Import competition, resource reallocation and productivity dispersion: micro-level evidence from China

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Abstract

This paper explores whether and how import competition affects productivity dispersion in China. Using three comprehensive micro-level datasets over the period of 2000-06, we find that import penetration reduces the productivity dispersion in general and the main channel is through the competition-induced resource reallocation within industries. The trade-induced productivity truncation is evident for industries importing final goods and for those importing standard intermediate goods, but not for industries importing upstream intermediate goods. The negative effect of imports on productivity dispersion is found for industries with differentiated products rather than for those with homogenous products, suggesting that import competition is more severe in heterogeneous product markets in China. When considering the effect of exports along with imports, we find that only the ordinary-trade exports are conducive to resource reallocation and reducing productivity dispersion, but not the processing-trade exports. The effect of import competition is found to be more significant in more competitive industries and after China's WTO accession. Our results are robust to various model specifications and estimation methods.

JEL classification: F14; L1; D24; O12

Keywords: import competition; productivity dispersion; reallocation of resources; China

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'*The benefits of openness lie on the import side, rather than the export side.*' -- Rodrik (1999, p.24)

1. Introduction

China has experienced dramatic trade liberalization since its economic reform. According to the World Bank data, both imports and exports as a share of GDP increase strongly and persistently, from 7.1% and 6.6% in 1978 to 27.3% and 31.4% in 2011 respectively. Despite a rapidly growing literature on China's trade pattern, most research focuses on the growth- and productivity- enhancing role of exports in the domestic markets (for instance, Amiti and Freund, 2010; Yu, 2011; Jarreau and Poncet, 2012; Manova and Zhang, 2012), or the implications of imports from China to the developed countries by inducing technical change or imposing pressures on their labor markets (for instance, Bloom *et al*., 2011; Mion and Zhu, 2013). By contrast, the research on imports to China in general, and its' impact on productivity in particular remain rather limited[1].

The traditional comparative advantage theory has predicted an efficiency gain through the import of goods and services that are otherwise too costly to produce within the country, and that producers for the domestic market can be stimulated by competition from imports. On the other hand, by virtue of its market size and growth momentum, China is an important trade partner of most of the economies in the world. The robust demand from China on manufacturing products has contributed significantly to the global recovery during the recent global financial crisis. China's ongoing rebalance from investment- and export-led growth towards boosting domestic consumption (as highlighted in its recent 5-Year Economic Plan) will further reinforce its demand for imports of final goods, which has significant implications to the rest of world. Lastly, the fact that a large proportion of Chinese firms conduct processing trade suggests the strong link between imports and exports in China. A proper understanding of China's imports thus has significant academic, economic and policy impacts to China and the world.

Using three comprehensive micro-level datasets over the period of 2000-06, we examine whether and how imports affect productivity dispersion in Chinese industries. We

[1] An exception is Yu *et al*. (2013), where they examine the effect of import penetration and exports on productivity improvement of Chinese firms.

find that import penetration reduces the productivity dispersion in general and the main channel is through the competition-induced resource reallocation within industries. The role of imports in reducing productivity dispersion is evident for industries importing final goods and for those importing standard intermediate goods due to the pro-competitive effect. We do not find any effect of imports on productivity dispersion for industries which are involved with importing upstream intermediate goods, where only the input effect works. Besides, the negative effect of imports on productivity dispersion is found for industries with differentiated products rather than for those with homogenous products, suggesting that import competition is more severe in heterogeneous product markets in China. When considering the effect of exports along with imports, it is important to take into account the information of various trade regimes, i.e. only the ordinary-trade exports are conducive to resource reallocation and reducing productivity dispersion, but not the processing-trade exports. The effect of import competition is found to be more significant in more competitive industries and after China's WTO accession. Our results are robust to various model specifications and estimation methods.

This paper relates closely to at least three strands of literature on productivity, i.e. the effect of trade liberalization on productivity, the productivity dispersion literature, and the effect of resource misallocation on aggregate productivity. First, there is a large literature showing that trade liberalization increases firm- and industry-level productivity (for instance, Pavcnik, 2002; Melitz, 2003; Amiti and Konings, 2007; Fernandes, 2007; Topalova and Kandelwal, 2011; Yu, 2011; Yu *et al.*, 2013). Metilz (2003) emphasizes on the inter-firm reallocation effect, i.e. the exposure to trade will induce the more productive firms to enter the export market and force the least productive firms to exit, so that aggregate productivity increases due to selection. Some recent empirical research examines the productivity gains from removing trade barriers and protections. Using Indonesian data, Amiti and Konings (2007) argue that reducing output tariffs can produce productivity gains by inducing tougher import competition, whereas cheaper imported inputs can raise productivity through learning, variety, and quality effects. Similar results are found for India and China by Topalova and Kandelwal (2011) and Yu (2011) respectively.

Second, the fact that firms differ in performance or productivity ignites another interesting literature on productivity dispersion. Syverson (2004) examines the effect of a demand side factor, product substitutability, on productivity dispersion using US industry-level data. He argues that imperfect product substitutability impedes resource reallocation so that low-substitutability industries exhibit high productivity dispersion. Balasubramanian and Sivadasan (2009) focus on the effect of sunk costs on productivity dispersion, and find that increases in capital resalability are associated with a reduction in productivity dispersion.

Third, there is a fast-growing literature which links the micro-level resource misallocation to aggregate productivity. Most works argue that the low aggregate total factor productivity (TFP) is a result of firm-/plant-level resource misallocation especially in developing countries, i.e. the most efficient firms fail to attract the large share of productive resources that efficiency would dictate (see, Olley and Pakes, 1996; Banerjee and Duflo, 2005; Foster *et al*., 2008; Heish and Klenow, 2009; Midrigan and Xu, 2010; Asker *et al*., 2011). Therefore reallocation of labor and capital across manufacturing firms is a key resource of productivity growth. In the case of China, Heish and Klenow (2009) claim that distortions reduce China's manufacturing productivity by 30-50% relative to an optimal distribution of capital and labor across existing manufacturers. Song *et al*. (2011), on the other hand, regard the initial misallocation as a pre-condition for China's sustained growth because efficient firms can count on a highly elastic supply of factors attracted from the less productive firms.

We are not the first to empirically link trade and productivity through the resource reallocation channel. Epifani and Gancia (2011) examine how trade barriers influence the amount of competition and hence markups, and argue that the heterogeneity in markups induced by trade barriers is a source of resource misallocation. Khandelwal *et al*. (2013) claim that trade barriers such as tariffs and quotas can distort resource allocation along the intensive and extensive margins. Focusing on Chinese textile and clothing exports, they find that quota removal coincides with substantial reallocation of export activity from incumbents to entrants, as well as a productivity gain by 28%. De Loecker and Goldberg (2013) confirm such views in their survey paper, and highlight the aggregate productivity gains arising from resource reallocation as a result of trade liberalization.

Our research is along these lines, but has at least the following four novelties. First, the focus of the paper is on the impact of imports on productivity dispersion in Chinese industries rather than on firm-level productivity. In other words, we examine the distributional effects of trade openness on aggregate productivity, i.e. whether and how import competition helps to drive the least efficient firms out of the market, to reallocate market shares towards more productive firms, and therefore to reduce productivity dispersion within industry? To the best of our knowledge, we are the first in the literature to investigate such macro-level productivity dispersion effect of Chinese imports based on the comprehensive micro-level datasets. Second, we construct a direct measure of market allocative efficiency following Melitz *et al*. (2012), which is a dynamic productivity decomposition approach accounting for firm entry and exit and is therefore superior to the standard Olley and Pakes (1996) approach. This measure allows us to examine the direct impact of imports on resource allocation, and thus shedding lights on the channel through which import competition affects productivity dispersion in Chinese industries. We are not aware of any existing literature using such technique to answer similar research questions to ours. Third, we investigate the heterogeneous effects of imported goods according to their nature, i.e. the final goods, standard intermediate goods and upstream intermediate goods. The motivation for this approach is that one imported product can have different impact on a number of related domestic industries, i.e. it brings in the competition pressure to domestic industries which produce the same product, but also provides the lowest-cost (or highest-quality) supply to downstream industries which rely on intermediate inputs from upstream industries. Therefore, it is important to disentangle such heterogeneous effect of imports on various types of domestic industries. Last but not least, we distinguish the effects of imports for industries with differentiated products and those with homogeneous products in order to pinpoint the markets where foreign competition is most furious in Chinese industries. None of the existing literature tends to explore the productivity implication of Chinese imports in such a systemic and compressive way.

The structure of the paper is as follows. Section 2 explains our empirical measures of TFP, productivity dispersion and market allocative efficiency, and introduces our basic model specification and hypotheses. Section 3 discusses the data and sample and presents some basic summary statistics. Section 4 presents the results of our baseline model for productivity dispersion and for market efficiency. Section 5 conducts a number of robustness tests to examine the effects of product differentiation, tariff reduction, various natures of imported products, the role of processing trade, and some other alternative model specifications. Section 6 concludes the paper.

