| | Processing of non-ferrous metals |
| | Manufacture of cultural and office machinery |
| | Manufacture of plastic products |
| | Smelting of Steel |
| | Processing of petroleum and nuclear fuel |
| | Manufacture of other computer equipment |
| | Manufacture of glass and glass products |
| | Manufacture of paper and paper products |
| | Manufacture of rubber products |
| | Manufacture of other electrical machinery and equipment |
| | Manufacture of auto parts and accessories |
| | Manufacture of shipbuilding and floating device |
| | Manufacture of pesticide |
| Midstream | |
| | Manufacture of leather, fur, feather and related products |
| | Manufacture of computer machine |
| | Manufacture of daily chemical products |
| | Manufacture of metal processing machinery |
| | Processing of feed |
| | Manufacture of home audio visual equipment |
| | Manufacture of boiler and prime mover |
| | Manufacture of other non-ferrous metals products |
| | Manufacture of knitwear, knitted goods and their products |
| | Hemp textile, silk textile and finishing |
| | Manufacture of refractory products |
| | Manufacture of articles for culture |
| | Processing of wood and manufacture of wood, bamboo, rattan, palm and grass products |

| | |
|---|---|
| | Manufacture of motor |
| | Manufacture of fertilizer |
| | Processing of steel |
| | Manufacture of other communication and electronic equipment |
| | Printing and reproduction of recording media |
| | Manufacture of other general purpose machinery |
| | Manufacture of textile products |
| | Wool textile, dyeing and finishing |
| | Manufacture of metal products |
| | Manufacture of measuring instruments |
| | Cotton, chemical fiber textile, printing, dyeing and finishing |
| Downstream | |
| | Processing of other food and manufacture of food |
| | Manufacture of toy, sports and entertainment products |
| | Manufacture of Special purpose machinery for agriculture, forestry, animal husbandry and fishery |
| | Manufacture of crafts and art production |
| | Manufacture of tobacco products |
| | Manufacture of other beverage |
| | Milling of grain |
| | Sugar |
| | Processing of vegetable oil |
| | Processing of aquatic products |
| | Manufacture of textile,apparel, footwear, and caps |
| | Manufacture of medicines |
| | Manufacture of alcohol and beverage |
| | Slaughtering and processing of meat |
| | Manufacture of household appliance |
| | Manufacture of cement, lime and gypsum |
| | Manufacture of other special purpose machinery |
| | Manufacture of communication equipment |
| | Manufacture of automobile |
| | Manufacture of other transport equipment |
| | Manufacture of furniture |
| | Manufacture of ceramics |
| | Manufacture of railway transport equipment |

Table 10: Heterogeneity Analysis of Entrants, Incumbents, and Exit Firms

| Dependent Variable: lnScope | Entrants (1) | Incumbents (2) | Exit firms (3) | Stayers (4) |
|---|---|---|---|---|
| treat×post | 0.06* | 0.07* | 0.03 | 0.10*** |
| | (0.03) | (0.04) | (0.02) | (0.03) |
| | | | | |
| Dependent Variable's Mean | 0.22 | 0.28 | 0.24 | 0.33 |
| Firm fixed effects | N | N | N | Y |
| Year fixed effects | Y | Y | Y | Y |
| Pre-determined industry controls | Y | Y | Y | Y |
| Time-varing firm controls | Y | Y | Y | Y |
| Industry fixed effects | Y | Y | Y | N |
| Tariff in 2001×year dummy | Y | Y | Y | Y |
| Proportion of SOE in 2001 ×year dummy | Y | Y | Y | Y |
| Constant | -0.17*** | -0.29*** | -0.09 | 0.31*** |
| | (0.05) | (0.10) | (0.13) | (0.10) |
| Observations | 62,496 | 154,349 | 40,594 | 58,159 |
| R-squared | 0.47 | 0.44 | 0.40 | 0.84 |

Note: 1) The subsamples contain firms that are entrants in year t, incumbents in year t, exit firms in year t + 1, and firms present throughout the whole sample period (stayers), respectively.
2) The variables *treat* is the treatment variable associated with the 2002 policy change. The time-varying firm control variables are log of firm output, log of firm age, log of firm's capital intensity, firm's financial ability, indicator for exporter, and indicator for SOE. Tariff is the 4-digit industry-level ad volorem tariff in 2001. Proportion of SOE is calculated by the ratio of SOE in each 4-digit industry in 2001.
3) ***, **, * denote significance at the 1%, 5% and 10% level, respectively. The standard errors reported in parentheses are clustered at the level 4-digit industry.

