Export Intensity and Input Trade Costs: Evidence from Chinese Firms*

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Preliminary and Comments Welcome

July 15, 2012

Abstract

How do reductions in input trade costs affect firm's sales decision between domestic and foreign markets? Aside from tariffs cut in ordinary imports over time, a large extent of firms to engage in duty-free processing trade also leads to a decline in input trade cost. Accordingly, the imported input tariffs reduction/exemption introduces firms to access more imported intermediate inputs and then export a larger proportion of final products since, compared to goods for domestic sales, exporting goods use better-quality imported intermediate inputs. By using Chinese firm-level production data and transaction-level trade data during 2000-2006 to construct firm-specific input trade costs, we find rich evidence that a reduction in input trade cost leads to an increase in export intensity (i.e., exports over total sales). Such results are robust to different empirical specification and econometric methods.

JEL: F1, F2

Keywords: Export Intensity, Input Trade Cost, Imported Intermediate Inputs, Processing Trade

*We thank Robert Feenstra, Chang-Tai Hsieh, Brad Jensen, Samuel Kortum, Justin Lin, James Tybout, Yang Yao and seminar and conference participants from the 14th NBER-CCER conference, the 2^{nd} China Trade Research Group (CTRG) conference, the 3^{rd} IEFS (China) conference, Zhejiang University, Nankai University, and Shanghai School of Foreign Trade for their helpful comments and constructive suggestions. However, all errors are ours.

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1 Introduction

Trade liberalization is one of the most important topics in international trade. It is of particular interests for both academia and policy makers to understand firm's decision in choosing markets when a country experiences gradual trade liberalization. Traditionally, import tariffs reduction on final goods is regarded as generating tougher import competition, which in turn force domestic firms to adjust their export intensity–the proportion of exports over total sales. Today, research interests on trade liberalization have been switched from output tariff reductions to input tariff reductions (see, for example, Amit and Konings 2007; Topalova and Khandelwal, 2011). However, there are still relatively little research on firm's response to adjust its export intensity upon facing tariffs reductions in import tariffs. The present paper tries to fill in this gap.

This paper investigates the effects of changing input trade costs on firm's export intensity using a very rich matched Chinese firm-level production data and transaction-level trade data. A novel element of the paper is that input trade costs are measured at and tailored to the firm-level, which allow us to exactly measure the input trade costs faced by a firm. Firms face declining input trade costs over the sample period 2000-2006 from two sources. First, gradual tariffs reduction in ordinary imports occurs over time after China acceded to the WTO in 2001. More interestingly, a large extent of Chinese firms self-select to engage in processing trade in which they could enjoy the free import duties. Thus, the declining input trade costs introduce firms to access more imported intermediate inputs, which in turn transfer to higher export intensity for two reasons.

Firstly, by definition, more processing imports imply more processing exports. When firms self-select to engage in a larger extent to processing trade, a larger proportion of their final products would sell abroad. Secondly and more interestingly, evidence from the Chinese transaction-level trade data reported in the paper suggests that imported intermediate goods used for producing exporting final goods have better quality than those used for producing non-exporting final goods (i.e., goods sold in the domestic market). With a declining input trade cost, firms would use more better-quality intermediate inputs. As a consequence, firms could generate more profits from foreign market than from domestic market hence secure a larger export intensity. To elaborate this point, a simple Melitz-type model is deliever in the paper to shed light on the mechanism.

To accurately estimate the impact of input trade cost on export intensity, we also control for the other two types of trade liberalization: import tariffs on final goods and external tariffs set by Chinese trading partners. As mentioned above, output tariffs reduction in final goods also generates tougher import competition, which could in turn change firm's export intensity. Meanwhile, during the sample period over 2000-2006, many Chinese firms export a variety of products to many countries. Chinese exporters also enjoyed large tariff reductions in their export destinations. With reductions in foreign trade costs, firms are able to access to larger foreign markets which could possibly result in a larger export intensity. We hence construct the firm-level external tariffs to measure the weighted tariffs across trading countries and across products over years. However, although the most ideal way is to obtain a corresponding firm-level import output tariffs, data on each product's domestic sales are unavailable, we hence only control for industry-level output import tariffs in the estimates.

As perhaps the most important feature of international trade in China, processing trade refers to the process by which a domestic firm initially obtains raw materials or intermediate inputs abroad, and after local processing, exports their value-added final goods. Processing trade in China enjoys the privilege of tariff exemptions. To fully capture the impact of processing trade on firm's export intensity, we adopt three different measures to examine the role of processing trade. We start using a processing dummy to distinguish processing firms from non-processing (i.e., ordinary) firms. However, firm's decision to engage in processing is endogenous. Less productive firms or foreign-invested firms in China are more likely to engage in processing trade (Yu, 2011). We hence estimate the probability of firms engaging in processing trade, and adopt the Heckman (1979) two-step approach to explore the effect of firm's predicted processing probability on export intensity. Finally, firm's input trade cost would be much different among firms with different extent to processing. We hence use a continuous variable–the extent to processing which is measured by processing imports over total imports–to highlight the role of processing trade on firm's export intensity.

We then decompose and identify the sources of variation in firm-level input trade costs. Firms may engage in processing trade or may not. Input tariff reduction would have a significant effect on non-processing firm's behavior like export intensity, but should not be so for pure-processing firms that 100% engage in processing trade since processing trade is already *de-facto* duty-free. Yet, perhaps the most interesting case is of hybrid firms which engage in both processing and ordinary trade. Thus, the variation of hybrid firm's input trade costs could come from two different components: input tariffs reduction in ordinary imports *and/or* the proportion allocation between processing and ordinary import components. Such information is carried to construct the firm-specific input tariff. Beyond this, we also identify sources of variation in input trade costs by different types of firms: pure ordinary, pure processing, and hybrid firms. Of course, some firms could switch from processing to ordinary trade, or vice versa. We hence also look at the effect of input trade costs on firm's export intensity for such switching firms specifically.

But, in which ways does the reduction in input trade cost affect firm's export intensity? Are they through the extensive margin, or intensive margin, or both? To check this out, we separate exporters to three types: new exporters, exiters, and continuing exporters. In particular, we find that the declining input trade cost not only increases the probability of firm's being new exporters (i.e., extensive margin) but also leads to a higher export intensity (i.e., intensive margin). However, the impact of either extensive margin or intensive margin is insignificant for exiting firms. By contrast, the impact of intensive margin is significant for continuing exporters. A similar finding are present when we turn the interest to the extensive margin–firm's export scopes.

The endogeneity of firm-specific input trade costs is also carefully discussed and addressed. Three different sources of endogeneity exist for the constructed firm input tariffs. As firm's export intensity is defined as export over sales, the first endogeneity issue is the possible reverse causality of sales on tariffs. Firms with small amount of sales may blame their bad market situation to tougher import competition due to trade liberation. Accordingly, they would lobby the government for protection. We therefore adopt an instrumental variable (IV) approach to control for such a possible reverse causality.

The second endogeneity comes from the possible reserve causality of firm's exports on its imports. Firm's exports are highly correlated with its imports. The last endogeneity issue raises from the measure of the input tariffs itself. Suppose that a firm faces a prohibitive tariff line for a product that it wishes to import, such a tariff is not included in firm's input tariffs due to its zero import. However, the firm indeed faces a high tariff (but not zero tariff). To control for these two endogeneity issues, we use firm's imports in the first year of the sample to construct a fixed weight for firm-specific input tariffs following Topalova and Khandelwal (2011). After controlling for a variety of endogeneity issues, we still find robust evidence that input tariff reduction leads to an increase in export intensity.

Finally, we also perform two important robustness checks. The first exercise is to consider the relative importance of *domestic* intermediate inputs against *imported* intermediate inputs and carry such difference to construct an alternative measure of input tariffs, which also suggests very similar results as our previous estimates: The declining trade cost reduction leads to an increase in export intensity.

Our last robustness check is to adopt the quantile estimates to examine the heterogenous impact of input trade cost on firm's export intensity by different quantiles. We first look at their response at the four quartiles and then examine them carefully in which quantiles are allowed to be measured at a continuum version. Both types of quantile analysis yield similar results as the standard fixed-effects OLS estimates. They also help us understand the economic magnitude of the estimates: A one-point decrease in firm-specific input trade costs would lead to around a 5.2% increase in its export intensity.

This paper joins a growing literature on both counts. The first is on the topic of export intensity. Previous studies have recognized that firms only sell a small fraction of their output abroad. This is documented by, among others, Bernard and Jensen (1995), Tybout (2001), Bernard *et al.* (2010), Arkolakis and Muendler (2010), and Eaton *et al.* (2011). Most of such studies focus on interpreting why export intensity is small. Specifically, Bernard *et al.* (2003) emphasized a key reason for large countries like the United States is the existence of a relatively large domestic market. Brooks (2005) argued the key reason for small countries like Columbia is due to the low quality of their export products. Asides from these, Bonaccorsi (1992) found evidence that firm's export intensity is positively associated with its size using Italian manufacturing industry-level data. Greenaway *et al.* (2004) investigated whether spillovers affect a firm's export propensity using British firm-level data.

However, there are still very limited research for China though it has become the second largest economy and largest exporter in the world. As documented in the later section, although China shares a common phenomenon with other countries in the sense that Chinese firms only export a small proportion of their products, there still exist a sizable proportion of firms that exports all of their products. Such a pattern is known as the U-shape as also observed in Lu (2011).[1] Therefore, it is worthwhile to ask how the declining input trade costs affect such Chinese firms' export pattern, which hence adds value to the related literature.

Another set of related literature is on input trade liberalization. Among many other papers, Amiti and Konings (2007) found that firm's gain from the reduction of input tariffs is at least twice as much as those from cutting output tariffs by using Indonesian firm-level data. Topalova and Khandelwal (2011) confirm that such a gain difference could be exaggerated to approximately ten times in magnitude in several industries in India. Turning to the application to China, Yu (2011) found that the declining output tariffs still have a larger impact on firm productivity than the reduction in input tariffs due, in large part, to the fact that processing trade in China is duty-free. However, to our limited knowledge, rare studies, if any, consider the impact of input trade cost on firm's export intensity despite both being tropical topics in the field.

The remainder of the paper is organized as follows. Section 2 introduces a theoretical model to guide our empirical analysis. Section 3 describes data used in the present paper. Section 4 introduces our measures for key variables and empirical specifications. Section 5 presents the estimation results and sensitivity analysis. Finally, Section 6 concludes.

2 Theoretical Framework

The aim of this section is to deliver a theoretical framework to provide some guidelines for the subsequently empirical analysis, though we have no ambition to develop a general theoretical model. For this purpose, we extend the Melitz-type(2003) model by allowing two types of inputs (i.e., labor and intermediate inputs) and introducing imported intermediate inputs to the model a là Halpern *et al.* (2011).

To investigate the impact of input trade cost on firm's export intensity, consider an exporter with productivity φ that serves in both domestic market and foreign market which has production functions

[1] Lu et al. (2010) also use Chinese firm-level data to find that, among foreign affiliates, exporters are less productive than non-exporters. Dai et al. (2012) points out the key reason for such a phonomenon is due to the prevalence of processing trade in China.

as follows:

$$q_r = \varphi L^{\beta} M_r^{(1-\beta)}, \forall r = d, x \tag{1}$$

where $q_r, \forall r = d, x$ denotes domestic sales (q_d) and foreign sales (q_x), respectively. L is labor and M is intermediate inputs. φ is firm productivity. The intermediate input is assembled from a combination of domestic and imported intermediate inputs. As suggested by Feng et al. (2012), firms that use more imported intermediate inputs are associated with more exports. One possible reason for this finding is that exporting goods use more imported intermediate inputs than those goods sold in the domestic market. Accordingly, the intermediate input production function is assumed to take the following form:

$$M_r = \left((A_r M_F)^{\frac{\theta-1}{\theta}} + M_H^{\frac{\theta-1}{\theta}} \right)^{\frac{\theta}{\theta-1}}, \forall r = d, x \tag{2}$$

where $M_r, \forall r = d, x$ is the intermediate inputs for final goods sold domestically (M_d) and abroad (M_x). M_F is imported intermediate inputs and M_H is domestic intermediate inputs. $\theta > 1$ is the elasticity of substitution between imported intermediate inputs and domestic intermediate inputs. The larger the elasticity θ, the less the difference between imported and domestic intermediate inputs. A_d and A_x represents the efficiency of combining imported inputs to produce final products that sell at home and abroad, respectively.

Compared to goods sold in domestic markets, the imported intermediate goods used for export final goods are presumed to have better quality ($A_x > A_d$). This is possibly because exporting firms or plants have better foreign network. They are able to access imported intermediate inputs with better quality. As shown in the following empirical parts, such a conjecture is highly supported by Chinese firm data.

By normalizing price of the domestic intermediate inputs as one, the aggregated price of intermediate input for domestic sales (S_d) and foreign sales (S_x) can be obtained by solving the cost-minimization problem in (2):

$$S_r = \left(S_h + (S_f/A_r)^{1-\theta} \right)^{\frac{1}{1-\theta}} = \left(1 + B_r^{\theta-1} \right)^{\frac{1}{1-\theta}}, \forall r = d, x$$

where S_h (S_f) is the price of domestic (imported) intermediate inputs. The second equality is obtained by normalizing the price of domestic intermediate inputs as a unity and using the notation that $B_r = A_r/S_f, \forall r = d, x$. Note that $S_r < 1$ since $B_r > 0$ and $\theta > 1$. Clearly, the better quality of the imported inputs, the higher price of the aggregated price index for intermediate inputs. As suggested by Halpern *et al.*(2011), the intuition is that combining imported intermediate inputs with domestic intermediate inputs is more productive than "the sum of the parts" in line with the idea of Hirschman (1958). Accordingly, the combined intermediate inputs have higher prices than the domestic intermediate inputs.