2. Empirical methodology

2.1 Measures of TFP and productivity dispersion

We calculate firms' TFP using the semi-parametric Olley and Pakes (1996) approach which alleviates both the selection bias and simultaneity bias (between input choices and productivity shocks). Another advantage of Olley-Pakes method is the flexible characterization of productivity, only assuming that it evolves according to a Markov process (Van Biesebroeck, 2007). Our approach is based on the recent development in the application of the Olley-Pakes method (for instance, Amiti and Konings, 2007; Brandt *et al*., 2012; Feenstra *et al*., 2013). First, we use different price deflators for inputs, outputs and investment. It is known in the productivity literature that ideally one would use firm-specific price deflators when constructing TFP. Since such information is not available in the data, we use different industry-specific price deflators for inputs, outputs and investment, which are directly drawn from Brandt *et al*. (2012). This implies that our TFP measure is a revenue-based productivity measure (TFPR) as introduced by Foster *et al*. (2008), which may capture both technical efficiency and price-cost markups. Second, we use the perpetual inventory method to compute the real investment variable, where the depreciation rate of physical capital is based on firms' reported actual depreciation figure rather than arbitrary assumptions.

Having obtained the firm-level TFP, we compute our measures of productivity dispersion. The primary productivity dispersion measure is the interquartile range (IQ range), i.e. the interquartile productivity difference divided by the industry's median productivity level[2]. Alternative measures such as standard deviations in TFP (scaled by industry mean productivity), the difference between TFP at the 90^{th} and 10^{th} percentile of the distribution, and at the 95^{th} and 5^{th} percentile of the distribution are all computed. To save space, we only report the results based on IQ range and standard deviations, and other results (which are quite similar) are available upon request.

2.2 Measures of market allocative efficiency

Our market allocative efficiency measure is based on Melitz *et al*. (2012), which is an extension of the productivity decomposition method developed by Olley and Pakes (1996). Olley-Pakes shows that when the level of industry productivity is measured by the weighted

[2] The measure of within-industry productivity dispersion should not be affected by pure scale differences among industries, provinces and years. We therefore remove such trend components at the productivity level and normalize the productivity dispersion measure in order to make it comparable across industries, provinces and years (Syverson, 2004; Balasubramanian *et al*., 2009).

average of firm-level productivity, it can be decomposed into the unweighted average of the productivity of firms and a covariance between market shares and productivity as follows.

$$TFP_t = \overline{TFP}_t + \sum_i (S_{it} - \overline{S}_t)(TFP_{it} - \overline{TFP}_t) = \overline{TFP}_t + cov(S_{it}, TFP_{it}) \quad (1)$$

where $\overline{TFP}_t = \frac{1}{n}\sum_{i\in j}^{n} TFP_{it}$ is the unweighted firm productivity mean, which is used to track the shifts in the distribution of productivity; $\overline{S}_t = \frac{1}{n}\sum_{i\in j}^{n} S_{it}$ is the mean of market share in year t; $cov(S_{it}, TFP_{it})$ is the covariance between the market shares and firm productivity, which is a key moment tracked by the Olley-Pakes decomposition to represent market allocative efficiency. One limitation of the Olley-Pakes approach is that it does not accommodate firm entry and exit when decomposing aggregate productivity changes into various components.

Melitz *et al*. (2012) extend the Olley-Pakes decomposition to a dynamic model which accounts for the contributions of both firm entry and exit. They start by writing the aggregate productivity in each period as a function of the aggregate share and aggregate productivity of the three groups of firms (survivors, entrants, and exiters):

$$TFP_{j,1} = S_{cont,1} \times TFP_{cont,1} + S_{exit,1} \times TFP_{exit,1} \quad (2)$$

$$TFP_{j,2} = S_{cont,2} \times TFP_{cont,2} + S_{entry,2} \times TFP_{entry,2} \quad (3)$$

where subscript 1 and 2 refer to period 1 and period 2 respectively. Applying equation (1) to all three groups, the productivity change can be written as

$$\Delta TFP_{j,t} = \Delta\overline{TFP}_{con,t} + \Delta cov + S_{entry,2}\left(TFP_{entry,2} - TFP_{cont,2}\right) + S_{exit,1}\left(TFP_{con,1} - TFP_{exit,1}\right) \quad (4)$$

where S and TFP are the aggregate market share and productivity of three groups of firms (survivors, entrants, and exiters). The sum of the first two terms represents the contribution of surviving firms to aggregate productivity growth, including a shift in the distribution of firm productivity ($\Delta\overline{TFP}_{con,t}$) and another component induced by market share reallocations (Δcov). The third term is the contribution made by the entering firms, and the last term is the corresponding contribution made by the exiting firms. In brief, aggregate productivity can change due to the productivity distribution shifts among surviving firms, changes in market share among surviving firms, the entry of new producers, and the exit of old ones. In this paper, we use the market share reallocations among surviving firms (Δcov) to proxy market allocative efficiency. A higher value of this measure means a better resource allocation among firms in the industry.

2.3 Model specification and hypotheses

Productivity dispersion is economically relevant, to the extent that it reflects movements away from an optimal feasible resource allocation (Asker *et al.*, 2011). The sources of productivity dispersion lie in both the supply-side-production factors such as technology shocks, management skill, R&D or investment patterns, and the demand-side conditions such as product differentiation and substitutability. In particular, Syverson (2004) argues that when consumers can easily switch between producers, inefficient (high costs) producers cannot operate profitably. Hence, an increase in product substitutability raises the cutoff productivity level, thus lowering productivity dispersion. We follow this line of thinking by capturing both the demand- and supply-side factors when empirically modeling the effect of import competition on productivity dispersion in China.

Our baseline model is specified as follows:

$$Dispersion_{ijt} = \alpha_0 + \alpha_1 IMP_{ijt} + \theta X_{ijt} + \eta_t + \zeta_j + \xi_i + \mu_{ijt} \quad (5)$$

where the subscript i refers to 4-digit industry sector, j refers to province, and t refers to year; the dependent variable is the productivity dispersion measure of industry i and province j in year t, which is defined by either the interquartile range or standard deviations of TFP; IMP_{ijt} is the import penetration ratio which is defined as follows:

$$IMP_{ijt} = \frac{Import_{ijt}}{Import_{ijt} + Output_{ijt} - Export_{ijt}} \quad (6)$$

where $Import_{ijt}$, $Export_{ijt}$ and $Output_{ijt}$ are total imports, exports and outputs of industry i and province j in year t. Import penetration ratio is viewed as a better proxy for trade liberalization than tariffs, as the latter does not take into account any non-tariff barriers of trade (Levinsohn, 1993). The new heterogeneous firm models in international economics highlight the role of trade liberalization as an important driver behind within-industry firm dynamics and productivity dispersion. For instance, Melitz (2003) argues that the benefits of exposure to foreign competition/markets enjoyed by the more productive domestic firms should drive the least efficient domestic producers out of business, thereby decreasing productivity dispersion. We therefore expect α_1 to be significant and negative in equation (5).

X_{ijt} consists of three groups of control variables, i.e. the demand-side factors, supply-side factors, and China-specific factors. On the demand-side factors, following Syverson (2004), we use a vector of measurable proxies for substitution elasticities among the outputs of industry producers. The first measure, $VALUELB$, represents a geographic barrier to substitution, which is the natural logarithm of the weighted sum of the dollar-value-to-weight ratios of all product classes in a given 4-digit industry, where the weights are the product classes' shares of the total industry tonnage shipped[3]. Geographic barriers to substitution arise when transport costs hinder producers from practically selling their output beyond certain distances. Therefore goods valuable in relation to their weight are more economical to ship. Industries with high values of $VALUELB$ are expected to have less geographically segmented output market and greater substitutability. We therefore expect a significantly negative relationship between $VALUELB$ and productivity dispersion.

The other substitutability measure is advertising intensity (ADV), which is defined as total advertising expenditure in an industry divided by total revenue[4]. The effect of branding and advertising on product substitutability is argued to be ambiguous. On the one hand, advertising may create artificial product differentiation so that industries with higher advertising intensities exhibit more product differentiation and less product substitutability; on the other hand, advertising is argued to be informative and serves to educate consumers about superior product, which allows more productive firms to take market share away from less efficient competitors. Hence we keep an open view on the coefficient of advertising intensity in the productivity dispersion equation.

We employee two variables to capture the supply-side factors, i.e. fixed operating costs, and sunk entry costs, both of which are expected to affect the critical productivity cutoff level and therefore the industry-level productivity dispersion. First, following Syverson (2004), we define the industry fixed cost index ($Fixed\ Cost$) as the share of nonproduction

[3] The transport data is from the US Bureau of the Census. We convert the SIC industry codes to corresponding GB (2002) industry level when merging it to the Chinese dataset.

[4] The data is from Compustat, a database that has financial statement data on all listed U.S. firms. We convert the 3-digit SIC industry codes to corresponding GB (2002) industry level when merging it to the Chinese dataset.

workers in total employment in each Chinese industry[5]. This measure is to proxy for the amount of overhead labor required by the industry technology and therefore the relative size of production-related fixed costs. It is argued that higher fixed costs make it difficult for inefficient firms to be profitable, leading them to exit in equilibrium. Thus we expect a significantly negative relationship between fixed costs and productivity dispersion at the industry level.

