Import liberalization and export product mix

Haichao FAN
Institute of World Economy, School of Economics, Fudan University
Shanghai Institute of International Finance and Economics.

Tuan Anh LUONG
Faculty of Business and Law, De Montfort University

Edwin L.-C. LAI
CESifo
Department of Economics, Hong Kong University of Science and Technology

Lina ZHANG
School of Economics, Fudan University

Abstract. This paper develops a monopolistic competition model of multiproduct firms to explain the effect of trade liberalization on the product mix of multiproduct exporting firms. The model shows that input-tariff reduction leads to increases in a firm's export values, especially for products that are farther from a firm's core competency. To test the theoretical predictions, we use the merged data built upon the highly disaggregated Chinese firm-level production data and customs data for 2000-2006. Consistent with the theory, the positive impact of input trade liberalization on export value is found to be more pronounced for peripheral products, and input-tariff reduction also expands a firm's product scope, affecting firm's average productivity.

Résumé. Inserted French abstract here.

JEL classification: F1, F4, O4

We thank Arnaud Costinot, Marc Melitz, John Romalis, Thomas Sampson, Peter Schott, Yao Amber Li as well as participants at various seminars for helpful comments and suggestions. We acknowledge the financial support from the "Ten Thousand Talents Program (Young Talents)" of China, Youth Innovative Team on Humanities and Social Sciences of Fudan University, the financial support from the National Natural Science Foundation of China (No. 71603155) and the Research Grants Council of Hong Kong (No. 642210 and 691813). All of the remaining errors are our own.
Corresponding author: Lina Zhang, linazhang2013@126.com

Canadian Journal of Economics / *Revue canadienne d'économique* 20XX 00(0)
January 20XX. Printed in Canada / *Janvier 20XX. Imprimé au Canada*

ISSN: 0000-0000 / 20XX / pp. 1–?? /

1. Introduction

In recent years, the international trade literature has devoted its attention to multi-product firms.[1] Notably, issues surrounding changes in export product mix, a phenomenon known as "product churning," within multiproduct firms after trade liberalization, have received much attention from economists. For example, Bernard et al. (2010) show that half of U.S. firms alter their product mix every five years.[2] Empirical evidence from Mayer et al. (2014) suggests that the toughness of the foreign market also affects a firm's export product scope. However, related studies are mostly focused on the competition effect induced by output trade liberalization. Does input trade liberalization lead to similar effects, and if so, how? To investigate these important yet unsettled research questions, we use China's accession into the World Trade Organization (WTO) as a quasi-natural experiment in this paper.[3]

We focus on China for several reasons. First, China's entry into the WTO offers an ideal setting for examining the impact of imported-input trade liberalization on export product mix. One characteristic of the tariff reductions by China upon her accession into the WTO is that they are widely viewed as unilateral trade liberalization by China.[4] Furthermore, during our sample period, China's imports were dominated by intermediate inputs. The share of final goods in its imports was much smaller. Based on the BEC (Broad Economic Categories) product classification, during our sample period, the majority of Chinese imports were intermediate goods (74%) and capital goods (19%), while final goods only account for 4% of total imports. Since both intermediate and capital goods can be regarded as intermediate inputs, over 90% of Chinese imports were intermediate inputs rather than final goods.[5] Second, during our sample period, a large share of China's exports was

1 In fact, a large fraction of exports are attributed to multiproduct firms. For example, Mayer and Ottaviano (2007) show that exporters with more than 10 products sold abroad account for more than 80% of the value of French exports. Similar statistics apply for other countries (e.g., Brazil (Arkolakis et al. 2019)).

2 They report that for every two firms, there is one that adds or drops at least one product.

3 Output trade liberalization here refers to the reduction of imported-output tariff, which is called "output-tariff reduction." Similarly, input trade liberalization refers to reduction in tariffs on imported intermediate goods, which we call "input-tariff reduction" hereafter.

4 As a condition of China's accession to the WTO in December 2001, tariffs imposed by China on imported goods significantly decreased. In particular, the average import tariffs fell by approximately 40% from 2000 to 2006. Meanwhile, Chinese export tariffs did not change much when China joined the WTO, as China long enjoyed Most Favored Nation (MFN) treatment from her major trading partners prior to the WTO accession (Fan et al. 2015).

5 Please see Figure A1 for a detailed account of the import composition, namely, the import share of goods in each category (i.e., intermediate, capital and the final goods) for China and the U.S. for 2000 to 2006. In contrast, the share of intermediate goods of total imports for the U.S. is only approximately 47% for the same sample period.

processing trade. This allows us to conduct a placebo test using processing trade data, as processing-trade firms are not supposed to be affected by imported-input tariff reduction.[6] Third, since China is the largest trading country in the world, understanding the effects of China's trade policy is of global important.

In this paper, we first construct a simple partial equilibrium model with heterogeneous firms and variable markups to provide a theoretical foundation for our empirical work.[7] Our theoretical model predicts that input-tariff reduction leads to an increase in the export value for each final product produced by a multiproduct firm, and it is more so for final products that are further from a firm's core competency. This is because after a reduction in the imported-input tariff, the marginal cost of the domestic firm falls, which enhances the firm's relative competitiveness in the foreign market. This leads domestic exporters to reallocate their resources towards peripheral products because the elasticity of revenue with respect to marginal cost increases with the marginal cost. This in turn implies that the higher the marginal cost, the more export revenue responds to the imported-input tariff reduction. [8]

To test our theoretical predictions, we use a merged data set built from highly disaggregated Chinese firm-level data and customs data. As predicted by our theoretical model, we find that input-tariff reduction results in an increase in the relative size of export revenue towards peripheral products, reducing the gap in export values between products in the top group (i.e., core products) and the bottom group (i.e., peripheral products). To be more precise, each increase in the log rank (of distance from the core product) of one standard deviation is associated with a 2% to 5% increase in the export value following a 1% reduction in the imported-input tariff. Our results are robust to a wide range of econometric specifications, including using alternative measures of product ranks and difference estimators, using different regression samples, considering potential endogeneity issues, and other mechanisms that can be at work. From a placebo test we do not find any effects of imported-input tariff reduction on the processing trade sample, which is consistent with our theory.

6 Processing trade was prevalent among Chinese trading firms. See Yu (2015) and Manova and Yu (2016) for more details.

7 We also provide two more extensions to the theoretical framework, under which our propositions still remain applicable. This further demonstrates the generality of our theory. Please see Appendix A1 in the Online Appendix for more discussion.

8 In contrast, output-tariff reductions increase foreign firms' profits and hence toughen the foreign market. As a result, output tariff reduction leads to a decrease in the export value for each final product produced by a multiproduct firm, and it is more so for final products that are further from a firm's core competency. These predictions are partially supported by our empirical results. However, considering that most of China's imports are dominated by intermediate inputs, the impact of output tariff reduction is insignificant in most of our empirical specifications.

More importantly, we find additional support for our theory from the theoretical predictions about the impacts of input-tariff reduction on firms' numbers of exported products and average firm-level productivity. Our theory predicts that input-tariff liberalization induces a firm to spread the value of its exports more evenly among exported products, reducing the skewness of export values among exported products. In our model, the productivity of the core product is the highest, while that of a noncore product decreases with the distance from the core product. Therefore, input trade liberalization engenders a decline in firms' average productivity, especially for firms that export more products.

This paper contributes to the vibrant literature that links the impact of improved import access to intermediate inputs to domestic firms' performance. Dimensions of firms' performance that have been studied include improved total factor productivity (Amiti and Konings 2007, Gopinath and Neiman 2014, Luong 2011, Halpern et al. 2015, Brandt et al. 2017), product quality upgrading (Amiti and Khandelwal 2013, Fan et al. 2015, Bas and Strauss-Kahn 2015) and export performance as well as expanded product scope (Goldberg et al. 2010, Feng et al. 2016). We fill the gap in the literature by tackling a different question that links the imports of intermediate goods to a firm's export product mix as well as to its productivity. In this paper, we discuss the impact of improved import access to intermediate inputs on both the intensive (export value of each variety) and extensive margins (the number of exported products and export destinations) of a firm's exports. In addition, we find a significant impact of trade-induced within-firm resource reallocation on a firm's average productivity.

Our paper also relates to a large body of literature on the behavior of multiproduct firms in the face of trade liberalization (e.g., Feenstra and Ma 2007, Dhingra 2013, Nocke and Yeaple 2014), especially in terms of trade-induced resource reallocation.[9] Baldwin and Gu (2009) find that trade liberalization induces exporters to reduce their product diversification. Liu (2010) further shows that multiproduct firms alter their product mix to focus on their core competencies in response to trade liberalization. Bernard et al. (2011) point out that firms tend to drop their least attractive products as a result of trade liberalization. Mayer et al. (2014) show that firms tend to skew their export sales to the best-performing products in reponse to tougher competition in the foreign market. In contrast to the literature, which largely emphasizes the competition effect of the trade liberalization of final goods, we direct our attention to the effect of imported-input trade liberalization. Tariff reductions in final goods increase foreign firms' profits, making the foreign

9 Other works such as Eckel and Neary (2010) and Eckel et al. (2015) explore the possibility of a core competency in a multiproduct firm.

market tougher for domestic firms to export to.[10] In contrast, input-tariff reductions improve domestic firms' productivity, making domestic firms more competitive in foreign markets.

The rest of this paper is organized as follows. In Section 2, we introduce a simple model used to examine how imported-input trade liberalization affects the behavior of domestic multiproduct firms. Section 3 discusses the data and the specifications of our empirical tests. Section 4 reports our main empirical results. In Section 5, we carry out a series of robustness checks. Section 6 concludes.

2. A Simple Model of Imported-Input Tariff and Export Value

In this section, we extend the model of Mayer et al. (2014) by incorporating input and output tariffs and present a simple framework to explain the effect of trade liberalization on the product mix of exporters. The market structure of final goods is assumed to be monopolistic competition with heterogeneous firms and variable markups. Each consumer is endowed with one unit of labor.

2.1. Preference and Demand

The utility of the representative consumer in country l is given by:

$$U_l = q_{l,0}^c + \alpha \int_{i\in\Omega_l} q_{l,i}^c di - \frac{1}{2}\gamma \int_{i\in\Omega_l} \left(q_{l,i}^c\right)^2 di - \frac{1}{2}\eta \left(\int_{i\in\Omega_l} q_{l,i}^c di\right)^2 \tag{1}$$

where $q_{l,0}^c$ and $q_{l,i}^c$ denote the individual consumption levels of the homogeneous good and the differentiated good i in country l respectively. The homogeneous good is chosen as the numeraire. Ω_l denotes the set of differentiated goods sold in country l. The demand-side parameters α, γ and η are all positive. In particular, γ indexes the degree of product differentiation between any pair of varieties. When $\gamma = 0$, varieties are perfect substitutes. In this case, consumers maximize their total consumption level over all varieties, $Q_l^c = \int_{i\in\Omega_l} q_{l,i}^c di$. We assume that incomes of consumers in all countries are high enough so that the demand for the numeraire good is always positive ($q_{l,0}^c > 0$). The inverse demand function for any given variety i in country l is then given by:

$$p_{l,i} = \alpha - \gamma q_{l,i}^c - \eta Q_l^c \tag{2}$$

whenever $q_{l,i}^c > 0$. Thus we have:

$$M_l \overline{p}_l = \alpha M_l - \left(\eta M_l + \gamma\right) Q_l^c \tag{3}$$

where M_l is the measure of the consumed varieties in Ω_l and $\overline{p}_l = (1/M_l) \int_{i\in\Omega_l} p_{l,i} di$ is their average price (over both locally produced and

10 These predictions of output-tariff reductions are partially supported by our empirical results as well.

imported goods) in country l. Substituting for Q_l^c in Equation (2) from the above expression and re-arranging terms, we have:

$$q_{l,i} \equiv L_l q_{l,i}^c = \frac{\alpha L_l}{\eta M_l + \gamma} - \frac{L_l}{\gamma} p_{l,i} + \left(\frac{\eta M_l}{\eta M_l + \gamma} \right) \frac{L_l}{\gamma} \overline{p}_l, \quad \forall i \in \Omega_l \tag{4}$$

Therefore, $p_{l,i}$ must satisfy:

$$p_{l,i} \leq p_l^{\max} \equiv \frac{\alpha\gamma + \eta M_l \overline{p}_l}{\eta M_l + \gamma}, \tag{5}$$

where the right-hand side price bound $p_l^{\max} \leq \alpha$, which we call choke price hereafter, represents the price at which the demand for the variety is driven to zero.

2.2. Production and Firm Behavior

Technology — The production of each unit of homogeneous final good, which we call outside good, requires one unit of labor. We assume that this outside good is produced by both the Home country and the Foreign country, and is freely traded so that the wage in both countries is equal to one, since the outside good is the numeraire. The production of each differentiated final good, however, requires the assembly of a bundle of intermediate inputs. Entry into the differentiated final-good sector is costly, as each firm incurs product development and production startup costs. Subsequent to entry, the production of each final good variety exhibits constant returns to scale.

While a firm may decide to produce more than one variety of differentiated goods, each firm has one key variety corresponding to its "core competency." This key variety is associated with a core productivity φ. Firms learn about their core productivity only after making the irreversible investment f_e required for entry.[11] A firm can introduce any number of new varieties, but each additional variety entails an additional customization cost per unit of output as it pulls the resources of a firm away from its core competency. We use variable m to denote the rank of a variety's distance, in the product space, from the firm's core variety (where $m = 0$). A value of m greater than zero corresponds to the firm's non-core variety. The productivity of the firm in producing a variety decreases as it gets further away from the core product. For the sake of tractability, we make the simplified assumption that the productivity in producing variety m by a firm with core productivity φ is given by $\phi(m, \varphi) = \omega^{-m}\varphi$, with $\omega > 1$.[12]

We index a final-good variety by the productivity in producing it, $\phi(m, \varphi)$. The production of each variety requires the assembly of a bundle of

11 We model this as a draw from a common (and known) distribution $G(\varphi)$ with support $[\varphi_{\min}, \infty)$.

12 It's straightforward to prove that our theoretical propostions still hold given any other functional form of productivity, as long as $\frac{\partial \phi}{\partial m} < 0$.

intermediates. Following Antras et al. (2017), we assume that the production of intermediates has to be outsourced to other firms, which can be domestic or foreign. The intermediate inputs are assumed to be imperfectly substitutable with each other with a constant elasticity of substitution ρ between any pair of varieties. All intermediates are produced with labor using variety-specific technologies.

Input sourcing and marginal cost — We use $a_h(v,\phi)$ to denote the variety-specific labor requirements to produce the intermediate good $v \in [0,1]$ that can be used in the production of final-good variety ϕ in country h.[13] There is no fixed cost of outsourcing. As a result, the final-good producer can source each of its input either from the home country or the foreign country. We call $\{h(v)\}_{v=0}^{1}$ the vector of production locations corresponding to the bundle of intermediate inputs. As in Antras et al. (2017), the marginal cost of producing the final-good variety ϕ in country l is given by:

$$c_l\left(\{h(v)\}_{v=0}^{1}, \phi\right) = \frac{1}{\phi}\left(\int_0^1 \left[\tau^i_{h(v)l} a_{h(v)}(v,\phi)\right]^{1-\rho} dv\right)^{\frac{1}{1-\rho}}$$

where τ^i_{hl} denotes the tariff (or trade cost) for importing the intermediate goods by the base country l from the production location $h(v)$, where $\tau^i_{ll} = 1$ and $\tau^i_{h(v)l} > 1$ if $h(v) \neq l$. From now on, the first subscript of a variable refers to the country of origin and the second subscript refers to the destination market.

Following Eaton and Kortum (2002), we assume that a country's efficiency distribution for producing the intermediate goods follows the Frechet distribution:

$$\Pr(a_h(v,\phi) \leq a) = e^{-T_h a^{-\theta}}$$

with $T_h > 0$. The variety-specific efficiency $a_h(v,\phi)$ is drawn independently across locations, inputs and the productivity of producing this variety ϕ. [14] The parameter T_h governs the state of technology in country h, while θ determines the variability of productivity draws across inputs. As a result, the marginal cost of producing the final-good variety ϕ in country l satisfies:

$$c_l(\phi) = \frac{1}{\phi}\left[\zeta\Theta_l\right]^{-1/\theta} = \omega^m \varphi^{-1}\left[\zeta\Theta_l\right]^{-1/\theta} \tag{6}$$

13 h can be Home or Foreign.

14 To closely link the theoretical framework with empirical results, here we do not consider the input-output linkage, which may also affect the product mix in Chinese multi-product firms (see footnote 42 for more discussion). We greatly thank the anonymous referee for pointing this out.

where $\Theta_l = T_l + T_h \left(\tau^i_{hl}\right)^{-\theta}$ is the sourcing capability of l, $\zeta = \left[\Gamma\left(\frac{\theta+1-\rho}{\theta}\right)\right]^{\theta/(1-\rho)}$, and $\Gamma(.)$ is the Gamma function. Note that all the firms in country l share the same sourcing capability Θ_l.

Firm behavior — Because the entry cost is sunk, firms only need to cover the marginal cost of their core variety in order to produce it. Taking the average price level $\bar{p}_l$ and total number of varieties M_l as given, these firms maximize their profits based on the residual demand function (4). The price and quantity of firm φ's product m that is produced in country l and sold in country h, could be denoted by $p_{lh}(m,\varphi)$ and $q_{lh}(m,\varphi)$, respectively. Combining Equations (4) and (5), we have:

$$q_{lh}(m,\varphi) = \frac{L_h}{\gamma}\left[p^{\max}_h - p_{lh}(m,\varphi)\right]. \tag{7}$$

Firm φ's marginal cost of exporting variety m from country l inclusive of the trade cost is therefore $\tau^o_{lh} c_l(m,\varphi)$, where $\tau^o_{lh} > 1$, which we call output-tariff, is a per-unit trade cost for each traded final good. Maximization of firms' export profit $\pi_{lh}(m,\varphi) = \left(p_{lh}(m,\varphi) - \tau^o_{lh} c_l(m,\varphi)\right) q_{lh}(m,\varphi)$ yields:

$$p_{lh}(m,\varphi) = \frac{1}{2}\left(p^{\max}_h + \tau^o_{lh} c_l(m,\varphi)\right) \tag{8}$$

$$q_{lh}(m,\varphi) = \frac{L_h}{2\gamma}\left[p^{\max}_h - \tau^o_{lh} c_l(m,\varphi)\right] \tag{9}$$

$$r_{lh}(m,\varphi) = \frac{L_h}{4\gamma}\left[\left(p^{\max}_h\right)^2 - \left(\tau^o_{lh} c_l(m,\varphi)\right)^2\right] \tag{10}$$

$$\pi_{lh}(m,\varphi) = \frac{L_h}{4\gamma}\left[p^{\max}_h - \tau^o_{lh} c_l(m,\varphi)\right]^2 \tag{11}$$

where $q_{ll}(\phi)$, $r_{ll}(\phi)$ and $\pi_{ll}(\phi)$ represent firms' export quantity, export revenue and export profit, respectively.[15]

2.3. Theoretical Predictions

We first begin our analysis of the impact of imported-input tariff reduction of country l on firms' export revenue to country h by differentiating Equation (10) with respect to country l's imported input tariff τ^i_{hl}:

$$\frac{\partial log(r_{lh}(m,\varphi))}{\partial log(\tau^i_{hl})} = -\frac{2(\tau^o_{lh} c_l(m,\varphi))^2}{(p^{\max}_h)^2 - (\tau^o_{lh} c_l(m,\varphi))^2}\frac{T_h(\tau^i_{hl})^{-\theta}}{T_l + T_h(\tau^i_{hl})^{-\theta}} < 0 \tag{12}$$

which implies that an input-tariff reduction would lead to an increase of firms' export revenue.