Meanwhile, firm's input trade cost (τ) provides a wedge between domestic import price S_f and world price p^*. That is, $S_f = p^*(1+\tau)$. For simplicity, we assume that the input trade costs have no any terms-of-trade effect like the case in a small open economy. Accordingly, we have $dB_r/d\tau < 0, \forall r = d, x$. The intuition is straightforward: a decrease in input trade costs transfers to a decrease in price of imported intermediate inputs which in turn leads to an increase in imported intermediate inputs.

Accordingly, the cost functions associated with production functions for domestic sales (C_d) and foreign sales (C_x) are:

$$C_r = (f + q_r/\varphi)w^\beta \left(1 + B_r^{\theta-1}\right)^{\frac{1-\beta}{1-\theta}}, \forall r = d, x \tag{3}$$

where f is the fixed costs of production and w is wages as in Melitz (2003).

In a monopolistic-competition environment, the equilibrium pricing rule implies that firm's marginal revenue equals marginal cost. Given that the representative consumer has a utility of constant elasticity σ as in Melitz (2003), the domestic price (p_d) faced by the firm with productivity φ is:

$$p_d(\varphi) = \frac{w^\beta \left(1 + B_d^{\theta-1}\right)^{\frac{1-\beta}{1-\theta}}}{\rho\varphi},$$

where $\rho = (\sigma - 1)/\sigma$. Meanwhile, the price faced by the firm with productivity φ in the foreign market is:

$$p_x(\varphi) = \frac{\nu w^\beta \left(1 + B_x^{\theta-1}\right)^{\frac{1-\beta}{1-\theta}}}{\rho\varphi},$$

where ν is the tariffs set by foreign trading countries. With such pricing rules, the firm's domestic revenue is:

$$r_d(\varphi) = E_h(w^{-\beta}\rho\varphi P)^{\sigma-1}(1 + B_d^{\theta-1})^{\frac{(1-\beta)(\sigma-1)}{\theta-1}}, \tag{4}$$

where E_h is home's aggregate expenditure where P is the aggregate price index.[2] Similarly, the firm's

[2] As in Melitz (2003), the aggregate price index is $P = \left(\int_0^\infty p(\varphi)^{1-\sigma} M\mu(\varphi)d\varphi\right)^{\frac{1}{\sigma-1}}$ where M is the mass of firms with distribution $\mu(\varphi)$ in an industry.

export sales is:

$$r_x(\varphi) = n\nu^{1-\sigma} E_f (w^{-\beta}\rho\varphi P)^{\sigma-1}(1 + B_x^{\theta-1})^{\frac{(1-\beta)(\sigma-1)}{\theta-1}}. \tag{5}$$

where n denotes the number of trading countries whereas ν is additional marginal cost of serving foreign market like import tariffs. For simplicity, foreign countries are assumed to be symmetric. Accordingly, foreign import tariffs ν and foreign country's aggregate expenditure E_f are identical for all countries.

Firm's profit at the domestic market (π_d) and foreign market (π_x) can be written as:

$$\pi_d(\varphi) = \frac{E_h}{\sigma}(w^{-\beta}\rho\varphi P)^{\sigma-1}(1 + B_d^{\theta-1})^{\frac{(1-\beta)(\sigma-1)}{\theta-1}} - f, \tag{6}$$

and

$$\pi_x(\varphi) = \frac{n\nu^{1-\sigma}}{\sigma} E_f (w^{-\beta}\rho\varphi P)^{\sigma-1}(1 + B_x^{\theta-1})^{\frac{(1-\beta)(\sigma-1)}{\theta-1}} - f_x, \tag{7}$$

where f_x is the exporting fixed costs. Firm's profit is the combination of domestic profit and foreign profit: $\pi(\varphi) = \pi_d(\varphi) + \pi_x(\varphi)$. Clearly, we have:

Proposition 1 *A decrease in firm's input trade cost leads to an increase in firm's total profit* ($\frac{d\pi}{d\tau} < 0$).

Proof. *See Appendix A1.* ■

Thus far, firm's export intensity (ζ) can be easily obtained from (4) and (5). To be more straightforward, we consider the inverse function of firm's export intensity as follows:

$$\begin{aligned} \frac{1}{\zeta} &\equiv \frac{r_x(\varphi) + r_d(\varphi)}{r_x(\varphi)} \\ &= 1 + \frac{E_h}{n\nu^{1-\sigma}E_f}\left(\frac{1 + B_d^{\theta-1}}{1 + B_x^{\theta-1}}\right)^{\frac{(1-\beta)(\sigma-1)}{\theta-1}}. \end{aligned}$$

Hence, we can obtain the following testable prediction:

Proposition 2 *A decrease in firm's input trade cost leads to an increase in exporting firm's export intensity* ($\frac{d\zeta}{d\tau} < 0$) *if imported intermediate inputs used for export have high quality than those used for domestic sales* ($A_x > A_d$).

Proof. See Appendix A2. ■

The economic intuition is straightforward. If imported intermediate inputs used for export are of better quality, the exported final goods can generate more profit since their price is relatively higher than final goods for domestic sales. Trade liberalization secures firms to access more intermediate inputs. Thus, the more the better imported intermediate inputs are used for exports, the higher the firm profit, and hence the larger the firm export intensity. Put another way, with tariff reductions, export sales increase faster than domestic sales since exporting goods have higher prices since they use higher-quality inputs.

We now turn to the empirical section to see whether such a theoretical prediction is supported by Chinese firm-level data.

3 Data

To investigate the impact of trade liberalization on firm's export intensity, this paper uses the following three disaggregated large panel data sets: tariffs data, firm-level production data, and product-level trade data.

Tariff data can be accessed directly from the WTO.[3] China's tariff data are available at HS six-digit level over years 2000–2006, which are less disaggregated than HS 8-digit transaction-level trade data.[4] We hence first aggregate transaction-level trade data to HS 6-digit level in concord with tariffs data. We use average *Ad Valorem* duty to measure trade liberalization given that our main interest is to estimate the effect of trade liberalization on export intensity.

3.1 Firm-Level Production Data

The sample used in this paper comes from a rich firm-level panel dataset which covers around 230,000 manufacturing firms per year over 2000-2006. The data are collected and maintained by China's National Bureau of Statistics in an annual survey of manufacturing enterprises. It contains entire information of three accounting sheets (i.e., Balance Sheet, Loss & Benefit Sheet, and Cash Flow Sheet). On average, the annual entire value of industrial production covered in such a data set accounts for

[3] source of the data: http://tariffdata.wto.org/ReportersAndProducts.aspx.

[4] China did not report its tariffs data to the WTO during 1998-2000. However, data from 1997 are available. As reported in *Customs Import & Export Tariff of the P.R. C.* (various years), China did not experience dramatic tariff reductions in 1998-2000, hence the 1997 tariffs are used as serve proxy for those of 2000.

around 95% of China's total industrial production by year. Indeed, aggregated data on the industrial sector in the annual China's Statistical Yearbook by the Natural Bureau of Statistics (NBS) are compiled from this dataset. The dataset includes more than 100 financial variables listed in the main accounting sheets of all these firms. Briefly, it covers two types of manufacturing firms: (1) all SOEs; (2) non-SOEs whose annual sales are more than five million RMB. As shown in Column (3) of Table A1, the number of firms that ever occurred in the dataset is 615,951 in total.

However, the raw production data set is still quite noisy since it still includes many unqualified firms with poor accounting systems.[5] Following Cai-Liu (2009), Feenstra-Li-Yu (2011), we delete observations according to the basic rules of Generally Accepted Accounting Principles if any of the following are true: (1) liquid assets are higher than total assets; (2) total fixed assets are larger than total assets; (3) the net value of fixed assets is larger than total assets; (4) number of employees is less than eight peole as suggested by Brandt *et al.*(2011); (4) the firm's identification number is missing; or (5) firm's established time is invalid (e.g., the opening month is later than December or earlier than January). Accordingly, the total number of firms covered in the data set is reduced to 438,165, around 1/3 of firms are dropped from the sample after such a filter process. As shown in Column (4) of Table A1, the attrition ratio is even higher in the initial years of the dataset: around 1/2 of firms are dropped in 2000.

3.2 Product-Level Trade Data

The disaggregated transaction-level monthly trade data during 2000-2006 are obtained from China's General Administration of Customs. As shown in Column (1) of Table A1, the annual number of observations increase from around 10 million in 2000 to around 16 million in 2006, ending with a huge number of observations, 118,333,831, in total for seven years. Column (2) of Table A1 exhibits that there are 286,819 firms that ever engage in international trade during this period.

For each transaction, the data set compiles three types of information: (1) basic trade information which includes value (measured at US current dollar), trade status (export or import), quantity, trade unit, and value per unit. (2) Trade mode and pattern such as destination country for exports, original

[5]For example, some family-based firms, which usually have no formal accounting system in place, reports their production information based on a unit of one RMB, whereas the official requirement is a unit of 1000 RMB.

country for imports, routing countries (i.e., whether the product is shipped through an intermediate country/regime), customs regime (e.g., processing trade or ordinary trade), transport mode (i.e., by sea, by truck, by air, or by post), and customs port (i.e., where the product departs or arrives). (3) Firm-level transaction information. In particular, it includes seven variables such as firm's name, identification number set by the customs, city where the firm is located, telephone, zip code, name of the manager/CEO, and even ownership type of firm (e.g., foreign affiliate, private, or state-own-enterprises).

We then match transaction-level trade data, firm-level production data, and tariffs data together. Since trade data and production data has no common identication numbers, the matching is of particular challenge. The detailed method and technique is decribed carefully in the Appendix. Briefly, the matched data accounts for around 40% of exporters in terms of number of firms and around 70% of export value.

4 Measures and Empirics

4.1 Firm-Specific Input Tariffs

A firm could import many products in different amounts. Since its imported intermediate input could vary arcoss industries, an aggregated industry-level tariff is insufficient to capture firm heterogeneity within a sector. Therefore, it is essential to construct a firm-specific variable of input trade costs.

A special feature of China's import tariffs is that processing imports in China are duty-free. More interestingly, different types of processing imports have different tariff treatments (Yu, 2011). In the reality, China has around 20 types of processing trade. But two of them are most important: Processing with assembly and processing with inputs (Feenstra and Hanson, 2005). They have two main key differences in such two types:

Firstly, processing with assembly refer to the process that firms passively receive materials from their foreign clients. In contrast, processing with inputs refer to the process that firms can make their own decision to import foreign intermediates or raw materials. Secondly, processing with assembly is 100% duty-free. By contrast, processing with inputs have to pay the input duty upon importation, and get a full-fund duty rebate when the processed final goods are exported. As a result, such firms still bear the opportunity cost of paying the import duty.

Therefore, we construct a firm-specific input tariff index (FIT_{it}) as follows:

$$FIT_{it} = \sum_{k \in O} \frac{m_{it}^k}{\sum_{k \in M} m_{it}^k} \tau_t^k + 0.05 \sum_{k \in I} \frac{m_{it}^k}{\sum_{k \in M} m_{it}^k} \tau_t^k, \tag{8}$$

where m_{it}^k is firm i's import value on product k in year t and, as before, τ_t^k is the *ad valorem* tariff of product k in year t. O is the set of firm's ordinary imports, I is the set of all processing imports other than processing with assembly, and M is the set of firm's total imports. That is, $O \cup I \cup A = M$ where A is the set of processing with assembly and by definition, is 100% duty free. Thus, this set is not included in Eq. (8). Note that the first term in Eq. (8) measures the input tariffs from ordinary imports, whereas the second term measures those from processing with inputs in which firms have to pay the import duties on imported materials from abroad but can get the full-amount duty rebate once the final value-added products export. Thus, firms engaged in processing with inputs have stronger demands on cash flow and have to bear extra risk-free interest–Otherwise firms could alternatively use the funds paid to cover their duty to invest at a risk-free rate. We hence follow Hsieh-Klenow (2009) to set the real interest rate to 0.05.[6]

4.2 Firm-Specific External Tariffs

To measure the tariff reductions in a firm's export destinations, we construct an index of firm-specific external tariffs (FET_{it}) as follows:

$$FET_{it} = \sum_k \left[\left(\frac{X_{it}^k}{\sum_k X_{it}^k}\right) \sum_c \left(\frac{X_{ikt}^c}{\sum_c X_{ikt}^c}\right) \tau_{kt}^c \right], \tag{9}$$

where τ_{kt}^c is product k's *ad valorem* tariff imposed by export destination country c at year t. A firm may export multiple types of products to multiple countries. The ratio in the second parentheses in Eq. (9), $X_{ikt}^c / \sum_c X_{ikt}^c$, measures the export ratio of product k produced by firm i but consumed in country c, yielding a weighted external tariff across Chinese firms' export destinations. Similarly, the first parenthesis in Eq. (9), $X_{it}^k / \sum_k X_{it}^k$, measures the proportion of product k's exports over firm i's total exports.

[6] Usually the processing activities could be done within a year (see Yu and Tian, 2012). Accordingly, firms only bear a one-year real risk-free interest rate. However, changing the number of China's real interest rate such as 1% or 3% does not affect our estimates at all.

As a control variable, the output import tariffs are measured at industrial level. Lower output import tariffs induce tougher import competition. To measure the impact of import competition, it is ideal to have information on domestic sales at product-level so that the output tariffs can be tailored to the firm level. A possible proxy is to presume that the proportion of domestic sales to total sales is the same as that of exports to total sales for each product (Yu, 2011). However, such an assumption may be inappropriate given that our key interest of this project is to investigate the share of firm's export over sales. We hence measure the output tariffs at the industry level.

