Trade Liberalization and Firms' Export Performance in China: Theory and Evidence*

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Abstract

The focus of the literature surrounding trade liberalization has recently shifted from trade liberalization in imported final goods to studying the effects of trade liberalization in imported intermediate inputs. This emphasis fits very well the trade liberalization experience of China following its accession to the WTO in 2001. In this paper, we build a multi-sector heterogenous-firm model with trade in both intermediate goods and final goods, and we ask: How do final-goods producers respond to trade liberalization in imported inputs? Do they respond differently across sectors? How do firms respond differently to trade liberalization in imported-outputs instead? We separate the total effect of trade liberalization into those caused by inter-sectoral resource allocation (IRA) and by within-sector selection of firms according to productivity (which we call Melitz selection effect). It is the IRA effect that gives rise to differential impacts of trade liberalization in different sectors. These impacts include changes in the probability of entry into the export market, the fraction of firms that export and the share of export revenue. To test our hypotheses, we carry out both quantitative analysis and empirical analysis by using Chinese firm-level data. The results are consistent with our theoretical predictions.

Keywords: Imported-input liberalization; Firms' export performance; Comparative advantage

JEL Classification codes: F12, F14

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1 Introduction

The focus of the literature surrounding trade liberalization has recently shifted from trade liberalization in imported final goods to studying the effects of trade liberalization in imported intermediate inputs. This emphasis fits very well the trade liberalization experience of China following its accession to the WTO in 2001. We build a multi-sector heterogenous-firm model with trade in both intermediate goods and final goods, and we ask: How do final-goods producers' entry, exit, production and exporting decisions respond to trade liberalization in imported intermediate goods? Do they respond differently across sectors? How do these firm responses affect the aggregate exporting performance? How do firms respond differently to trade liberalization in imported-outputs as opposed to imported-inputs? We then test our hypotheses using Chinese firm-level data for the years after China's accession to WTO in 2001.

How firms' behaviors are affected by bilateral trade liberalization of final goods has been analyzed by Melitz (2003) and many follow-up papers. However, not all episodes of trade liberalization have been bilateral in nature and many of them resulted in mainly tariff cuts on intermediate goods. Firms respond differently to different types of unilateral trade liberalization. When there is unilateral reduction of tariffs on imported final goods, the firms in the domestic country are hurt, as foreign products become relatively cheaper and therefore more competitive in the domestic market. When there is unilateral reduction of tariffs on import-inputs, the domestic final goods producers benefit because it reduces their costs. The recent literature in global value chain (e.g. Johnson and Noguera, 2017; Koopman, Wang and Wei, 2014) shows that trade in intermediate inputs has become increasingly important to global trade. This has prompted economists to switch their attentions to trade liberalization in intermediate goods. As we shall demonstrate in this paper, firms respond differently following unilateral trade liberalization in intermediate goods than liberalization in final goods.

It is widely recognized that China long enjoyed the most favored nation (MFN) treatment from its major trading partners prior to joining the WTO.[1] China's accession to the WTO has been generally believed to have involved a primarily unilateral reduction of import tariffs (see, for example, Fan, Li and Yeaple, 2018). This view can also be verified by Figure 1, which summarizes the trend of changes in different types of tariffs in China during the period 2001-2006. Chinese customs data (refer to Figure A1 in the appendix) shows that the majority of Chinese imports were for intermediate goods rather than for final goods (see, for example, Fan, Gao, Li and Tuan, 2018). Intermediate goods and capital goods accounted for 74% and 19% respectively, and final goods accounted for only 4%, of the total value of imports of China during the period 2001-2006. Therefore, it is reasonable to assume that the main consequence of China's accession to the WTO is an unilateral trade liberalization of intermediate inputs. Chinese final-goods producers in general enjoyed the cost-saving in inputs associated with this episode of trade liberalization, and this paper shows that different sectors responded differently to this event. In addition, we also analyze and test the impact of an imported-output tariff change and an export tariff change respectively.

To understand how different sectors respond differently to unilateral trade liberalization in imported

[1] For some trading partners, the MFN treatment was somewhat precarious.

inputs, we develop a model that incorporates Ricardian comparative advantage and Eaton and Kortum's (2002) type of selection of intermediate inputs into a multi-sector, two-country version of Melitz's (2003) monopolistic competition model with heterogenous firms. We use the model to explain how comparative advantage and economies of scale interact to affect firms in sector with different initial comparative advantage differently. We then analyze the effects of unilateral trade liberalization, with a special focus on imported-input trade liberalization. We decompose the total effect of trade liberalization into those caused by inter-sectoral resource allocation (which we call IRA effect) and by within-sector selection of firms according to productivity (which we call Melitz selection effect).

Following imported-input trade liberalization, all final-goods firms enjoy cheaper intermediate goods. Melitz's selection effect predicts that, in each final-goods sector, such liberalization tends to increase the productivity cutoff for survival and reduce the productivity cutoff for exporting within the sector, and this tends to increase the average productivity of the firms serving the domestic market in that sector. All sectors are affected equally. On the other hand, the IRA effect predicts that such liberalization leads to resources in the home country being reallocated towards the sectors with stronger initial comparative advantage. The IRA effect also tends to raise the productivity cutoff for survival and lower the productivity cutoff for exporting. The effect is larger, the stronger is the initial comparative advantage of a sector.