Second, we adopt the method of Balasubramanian and Sivadasan (2009) to measure sunk entry costs ($Sunk\ Cost$), which is a capital resalability index defined as the share of used capital investment in total capital investment at the 4-digit industry level[6]. This measure of capital resalability is to capture recoverability of investments, which is an inverse proxy for the extent of sunkenness of capital investments. Compared with the standard method of Sutton (1991), where investments in physical capital (usually in the median plant size) are used to proxy sunk costs, the capital resalability index better accords with the theoretical definition of sunk costs where the resale value of investment should be strictly excluded. According to Hopenhayn (1992), sunk costs act as a barrier to entry and exit, and protect incumbent firms. Thus, an increase in sunk costs (as reflected by a decrease in capital resalability) leads to a reduction in the cutoff productivity, implying an increase in the productivity dispersion.

We also include a number of China-specific factors which may affect productivity dispersion in the Chinese context. First, we include two ownership variables, SOE and FIE, which are defined as the share of state-owned capital and foreign capital in total capital respectively. It is widely believed that despite decades of economic reform, state-owned enterprises (SOEs) remain the least efficient sector in the economy with an average return on capital well below that in the private sector (Dougherty and Herd, 2005; Ding *et al*., 2012). On the other hand, foreign ownership is associated with not only higher levels of TFP but also fewer financial constraints (Manova *et al*., 2011). We hypothesize that both SOE and FIE may increase productivity dispersion but from two different directions, i.e. the state ownership hinders the exit of least efficient firms therefore increasing the dispersion from the lower end of the distribution, whereas foreign ownership increases the top end of the productivity distribution and enlarges the dispersion from the right.

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[5] Data come from various issues of China statistical yearbook.

[6] The used capital expenditure data is from the US Bureau of the Census. We convert the SIC industry codes to corresponding GB (2002) industry level when merging it to the Chinese dataset.

Second, government subsidy may affect the entry and exit of firms in the market, and therefore influence productivity dispersion in industries. Our subsidy measure ($Subsidy$) is defined as the ratio of subsidy to the value added of firms. We expect a positive relationship between subsidy and productivity dispersion, as the former may keep the least efficient producers viable.

Lastly, we include time-specific (η_t), province-specific (ζ_j), and industry-specific (ξ_i) fixed effects, as well as an idiosyncratic error term (μ_{ijt}) in the regression. Our estimation method is panel data fixed effects[7].

3. Data and summary statistics

3.1 Data and sample

We make use of a number of comprehensive datasets in this paper, including the firm-level production data drawn from the annual survey of Chinese industrial firms by National Bureau of Statistics (NBS), the transaction-level trade data from Chinese General Administration of Customs (GAC), the product-level tariff information published by World Trade Organization (WTO), and a number of US datasets (such as Compustat and US Bureau of the Census).

The first firm-level dataset is drawn from the annual accounting reports filed by industrial firms with the NBS over the period of 1998-2007. This dataset includes all SOEs and other types of enterprises with annual sales of five million yuan (about $817,000) or more. These firms operate in the manufacturing sectors[8] and are located in all 30 Chinese provinces or province-equivalent municipal cities[9]. Following the literature, we drop observations with negative total assets minus total fixed assets, negative total assets minus liquid assets, and negative sales, as well as negative accumulated depreciation minus current depreciation. Firms with less than eight employees are also excluded as they fall under a different legal regime (see, Brandt *et al*., 2012). Lastly, to isolate our results from potential outliers, we exclude observations in the one percent tails of each of the regression variables.

[7] The endogeneity problem is argued to be less important when modelling productivity dispersion as firms do not observe the industry-level distribution information when making decisions.

[8] We exclude utilities and mining sectors for our research purpose in this paper.

[9] Our dataset does not contain any firm in Tibet.

The second database from the Chinese Customs contains detailed transaction-level information of all imports and exports in China during the period of 2000-06, which includes 243 trading partners and 7526 different products in the 8-digit Harmonized System (HS). A feature of this dataset is its rich information on trade transactions. For instance, for each transaction it reports the transaction date, 8-digit HS product code, trade volume, trading partner, unit price, shipment method, trade regime and so on. Following Manova and Zhang (2012), we eliminate some trading firms which do not engage in manufacturing but act as intermediaries between domestic producers/suppliers and foreign trade partners.

The difficulty of merging these two datasets lies in the absence of a common firm identifier shared by both datasets. We therefore rely on other firm characteristics such as firm name, telephone number, zip code, and firm address to achieve the best possible match of two datasets. Table 1 presents a brief summary of the datasets. We find that the number of exporting firms in the NBS dataset is much smaller than that in the Customs dataset[10]. There are two explanations for this discrepancy. First, most trading firms are quite small, so that they are not included in the 'above-scale' NBS dataset (Yu, 2011). Second, the NBS dataset covers manufacturing firms only, whereas the Customs dataset consists of trading firms in all sectors in China such as manufacturing, agriculture, service, and so on. During the period of 2000-06, the number of exporting firms in our merged dataset accounts for 58.5% of total exporting firms in the NBS dataset on average.

Our tariff data is from WTO, which provides product-level tariffs at the 6-digit HS level of all WTO member countries/regions. Following Yu (2011) and Qiu and Yu (2013), we use the average ad valorem (AV) duty in our empirical regression[11]. Lastly, when computing our measures of product substitutability, we use the US data for 3-digit SIC sectors from Syverson (2004) and then match them to our GB (2002) industry level. Similarly, our measure of sunk costs is from US Bureau of the Census as in Balasubramanian and Sivadasan (2009). One benefit of using the US industry information is their strict exogeneity in our regressions.

3.2 Summary statistics

[10] Note that although Customs dataset includes both imports and exports information, the NBS dataset contains exporting information only.
[11] China's tariffs from 1998 to 2000 are missing from WTO, so we use the tariffs in 1997 for 2000 in our empirical analysis.

Table 2(a) provides the summary statistics of variables in the baseline models. It shows that on average the productivity dispersion measure based on the IQ range (0.591) is slightly higher than that based on the standard deviation (0.452). The import penetration ratio is averaged at 0.104 among all industries during the sample period. The two demand-side factors ($VALUELB$ and ADV) and two supply-side factors ($Fixed\,Cost$ and $Sunk\,Cost$) are industry-specific and time-invariant variables so that the sample size is 425 4-digit narrowest-defined industries in China. The proportion of state- and foreign-owned firms is 17.0% and 11.9% respectively in the sample. Lastly, government subsidy ($Subsidy$) is averged about 0.4% of value added of firms.

Table 2(b) presents the productivity dispersion of Chinese industries, where the dispersion measure is based on the interquartile range[12]. There is significant cross-sectional heterogeneity of productivity dispersion among 2-digit industries. For instance, some monopolistic sectors such as tobacco processing (1.159) have much higher dispersion than the more competitive sectors such as textile (0.529). In terms of time dynamics, it is interesting to see that the productivity dispersion shows a decreasing trend for most industries over the sample period of 2000-06, indicating that the reallocation process plays a substantial role in the data[13].

Table 2(c) reports the import penetration ratio in 2-digit Chinese industrial sectors during the period of 2000-06. There is no clear pattern on the import penetration ratio over time across industries. It is interesting to see that there exists vast heterogeneity among industries, where import penetration shows a rising trend in some industries (such as electronic machinery) and a decreasing trend in others (such as textile). In order to have a general idea regarding the relationship between import penetration and productivity dispersion, we aggregate the data and plot the relationship of these two variables in Figure 1, where the productivity dispersion is found to decrease over time, and import penetration is found to increase steadily over the sample period. Thus, an interesting research question arises: whether and how imports contribute to the reduction of productivity dispersion in China?

[12] To save space, the productivity dispersion based on the standard deviation is not reported but available upon request.

[13] Exception holds for four industries of leather, educational goods, petroleum processing and other manufacturing where productivity dispersion displays no significant change or a non-linear trend.

4. Baseline empirical results

4.1 The productivity dispersion regression

Table 3 presents the results of our baseline model (equation 5). It is interesting to see that the effect of imports on productivity dispersion (measured by both the IQ range and standard deviation) is negative and significant[14]. Theoretically speaking, trade openness should cause a resource reallocation towards more efficient firms, the exit of less productive firms, and the entry of more productive ones (see, Bernard *et al*., 2003; Melitz, 2003). In other words, increased competition from trade is expected to lead to lower prices and an increase in the cutoff productivity level. As a result, a lower within-sector dispersion of productivity should be observed. Our results confirm this view and prove the trade-driven truncation of the productivity dispersion in the Chinese industries. This corrects the puzzle in Syverson (2004) where the effect of trade openness on productivity dispersion is absent.

In terms of the measures of product substitutability, the coefficient of the dollar-value-to-weight ratio ($VALUELB$) is significant and negative, which is consistent with the theoretical hypothesis that higher geographic barrier to substitution reduces the cutoff productivity level, and thus increasing productivity dispersion. On the other hand, the advertising intensity (ADV) has a significant and positive effect on productivity dispersion, indicating that greater artificial product differentiation reduces product substitutability and increases productivity dispersion.

Fixed cost ($Fixed\ Cost$) is found to reduce productivity dispersion and to improve resource allocation, which is in line with the theoretical prediction that higher fixed costs can help to drive the inefficient firms out of the market, thus contributing to the productivity dispersion reduction. The coefficient of sunk cost ($Sunk\ Cost$) is also negative and significant. This is because the capital resalability index is an inverse proxy for the extent of sunkennesss of capital investments. Sunk costs can impede competitive forces and prevent the attainment of both technical efficiency and allocative efficiency, as they make the act of exit costly and affect the discipline on incumbents. Our result confirms this argument.