15 The relationship between output price and productivity is negative here. If we introduce quality into our model as in Manova and Zhang (2012), this relationship becomes positive instead. However, the relationship between sales and productivity should remain positive in the model with or without quality upgrading.

Now we consider the above effect on adjustments of firms' export product mix by differentiating Equation (12) with respect to the log of product rank m. Noting that the marginal cost in producing a variety increases with its rank m, we then have:

$$\frac{\partial^2 log(r_{lh}\,(m,\varphi))}{\partial log(\tau^i_{hl})\partial logm} = -\frac{4(c_{hh}\tau^o_{lh}c_l\,(m,\varphi))^2 m}{((p^{\max}_h)^2-(\tau^o_{lh}c_l\,(m,\varphi))^2)^2}\frac{T_h(\tau^i_{hl})^{-\theta}}{T_l+T_h(\tau^i_{hl})^{-\theta}}log\omega < 0 \quad (13)$$

which implies that the impact of an input-tariff reduction on exported revenue is more pronounced for peripheral products. Therefore, we have the following proposition:

PROPOSITION 1. *[Export Value and Imported-Input Tariff] A reduction in the imported-input tariff will increase the export revenue with more pronounced effects occuring for products that are further from a firm's core competency (m is larger).*

The intuition here is straightforward. After a reduction in the imported-input tariff, the marginal cost of the domestic firm falls, which enhances the firm's competitiveness in the foreign market. This leads domestic exporters to reallocate their resource to peripheral products because the elasticity of revenues with respect to the marginal cost increases with the marginal cost. This in turn implies that the higher the marginal cost, the more export revenue respond to the imported-input tariff reduction. Therefore, a cut in the imported-input tariff induces the domestic exporter to expand its export scope and reallocate revenues to noncore products.

It is noteworthy that Proposition 1 can be applicable in more general cases.[16] First, this proposition is not tied to the demand structure. According to Mayer et al. (2020), Proposition 1 would continue to hold as long as

16 Additionally, our propositions could still hold in a model with quality sorting. Specifically, although the relationship between firms' output price and sales in the efficiency sorting model could be distinct from that in the quality sorting model as shown in Manova and Zhang (2012) and Manova and Yu (2017), the impact of input-tariff reduction on export sales remains the same in the model with and without quality upgrading. For instance, Fan et al. (2018) show theoretically and empirically that under the quality sorting model, less productive Chinese exporters increase export sales more than more productive ones in response to a reduction in imported-input tariffs. This result is consistent with our prediction that firms reallocate their resources to the less productive products after a reduction in imported-input tariff. In other words, our proposition continues to hold in a setting with quality differentiation. However, since our focus is on the effect of intermediate-good trade liberalization on export revenue, we do not consider quality differentiation in our theoretical framework. Nonetheless, we thank the anonymous referee for pointing out the possibility of incorporating vertical quality differentiation into our theory.

Marshall's Second Law of Demand (MSLD, hereafter) condition is satisfied.[17] Second, we assume that input-tariff reduction would not affect the choke price of the foreign country ($p_h^{\max}$). In fact, Proposition 1 would still be applicable if we relaxed this assumption.[18] In a more general framework, a reduction in the imported-output tariff increases foreign firms' profits, which induces a rise in the foreign country's choke price ($p_h^{\max}$). As a result, the foreign market becomes more difficult for domestic firms to export to.[19]

3. Empirical Specification, Data and Measurement

In this section, we specify our econometric specifications and describe the data and measurements used to estimate them.

3.1. Empirical Specification

As we discussed above, the majority of Chinese imports were intermediate goods during the sample period. Therefore, we mainly focus on the impact of input-tariff reduction in our empirical tests. Meanwhile, we also control the output tariff and its interaction term with product rank in the empirical specification as follows:

$$\begin{aligned} \Delta \log V_{fpt} = {} & \alpha_0 \Delta Input\_tariff_{it} + \alpha_1 \Delta Input\_tariff_{it} \times Rank_{fpt} \\ & + \beta_0 \Delta Output\_tariff_{it} + \beta_1 \Delta Output\_tariff_{it} \times Rank_{fpt} \\ & + \gamma Rank_{fpt} + \Psi \Delta \mathbf{X}_{ft} + \phi \Delta \mathbf{X}_{it} + \varphi_{(o)t} + \varphi_f + \epsilon_{ft} \end{aligned} \tag{14}$$

Here, Δ denotes a year-on-year change in any variable.[20] Variable V_{fpt} is the export value of the Harmonized System (HS) 6-digit product p exported by firm f to the whole world. $Input\_tariff_{it}$ and $Output\_tariff_{it}$ are

17 Specifically, it requires the elasticities of inverse demand and marginal revenue both increase with the quantity (output) consumed. See subsection A1 in the Online Appendix for the specific proof.

18 Please see subsection A2 in the Online Appendix for the specific proof. It is noteworthy that even though we relax the assumption that p_h^{max} is fixed, our model is still not a general equilibium model since the wage is exogenous instead of endogenous due to our assumption on the homogenous goods.

19 In addition, the derivations in our partial equilibrium model are the same regardless of whether we consider an ad-valorem tariff or an iceberg trade cost. However, if we relax the assumption that the choke price of foreign country ($p_h^{\max}$) is fixed, an iceberg trade cost is not equivalent to the ad-valorem tariff according to Cole (2011) and Besedes and Cole (2017). They provide in-depth discussions of the diverse effects of different trade cost specifications in a general equilibrium model. Additionally, when we conduct a welfare analysis, an ice-berg trade cost and the ad-valorem tariff are not equivalent either. In particular, if we treat tariffs as ice-berg trade costs, we ignore revenues from tariffs. We thank the anonymous referee for pointing this out.

20 One might be concerned that changes in the extensive margin have been excluded, since the left side of Equation (14) shows the first-difference in logs of export sales, leaving $log(0)$ undefined. As explained in Subsection 3.2, to partly address this concern, we do not consider recently exported products.

imported-input and imported-output tariffs of the 4-digit Chinese Industry Classification (CIC) for industry i at year t, respectively. Variable $Rank_{fpt}$ is defined as the log rank of each product of a firm according to its total exports to the whole world. This rank increases from the most successful product in terms of sales (the core product) to the least successful (the most peripheral one), which means that the best performing product is ranked first.

Since Chinese custom data also report the destination information for each trade transaction, we extend the above regression to the following specification to fully utilize the database available:

$$\begin{aligned}\Delta \log V_{fpct} = {} & \alpha_0 \Delta Input\_tariff_{it} + \alpha_1 \Delta Input\_tariff_{it} \times Rank_{fpct} \\ & + \beta_0 \Delta Output\_tariff_{it} + \beta_1 \Delta Output\_tariff_{it} \times Rank_{fpct} \\ & + \gamma Rank_{fpct} + \Psi \Delta \mathbf{X}_{ft} + \phi \Delta \mathbf{X}_{it} + \varphi_{(o)t} + \varphi_{f(c)} (+\varphi_c) + \epsilon_{fct}\end{aligned} \quad (15)$$

Variable V_{fpct} is now defined as the export value of the Harmonized System (HS) 6-digit product p exported by firm f to destination country c.[21] $Rank_{fpct}$ represents the log rank of each variety exported by firm f according to its export value with the best performing product being ranked first as well. In Section 4, we report the empirical results of both specifications.

To control for the time-varying firm attributes that might affect resource allocation across products, we include firm-level controls (X_{ft}), which include firm-level productivity (TFP), the firm-level capital-labor ratio (factor intensity), the firm-level average wage and firm size (measured by total employment). When the product is defined as the HS 6-digit-country combination, we add firm fixed effect φ_f and country fixed effect φ_c while in the alternative specification, we replace the firm and country fixed effects with the more stringent firm-country fixed effect φ_{fc}. As our sample includes firms of different ownership types and as ownership-specific policy shocks may be correlated with firms' export and resource allocation decisions, we include ownership-year fixed effect φ_{ot} to address this concern.[22] All error terms are clustered at the 4-digit Chinese Industrial Classification (CIC) industry level to address potential correlations between errors within each industry over time.

The variable of interest is the interaction term $Input\_tariff_{it} \times Rank_{fp(c)t}$. As predicted by our theory, imported-input tariff cuts result in a shift of revenue resources to peripheral products, reducing the variance in export value among products. This means that a product further from the core product is more affected by imported-input tariff reductions and enjoys a

21 Similarly, Δ denotes a year-on-year change in any variable; $Input\_tariff_{it}$ and $Output\_tariff_{it}$ represent the 4-digit CIC industry-level imported-input and imported-output tariff, respectively.

22 ASIP and Chinese custom data generally report the following three types of firm ownership: state-owned enterprises (SOE), domestic private firms and foreign firms.

larger percentage increase in export value. In other words, we expect $\alpha_1 < 0$.[23] More precisely, we expect the Chinese exporter to raise its export values and especially those ranked high (peripheral products) following an imported-input tariff reduction.

3.2. Data Description

To investigate the relationship between the imported-input tariff reduction and firms' export product mix, we merge the following three sets of information for the purpose of the present paper: (1) the firm-product-level customs data, obtained from China's General Administration of Customs, (2) the import tariff data, which are taken from the World bank's WITS dataset, and (3) the information on the firm's characteristics, which is captured by the firm-level manufacturing survey data from the National Bureau of Statistics of China (NBSC). The sample period ranges from 2000 to 2006.

China's General Administration of Customs data set provides us with the universe of all Chinese trade transactions by importing and exporting firms at the HS 8-digit level, covering the universe of all Chinese exports and imports in 2000-2006. It records detailed information for each trade transaction, including import and export values, quantities, product name, source or destination countries, contact information of the firm (e.g., company name, telephone, zip code, contact person), type of enterprise (e.g., state owned, domestic private firms, foreign invested and joint ventures) and customs regime (e.g., "Processing and Assembling" and "Processing with Imported Materials"). As firms under the processing trade regime are not subject to tariffs, we focus only on firms under the ordinary trade regime.[24]

Since the customs data are recorded on a monthly basis, we aggregate the data to the annual level to eliminate seasonal variations.[25] Products that are recorded at the HS 8-digit level are aggregated to the HS 6-digit level so as to enable consistent comparison of data over time, as China changed the HS 8-digit codes in 2002, and the concordance between the old and the new HS 8-digit codes (before and after 2002) is not available. To ensure the consistency of the product categorization over time (2000-2006), we adopt HS 6-digit codes maintained by the World Customs Organization and use the conversion table

23 As China's imports are mostly dominated by intermediates with a much smaller share of final consumption goods, we also expect β_1 to be insignificant or significantly positive on occasion.

24 As imports under the ordinary trade regime include final goods and intermediate goods, we use the Broad Economic Categories classification to distinguish final goods and intermediate goods.

25 It's a practice commonly used in other related literature, such as Manova and Zhang (2012), Fan et al. (2015, 2018) and so forth. Actually, Manova and Zhang (2012) point out seasonality and lumpiness issues in the monthly data, and most firms do not export a given product to a given destination in every month. By focusing on the annual data, we can abstract from these issues and related concerns with sticky prices. Also, outliers are likely to be of greater concern in the monthly data.

from UN Comtrade to convert the HS 2002 codes into the HS 1996 codes. We only focus on manufacturing products to be consistent with the second database, namely the NBSC manufacturing firm production data.[26]

To characterize firms' attributes, such as TFP and capital intensity, we also use the NBSC firm-level production data from annual surveys of Chinese manufacturing firms, covering all SOEs, and non-SOEs with annual sales of at least five million renminbi (the Chinese currency). The NBSC database contains detailed firm-level information on manufacturing enterprises in China, such as employment, capital stock, gross output, value added, firm identification (e.g., company name, telephone number, zip code, contact person, etc.), and complete information on the three major accounting statements (i.e., balance sheets, profit & loss accounts, and cash flow statements).[27] Due to mis-reporting by some firms, we use the following rules to delete unsatisfactory observations and construct our sample, following Cai and Liu (2009) and the General Accepted Accounting Principles: (1) the total assets must be greater than the liquid assets; (2) the total assets must be greater than the total fixed assets; (3) the total assets must be greater than the net value of the fixed assets; (4) a firm's identification number cannot be missing and must be unique; and (5) the established time must be valid.

Then, we match the firm-product-level trade data between the Chinese Customs Database and the NBSC database, according to the contact information of manufacturing firms, as there is no consistent coding system of firm identity between these two databases.[28] Our matching procedure is done in three steps: (1) by company name, (2) by telephone number and zip code, and (3) by telephone number and contact person name together (see detailed description of the matching process in Fan et al. (2015)). Compared with the exporting and importing firms reported by the Customs database, the matching rate of our sample (in terms of the number of firms) covers 45.3% of exporters and 40.2% of importers, corresponding to 52.4% of total export value and 42% of total import value reported by the Customs database.[29]

26 See http://unstats.un.org/unsd/tradekb/Knowledgebase/HS-Classification-by-Section. There are originally 20 sectors in the UN list for HS product classification. We delete sectors 1 to 3, agricultural sectors; sector 5, a mining sector; and sector 19, Arms and Ammunition.

27 The firm identification information is used to match the NBSC database with the customs database.

28 In the NBSC database, firms are identified by their corporate representative codes and contact information. In the customs database, firms are identified by their corporate custom codes and contact information. These two coding systems are neither consistent nor transferable with each other.

29 Our matching rate is highly comparable to that of other studies that employ the same dataset. For example, the database of Yu (2015) accounts for around 53% in terms of export value. The matched dataset of Wang and Yu (2012) covers nearly 50% and 40% of China's total exports and imports separately.

As explained by Bernard et al. (2017), an entry issue should be taken into consideration when we use the annual customs data. Firms could enter the same market in different months, which leads to an upwardly biased growth rate between the year of entry and the following years.[30] Therefore, we need to be aware of the timing issue when we compare the values of exports. To correct for this timing bias, we do not consider the products that just exported. Instead, we require them to be exported at least in the previous year to make sure that the value growth of exports indeed indicates the products performance. Also, we exclude the single product firms, which only export one product and to only one destination. Besides, all intermediary firms or trading companies are removed from our sample as well.[31] In addition, to ensure our results are not driven by outliers, we delete products ranked higher than 100, reducing the number of observations by about 0.15%.[32]

Finally, we merge the above matched dataset with the imported input and output tariff data at the industry level to obtain the final firm-product-year and the firm-product-country-year level regression samples, which include 141,788 and 329,739 observations in total, respectively. Table A1 shows the descriptive statistics for our sample. In particular, we report the summary statistics for the number of firms' export products in Table 1. As shown in Table 1, on average, a Chinese multi-product firm exports more than seven products (at the HS 6-digit level) to over 12 countries, and the average number of country-product pair is about 33.

3.3. Measurements

After describing the data used in our empirical analysis, we now detail how we measure the key variables explored in this paper.

Tariffs — One main variable we are concerned with is the imported-input tariff at the industry level. To construct the tariff variable, we first draw tariff lines from the WITS database to obtain import tariff rates at the HS 6-digit

30 For instance, a firm started to export product A and B in the same year, say 2002. However, for some reason (e.g., paper work), product A was started several months earlier. To make the issue simpler, suppose these two products performed identically in the export market. As product A started earlier, records in the year 2002 should show that product A has better sales. In the next year (2003), both products had the same amount of months of export. With their similar performance, they would have the same export value in 2003. But because product A started earlier and, hence, was "better" in 2002, we would conclude wrongly that product A grew slower than product B.

31 See Brandt et al. (2017) for the identification of trading (intermediary) firms. The reason for excluding these firms lies in that trading firms are not wholesalers that buy products and resell them, they are basically not involved in the production process, and can be selected by manufactures (Peng and Ilinitch 1998). Therefore, including the intermediaries may confound the cost effect induced by input-tariff reduction on firms' product mix. Actually, our results are unaffected whether we exclude the trading firms or not.

32 Aboout 1.9% of the observations are removed in the alternative regression sample (firm-product level).

TABLE 1
Summary Statistics for Number of Firms' Export Products

	(1) Obs	(2) Mean	(3) Median	(4) S. D.
	Firm-Product-Year Level			
Export Products (Number of HS-6 Product)	141,788	8.890	5.000	10.802
	Firm-Country-Product-Year Level			
Export Products (Number of HS-6 product-country pair)	329,739	33.338	15.000	67.447
Export Products (Number of HS-6 product per firm)	329,739	7.104	4.000	13.034
Export Products (Number of HS-6 product per firm-country)	329,739	3.670	2.000	5.724
Export Destination (Number of destination per firm)	329,739	12.631	9.000	12.695

Notes: The top panel is for the sample in firm-product-year level while the bottom panel is for that in the firm-country-product-year level.

level.[33] Since our production data utilize the CIC 4-digit code, we map them to the 4-digit CIC level using the concordance provided by Brandt et al. (2017) to obtain the imported output tariff used.[34]

To compute the input tariff, we use an input cost-weighted average of output tariffs as in Amiti and Konings (2007):

$$\tau_{it}^{input} = \sum\nolimits_k a_{ki}\tau_{kt}^{output}$$

where τ_{kt}^{output} is the tariff on industry k at time t, and a_{ki} is the weight of industry k in the input cost of industry i.[35] For instance, if industry i incurs 80% of its costs in steel and 20% of its costs in rubber, then steel tariffs receive an 80% weight in our calculation of input tariffs in industry i, while rubber tariffs receive a 20% weight. These weights are taken from the IO table

33 WITS provides the HS 8-digit tariff lines, and we average these to the HS 6-digit level; the original data are available at https://wits.worldbank.org/.

34 Brandt et al. (2017) extend the HS-CIC concordance table constructed by the NBSC to include all CIC manufacturing industries and HS products to correct several mistakes. Moreover, they provide a consistent classification for the sample period to deal with changes made to the CIC codes in 2003. We follow their method in our analysis and include 424 CIC-4 digit manufacturing industries in our sample.

35 To avoid the well-known endogeneity of weighted tariffs, i.e., the negative correlation between imports and the imported tariffs, we use an unweighted average. However, when we use the trade weighted tariff, our empirical results still hold.