The interaction of the Melitz selection effect and the IRA effect causes firms in different sectors to respond differently to imported-input trade liberalization. The theory predicts that, for the sectors with stronger initial comparative advantage, the probability of entry into the export market for previously non-exporting firms, the change in the fraction of firms that export, and the change in the revenue share from exporting, are all higher. We test the hypotheses related to these reallocative effects of trade liberalization using Chinese firm-level data for the years 2001-2006, that is, around the time of China's accession to WTO in 2001. We choose China because its accession to the WTO has been widely recognized as primarily unilateral reduction of import tariffs and a vast majority of China's imports were intermediate goods in the covered period. We use the tariff data from the WTO database to estimate the industry-level imported-input tariffs and use the trade flow data from CEPII to estimate the industry-level reveal comparative advantage (RCA) index to proxy for sectoral comparative advantage.[2] The estimation results confirm the predictions of our theory. Our results are robust to various alternative econometric specifications and alternative measures of imported-input tariff reduction and RCA index. In addition, we show that our results are not driven by other potential mechanisms such as currency appreciation and Multi-Fibre Arrangement.

Our model can also be used to investigate other types of unilateral trade liberalization. Our theory predicts that unilateral trade liberalization in imported final goods, which we call imported-output trade liberalization, results in the domestic final-goods firms facing more competition from foreign firms, which leads to opposite effects on firms' exporting behaviors when compared with imported-input trade liberalization. Our empirical findings also verify this theoretical prediction. Furthermore, reduction of tariffs on the domestic country's exported final goods reinforces domestic final-goods firms'

[2] The full name of CEPII is Centre d'Etudes Prospectives et d'Information Internationales.

competitiveness in the foreign market; thus, it has a similar effect as imported-input trade liberalization. However, our empirical results show that the effect reductions in export tariffs would be not significant since the variations in the changes of export tariffs are small.[3] Here, we do not test the impact of the changes in the trade policy uncertainty since it is out of our theme.[4]

Focusing on the imported-input trade liberalization, our paper is naturally linked to an emerging literature that relates the effects of improved access to imported intermediate inputs to firm performance. Imported-input trade liberalization allows firms to access to cheaper intermediate inputs, and thus become more competitive. Dimensions in which superior performance are measured include improved total factor productivity (Amiti and Konings, 2007; Halpern, Koren and Szeidl, 2015; Gopinath and Neiman, 2014), upgrading of product quality (Amiti and Khandelwal, 2013, Fan, Li and Yeaple, 2015; Bas and Strauss-Kahn, 2015), and product scope expansion (Goldberg, Khandelwal and Pavcnik, 2010). Most of these papers focus on the effects of the imported-input trade liberalization within a sector. In contrast, we focus on the effect of the initial comparative advantage of sectors affecting the resource reallocation across sectors. While the within-sector Melitz selection effect presented in the literature is included in our model, we contribute to the literature by introducing the inter-sectoral resource allocation caused by the initial comparative advantage of the sectors, which leads to more fruitful results regarding the cross-sectoral variations in the effect of imported-input trade liberalization. Another difference between our paper with these papers is that they adopt a partial equilibrium approach. In our paper, we build a general equilibrium model to analyze the effect of different types of unilateral trade liberalization. Antras, Fort and Tintelnot (2017) developed a general equilibrium model by incorporating the choice of intermediate goods from different sources into Melitz's (2003) paper and studied the extensive and intensive margins of firms' global sourcing. Despite the similarity in the modeling technique in the input-bundle choice, the focus of our paper is quite different.

The theory part of our paper also shares some common features with the literature introducing Ricardian comparative advantage into the Melitz type of firm heterogeneity. Okubo (2009) incorporates multiple-sector Ricardian comparative advantage into the Melitz model, and analyzes the general equilibrium effects, allowing for the endogenous determination of the relative wage. Bernard, Redding and Schott (2007) incorporate firm heterogeneity into a two-sector, two-country Heckscher-Ohlin model, and analyze how trade leads to the reallocation of resources, both within and across industries. Inter-sectoral resource reallocation changes the ex-ante comparative advantage and provides a new source of welfare gains from trade as well as causes redistribution of income across factors. A common feature of these papers is their focus on the bilateral trade liberalization of final goods. In our paper, we model trade in both intermediate goods and final goods, and analyze the effects of imported-input trade liberalization on final-goods firms' exporting behavior. Moreover, we carry out detailed empirical tests of the theory.

Finally, our paper is also related to the strand of literature that analyzes the difference between the effects of trade reforms in the final goods market and those in the intermediate goods market. Amiti and

[3] A possible explanation is that China has been enjoying the MFN (most-favored-nation) rates from most of its trading partners before its accession to the WTO.

[4] As shown in Handley and Limão (2017) and Pierce and Schott (2016) , the trade policy uncertainty for China' exports to U.S also reduces after China's WTO accession.

Konings (2007) show that, compared with trade liberalization in final goods market, trade liberalization in the intermediate-goods markets has a far more important impact on firms' productivity. On the other hand, De Locker, Goldberg, Khandelwal and Pavcnik (2016) analyze the difference between the effects of imported-input tariff reductions and imported-output tariff reductions on firm-product markups. In this paper, we analyze the different effects of imported-input tariff reductions and imported-output tariff reductions on intra-sectoral and inter-sectoral resource allocation.