4.3 Estimation Framework

To investigate the effect of input tariff reductions on firm export intensity, we then consider an empirical framework as follows:

$$Exp\_int_{ijt} = \alpha_0 + \alpha_1 FIT_{it} + \alpha_2 FET_{it} + \alpha_3 FET_{it} \times PE_{it} + \alpha_4 OT_{jt} \quad (10)$$

$$+\alpha_5 OT_{jt} \times PE_{it} + \alpha_4 PE_{it} + \boldsymbol{\theta}\mathbf{X}_{it} + \eta_i + \zeta_t + \epsilon_{it,} \quad (11)$$

where Exp_int_{ijt} measures firm's export intensity for firm i in industry j in year t, as discussed before. FIT_{it} and FET_{it} denote firm-specific weighted input tariff and external tariff in year t respectively. PE_{it} is a processing indicator which equals one if firm i engages in processing activity in year t, and zero otherwise. OT_{jt} denotes industry-level tariffs for industry j in year t. $\mathbf{X}_{it}$ denotes other firm characteristics such as type of ownership (*i.e.*, state-owned-enterprises or multinational firms), firm size (*i*.e., log employment), and firm productivity. Finally, the error term is divided into three components: (1) firm-specific fixed effects η_i to control for time-invariant factors such as a firm's location; (2) year-specific fixed effects ζ_t to control for firm-invariant factors such as China's accession to the WTO in 2001 and Chinese *RMB* appreciation after 2005; (3) an idiosyncratic effect ϵ_{it} with normal distribution $\epsilon_{it} \sim N(0, \sigma_i^2)$ to control for other unspecified factors.

5 Empirical Results

5.1 Benchmark Results

As described above, the attrition rate of the merged data set is high, though it is a suitable representative of the full-sample firm data. Therefore, it is reasonable to ask whether such a high attrition rate affects estimation results. Hence our estimations begin from a comparison between the full-sample data set and merged data set. Column (1) of Table 2 reports the estimates using full-sample firm-level data. Without merging with the transaction-level trade data, the firm-level data have no information on products, so it is impossible to measure input tariffs at the firm level. We hence abstract away the firm input tariffs but only keep output industry tariffs. Hence, the estimate in Column (1) with a full-sample of 725,993 observations concentrates on the impact on firm export intensity of output tariffs, which is measured at the HS 2-digit industry-level. Clearly, industrial output tariffs are positively associated with firm's export intensity. Column (2) includes more control variables like SOEs and foreign indicators and yields the similar results in both magnitudes and signs. Column (3) drops the two extreme values of export intensity (i.e., zero and one) and, again, obtain similar results.

The rest of Table 2 runs regressions by using the merged data set. For a close comparison, Columns (4)-(6) of Table 2 perform the exact identical estimates as their counterparts in Columns (1)-(3). Once again, the coefficients of industry tariffs are all positive significant, indicating the use of matched data is a suitable representative of the full-sample data set.

Of all the specifications in Table 2, firm's ownership matters for firm export intensity as well. The statistically significant and positive coefficients of the foreign indicator suggest that multinational affiliates have higher export intensity. Similarly, after controlling for firm-specific and year-specific fixed effects, the negative and significant signs of SOEs indicator suggest that SOEs sell a larger proportion of their products at home.

[Insert Table 2 Here]

Before adopting the matched samples to perform the estimations, it is worthwhile to check whether the distribution of firm's export intensity in the full sample is similar to that in the matched sample. If not, then our estimation results would be a suspect. As seen from Figure 1, firm's export intensity in the matched-sample shows a U-shape in the LHS of Figure 1B, which is very similar to that in the full-sample in the LHS of Figure 1A. Of course, around 72% of firms do not export in the full-sample production firm-level dataset whereas only 17% of firms do not export in the matched data set given that the matched data, by construction, only cover trading firms (i.e., either export or import, or both). Therefore, the density for the extreme values of firm's export intensity (i.e., zero and one) would be different. However, their non-parametric kernel density after dropping the two-side extreme values are very similar, as shown in the RHS of Figure 1A and 1B. Therefore, the matched data set is a good representative of the full-sample data set. Finally, as suggested by Ahn et al. (2011), the carry-along trading importers and exporters (i.e., intermediaries) would have different production and sales behavior. For instance, indirect trading exporters would sell their 100% of their products abroad. We therefore drop both indirect trading exporters and importers from our sample in all estimates.

[Insert Figure 1 Here]

To investigate the impact of firm-specific input tariffs reduction on export intensity, we start from plotting firm's export intensity against firm-specific input tariffs, which are aggregated in industry level over years. Figure 2 clearly suggests a negative correlation between the average firm-specific export intensity and input tariffs. Of course, such a negative correlation could be just driven by other unspecified factors. In addition to the output import tariffs reductions, the tariffs reduction in China's trading partners may also affect Chinese firm's export intensity. Thus, controlling for tariff reduction in China's export destinations is also worthwhile in obtaining the precise estimate of the effect of import tariff reductions on a firm's export intensity. We then control for industrial output tariffs and firm-specific external tariffs as well as firm's type of ownership (*i.e.*, SOEs and foreign firms) and trade regime (*i.e.*, processing and ordinary firms) in all estimates in Table 3.

To understand the overall impact of input tariff reduction on export intensity, estimate in Column (1) starts from abstracting away the interaction role of various tariffs reduction and firm's processing status. After controlling for firm-specific fixed effects and year-specific fixed effects, estimates in Column (1) show that firm's input tariffs reduction leads to larger proportion of exports to sales, though the impact of industrial output tariffs and firm-specific external tariffs on export intensity is insignificant. Adding the interaction terms between processing dummy and input tariffs (external tariffs, and output tariffs) does not change the estimation results in terms of signs or magnitudes.

One may concern that the large proportion of pure domestic firms which have zero export may affects our estimation results given that around 17% of Chinese firms have zero exports in our matched data. A similar argument applies to a fairly large proportion of pure exporting firms–12% exporters export all of their products. Meanwhile, some Chinese firms notably do not have their own production activity, but only export goods collected from other domestic firms or import goods from abroad and then sell to other domestic companies (Ahn *et al.*, 2011). Such firms would result in a unit of export intensity. We hence drop firms which export intensity is zero in Column (4) and one in Column (5). Column (6) goes further to drop observations if export intensity is either zero or one. Neither of such specifications change our estimation results for the key variable: the coefficient of firm input tariff is always negative and highly significant at conventional statistical level.

[Insert Table 3 Here]

5.2 Discussion on the Impact Channels

It is interesting to ask why input tariffs reduction can lead to higher export intensity. One possible reason is that input tariffs reduction generates more firm profitability (*i.e.*, firm's profit over sales) which in turn introduces higher export intensity (export over sales). Given that higher firm profitability is positively associated with higher export intensity, the key interest is how reduction in input trade costs generates more firm profitability. This could come from two channels. The first one is from the change of firm markup. Input tariffs reduction could have a cost-saving effect for firms and hence raise the price-to-cost markup. Another possibility is that lower tariffs make firms access to more input varieties which in turn foster more profit.

To check whether such conjectures are supported by data, Column (1) of Table 4 first includes firm's markup, which is measured by firm's revenue over the difference between revenue minus profit following Keller and Yeaple (2009). It turns out the coefficient of firm's markup is negative but insignificant. However, when we include the interaction terms between firm markup and the three tariff variables, the variable of markup itself turns to be positively significant. In addition, firm-specific input tariff is negative significant whereas its interaction with firm markup is positive significant, indicating that firm markup is an important channel of input tariffs on firm's export intensity. Meanwhile, the significant term of firm input tariffs suggests the existence of other channels.

In our sample, many Chinese firms export multiple products, with the maximum even reaching 745 (see Table 1). We hence include a variable of firm's import scope in Column (3) which yields a significant and positive sign. Similarly, we add its interaction term with the three tariff variables. As seen from Column (4), the coefficient of input tariff is negative and significant whereas its interaction term with import scope is also negative and significant, suggesting that access to more import varieties is an important channel for firms to realize higher export intensity from input tariffs reduction. The negative sign of the interaction term between firm input tariffs and firm import scope also suggests that firms with more import varieties can increase more export intensity from their input tariffs reduction.

[Insert Table 4 Here]

In fact, such a theoretical conjecture is well supported by Chinese trade data. By using unit-value of imports as a proxy of quality as suggested by Hallak (2006), Column (1) of Table 1 shows that the intermediate inputs used for processing imports have better quality than those for ordinary imports. By definition, processing intermediate imports are used for export only. In contrast, ordinary intermediate imports could be used to produce goods for either exports or domestic sales. Thus, the fact that the unit-price of intermediate processing imports is higher than that of intermeidate ordinary imports suggests that imported intermediate goods *for exports* have better quality than imported intermediate goods *for domestic sales*. Such an observation is even true when the intermediate inputs are broken-down to sub-catogories including parts & components and semi-finished goods according to the classification of broader economic categories (BEC) as shown in Columns (2)-(3) of Table 1.

[Insert Table 8 Here]

5.3 Sources of the Input Trade Costs Reduction

Figure 2B demonstrates that the average firm input tariffs across industries exhibited a declining trend over the period 2000-2006 which witness China's trade liberalization in the period. It is worthwhile to ask where are the sources of the firm-specific input tariffs. The first answer that come to our minds is due to the tariffs reduction of products that firms import. In the measure of firm-specific input tariffs (8), if τ_t^k decreases, firm input tariffs FIT_{it} would decrease even other components are unchanged.[7] Meanwhile, there still exist another source for input tariffs reduction. When faced by some negative

[7] Of course, when tariff τ_t^k decreases, the import weight m_{it}^k for the product k for firm i could change as well. However, change the weight to a fixed weight using the initial year in the period ($m_{i,2000}^k$) or a floating one-period lag weight (m_{it-1}^k) does not change our estimation results.

demand shocks, firms may adjust their production structure between processing imports and ordinary imports. Since processing activities has a lower threshold to entry, firms may engage in more processing activities when they are in a short position in the market (Yu, 2011). If firms have more weights in processing activities, they would be able to bear a lower firm-specific input tariffs. However, in the reality such two sources are combined automatically. Therefore, it is worthwhile to decompose the two sources and identify their effects.

Table 5 therefore picks up such a task. In the estimate of Column (1), only pure ordinary firms are included in which firm-specific input tariff only has its first component $FIT_{it} = \sum_{k \in \mathring{\Theta}} \frac{m_{it}^k}{\sum_{k \in \Theta} m_{it}^k} \tau_t^k$. Similarly, Column (2) only covers pure processing firms in which firm-specific input tariff only has its second component $FIT_{it} = 0.05 \left(\sum_{k \in \mathring{\Theta}} \frac{m_{it}^k}{\sum_{k \in \Theta} m_{it}^k} \tau_t^k \right)$. Column (3) covers hybrid firms that have some ordinary imports and some processing imports. However, since the firm-specific tariffs (8) still reflects the changes in both processing share and tariffs change, we fix the tariffs by using the tariffs line for products in the initial years so that one can clearly observe the impact of changing processing share on the export intensity. That is, the firm-specific tariff in Column (3) is measured as $\sum_{k \in \mathring{\Theta}} \frac{m_{it}^k}{\sum_{k \in \Theta} m_{it}^k} \tau_{2000}^k + 0.05 \sum_{k \in \tilde{\Theta}} \frac{m_{it}^k}{\sum_{k \in \Theta} m_{it}^k} \tau_{2000}^k$. It turns out that the coefficients of firm-specific input tariffs are negative and significant in Columns (1)-(3), indicating that changes in both tariffs and processing share matters for firms to realizing the increase in their export share.

We now go further to explore the transition probability for the trade regime switch. As shown in Appendix Table A4, it is more likely for firms to switch from pure processing firms to hybrid firms, but less likely for firms to switch from hybrid firms to non-hybrid firms or from ordinary firms to non-ordinary firms. The reason is straightforward. Given that the threshold of processing trade is low in China, pure ordinary firms would entry to processing trade only when the market is tough. In contrast, pure processing firms would start to engage in ordinary trade if the market is soft. Columns (4)-(6) hence preform the estimates for firms that switch from ordinary to hybrid, from pure processing to hybrid, and from hybrid to non-hybrid firms, respectively. It turns out that only the effect of input tariff on export intensity for firms that switch from ordinary to hybrid are negative and significant.

[Insert Table 5 Here]

5.4 Estimates for Entry and Exit

As suggested by Blum et al. (2012), Chilean firms would reduce their domestic sales when they enter foreign markets. Meanwhile, for continuing exporters, Chilean firms' foreign and domestic sales are negatively correlated over time. Having explored the sources of the variation of input trade costs, we now ask whether the impact of firm's input trade costs on export intensity is different across starter, continuing firms, and exiters. Column (1) of Table 6 includes only starters that include both exporters and non-exporters whereas Column (2) includes new exporters only. Similarly, Columns (3) and (4) includes all exiters and exiting exporters, respectively. Columns (5)-(6) covers continuing firms and continuing exporters, respectively. It turns out that the coefficients of firm-specific input tariffs are negative and significant. Interestingly, the magnitudes for starters and exiters in Columns (1)-(4) are more pronounced than those continuing firms in Columns (5)-(6), suggesting that the effect of reduction in firm input trade costs on export intensity are more important for starters and exiters.