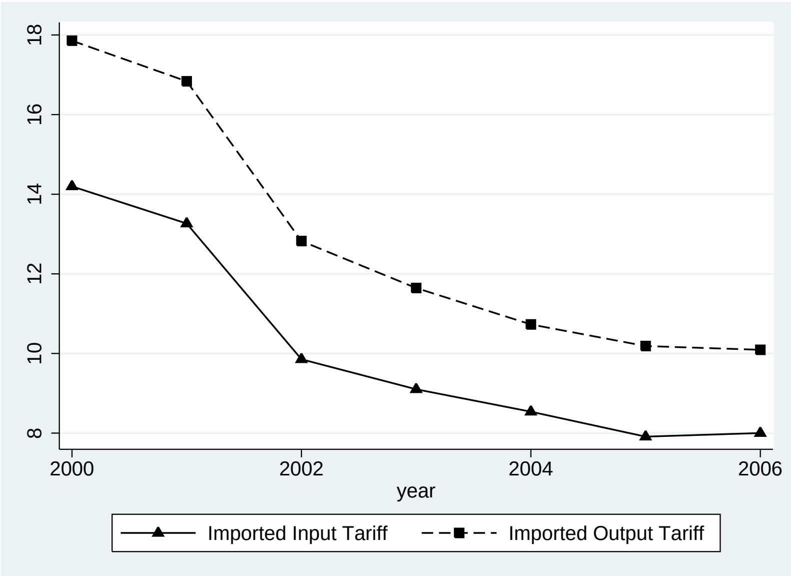

FIGURE 1 Imported-Input Tariff and Imported-Output Tairff in China (2000-2006)
Note: We take the average of the (4-digit CIC) industry-level input and output tariffs for each year.

issued in 2002.[36] The above procedures now yield a set of imported-input and imported-output tariffs of the 4-digit CIC code.

Figure 1 presents the average imported-input and imported-output tariff levels for China during 2000-2006. The figure shows a drastic reduction in tariff rates since China joined the WTO in 2001. We also plot changes in imported-input (-output) tariffs occurring between 2000 and 2006 on the vertical axis against the initial level shown on the horizontal axis in Figure A2. We find a strong negative correlation between the initial tariff level and the change in tariffs for both input and output tariffs in China. In other words, highly protected industries also received larger tariff cuts.

Productivity — To control for changes in firm productivity found in some of our regressions, we employ various measures of productivity, including both total factor productivity (TFP) and labor productivity.

Our primary measure of productivity included in the specifications is the TFP measure closely based on Ackerberg et al. (2015) augmented by Levinsohn and Petrin (2003) (ACF augmented L-P method hereafter), which has been widely adopted in the literature such as De Loecker and Warzinsky

36 We also use the IO table issued in 2007 and obtain similar results

(2012) and De Loecker et al. (2016).[37] While the details of the estimation are presented in the Online Appendix A2, it is worth mentioning that we have included both input and output tariff changes in the TFP realization. [38] In estimating TFP, we use value-added to measure production output and deflate firms' inputs (e.g., capital) and value-added using the input-price and output-price deflators from Brandt et al. (2012). Specifically, the output deflators are constructed using "reference price" information from China's Statistical Yearbooks, and input deflators are constructed based on output deflators and China's National Input-Output Table (2002).[39] Then, we construct the real investment variable by using the perpetual inventory method to investigate the law of motion for real capital and real investment. To measure the depreciation rate, we use each firm's real depreciation rate provided by the NBSC firm-production database. We use the deflated value-added per worker to proxy for a firm's labor productivity.

4. Main Results

In this section, we report main results obtained from testing our theoretical predictions about the effect of input-tariff reduction on export value across products. In addition, we analyze the impacts of input trade liberalization on firms' export scope and discuss how within-firm resource allocation induced by input trade liberalization affects firms' average productivity.

4.1. Effect of Trade Liberalization on Export Value across Products

Table 2 reports our results based on the specifications of Equations (14) and (15). In the first three columns, dependent variables are changes in the firm-product-year level export value, and we add the firm fixed effect to exploit export value adjustment across products within a firm. In the other columns, dependent variables measure changes in firm-product-destination-year level export value. To investigate the adjustment of export value within firms and destinations, we add both the firm fixed effect and the country fixed effect in columns (4)-(6).[40] Alternatively, we add the firm-country fixed

37 Our results are robust when we use the OLS method, the method developed by Olley and Pakes (2003), and the ACF augmented O-P method to estimate TFP. All of these results are available upon request.

38 We also control firms' numbers of products in the productivity law of motion, as our studies (see Section 4) illustrate that the improvement in firms' average productivity is less for the firms that export more varieties once the imported tariff is lowered. Please see more discussion on this point in Subsection 4.2.

39 The data can be accessed via http://www.econ.kuleuven.be/public/N07057/CHINA/appendix/.

40 A product, measured at the HS 6-digit level, can be defined as a variety. Alternatively, a product-country pair can also be seen as a variety.

effect in columns (7)-(9). To further test our theoretical propositions, we also apply the specifications without rank effects (see the results listed in columns (1), (4) and (7)). As predicted, the coefficients of input tariff reduction ($\Delta\tau_{in}$) shown in columns (1), (4) and (7) are negative and significant, which supports our theoretical proposition that export revenues rise with input-tariff reductions for all products. Furthermore, when we consider the effect of trade liberalization on firms' export value across products, the coefficients of $\Delta\tau_{in} \times Rank$, α_1 are significantly negative in all other specifications.[41] More precisely, each one standard deviation increase in the log rank is associated with a 2% to 5% increase in the export value following a 1% fall in the imported-input tariff.[42]

In addition, after further controlling interaction term ($\Delta\tau_{in} \times Rank$), the coefficients of $\Delta\tau_{in}$ are insignificant.[43] Regarding the effect of output-tariff reduction ($\Delta\tau_{out}$), the coefficients of the interaction terms with product rank ($\Delta\tau_{out} \times Rank$) are positive. When we focus on the firm-product-year level regression sample, the coefficients of such an interaction term are significantly positive, which partially supports our theoretical predictions about the impact of output-tariff reduction.[44] Moreover, both the magnitude and significance level of this interaction term of the output tariff ($\Delta\tau_{out} \times Rank$) are lower than that of the input tariff ($\Delta\tau_{in} \times Rank$). This is consistent with the characteristics of Chinese import commodity composition as China's imports are mostly dominated by intermediate goods with a much smaller share of final consumption goods.[45, 46]

41 As stated above, when we use trade weighted data, the results still hold. All interactions between input tariff reduction ($\Delta\tau_{in}$) and product rank are negatively significant (see Table A2 in the Online Appendix).

42 The standard deviation of the log rank shown in the first three columns of Table 2 is 1.11 and that shown in the others is 0.92. In addition, as pointed out by the anonymous referee, the input-tariff computed using IO tables implies that the intensity of intermediate inputs of the product is the same whatever the rank of the product is. As we do not have access to the disaggregated product-level data for the input intensity of each product of Chinese multiproduct firms, we leave this issue for the further investigation when the detailed dataset becomes available.

43 This indicates that in general input trade liberalization has no effect on the exports of core products. When we focus on the firm-product-country-year level sample, the coefficients of input-tariff reduction ($\Delta\tau_{in}$) are negative (see columns (5)-(6) and (8)-(9)), partially supporting our theory.

44 See more elaborations on such an effect of output-tariff reduction in the Model Extension "Relax the assumption of fixed choke price p_h^{max}" shown in the Online Appendix A1.

45 For our sample period, Chinese imported inputs account for over 90% of imports.

46 In addition, we rerun the specifications applied in columns (5)-(6) and (8)-(9) in Table 2, by using only a subsample of important countries (importers and exporters) that trade intensively with China. We find that most of the coefficients of the interaction terms between output-tariff reduction and product rank ($\Delta\tau_{out} \times Rank$) becomes significantly positive (see Table A4 of the Online Appendix). Specifically, for each Chinese trading partner such as the United States, we compute the share of goods

TABLE 2
Effect of Trade Liberalization on Export Value across Products

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\Delta\tau_{in}$	-0.028*	0.027	0.026	-0.027**	-0.008	-0.008	-0.026*	-0.013	-0.013
	(0.016)	(0.026)	(0.025)	(0.012)	(0.014)	(0.013)	(0.014)	(0.014)	(0.014)
$\Delta\tau_{in}$ × Rank		-0.050***	-0.050***		-0.032***	-0.032***		-0.022**	-0.023**
		(0.015)	(0.015)		(0.010)	(0.010)		(0.010)	(0.010)
$\Delta\tau_{out}$	0.004	-0.025	-0.024	0.013	0.005	0.005	0.007	-0.000	-0.000
	(0.013)	(0.020)	(0.021)	(0.010)	(0.010)	(0.010)	(0.011)	(0.011)	(0.011)
$\Delta\tau_{out}$ × Rank		0.027*	0.027*		0.014	0.014		0.012	0.011
		(0.016)	(0.016)		(0.009)	(0.010)		(0.009)	(0.009)
Rank	0.413***	0.395***	0.395***	0.425***	0.412***	0.412***	0.517***	0.510***	0.509***
	(0.030)	(0.028)	(0.029)	(0.017)	(0.016)	(0.016)	(0.015)	(0.017)	(0.017)
Δ(TFP)	0.082***	0.082***	0.082***	0.050***	0.051***	0.051***	0.046***	0.047***	0.046***
	(0.010)	(0.010)	(0.010)	(0.007)	(0.008)	(0.007)	(0.009)	(0.009)	(0.009)
Δ(K/L)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Δ(Wage)	0.050***	0.051***	0.051***	0.051***	0.051***	0.051***	0.056***	0.055***	0.056***
	(0.013)	(0.013)	(0.013)	(0.011)	(0.011)	(0.011)	(0.013)	(0.012)	(0.013)
Δ(Labor)	0.179***	0.179***	0.179***	0.134***	0.134***	0.133***	0.133***	0.133***	0.132***
	(0.025)	(0.027)	(0.026)	(0.018)	(0.019)	(0.019)	(0.021)	(0.021)	(0.021)
Year FE	No	Yes	No	No	Yes	No	No	Yes	No
Owntype-Year FE	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
Country FE	No	No	No	Yes	Yes	Yes	No	No	No
Firm-Country FE	No	No	No	No	No	No	Yes	Yes	Yes
Observations	141,788	141,788	141,788	329,739	329,739	329,739	284,128	284,128	284,128
R^2	0.163	0.163	0.164	0.112	0.112	0.112	0.237	0.237	0.237
Adjusted R^2	0.057	0.057	0.057	0.062	0.062	0.062	0.025	0.025	0.025

NOTES: * $p < 0.1$, **$p < 0.05$, *** $p < 0.01$. In columns (1)-(3), dependent variable is changes of firm-product export value while in columns (4)-(9) dependent variable is changes of firm-product-country export value. As we aggregate the sample from firm-product-country level to firm-product level, the sample size in columns (1)-(3) is only about half of the full sample size in columns (4)-(9). All the standard errors are clustered at the industry level.

To further support the above main findings and to more accurately capture firms' trade-induced product switch after imported-input tariff reductions, we also employ an alternative measure of product rank in Table 3 by using a series of rank dummies. Specifically, in Panel A, $TopHalf$ is equal to one when the product rank falls into the top 50% and zero otherwise; $BottomHalf$ is equal to one when the product ranks in the bottom 50% and zero otherwise. In panel B, $TopThird$, $MiddleThird$ and $BottomThird$ are equal to one if and only if the product is ranked within the top 33%, middle 33% and bottom 33%, respectively. In column (1), we control for firm and country fixed effects while in column (2) we add firm-country pair fixed effect. Unlike in the first two columns, we further control for more stringent ownership-year fixed effect (instead of year fixed effect) in the last two columns. We expect the coefficients of terms capturing the interaction between the input-tariff change and rank dummies, which we are most interested in, to show a gradual increase in magnitude from the highest to the lowest ranked, according to our theoretical model. As reported in Table 3, all the coefficients of interaction terms between $\Delta\tau_{in}$ and Rank dummies ($TopHalf$, $BottomHalf$, $TopThird$, $MiddleThird$, and $BottomThird$) are significantly negative, and the absolute values of the corresponding coefficients steadily increase with the rank dummies. For instance, in column (4) in Panel B, sequential to -0.026 in the first interaction term, the coefficients become -0.227 and -0.398 in the other two tertiles of product rank, which are significant at the 10% and 5% levels, respectively. In addition, all the coefficients of terms capturing the interactions between output-tariff reduction ($\Delta\tau_{out}$) and Rank dummies are positive, of which the absolute values gradually increase with the rank dummies. In particular, when we focus on the sample of the firm-product-year level, most of the coefficients of these interaction terms (between $\Delta\tau_{out}$ and Rank dummies) are significant (see columns (1) and (3)), which partially supports our theory.[47] This further confirms a pattern of resource reallocation over the core-periphery space of competency within a multiproduct firm, further corroborating our theoretical predictions and earlier empirical findings.

4.2. Effect of Trade Liberalization: Extension

In this subsection, we use the merged database to analyze how Chinese input trade liberalization affects firms' export scope and firm-level average productivity through resource reallocation resulting from a switch in export product mix.

exported to (imported from) China in U.S. exports (imports). We then rank these shares across all of China's trading partners, and countries with exporting (importing) shares exceeding the median are defined as Key Exporters (Importers). We also use the GDP of the trading partner as the denominator of these shares instead of the total value of exported (imported) goods of trading partners.

47 See more discussion on the effect of output-tariff reduction in the Online Appendix A1.

TABLE 3
Effect of Trade Liberalization on Export Value across Products: Rank Dummy

	(1)	(2)	(3)	(4)
Panel A				
$\Delta\tau_{in} \times TopHalf$ (50%)	-0.026**	-0.025*	-0.026**	-0.026*
	(0.012)	(0.014)	(0.012)	(0.014)
$\Delta\tau_{in} \times BottomHalf$ (50%)	-0.548***	-0.294***	-0.551***	-0.298***
	(0.106)	(0.106)	(0.106)	(0.105)
$\Delta\tau_{out} \times TopHalf$ (50%)	0.013	0.007	0.012	0.007
	(0.010)	(0.011)	(0.010)	(0.011)
$\Delta\tau_{out} \times BottomHalf$ (50%)	0.470***	0.188	0.472***	0.190
	(0.133)	(0.134)	(0.133)	(0.134)
Observations	329,739	284,128	329,739	284,128
R^2	0.112	0.237	0.112	0.237
Adjusted R^2	0.062	0.025	0.062	0.025
Panel B				
$\Delta\tau_{in} \times TopThird$ (33%)	-0.025**	-0.025*	-0.025**	-0.025*
	(0.012)	(0.014)	(0.012)	(0.014)
$\Delta\tau_{in} \times MiddleThird$ (33%)	-0.321***	-0.222**	-0.323***	-0.225**
	(0.093)	(0.105)	(0.093)	(0.104)
$\Delta\tau_{in} \times BottomThird$ (33%)	-0.660**	-0.392**	-0.664**	-0.397**
	(0.299)	(0.195)	(0.300)	(0.196)
$\Delta\tau_{out} \times TopThird$ (33%)	0.012	0.006	0.012	0.006
	(0.010)	(0.011)	(0.010)	(0.011)
$\Delta\tau_{out} \times MiddleThird$ (33%)	0.266**	0.157	0.267**	0.158
	(0.131)	(0.126)	(0.132)	(0.126)
$\Delta\tau_{out} \times BottomThird$ (33%)	0.545*	0.245	0.547*	0.248
	(0.315)	(0.231)	(0.316)	(0.232)
Observations	329,739	284,128	329,739	284,128
R^2	0.113	0.237	0.113	0.237
Adjusted R^2	0.062	0.025	0.062	0.025
Other Controls	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	No	No
Owntype-Year FE	No	No	Yes	Yes
Firm FE	Yes	No	Yes	No
Country FE	Yes	No	Yes	No
Firm-Country FE	No	Yes	No	Yes

NOTES: * $p < 0.1$, **$p < 0.05$, *** $p < 0.01$. Dependent variable is changes of firm-product-country export value. Other controls include the rank dummy index (eg. Top Half (Third)), Bottom Half (Third) (and Middle (third))), the product rank, firm-level productivity, the firm-level capital-labor ratio, the firm-level average wage and firm size (measured by total employment). All the standard errors are clustered at the industry level.

The number of products and markets — According to our theory, the reduction of imported-input tariffs lowers the cost of domestic firms, raising the number of products exported. In other words, our theory predicts that a multiproduct firm expands its export product scope in response to trade liberalization.[48]

To test this prediction, we run the following reduced-form regression:

$$\begin{aligned}\Delta\left(M_{f(c)t}\right) &= \alpha\Delta Input\_tariff_{it} + \beta\Delta Output\_tariff_{it} \\ &\quad + \gamma\Delta\mathbf{X}_{ft} + \phi\Delta\mathbf{X}_{it} + \varphi_{ot}(+\varphi_c) + \epsilon_{f(c)t}\end{aligned} \tag{16}$$

which represents several specifications. In particular, $M_{f(c)t}$ represents either M_{ft} or M_{fct}. Variable M_{ft} refers to the firm's number of exported products (at the HS 6-digit level) across all destinations, while M_{fct} denotes the number of products exported by firm f to country c at time t in an alternative specification. When we consider a firm's number of exported products within each destination, we also add country fixed effect φ_c. Our theory predicts that $\alpha < 0$, indicating that trade liberalization in imported-intermediate goods leads a firm to expand its export product scope.

Table 4 shows the regression results of (16), which generally support our theoretical predictions. In Table 4, the dependent variables are ΔM_{ft} and ΔM_{fct} in columns (1)-(2) and (3)-(4), respectively. The owntype-year (year) fixed effect is included in all even (odd) columns while the country fixed effect is included only in columns (3) and (4). We also consider the input trade liberalization effect on the other extensive margin (in columns (5) and (6)) – the number of markets to which a firm sells a certain product – by replacing the dependent variable with firm's number of export destinations for each product. We also replace the country fixed effect with the product fixed effect in columns (5)-(6). As predicted, coefficient α is significantly negative in columns (1)-(6), which implies that a tariff reduction in imported intermediate goods induces the entry of new products.[49]

Entropy — Next, we replace the number of products in Equation (16) with an alternative measure of product diversification, namely, the entropy statistic first introduced by Jacquemin and Berry (1979) and later used in Baldwin and Gu (2009) and Bernard et al. (2011). Such a statistic is constructed as $\sum\limits_p s_{fpt}\log\left(1/s_{fpt}\right)$ where s_{fpt} is the share of product p in firm f at time t. This entropy statistic measures the concentration of sales at the product level and captures the extent to which a firm's output is skewed towards its core product. When a firm's sales are evenly spread across all N products that

48 Specifically, the number of products exported in our model is given by the following equation:

$$M_{lh}\left(\varphi,m\right) = \begin{cases} 0 & \text{if } c_l(\varphi,m) > \frac{p_h^{max}}{\tau_{lh}^o} \\ \max\left\{m|c_l(\varphi,m) \leq \frac{p_h^{max}}{\tau_{lh}^o}\right\}+1 & \text{if } c_l(\varphi,m) \leq \frac{p_h^{max}}{\tau_{lh}^o} \end{cases}$$

49 As discussed above, in all specifications shown in Table 4, we exclude single-product firms. Including them in the regression sample would not change our results.