The paper is organized as follows. Section 2 presents a two-country, multi-sector model with heterogeneous firms, where there is trade in intermediate and final goods, and examines the properties of the global equilibrium. We analyze the pattern of specialization and trade and identify the existence of inter-industry trade as well as intra-industry trade. In section 3, we analyze the effects of trade liberalization, focusing on that of imported-inputs, and demonstrate how the IRA effect and Melitz selection effect interact in the two-way trade sectors, which differ from each other according to their strengths of comparative advantage. We also carry out a quantitative analysis of the model to verify the theoretical predictions. In section 4, we describe the specification of the empirical tests to be carried out, the data sources and the construction of the measures for the key variables such as tariffs and RCAs. In section 5, the empirical tests of the propositions presented in section 3 are carried out. In Section 6, we carry out various robustness checks for the empirical estimations. Section 7 concludes.

2 An Open-economy Model

We consider a global economy with two countries: Home and Foreign. There are L and L^* consumers in Home and Foreign respectively, each supplying one unit of labor. We attach an asterisk to all the variables pertaining to Foreign. In the rest of this section, we mainly focus on deriving the equations and expressions for Home. The corresponding equations and expressions for Foreign are given analogously unless otherwise stated. The preferences of a representative consumer in Home is given by a nested Cobb-Douglas function:

$$\ln U = \alpha \ln Q_h + \int_0^1 \beta_k \ln Q_k dk \qquad \text{with } \int_0^1 \beta_k dk = 1 - \alpha$$
$$\text{and } Q_k = \left(\int_0^{\theta_k} q_k(j)^\rho dj\right)^{\frac{1}{\rho}} \text{ with } 0 < \rho < 1;\ 1 < \sigma = \frac{1}{1-\rho} < \infty$$

where $q_k(j)$ is the consumption of variety j in differentiated final goods sector k; Q_h is the consumption of a homogeneous good; σ is the elasticity of substitution between any pair of varieties within a differentiated final goods sector; α is the share of expenditure on the homogenous good, β_k is the share of expenditure on a differentiated final goods $k \in [0, 1]$; θ_k is the endogenously determined mass of varieties in differentiated-good sector k (which may originate from Home or Foreign) available to consumers in Home. The representative consumer in Foreign has analogous preferences.

There is only one primary factor input called labor. The homogeneous good is produced using labor according to a constant returns to scale technology, and the sector is under perfect competition. The labor productivity in the homogeneous good sector are respectively A_h and A_h^* in Home and Foreign.

In the rest of the paper, we assume that the homogeneous good sector is sufficiently large so that the homogeneous good is produced in both countries.[5] We also assume that there is no trade cost associated with the homogeneous good. Therefore free trade of homogeneous goods implies that the wage ratio is determined by relative labor productivity in the sector, i.e. $\omega \equiv \frac{w}{w^*} = \frac{A_h}{A_h^*}$, where w denotes Home's wage and w^* denotes Foreign's wage. Without loss of generality, we assume that $\frac{A_h}{A_h^*} = 1$ and normalize by setting $w^* = 1$. Therefore, in equilibrium $w = w^* = 1$.

Production of differentiated final goods

In the differentiated-good sectors, firms are free to choose which sector they enter. Upon payment of the entry cost f_e, the firm earns the opportunity to make a random draw that determines the firm-specific component, φ_k, of the firm's total factor productivity. The total factor productivity of a firm in the differentiated-good sector k is the product of two terms: one is a firm-specific, random variable φ_k, which follows a Pareto distribution $P(1, \gamma) = 1 - \left(\frac{1}{\varphi_k}\right)^\gamma$ where $\varphi_k \in [1, \infty]$ and γ ($> \sigma - 1$) is the shape parameter of the distribution; the other is A_k, which is exogenous and sector-specific.[6] The total factor productivity of a firm is thus equal to $A_k\varphi_k$. We denote the sector-specific component of the relative total factor productivity by $a(k) \equiv a_k \equiv \frac{A_k}{A_k^*}$, and we index sectors in such a way that $a'(k) > 0$.[7] The production function of a differentiated-good firm with total factor productivity $A_k\varphi_k$ is given by $A_k\varphi_k l^{1-\mu}M^\mu$, where l denotes labor input; M denotes the measure of an intermediate-input bundle, which is costlessly assembled from a continuum of intermediate inputs that are indexed by z according to the production function:

$$M = \left\{ \int_\Omega [m(z)]^{\frac{\eta-1}{\eta}} \, dz + \int_{\Omega^*} [m(z)]^{\frac{\eta-1}{\eta}} \, dz \right\}^{\frac{\eta}{\eta-1}}$$

where $m(z)$ is the quantity of intermediate input z. The set of intermediate inputs supplied by Home (Foreign) is denoted by Ω (Ω^*). For a cost-minimizing differentiated-good firm, the unit price of an intermediate-input bundle is given by $P_M = \left[\int_0^1 c_m(z)^{1-\eta} dz\right]^{\frac{1}{1-\eta}}$, where $c_m(z)$ is the lowest unit cost of intermediate input z available to the firm. Intermediate inputs are produced using labor only. To a differentiated-good firm, the unit cost of an intermediate input z depends on whether the input was purchased from a domestic supplier or from a foreign supplier. If the firm purchases input z locally, its unit cost is equal to the wage of $1/b\,(z)$ units of labor, where $b\,(z)$ is domestic country's realized labor productivity in producing intermediate goods z. If the firm imports input z, then it must first pay a cost equal to the wage of $\tau_{ik}/b^*\,(z)$ units of foreign labor, where $b^*\,(z)$ is foreign country's realized labor productivity in producing intermediate goods z, and τ_{ik} (> 1) is the iceberg trade cost for imported inputs in sector k, such that τ_{ik} units of goods have to be shipped from the source in order for one