[Insert Table 6 Here]

5.5 First-Difference Estimates

Firm's export intensity could be affected by other factors that are unspecified in the estimations above. Although we have employed firm-specific fixed-effects and year-specific fixed-effects to control for factors that are only variant across firms and over years, respectively. It is still possible to exist some other omitted factors that change both across firms and over years. For instance, China's government is allowed some exportable products to enjoy the previledge of "export value-added tax rebate". Such value-added tax rebate ratio differs across industries and over year[8], though the detailed data are not reported either in firm-level data or transaction-level data. We hence perform the following first-difference estimate to control for such possible omitted variables as suggested by Trefler (2004):

$$\Delta Exp\_int_{ijt} = \alpha_0 + \alpha_1 \Delta FIT_{it} + \alpha_2 \Delta FET_{it} + \alpha_3 \Delta FET_{it} \times PE_{it} + \alpha_4 \Delta OT_{jt} \quad (12)$$

$$+\alpha_5 \Delta OT_{jt} \times PE_{it} + \alpha_4 PE_{it} + \boldsymbol{\theta} \mathbf{X}_{it} + \varpi_i + \eta_t + \mu_{it,} \quad (13)$$

[8]Most commodities are mandatory to pay 13% or 17% value-added tax for their value-added in China. However, if such commodities are exportable goods, firms can get the value-added tax rebate when such products are exported. The value-added tax rate is set as 5%, 9%, 11%, 13%, or 17% which is contigent on products.

where Δy_{it} is the first-difference of the variable $y_{it} \in \left\{Exp\_int_{ijt}, FIT_{it}, FET_{it}, OT_{jt}\right\}$ denoting $y_{it} - y_{it-1}$.We also include the firm (year)-specific fixed effects to control for the time-invariant (variant) growth factors.

As shown in Column (1) of Table 7, the variable of first-difference in firm-input tariffs is still negative and significant. To check whether such results are sensitive to the extreme values of the variable of export intensity, we drop samples with zero export intensity in Column (2) and samples with a unit of export intensity in Column (3). Finally, we even drop samples which export intensity is zero or one. All of such specifications have a similar result: the reduction in firm-specific input tariffs leads to an increasing export intensity.

[Insert Table 7 Here]

5.6 Selection to Processing

Column (1) of Table 3 shows that the variable of processing dummy is positive. Such a finding is intuitive. By definition, processing firms should export, more or less, their final products to the rest of the world. Yet, the insignificant sign of processing dummy is, somehow, unexpected. One possible reason is that the processing dummy, as a binary variable, is too coarse to measure firm's processing activity. The processing indicator variable is, in itself, endogenous. Foreign firms may self-select to engage in processing firms by offshoring some low value-added activities to China (Feenstra-Hansen, 1999). To control for this, We perform the Heckman (1979)'s two-step approach to estimate the effect of input tariff on export extensity. In the first step, we introduce a selection equation that estimates the probability of a firm to involve in processing based on its type of ownerships and other variables, we then experiment using such a predicted processing probability as an alternative to the processing indicator.

In particular, we estimate the following selection equation by the Probit model:

$$\begin{aligned} \Pr(\Pr oces\sin g_{it} &= 1) = \Pr(V_{it} \geq 0) \\ &= \Phi(\alpha_0 + \alpha_1 \ln TFP_{it} + \alpha_2 SOE_{it} + \alpha_3 FIE_{it} + \alpha_2 tenure_{it} + \lambda_j + \varsigma_t) \end{aligned} \quad (14)$$

where V_{it} denotes the latent variable faced by firm i. $\Phi(.)$ is the cumulative density function of the normal distribution. In addition to the logarithm of firm's previous TFP, a firm's decision to engage in processing trade is also affected by other factors such as firm's productivity (measured by the Olley-Pakes total factor productivity). The Heckman two-step approach requires a restriction variable that is statistically significant in the first-step but not in the second-step. The variable of firm's tenure ($tenure_{it}$) that measure firm's age is proposed to serve as such a variable. Finally, we also include the HS 2-digit level industrial dummies λ_j and year dummies ς_t to control for other unspecified factors.

Table 8 reports the estimation results for the selection equation (14) using the Probit model. We see that foreign firms are more likely to engage in processing trade. Similarly, firms that established earlier (*i.e.*, larger tenure) are more likely to engage in processing trade. SOEs and low productive firms are less likely to become processing firms, though their coefficients are insignificant.

[Insert Table 8 Here]

Columns (1)-(2) of Table 9 then report the second-step estimation results by replacing the processing indicator with predicted processing probability for Eq. (14). The predicted processing probability produces a mean higher that of the processing indicator, as shown in the summary statistics of Table 1. We starts from Column (1) to include all observations but drop extreme values of export intensity in Column (2). In both estimates, firm's tenure are found to be insignificant in the second-step estimates, suggesting that firm's tenure is an appropriate restrictive variable. By contrast, the inverse Mills ratios, which is defined as the probability density function over cumulative density function for the residual that obtained in the linear estimation in the first-step, are included in the current second-step estimates and found to be significant. Once again, the coefficients of firm-specific input tariffs are negative and significant. Meanwhile, the coefficients of processing indicators now turn to be positive and significant.

[Insert Table 9 Here]

In the reality, some firms only engage a small proportion of its output in processing trade whereas some other firms engage in a large proportion. Ignoring such a difference may not be able to capture the production difference across firms. To overcome such an identification challenge, we then take a step forward to consider a continuous measure of the extent to which a firm is engaged in processing trade to replace the predicted processing probability. In particular, the extent of processing engagement is measured through a firm's total processing imports over total imports in each year. We estimate the effect of firm-specific input tariff on export intensity in Columns (3)-(4) of Table 9, by using the variable of extent to processing to replace the processing probability. Once again, the coefficients of firm-specific input tariffs are negative and significant, indicating that input tariff reduction leads to greater export intensity.

5.7 The Endogeneity Issues

5.7.1 Reverse Causality of Export intensity on Tariffs

Some Chinese firms may have to cut their production when facing tougher import competition due to the import tariff reductions. Hence, such firms could lobby the government for protection (Grossman and Helpman, 1994). In this way, firm's export-intensity would reversely affect the tariffs that it faces. Of course, in the reality, China' labor union may not be strong enough to affect foreign trade policy. For the sake of completeness, it is still better to introduce the instrument-variable approach to address such an endogeneity caused by the reverse causality.

Determining a good instrument for tariffs is usually challenging. Inspired by Amiti and Konings (2007), here we construct the following firm-specific input tariffs in 1996 as instruments, by replacing the tariff τ_k^t for product k in year t in Eq. (8) with the tariff τ_k^{1996} for product k in 1996.

$$FIT_{it} = \sum_{k \in \mathring{\Theta}} \frac{m_{it}^k}{\sum_{k \in \Theta} m_{it}^k} \tau_{1996}^k + 0.05 \sum_{k \in \tilde{\Theta}} \frac{m_{it}^k}{\sum_{k \in \Theta} m_{it}^k} \tau_{1996}^k, \tag{15}$$

As a result, the firm-specific input tariffs in 1996 capture the importance of such tariffs on products that firms currently *import*. Their economic rationales are as follows. The government generally has difficulties in removing the high protection *status quo ante* from an industry with high tariffs, possibly because of the domestic pressure from special interest groups. Hence, compared with other sectors, industries with high tariffs five years before China's accession to the WTO can still be expected to have relatively high tariffs at present.

Table 10 reports the 2SLS estimation results. We measure processing indicators in three different ways: Column (1) takes the form of processing dummy, Column (2) adopts the processing probability, and Columns (3)-(4) employ the extent to processing imports. In all estimates, firm-specific input tariffs are found to be statistically significant and have close magnitudes with the benchmark OLS estimates in Table 3.

A final remark is that the coefficient of TFP is negative and significant, indicating that high productive Chinese firms have lower export intensity. This finding indeed is suggested by Lu (2011) who documents that Chinese exporters have lower productivities than non-exporters. One possible reason could be due to the processing trade (Dai, et al., 2012) who confirm the finding suggested by Yu (2011) that less productive firms are more likely to engage in processing trade. In any case, the exploration of Chinese firms' TFP is out of the scope of the current project, though it is an interesting future work.

Several tests were performed to verify the quality of the instruments. First, we check whether such an exclusive instruments are "relevant". That is, whether they are correlated with the endogenous regressors (i.*e.*, the current firm's input tariffs). In our econometric model, the error term is assumed to be heteroskedastic: $\epsilon_{it} \sim N(0, \sigma_i^2)$. Therefore, the usual Anderson (1984) canonical correlation likelihood ratio test is invalid because it only works under the homoskedastic assumption of the error term. Instead, we use the Kleibergen–Paap (2006) Wald statistic to check whether the excluded instruments correlate with the endogenous regressors. As shown in Table 10, the null hypothesis that the model is under-identified is rejected at the 1% significance level.

Second, we test whether or not the instruments are weakly correlated with the firm's current input tariffs. If so, then the estimates will perform poorly in the IV estimate. The Anderson-Rubin Wald χ^2 tests provide strong evidence to reject the null hypothesis that the first stage is weakly identified at a highly significant level.

Finally, the first-stage estimates reported in the lower module of Table 10 offer more supportive evidence to justify such instruments. In particular, all the t-values of the instruments are significant. The excluded F–statistics in the first stage are also highly significant. Thus, these statistical tests provide sufficient evidence that the instrument performs well and, therefore, the specification is well justified.

[Insert Table 10 Here]

5.7.2 Endogeneity of the Measure of Input Tariffs

Furthermore, the weight construction in firm-specific input tariffs in Eq. (8) is still endogenous because goods with high tariffs would be imported less, thus generating a lower import weight in Eq. (8). Taking an extreme example, if China imposes a prohibitive tariff on product k, then its import share on such a good would be zero, because m_{it}^k in Eq. (8) is zero. Meanwhile, firm's exports are also possible related to its imports since firms with more exports usually use more intermediate imports, as documented by Feng et al. (2012). If so, the LHS variable, firm's export intensity, also reversely affects the import weight in the firm-specific input tariffs FIT_{it}.

Hence, the input tariffs that a firm faces may be underestimated. Thus, to avoid such a problem, following Topalova and Khandelwal (2011), we choose firm's import value in the initial year (*i.e.*, 2000) to construct a fixed weight in the firm-specific input tariffs (FIT_{it}^{2000}) as follows:

$$FIT_{it}^{2000} = \sum_{k \in \mathring{\Theta}} \frac{m_{i,2000}^k}{\sum_{k \in \Theta} m_{i,2000}^k} \tau_t^k + 0.05 \sum_{k \in \tilde{\Theta}} \frac{m_{i,2000}^k}{\sum_{k \in \Theta} m_{i,2000}^k} \tau_t^k, \tag{16}$$

where $m_{i,2000}^k$ is firm i's imports of product k in 2000. As a result, the import weight is unaffected by tariff reductions. We then use this measure of tariff reductions to run regressions in Table 11 as a robustness check.

[Insert Table 11 Here]

Table 11 reports the estimates using firm-level tariffs with fixed weights. In all estimates we use the extent to processing imports to measure firm's processing activities. It is worthwhile to check whether the effects of firm-level input tariffs on export intensity pick up the role of firm size given that large firms usually have larger export intensity (Bonaccorsi, 1992). Column (2) includes the variable of firm's productivity whereas Column (3) includes the variable of firm size measured by the log of firm's employment. Column (4) even includes such two variables. It turns out that larger firms usually have higher export intensity. Nevertheless, the effect of firm-specific input tariffs on export intensity is negative and significant in all estimates, which is consistent with our previous findings.

5.8 Additional Estimates with Alternative Measure of Input Tariffs

Thus far, we have seen rich evidences that the input tariff reduction leads to an increase in firm's export intensity. Our final work is to provide additional estimates with alternative measure of input tariffs as a robustness check.

The key variable, firm-specific input tariff FIT_{it} have captured the importance of each product for a firm. However, in the reality, some firms use more intermediate inputs whereas some other firms may use more domestic inputs. It is worthwhile to incorporate such information into the index. We hence consider the following index

$$FIT_{it}^{Alt} = \frac{\sum_{k \in \Theta} m_{it}^k}{Input_{it}} \left(\sum_{k \in \mathring{\Theta}} \frac{m_{it}^k}{\sum_{k \in \Theta} m_{it}^k} \tau_t^k + 0.05 \sum_{k \in \tilde{\Theta}} \frac{m_{it}^k}{\sum_{k \in \Theta} m_{it}^k} \tau_t^k \right), \tag{17}$$

where $Input_{it}$ is firm's use of total intermediate inputs which include both imported inputs and domestic inputs. Table 12 adopts such an alternative measure of input tariffs to replace the FIT_{it} but still yields very similar results for all estimates: the reduction in firm's input trade cost leads to an increase in export intensity. The intuition is straightforward, the effect of the first firm $(\sum_{k \in \Theta} m_{it}^k)/Input_{it}$ shown in (17) are indeed captured by the estimate coefficients in all the previous tables.

[Insert Table 12 Here]

5.9 Further Quantile Estimates

A possible concern is whether or not the OLS estimates is appropriate for estimation given that the sample of firm's export intensity exhibits a U-shape, which is far from the normal distribution that requires for OLS estimates. However, this is not a problem since that the U-shape of firm's export intensity across firms is due, in large part, to the variation of firm's characteristics. Given that we have already controlled for firm-specific fixed-effects and year-specific fixed effects, such omitted characteristics have been well controlled.

However, the U-shape of firm's export intensity also hints us that the response of input trade cost to export intensity may not be identical across all firms. The fixed-effect OLS estimates so far only focus on the *mean* level of the response of firm input tariff. The rich heterogeneity across all firms are hence abstracted away. To gain a better understanding the economic magnitude of the effect of input trade cost on firm export intensity, the quantile estimates would be a plus to help us identify such heterogenous magnitudes across firms.