TABLE 4
Effect of Trade Liberalization on the Number of Exported Products and Exported Markets

	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta\tau_{in}$	-0.009**	-0.009**	-0.010***	-0.010***	-0.004*	-0.005*
	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)
$\Delta\tau_{out}$	0.001	0.000	0.003	0.003	0.001	0.001
	(0.004)	(0.004)	(0.002)	(0.002)	(0.003)	(0.003)
Other Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	No	Yes	No	Yes	No
Owntype-Year FE	No	Yes	No	Yes	No	Yes
Country FE	No	No	Yes	Yes	No	No
Product FE	No	No	No	No	Yes	Yes
Observations	79,078	79,078	483,874	483,874	323,531	323,531
R^2	0.007	0.009	0.004	0.005	0.022	0.024
Adjusted R^2	0.007	0.008	0.004	0.004	0.011	0.013

NOTES: * $p < 0.1$, **$p < 0.05$, *** $p < 0.01$. In columns (1) and (2), dependent variables are a firm's number of exported products at the HS 6-digit level while that of columns (3) to (4) are the number of exported varieties by firm f to country c at time t. In columns (5) and (6), dependent variables are the number of a firm's exported markets. Other controls include firm-level productivity, the firm-level capital-labor ratio, the firm-level average wage and firm size (measured by total employment). All the standard errors are clustered at the industry level.

it can possibly sell, the entropy statistic takes on maximum value $\log(N)$; when a firm's sales are concentrated to a single product, the entropy statistic is valued zero.[50] In other words, the larger the entropy statistic is, the more disperse a firm's sales are. As a result, we expect a rise in the entropy statistic following a cut in the imported-input tariff.

Table 5 presents our results. We rerun the same specifications (columns (1)-(4)) in Table 4 but with the dependent variable changed to the entropy statistic. In columns (1) to (2), we use firm-product-year level data to measure the entropy statistic while in columns (3) to (4), the dependent variables are measured using firm-product-country-year level data.[51] As described in Subsection 3.1, we replace the year fixed effect with the ownertype-year fixed

50 As discussed above (in the subsection on the number of products), N is here defined as the number of a firm's exported products. Specifically, N is the number of products at the HS 6-digit level exported by firm f to country c at time t if the dependent variable is of the firm-product-country level. Correspondingly, N denotes a firm's number of exported products across all destinations if the dependent variable is of the firm-product level.

51 When we use the firm-country-product-year level data, the entropy statistic is constructed as $\sum_{pc} s_{fpct} \log\left(1/s_{fpct}\right)$.

TABLE 5
Effect of Trade Liberalization on the Entropy Statistic

Depedent variable: Changes in the Entropy Statistic	(1)	(2)	(3)	(4)
Panel A				
$\Delta\tau_{in}$	-0.013***	-0.013***	-0.009***	-0.009***
	(0.005)	(0.005)	(0.003)	(0.003)
$\Delta\tau_{out}$	0.003	0.003	0.002	0.002
	(0.003)	(0.003)	(0.002)	(0.002)
Other Controls	No	Yes	No	Yes
Year FE	Yes	Yes	Yes	Yes
Country FE	No	No	Yes	Yes
Observations	79,195	79,078	484,348	483,874
R^2	0.001	0.002	0.001	0.002
Adjusted R^2	0.001	0.002	0.001	0.002
Panel B				
$\Delta\tau_{in}$	-0.013***	-0.013**	-0.009***	-0.009***
	(0.005)	(0.005)	(0.003)	(0.003)
$\Delta\tau_{out}$	0.003	0.003	0.002	0.002
	(0.003)	(0.003)	(0.002)	(0.002)
Other Controls	No	Yes	No	Yes
Owntype-Year FE	Yes	Yes	Yes	Yes
Country FE	No	No	Yes	Yes
Observations	79,195	79,078	484,348	483,874
R^2	0.002	0.003	0.001	0.002
Adjusted R^2	0.001	0.002	0.001	0.002

Notes: * $p < 0.1$, **$p < 0.05$, *** $p < 0.01$. Other controls include firm-level productivity, the firm-level capital-labor ratio, the firm-level average wage and firm size (measured by total employment). All the standard errors are clustered at the industry level.

effect in Panel B to control ownership-specific policy shocks. Table 5 shows that all of the results are consistent with our predictions: coefficient α is significantly negative in all columns.

The Improvement of Firm-Level Productivity — We have just shown the impacts of Chinese input trade liberalization on a firm's intensive and extensive margins. We now investigate the link between input-tariff reduction and the change in firm-level productivity through a switch in product mix.

As highlighted in our theoretical section, productivity varies across the core-periphery space of competency in a multiproduct firm. In particular, the productivity of the core-competency variety is the highest while that of a noncore product decreases with the distance from the core one.[52] Moreover, the previous sections show that a multiproduct firm skews its production (and export value) towards peripheral varieties after the unilateral input-tariff reduction. Therefore, holding the productivity of producing each individual product fixed, the more varieties a firm exports, the smaller the productivity gains resulting from imported-input trade liberalization due to resource reallocation across products within firms.[53] In other words, we expect the average firm-level productivity improvement to decrease with a firm's number of exported products after the imported-input tariff reduction.[54] The empirical specification is therefore:

$$\begin{aligned}\Delta\left(Productivity_{ft}\right) = {} & \alpha_0 \Delta Input\_tariff_{it} + \alpha_1 \Delta Input\_tariff_{it} \times log(N_{ft}) \\ & + \beta_0 \Delta Output\_tariff_{it} + \beta_1 \Delta Output\_tariff_{it} \times log(N_{ft}) \\ & + \gamma \Delta \mathbf{X}_{ft} + \phi \Delta \mathbf{X}_{it} + \varphi_{ot} + \epsilon_{ft} \qquad (17)\end{aligned}$$

where N_{ft} denotes firms' numbers of exported products,[55] and $Productivity_{ft}$ represents changes in firm-level productivity. Here, the productivity measure is simply the total factor productivity (TFP) included in the benchmark regression based on the ACF augmented L-P method.[56] According to our theory, we expect $\alpha_1 > 0$, indicating that the improvement in firms' average productivity is smaller for firms that export more varieties in response to the imported-input tariff reduction.

Table 6 shows the result of specification (17). We first test the impact of input-tariff reduction on firm-level productivity in columns (1)-(2). Our result shows that a reduction in the imported-input tariff leads to an improvement in firm-level total factor productivity. More importantly, consistent with our expectations, the interactions of input-tariff reduction ($\Delta\tau_{in}$) and the log of a firm's number of exported products ($log(N)$) are significantly negative in columns (3)-(4). As robustness checks, in columns (5)-(6) and (7)-(8), we further estimate firm-level productivity based on the ACF augmented O-P

52 Related works adopt a similar assumption, including Ecker and Neary (2010), Mayer et al. (2014) and so forth.

53 The Chinese imported-input tariff reduction induces an entry of new products and the reallocation of revenues towards less performing products, decreasing firm-level weighted average productivity.

54 One might be concerned that controlling for TFP changes could lead to problems since here we show that input and output tariff changes also affect the adjustment of firm-level productivity. In fact, we observe few differences in the results with and without the control of TFP changes (ΔTFP). Therefore, this issue is not a first order concern.

55 Please see our previous discussion on entropy statistics for a detailed description of the measurement method.

56 See Section A2 of the Online Appendix for further details on the productivity estimation procedure.

TABLE 6
Effect of Trade Liberalization on the Adjustment of Firm-level Productivity

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta\tau_{in}$	-0.009*	-0.009*	-0.021***	-0.021***	-0.025***	-0.025***	-0.008	-0.008
	(0.005)	(0.005)	(0.008)	(0.008)	(0.008)	(0.008)	(0.007)	(0.007)
$\Delta\tau_{in} \times log(N)$			0.005*	0.005*	0.007***	0.007***	0.005**	0.005**
			(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)
$\Delta\tau_{out}$	0.001	0.001	0.007	0.007	0.002	0.002	0.005	0.005
	(0.004)	(0.004)	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)
$\Delta\tau_{out} \times log(N)$			-0.003	-0.003	-0.004*	-0.004**	-0.004**	-0.004**
			(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Other Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	No	Yes	No	Yes	No	Yes	No
Owntype-Year FE	No	Yes	No	Yes	No	Yes	No	Yes
Observations	79,188	79,188	79,078	79,078	79,078	79,078	79,078	79,078
R^2	0.036	0.037	0.036	0.037	0.037	0.038	0.120	0.121
Adjusted R^2	0.036	0.036	0.036	0.036	0.037	0.037	0.120	0.120

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Dependent variables in columns (1)-(4) are changes of firm-level productivity estimated based on the ACF augmented L-P method, that in columns (5)-(6) are changes in firm-level productivity based on the ACF augmented O-P method, and that in columns (7)-(8) are changes in firm-level labor productivity measured by sales per worker. Other controls include the firm-level capital-labor ratio, the firm-level average wage and firm size (measured by total employment). All the standard errors are clustered at the industry level.

method and labor productivity measured by value-added per worker.[57] The significantly negative coefficients of interaction terms ($\Delta\tau_{in} \times log(N)$) further support our conjecture.[58] This implies that although input trade liberalization improved the average firm-level productivity, this effect is less significant for firms with more export products.

5. Robustness Checks

In this section, we run a series of robustness checks to determine whether our results continue to hold under various types of alternative specifications.

5.1. Endogeneity Issues

When studying the impact of trade liberalization, tariff changes may not be set exogenously. To address this issue, we rely on the history of trade protection to find appropriate instruments for policy changes in this section.

Based on the observation of a strong correlation between tariff changes and pre-reform tariff levels, Goldberg and Pavcnik (2005) suggest using the latter as an instrumental variable. The history of trade protection in China displays a similar pattern.[59] In particular, tariff cuts were higher in heavily protected industries (see Liu et al. 2016). As our sample is for 2000-2006, we select input and output tariff levels for 1999 as our simple set of instruments. Consistent with other specifications, in columns (1) and (4), dependent variables are changes in the log firm-product level export value while in other columns, dependent variables are changes in the log firm-product-country level export value. As shown in Table 7, our results are robust to adopting the instrumental variable approach. Clearly, Table 7 illustrates that the coefficients of interaction terms $\Delta\tau_{in} \times Rank$ are significantly negative in all specifications, at a significance level of 1%.[60] This is consistent with

57 In applying the ACF augmented O-P method, we use the investment demand function instead of the intermediate input demand function used for the ACF augmented L-P method.

58 The coefficients of interaction terms between output-tariff reduction and the log of firms' numbers of exported products ($\Delta\tau_{out} \times log(N)$) are negative, which is consistent with the decrease in firms' number of exported products occurring in response to the output-tariff reduction.

59 See Figure A2.

60 The larger magnitude of coefficients found in the IV regressions (Table 7) than from the OLS regressions (Table 2) may be attributable to the fact that firms facing a larger average input-tariff reduction might be those that were more likely to increase export sales once tariffs decreased. In addition, although the sign of tariff changes is not consistent with our predictions, the coefficients of interaction terms, which we are most interested in, remain significantly negative across all columns in Table 7.

our main prediction that Chinese input trade liberalization increased export values with more prominent effects observed for peripheral products.[61]

One concern with the instrumental variable approach relates to its weak instrument. It turns out that our first stage results (in Table A5) reveal that all coefficients of each instrument for the first stage are significantly negative, showing that the higher the initial tariff level of an industry, the larger tariff cuts it receives.[62] Notably, the significant Sanderson-Windmeijer (2016) first-stage F statistic and Chi-squared statistic suggest that none of our endogenous regressors are weakly identified.[63] We also conduct two joint tests to verify the quality of the instruments. The first is applied to assess the strength of our identification. We adopt the Kleibergen and Paap (2006) rk statistic based on a Langrange-Multiplier (LM) test for underidentification. The Kleibergen-Paap (2006) rk Lagrange Multiplier (LM) statistic reveals that our model passes the under-identification test. The second diagnostic test we perform is the Cragg and Donald (1993) Wald F-statistic, which we used to check whether the instrument is weakly correlated with the endogenous variable. It turns out that the F statistic is way above the Stock and Yogo (2005) critical value, providing strong evidence to reject the null hypothesis that the first stage is weakly identified. In other words, all of our results suggest that the instruments are valid and strong. [64]

5.2. Customs Data

For the benchmark case, our database merges the customs data and the manufacturing survey data.[65] The merged data set allows us to incorporate

61 We also employ tariff levels for year 1997 as the fixed past level to instrument tariff changes occurring between 2000 and 2006, and all of the results still hold. See Table A7 in the Online Apeendix.

62 In particular, since we have four endogenous variables ($\Delta\tau_{in}$, $\Delta\tau_{in} \times$ Rank, $\Delta\tau_{out}$, $\Delta\tau_{out} \times$ Rank) here, we use Input_Tariff#1999, Input_tariff#1999 × Rank, Output_tariff#1999, Output_tariff#1999 × Rank, respectively, to instrument the endogenous variables. Therefore, four first-stage regressions for each column of Table 7 are given in Table A5 in the Online Appendix.

63 As a rule of thumb, many researchers conclude that their instruments are sufficiently strong if the first-stage F statistic exceeds 10. However, Stock and Yogo (2005) find that this rule might be not very reliable. Therefore, we rely on Sanderson-Windmeijer (2006) first-stage statistics here. Nevertheless, we still report the traditional first-stage F statistic in Table A5, and the F statistic values are high (exceeding 10) in almost all of the first stage specifications. We thank the anonymous referee for recommending that we report the Sanderson-Windmeijer (2016) first-stage F statistic and the Chi-squared statistic, as they are more valid under more general conditions than the Angrist-Pischke (2009) statistics.

64 In addition, to test for the significance of the endogenous regressors, we run two more tests. The first is Anderson and Rubin's (1949) test, which provides Chi-squared and F-statistic values. The second test, which is closely related, is proposed by Stock and Wright (2000), and yields the S-statistic. The high values of these statistics suggest that our model passes all of these tests.

65 Similarly, we remove intermediary and trading firms from the merged sample.

TABLE 7
Effect of Trade Liberalization on Export Value across Products (Instrumental Variables)

	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta\tau_{in}$	0.471***	0.219**	0.280**	0.467***	0.224**	0.289**
	(0.088)	(0.097)	(0.115)	(0.089)	(0.098)	(0.116)
$\Delta\tau_{in}$ × Rank	-0.199***	-0.119***	-0.108***	-0.198***	-0.118***	-0.106***
	(0.045)	(0.038)	(0.039)	(0.045)	(0.038)	(0.039)
$\Delta\tau_{out}$	-0.134*	-0.077	-0.146	-0.131	-0.080	-0.151
	(0.080)	(0.080)	(0.095)	(0.081)	(0.081)	(0.097)
$\Delta\tau_{out}$ × Rank	0.012	-0.012	0.013	0.011	-0.012	0.013
	(0.041)	(0.041)	(0.043)	(0.042)	(0.041)	(0.043)
Rank	0.243***	0.318***	0.439***	0.243***	0.318***	0.440***
	(0.041)	(0.032)	(0.038)	(0.041)	(0.032)	(0.038)
Kleibergen-Paap rk LM $\chi^2(1)$	26.000	29.750	27.656	25.505	29.189	27.136
Kleibergen-Paap rk F statistic	10.097	8.619	6.777	9.890	8.462	6.649
Cragg-Donald Wald F statistic	394.969	796.759	553.293	389.167	790.376	549.414
Anderson-Rubin Wald F-statistic	7.63	6.77	4.98	7.38	6.82	5.09
Anderson-Rubin Wald $\chi^2(4)$	34.50	28.68	25.52	33.39	28.90	26.08
Stock-Wright LM S Statistic $\chi^2(4)$	30.83	12.55	12.40	34.34	15.36	16.12
Other Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	No	No	No
Owntype-Year FE	No	No	No	Yes	Yes	Yes
Firm FE	Yes	Yes	No	Yes	Yes	No
Country FE	No	Yes	No	No	Yes	No
Firm-Country FE	No	No	Yes	No	No	Yes
Observations	141,788	329,739	284,128	141,788	329,739	284,128

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. In columns (1) and (4), dependent variable is changes of firm-product export value while in other columns, dependent variable is changes of the firm-product-country export value. Other controls include firm-level productivity, the firm-level capital-labor ratio, the firm-level average wage and firm size (measured by total employment). We use the 1999 tariff level to instrument the tariff changes between 2000 and 2006 in this table. All the standard errors are clustered at the industry level.

firms' characteristics into our observations such as productivity and size. The database, however, covers all SOEs and large non-SOEs with annual sales of at least five million RMB (approximately equivalent to US$ 800,000).[66] In

66 In other words, some small exporters are unaccounted for, which may result in selection bias.

TABLE 8
Effect of Trade Liberalization on Export Value across Products (based on Customs Data Sample)

	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta\tau_{in}$	0.019**	0.019**	0.020***	0.021***	0.012*	0.013*
	(0.009)	(0.009)	(0.006)	(0.006)	(0.007)	(0.007)
$\Delta\tau_{in}$ × Rank	-0.009***	-0.010***	-0.010***	-0.012***	-0.010***	-0.012***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
$\Delta\tau_{out}$	-0.020**	-0.017**	-0.009*	-0.006	-0.016**	-0.013**
	(0.008)	(0.008)	(0.005)	(0.005)	(0.006)	(0.006)
$\Delta\tau_{out}$ × Rank	0.005*	0.004	-0.003	-0.004	0.000	-0.001
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Rank	0.261***	0.260***	0.307***	0.304***	0.416***	0.413***
	(0.007)	(0.007)	(0.005)	(0.005)	(0.006)	(0.006)
Year FE	Yes	No	Yes	No	Yes	No
Owntype-Year FE	No	Yes	No	Yes	No	Yes
Firm FE	Yes	Yes	Yes	Yes	No	No
Country FE	No	No	Yes	Yes	No	No
Firm-Country FE	No	No	No	No	Yes	Yes
Observations	918,269	918,269	1,878,974	1,878,974	1,760,206	1,760,206
R^2	0.141	0.142	0.097	0.097	0.192	0.193
Adjusted R^2	0.090	0.091	0.071	0.071	0.070	0.070

Notes: * $p < 0.1$, **$p < 0.05$, *** $p < 0.01$. In columns (1)-(2), dependent variable is changes of firm-product export value while in columns (3)-(6), dependent variable is changes of the firm-product-country export value.

this section, we test our theory using only customs data to cover the whole universe of exporters. Using the concordance table provided by Brandt et al. (2017), we map 4-digit CIC industry level imported-input and imported-output tariffs to the HS 6-digit level, yielding a set of input and output tariffs of the HS 6-digit level.[67]

In Table 8, dependent variables in columns (1) and (2) are changes in the firm-product level export value while those in columns (3)-(6) are changes in the firm-product-country level. Odd columns control for the year fixed effect while the ownership-year fixed effect is included in the even columns. As shown in Table 8, all the coefficients of interest ($\Delta\tau_{in}\times$ Rank) have the predicted signs, which further supports our theoretical predictions: a reduction in the imported-input tariff induces an exporter to reallocate its resources to peripheral goods.

67 Hence, we cluster error terms at the (HS 6-digit) product level to address potential correlations between errors of each HS 6-digit category over time.