[5] The sufficient condition is $\alpha > \max\left\{\frac{L}{L+L^*}, \frac{L^*}{L+L^*}\right\}$. However, this is just a sufficient, not necessary, condition. In general, we do not need such a strong assumption on α, as each country usually both imports and exports differentiated goods. If trade in differentiated goods is close to balanced, α can be much smaller.

[6] The assumption $\gamma > \sigma - 1$ ensures that, in equilibrium, the size distribution of firms has a finite mean.

[7] To analyze the impact of trade liberaliztion across different sectors with different comparative advantage, we focus on and assume that only tariff and productivity are different across sectors.

unit to arrive at the destination. Following Eaton and Kortum (2002) and Antras, Fort and Tintelnot (2017), we assume that Home's efficiency distribution in producing the intermediate inputs follows the Fréchet distribution:

$$\Pr\left(b\left(z\right) \leq b\right) = e^{-Tb^{-\lambda}}, \quad \text{with } T > 0$$

where T governs the state of technology in Home, while λ determines the variability of labor productivity draws in both countries. Foreign's efficiency distribution in producing the intermediate goods follows the Fréchet distribution, with T^* governing the state of technology in Foreign. The unit cost of each bundle of intermediate-inputs in sector k faced by a Home differentiated-good producer is therefore given by:

$$c_k = \zeta\left[T + T^*\left(\tau_{ik}\right)^{-\lambda}\right]^{-1/\lambda}$$

where $\zeta = \left[\Gamma\left(\frac{\lambda+1-\eta}{\lambda}\right)\right]^{1/(1-\eta)}$ and $\Gamma\left(.\right)$ is the Gamma function. Hence, the variable cost of final goods production is equal to $\left[\frac{1}{\mu^\mu(1-\mu)^{1-\mu}}\right]\frac{(c_k)^\mu}{A_k\varphi_k}$. The expression for c_k^* is given analogously.

We assume the following: Home's final goods producers import only intermediate inputs, and export only final goods; Home's intermediate inputs producers export only intermediate inputs, and import nothing; Home's consumers import final goods directly from Foreign's firms. Analogous assumptions apply to Foreign. The variable τ_{ik} (τ_{ik}^*) denotes the iceberg-cost-equivalent tariff on Home's (Foreign's) imported intermediate inputs; while τ_{xk} (τ_{xk}^*) denotes the iceberg-cost-equivalent tariff on Home's (Foreign's) exported final goods. In other words, all trade costs are attributed to tariffs — transport costs are assumed to be zero.[8]

The aggregate price index of final goods in sector k sold in Home is given by

$$P_k = \left[\int_0^{\theta_k} p_k(j)^{1-\sigma}dj\right]^{\frac{1}{1-\sigma}},$$

where $p_k(j)$ denotes the price of variety j in sector k. The analogous index for Foreign is P_k^*.

The subscript "dk" pertains to a domestic firm serving the domestic market in sector k; the subscript "xk" pertains to a domestic firm serving the foreign market in sector k; and the subscript "k" pertains to final goods sector k regardless of who serves the market. Therefore, under monopolistic competition in sector k the profit-maximizing price for a domestic firm serving the domestic market is given by $p_{dk}(j) = \frac{(c_k)^\mu}{\widetilde{\rho}A_k\varphi_k(j)}$, where $\widetilde{\rho} = \frac{(\sigma-1)\mu^\mu(1-\mu)^{1-\mu}}{\sigma}$.[9] But Home's final-goods exporting firms will set higher prices in Foreign's market due to the existence of an iceberg trade cost τ_{xk} (> 1). Therefore, the profit-maximizing price of a Home-produced good sold in Foreign is given by $p_{xk}(j) = \frac{(c_k)^\mu\tau_{xk}}{\widetilde{\rho}A_k\varphi_k(j)}$. Similarly, Foreign's firms' pricing rules are given by $p_{dk}^*(j) = \frac{\left(c_k^*\right)^\mu}{\widetilde{\rho}A_k^*\varphi_k^*(j)}$ and $p_{xk}^*(j) = \frac{\left(c_k^*\right)^\mu\tau_{xk}^*}{\widetilde{\rho}A_k^*\varphi_k^*(j)}$. In the rest of the paper, we assume that trade costs are asymmetric, i.e., we allow for the possibility that $\tau_{xk} \neq \tau_{ik} \neq \tau_{xk}^* \neq \tau_{ik}^*$. In addition to the trade cost (which is a variable cost), there is a fixed cost of final goods production, f, and a fixed cost of exporting final good, f_x, which are incurred in every period.[10]

[8] Alternatively, we assume that the trade costs other than tariff are symmetric and do not change over time.

[9] Note that we could allow γ and σ to be different across sectors and still obtain all the propositions of this paper, but the derivation would be very tedious and no additional insights would be obtained.