The results of all China-specific variables are in line with our expectation, where both state- and foreign-ownership (SOE and FIE) are found to have positive and significant

[14] Our results are robust when alternative dispersion measures are used, for instance, the 90-10 division and 95-5 division. To save space, we do not report such results, but they are available upon request.

effect on dispersion. And the positive effect of government subsidy ($Subsidy$) appears significant when dispersion is measured as the standard deviation of TFP.

4.2 The market efficiency regression

In order to examine the channel through which imports affect productivity dispersion, we estimate the following equation:

$$Market\ allocative\ efficiency_{ijt} = \alpha_0 + \alpha_1 IMP_{ijt} + \theta X_{ijt} + \eta_t + \zeta_j + \xi_i + \mu_{ijt} \qquad (7)$$

where the dependent variable is the market allocative efficiency measure constructed in section 2.2, and all other variables are the same as those in equation (5). The results are shown in Table 4. In all the models, imports are found to contribute positively and significantly to the market allocation efficiency. This confirms our hypothesis that the growing inflows of foreign goods initiate a restructuring process in the industrial sector in China, which leads to a reallocation of resources towards more efficient firms. In terms of other control variables, we find that lower geographic barrier to substitution (higher $VALUELB$), lower artificial product differentiation (lower ADV) and higher fixed cost (higher $Fixed\ Cost$) are conducive to efficient resource allocation in Chinese industries. Lastly, both state ownership (SOE) and government subsidy ($Subsidy$) have significantly negative impact on market allocative efficiency, indicating the distortionary effect of government intervention in the market.

5. Robustness tests

5.1 The nature of imported products

Theoretically speaking, there are at least two channels through which import penetration affects firm-level productivity and industry-level productivity dispersion. On the one hand, imports of final goods[15] lead to tougher competition in the domestic market, which forces firms to increase their efficiency, drives the least efficient domestic producers out of market and therefore reducing the productivity dispersion. This is often referred to as the *pro-competitive effect* of trade liberalization (see, for instance, Topalova and Khandelwal, 2011;

[15] Final goods are the goods that are ultimately consumed by the consumers rather than used in the production of another good.

De Loecker and Goldberg, 2013). On the other hand, openness to foreign supply markets increases the availability of intermediate goods[16] that may be cheaper or with a higher quality and technological content than domestic products (Halpern *et al.*, 2005; Maggioni, 2012). In other words, trade liberalization brings in more and cheaper imported inputs, which can raise domestic firms' productivity via learning, variety, and quality effect. This is referred to as the *input effect* which drives the productivity gains.

In order to distinguish the heterogeneous effects of various types of imports on productivity dispersion, we classify imports in the Customs dataset into three groups, i.e. the final imported goods ($Fin - Import$), standard intermediate imported goods ($In - Import$) and upstream intermediate imported goods ($Up - Import$). Firstly, the distinction between final and intermediate goods is made by judging whether the imported goods are purchased by domestic manufacturing firms. Since manufacturing firms seldom engage in the retail business in China, the goods imported by manufacturing firms are intermediate goods for the production of final goods. On the other hand, we treat imports which are not purchased by manufacturing firms as final goods, which are directly purchased and consumed by consumers[17]. We expect that the final imported goods may reveal only the pro-competitive effect, whereas the imported intermediate goods may capture both the input effect for downstream firms and the pro-competitive effect for the same type of goods produced by domestic firms.

In order to disentangle the two different effects of imported intermediate goods, we further classify the intermediate goods into (i) the standard imported intermediate goods and (ii) those imported by upstream industries[18]. To achieve this goal, we first aggregate all imported products in the Customs dataset according to the 8-digit HS level, and then match them with the GB (2002) industry classification used in the NBS dataset. We identify the upstream industry information by examining the number and category of imported goods of each firm. For instance, if firm i in industry j imports x category of intermediate goods, then industries of these x category of goods represent upstream industries of firm i. We then aggregate the value of all imports of x category of goods in their industries and divide

[16] Intermediate goods are goods that are used as inputs in the production of final goods, such as partly finished goods.
[17] Note that we exclude the trading firms that do not engage in manufacturing but act as intermediaries between domestic producers/suppliers and foreign trade partners in the NBS dataset. This is because it is not clear whether the imports purchased by them are for the production of final goods or for consumers.
[18] Upstream industries are those processing the basic or raw material into intermediary products which are converted into finished products by the downstream industries.

it by total value added of industry j to proxy the upstream intermediate imports. We expect the pro-competitive effect is dominant for the standard imported intermediate goods, whereas the input effect is dominant for the upstream imported intermediate goods. In other words, the same import flow may represent a threat for firms operating in that sector, but an opportunity for the downstream firms.

Table 5 reports the results. We find the negative and significant effect of both final imported goods and standard intermediate imported goods on productivity dispersion, and the effect is greater for final imported goods. No such effect is found for the upstream intermediate imported goods. This is in line with our expectation that the pro-competitive effect of imports is best captured by the final imported goods, where the tough foreign competition improves resource allocation and reduces productivity dispersion in domestic industries. The competition effect is also found for standard intermediate imported goods, as such goods can compete with products in the same industry and generate learning effects from the foreign technology embodied in the imported intermediate inputs, which helps to reduce productivity dispersion. No competition effect is found for the upstream intermediate imported goods, where international integration offers domestic downstream firms the opportunity to exploit an increase variety of intermediates with cheaper price or higher quality than domestic ones. Such input effect is not conducive to better resource allocation or reducing productivity dispersion.

5.2 The product differentiation effect

There is a recent literature on trade and product complexity, which emphasizes on the heterogeneous effect of trade liberalization on firms producing complex goods versus simple goods (see, Berkowitz *et al*., 2006; Yu *et al*., 2013). For instance, Yu *et al*. (2013) claim that trade liberalization generates learning and productivity-enhancing effects for firms producing complex goods, but not for those producing simple goods. In this paper, we are interested in exploring whether the effect of import competition on productivity dispersion varies among firms producing various types of products.

We adopt the method of Rauch (1999) to classify the 4-digit SITC (GB/T 4754-2002) industries into three different categories: (i) goods that are traded on organized exchanges; (ii) goods that are reference-priced; (iii) goods that are not traded on organized exchanges and do not have reference prices[19]. We refer these three categories of products as homogenous goods (Con_w), referenced goods (Con_r) and differentiated goods (Con_n) respectively. We test our hypothesis by including reference goods and differentiated goods and their interactions with import penetration ratio in the productivity dispersion equation, where the default group omitted in the regression is the homogenous goods.

The results are reported in Table 6. We find that the product differentiation itself (as proxied by Con_r and Con_n) increases productivity dispersion by impeding the substitutability among products, i.e. idiosyncratic consumer preferences across attributes may allow some less efficient producers to remain viable. However, when interacted with imports, both interaction terms appear significant and negative and the coefficient of imports itself becomes significantly positive. This shows that when considering the heterogeneous nature of products, the import competition effect on productivity dispersion is mainly through the differentiated products rather than the homogeneous products in China. In other words, the tough competition driven by inflows of foreign goods mainly exists in the differentiated product market, where domestic firms are forced to reduce price/markup or improve quality, the least productive ones are forced to exit, and productivity dispersion is therefore reduced. On the other hand, such effect is not found for the homogeneous product market.

5.3 The instrumental variable approach

There is a large literature on the effect of tariff reduction on firm productivity and researchers tend to distinguish the heterogeneous effect between input tariff reduction and output tariff reduction (see, Amiti and Konings, 2007; Topalova and Khandelwal, 2011; Yu, 2011; Amiti and Khandelwal, 2013). Compared with imports, tariff is a policy variable which is highly exogenous. As a robustness test, we use the product-level output tariffs obtained from WTO as an instrument variable to the import penetration variable in the regressions. In Table 7, our instrumental variable regression confirms the exogenous role of imports in reducing within-industry productivity dispersion, i.e. tougher import competition forces firms to search for ways to improve their efficiency, which improves resource allocation and reduces productivity dispersion at the industry level.

5.4 The role of exports and processing trade

[19] Rauch (1999) has two classification methods: liberal and conservative. Similar to Yu *et al*. (2013), we adopt the conservative method.

Another important dimension of trade openness is exports. Melitz (2003) argues that the fixed and sunk costs of exporting has an important impact on industry structure and performance by inducing reallocations of market shares across firms with different productivity levels. We therefore expect a negative relationship between exports and productivity dispersion. Our export variable ($export$) is defined as the ratio of total exports over total sales in the industry. The results are reported in Table 8. Surprisingly, although the impact of import competition remains significant negative, we find a positive and significant effect of exports on productivity dispersion, which seems contradictory to the theoretical predictions.

One possible explanation of this result may lie in the role of processing trade[20] in the Chinese economy. One feature of China's trade pattern is the sheer magnitude of processing trade, i.e. about 60% of Chinese exports are in the processing trade sector during the period 2000-06 (Wang and Yu, 2011). There is a rising literature on the effect of different trade regimes (ordinary versus processing trade) on firm performance in China, which indicates that generally speaking, firms conducting processing trade have inferior performance than their counterparts who are engaged in ordinary trade business (see, Yu, 2011; Jarreau and Poncet, 2012; Manova and Yu, 2012). For instance, Jarreau and Poncet (2012) claim that the growth-enhancing gains of trade are limited to the ordinary export activities undertaken by domestic firms, but not processing trade activities. Following this line of thinking, we distinguish the heterogeneous effect of ordinary trade versus processing trade in our regression and expect that the role of exports in reducing productivity dispersion is only significant for firms conducting ordinary trade.