Table 11: Regressions of Radical and Incremental Innovation

| Dependent Variables: | Add same industry (1) | Add different industry (2) | Add same sector (3) | Add different sector (4) |
|---|---|---|---|---|
| treat×post | 0.01* | 0.001 | 0.02* | -0.0002 |
| | (0.01) | (0.002) | (0.01) | (0.002) |
| Dependent Variable's Mean | 0.03 | 0.02 | 0.04 | 0.01 |
| Firm fixed effects | Y | Y | Y | Y |
| Year fixed effects | Y | Y | Y | Y |
| Pre-determined industry controls | Y | Y | Y | Y |
| Time-varing firm controls | Y | Y | Y | Y |
| Tariff in 2001×year dummy | Y | Y | Y | Y |
| Proportion of SOE in 2001 ×year dummy | Y | Y | Y | Y |
| Constant | -0.06* | 0.02 | -0.05 | 0.01 |
| | (0.03) | (0.02) | (0.03) | (0.01) |
| Observations | 234,227 | 234,227 | 234,227 | 234,227 |
| R-squared | 0.37 | 0.30 | 0.37 | 0.29 |

Note: 1) The dependent variables are indicators for adding a new product in the same industry, a new industry, the same sector, and a new sector, respectively.
2) The variables *treat* is the treatment variable associated with the 2002 policy change. The time-varying firm control variables are log of firm output, log of firm age, log of firm's capital intensity, firm's financial ability, indicator for exporter, and indicator for SOE. Tariff is the 4-digit industry-level ad volorem tariff in 2001. Proportion of SOE is calculated by the ratio of SOE in each 4-digit industry in 2001.
3) ***, **, * denote significance at the 1%, 5% and 10% level, respectively. The standard errors reported in parentheses are clustered at the level 4-digit industry.

Table 12: Regressions of Product Turnover Rates

| Dependent Variables: | Add rate | Retire rate | Net rate |
|---|---|---|---|
| | (1) | (2) | (3) |
| treat×post | 0.02** | -0.002 | 0.02*** |
| | (0.01) | (0.01) | (0.01) |
| Dependent Variable's Mean | 0.04 | 0.03 | 0.01 |
| Firm fixed effects | Y | Y | Y |
| Year fixed effects | Y | Y | Y |
| Pre-determined industry controls | Y | Y | Y |
| Time-varing firm controls | Y | Y | Y |
| Tariff in 2001×year dummy | Y | Y | Y |
| Proportion of SOE in 2001×year dummy | Y | Y | Y |
| Constant | -0.01 | 0.08*** | -0.09*** |
| | (0.04) | (0.02) | (0.03) |
| Observations | 234,227 | 234,227 | 234,227 |
| R-squared | 0.35 | 0.36 | 0.28 |

Note: 1) The dependent variables are the rate of adding new products, the rate of retiring products, and the net rate of adding new products, respectively.
2) The variables *treat* is the treatment variable associated with the 2002 policy change. The time-varying firm control variables are log of firm output, log of firm age, log of firm's capital intensity, firm's financial ability, indicator for exporter, and indicator for SOE. Tariff is the 4-digit industry-level ad volorem tariff in 2001. Proportion of SOE is calculated by the ratio of SOE in each 4-digit industry in 2001.
3) ***, **, * denote significance at the 1%, 5% and 10% level, respectively. The standard errors reported in parentheses are clustered at the level 4-digit industry.

Table 13: Regression of TFP

| Dependent Variable: | ln(TFP) |
|---|---|
| | (1) |
| treat×post | -0.11** |
| | (0.05) |
| | |
| Dependent Variable's Mean | 10.11 |
| Firm fixed effects | Y |
| Year fixed effects | Y |
| Pre-determined industry controls | Y |
| Time-varying firm controls | Y |
| tariff, 2001×year dummy | Y |
| Proportion of SOE, 2001×year dummy | Y |
| Constant | 1.96*** |
| | (0.17) |
| Observations | 329,900 |
| R-squared | 0.90 |

Notes: 1) The variables *treat* is the treatment variable associated with the 2002 policy change. The time-varying firm control variables are log of firm output, log of firm age, log of firm's capital intensity, firm's financial ability, indicator for exporter, and indicator for SOE. Tariff is the 4-digit industry-level ad volorem tariff in 2001. Proportion of SOE is calculated by the ratio of SOE in each 4-digit industry in 2001.
2) ***, **, * denote significance at the 1%, 5% and 10% level, respectively. The standard errors reported in parentheses are clustered at the level 4-digit industry.