[10] To be simplified, there is no fixed cost of importing intermediate goods. Incorporating the fixed cost of importing

2.1 Firm entry and exit

Cost minimization implies that the gross revenue and net profit of Home's firm j in differentiated sector k from domestic sales are, respectively:

$$r_{dk}(j) = \beta_k L \left[\frac{p_{dk}(j)}{P_k}\right]^{1-\sigma},$$
$$\pi_{dk}(j) = \frac{r_{dk}(j)}{\sigma} - f.$$

The expressions for the corresponding variables for Foreign's firms, $r^*_{dk}(j)$ and $\pi^*_{dk}(j)$, are defined analogously. Following the same logic, the gross exporting revenue and net exporting profit of Home's firm j in sector k are, respectively:

$$r_{xk}(j) = \beta_k L^* \left[\frac{p_{xk}(j)}{P^*_k}\right]^{1-\sigma},$$
$$\pi_{xk}(j) = \frac{r_{xk}(j)}{\sigma} - f_x.$$

The expressions for the corresponding variables for Foreign's firms, $r^*_{xk}(j)$ and $\pi^*_{xk}(j)$, are defined analogously.

Hereinafter, "productivity" is synonymous with "total factor productivity" unless otherwise stated. If a firm's productivity is too low, it would not survive after entry, as its expected economic profit is negative. Likewise, a surviving firm would not export if its productivity is so low that its expected economic profits from exporting is negative. Let $\overline{\varphi}_{dk}$ and $\overline{\varphi}_{xk}$ denote the firm-specific components of the productivity cutoffs in sector k for domestic sales (i.e. for survival) and exporting respectively for Home's firms; $\overline{\varphi}^*_{dk}$ and $\overline{\varphi}^*_{xk}$ denote the corresponding variables for Foreign. It is clear that the mass of exporting firms in Home, θ_{xk}, can be expressed as:

$$\theta_{xk} = \frac{1 - G(\overline{\varphi}_{xk})}{1 - G(\overline{\varphi}_{dk})}\theta_{dk} = \left(\frac{\overline{\varphi}_{dk}}{\overline{\varphi}_{xk}}\right)^{\gamma}\theta_{dk}$$

where θ_{dk} denotes the mass of surviving firms in Home, and $G(.)$ denotes the c.d.f. of the Pareto distribution with shape parameter γ. The corresponding relationship between the variables θ^*_{xk} and θ^*_{dk} for Foreign can be written analogously. By definition, the mass of varieties available to consumers in differentiated-good sector k in Home is equal to

$$\theta_k = \theta_{dk} + \theta^*_{xk}\ ,$$

and θ^*_k is defined analogously. The aggregate price indexes of final goods in sector k in Home and Foreign, respectively, are given by:

$$P_k = (\theta_k)^{\frac{1}{1-\sigma}}\, p_{dk}(\widetilde{\varphi}_k), \qquad P^*_k = (\theta^*_k)^{\frac{1}{1-\sigma}}\, p^*_{dk}(\widetilde{\varphi}^*_k) \tag{1}$$

intermediate goods, as in Antras, Fort and Tintelnot (2017), would imply that firms in the sectors with higher comparative advantage are more prone to import and hence would enhance our prediction.

where $\widetilde{\varphi}_k$ and $\widetilde{\varphi}_k^*$ denote the firm-specific component of the aggregate productivity in differentiated-good sector k for goods sold in Home and Foreign, respectively; $p_{dk}(\varphi) \equiv \frac{(c_k)^\mu}{\rho A_k \varphi}$ and $p_{dk}^*(\varphi) \equiv \frac{(c_k^*)^\mu}{\rho A_k^* \varphi}$. It is straightforward to show that

$$(\widetilde{\varphi}_k)^{\sigma-1} = \frac{1}{\theta_k}\left\{\theta_{dk}\left(\widetilde{\varphi}_{dk}\right)^{\sigma-1} + \theta_{xk}^*\left[\frac{1}{\tau_{xk}^* a_k}\left(\frac{c_k}{c_k^*}\right)^\mu \widetilde{\varphi}_{xk}^*\right]^{\sigma-1}\right\}, \tag{2}$$

$$(\widetilde{\varphi}_k^*)^{\sigma-1} = \frac{1}{\theta_k^*}\left\{\theta_{dk}^*\left(\widetilde{\varphi}_{dk}^*\right)^{\sigma-1} + \theta_{xk}\left[\frac{a_k}{\tau_{xk}}\left(\frac{c_k^*}{c_k}\right)^\mu \widetilde{\varphi}_{xk}\right]^{\sigma-1}\right\} \tag{3}$$

where $\widetilde{\varphi}_{dk}$ ($\widetilde{\varphi}_{dk}^*$) and $\widetilde{\varphi}_{xk}$ ($\widetilde{\varphi}_{xk}^*$) denote respectively the firm-specific component of aggregate productivity level of all of Home's (Foreign's) surviving firms and Home's (Foreign's) exporting firms.[11] The relationships between $\widetilde{\varphi}_{dk}$ and $\overline{\varphi}_{dk}$, between $\widetilde{\varphi}_{dk}^*$ and $\overline{\varphi}_{dk}^*$, between $\widetilde{\varphi}_{xk}$ and $\overline{\varphi}_{xk}$, and between $\widetilde{\varphi}_{xk}^*$ and $\overline{\varphi}_{xk}^*$, are given by

$$\widetilde{\varphi}_{sk} = \left(\frac{\gamma}{\gamma-\sigma+1}\right)^{\frac{1}{\sigma-1}} \overline{\varphi}_{sk} \quad \text{and} \quad \widetilde{\varphi}_{sk}^* = \left(\frac{\gamma}{\gamma-\sigma+1}\right)^{\frac{1}{\sigma-1}} \overline{\varphi}_{sk}^* \qquad \text{for} \quad s = x, d. \tag{4}$$