TABLE 9
Effect of Trade Liberalization on Export Value across Products (using Processing Trade Data)

	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta\tau_{in}$	0.032	0.033	0.023	0.023	0.033	0.034*
	(0.025)	(0.025)	(0.015)	(0.014)	(0.021)	(0.020)
$\Delta\tau_{in}$ × Rank	0.007	0.006	-0.013	-0.014	-0.006	-0.006
	(0.012)	(0.012)	(0.013)	(0.013)	(0.014)	(0.014)
$\Delta\tau_{out}$	-0.005	-0.002	0.003	0.004	-0.007	-0.007
	(0.020)	(0.020)	(0.012)	(0.012)	(0.013)	(0.013)
$\Delta\tau_{out}$ × Rank	-0.006	-0.006	0.004	0.004	0.008	0.008
	(0.015)	(0.015)	(0.009)	(0.009)	(0.009)	(0.009)
Rank	0.265***	0.265***	0.281***	0.280***	0.341***	0.340***
	(0.033)	(0.034)	(0.024)	(0.024)	(0.027)	(0.027)
Other Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	No	Yes	No	Yes	No
Owntype-Year FE	No	Yes	No	Yes	No	Yes
Firm FE	Yes	Yes	Yes	Yes	No	No
Country FE	No	No	Yes	Yes	No	No
Firm-Country FE	No	No	No	No	Yes	Yes
Observations	39,308	39,308	89,926	89,926	80,070	80,070
R^2	0.163	0.165	0.101	0.101	0.226	0.227
Adjusted R^2	0.050	0.051	0.049	0.050	0.026	0.027

Notes: * $p < 0.1$, **$p < 0.05$, *** $p < 0.01$. In columns (1)-(2), dependent variable is changes of the firm-product export value while in columns (3)-(6) dependent variable is changes of firm-product-country export value. Other controls include firm-level productivity, the firm-level capital-labor ratio, the firm-level average wage and firm size (measured by total employment). All the standard errors are clustered at the industry level.

5.3. Placebo Test

A prevalent feature of Chinese trading activities is the presence of processing trade (Manova and Yu 2016, Fan et al. 2015, Yu 2015). A Chinese firm can obtain inputs from its trading partners, use them to assemble final goods, and export them back to its trading partners. This type of trading activity is recorded as processing with supplied inputs in customs documents. Alternatively, firms can pay for imported inputs from foreign suppliers, assemble the final good and export all processed goods. This practice is documented as processing with imported inputs. The processing-trade regime allows firms to enjoy duty-free imports. For processing trade, we expect to find no impact of changes in imported-input tariffs on their export performance.[68]

68 Since Chinese exporters might be involved with both processing trade and ordinary trade business at the same time, we employ the pure processing trade sample here to

As shown in Table 9, the coefficients of interactions between input-tariff reduction ($\Delta\tau_{in}$) and product rank ($Rank$) are insignificant, suggesting that the impact of imported-input tariff reduction is insignificant.[69] In other words, the use of the processing-trade regime as a placebo test provides additional evidence in support of our results.

5.4. Long Difference

In this subsection, we show that our results do not change when we apply longer difference estimators. In Table 10, we use a two-year difference estimator in columns (1)-(3), a three-year difference estimator in columns (4)-(6) and a four-year difference estimator in columns (7)-(9).[70] In columns (1), (4) and (7), the dependent variable is the firm-product level export value, and in the other columns, the dependent variable is at the firm-product-country level. Consistent with our predictions, all coefficients of the variables of interest have the predicted signs; namely, they are significantly negative for $\Delta\tau_{in} \times$ Rank. In other words, when we consider the long-term effect of input tariff reduction, our theoretical predictions continue to hold.

5.5. Other Mechanisms

Other mechanisms may also affect the reallocation of outputs across products within a firm. In this section, we show that other mechanisms that are widely considered in the literature do not change our main results.

One may be concerned that such reallocation across products within firm-destinations is partially due to the appreciation of the renminbi (RMB). In late 2005, China adopted the floating regime and allowed the RMB to appreciate. This policy could clearly affect the import/export decisions of Chinese firms (Tang and Zhang 2012), and this problem can be addressed by using the pre-2005 database to separate the effects of this policy from those of the trade reforms (Fan et al. 2017). Another concern relates to policy uncertainty. Prior to WTO accession, China already enjoyed MFN status from the U.S. and the European Union, among other countries, granting low tariffs to Chinese exports. However, this status was subject to annual review in some countries, notably the United States. It is therefore natural to suspect China's WTO accession reduced policy uncertainty faced by Chinese exporters.[71] We

better identify the differential effect of trade liberalization on firms with processing trade and ordinary trade activities. In other words, exporters in our sample only engaged in processing trade throughout the whole sample period (from 2000 to 2006).

69 One should note that the coefficient of the output-tariff reduction as well as the interaction between output-tariff reduction and product rank are also insignificant. This is the case because Chinese trade liberalization largely operates on imported intermediate goods. Please see our related discussion in the introduction.

70 We also use a five-year difference estimator, and our results still hold.

71 Pierce and Schott (2013) find that most of the uncertainty faced by Chinese exporters actually originates from the United States.

TABLE 10
Effect of Trade Liberalization on Export Value across Products (using Long Difference Estimators)

	Two-year Difference			Three-year Difference			Four-year Difference		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\Delta\tau_{in}$	0.022	0.026*	0.032*	-0.014	0.004	0.009	-0.021	-0.010	-0.008
	(0.023)	(0.014)	(0.017)	(0.028)	(0.026)	(0.028)	(0.030)	(0.026)	(0.027)
$\Delta\tau_{in}$ × Rank	-0.033***	-0.036***	-0.034**	-0.044***	-0.052***	-0.046**	-0.038***	-0.039***	-0.034**
	(0.011)	(0.011)	(0.014)	(0.011)	(0.014)	(0.019)	(0.010)	(0.011)	(0.015)
$\Delta\tau_{out}$	-0.009	-0.010	-0.018	-0.001	-0.022	-0.021	0.011	-0.019	-0.018
	(0.017)	(0.013)	(0.015)	(0.020)	(0.021)	(0.022)	(0.025)	(0.023)	(0.026)
$\Delta\tau_{in}$ × Rank	0.029***	0.025**	0.029**	0.032**	0.032***	0.036**	0.014	0.024**	0.026*
	(0.010)	(0.010)	(0.012)	(0.013)	(0.011)	(0.016)	(0.008)	(0.011)	(0.015)
Rank	-0.171***	-0.111***	-0.118***	-0.240***	-0.151***	-0.146***	-0.379***	-0.202***	-0.206***
	(0.031)	(0.019)	(0.027)	(0.042)	(0.035)	(0.042)	(0.055)	(0.056)	(0.071)
Owntype-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No
Country FE	No	Yes	No	No	Yes	No	Mo	Yes	No
Firm-Country FE	No	No	Yes	No	No	Yes	No	No	Yes
Observations	65,407	138,345	120,190	34,521	69,232	56,273	16,395	31,227	23,539
R^2	0.198	0.147	0.320	0.273	0.206	0.409	0.342	0.261	0.479
Adjusted R^2	0.079	0.088	0.110	0.136	0.132	0.194	0.169	0.164	0.236

Notes: * $p < 0.1$, **$p < 0.05$, *** $p < 0.01$. In columns (1), (4) and (7), dependent variable is changes of firm-product export value while in other columns, dependent variable is changes of the firm-product-country export value. Other controls include firm-level productivity, the firm-level capital-labor ratio, the firm-level average wage and firm size (measured by total employment). All the standard errors are clustered at the industry level.

TABLE 11
Effect of Other Mechanism

	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta\tau_{in}$	0.037	0.037	0.010	0.010	0.008	0.008
	(0.032)	(0.031)	(0.010)	(0.009)	(0.010)	(0.010)
$\Delta\tau_{in}$ × Rank	-0.054**	-0.054***	-0.029***	-0.029***	-0.023**	-0.022**
	(0.021)	(0.021)	(0.011)	(0.011)	(0.010)	(0.010)
$\Delta\tau_{out}$	-0.014	-0.014	0.001	0.000	-0.001	-0.001
	(0.028)	(0.028)	(0.005)	(0.005)	(0.005)	(0.005)
$\Delta\tau_{out}$ × Rank	0.019	0.019	0.002	0.002	0.001	0.001
	(0.018)	(0.018)	(0.006)	(0.006)	(0.006)	(0.006)
Rank	0.406***	0.405***	0.425***	0.425***	0.519***	0.519***
	(0.024)	(0.025)	(0.016)	(0.016)	(0.019)	(0.019)
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	No	Yes	No	Yes	No
Owntype-Year FE	No	Yes	No	Yes	No	Yes
Firm FE	Yes	Yes	Yes	Yes	No	No
Country FE	No	No	Yes	Yes	No	No
Firm-Country FE	No	No	No	No	Yes	Yes
Observations	60,126	60,126	191,838	191,838	165,242	165,242
R^2	0.193	0.193	0.122	0.122	0.253	0.253
Adjusted R^2	0.060	0.060	0.066	0.066	0.024	0.024

Notes: * $p < 0.1$, **$p < 0.05$, *** $p < 0.01$. All the transactions after year 2005 as well as to and from the United States are removed in all the columns. In columns (1)-(2), the dependent variable is the changes of firm-product export value while in columns (3)-(6), the dependent variable is changes of the firm-product-country export value. Other controls include firm-level productivity, the firm-level capital-labor ratio, the firm-level average wage and firm size (measured by total employment). All the standard errors are clustered at the industry level.

address this policy uncertainty issue by removing U.S. transactions from our sample. Table 11 reports our results based on the sample after we remove transactions with the U.S. and in years following 2005. In columns (1) and (2), the dependent variables are changes in firm-product-year level export value while that in other columns are changes in firm-product-country-year level export value. Again, as predicted by our theory, the coefficients of the term capturing the interaction between imported-input tariff and log rank ($\Delta\tau_{in}$ × Rank) are negative and significant. [72]

72 Table A8 in the Online Appendix reports results obtained when we consider the exchange rate and policy uncertainty mechanism separately. Panel A of Table A8 reports the results of using the pre-2005 database, and Panel B reports the results obtained when employing the subsample without transactions to the U.S. All of the results shown in Table A8 support our main findings.

6. Conclusion

Economists have long been concerned with how policies affect resource allocation. The earlier international trade literature focused on resource reallocation across firms (e.g., a firm's entry, exit, export value, quantity and price) following trade liberalization. More recently, however, there has been a surge of interest in trade-induced resource reallocation across products within multiproduct firms. In this paper, we develop a model that highlights such within-firm resource allocation driven by input trade liberalization. We use a highly disaggregated data set for China for 2000-2006 to test our hypothesis. Consistent with our theoretical predictions, a reduction of imported-input tariff is found to induce a firm to increase the export sales of peripheral products by a larger percentage than those of core products. As a result, a firm expands its product scope to products of lower-productivity, and diversifies its product line, thus lowering the firm's average productivity.

Our study contributes to a vibrant literature that links improved access to imported intermediate inputs to firm performance, analyzes multiproduct firms and studies trade-induced resource reallocations across/within firms. In future research, it would be interesting to assess the impact of trade liberalization on the value of exports along the quantity and price dimensions. Furthermore, it would be worthwhile to investigate the impact of financial friction on how firms adjust their product mix in response to input trade liberalization.[73]

73 Since the financial crisis of 2008, a growing body of literature has focused on the impact of financial constraints on a firm's export performance (Manova 2013, Manova et al. 2015, Fan et al. 2015).

References

Ackerberg, Daniel, Kevin Caves and Garth Frazer (2015) "Structural Identification of Production Functions," *Econometrica*, 83(6): 2411–2451

Amiti, Mary and Amit Khandelwal (2013) "Import Competition and Quality Up-grading." *Review of Economics and Statistics,* 95(2), 476–490

Amiti, Mary and Josef Konings (2007) "Trade Liberalization, Intermediate Inputs and Productivity: Evidence from Indonesia," *American Economic Review*, 97(5), 1611-1638

Anderson, T. W., and H. Rubin (1949) "Estimation of the parameters of a single equation in a complete system of stochastic equations," *Annals of Mathematical Statistics*, 20, 46–63

Angrist, J.D., and J. S. Pischke (2009) *Mostly Harmless Econometrics: An Empiricist's Companion,* Princeton: Princeton University Press

Antras, Pol, Teresa Fort, and Felix Tintelnot (2017) "The Margins of Global Sourcing: Theory and Evidence from U.S. Firms," *American Economic Review*, 107(9), 2514–2564

Antoniades, Alexis (2015) "Heterogeneous Firms, Quality and Trade," *Journal of International Economics*, 95, 263–273

Arkolakis, Costas, Sharat Ganapati and Marc-Andreas Muendler (2019) "The Extensive Margin of Exporting Goods: A Firm-level Analysis," NBER working paper no. 16641

Baldwin, Richard, and Wulong Gu (2009) "The Impact of Trade on Plant Scale, Production-Run Length and Diversification," in *Producer Dynamics: New Evidence from Micro Data (Volume 80)*, pp. 557–596

Bas, Maria, and Vanessa Strauss-Kahn (2015) "Input-trade liberalization, export prices and quality upgrading," *Journal of International Economics*, 95(2), 250–262

Bernard, Andrew, Renzo Massari, Jose-Daniel Reyes, and Daria Taglioni (2017) "Exporter Dynamics and Partial-Year Effects," *American Economic Review*, 107(10), 3211–28

Bernard, Andrew, Stephen J. Redding, and Peter K. Schott (2010) "Multiple-Product Firms and Product Switching," *American Economic Review*, 100(1), 70–97

Bernard, Andrew, Stephen J. Redding, and Peter K. Schott (2011) "Multi-product Firms and Trade Liberalization," *Quarterly Journal of Economics*, 126(3), 1271–1318

Besedes, Tibor, and Matthew T. Cole (2017) "Distorted Trade Barriers: A Dissection of Trade Costs in a 'Distored Gravity' Model," *Review of International Economics*, 25(1), 148–164

Brandt, Loren, Johannes Van Biesebroeck, and Yifan Zhang (2012) "Creative Accounting or Creative Destruction? Firm-level Productivity Growth in Chinese Manufacturing," *Journal of Development Economics*, 97(2), 339–351

Brandt, Loren, Johannes Van Biesebroeck, Luhang Wang, and Yifan Zhang (2017) "WTO Accession and Performance of Chinese Manufacturing Firms," *American Economic Review*, 107(9): 2784–2820

Cai, Hongbin, and Qiao Liu (2009) "Competition and Corporate Tax Avoidance: Evidence from Chinese Industrial Firms," *Economic Journal*, 119: 764–795

Cameron, A. Colin, Jonah B. Gelbach, and Douglas L. Miller (2011) "Robust Inference With Multiway Clustering," *Journal of Business and Economic Statistics*, 29(2): 238–249

Cole. Matthew T. (2011) "Not all trade restrictions are created equally," *Review of World Economics*, 147 (3): 411-427

Cragg, John G., and Stephen G. Donald (1993) "Testing Identifiability and Specification in Instrumental Variable Models," *Econometric Theory*, 9(2): 222–240

Dhingra, Swati (2013) "Trading Away Wide Brands for Cheap Brands," *American Economic Review*, 103(6): 2554–2584

Eaton, Jonathan, and Samuel Kortum (2002) "Technology, Geography, and Trade." *Econometrica*, 70(5): 1741–1779

Eckel, Carsten, Leonardo Iacovone, Beata Javorcik, and J. Peter Neary (2015) " Multi-product firms at home and away: Cost-versus quality-based competence," *Journal of International Economics*, 95(6): 216–232

Eckel, Carsten, and J. Peter Neary (2010) "Multi-Product Firms and Flexible Manufacturing in the Global Economy," *Review of Economic Studies*, 77: 188–217

Fan, Haichao, Edwin Lai, and Yao Amber Li (2015) "Credit Constraints, Quality, and Export Prices: Theory and Evidence from China," *Journal of Comparative Economics*, 43(2): 390–416

Fan, Haichao, Yao Amber Li, and Stephen Yeaple (2015) "Trade Liberalization, Quality and Export Prices," *Review of Economics and Statistics*, 97(5): 1033–51

Fan Haichao, Yao Amber Li and Stephen Yeaple (2018) " On the Relationship Between Quality and Productivity: Evidence from China's Accession to the WTO," *Journal of International Economics*, 110(1): 28–49

Feenstra, Robert C., and Hong Ma (2007) "Optimal Choice of Product Scope for Multiproduct Firms under Monopolistic Competition," NBER working paper no. 13703

Feng, Ling, Zhiyuan Li, and Deborah Swenson (2016) " The connection between imported intermediate inputs and exports: Evidence from China," *Journal of International Economics*, 101: 86–101

Goldberg, Pinelopi, Amit Khandelwal, Nina Pavcnik, and Petia Topalova (2010) "Imported Intermediate Inputs and Domestic Product Growth: Evidence from India," *Quarterly Journal of Economics*, 125(4): 1727–1767

Goldberg, Pinelopi, and Nina Pavcnik (2005) "Trade, wages and the political economy of trade protection: evidence from the Colombian trade reforms," *Journal of International Economics*, 66: 75–105

Gopinath, Gita, and Brent Neiman (2014) "Trade Adjustment and Productivity in Large Crises," *American Economic Review*, 104(3): 793–831

Halpern, Laszlo, Miklos Koren, and Adam Szeidl (2015) "Imported Inputs and Productivity," *American Economic Review*, 105(12): 3660–3703

Jacquemin, Alexis P., and Charles H. Berry (1979) "Entropy Measure of Diversification and Corporate Growth," *Journal of Industrial Economics*, 27(4): 359–69

Ju, Jiandong, Kang Shi, and Shang-Jin Wei (2012) "Trade Reforms and Current Account Imbalances: When Does the General Equilibrium Effect Overturn a Partial Equilibrium Intuition?,"NBER working paper no. 18653

Kleibergen, Frank, and Richard Paap (2006) "Generalized reduced rank tests using the singular value decomposition," *Journal of Econometrics*, 133(1): 97–126

Levinsohn, James, and Amil Petrin (2003) "Estimating production functions using Inputs to Control for Unobservables," *Review of Economic Studies*, 70: 317–341

Liu, Qing, Ruosi Lu, Yi Lu, and Tuan Anh Luong (2015) "Is Free Trade Good or Bad for Innovation?," FREIT Working Paper

Luong, Tuan Anh (2011) “The Impact of Input and Output Tariffs on Firms Productivity: Theory and Evidences,” *Review of International Economics*, 19(5): 821–35

Liu, Runjuan (2010) “Import Competition and Firm Refocusing,” *Canadian Journal of Economics*, 43(2): 440–466

Manova, Kalina (2013) “Credit constraints, heterogeneous firms and international trade,” *Review of Economic Studies*, 80(2): 711–744

Manova, Kalina, Shang-Jin Wei, and Zhiwei Zhang (2015) “Firm Exports and Multinational Activity Under Credit Constraints,” *Review of Economics and Statistics*, 97(3): 574–558

Manova, Kalina, and Zhihong Yu (2016) “How firms export: Processing vs. ordinary trade with financial frictions?,” *Journal of International Economics*, 100: 120–137

Manova, Kalina, and Zhihong Yu (2017) “Multi-product Firms and Product Quality,” *Journal of International Economics*, 109: 116–137