Our proxy for ordinary trade ($Export\_OT$) is defined as the share of exports of ordinary-trade firms in total exports in the industry, and processing trade ($Export\_PT$) is defined as the share of exports of processing-trade firms in total industry-level exports. In Table 8, we find that that ordinary-trade exports help to reduce the within-industry productivity dispersion, whereas processing-trade exports have a significant and positive effect. This is consistent with our expectation that only ordinary-trade exports are conducive to more efficient resource allocation, leading to a lower productivity dispersion. On the contrary, processing-trade exports which involve assembling imported inputs into final goods

[20] Processing trade is officially defined as business activities in which the operating enterprise imports all or part of the raw or ancillary materials, spare parts, components, and packaging materials, and re-exports finished products after processing or assembling these materials/parts (Manova and Yu, 2012).

for resale in the foreign markets have no such effect. Our results also confirm the view that it is important to disentangle the effect of different trade regimes when analyzing exports in China.

5.5 The weighted regression method

The quality of the productivity dispersion index is likely to be affected by the size of industries (Syverson, 2004； Balasubramanian and Sivadasan, 2009). For instance, industries with a small number of firms and monopolistic market structure tend to have lower productivity dispersion, which however cannot be interpreted as better resource allocation. To correct for this potential bias, we set the reciprocal of the number of firms as weights and run weighted regressions as a robustness test. The results are reported in Table 9, and our main finding that import competition induces truncation of productivity distribution and reduces its dispersion remains intact.

5.6 The market structure effect

The threat from competitors both intra- and inter-industry will affect resource allocation and then productivity dispersion (Syverson, 2011). Tougher domestic competition is argued to lower productivity dispersion, i.e. inefficient firms are hard to survive in a very competitive market. It is therefore important to control for the market structure effect when modeling the impact of import competition on productivity dispersion. It is also interesting to examine whether and how the import competition affects productivity dispersion through its influence on market structure.

We construct the Herfindahl–Hirschman Index (HHI)[21] to capture the market structure or competition status in 4-digit industries in each province. A lower HHI figure indicates higher degree of competition in the industry. The results are presented in Table 10. We find that a more competitive market (lower HHI) is associated with better resource allocation and lower productivity dispersion. And the impact of imports on productivity dispersion is more significant in more competitive market, as shown by the negative and significant product term of imports and HHI when standard deviation measure is used to proxy dispersion.

[21] HHI is defined as the sum of the squares of the market shares of the 50 largest firms within the industry, where the market shares are expressed as fractions.

5.7 The WTO effect

We are also interested in the question of whether the effect of import competition on productivity dispersion is more evident after China's accession to WTO in 2001. We test this hypothesis by including a post-WTO dummy (WTO) and interacting it with the import variable in the productivity dispersion regression. In Table 11, we find that the WTO entry itself has a negative and significant effect on productivity dispersion. The negative and significant product term shows that the import competition effect in driving better resource allocation and reducing productivity dispersion is more evident after China's WTO accession.

5.8 Alternative productivity measure

Lastly, we construct TFP using the Levinsohn and Petrin (2003) approach as a robustness test. As shown in Table 12, our results remain robust when productivity dispersion is computed based on an alternative TFP measure.

6. Conclusion

The effect of trade liberalization on individual firms is important. However, at the end of the day what we care about is how an industry, country or group of countries is affected by trade. Reallocation of economic resources from less towards more productive firms is one way in which industry- (or country) performance can increase even in the absence of any effects on individual firms (De Loecker and Goldberg, 2013). In this paper, we follow this line of thinking and explore the impact of import competition on productivity dispersion in Chinese industries.

Using three comprehensive datasets, we find that the import-driven truncation of productivity distribution is indeed present in China. After constructing a direct measure of market allocative efficiency following Melitz *et al*. (2012), we are able to confirm that the competition-induced resource reallocation within industries is the main channel through which imports affect productivity dispersion. We then distinguish the heterogeneous effects for various types of imports, and find that pro-competitive effect is dominant for industries importing final goods and standard intermediate goods, whereas the input effect is dominant for those importing upstream intermediate goods. When considering various types of products, we find that import competition is more furious in differentiated products than in homogeneous goods. When considering the effect of exports along with imports, it is important to take into account the information of trade regimes, as we find that only ordinary-trade exports are conducive to resource reallocation and reducing productivity dispersion. The effect of import competition is found to be more significant in more competitive industries and after China’s WTO accession. Our results are robust when alternative measures of imports and TFP and the weighted regression are adopted.

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Table 1. Basic summary of datasets

	2000	2001	2002	2003	2004	2005	2006
NBS data [a]	119,444	131,437	145,464	163,332	238,078	237,116	263,158
##Export	36,908	40,128	45,040	50,616	76,607	74,395	77,723
Customs data [b]	81,995	89,660	104,245	124,299	153,779	179,666	208,425
##Export	62,746	68,487	78,612	95,688	120,590	144,030	171,205
##Import	62,750	67,588	77,303	87,934	102,242	113,456	121,835
Merged data [c]	25,712	29,615	33,918	39,020	56,937	57,058	60,999
##Export	19,104	21,914	25,683	30,611	44,790	46,372	50,211
##Import	18,094	20,041	22,700	25,787	36,943	36,332	38,102
Merge Ratio [d]	51.76%	54.61%	57.02%	60.48%	58.47%	62.33%	64.60%

Notes: (a) the NBS firm-level dataset includes above-scale firms in the manufacturing sectors in China; it also reports firms' export sales, but there is no information on imports; (b) Customs dataset contains detailed product-level information of international trade (both exports and imports) at the monthly level; we therefore aggregate such information to the firm-year level in order to merge it with the NBS dataset; (c) The merge of the two dataset is mainly based on the firm name, and other firm characteristics such as telephone number, zip code and firm address; (d) The merge ratio is computed as the number of exporting firms in the merged dataset in relation to the number of total exporting firms in the NBS dataset.

Table 2(a). Summary Statistics of variables in the basic regressions

	Observation	Mean	Std. Dev.	Min	Max
Dependent variable (productivity dispersion)					
TFP IQ Range	17712	0.591	0.240	0.042	2.817
TFP Std. Dev	17712	0.452	0.137	0.033	1.783
Independent variables					
Import penetration	17712	0.104	0.183	0.000	0.988
VALUELB	425	4.229	10.686	0.008	100.000
ADV	425	0.012	0.018	0.000	0.184
Fixed Cost	425	0.298	0.104	0.098	0.654
Sunk Cost	425	0.094	0.059	0.003	0.438
SOE	17712	0.170	0.232	0.000	1.000
FIE	17712	0.119	0.176	0.000	1.000
Subsidy	17712	0.004	0.013	0.000	0.932

Table 2(b). Productivity dispersion in 2-digit Chinese industrial sectors (2000-06, based on the interquartile range)

Industrial sectors	2000	2001	2002	2003	2004	2005	2006
Food processing industry	0.656	0.647	0.635	0.616	0.603	0.579	0.561
Food Manufacturing industry	0.680	0.647	0.650	0.651	0.648	0.642	0.631
Beverage Manufacturing industry	0.838	0.834	0.801	0.790	0.795	0.751	0.723
Tobacco processing industry	1.159	1.101	1.082	0.970	0.974	0.806	0.694
Textile industry	0.529	0.517	0.506	0.496	0.491	0.476	0.476
Clothing and other fiber products manufacturing	0.579	0.562	0.542	0.537	0.535	0.532	0.529
Leather, fur, down and down products industry	0.608	0.629	0.625	0.608	0.604	0.604	0.607
Timber Processing, Bamboo, Cane, Palm Fiber and Straw Products industry	0.597	0.549	0.539	0.516	0.532	0.472	0.486
Furniture Manufacturing industry	0.672	0.617	0.594	0.610	0.604	0.595	0.594
Paper and paper products industry	0.580	0.554	0.540	0.527	0.526	0.527	0.530
Printing and Record Medium Reproduction industry	0.814	0.769	0.751	0.718	0.678	0.653	0.619
Educational and Sports Goods industry	0.543	0.555	0.541	0.543	0.557	0.535	0.543
Petroleum processing and coking industry	0.708	0.684	0.665	0.657	0.710	0.713	0.751
Chemical materials and chemical products manufacturing industry	0.655	0.606	0.582	0.557	0.556	0.532	0.521
Pharmaceutical Manufacturing industry	0.638	0.614	0.606	0.616	0.649	0.616	0.607
Manufacture of Chemical Fibers industry	0.821	0.772	0.781	0.721	0.696	0.640	0.673
Rubber product industry	0.575	0.570	0.603	0.573	0.550	0.540	0.554
Plastic products industry	0.537	0.512	0.510	0.509	0.516	0.505	0.511
Non-metallic mineral products industry	0.501	0.481	0.472	0.452	0.457	0.440	0.436
Ferrous metal smelting and rolling processing industry	0.635	0.624	0.628	0.643	0.673	0.630	0.627
Non-ferrous metal smelting and rolling processing industry	0.692	0.677	0.666	0.664	0.676	0.640	0.623
Fabricated Metal Products industry	0.593	0.557	0.536	0.529	0.530	0.516	0.517
General machinery manufacturing industry	0.613	0.595	0.577	0.558	0.560	0.543	0.530
Special equipment manufacturing industry	0.534	0.516	0.504	0.471	0.467	0.456	0.452
Transportation Equipment Manufacturing industry	0.688	0.624	0.631	0.623	0.616	0.591	0.589
Electrical machinery and equipment manufacturing	0.659	0.639	0.634	0.636	0.645	0.640	0.637
Electronic and communication equipment manufacturing industry	0.746	0.702	0.730	0.752	0.730	0.734	0.727
Instrumentation and culture, office machinery manufacturing industry	0.678	0.653	0.623	0.613	0.644	0.621	0.641
Other manufacturing industry	0.523	0.524	0.507	0.546	0.545	0.514	0.534