Another rationale to appeal to the quantile estimates is the residual obtained from the benchmark estimates shown in the last column of Table 3 is asymmetric, as shown in Figure 3, which deviates from the requirement of standard OLS estimates. In this case, the quantile analysis is also a need (Koenker-Bassett, 1978). Different from minimizing the sum of square errors in the OLS estimates, the quantile estimates propose to minimize the weight of the estimation residual as follows:

$$\beta_q = \arg\min \sum\nolimits_{i:y_i \geqq \mathbf{X}_i\boldsymbol{\beta}_q}^{n} q \left| y_i - \mathbf{X}_i\boldsymbol{\beta}_q \right| + \sum\nolimits_{i::y_i < \mathbf{X}_i\boldsymbol{\beta}_q}^{n} (1-q) \left| y_i - \mathbf{X}_i\boldsymbol{\beta}_q \right| \tag{18}$$

where q is the quantile level, y_i is the LHS variable and $\mathbf{X}_i\boldsymbol{\beta}_q$ are the fitted value at quantile q. Intuitively, the quantile estimates give much more weights for those observations are lower than their fitted value at every quantile q. In this way, the estimates would be able to capture the heterogenous behavior of firm's export intensity.

Table 13 therefore reports the quantile estimates for the first-quantile, median, and the third quantile. To capture the impact of various tariff reduction on export intensity, we abstract away other control variables but only include firm-specific input tariffs, output import tariffs, and external tariffs. For comparison, we also include the OLS estimate in Column (1). It turns out that the impact of firm-specific input tariffs reduction leads to an increase in export intensity in all estimates.

[Insert Table 13 Here]

Finally, we take a step further to perform the quantile estimates in a continuous version that the quantiles vary from zero to one. Figure 4 shows the heterogenous response of the coefficients for industry output tariffs, firm-specific input tariffs, and firm-specific external tariffs and the constant intercept term. Clearly, the coefficients of firm-specific input tariffs exhibit a concave shape. Similarly, the coefficients of output tariffs exhibit a hump-shape. These two figures suggest that the coefficient of the firm input tariffs should reach its maximum around the median level in an absolute value. This is exactly consistent with the empirical findings shown in Table 13.

Our final remark is about the economic magnitude of firm's export intensity in response to the input trade costs reduction. As shown in both Figure 4 and Table 13, the coefficient of input trade cost reaches, in the absolute value, its maximum of 0.052 at the mean level but records a relatively low number of 0.016 at the first-quarter level and of 0.035 at the third-quarter level. This suggests that a one-percent declining in input trade costs leads to 5.2% increase in export intensity for firms around median level of export intensity, and 1.6 (3.5) % increase in export intensity for firms around first (third)-quarter level of export intensity. Given that the mean of input trade costs is 2.73% and of export intensity is 48.8% as shown in Table 1, and 53% (58%) for firms with first (third)-quarter export intensity.

[Insert Figure 4 Here]

6 Concluding Remarks

The paper explores how reductions in tariffs on imported inputs affect firms' export intensity by exploiting the special tariff treatment afforded to the imported inputs by processing firms as opposed to non-processing firms in China. As a popular trade pattern in a large number of developing countries, including China, processing trade plays an important role in a variation of export intensity for firms. Since processing trade in China enjoys zero tariffs on imported inputs, We find that a reduction in input tariffs leads to an increase in export intensity.

The present paper is one of the first to explore the role of processing trade on Chinese firm's export share. The rich data set enables the determination of whether a firm engages in processing trade and the examination of the effect of the firms' extent of processing trade engagement on export intensity. With such information, firm-specific input tariffs were also constructed, as one of the first attempts in the literature, which, in turn, enriches the understanding of the economic effect of the special tariff reform in processing trade.

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Table 1: The Unit-Value of Intermeidate Inputs for Processing v.s. Ordinary Imports

BEC Classification	Intermediate Goods	Parts & Components	Semi-finished Goods
	(1)	(2)	(3)
Processing Imports	73,908	24.06	135,966
Ordinary Imports	70,546	17.61	129,784
Difference	3,362***	6.44***	6,182***
	(3.05)	(4.34)	(3.06)
Observations	931	425	506

Notes: Numbers in the parenthesis are t-value. Here intermediate inputs are defined by the Classification by Broad Economic Categories (BEC, 2002 version) which include semi-final goods (i.e., food and beverages, processed, mainly for industry which is coded as 121) and parts & components (i.e., of transport equipment which is coded as 53). There are 931 observations in HS 6-digit level sectors over years 2000-2006. Since processing imports are duty-free in China, the actual processing imports are inappropriate to compare with actual ordinary imports directly as a measure of quality index. We hence construct the counterfactual unit-price for processing imports by multiplying tariffs at HS 6-digit level if such products were imposed by import tariffs.

Table 2: Summary Statistics (2000-2006)

Variables	Mean	Std. Dev.	Min.	Max
Year	2003	1.85	2000	2006
Firm's Export Intensity	.488	.399	0	1
Industry-level Output Tariffs	11.60	5.23	0	50.5
Firm-level Input Tariffs	2.32	3.93	0	90
Firm-Level External Tariffs	8.13	19.22	0	4,275
Processing Indicator	.319	.466	0	1
Predicted Processing Probability	.449	.130	.026	.826
Extents to Processing Imports	.552	.474	0	1
Firm's Log TFP (Olley-Pakes)	1.273	.350	-1.55	10.41
Firm Tenure	10.76	10.36	0	57
Firm Markup	1.046	1.455	.082	554
Firm Scope	6.49	9.84	1	527
SOEs Indicator	.020	.141	0	1
Foreign Indicator	.615	.486	0	1

Table 2: Baseline OLS Estimates

Export Intensity (*Exp_int*)	Full-sample			Matched-sample		
	(1)	(2)	(3)	(4)	(5)	(6)
Industrial Tariffs	.544***	.403*	.540***	.012***	.011***	.010**
	(98.71)	(81.13)	(42.91)	(59.40)	(49.24)	(49.24)
State-Owned Enterprises		-.062***	-.222***		-.163***	-.175***
		(-68.42)	(-57.63)		(-27.39)	(-25.57)
Foreign Invested Enterprises		.308***	.128***		.185***	.140**
		(266.5)	(75.60)		(83.22)	(59.92)
Obs. Dropped if $Exp\_int = 0$ or 1	No	No	Yes	No	No	Yes
Observations	725,993	725,993	172,137	124,618	124,618	87,349
R-squared	.02	.16	.06	.03	.08	.08

Notes: Robust t-values corrected for clustering at the firm level in parentheses. *, **, and *** indicates significance at the 10, 5, and 1 percent level, respectively.

Table 3: Estimates of Tariffs Reduction on Firm's Export Intensity

Export Intensity (Exp_int)	(1)	(2)	(3)	(4)	(5)
Industrial Tariffs	0.0004	-0.0001	-0.0001	-0.0002	0.0001
	(1.20)	(-0.17)	(-0.20)	(-0.49)	(0.01)
Industrial Tariffs		0.001***	0.001***	0.001***	0.001***
×Processing Dummy		(2.92)	(3.16)	(3.11)	(3.07)
Firm Input Tariffs	-0.002***	-0.002***	-0.002***	-0.002***	-0.003***
	(-4.75)	(-4.67)	(-7.56)	(-4.83)	(-7.89)
Firm External Tariffs	-0.000	0.000	-0.000	-0.000	-0.000
	(-1.07)	(0.11)	(-0.16)	(-0.26)	(-0.41)
Firm External Tariffs		-0.000*	-0.000	-0.000	-0.000
×Processing Dummy		(-1.92)	(-0.44)	(-1.16)	(-0.88)
Processing Dummy	0.001	-0.013**	-0.011**	-0.016***	-0.013**
	(0.25)	(-2.27)	(-2.19)	(-2.71)	(-2.33)
State-owned Enterprises	0.019	0.019	0.011	0.017	0.011
	(0.97)	(0.98)	(0.69)	(0.90)	(0.62)
Foreign Invested Enterprises	0.033***	0.033***	-0.001	0.021*	-0.010
	(2.74)	(2.74)	(-0.11)	(1.65)	(-0.84)
Obs. Dropped if $Exp\_int = 0$	No	No	Yes	No	Yes
Obs. Dropped if $Exp\_int = 1$	No	No	No	Yes	Yes
Year-specific Fixed Effects	Yes	Yes	Yes	Yes	Yes
Firm-specific Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	79,212	79,212	67,086	68,420	56,294
R-squared	0.01	0.01	0.01	0.01	0.01

Notes: Robust t-values corrected for clustering at the firm level in parentheses. *, **, and *** indicates significance at the 10, 5, and 1 percent level, respectively.

Table 4: Estimates for Sources of Input Tariffs Variation

Export Intensity	Pure Ordinary Firms	Pure Processing Firms	Hybrid Firms	Switching Firms from pure ord. to hybrid	Switching Firms from pure proc. to hybrid	Switching Firms from hybrid to non-hybrid
	(1)	(2)	(3)	(4)	(5)	(6)
Industrial Tariffs	-0.000	0.004	0.000	0.001	0.005	-0.000
	(-0.76)	(1.59)	(0.68)	(0.66)	(0.85)	(-0.19)
Firm Input Tariffs	-0.002***	-0.044*		-0.004**	-0.002	-0.001
	(-5.21)	(-1.68)		(-2.04)	(-0.10)	(-0.39)
Firm Input Tariffs (Fixed Tariffs)			-0.001***			
			(-2.96)			
Firm External Tariffs	-0.000	-0.000	0.000	-0.000	-0.001	0.000
	(-0.50)	(-0.79)	(0.03)	(-0.50)	(-0.68)	(0.19)
State-owned Enterprises	0.008	0.021	0.014	0.023	–	0.005
	(0.43)	(0.12)	(0.47)	(0.27)		(0.06)
Foreign Invested Enterprises	-0.011	0.071	0.029	0.060	0.416**	0.006
	(-0.66)	(1.28)	(1.63)	(1.37)	(2.32)	(0.07)
Year-specific Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm-specific Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	31,740	8,063	46,831	12,524	3,644	9,395
R-squared	0.01	0.01	0.01	0.01	0.03	0.02

Notes: Robust t-values corrected for clustering at the firm level in parentheses. *, **, and *** indicates significance at the 10, 5, and 1 percent level, respectively.

Table 5: Estimates of Firm Input Tariffs on Export Intensity by Extry and Exit

Type	New Exporters		Exiters		Continuing Exporters	
Regressand	Export Dummy	Export Intensity	Export Dummy	Export Intensity	Export Intensity	Export Scope
Econometric Method	Probit	FE	Probit	FE	FE	Neg. Binomial
	(1)	(2)	(3)	(4)	(5)	(6)
Industrial Tariffs	0.005***	-0.001	0.004*	-0.003*	-0.001	-0.001
	(2.79)	(-0.41)	(1.89)	(-1.68)	(-1.33)	(-0.67)
Industrial Tariffs	-0.004**	-0.000	-0.003	0.003	0.002***	0.002
× Processing Dummy	(-2.08)	(-0.04)	(-1.08)	(1.44)	(2.72)	(0.85)
Firm Input Tariffs	-0.009***	-0.002*	-0.000	-0.001	-0.002***	-0.007***
	(-6.00)	(-1.77)	(-0.24)	(-0.84)	(-3.15)	(-4.17)
Firm External Tariffs	-0.002**	-0.001	-0.000	0.000	-0.000	0.001
	(-1.99)	(-0.89)	(-0.41)	(0.57)	(-0.75)	(0.71)
Firm External Tariffs	0.001	0.001	0.001	0.000	0.000	0.001
× Processing Dummy	(1.57)	(0.94)	(1.05)	(0.52)	(0.16)	(0.45)
Processing Dummy	0.128***	-0.017	0.101***	-0.047*	-0.022**	-0.042
	(4.65)	(-0.65)	(3.05)	(-1.90)	(-2.31)	(-1.37)
Firm's TFP	-0.102***	-0.039***	0.039**	-0.031**	-0.042***	0.054***
	(-6.56)	(-2.87)	(2.22)	(-2.04)	(-4.76)	(2.95)
State Owned Enterprises	-0.202***	-0.047	0.346***	0.039	-0.001	-0.097
	(-4.20)	(-1.25)	(7.21)	(1.28)	(-0.02)	(-1.02)
Foreign Invested Enterprises	0.089***	-0.075*	0.134***	0.006	-0.028	0.258***
	(6.95)	(-1.66)	(8.57)	(0.11)	(-1.19)	(3.80)
Observations	65,422	21,624	46,862	32,098	18,053	11,677
R-squared	–	0.02	–	0.01	0.02	–
Year-specific Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	No	Yes	No	No	No
Firm-specific Fixed Effects	No	Yes	No	Yes	Yes	Yes

Notes: Robust t-values corrected for clustering at the firm level in parentheses. *, **, and *** indicates significance at the 10, 5, and 1 percent level, respectively.

Table 6: First Difference Estimates of Firm Input Tariffs on Export Intensity

First Difference in Export Intensity (ΔExp_int)	(1)	(2)	(3)	(4)
First Difference in Industrial Tariffs	-0.000	0.001	-0.000	0.001
	(-0.08)	(1.01)	(-0.31)	(0.85)
First Difference in Industrial Tariffs	-0.000	-0.000	0.001	0.000
× Processing Dummy	(-0.36)	(-0.32)	(0.52)	(0.34)
First Difference in Firm Input Tariffs	-0.001	-0.001*	-0.001	-0.001**
	(-1.04)	(-1.88)	(-1.28)	(-2.11)
First Difference in Firm External Tariffs	-0.000	0.000	-0.000	-0.000
	(-0.08)	(0.01)	(-0.30)	(-0.03)
First Difference in Firm External Tariffs	-0.000	0.000	0.000	0.000
× Processing Dummy	(-0.76)	(1.34)	(0.54)	(0.90)
Processing Dummy	0.000	0.002	0.002	0.003
	(0.04)	(0.49)	(0.34)	(0.61)
State-Owned Enterprises	0.003	-0.002	0.001	-0.005
	(0.07)	(-0.06)	(0.02)	(-0.13)
Foreign Invested Enterprises	0.040	0.023	0.023	0.001
	(1.51)	(0.97)	(0.83)	(0.03)
Obs. Dropped if $Exp\_int = 0$	No	Yes	No	Yes
Obs. Dropped if $Exp\_int = 1$	No	No	Yes	Yes
Year-specific Fixed Effects	Yes	Yes	Yes	Yes
Firm-specific Fixed Effects	Yes	Yes	Yes	Yes
Observations	36,266	31,623	31,707	27,064
R-squared	0.02	0.01	0.01	0.01

Notes: Robust t-values corrected for clustering at the firm level in parentheses. *, **, and *** indicates significance at the 10, 5, and 1 percent level, respectively.