Manova, Kalina, and Zhiwei Zhang (2012) “Export Prices across Firms and Destinations,” *The Quarterly Journal of Economics*, 127: 379–436

Mayer, Thierry, and Gianmarco Ottaviano (2007) “The Happy Few: The internationalisation of European firms. New facts based on Firm-Level Evidence,” *Intereconomics/Review of European Economic Policy*, 43(3): 135–48

Mayer, Thierry, Marc Melitz, and Gianmarco Ottaviano (2014) “Market size, Competition and the Product Mix of Exporters,” *American Economic Review*, 104(2): 495–536

Mayer, Thierry, Marc Melitz, and Gianmarco Ottaviano (2020) “Product Mix and Firm Productivity Responses to Trade Competition,” *The Review of Economics and Statistics*, forthcoming

Melitz, Marc, and Gianmarco Ottaviano (2008) “Market size, Trade and Productivity,” *Review of Economic Studies*, 75: 295–316

Nocke, Volker, and Stephen Yeaple (2014) “Globalization and Multiproduct firms,” *International Economic Review*, 55(4): 993–1018

Olley, Steven, and Ariel Pakes (1996) “The Dynamics of Productivity in the Telecommunications Equipment Industry,” *Econometrica*, 64(6): 1263–1297

Pierce, Justin, and Peter Schott (2016) “The Surprisingly Swift Decline of U.S. Manufacturing Employment,” *American Economic Review*, 106(7):1632–1662

Peng, Mike W. and Anne Y. Ilinitch (1998) “Export Intermediary Firms: A Note on Export Development Research,” *Journal of International Business Studies*, 29(3):609–620

Sanderson, Eleanor, and Frank Windmeijer (2016) “A Weak Instrumen F-test in liner IV models with multiple endogenous variables,” *Journal of Econometrics*, 190(2):212–221

Stock, James H., and Motohiro Yogo (2005) “Testing for Weak Instruments in Linear IV Regression,” in *Identication and Inference for Econometric Models: Essays in Honor of Thomas Rothenberg*, New York: Cambridge University Press

Stock, James H., and Jonathan H. Wright (2000) “GMM with Weak Identification,” *Econometrica*, 68(5): 1055–1096

Tang, Heiwai, and Yifan Zhang (2012) “Exchange Rates and the Margins of Trade: Evidence from Chinese Exporters,” *CESifo Economic Studies*, 58(4): 671–702

Wang, Zheng, and Zhihong Yu (2012) “Trading partners, traded products, and firm performances of China’s exporters and importers: does processing trade make a difference?,” *World Economy*, 35(12): 1795–824

Yu, Miaojie (2015) “Processing Trade, Tariff Reductions and Firm Productivity: Evidence from Chinese Firms,” *Economic Journal*, 125(585): 943–988

Appendix A1: Model Extension

A1. Model Extension: More General Demand Function

In the main text, we adopt a quardratic demand function as in Meliz and Ottaviano (2008). In this section, we show that our results still go through with a rather general demand function, as long as the endogenous price elasticities satisfy the Marshall's Second Law of Demand (MSLD, hereafter) condition.[74]

Each consumer's utility is assumed to be additively separable over a continuum of imperfectly substitutable products indexed by $i \in [0, M]$ where M is the measure of products available. The representative consumer solves the following utility maximization problem:

$$max \int_0^M u(q_i)di \text{ s.t. } \int_0^M p_i q_i di = 1 \tag{A1}$$

where $u(q_i)$ is the sub-utility associated with the consumption of q_i units of product i. We assume that this sub-utility exhibits the following properties:

$$u(q_i) \geq 0 \text{ with equality for } q_i = 0$$

$$u'(q_i) > 0 \text{ for } q_i > 0; u''(q_i) < 0 \text{ for } q_i > 0$$

We then have the following inverse residual demand function:

$$p(q_i) = \frac{u^{'}(q_i)}{\lambda} \tag{A2}$$

where $\lambda = \int_0^M u'(q_i)q_i di$ is the marginal utility of income or the aggregate demand shifter. The revenue curve $(r(q_i))$ as well as the marginal revenue curve $(\psi(q_i))$ can be expressed as:

$$r(q_i) = p(q_i)q_i = \frac{u^{'}(q_i)q_i}{\lambda} \tag{A3}$$

$$\psi(q_i) = \frac{u^{'}(q_i) + u^{''}(q_i)q_i}{\lambda} \tag{A4}$$

As in Mayer et al. (2020), we define the elasticities of inverse demand and of marginal revenue, respectively, as:

$$\epsilon_p(q_i) = -\frac{p'(q_i)}{p(q_i)}q_i \quad and \quad \epsilon_\psi(q_i) = -\frac{\psi'(q_i)}{\psi(q_i)}q_i$$

Following Mayer et al. (2020), the choices of preferences satisfy $0 \leq \epsilon_p(q_i) < 1$ and $\epsilon_\psi(q_i) > 0$ for $q_i \leq 0$.

We start our devriation from Equation (6), which depicts the the marginal cost of producing firm φ's product m:

74 The MSLD condition implies that the price elasticity of demand decreases with consumption. Please see more details in Mayer et al. (2020).

$$c_l\left(m,\varphi\right)=\omega^{m}\varphi^{-1}\left[\zeta\Theta_l\right]^{-1/\theta} \tag{A5}$$

where $\Theta_l = T_l + T_h\left(\tau^i_{hl}\right)^{-\theta}$ is the sourcing capability, $\zeta = \left[\Gamma\left(\frac{\theta+1-\rho}{\theta}\right)\right]^{\theta/(1-\rho)}$ and Γ is the Gamma function.[75]

The profit maximization condition of firms in country l implies that the marginal revenue of exporting a product from country l to country h equals the marginal cost multiplied by the output-tariff:

$$\psi_{lh}(q(m,\varphi))=\tau^o_{lh}c_l\left(m,\varphi\right) \tag{A6}$$

Differentiating the logarithm of Equation (A3) with respect to the logarithm of country l's imported-input tariff τ^i_{hl}, we have[76]:

$$\begin{aligned}
\frac{\partial log(r_{lh}\left(m,\varphi\right))}{\partial log(\tau^i_{hl})} &= \frac{\partial r(m,\varphi)}{\partial \tau^i_{lh}}\frac{\tau^i_{lh}}{r(m,\varphi)}\\
&= \frac{\partial q(m,\varphi)}{\partial \tau^i_{lh}}p(m,\varphi)\left[p'(q(m,\varphi))\frac{q(m,\varphi)}{p(m,\varphi)}+1\right]\frac{\tau^i_{lh}}{r(m,\varphi)}\\
&= \frac{\partial log(q(m,\varphi))}{\partial log(\tau^i_{lh})}\left[p'(q(m,\varphi))\frac{q(m,\varphi)}{p(m,\varphi)}+1\right] && \text{(A7)}\\
&= -\frac{1}{\epsilon_{\psi_{lh}}(q(m,\varphi))}\left[1-\epsilon_p(q(m,\varphi))\right]\frac{T_h(\tau^i_{hl})^{-\theta}}{\Theta_l} && \text{(A8)}
\end{aligned}$$

Since $0 \leq \epsilon_p(q_i) < 1$ and $\epsilon_{\psi_{lh}}(q_i) > 0$, we have $\frac{\partial log(r_{lh}(m,\varphi))}{\partial log(\tau^i_{hl})} < 0$. This implies that an input-tariff reduction leads to an increase of firms' export revenue.

Next, we consider such effect on the adjustment of firms' export product mix by further differentiating Equation (A8) with respect to the log of product

75 Similarly, all firms in country l share the same sourcing capability Θ_l.

76 By differentiating Equation (A6) with respect to τ^i_{hl}, one could easily obtain that $\frac{\partial log(q(m,\varphi))}{\partial log(\tau^i_{lh})} = -\frac{1}{\epsilon_{\psi_{lh}}(q(m,\varphi))}\frac{T_h(\tau^i_{hl})^{-\theta}}{\Theta_l}$. Since $p'(q(m,\varphi))\frac{q(m,\varphi)}{p(m,\varphi)}+1 = 1-\epsilon_p(q(m,\varphi))$, it's straightforward to get Equation (A8) from Equation (A7).

rank m. Then, we have[77]:

$$\frac{\partial^2 log(r_{lh}(m,\varphi))}{\partial log(\tau^i_{hl})\partial logm} = \frac{T_h(\tau^i_{hl})^{-\theta}}{\Theta_l} \times \frac{\partial q(m,\varphi)}{\partial logm} \times \frac{\epsilon'_p(q(m,\varphi))\epsilon_{\psi_{lh}}(q(m,\varphi)) + \epsilon'_{\psi_{lh}}(q(m,\varphi))(1-\epsilon_p(q(m,\varphi)))}{\epsilon^2_{\psi_{lh}}(q(m,\varphi))} \tag{A9}$$

$$= \frac{T_h(\tau^i_{hl})^{-\theta}}{\Theta_l} \times \frac{\tau^0_{lh} c_l(m,\varphi) mln\omega}{\psi'_{lh}(q(m,\varphi))} \times \frac{\epsilon'_p(q(m,\varphi))\epsilon_{\psi_{lh}}(q(m,\varphi)) + \epsilon'_{\psi_{lh}}(q(m,\varphi))(1-\epsilon_p(q(m,\varphi)))}{\epsilon^2_{\psi_{lh}}(q(m,\varphi))} \tag{A10}$$

Following Mayer et al. (2020), we suppose the shapes of demand and marginal revenue satisfy the following conditions that are related to MSLD[78]:

$$\begin{aligned} &\textbf{(MLSD)} \quad \epsilon'_p(q_i) > 0 \text{ for } q_i > 0 \\ &\textbf{(MLSD')} \quad \epsilon'_{\psi_{lh}}(q_i) > 0 \text{ for } q_i > 0 \end{aligned} \tag{A11}$$

Then, we can easily obtain that $\frac{\partial^2 log(r_{lh}(m,\varphi))}{\partial log(\tau^i_{hl})\partial logm} < 0$. In other words, our theoretical propositions in the main text still hold under a rather general demand function:

PROPOSITION A1. *An imported input-tariff cut will increase the export revenue and such effect is larger for peripheral products (i.e. higher m).*

A2. Model Extension: Relax the assumption of fixed choke price p_h^{max}

We make the simplified assumption that the input-tariff reduction would not affect the choke price of foreign country (p_h^{max}) in Section 2 in the main text. In this section, we show that our theoretical propositions still hold if we relax this assumption.

By definition, the demand for the marginal variety $q_{ll}(\phi_{ll})$ in the domestic market is zero and so the marginal cost cutoff is given by $c_{ll} = p_{ll}(\phi_{ll}) = p_l^{\max}$, which still satisfies Equation (6). Correspondingly, firms' domestic

77 By differentiating Equation (A6) to the log of product rank $logm$, one could easily obtain that $\frac{\partial q(m,\varphi)}{\partial logm} = \frac{\psi_{lh}(q(m,\varphi))}{\psi'_{lh}(q(m,\varphi))} mln\omega = \frac{\tau^0_{lh} c_l(m,\varphi) mln\omega}{\psi'_{lh}(q(m,\varphi))}$. Then, it becomes much straightforward to get Equation (A10) from Equation (A9).

78 Assumption (MSLD') is more restrictive than (MSLD), and Mayer et al. (2016) provides a detailed proof in the appendix which shows that (MSLD') implies (MSLD).

performance measures, price ($p_{ll}(\phi)$), quantity ($q_{ll}(\phi)$), revenue ($r_{ll}(\phi)$) and profit ($\pi_{ll}(\phi)$), are respectively given by:

$$
\begin{aligned}
p_{ll}(\phi) &= \frac{1}{2}\left[c_{ll} + c_l(\phi)\right] = \frac{[\zeta\Theta_l]^{-1/\theta}}{2}\left[\frac{1}{\phi_{ll}} + \frac{1}{\phi}\right] \\
q_{ll}(\phi) &= \frac{L_l}{2\gamma}\left[c_{ll} - c_l(\phi)\right] = \frac{L_l[\zeta\Theta_l]^{-1/\theta}}{2\gamma}\left[\frac{1}{\phi_{ll}} - \frac{1}{\phi}\right] \\
r_{ll}(\phi) &= \frac{L_l}{4\gamma}\left[c_{ll}^2 - c_l^2(\phi)\right] = \frac{L_l[\zeta\Theta_l]^{-2/\theta}}{4\gamma}\left[\frac{1}{\phi_{ll}^2} - \frac{1}{\phi^2}\right] \\
\pi_{ll}(\phi) &= \frac{L_l}{4\gamma}\left[c_{ll} - c_l(\phi)\right]^2 = \frac{L_l[\zeta\Theta_l]^{-2/\theta}}{4\gamma}\left[\frac{1}{\phi_{ll}} - \frac{1}{\phi}\right]^2
\end{aligned}
\tag{A12}
$$

Similarly, in the foreign market h, there is the marginal cost cutoff c_{hh}, which corresponds to the variety-specific productivity cutoff ϕ_{hh} and firm productivity cutoff φ_{hh}. Maximization of firms' export profit $\pi_{lh}(\phi) = (p_{lh}(\phi) - \tau_{lh}^o c_l(\phi))\, q_{lh}(\phi)$ then yields:

$$p_{lh}(\phi) = \frac{1}{2}\left(c_{hh} + \tau_{lh}^o c_l(\phi)\right) = \frac{\tau_{lh}^o[\zeta\Theta_l]^{-1/\theta}}{2}\left[\frac{1}{\phi_{lh}} + \frac{1}{\phi}\right] \tag{A13}$$

$$q_{lh}(\phi) = \frac{L_h}{2\gamma}\left[c_{hh} - \tau_{lh}^o c_l(\phi)\right] = \frac{L_h\tau_{lh}^o[\zeta\Theta_l]^{-1/\theta}}{2\gamma}\left[\frac{1}{\phi_{lh}} - \frac{1}{\phi}\right] \tag{A14}$$

$$r_{lh}(\phi) = \frac{L_h}{4\gamma}\left[c_{hh}^2 - \left(\tau_{lh}^o c_l(\phi)\right)^2\right] = \frac{L_h\left(\tau_{lh}^o[\zeta\Theta_l]^{-1/\theta}\right)^2}{4\gamma}\left[\frac{1}{\phi_{lh}^2} - \frac{1}{\phi^2}\right] \tag{A15}$$

$$\pi_{lh}(\phi) = \frac{L_h}{4\gamma}\left[c_{hh} - \tau_{lh}^o c_l(\phi)\right]^2 = \frac{L_h\left(\tau_{lh}^o[\zeta\Theta_l]^{-1/\theta}\right)^2}{4\gamma}\left[\frac{1}{\phi_{lh}} - \frac{1}{\phi}\right]^2 \tag{A16}$$

where ϕ_{lh} is the productivity cutoff of a variety exported from country l to country h, which corresponds to the marginal cost inclusive of the trade cost $\tau_{lh}^o c_{lh} = \frac{\tau_{lh}^o[\zeta\Theta_l]^{-1/\theta}}{\phi_{lh}}$. By construction, this marginal cost inclusive of the trade cost should equal to the maximum price in the foreign market, i.e., $\tau_{lh}^o c_{lh} = p_h^{\max} = c_{hh} = \frac{[\zeta\Theta_h]^{-1/\theta}}{\phi_{hh}}$. Hence, the variety-specific productivity cutoff satisfies:

$$\phi_{lh} = \frac{\tau_{lh}^o[\zeta\Theta_l]^{-1/\theta}}{[\zeta\Theta_h]^{-1/\theta}}\phi_{hh} \tag{A17}$$

Since firms with core productivity $\varphi < \phi_{lh}$ cannot profitably sell any variety in the foreign market, including their core variety, the threshold $\varphi_{lh} = \phi_{lh}$ is also the domestic firms' export productivity cutoff. Hence, we also have:

$$\varphi_{lh} = \frac{\tau_{lh}^{o} \left[\zeta \Theta_{l}\right]^{-1/\theta}}{\left[\zeta \Theta_{h}\right]^{-1/\theta}} \varphi_{hh} \tag{A18}$$

All the results derived so far hold for any distribution of core productivity draw $G(\varphi)$. To simplify the analysis, we assume that core productivity φ is drawn from a Pareto distribution with the scale parameter $\varphi_{\min}$ and shape parameter $k \geq 1$, given by:

$$G(\varphi) = 1 - \left(\frac{\varphi}{\varphi_{\min}}\right)^{-k}, \ \ \varphi \in [\varphi_{\min}, \infty).$$

The shape parameter k indicates the dispersion of productivity draws. Any truncation of the productivity distribution from below will increase $\varphi_{\min}$ but retain the same distribution function and shape parameter k. The productivity distribution of surviving firms will therefore also be Pareto with shape k, and the truncated productivity distribution for the domestic producing and the exporting firm are respectively:

$$G_{ll}(\varphi) = 1 - \left(\frac{\varphi}{\varphi_{ll}}\right)^{-k}; \ \ G_{lh}(\varphi) = 1 - \left(\frac{\varphi}{\varphi_{lh}}\right)^{-k}$$

We can then define a firm's total profits from the domestic and export markets by aggregating over these varieties:

$$\Pi_{ll}(\varphi) = \sum_{m=0}^{M_{ll}(\varphi)-1} \pi_{ll}(\phi(m, \varphi)); \quad \Pi_{lh}(\varphi) = \sum_{m=0}^{M_{lh}(\varphi)-1} \pi_{lh}(\phi(m, \varphi))$$

where the total number of varieties produced and sold in the domestic market by a firm with productivity φ, $M_{ll}(\varphi)$, and the total number of varieties domestically produced and exported to the foreign market, $M_{lh}(\varphi)$, are respectively given by:

$$M_{ll}(\varphi) = \begin{cases} 0 & \text{if } \varphi < \varphi_{ll} \\ \max\{m | \varphi \geq \omega^{-m} \varphi_{ll}\} + 1 & \text{if } \varphi \geq \varphi_{ll} \end{cases} \tag{A19}$$

$$M_{lh}(\varphi) = \begin{cases} 0 & \text{if } \varphi < \varphi_{lh} \\ \max\{m | \varphi \geq \omega^{-m} \varphi_{lh}\} + 1 & \text{if } \varphi \geq \varphi_{lh} \end{cases} \tag{A20}$$