Table 2(c). Import penetration ratio in 2-digit Chinese industrial sectors (2000-06)

	2000	2001	2002	2003	2004	2005	2006
Food processing industry	0.075	0.066	0.068	0.075	0.076	0.056	0.052
Food Manufacturing industry	0.037	0.040	0.035	0.032	0.032	0.025	0.023
Beverage Manufacturing industry	0.007	0.006	0.005	0.005	0.005	0.005	0.006
Tobacco processing industry	0.015	0.017	0.013	0.015	0.014	0.019	0.022
Textile industry	0.126	0.123	0.101	0.092	0.075	0.061	0.049
Clothing and other fiber products manufacturing	0.049	0.046	0.040	0.039	0.040	0.030	0.026
Leather, fur, down and down products industry	0.079	0.066	0.072	0.064	0.068	0.049	0.043
Timber Processing, Bamboo, Cane, Palm Fiber and Straw Products industry	0.129	0.087	0.086	0.090	0.070	0.048	0.031
Furniture Manufacturing industry	0.060	0.075	0.076	0.104	0.099	0.069	0.058
Paper and paper products industry	0.173	0.157	0.144	0.133	0.11	0.088	0.073
Printing and Record Medium Reproduction industry	0.032	0.033	0.029	0.026	0.026	0.025	0.024
Educational and Sports Goods industry	0.290	0.312	0.339	0.348	0.371	0.359	0.325
Petroleum processing and coking industry	0.033	0.03	0.138	0.148	0.161	0.158	0.184
Chemical materials and chemical products manufacturing industry	0.317	0.331	0.317	0.324	0.319	0.297	0.271
Pharmaceutical Manufacturing industry	0.061	0.073	0.068	0.070	0.072	0.068	0.065
Manufacture of Chemical Fibers industry	0.153	0.164	0.158	0.143	0.127	0.102	0.072
Rubber product industry	0.076	0.084	0.076	0.102	0.103	0.094	0.111
Plastic products industry	0.131	0.126	0.120	0.128	0.126	0.125	0.115
Non-metallic mineral products industry	0.045	0.046	0.043	0.043	0.041	0.035	0.030
Ferrous metal smelting and rolling processing industry	0.131	0.129	0.143	0.148	0.116	0.111	0.088
Non-ferrous metal smelting and rolling processing industry	0.225	0.227	0.209	0.216	0.193	0.193	0.160
Fabricated Metal Products industry	0.132	0.135	0.134	0.134	0.145	0.123	0.114
General machinery manufacturing industry	0.353	0.377	0.362	0.373	0.355	0.313	0.283
Special equipment manufacturing industry	0.371	0.452	0.421	0.426	0.404	0.368	0.329
Transportation Equipment Manufacturing industry	0.114	0.177	0.142	0.171	0.15	0.145	0.172
Electrical machinery and equipment manufacturing	0.464	0.511	0.607	0.686	0.858	0.903	1.079
Electronic and communication equipment manufacturing industry	0.494	0.555	0.573	0.702	0.746	0.737	0.705
Instrumentation and culture, office machinery manufacturing industry	0.152	0.148	0.122	0.113	0.114	0.090	0.075
Other manufacturing industry	0.672	0.782	0.733	0.830	0.693	0.678	0.646

Table 3. Baseline results: the effects of import competition on productivity dispersion

Dispersion Measure	IQ Range			Standard Deviation		
	(1)	(2)	(3)	(4)	(5)	(6)
Import	-0.059***	-0.062***	-0.063***	-0.056***	-0.058***	-0.059***
	(-5.230)	(-5.584)	(-5.613)	(-9.200)	(-9.776)	(-9.835)
VALUELB	-0.002***	-0.002***	-0.002***	-0.001***	-0.001***	-0.001***
	(-8.417)	(-9.088)	(-9.177)	(-10.436)	(-11.630)	(-11.810)
ADV	0.493***	0.315**	0.312**	0.250***	0.115*	0.112*
	(3.945)	(2.549)	(2.527)	(3.677)	(1.733)	(1.693)
Fixed Cost	-0.133***	-0.128***	-0.131***	-0.081***	-0.077***	-0.080***
	(-4.202)	(-4.088)	(-4.179)	(-4.717)	(-4.566)	(-4.746)
Sunk Cost	-0.119***	-0.145***	-0.146***	-0.012	-0.035*	-0.036*
	(-3.344)	(-4.138)	(-4.163)	(-0.609)	(-1.855)	(-1.903)
SOE		0.187***	0.186***		0.147***	0.146***
		(22.283)	(22.084)		(32.742)	(32.393)
FIE		0.070***	0.070***		0.034***	0.034***
		(6.505)	(6.538)		(5.951)	(6.016)
Subsidy			0.080			0.111**
			(0.758)			(2.024)
Year-Fixed	Yes	Yes	Yes	Yes	Yes	Yes
Province-Fixed	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Fixed	Yes	Yes	Yes	Yes	Yes	Yes
Adj-R^2	0.155	0.179	0.179	0.229	0.273	0.274
Observation	17,712	17,712	17,712	17,712	17,712	17,712

T-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 4. Baseline results: the effects of import competition on market allocative efficiency

	(1)	(2)	(3)
Import	0.103***	0.120**	0.129**
	(3.715)	(3.421)	(3.417)
VALUELB	0.012**	0.017**	0.016**
	(2.303)	(2.258)	(2.239)
ADV	-0.559	-0.567*	-0.573*
	(-1.632)	(-1.655)	(-1.672)
Fixed Cost	0.025***	0.017***	0.253***
	(-4.808)	(-3.044)	(-2.598)
Sunk Cost	-0.065	-0.083*	-0.087*
	(-1.411)	(-1.786)	(-1.866)
SOE		-0.219***	-0.218***
		(-7.249)	(-7.211)
FIE		0.041	0.040
		(1.087)	(1.055)
Subsidy			-0.896**
			(-2.044)
Year-Fixed	Yes	Yes	Yes
Province-Fixed	Yes	Yes	Yes
Industry-Fixed	Yes	Yes	Yes
Adj-R^2	0.096	0.098	0.098
Observation	17,712	17,712	17,712

T-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 5. Robustness tests: the nature of imported goods

Dispersion Measure	IQ Range				Standard Deviation			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Import				-0.063***				-0.059***
				(-5.643)				(-9.955)
Fin-Import	-0.026***	-0.025**	-0.025**		-0.031***	-0.030***	-0.030***	
	(-2.655)	(-2.534)	(-2.505)		(-5.756)	(-5.538)	(-5.604)	
In-Import		-0.017**	-0.017**			-0.016***	-0.017***	
		(-2.187)	(-2.184)			(-3.949)	(-4.042)	
Up-Import			0.022	0.022			0.029**	0.029**
			(1.000)	(1.040)			(2.545)	(2.547)
VALUELB	-0.002***	-0.002***	-0.002***	-0.002***	-0.001***	-0.001***	-0.001***	-0.001***
	(-9.805)	(-9.898)	(-9.867)	(-10.138)	(-12.463)	(-12.639)	(-12.590)	(-13.005)
ADV	0.290**	0.284**	0.288**	0.254**	0.103	0.098	0.102	0.075
	(2.359)	(2.313)	(2.345)	(2.064)	(1.575)	(1.491)	(1.559)	(1.137)
Fixed Cost	-0.119***	-0.120***	-0.121***	-0.112***	-0.071***	-0.072***	-0.072***	-0.066***
	(-3.828)	(-3.852)	(-3.869)	(-3.583)	(-4.264)	(-4.309)	(-4.348)	(-3.948)
Sunk Cost	-0.131***	-0.131***	-0.131***	-0.137***	-0.025	-0.025	-0.025	-0.029
	(-3.757)	(-3.750)	(-3.755)	(-3.906)	(-1.329)	(-1.316)	(-1.348)	(-1.570)
SOE	0.172***	0.172***	0.172***	0.172***	0.137***	0.137***	0.137***	0.137***
	(20.377)	(20.349)	(20.336)	(20.400)	(30.339)	(30.297)	(30.302)	(30.427)
FIE	0.069***	0.070***	0.069***	0.069***	0.033***	0.035***	0.034***	0.033***
	(6.439)	(6.550)	(6.452)	(6.424)	(5.867)	(6.078)	(5.893)	(5.791)
Subsidy	0.200***	0.200***	0.200***	0.200***	0.138***	0.137***	0.137***	0.137***
	(13.310)	(13.294)	(13.286)	(13.293)	(17.126)	(17.101)	(17.104)	(17.124)
Year-Fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province-Fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj-R2	0.186	0.186	0.186	0.187	0.282	0.283	0.283	0.285
Observation	17,712	17,712	17,711	17,711	17,712	17,712	17,711	17,711