Table 7: Channels of Tariffs Reduction on Firm's Export Intensity: Import Scope

Regressand	Export Intensity				Log Profit
	(1)	(2)	(3)	(4)	(5)
Industrial Output Tariffs	-0.000	0.000	-0.000	-0.000	0.011***
	(-0.48)	(0.09)	(-0.86)	(-0.90)	(3.36)
Industrial Output Tariffs	0.001*	0.001**	0.001*	0.001*	0.000
× Processing Dummy	(1.93)	(2.14)	(1.85)	(1.71)	(0.10)
Industrial Output Tariffs		-0.000***		0.000***	0.000
× Firm Import Scope		(-15.76)		(3.01)	(0.42)
Firm Input Tariffs	-0.002***	-0.001***	-0.002***	-0.001***	-0.005*
	(-3.91)	(-3.20)	(-5.72)	(-3.60)	(-1.65)
Firm Input Tariffs		-0.000		-0.000***	0.000***
× Firm Import Scope		(-1.19)		(-5.36)	(2.81)
Firm External Tariffs	-0.000	-0.000	-0.000*	-0.000	-0.000
	(-0.77)	(-0.47)	(-1.66)	(-0.84)	(-0.31)
Firm External Tariffs	0.000	0.000	-0.000	-0.000	0.000
× Processing Dummy	(0.36)	(0.34)	(-0.55)	(-0.10)	(0.05)
Firm External Tariffs		-0.000		-0.000*	-0.000*
× Firm Import Scope		(-0.15)		(-1.78)	(-1.69)
Firm Import Scope	0.000**	0.001***	0.000***	0.000***	0.003***
	(2.17)	(9.94)	(3.68)	(3.33)	(4.10)
Processing Dummy	-0.013*	-0.014**	-0.011*	-0.011*	-0.007
	(-1.90)	(-1.99)	(-1.76)	(-1.79)	(-0.16)
State-owned Enterprises	0.018	0.016	0.017	0.017	-0.144
	(0.81)	(0.73)	(0.92)	(0.88)	(-1.08)
Foreign Invested Enterprises	0.018	0.017	-0.015	-0.016	0.142
	(1.32)	(1.24)	(-1.19)	(-1.20)	(1.56)
Firm TFP (Olley-Pakes)	-0.024***	-0.023***	-0.046***	-0.046***	0.599***
	(-5.69)	(-5.43)	(-10.45)	(-10.48)	(17.94)
Observations	65,418	65,418	46,388	46,388	37,407
R-squared	0.01	0.02	0.01	0.01	0.06
Year-specific Fixed Effects	Yes	Yes	Yes	Yes	Yes
Firm-specific Fixed Effects	Yes	Yes	Yes	Yes	Yes

Notes: Robust t-values corrected for clustering at the firm level in parentheses. *, **, and *** indicates significance at the 10, 5, and 1 percent level, respectively.

Table 8: The Probit Estimates of Selection Effects of Processing Firms

Variables	Coefficient	Variables	Coefficient
Log of TFP	-.007	Foreign Indicator	1.008**
	(-.55)		(105.6)
SOEs Indicator	-.015	Tenure	.009**
	(-.41)		(16.34)

Notes: Robust t-values corrected for clustering at the firm level in parentheses. *, **, and *** indicates significance at the 10, 5, and 1 percent level, respectively. The selection model is equation (14) in the text. The regressand is firm's processing indicator. The 2-digit industry-specific fixed effects and year-specific fixed effects are also included in the estimation.

Table 9: Endogenous Choice of Processing Firms

Export Intensity (Exp_int)	Processing Probability		Extents to Processing	
	(1)	(2)	(3)	(4)
Industrial Tariffs	-0.001	0.000	-0.001	-0.001
	(-1.25)	(0.00)	(-0.80)	(-1.00)
Industrial Tariffs	0.004*	0.001	0.001	0.002**
$\times$ Processing Indicator	(1.65)	(0.62)	(1.04)	(2.36)
Firm Input Tariffs	-0.002***	-0.002***	-0.003***	-0.003***
	(-3.73)	(-5.65)	(-2.92)	(-4.45)
Firm External Tariffs	-0.000	-0.000	0.000	-0.000
	(-0.87)	(-0.75)	(0.32)	(-0.02)
Firm External Tariffs	0.000	0.000	-0.000	-0.000
$\times$ Processing Indicator	(0.70)	(0.64)	(-1.56)	(-1.27)
Processing Indicator	0.214**	0.194**	-0.002	-0.007
	(2.05)	(2.05)	(-0.21)	(-0.65)
State-owned Enterprises	0.018	0.014	0.045	0.037
	(0.75)	(0.69)	(1.19)	(1.12)
Foreign Invested Enterprises	0.037*	-0.016	0.041*	0.003
	(1.72)	(-0.79)	(1.95)	(0.16)
Firm TFP	-0.025***	-0.045***	-0.023***	-0.041***
	(-6.10)	(-10.55)	(-3.93)	(-6.56)
Firm Tenure	0.001	0.000		
	(1.13)	(0.22)		
Inverse Mills Ratio	0.124**	0.087**		
	(2.57)	(2.03)		
Obs. dropped if $Exp\_int = 0$ or 1	No	Yes	No	Yes
Year-specific Fixed Effects	Yes	Yes	Yes	Yes
Firm-specific Fixed Effects	Yes	Yes	Yes	Yes
Observations	65,018	46,042	37,606	26,127
R-squared	0.01	0.01	0.01	0.01

Notes: Numbers in paranthesis are t-values. ***(**,*) denotes the significance at 1% (5%, 10%) level.

Table 10: Instrumental-Variable Estimates of Tariffs Reduction on Firm's Export Intensity

Export Intensity	Processing Dummy	Processing Probability	Extent to Processing	
	(1)	(2)	(3)	(4)
Firm Input Tariffs	-0.002***	-0.002***	-0.004***	-0.007***
	(-2.99)	(-3.02)	(-2.85)	(-5.14)
Industrial Tariffs	-0.002***	-0.002**	-0.001	-0.001
	(-3.78)	(-2.11)	(-0.71)	(-0.82)
Industrial Tariffs	0.001	0.006***	0.001	0.002**
× Processing Indicator	(1.51)	(2.74)	(0.90)	(2.05)
Firm External Tariffs	0.000	-0.000	0.000	-0.000
× Processing Indicator	(0.17)	(-0.86)	(0.31)	(-0.04)
Firm External Tariffs	-0.000**	0.000	-0.000	-0.000
	(-1.98)	(0.69)	(-1.58)	(-1.29)
Processing Dummy	-0.009	-0.016	-0.004	-0.009
	(-1.35)	(-0.31)	(-0.31)	(-0.85)
Foreign Invested Enterprises	0.031**	0.008	0.040*	0.003
	(2.29)	(0.43)	(1.93)	(0.13)
State-owned Enterprises	0.010	0.017	0.046	0.040
	(0.46)	(0.72)	(1.22)	(1.23)
Firm TFP	-0.023***	-0.025***	-0.023***	-0.041***
	(-5.64)	(-6.09)	(-3.94)	(-6.57)
Firm Tenure		0.001		
		(1.12)		
Inverse Mills Ratio		0.124**		
		(2.57)		
Kleibergen-Paap rk LM statistic (χ^2)	9,980†	32,737†	1,456†	5,791†
Anderson-Rubin Wald test (χ^2)	942.0†	2,130†	305.6†	8.11‡
Obs. Dropped if $Exp\_int = 0$ or 1	No	No	No	Yes
Year-specific Fixed Effects	Yes	Yes	Yes	Yes
Firm-specific Fixed Effects	Yes	Yes	Yes	Yes
Observations	49,943	49,589	24,556	6108
R-squared	0.15	0.01	0.01	0.01
	First-Stage Regression			
IV for Firm Input Tariffs	.343**	.343**	.354**	.360**
	(142.8)	(145.9)	(96.74)	(76.01)
	[20,441]	[21,300]	[9,358]	[5,778]

Notes: Robust t-values corrected for clustering at the firm level in parentheses. *, **, and *** indicates significance at the 10, 5, and 1 percent level, respectively. Numbers in bracket are F-values. †(‡) dontes the p-value is lower than .001 (.01), respectively.

Table 11: Estimates using Firm-Level Tariffs with Fixed Weights

Export Intensity	(1)	(2)	(3)	(4)
Industrial Tariffs	0.000	0.001	0.000	0.002
	(0.06)	(0.44)	(0.06)	(0.45)
Industrial Tariffs	0.001	-0.001	0.001	-0.001
× Extent to Processing Imports	(0.33)	(-0.35)	(0.32)	(-0.37)
Firm Input Tariffs (fixed weights)	0.000	-0.0001*	-0.0001	-0.0001*
	(-1.56)	(-1.78)	(-1.59)	(-1.83)
Firm External Tariffs	-0.000	0.000	-0.000	0.000
	(-0.11)	(0.06)	(-0.07)	(0.07)
Firm External Tariffs	-0.000	-0.000	-0.000	-0.000
× Extent to Processing Imports	(-0.09)	(-0.20)	(-0.13)	(-0.21)
Extent to Processing Imports	0.084**	0.078*	0.085**	0.080*
	(2.38)	(1.75)	(2.42)	(1.78)
State-owned Enterprises	0.177**	0.137	0.177**	0.139
	(2.00)	(1.07)	(2.00)	(1.08)
Foreign Invested Enterprises	0.052*	0.040	0.052*	0.041
	(1.81)	(1.22)	(1.80)	(1.23)
Firm TFP		-0.022**		-0.022**
		(-2.48)		(-2.49)
Log Employment			0.015**	0.014*
			(2.40)	(1.70)
Year-specific Fixed Effects	Yes	Yes	Yes	Yes
Firm-specific Fixed Effects	Yes	Yes	Yes	Yes
Observations	28,312	22,655	28,312	22,655
R-squared	0.01	0.01	0.01	0.01

Notes: Robust t-values corrected for clustering at the firm level in parentheses. *, **, and *** indicates significance at the 10, 5, and 1 percent level, respectively.

Table 12: Estimates using Alternative Firm Input Tariffs

Export Intensity	(1)	(2)	(3)	(4)
Industrial Tariffs	-0.001	-0.001	-0.001	-0.001
	(-0.78)	(-1.01)	(-0.78)	(-1.00)
Industrial Tariffs	0.001*	0.002*	0.001*	0.002*
× Extent to Processing Imports	(1.74)	(1.79)	(1.72)	(1.75)
Firm Input Tariffs (Alternative)	-0.010***	-0.008***	-0.010***	-0.008***
	(-4.82)	(-3.26)	(-4.73)	(-3.17)
Firm External Tariffs	-0.000	-0.000	-0.000	-0.000
	(-0.16)	(-0.04)	(-0.15)	(-0.02)
Firm External Tariffs	-0.000	-0.000	-0.000	-0.000
× Extent to Processing Imports	(-1.15)	(-1.33)	(-1.13)	(-1.33)
Processing Indicator	0.007	0.003	0.007	0.004
	(0.74)	(0.31)	(0.76)	(0.35)
State-owned Enterprises	0.034	0.050	0.033	0.048
	(1.22)	(1.54)	(1.20)	(1.49)
Foreign Invested Enterprises	-0.001	-0.004	-0.001	-0.003
	(-0.07)	(-0.17)	(-0.08)	(-0.16)
Firm TFP		-0.048***		-0.048***
		(-5.26)		(-5.28)
Log Employment			0.008*	0.012**
			(1.71)	(2.00)
Obs. Dropped if $Exp\_int = 0$ or 1	Yes	Yes	Yes	Yes
Year-specific Fixed Effects	Yes	Yes	Yes	Yes
Firm-specific Fixed Effects	Yes	Yes	Yes	Yes
Observations	29,210	23,608	29,210	23,608
R-squared	0.01	0.01	0.01	0.01

Notes: Robust t-values corrected for clustering at the firm level in parentheses. *, **, and *** indicates significance at the 10, 5, and 1 percent level, respectively.

Table 13: Quantile Estimates

Export Intensity	OLS	Quantile 25%	Quantile 50%	Quantile 75%
Industrial Tariffs	0.010**	0.010**	0.020**	0.005**
	(40.08)	(38.26)	(45.25)	(41.51)
Firm Input Tariffs	-0.027**	-0.016**	-0.052**	-0.035**
	(-55.35)	(-56.49)	(-89.1)	(-189.2)
Firm External Tariffs	-0.0001	-.0000	-0.001**	-0.001**
	(-1.46)	(-0.99)	(-10.21)	(-8.45)
Constant	0.469**	0.0641**	0.479**	0.920**
	(120.63)	(17.39)	(76.47)	(568.6)

Notes: Robust t-values corrected for clustering at the firm level in parentheses. *, **, and *** indicates significance at the 10, 5, and 1 percent level, respectively.