From the above equations, it is obvious that these aggregate productivity measures as well as aggregate price indexes are functions of ($\overline{\varphi}_{dk}$, $\overline{\varphi}_{dk}^*$, $\overline{\varphi}_{xk}$, $\overline{\varphi}_{xk}^*$, θ_{dk}, θ_{dk}^*). As will be shown below, as long as $\frac{f_x}{f}$ is sufficiently large, then for each sector, only a fraction of surviving firms will export. In that case, an entering firm will produce only if it can generate positive expected profit by selling domestically, and export only if it can generate positive expected profit by selling abroad.[12] The zero cutoff profit (ZCP) condition dictates that the marginal surviving firm makes zero post-entry expected economic profits. Thus we obtain four ZCP conditions, which are relegated to the appendix. Suppose $\widetilde{\pi}_k$ and $\widetilde{\pi}_k^*$ denote the average profit flow of a surviving firm in sector k in Home and Foreign respectively. A firm will enter if its expected post-entry profit is above the fixed cost of entry. The free entry (FE) condition determines that the entry cost is equal to the post-entry expected economic profits. Hence, the FE conditions for Home and Foreign are, respectively $f_e = [1 - G(\overline{\varphi}_{dk})]\,\widetilde{\pi}_k$ and $f_e = [1 - G(\overline{\varphi}_{dk}^*)]\,\widetilde{\pi}_k^*$. These equations can be expressed in terms of $\overline{\varphi}_{dk}$, $\overline{\varphi}_{xk}$, $\overline{\varphi}_{dk}^*$, and $\overline{\varphi}_{xk}^*$ owing to the ZCP conditions. They are relegated to the appendix.

2.2 General equilibrium

Assuming that both countries produce in sector k, given the wage ratio $A_h/A_h^* = 1$, we can solve for ($\overline{\varphi}_{dk}$, $\overline{\varphi}_{dk}^*$, $\overline{\varphi}_{xk}$, $\overline{\varphi}_{xk}^*$, θ_{dk}, θ_{dk}^*) from the four zero cutoff profit conditions and two free entry conditions since the aggregate prices are functions of these six variables. (For details, please refer to Appendix A). The solutions are given below. Define $D_1 \equiv \left(\frac{\sigma-1}{\gamma-\sigma+1}\right)\frac{f}{f_e}$ and $D_2(k) \equiv \left(\frac{\gamma-\sigma+1}{\gamma}\right)\frac{\beta_k}{\sigma f}$.

[11] The derivation of the above two equations are available from the corresponding author's homepage at http://ihome.ust.hk/~elai/ or upon request.

[12] The condition is $\frac{f_x}{f} > \max\{\frac{L}{L^*}, \frac{L^*}{L}\}$. If this condition is not satisfied, then there exist some sectors in which all firms export (besides serving the domestic market).

$$(\overline{\varphi}_{dk})^{\gamma} = D_1 \left[\frac{B_{1k} - B_{2k}^{-1}}{B_{1k} - \widetilde{a}_k^{\gamma}} \right] \tag{5}$$

$$(\overline{\varphi}_{dk}^{*})^{\gamma} = D_1 \left[\frac{B_{2k} - B_{1k}^{-1}}{B_{2k} - \widetilde{a}_k^{-\gamma}} \right] \tag{6}$$

$$\overline{\varphi}_{xk} = \left(\frac{B_{1k} f_x}{f} \right)^{\frac{1}{\gamma}} \frac{\overline{\varphi}_{dk}^{*}}{\widetilde{a}_k} \tag{7}$$

$$\overline{\varphi}_{xk}^{*} = \left(\frac{B_{2k} f_x}{f} \right)^{\frac{1}{\gamma}} \widetilde{a}_k \overline{\varphi}_{dk} \tag{8}$$

$$\theta_{dk} = D_2(k) \left[\frac{B_{1k} L - \frac{B_{1k} - \widetilde{a}_k^{\gamma}}{B_{2k} \widetilde{a}_k^{\gamma} - 1} L^*}{B_{1k} - B_{2k}^{-1}} \right] \tag{9}$$

$$\theta_{dk}^{*} = D_2(k) \left[\frac{B_{2k} L^* - \frac{B_{2k} \widetilde{a}_k^{\gamma} - 1}{B_{1k} - \widetilde{a}_k^{\gamma}} L}{B_{2k} - B_{1k}^{-1}} \right] \tag{10}$$

where $B_{1k} \equiv (\tau_{xk})^{\gamma} \left(\frac{f_x}{f} \right)^{\frac{\gamma}{\sigma-1}-1}$; $B_{2k} \equiv (\tau_{xk}^{*})^{\gamma} \left(\frac{f_x}{f} \right)^{\frac{\gamma}{\sigma-1}-1}$, which are summary measures of export trade barriers in sector k. $\widetilde{a}_k = \left[\frac{T^* + T \cdot (\tau_{ik}^{*})^{-\lambda}}{T + T^* \cdot (\tau_{ik})^{-\lambda}} \right]^{-\mu/\lambda} a_k$ reflects the relative competitiveness of Home in differentiated-good sector k, and hence captures the comparative advantage of the sector.[13]