T-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 6. Robustness tests: the product differentiation effect

Dispersion Measure	IQ Range			Standard Deviation		
	(1)	(2)	(3)	(4)	(5)	(6)
Import	0.078**	0.072*	0.072*	0.020	0.017	0.017
	(2.073)	(1.956)	(1.960)	(0.985)	(0.863)	(0.868)
Import•Con_r	-0.110***	-0.093**	-0.093**	-0.064***	-0.053**	-0.053**
	(-2.601)	(-2.249)	(-2.243)	(-2.800)	(-2.382)	(-2.373)
Import•Con_n	-0.157***	-0.158***	-0.159***	-0.090***	-0.091***	-0.092***
	(-4.039)	(-4.116)	(-4.130)	(-4.258)	(-4.428)	(-4.453)
Con_r	0.051***	0.047***	0.047***	0.033***	0.029***	0.029***
	(6.115)	(5.710)	(5.657)	(7.148)	(6.668)	(6.582)
Con_n	0.074***	0.079***	0.080***	0.027***	0.031***	0.032***
	(7.822)	(8.413)	(8.522)	(5.245)	(6.213)	(6.397)
VALUELB	-0.002***	-0.002***	-0.002***	-0.001***	-0.001***	-0.001***
	(-8.022)	(-8.505)	(-8.583)	(-10.776)	(-11.671)	(-11.802)
ADV	0.241*	0.059	0.053	0.156**	0.017	0.012
	(1.830)	(0.456)	(0.409)	(2.183)	(0.244)	(0.168)
Fixed Cost	-0.137***	-0.132***	-0.136***	-0.077***	-0.073***	-0.076***
	(-4.296)	(-4.197)	(-4.318)	(-4.436)	(-4.323)	(-4.523)
Sunk Cost	-0.127***	-0.155***	-0.156***	-0.011	-0.035*	-0.036*
	(-3.559)	(-4.412)	(-4.454)	(-0.547)	(-1.856)	(-1.925)
SOE		0.190***	0.188***		0.147***	0.146***
		(22.582)	(22.378)		(32.750)	(32.436)
FIE		0.067***	0.068***		0.034***	0.034***
		(6.311)	(6.342)		(5.963)	(6.013)
Subsidy			0.332***			0.288***
			(2.681)			(4.350)
Year-Fixed	Yes	Yes	Yes	Yes	Yes	Yes
Province-Fixed	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Fixed	Yes	Yes	Yes	Yes	Yes	Yes
F-Test	12.79***	24.96***	26.76***	2.33	0.26	0.80
Adj-R^2	0.158	0.182	0.183	0.232	0.276	0.277
Observation	17,712	17,712	17,712	17,712	17,712	17,712

T-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 7. Robustness tests: the instrument variable approach (tariff as an IV)

Dispersion Measure	IQ Range			Standard Deviation		
	(1)	(2)	(3)	(4)	(5)	(6)
Import	-0.360***	-0.078***	-0.079***	-0.056***	-0.067***	-0.067***
	(-4.543)	(-7.173)	(-7.196)	(-9.217)	(-11.102)	(-11.149)
VALUELB	-0.004***	-0.003***	-0.003***	-0.001***	-0.002***	-0.002***
	(-16.274)	(-19.476)	(-19.569)	(-10.457)	(-23.496)	(-23.737)
ADV	-0.209	0.225**	0.229**	0.250***	0.126**	0.130**
	(-1.100)	(2.189)	(2.225)	(3.684)	(2.214)	(2.285)
Fixed Cost	-0.261***	-0.139***	-0.138***	-0.081***	0.093***	0.092***
	(-7.591)	(-7.735)	(-7.690)	(-4.726)	(9.357)	(9.273)
Sunk Cost	-0.196***	-0.260***	-0.259***	-0.012	-0.135***	-0.134***
	(-5.812)	(-8.748)	(-8.741)	(-0.610)	(-8.194)	(-8.181)
SOE		0.223***	0.222***		0.176***	0.175***
		(26.674)	(26.458)		(38.002)	(37.628)
FIE		0.084***	0.085***		0.037***	0.037***
		(7.682)	(7.722)		(6.059)	(6.140)
Subsidy			0.242*			0.262***
			(1.893)			(3.699)
Year-Fixed	Yes	Yes	Yes	Yes	Yes	Yes
Province-Fixed	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Fixed	Yes	Yes	Yes	Yes	Yes	Yes
Adj-R2	0.029	0.105	0.105	0.229	0.154	0.155
Observation	17,212	17,712	17,712	17,712	17,712	17,712

T-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 8. Robustness tests: the role of exports and processing trade

Dispersion Measure	IQ Range				Standard Deviation			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Import	-0.057***	-0.072***	-0.070***	-0.065***	-0.053***	-0.066***	-0.065***	-0.060***
	(-5.142)	(-6.457)	(-6.337)	(-5.849)	(-9.070)	(-11.111)	(-10.984)	(-10.120)
Export	0.065***			0.055***	0.062***			0.053***
	(7.432)			(6.130)	(13.152)			(11.218)
Export_OT		-0.053***				-0.041***		
		(-8.013)				(-11.729)		
Export_PT			0.059***	0.051***			0.048***	0.040***
			(8.009)	(6.818)			(12.185)	(10.070)
VALUELB	-0.002***	-0.002***	-0.002***	-0.002***	-0.001***	-0.001***	-0.001***	-0.001***
	(-9.475)	(-10.320)	(-9.776)	(-9.252)	(-11.890)	(-13.306)	(-12.492)	(-11.577)
ADV	0.249**	0.221*	0.236*	0.237*	0.069	0.048	0.059	0.060
	(2.031)	(1.802)	(1.924)	(1.935)	(1.063)	(0.730)	(0.902)	(0.921)
Fixed Cost	-0.098***	-0.113***	-0.113***	-0.102***	-0.053***	-0.067***	-0.067***	-0.056***
	(-3.147)	(-3.646)	(-3.646)	(-3.277)	(-3.175)	(-4.028)	(-4.034)	(-3.371)
Sunk Cost	-0.142***	-0.140***	-0.137***	-0.142***	-0.034*	-0.031*	-0.029	-0.034*
	(-4.065)	(-3.999)	(-3.929)	(-4.064)	(-1.829)	(-1.679)	(-1.579)	(-1.825)
SOE	0.175***	0.172***	0.171***	0.174***	0.140***	0.137***	0.136***	0.139***
	(20.801)	(20.431)	(20.377)	(20.700)	(31.210)	(30.514)	(30.440)	(31.109)
FIE	0.055***	0.063***	0.060***	0.049***	0.021***	0.029***	0.026***	0.016***
	(5.104)	(5.905)	(5.617)	(4.559)	(3.569)	(5.093)	(4.633)	(2.777)
Subsidy	0.194***	0.200***	0.199***	0.194***	0.132***	0.137***	0.136***	0.132***
	(12.915)	(13.307)	(13.254)	(12.934)	(16.494)	(17.162)	(17.086)	(16.544)
Year-Fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province-Fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj-R2	0.189	0.190	0.190	0.191	0.292	0.291	0.291	0.296
Observation	17,712	17,712	17,712	17,712	17,712	17,712	17,712	17,712

T-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 9. Robustness tests: the weighted regression method

Dispersion Measure	IQ Range			Standard Deviation		
	(1)	(2)	(3)	(4)	(5)	(6)
Import	-0.079***	-0.081***	-0.082***	-0.082***	-0.072***	-0.072***
	(-6.530)	(-6.827)	(-6.860)	(-6.860)	(-11.310)	(-11.371)
VALUELB	-0.002***	-0.002***	-0.002***	-0.002***	-0.001***	-0.001***
	(-6.807)	(-7.435)	(-7.488)	(-7.488)	(-9.726)	(-9.824)
ADV	0.521***	0.346***	0.344***	0.344***	0.095	0.093
	(3.950)	(2.657)	(2.642)	(2.642)	(1.366)	(1.340)
Fixed Cost	-0.138***	-0.126***	-0.129***	-0.129***	-0.082***	-0.086***
	(-3.903)	(-3.615)	(-3.723)	(-3.723)	(-4.429)	(-4.620)
Sunk Cost	-0.128***	-0.160***	-0.162***	-0.162***	-0.043**	-0.045**
	(-3.262)	(-4.129)	(-4.177)	(-4.177)	(-2.066)	(-2.151)
SOE		0.199***	0.197***	0.197***	0.156***	0.154***
		(22.857)	(22.652)	(22.652)	(33.443)	(33.110)
FIE		0.067***	0.067***	0.067***	0.034***	0.034***
		(5.952)	(5.979)	(5.979)	(5.681)	(5.729)
Subsidy			0.287**	0.287**		0.269***
			(2.399)	(2.399)		(4.196)
Year-Fixed	Yes	Yes	Yes	Yes	Yes	Yes
Province-Fixed	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Fixed	Yes	Yes	Yes	Yes	Yes	Yes
Adj-R2	0.135	0.161	0.161	0.161	0.248	0.248
Observation	17,712	17,712	17,712	17,712	17,712	17,712