Table 14: Regressions with Trade Liberalisation and Intermediate Inputs

| Dependent Variable: lnscope | (1) | (2) | (3) |
|---|---|---|---|
| treat×post | 0.03** | 0.04** | 0.05*** |
| | (0.01) | (0.02) | (0.02) |
| ouput tariff | 0.003 | | |
| | (0.01) | | |
| input tariff | | 0.02 | |
| | | (0.01) | |
| ln(no. of intermediate inputs) | | | 0.002 |
| | | | (0.003) |
| | | | |
| Dependent Variable's Mean | 0.35 | 0.38 | 0.26 |
| Firm fixed effects | Y | Y | Y |
| Year fixed effects | N | N | Y |
| Pre-determined industry controls | Y | Y | Y |
| Time-varing firm controls | Y | Y | Y |
| Sector-year fixed effects | Y | Y | N |
| Tariff in 2001×year dummy | Y | Y | Y |
| Proportion of SOE in 2001 ×year dummy | Y | Y | Y |
| Constant | 0.09 | 0.06 | 0.21** |
| | (0.08) | (0.11) | (0.08) |
| Observations | 37,834 | 20,315 | 338,203 |
| R-squared | 0.93 | 0.92 | 0.89 |

Note: 1) The variables *treat* is the treatment variable associated with the 2002 policy change. *output tariff*, *input tariff* and ln(*no.ofintermediateinputs*) are the trade-weighted output tariff, trade-weighted input tariff, and the log of the number of intermediate inputs used at the firm level, respectively. The time-varying firm control variables are log of firm output, log of firm age, log of firm's capital intensity, firm's financial ability, indicator for exporter, and indicator for SOE. Tariff is the 4-digit industry-level ad volorem tariff in 2001. Proportion of SOE is calculated by the ratio of SOE in each 4-digit industry in 2001.
2) ***, **, * denote significance at the 1%, 5% and 10% level, respectively. The standard errors reported in parentheses are clustered at the level 4-digit industry.

Table 15: Alternative Identification Using Synthetic DID

| Dependent Variable: lnScope | Synthetic DID | DID |
|---|---|---|
| | (1) | (2) |
| treat×post | 0.17*** | 0.10*** |
| | (0.01) | (0.03) |
| | | |
| Dependent Variable's Mean | 0.33 | 0.33 |
| Firm fixed effects | Y | Y |
| Year fixed effects | Y | Y |
| Pre-determined industry controls | Y | Y |
| Time-varying firm controls | Y | Y |
| Tariff, 2001×year dummy | Y | Y |
| Proportion of SOE, 2001×year dummy | Y | Y |
| Constant | - | 0.32*** |
| | - | (0.09) |
| Observations | 49,432 | 49,432 |

Notes: 1) The variables *treat* is the treatment variable associated with the 2002 policy change. The time-varying firm control variables are log of firm output, log of firm age, log of firm's capital intensity, firm's financial ability, indicator for exporter, and indicator for SOE. Tariff is the 4-digit industry-level ad volorem tariff in 2001. Proportion of SOE is calculated by the ratio of SOE in each 4-digit industry in 2001.
2) ***, **, * denote significance at the 1%, 5% and 10% level, respectively. The standard errors reported in parentheses are clustered at the level 4-digit industry.

## Appendix

In this appendix, we explain and justify the definition of products in the China Product Output Database. In this database, products are coded in 5-digit codes (hereinafter, "original codes") which are augmented by product names. The total number of codes is 729. We follow the literature (e.g., Bernard et al. 2010) in identifying products with the 5-digit product codes. However, because the 5-digit original codes we used are not organized in the SIC system and hence not equivalent to the 5-digit SIC codes used by Bernard et al. 2010, in order to ensure that the original codes can be plausibly interpreted as products, we map the original codes onto the 5-digit product codes in the Central Product Classification (CPC version 1.0) published by the United Nations to show the comparability between product definitions.

We make the mapping from the original codes to 5-digit CPC codes in two steps. In the first step, we map the original codes to the codes in the Product Code Classification for Statistics[13], published by the National Bureau of Statistics of China (NBSC) in 2010. The latter codes are the standard product codes used by NBSC since 2010. In the second step, we use the concordance published by the NBSC to link the codes in the Product Code Classification to product codes in the Central Product Classification (CPC version 1.0) published by the United Nations. In the end, we identified 612 products by CPC codes. Overall, we argue that the original codes can be used to define products in the sample.[14]

[13]The Chinese name is *Tongji Yong Chanpin Fenlei Daima*.

[14]In principle, we can map the original codes to SIC codes in two additional steps, that is, by using the concordance provided by the United Nations to map the codes in the CPC version 1.0 to 6-digit HS codes, then map the HS codes to SIC codes with the standard concordance. However, it is most unfortunate that the codes in CPC version 1.0 are 5-digit codes and hence much coarser than the 6-digit HS codes. This means that a particular product code in CPC version 1.0 can map onto multiple (on average 12) 6-digit HS codes based on the concordance of CPC 1.0 and HS96 from WITS. We chose not to take this route because the additional mapping would systematically inflate the number of products in the sample.