Now, the free entry condition implies that the sunk cost equals each potential entrant's expected profits:

$$
\begin{aligned}
f_e &= \int_{\varphi_{ll}}^{\infty} \Pi_{ll}(\varphi)\, dG(\varphi) + \int_{\varphi_{lh}}^{\infty} \Pi_{lh}(\varphi)\, dG(\varphi) \\
&= \int_{\varphi_{ll}}^{\infty} \sum_{m=0}^{M_{ll}(\varphi)} \pi_{ll}(\phi(m,\varphi))\, dG(\varphi) + \int_{\varphi_{lh}}^{\infty} \sum_{m=0}^{M_{lh}(\varphi)} \pi_{lh}(\phi(m,\varphi))\, dG(\varphi) \\
&= \sum_{m=0}^{\infty} \int_{\omega^{-m}\varphi_{ll}}^{\infty} \pi_{ll}(\phi(m,\varphi))\, dG(\varphi) + \sum_{m=0}^{\infty} \int_{\omega^{-m}\varphi_{lh}}^{\infty} \pi_{lh}(\phi(m,\varphi))\, dG(\varphi) \\
&= \frac{\Omega \varphi_{\min}^{k}}{2\gamma(k+1)(k+2)} \left[L_l [\zeta\Theta_l]^{-2/\theta} \varphi_{ll}^{-k-2} + L_h (\tau_{lh}^{o})^2 [\zeta\Theta_l]^{-2/\theta} \varphi_{lh}^{-k-2} \right] \\
&= \frac{\Omega \varphi_{\min}^{k}}{2\gamma(k+1)(k+2)} \left[L_l [\zeta\Theta_l]^{-2/\theta} \varphi_{ll}^{-k-2} + L_h [\zeta\Theta_h]^{-2/\theta} \left(\frac{\tau_{lh}^{o} [\zeta\Theta_l]^{-1/\theta}}{[\zeta\Theta_h]^{-1/\theta}} \right)^{-k} \varphi_{hh}^{-k-2} \right]
\end{aligned}
$$

In the expressions above, $\Omega = \sum_{m=0}^{\infty} \omega^{mk} = \left(1-\omega^k\right)^{-1} < 1$.[79] The two free-entry conditions above (one for each country) forms a 2x2 system which can then be solved for the domestic productivity cutoffs in both countries:

$$
\varphi_{ll}^{-k-2} = \frac{2\gamma(k+1)(k+2)\varphi_{\min}^{-k} f_e}{\Omega L_l [\zeta\Theta_l]^{-2/\theta}} \frac{1 - \left[\frac{\tau_{lh}^{o}[\zeta\Theta_l]^{-1/\theta}}{[\zeta\Theta_h]^{-1/\theta}}\right]^{-k}}{1 - \left(\tau_{lh}^{o}\tau_{hl}^{o}\right)^{-k}} \tag{A21}
$$

$$
\varphi_{hh}^{-k-2} = \frac{2\gamma(k+1)(k+2)\varphi_{\min}^{-k} f_e}{\Omega L_h [\zeta\Theta_h]^{-2/\theta}} \frac{1 - \left[\frac{\tau_{hl}^{o}[\zeta\Theta_h]^{-1/\theta}}{[\zeta\Theta_l]^{-1/\theta}}\right]^{-k}}{1 - \left(\tau_{lh}^{o}\tau_{hl}^{o}\right)^{-k}} \tag{A22}
$$

From (A18), (A21) and (A22), we have:

$$
\varphi_{lh}^{-k-2} = \frac{2\gamma(k+1)(k+2)[\zeta\Theta_l]^{2/\theta} f_e}{\Omega L_h \left(\tau_{lh}^{o}\right)^2 \varphi_{\min}^{k}} \frac{\left[\frac{\tau_{lh}^{o}[\zeta\Theta_l]^{-1/\theta}}{[\zeta\Theta_h]^{-1/\theta}}\right]^{-k} - \left(\tau_{lh}^{o}\tau_{hl}^{o}\right)^{-k}}{1 - \left(\tau_{lh}^{o}\tau_{hl}^{o}\right)^{-k}} \tag{A23}
$$

$$
\varphi_{hl}^{-k-2} = \frac{2\gamma(k+1)(k+2)[\zeta\Theta_h]^{2/\theta} f_e}{\Omega L_h \left(\tau_{hl}^{o}\right)^2 \varphi_{\min}^{k}} \frac{\left[\frac{\tau_{hl}^{o}[\zeta\Theta_h]^{-1/\theta}}{[\zeta\Theta_l]^{-1/\theta}}\right]^{-k} - \left(\tau_{lh}^{o}\tau_{hl}^{o}\right)^{-k}}{1 - \left(\tau_{lh}^{o}\tau_{hl}^{o}\right)^{-k}} \tag{A24}
$$

The lower bound of the productivity level is $\varphi_{\min}$. The necessary condition to guarantee that φ_{ll}, φ_{hh}, φ_{lh} and φ_{hl} are larger than this lower bound is $\left(\tau_{lh}^{o}\tau_{hl}^{o}\right)^{-k} < \left[\frac{\tau_{lh}^{o}[\zeta\Theta_l]^{-1/\theta}}{[\zeta\Theta_h]^{-1/\theta}}\right]^{-k} < 1$. This condition, which is equivalent to

79 Variable Ω indicates multi-product flexibility that increases with ω.

$(\tau^o_{lh})^{-1} < \frac{[\zeta\Theta_l]^{-1/\theta}}{[\zeta\Theta_h]^{-1/\theta}} < \tau^o_{hl}$, implies that φ_{ll}, φ_{hh}, φ_{lh} and φ_{hl} are at least larger than 0.[80]

Since now we relax the assumption of fixed choke price p^{max}_h, the output-tariff reduction can also affect the product mix now in the current setting. Therefore, a reduction in the imported-input tariff τ^i_{hl} and a reduction in the imported-output tariff τ^o_{hl} would both result in a change in the export value, according to the Equation (A15), which satisfies the following equation:

$$\Delta \log r_{lh} = 2\left[1-\left(\frac{1}{k+2}\right)\frac{\varphi_{lh}^{-2}}{\varphi_{lh}^{-2}-\omega^{-2m}\varphi^{-2}}\left(2+\frac{k}{1-\left[\frac{\tau^o_{hl}[\zeta\Theta_h]^{-1/\theta}}{[\zeta\Theta_l]^{-1/\theta}}\right]^{-k}}\right)\right]\frac{\Delta\log\tau^i_{hl}}{\frac{T_l}{T_h}\left(\tau^i_{hl}\right)^{\theta}+1} \tag{A25}$$

$$-\frac{2\varphi_{lh}^{-2}}{\varphi_{lh}^{-2}-\omega^{-2m}\varphi^{-2}}\left(\frac{k}{k+2}\right)\left(\frac{\left(\tau^o_{lh}\tau^o_{hl}\right)^{-k}}{1-\left(\tau^o_{lh}\tau^o_{hl}\right)^{-k}}-\frac{\left(\tau^o_{lh}\tau^o_{hl}\right)^{-k}}{\left[\frac{\tau^o_{lh}[\zeta\Theta_l]^{-1/\theta}}{[\zeta\Theta_h]^{-1/\theta}}\right]^{-k}-\left(\tau^o_{lh}\tau^o_{hl}\right)^{-k}}\right)\Delta\log\tau^o_{hl}$$

Note that the coefficient of $\Delta\log\tau^i_{hl}$ in Equation (A25) is negative, since $\left[\frac{\tau^o_{hl}[\zeta\Theta_h]^{-1/\theta}}{[\zeta\Theta_l]^{-1/\theta}}\right]^{-k} < 1$.[81] In other words, the reduction in the imported-input tariff leads to increases in the values of exported products. The strength of these effects rises with the distance from the core competency. This is because $\frac{\varphi_{lh}^{-2}}{\varphi_{lh}^{-2}-\omega^{-2m}\varphi^{-2}}$ increases as m increases. In other words, our theoretical prediction about the effect of input-tariff reduction in the main text continues to hold:

PROPOSITION A2. *A reduction in the imported-input tariff will cause a higher percentage increase in the export revenue for the products that are further from firm's core competency.*

80 This condition is a mild condition. As $\Theta_l = T_l + T_h\left(\tau^i_{hl}\right)^{-\theta}$ and $\Theta_h = T_h + T_l\left(\tau^i_{lh}\right)^{-\theta}$, we can rewrite $\left(\tau^o_{lh}\right)^{-1} < \frac{[\zeta\Theta_l]^{-1/\theta}}{[\zeta\Theta_h]^{-1/\theta}} < \tau^o_{hl}$ as $\left(\tau^o_{lh}\right)^{-1} < \left(\frac{T_l+T_h\left(\tau^i_{hl}\right)^{-\theta}}{T_h+T_l\left(\tau^i_{lh}\right)^{-\theta}}\right)^{-1/\theta} < \tau^o_{hl}$. When $T_l = T_h$ and $\tau^i_{hl} = \tau^i_{lh}$, it is equivalent to $\tau^o_{hl} > 1 > \left(\tau^o_{lh}\right)^{-1}$, which is always satisfied.

81 When $\left[\frac{\tau^o_{hl}[\zeta\Theta_h]^{-1/\theta}}{[\zeta\Theta_l]^{-1/\theta}}\right]^{-k} < 1$,

$$\left(\frac{1}{k+2}\right)\frac{\varphi_{lh}^{-2}}{\varphi_{lh}^{-2}-\omega^{-2m}\varphi^{-2}}\left(2+\frac{k}{1-\left[\frac{\tau^o_{hl}[\zeta\Theta_h]^{-1/\theta}}{[\zeta\Theta_l]^{-1/\theta}}\right]^{-k}}\right) > \frac{\varphi_{lh}^{-2}}{\varphi_{lh}^{-2}-\omega^{-2m}\varphi^{-2}} > 1.$$

In contrast, the coefficient of $\Delta \log \tau^o_{hl}$ in the Equation (A25) is negative, since $\left[\frac{\tau^o_{lh}[\zeta\Theta_l]^{-1/\theta}}{[\zeta\Theta_h]^{-1/\theta}}\right]^{-k} < 1$. That is to say, a reduction in the imported-output tariff will increase the export productivity cutoff φ_{lh}. Put differently, the reduction in the imported-output tariff would lead to a decrease in the values of exported products, especially for the products that are further away from firm's core competency. Hence we have the following proposition on the effect of output-tariff reduction.[82]

PROPOSITION A3. *Incontrast to the effect of input-tariff reduction, a reduction in the imported-output tariff will cause a higher percentage reduction in the export revenue for the products that are further away from the firm's core competency.*

Appendix A2: Measurement of Productivity

Here in this section, we discribe the details of the estimation process of firm-level total factor productivity. We start from the following production function.[83]

$$y_{ft} = \beta_l l_{ft} + \beta_k k_{ft} + \beta_{ll} l^2_{ft} + \beta_{kk} k^2_{ft} + \beta_{lk} l_{ft} k_{ft} + \omega_{ft} + \epsilon_{ft} \tag{A26}$$

where y_{ft} denotes the value-added of firm f's production output in year t. l_{ft} and k_{ft} represent the input of labor and capital in firms' production. ω_{ft} is firm-level productivity to be estimated, and ϵ_{ft} is the measurement error or unanticipated shocks. All the variables in the above production function are in the form of logarithm. Firms' inputs (e.g., capital) and value-added are deflated using the input-price deflators and output-price deflators from Brandt et al. (2012).[84]

Following Levinsohn and Petrin (2003), we assume that firms' input of material depends on firms' input of labor and capital, firm-level productivity and a vector of other firm-level decisions Z_{ft}[85]:

82 Positively significant coefficients of the interaction terms between output-tariff reduction and the product rank ($\Delta\tau_{out}$ × Rank) in columns (1)-(2) in Table 2 and Table A4 further convince the theoretical analysis here.

83 Our results still hold if we adopt a Cobb-Douglas production function.

84 Specifically, the output deflators are constructed using "reference price" information from China's Statistical Yearbooks, and the input deflators are constructed based on output deflators and China's national input-output table (2002). These data can be accessed via http://www.econ.kuleuven.be/public/N07057/CHINA/appendix/. We construct the real investment variable by adopting the perpetual inventory method to investigate the law of motion for real capital and real investment. To measure the depreciation rate, we use each firm's real depreciation rate provided by the NBSC firm-production database.

85 We also adopt the ACF augmented O-P method to estimate the firm-level productivity by inverting an intermediate input demand function instead of the investment demand function. Our results still hold.

$$m_{ft} = m(l_{ft}, k_{ft}, \omega_{ft}, z_{ft}) \tag{A27}$$

To be specific, this vector z_{ft} includes both the changes of industry-level input-tariff and the output-tariff (τ^I_{it-1} and τ^O_{it-1}) to control for the shock of trade liberalization on firms' export (import) decisions. Moreover, since related studies (see Section 4) in the main text illustrate that the improvement of firms' average productivity is less for the firms that export more varieties once the imported tariff is lowered, we also control the firms' number of products (N_{ft}).

Under the assumption that there exist a monotonic relationship between m_{it} and ω_{it}, we can invert this function to obtain the following expression as a proxy for firm-level productivity (ω_{ft}):

$$\omega_{ft} = h_t(l_{ft}, k_{ft}, m_{ft}, z_{ft}) \tag{A28}$$

Thus, the production function (A26) could be rewritten as:

$$y_{ft} = \Phi(l_{ft}, k_{ft}, m_{ft}, z_{ft}) + \epsilon_{ft} \tag{A29}$$

Therefore, we could estimate the firm-level productivity in the following two steps.

In the fisrt stage, we approximate the function $\Phi(.)$ using a second order polynomial of capital, labor intermediate inputs as well as the interactions of the terms in the polynomial, with the above variables related to firm-level decisions, including the changes of industry-level input and output tariffs and firms' number of exported products. Besides, we also control the 4-digit industry fixed effect in the vector z_{it}. After that, we can obtain the predicted value ($\tilde{\Phi}_{ft}$) of $\Phi_{ft}(.)$, and estimate firm-level productivity using the following function, given each value of the vector $\beta = (\beta_l, \beta_k, \beta_{ll}, \beta_{kk}, \beta_{lk})$:

$$\omega_{ft}(\beta) = \tilde{\Phi}_{ft} - \beta_l l_{ft} - \beta_k k_{ft} - \beta_{ll} l^2_{ft} - \beta_{kk} k^2_{ft} - \beta_{lk} l_{ft} k_{ft} \tag{A30}$$

Now in the second stage, we estimate the vector β by assuming that productivity ω_{ft} follows a Markov process over time:

$$\begin{aligned} \omega_{ft} &= g(\omega_{ft-1}) + \xi_{ft} \\ &= \gamma_1 \omega_{ft-1} + \gamma_2 \tau^O_{it-1} + \gamma_2 \tau^I_{it-1} + \gamma_N N_{ft} + \xi_{ft} \end{aligned} \tag{A31}$$

We can estimate the above linear Equation (A31) to obtain the predicted value of $\hat{\xi}_{ft}$, which is a function of β. Given the Markov assumption, we can then estimate all the predicted values of vector β using the following moment condition:

$$E(\xi_{ft} T_{ft}) = 0 \tag{A32}$$

where vector T_{ft} includes the lagged variable of labor, current capital as well as the quardratic terms and the interaction terms.

Appendix A3: More Figures and Tables

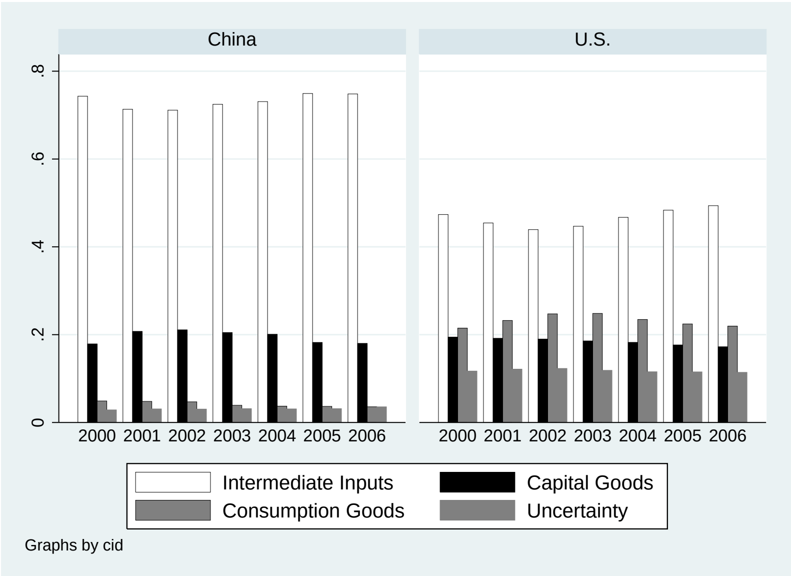

FIGURE A1 Import Composition of China and the U.S. (2000-2006)

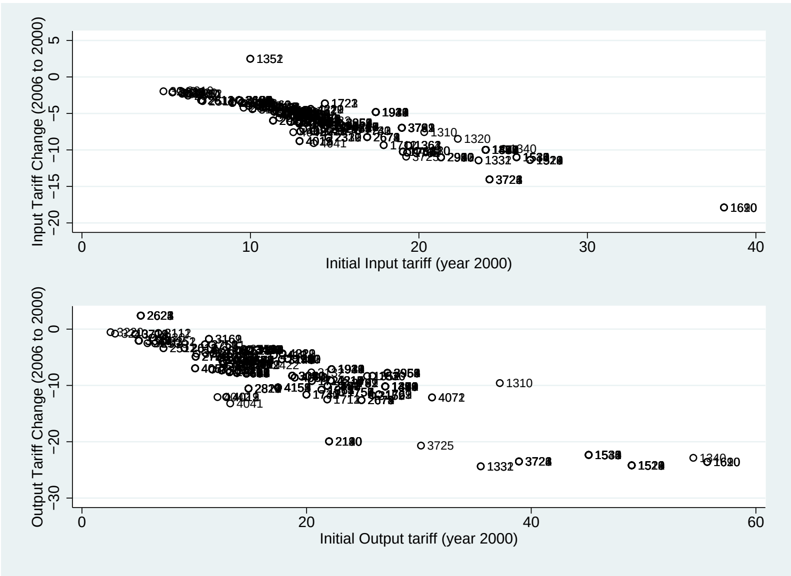

FIGURE A2 Initial Imported Tariffs and Tariff Cuts in China (2000-2006)

TABLE A1
Descriptive Statistics

	Obs	Mean	Median	S. D.
		Firm-Product-Year Level		
log(Export Value)	141,788	11.377	11.612	2.478
TFP	141,788	6.499	6.467	0.929
Wage	141,788	2.583	2.539	0.582
Firm Size	141,788	5.745	5.704	1.123
Capital Intensity	141,788	81.288	54.442	108.026
		Firm-Country-Product-Year Level		
log(Export Value)	329,739	10.622	10.763	2.186
TFP	329,739	6.573	6.536	0.925
Wage	329,739	2.601	2.548	0.586
Firm Size	329,739	5.875	5.838	1.145
Capital Intensity	329,739	84.914	55.325	115.781

Notes: The top panel is for the sample in firm-product-year level while the bottom panel is in the firm-product-country-year level. As we aggregate the sample from firm-product-country-year level to firm-product-year level, the sample size in the top panel is only about half of the full sample size in the bottom panel (firm-product-country-year level).