T-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 10. Robustness tests: the market structure effect

Dispersion Measure	IQ Range				Standard Deviation			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Import	-0.057***	-0.060***	-0.061***	-0.066***	-0.055***	-0.043***	-0.057***	-0.047***
	(-5.175)	(-3.409)	(-5.542)	(-3.778)	(-9.564)	(-4.743)	(-10.153)	(-5.262)
Import•HHI		0.012		0.024		-0.057*		-0.050
		(0.184)		(0.360)		(-1.669)		(-1.481)
HHI	0.281***	0.280***	0.255***	0.253***	0.299***	0.304***	0.280***	0.284***
	(24.906)	(21.970)	(22.728)	(19.974)	(51.412)	(46.304)	(48.926)	(44.045)
VALUELB	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***
	(-5.569)	(-5.571)	(-6.474)	(-6.483)	(-5.054)	(-4.977)	(-6.535)	(-6.466)
ADV	0.363***	0.363***	0.213*	0.213*	0.111*	0.111*	0.004	0.004
	(2.950)	(2.949)	(1.751)	(1.751)	(1.749)	(1.751)	(0.057)	(0.059)
Fixed Cost	-0.160***	-0.160***	-0.156***	-0.155***	-0.109***	-0.110***	-0.107***	-0.107***
	(-5.118)	(-5.114)	(-5.038)	(-5.031)	(-6.800)	(-6.825)	(-6.779)	(-6.803)
Sunk Cost	-0.086**	-0.086**	-0.113***	-0.113***	0.023	0.025	0.001	0.002
	(-2.461)	(-2.467)	(-3.251)	(-3.265)	(1.286)	(1.366)	(0.058)	(0.131)
SOE			0.164***	0.164***			0.122***	0.122***
			(19.615)	(19.617)			(28.608)	(28.584)
FIE			0.067***	0.067***			0.031***	0.031***
			(6.354)	(6.353)			(5.813)	(5.816)
Subsidy			0.278**	0.277**			0.285***	0.287***
			(2.282)	(2.270)			(4.587)	(4.629)
Year-Fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province-Fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj-R2	0.184	0.184	0.202	0.202	0.329	0.329	0.361	0.361
Observation	17,712	17,712	17,712	17,712	17,712	17,712	17,712	17,712

T-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 11. Robustness tests: the WTO effect

Dispersion Measure	IQ Range				Standard Deviation			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Import	-0.059***	-0.020	-0.063***	-0.012	-0.056***	-0.036***	-0.059***	-0.030***
	(-5.230)	(-1.044)	(-5.613)	(-0.639)	(-9.200)	(-3.395)	(-9.835)	(-2.878)
Import•WTO		-0.051**		-0.066***		-0.027**		-0.038***
		(-2.420)		(-3.191)		(-2.350)		(-3.436)
WTO	-0.031***	-0.026***	-0.004	0.002	-0.016***	-0.013***	0.007**	0.011***
	(-4.920)	(-3.921)	(-0.645)	(0.358)	(-4.651)	(-3.687)	(2.000)	(2.953)
VALUELB	-0.002***	-0.002***	-0.002***	-0.002***	-0.001***	-0.001***	-0.001***	-0.001***
	(-8.417)	(-8.407)	(-9.177)	(-9.168)	(-10.436)	(-10.427)	(-11.810)	(-11.801)
ADV	0.493***	0.498***	0.312**	0.317**	0.250***	0.253***	0.112*	0.115*
	(3.945)	(3.984)	(2.527)	(2.571)	(3.677)	(3.714)	(1.693)	(1.740)
Fixed Cost	-0.133***	-0.133***	-0.131***	-0.130***	-0.081***	-0.081***	-0.080***	-0.079***
	(-4.202)	(-4.180)	(-4.179)	(-4.151)	(-4.717)	(-4.695)	(-4.746)	(-4.716)
Sunk Cost	-0.119***	-0.119***	-0.146***	-0.146***	-0.012	-0.012	-0.036*	-0.036*
	(-3.344)	(-3.345)	(-4.163)	(-4.167)	(-0.609)	(-0.610)	(-1.903)	(-1.907)
SOE			0.186***	0.187***			0.146***	0.146***
			(22.084)	(22.168)			(32.393)	(32.485)
FIE			0.070***	0.071***			0.034***	0.035***
			(6.538)	(6.617)			(6.016)	(6.101)
Subsidy			0.279**	0.284**			0.286***	0.289***
			(2.260)	(2.299)			(4.327)	(4.369)
Year-Fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province-Fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj-R2	0.155	0.155	0.179	0.179	0.229	0.229	0.274	0.274
Observation	17,712	17,712	17,712	17,712	17,712	17,712	17,712	17,712

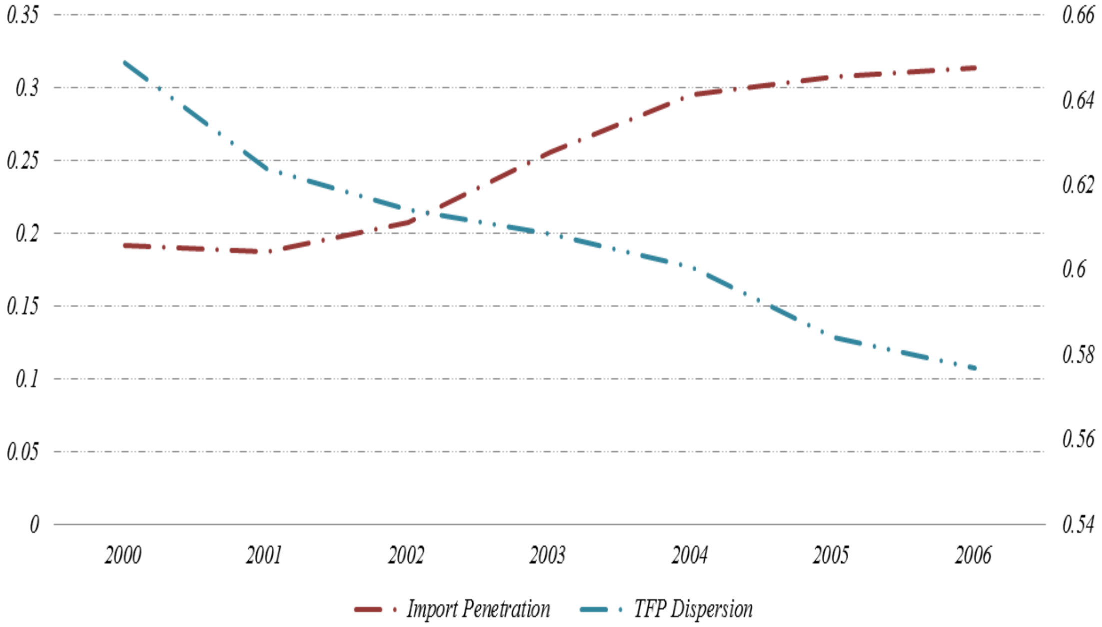
T-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 12. Robustness tests: an alternative productivity measure based on Levinsohn and Petrin (2003)

Dispersion Measure	IQ Range			Standard Deviation		
	(1)	(2)	(3)	(4)	(5)	(6)
Import	-0.087***	-0.088***	-0.088***	-0.061***	-0.061***	-0.062***
	(-8.069)	(-8.201)	(-8.205)	(-9.257)	(-9.382)	(-9.397)
VALUELB	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***
	(-7.555)	(-7.615)	(-7.625)	(-6.259)	(-6.356)	(-6.401)
ADV	0.060	0.020	0.019	0.176**	0.148**	0.147**
	(0.499)	(0.166)	(0.162)	(2.420)	(2.039)	(2.028)
Fixed Cost	-0.020	-0.020	-0.021	0.021	0.021	0.020
	(-0.669)	(-0.660)	(-0.676)	(1.119)	(1.143)	(1.091)
Sunk Cost	-0.029	-0.031	-0.031	-0.032	-0.034*	-0.035*
	(-0.856)	(-0.914)	(-0.918)	(-1.546)	(-1.658)	(-1.671)
SOE		0.035***	0.035***		0.026***	0.025***
		(4.301)	(4.265)		(5.231)	(5.138)
FIE		0.039***	0.039***		0.021***	0.021***
		(3.757)	(3.762)		(3.360)	(3.377)
Subsidy			0.047			0.088
			(0.394)			(1.208)
Year-Fixed	Yes	Yes	Yes	Yes	Yes	Yes
Province-Fixed	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Fixed	Yes	Yes	Yes	Yes	Yes	Yes
Adj-R2	0.098	0.099	0.099	0.128	0.130	0.130
Observation	17,712	17,712	17,712	17,712	17,712	17,712

T-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Figure 1. Import penetration and productivity dispersion in Chinese industries (2000-06)



Notes: import penetration is defined as the ratio of imports to the sum of GDP plus exports minus imports using the data from China Statistical Yearbook from 2000 to 2006; productivity dispersion is defined as the Olley-Pakes TFP interquartile range using the NBS firm-level data from 2000 to 2006.