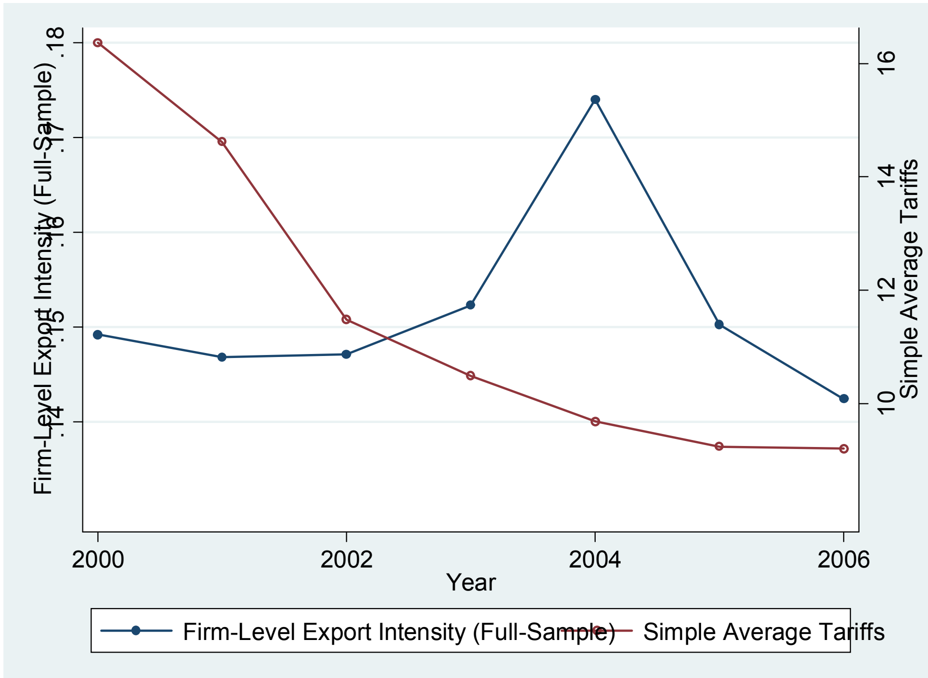


Figure 1A: Export Intensity against Tariffs in the Full-Sample Firm Data

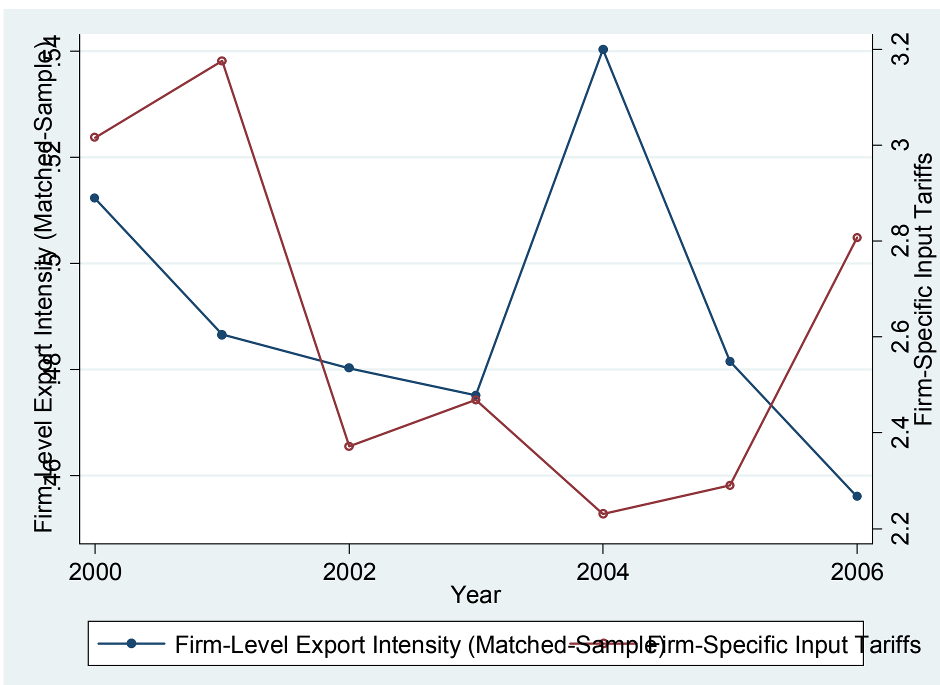


Figure 1B: Export Intensity against Tariffs in the Matched Firm Data

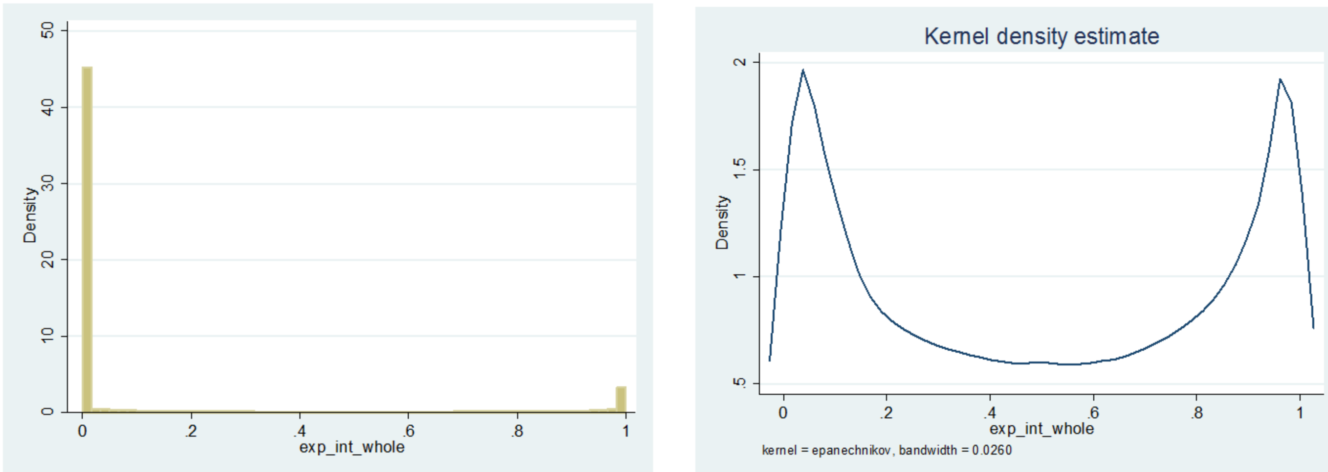


Figure 2A: The Distribution of Firm's Export Intensity in Full-Sample Dataset

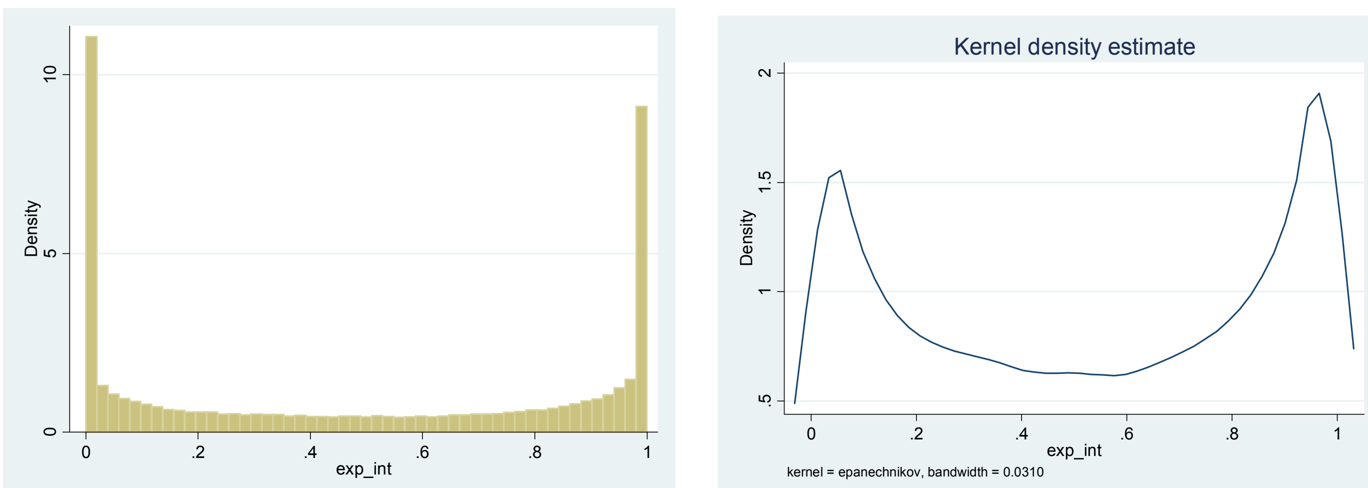


Figure 2B: The Distribution of Firm's Export Intensity in Matched-Sample Dataset

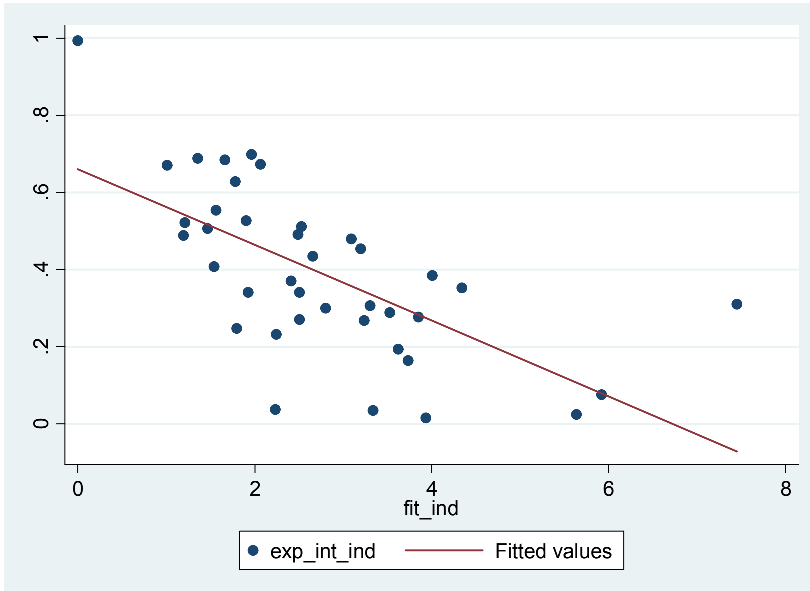


Figure 3: Firm Export Intensity against Firm Input Tariffs

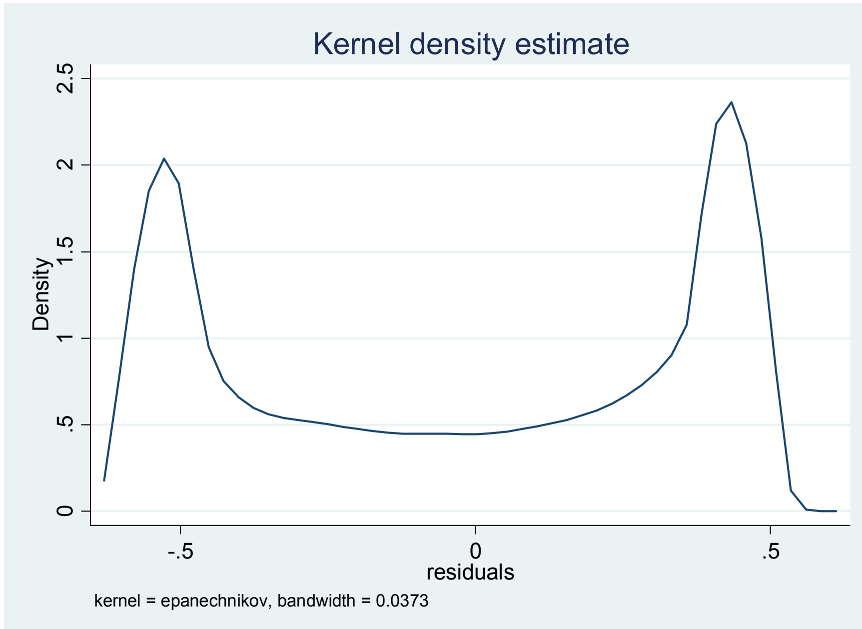


Figure 4: Distribution of Residuals

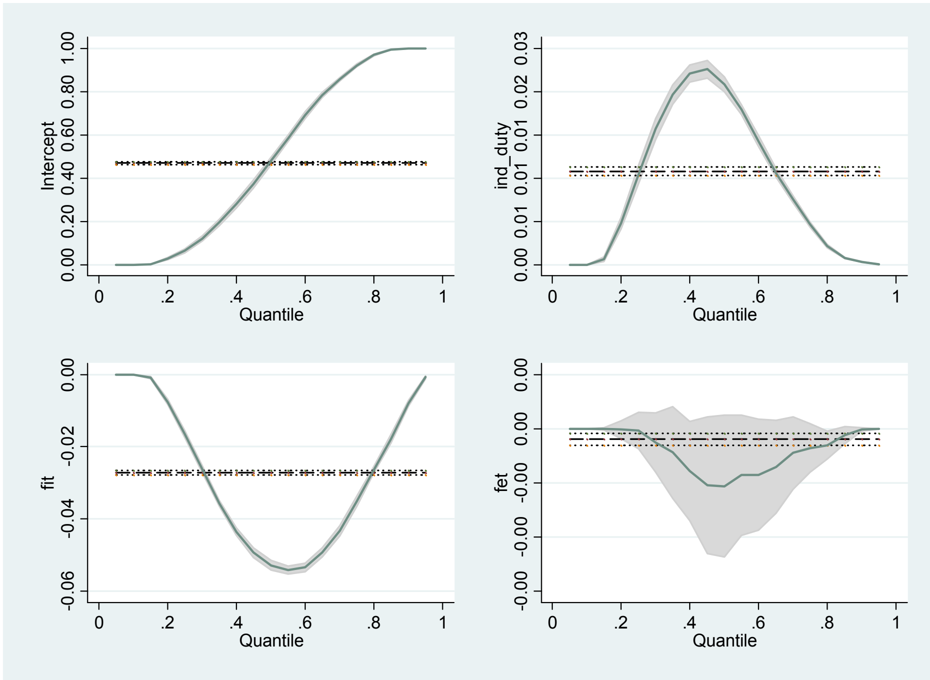


Figure 5: The Quantile Estimates of Various Tariffs Reductions

7 Appendix

7.1 Appendix A1: Proof of the Proporsition 1

Since $\frac{dB_r}{d\tau} = -\frac{A_r}{S_F^2}\frac{dS_F}{d\tau} < 0, \forall r = d, x$, and firm's domestic profit is:

$$\pi_d(\varphi) = \frac{E_h}{\sigma}(w^{-\beta}\rho\varphi P)^{\sigma-1}(1 + B_d^{\theta-1})^{\frac{(1-\beta)(\sigma-1)}{\theta-1}} - f,$$

we have $\frac{d\pi_d(\varphi)}{d\tau} = \frac{\partial\pi_d(\varphi)}{\partial B_d}\frac{dB_d}{d\tau} < 0$ since $\frac{\partial\pi_d(\varphi)}{\partial B_d} > 0$. Similarly, given firm's profit at foreign market is:

$$\pi_x(\varphi) = \frac{n\nu^{1-\sigma}}{\sigma}E_f(w^{-\beta}\rho\varphi P)^{\sigma-1}(1 + B_x^{\theta-1})^{\frac{(1-\beta)(\sigma-1)}{\theta-1}} - f_x,$$

we have $\frac{d\pi_x(\varphi)}{d\tau} = \frac{\partial\pi_x(\varphi)}{\partial B_x}\frac{dB_x}{d\tau} < 0$. Therefore a decrease in input trade cost leads to an increase in firm's profit.