In a one-sector model, Melitz (2003) imposes the condition $\tau^{\sigma-1} f_x > f$ so as to ensure that some firms produce exclusively for their domestic market in both countries. In this paper, we adopt a more stringent condition, $\frac{f_x}{f} > \max\{\frac{L}{L^*}, \frac{L^*}{L}\}$, so as to ensure that, in each country, some firms sell exclusively to their domestic market in all sectors.[14] This condition implies that B_{1k} and B_{2k} are both larger than one.[15]

Home's firms will exit sector k when $\theta_{dk} \leq 0$, and Foreign's firms will exit the sector if $\theta_{dk}^{*} \leq 0$. From equations (9) and (10), this implies that

$$B_{1k}^{-1} \left[\frac{B_{1k} - \widetilde{a}_k^{\gamma}}{B_{2k} \widetilde{a}_k^{\gamma} - 1} \right] < \frac{L}{L^*} < B_{2k} \left[\frac{B_{1k} - \widetilde{a}_k^{\gamma}}{B_{2k} \widetilde{a}_k^{\gamma} - 1} \right]$$

[13]Note that $\widetilde{a}_k$ is composed of two parts: one part is $a_k \equiv \frac{A_k}{A_k^*}$, which reflects the sector-specific component of Home's relative productivity compared to Foeign; the other part is $\left[\frac{T^* + T(\tau_{ik}^{*})^{-\lambda}}{T + T^*(\tau_{ik})^{-\lambda}} \right]^{-\mu/\lambda}$, which represents the Home's relative cost of intermediate inputs compared to Foreign.

[14]The proof is straightforward. From Table A1, we see that $\overline{\varphi}_{dk} < \overline{\varphi}_{xk} \Leftrightarrow \frac{f_x}{f} > \frac{1}{B_{2k}} \left[\frac{B_{2k} \widetilde{a}_k^{\gamma} - 1}{B_{1k} - \widetilde{a}_k^{\gamma}} \right]$. Similarly, $\overline{\varphi}_{dk}^{*} < \overline{\varphi}_{xk}^{*} \Leftrightarrow \frac{f_x}{f} > \frac{1}{B_{1k}} \left[\frac{B_{1k} - \widetilde{a}_k^{\gamma}}{B_{2k} \widetilde{a}_k^{\gamma} - 1} \right]$. Equations (9) and (10) imply that $\frac{1}{B_{2k}} \left[\frac{B_{2k} \widetilde{a}_k^{\gamma} - 1}{B_{1k} - \widetilde{a}_k^{\gamma}} \right] \leq \frac{L^*}{L}$ and $\frac{1}{B_{1k}} \left[\frac{B_{1k} - \widetilde{a}_k^{\gamma}}{B_{2k} \widetilde{a}_k^{\gamma} - 1} \right] \leq \frac{L}{L^*}$ for $k \in [k_1, k_2]$, where $\theta_{dk} \geq 0$ and $\theta_{dk}^{*} \geq 0$. Hence $\frac{f_x}{f} > \max\{\frac{L}{L^*}, \frac{L^*}{L}\}$ is a sufficient condition for $\overline{\varphi}_{dk} < \overline{\varphi}_{xk}$ and $\overline{\varphi}_{dk}^{*} < \overline{\varphi}_{xk}^{*}$ for all two-way trade sectors.

In addition, Table A1 shows that $\frac{f_x}{f} > \max\{\frac{L}{L^*}, \frac{L^*}{L}\}$ is also a sufficient condition for $\overline{\varphi}_{dk} < \overline{\varphi}_{xk}$ and $\overline{\varphi}_{dk}^{*} < \overline{\varphi}_{xk}^{*}$ (whenever the country produces) for all one-way trade sectors.

[15]As $\tau > 1$, $\frac{f_x}{f} \geq 1$, and $\gamma > \sigma - 1$, it is obvious that B_1 and B_2 are both larger than one under our condition.

is needed for both countries to produce positive outputs in sector k. Otherwise there will be complete dominance by one country in the sector and one-way trade. In the rest of the paper, we focus on the *two-way trade sectors* to fit the reality. The case of one-way trade sectors is also discussed in details in the appendix for completeness.

3 Trade liberalization

China's trade liberalization following her accession to the World Trade Organization (WTO) has been widely recognized as primarily unilateral liberalization. It also provides a natural experiment for us to evaluate the impacts of exogenous tariff reduction (Fan, Li and Yeaple (2015)). Chinese customs data (refer to Figure A1 in the appendix) also shows that a vast majority of Chinese imports were intermediate goods rather than final goods at the time of the WTO-induced trade liberalization in China in 2001 (Fan, Li and Yeaple (2015)). This justifies the focus of our empirical analysis being on the effects of unilateral imported-input trade liberalization.

According to our theory, in the one-way trade sectors, the productivity cutoff for survival and productivity cutoff for exporting are independent of τ_{xk}, τ_{ik}, τ_{xk}^* and τ_{ik}^*, which means that trade liberalization has no effect on firm production and exporting behavior. We do not believe this is consistent with the behavior of the firms in our data. Therefore, we only focus on the two-way trade sectors.