TABLE A2
Effect of Trade Liberalization on Export Value across Products (using Weighted Tariff)

	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta\tau_{in}$	0.027	-0.008	-0.013	0.026	-0.008	-0.013
	(0.026)	(0.014)	(0.014)	(0.025)	(0.013)	(0.014)
$\Delta\tau_{in}$ × Rank	-0.050***	-0.032***	-0.022**	-0.050***	-0.032***	-0.023**
	(0.015)	(0.010)	(0.010)	(0.015)	(0.010)	(0.010)
$\Delta\tau_{out}$	-0.025	0.005	-0.000	-0.024	0.005	-0.000
	(0.020)	(0.010)	(0.011)	(0.021)	(0.010)	(0.011)
$\Delta\tau_{out}$ × Rank	0.027*	0.014+	0.012	0.027*	0.014	0.012
	(0.016)	(0.009)	(0.009)	(0.016)	(0.010)	(0.009)
Rank	0.395***	0.413***	0.510***	0.395***	0.412***	0.509***
	(0.028)	(0.016)	(0.017)	(0.029)	(0.016)	(0.017)
Other Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	No	No	No
Owntype-Year FE	No	No	No	Yes	Yes	Yes
Firm FE	Yes	Yes	No	Yes	Yes	No
Country FE	No	Yes	No	No	Yes	No
Firm-Country FE	No	No	Yes	No	No	Yes
Observations	141,788	329,739	284,128	141,788	329,739	284,128
R^2	0.163	0.112	0.237	0.164	0.112	0.237
Adjusted R^2	0.057	0.062	0.025	0.057	0.062	0.025

Notes: * $p < 0.1$, **$p < 0.05$, *** $p < 0.01$. Dependent variable in columns (1) and (4) is changes of firm-product export value while in other columns, dependent variable is changes of firm-product-country export value. Other controls include firm-level productivity, the firm-level capital-labor ratio, the firm-level average wage and firm size (measured by total employment). All the standard errors are clustered at the industry level.

TABLE A3
Effect of Trade Liberalization on Export Values

	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta\tau_{in}$	-0.026⁎	-0.026**	-0.026*	-0.028*	-0.027**	-0.026*
	(0.016)	(0.012)	(0.014)	(0.016)	(0.012)	(0.014)
$\Delta\tau_{out}$	0.004	0.013	0.007	0.004	0.013	0.007
	(0.013)	(0.010)	(0.011)	(0.013)	(0.010)	(0.011)
Other Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	No	No	No
Owntype-Year FE	No	No	No	Yes	Yes	Yes
Firm FE	Yes	Yes	No	Yes	Yes	No
Country FE	No	Yes	No	No	Yes	No
Firm-Country FE	No	No	Yes	No	No	Yes
Observations	141,788	329,739	284,128	141,788	329,739	284,128
R^2	0.163	0.112	0.237	0.163	0.112	0.237
Adjusted R^2	0.056	0.062	0.025	0.057	0.062	0.025

Notes: ⁎ $p < 0.15$, * $p < 0.1$, **$p < 0.05$, *** $p < 0.01$. Dependent variable in columns (1) and (4) is changes of firm-product export value while in other columns, dependent variable is changes of firm-product-country export value. Other controls include the product rank, firm-level productivity, the firm-level capital-labor ratio, the firm-level average wage and firm size (measured by total employment). All the standard errors are clustered at the industry level.

TABLE A4
Effect of Trade Liberalization on Export Value across Products (Important Trading Partners)

	Key Exporters (A)		Key Importers (A)		Key Exporters (B)		Key Importers (B)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta\tau_{in}$	0.021	0.024	0.009	0.009	0.008	0.010	-0.005	0.001
	(0.018)	(0.019)	(0.017)	(0.019)	(0.017)	(0.018)	(0.017)	(0.020)
$\Delta\tau_{in}$ × Rank	-0.049***	-0.040***	-0.056***	-0.053***	-0.060***	-0.052***	-0.057***	-0.056***
	(0.013)	(0.015)	(0.016)	(0.016)	(0.015)	(0.018)	(0.017)	(0.018)
$\Delta\tau_{out}$	0.008	0.004	0.005	0.004	0.013	0.006	0.009	0.006
	(0.014)	(0.014)	(0.015)	(0.017)	(0.015)	(0.016)	(0.015)	(0.016)
$\Delta\tau_{out}$ × Rank	0.020*	0.020*	0.023*	0.026*	0.027**	0.027*	0.028*	0.031**
	(0.012)	(0.012)	(0.013)	(0.014)	(0.013)	(0.014)	(0.015)	(0.015)
Rank	0.418***	0.493***	0.412***	0.495***	0.428***	0.520***	0.427***	0.509***
	(0.021)	(0.018)	(0.019)	(0.018)	(0.017)	(0.018)	(0.018)	(0.017)
Other Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Owntype-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	No	Yes	No	Yes	No	Yes	No
Country FE	Yes	No	Yes	No	Yes	No	Yes	No
Firm-Country FE	No	Yes	No	Yes	No	Yes	No	Yes
Observations	155,009	136,535	145,905	127,663	141,570	122,536	150,373	129,998
R-squared	0.143	0.234	0.143	0.243	0.143	0.248	0.141	0.246
Adjusted R-squared	0.058	0.034	0.057	0.031	0.057	0.026	0.059	0.026

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. * denotes a significance level of 12%. Dependent variable is changes of firm-product-country export value. Other controls include firm-level productivity, the firm-level capital-labor ratio, the firm-level average wage and firm size (measured by total employment). All the standard errors are clustered at the industry level. The important countries (Key Exporters/Importers) are selected based on their trade-independence on China. Specifically, for each Chinese trading partner, for instance the U.S., we compute the share of goods exported to (imported from) China in U.S. exports (imports). We then rank these shares across all China's trading partners, and countries of which exporting shares exceeding the median are defined as the Key Exporters (A) (corresponding to columns (1)-(2)). Key Importers (A) then represent the countries of which importing shares are above the median. Similarly, we could define the Key Exporters (B) (Key Importers (B)) by changing the denominator of the shares from the total value of exported (imported) goods in the trading partners to the GDP of this trading partner. Related results are correspondingly reported in columns (5)-(6) and (7)-(8).

TABLE A5
Effect of Trade Liberalization on Export Value across Products using Instrumental Variables (1st-Stage Results of Table 7)

	Column (1) in Table 7				Column (2) in Table 7				Column (3) in Table 7			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	$\Delta\tau_{in}$	$\Delta\tau_{in}$ × Rank	$\Delta\tau_{out}$	$\Delta\tau_{out}$ × Rank	$\Delta\tau_{in}$	$\Delta\tau_{in}$ × Rank	$\Delta\tau_{out}$	$\Delta\tau_{out}$ × Rank	$\Delta\tau_{in}$	$\Delta\tau_{in}$ × Rank	$\Delta\tau_{out}$	$\Delta\tau_{out}$ × Rank
Input_tariff#1999	-0.104***	-0.064***	-0.010	-0.076**	-0.100***	-0.038**	-0.029	-0.043**	-0.100***	-0.040**	-0.030	-0.051**
	(0.008)	(0.019)	(0.024)	(0.038)	(0.009)	(0.016)	(0.020)	(0.020)	(0.010)	(0.017)	(0.022)	(0.022)
Input_tariff#1999 × Rank	0.004***	-0.070***	0.004**	0.057*	0.002***	-0.079***	0.003*	0.025	0.003***	-0.080***	0.003	0.035
	(0.001)	(0.010)	(0.001)	(0.031)	(0.001)	(0.010)	(0.001)	(0.032)	(0.001)	(0.010)	(0.002)	(0.034)
Output_tariff#1999	0.000	-0.000	-0.073***	-0.021	-0.000	0.005	-0.063***	-0.008	-0.000	0.005	-0.062***	-0.005
	(0.004)	(0.009)	(0.013)	(0.017)	(0.004)	(0.008)	(0.012)	(0.009)	(0.005)	(0.008)	(0.013)	(0.010)
Output_tariff#1999 × Rank	-0.000	-0.000	-0.002*	-0.070***	0.000	0.003	-0.001	-0.058***	0.000	0.002	-0.001	-0.063***
	(0.001)	(0.007)	(0.001)	(0.016)	(0.001)	(0.006)	(0.001)	(0.016)	(0.001)	(0.007)	(0.001)	(0.018)
Other Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Owntype-Year FE	No	No	No	No	No	No	No	No	No	No	No	No
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No
Country FE	No	No	No	No	Yes	Yes	Yes	Yes	No	No	No	No
Firm-Country FE	No	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes
Observations	141,788	141,788	141,788	141,788	329,739	329,739	329,739	329,739	284,128	284,128	284,128	284,128
Instrument Tests												
F-statistic	115.84$^{\Psi}$	75.25$^{\Psi}$	15.94$^{\Psi}$	10.76$^{\Psi}$	79.44$^{\Psi}$	46.12$^{\Psi}$	14.00$^{\Psi}$	6.81$^{\Psi}$	81.14$^{\Psi}$	47.87$^{\Psi}$	12.59$^{\Psi}$	6.18$^{\Psi}$
Sanderson & Winderjei F-Statistic	55.18$^{\Psi}$	41.96$^{\Psi}$	44.05$^{\Psi}$	22.15$^{\Psi}$	47.04$^{\Psi}$	32.36$^{\Psi}$	34.43$^{\Psi}$	22.18$^{\Psi}$	36.98$^{\Psi}$	33.31$^{\Psi}$	28.11$^{\Psi}$	18.76$^{\Psi}$
Sanderson & Winderjei Chi-squared	62.38$^{\Psi}$	47.43$^{\Psi}$	49.79$^{\Psi}$	25.04$^{\Psi}$	49.82$^{\Psi}$	34.28$^{\Psi}$	36.47$^{\Psi}$	23.50$^{\Psi}$	47.37$^{\Psi}$	42.66$^{\Psi}$	36.00$^{\Psi}$	24.03$^{\Psi}$

To be continued (See next page).

TABLE A6
Table A5 Continued.

	Column (4) in Table 7				Column (5) in Table 7				Column (6) in Table 7			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	$\Delta\tau_{in}$	$\Delta\tau_{in}$ × Rank	$\Delta\tau_{out}$	$\Delta\tau_{out}$ × Rank	$\Delta\tau_{in}$	$\Delta\tau_{in}$ × Rank	$\Delta\tau_{out}$	$\Delta\tau_{out}$ × Rank	$\Delta\tau_{in}$	$\Delta\tau_{in}$ × Rank	$\Delta\tau_{out}$	$\Delta\tau_{out}$ × Rank
Input_tariff#1999	-0.104***	-0.063***	-0.011	-0.077**	-0.099***	-0.038**	-0.029	-0.044**	-0.101***	-0.040**	-0.031	-0.053**
	(0.008)	(0.019)	(0.025)	(0.038)	(0.009)	(0.016)	(0.019)	(0.020)	(0.010)	(0.017)	(0.021)	(0.022)
Input_tariff#1999 × Rank	0.004***	-0.070***	0.004***	0.057*	0.002***	-0.079***	0.003**	0.025	0.003***	-0.080***	0.003	0.034
	(0.001)	(0.010)	(0.001)	(0.031)	(0.001)	(0.010)	(0.001)	(0.032)	(0.001)	(0.010)	(0.002)	(0.034)
Output_tariff#1999	-0.000	-0.000	-0.072***	-0.021	0.000	0.005	-0.062***	-0.008	-0.000	0.005	-0.061***	-0.004
	(0.003)	(0.009)	(0.013)	(0.017)	(0.004)	(0.008)	(0.011)	(0.009)	(0.005)	(0.008)	(0.012)	(0.010)
Output_tariff#1999 × Rank	-0.000	-0.000	-0.002*	-0.070***	0.000	0.003	-0.001	-0.058***	0.000	0.002	-0.001	-0.063***
	(0.001)	(0.007)	(0.001)	(0.016)	(0.001)	(0.006)	(0.001)	(0.016)	(0.001)	(0.007)	(0.001)	(0.018)
Other Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	No	No	No	No	No	No	No	No	No	No	No
Owntype-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No
Country FE	No	No	No	No	Yes	Yes	Yes	Yes	No	No	No	No
Firm-Country FE	No	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes
Observations	141,788	141,788	141,788	141,788	329,739	329,739	329,739	329,739	284,128	284,128	284,128	284,128
Instrument Tests												
F-statistic	119.50$^{\Psi}$	75.13$^{\Psi}$	16.26$^{\Psi}$	11.03$^{\Psi}$	81.08$^{\Psi}$	45.69$^{\Psi}$	14.28$^{\Psi}$	6.91$^{\Psi}$	81.93$^{\Psi}$	47.38$^{\Psi}$	12.82$^{\Psi}$	6.30$^{\Psi}$
Sanderson & Winderjei F-Statistic	53.90$^{\Psi}$	42.42$^{\Psi}$	44.11$^{\Psi}$	22.17$^{\Psi}$	45.88$^{\Psi}$	31.71$^{\Psi}$	34.17$^{\Psi}$	21.89$^{\Psi}$	36.30$^{\Psi}$	32.47$^{\Psi}$	27.97$^{\Psi}$	18.70$^{\Psi}$
Sanderson & Windmeijer Chi-squared	60.93$^{\Psi}$	47.96$^{\Psi}$	49.86$^{\Psi}$	25.07$^{\Psi}$	48.59$^{\Psi}$	33.59$^{\Psi}$	36.20$^{\Psi}$	23.19$^{\Psi}$	46.50$^{\Psi}$	41.59$^{\Psi}$	35.83$^{\Psi}$	23.95$^{\Psi}$

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Ψ indicates significance at the 0.01% level (p-value < 0.0001). In the first four columns in both panels, dependent variable is changes of firm-product export value while in other columns, dependent variable is changes of the firm-product-country export value. Other controls include the product rank, firm-level productivity, the firm-level capital-labor ratio, the firm-level average wage and firm size (measured by total employment). All the standard errors are clustered at the industry level.

TABLE A7
Results of using Instrumental Variables (Alternative IV)

	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta\tau_{in}$	0.479***	0.210**	0.258**	0.476***	0.215**	0.266**
	(0.080)	(0.088)	(0.103)	(0.082)	(0.088)	(0.104)
$\Delta\tau_{in}$ × Rank	-0.201***	-0.117***	-0.103***	-0.200***	-0.116***	-0.102***
	(0.045)	(0.036)	(0.036)	(0.045)	(0.037)	(0.036)
$\Delta\tau_{out}$	-0.145**	-0.072	-0.130	-0.143*	-0.075	-0.134
	(0.072)	(0.075)	(0.087)	(0.073)	(0.075)	(0.088)
$\Delta\tau_{out}$ × Rank	0.013	-0.017	0.006	0.012	-0.017	0.006
	(0.038)	(0.038)	(0.040)	(0.038)	(0.038)	(0.040)
Rank	0.243***	0.316***	0.436***	0.242***	0.316***	0.437***
	(0.040)	(0.032)	(0.037)	(0.040)	(0.032)	(0.037)
Kleibergen-Paap rk LM $\chi^2(1)$	19.902	24.112	22.703	19.532	23.696	22.302
Cragg-Donald Wald F statistic	483.650	949.413	667.834	478.770	945.264	665.447
Kleibergen-Paap rk F statistic	12.936	8.933	7.175	12.627	8.774	7.043
Anderson-Rubin Wald F-statistic	9.51	7.59	5.19	9.23	7.67	5.30
Anderson-Rubin Wald $\chi^2(4)$	43.02	32.16	26.59	41.75	32.48	27.17
Stock-Wright LM S Statistic $\chi^2(4)$	31.39	13.14	12.45	34.84	15.83	16.00
Hansen J statistic	0.000	0.000	0.000	0.000	0.000	0.000
Other Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	No	No	No
Owntype-Year FE	No	No	No	Yes	Yes	Yes
Firm FE	Yes	Yes	No	Yes	Yes	No
Country FE	No	Yes	No	No	Yes	No
Firm-Country FE	No	No	Yes	No	No	Yes
Observations	141,788	329,739	284,128	141,788	329,739	284,128

Notes: * $p < 0.1$, **$p < 0.05$, *** $p < 0.01$. In columns (1) and (4), dependent variable is changes of firm-product export value while in other columns, dependent variable is changes of the firm-product-country export value. We employ the 1997 tariff level to instrument the tariff changes here in this table. Other controls include firm-level productivity, firm-level capital-labor ratio, firm-level average wage and firm size (measured by total employment). All the standard errors are clustered at the industry level. All the first-stage results, which are available upon request, indicate that the instruments are significantly strong and valid.

TABLE A8
Effects of Other Mechanisms

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A			Trade Uncertainty			
$\Delta\tau_{in}$	0.027	0.026	0.010	0.011	0.007	0.008
	(0.028)	(0.027)	(0.008)	(0.008)	(0.008)	(0.008)
$\Delta\tau_{in}$ × Rank	-0.041***	-0.041***	-0.024***	-0.024***	-0.015*	-0.015*
	(0.013)	(0.013)	(0.007)	(0.007)	(0.009)	(0.009)
$\Delta\tau_{out}$	-0.002	-0.002	-0.003	-0.003	-0.004	-0.004
	(0.022)	(0.023)	(0.005)	(0.005)	(0.005)	(0.005)
$\Delta\tau_{out}$ × Rank	0.014	0.013	0.004	0.004	0.002	0.002
	(0.015)	(0.015)	(0.005)	(0.005)	(0.005)	(0.005)
Rank	0.403***	0.403***	0.425***	0.424***	0.519***	0.518***
	(0.029)	(0.029)	(0.015)	(0.015)	(0.016)	(0.016)
Observations	131,147	131,147	293,812	293,812	251,228	251,228
R^2	0.169	0.169	0.116	0.116	0.242	0.243
Adjusted R^2	0.059	0.059	0.063	0.063	0.025	0.025
Panel B			Exchange Rate			
$\Delta\tau_{in}$	0.037**	0.037**	0.012	0.013	0.009	0.010
	(0.016)	(0.016)	(0.009)	(0.009)	(0.010)	(0.010)
$\Delta\tau_{in}$ × Rank	-0.040***	-0.040***	-0.029***	-0.029***	-0.023**	-0.022**
	(0.013)	(0.013)	(0.011)	(0.011)	(0.009)	(0.009)
$\Delta\tau_{out}$	-0.009	-0.009	-0.001	-0.001	-0.003	-0.003
	(0.010)	(0.010)	(0.005)	(0.005)	(0.005)	(0.005)
$\Delta\tau_{out}$ × Rank	0.014*	0.014*	0.005	0.004	0.003	0.003
	(0.008)	(0.008)	(0.005)	(0.005)	(0.005)	(0.005)
Rank	0.400***	0.400***	0.413***	0.413***	0.511***	0.511***
	(0.024)	(0.025)	(0.016)	(0.016)	(0.019)	(0.019)
Observations	95,747	95,747	215,712	215,712	187,233	187,233
R^2	0.167	0.167	0.119	0.119	0.247	0.247
Adjusted R^2	0.055	0.055	0.066	0.066	0.025	0.025
Other Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	No	Yes	No	Yes	No
Owntype-Year FE	No	Yes	No	Yes	No	Yes
Firm FE	Yes	Yes	Yes	Yes	No	No
Country FE	No	No	Yes	Yes	No	No
Firm-Country FE	No	No	No	No	Yes	Yes

Notes: * $p < 0.1$, **$p < 0.05$, *** $p < 0.01$. All the transactions to and from the United States are removed in the top panel while in the bottom panel, transactions after year 2005 are revoved. In columns (1)-(2), dependent variable is changes of firm-product export value while in other columns, dependent variable is changes of the firm-product-country export value. Other controls include firm-level productivity, the firm-level capital-labor ratio, the firm-level average wage and firm size (measured by total employment). All the standard errors are clustered at the industry level.