$$\frac{d\pi(\varphi)}{d\tau} = \frac{d\pi_d(\varphi)}{d\tau} + \frac{d\pi_x(\varphi)}{d\tau} < 0.$$

(QED)

7.2 Appendix A2: Proof of the Proporsition 2

To show that a decease in firm input trade costs lead to firm's export intensity, we need to show $\frac{d(1/\varsigma)}{d\tau} > 0$. Given

$$\frac{1}{\zeta} = 1 + \frac{E_h}{n\upsilon^{1-\sigma}E_f}\left(\frac{1 + B_d^{\theta-1}}{1 + B_x^{\theta-1}}\right)^{\frac{(1-\beta)(\sigma-1)}{\theta-1}},$$

we have:

$$\begin{aligned}\frac{d(1/\varsigma)}{d\tau} &= \frac{E_h}{n\upsilon^{1-\sigma}E_f}\frac{(1-\beta)(\sigma-1)}{\theta-1}\left(\frac{1 + B_d^{\theta-1}}{1 + B_x^{\theta-1}}\right)^{\frac{(1-\beta)(\sigma-1)}{\theta-1}-1} \\ &\cdot\frac{(\theta-1)\left(\left(1 + B_x^{\theta-1}\right)B_d^{\theta-2}\frac{dB_d}{d\tau} - \left(1 + B_d^{\theta-1}\right)B_x^{\theta-2}\frac{dB_x}{d\tau}\right)}{\left(1 + B_x^{\theta-1}\right)^2}.\end{aligned}$$

Since $\frac{dB_r}{d\tau} = -\frac{A_r}{S_F^2}\frac{dS_F}{d\tau} < 0, \forall r = d, x$, we know that $\frac{d(1/\varsigma)}{d\tau} > 0$ is equivalent to:

$$\left(1 + B_x^{\theta-1}\right)B_d^{\theta-2}A_d < \left(1 + B_d^{\theta-1}\right)B_x^{\theta-2}A_x,$$

or,

$$\left(\frac{1 + B_d^{\theta-1}}{1 + B_x^{\theta-1}}\right)^{\frac{1}{\theta-1}} > \frac{A_d}{A_x}$$

given $B_d/B_x = A_d/A_x$ from $B_r = A_r/S_F$. By simplying, the expression above is equivalent to:

$$A_x > A_d.$$

(QED)

7.3 Appendix B: Method of Matching Firm and Trade Data

Although these two data sets have rich information on production and trade, it is challenging to match them together. Both data sets contain a variable of firm's identification number. But their coding systems are completely different and share no any common characteristics. For example, the lengths of the firm's ID variable in transaction-level data set are 10 digits whereas those in firm-levels only have 9 digits. China's customs administration just constructs a complete coding system different from the one adopted by the National Bureau of Statistics.

To address this challenge, we use two ways to match transaction-level trade data and firm-level production data. First, we match two data sets by firm's name and year. That is, if a firm has an exact Chinese name in both data sets in a particular year, they should be an identical firm.[9] As a result, the number of matching firm is 83,679 in total by using the raw production data set, and reduced to 69,623 in total by using the more accurate filtered production data set.

Equally importantly, we then use another matching technique to serve as a supplement. Here we rely on two other common variables to identify firms, namely, zip code and the last seven digits of a firm's phone number. The rationale is that firms should have different and unique phone numbers within a postal district. Although this method seems straightforward, subtle technical and practical difficulties still remain.[10] Therefore, we use the last seven digits of the phone number to serve a proxy for firm identification.[11]

A firm could miss its name information in either trade or production data set. Similarly, a firm could lose information on phone and/or zip code. To secure that our matched data set can cover common firms as many as possible, we then include the observations in the matched data set if a firm occurred in either the name-adopted matched data set or the phone-and-post-adopted matched data set. As a result, the number of matched firms increases to 90,558 when the raw production data set is used, as shown in Column (7) of Table A1. By way of comparison, such a matching performance is in the same magnitude to (or even better than) other similar studies.[12] Finally, if we adopt the more rigorous filtered production data to merge with firm data, the matched data set ends up with 76,823 firms in total, as shown in the last column of Table A1.

[9] The year variable is necessary to use for an auxiliary identification variable since some firms could change their name in different years and new comers could possible take their original name.

[10] For example, the phone numbers in the product-level trade data include both area phone codes and a hyphen, whereas those in the firm-level production data do not.

[11] This approached is adopted for two reasons: (1) during 2000–2006, some large Chinese cities changed their phone number digits from seven to eight, which usually added one more digit at the start of the number. Therefore, sticking to the last seven digits of the number would not confuse the firm's identification; and (2) in the original data set, phone number is defined as a string of characters with the phone zip code. However, it is inappropriate to de-string such characters to numerals since a hyphen bar is used to connect the zip code and phone number. Using the last seven-digit substring solves this problem neatly.

[12] For example, Ge et.al (2011) used the same data sets and similar matching techniques but ends up with 86,336 matched firms in total.

Table A1: Matched Statistics–Number of Firms

Year	Trade Data		Production Data		Matched Data			
# of	Transactions	Firms	Raw Firms	Filtered Firms	w/ Raw Firms	w/ Filtered Firms	w/ Raw Firms	w/ Filtered Firms
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2000	10,586,696	80,232	162,883	83,628	18,580	12,842	21,665	15,748
2001	12,667,685	87,404	169,031	100,100	21,583	15,645	25,282	19,091
2002	14,032,675	95,579	181,557	110,530	24,696	18,140	29,144	22,291
2003	18,069,404	113,147	196,222	129,508	28,898	21,837	34,386	26,930
2004	21,402,355	134,895	277,004	199,927	44,338	35,007	50,798	40,711
2005	24,889,639	136,604	271,835	198,302	44,387	34,958	50,426	40,387
2006	16,685,377	197,806	301,960	224,854	53,748	42,833	59,133	47,591
All Year	118,333,831	286819	615,951	438,165	83,679	69,623	90,558	76,946

Notes: Column (1) reports number of observations of HS eight-digit monthly transaction-level trade data from China's General Administration of Customs by year. Column (2) reports number of firms covered in the transaction-level trade data by year. Column (3) reports number of firms covered in the firm-level production dataset compiled by China's National Bureau of Statistics without any filter and cleaning. By contrast, Column (4) presents number of firms covered in the firm-level production dataset with careful filter according to the requirement of GAAP. Accordingly, Column (5) reports number of matched firms using exactly identical company's names in both trade dataset and raw production dataset. By contrast, Column (6) reports number of matched firms using exactly identical company's names in both trade dataset and filtered production dataset. Finally, Column (7) reports number of matched firms using exactly identical company's names and exactly identical zip code and phone numbers in both trade dataset and raw production dataset. By contrast, Column (8) reports number of matched firms using exactly identical company's names and exactly identical zip code and phone numbers in both trade dataset and filtered production dataset.

Table A2: Comparison of the Merged Dataset and the Full-sample Production Dataset

Variables	Merged Data			Full-sample Data			Percentage
	Mean	Min.	Max.	Mean	Min.	Max.	
Sales	150,071	5000	1.57e+08	85,065	5000	1.57e+08	25.4%
Exports	53,314	0	1.52e+08	16,544	0	1.52e+08	52.8%
Number of Employees	478	10	157,213	274	10	165,878	23.7%

Table A3: Merged Importers by Type

Types of Firms	2000	2001	2002	2003	2004	2005	2006	Total	Percent
Ordinary Importers	1,659	2,324	2,910	3,931	5,090	4,894	5,070	25,878	35.5%
Processing Importers	5,393	5,947	6,254	6,562	8,160	7,602	6,999	46,917	64.5%
Hybrid Processing Importers	2,175	2,440	2,695	3,059	3,742	3,613	2,971	20,695	28.5%
Other Types of Processing	671	717	181	298	386	296	245	2,794	3.9%
Processing with Assembly	283	322	416	482	570	556	426	3,055	4.2%
Processing with Inputs	1,221	1,401	2,098	2,279	2,786	2,761	2,300	14,846	20.4%
Pure Processing Importers	3,218	3,507	3,559	3,503	4,418	3,989	4,028	26,222	36.0%
Processing with Assembly	353	493	461	490	611	632	679	3,719	5.1%
Processing with Inputs	2,865	3,014	3,098	3,013	3,807	3,357	3,349	22,503	30.9%

Table A4: Firm's Switching by Type

Panel A: Transition Probability from
Pure Processing Firms to Non-Processing Firms

	Pure Processing Next Year		
Pure Processing today	0	1	Total
0	45.70	54.30	100.00
1	6.27	93.73	100.00
Total	11.18	88.82	100.00

Notes: 0 means pure-processing firms, 1 means non-pure processing firms

Panel B: Transition Probability from
Ordinary Firms to Non-ordinary Firms

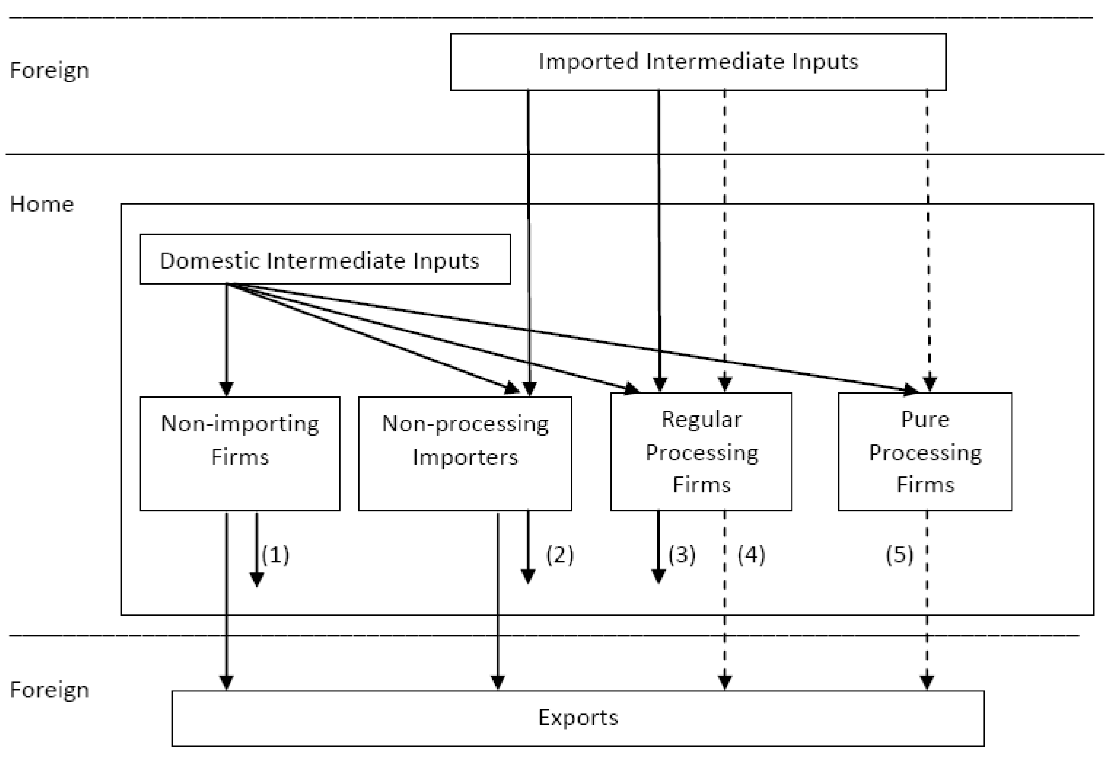
	Ordinary Next Year		
Ordinary today	0	1	Total
0	85.23	14.77	100.00
1	34.08	65.92	100.00
Total	67.85	32.15	100.00

Notes: 0 means ordinary firms, 1 means non-ordinary firms

Panel C: Transition Probability from
Hybrid Firms to Non-Hybrid Firms

	Hybrid Next Year		
Hybrid today	0	1	Total
0	81.45	18.55	100.00
1	52.06	47.94	100.00
Total	73.46	26.54	100.00

Notes: 0 means hybrid firms, 1 means non-hybrid firms



Appendix Figure 1: Four Types of Chinese Firms

Notes: Dotted lines denote firms' processing imports/exports whereas real lines represent firms' non-processing imports/exports.