3.1 Imported-input trade liberalization

According to equations (5) and (7), the effects of trade liberalization in imported inputs on the productivity cutoff for survival, $\overline{\varphi}_{dk}$, and productivity cutoff for exporting, $\overline{\varphi}_{xk}$, are given by

$$\frac{d\ln\left(\overline{\varphi}_{dk}\right)}{d\tau_{ik}} = -\left[\frac{\widetilde{a}_k^{\gamma}}{B_{1k}-\widetilde{a}_k^{\gamma}}\right]\frac{\mu T^*\left(\tau_{ik}\right)^{-\lambda-1}}{T+T^*\left(\tau_{ik}\right)^{-\lambda}} < 0 \tag{11}$$

$$\frac{d\ln\left(\overline{\varphi}_{xk}\right)}{d\tau_{ik}} = \left[\frac{B_{2k}}{B_{2k}-\widetilde{a}_k^{-\gamma}}\right]\frac{\mu T^*\left(\tau_{ik}\right)^{-\lambda-1}}{T+T^*\left(\tau_{ik}\right)^{-\lambda}} > 0 \tag{12}$$

That is, trade liberalization in imported inputs (a reduction of τ_{ik}) leads to a rise in $\overline{\varphi}_{dk}$ and a fall in $\overline{\varphi}_{xk}$. Moreover, the effect of trade liberalization in imported inputs are more significant in the sector with higher initial comparative advantage (i.e., a higher $\widetilde{a}_k$).

Moreover, the fraction of exporting firms in sector k is given by $\frac{\theta_{xk}}{\theta_{dk}} = \left(\frac{\overline{\varphi}_{dk}}{\overline{\varphi}_{xk}}\right)^{\gamma} = \frac{f}{f_x}\left[\frac{\widetilde{a}_k^{\gamma}-B_{2k}^{-1}}{B_{1k}-\widetilde{a}_k^{\gamma}}\right]$. Therefore, the effect of trade liberalization in imported inputs on the fraction of exporting firms in sector k is given by

$$\frac{d\left[\frac{\theta_{xk}}{\theta_{dk}}\right]}{d\tau_{ik}} = \frac{d\left[\left(\frac{\overline{\varphi}_{dk}}{\overline{\varphi}_{xk}}\right)^{\gamma}\right]}{d\tau_{ik}} = -\frac{f}{f_x}\left[\frac{\left(B_{1k}-B_{2k}^{-1}\right)\widetilde{a}_k^{\gamma}}{\left[B_{1k}-\widetilde{a}_k^{\gamma}\right]^2}\right]\frac{\mu\gamma T^*\left(\tau_{ik}\right)^{-\lambda-1}}{T+T^*\left(\tau_{ik}\right)^{-\lambda}}$$

which is negative and decreases with $\widetilde{a}_k$. Thus, trade liberalization in imported inputs leads to an increase in the fraction of exporting firms in all sectors, with the effect stronger in the sector with higher initial comparative advantage (i.e., a higher $\widetilde{a}_k$).

We summarize the above results in the following proposition.[16]

Proposition 1 *Consider the sectors in which both countries produce. Following trade liberalization in imported intermediate inputs, the productivity cutoff for survival, $\overline{\varphi}_{dk}$, increases and productivity cutoff for exporting, $\overline{\varphi}_{xk}$, decreases in these sectors. Thus the fraction of firms that export increases in all sectors. Moreover, the effect is stronger in the sector with higher initial comparative advantage (i.e., a higher $\widetilde{a}_k$).*

The intuition of the above proposition can be understood more clearly by decomposing the total effect of unilateral trade liberalization in imported inputs into two effects: the Melitz selection effect and the inter-sectoral resource allocation (IRA) effect. We shall analyze from the perspective of Home and Home's firms, and we only focus on the two-way trade sectors.

1. **The Melitz selection effect** (within-sector resource allocation effect) – leading to $\overline{\varphi}_{dk} \uparrow$ and $\overline{\varphi}_{xk} \downarrow$ in all sectors. As the tariff on imported inputs τ_{ik} falls, it raises the aggregate productivity of Home firms in all sectors. As a result, the export revenue of a typical exporting firm in Home will increase. which **creates pressure for $\overline{\varphi}_{xk}$ to decrease.** The exporting firms in Home would expand, bidding up Home's wage, and compete away resources from the less productive, non-exporting, firms. This will force the least productive firms in Home to exit, which **creates pressure for $\overline{\varphi}_{dk}$ to increase.** This is the Melitz selection effect. Its magnitude is independent of the strength of initial comparative advantage of a sector.

2. **The inter-sectoral resource allocation (IRA) effect -** leading to $\overline{\varphi}_{dk} \uparrow$ and $\overline{\varphi}_{xk} \downarrow$ with the change in $(\overline{\varphi}_{dk}/\overline{\varphi}_{xk})^{\gamma}$ larger the stronger is the initial comparative advantage of the sector. According to equations (5) to (10), the cost saving from trade liberalization in imported intermediate inputs makes all Home firms more competitive in the international market. Moreover, this causes a **reallocation of resources from the comparative disadvantage sectors towards the initial comparative advantage sectors**. In a sector with stronger initial comparative advantage (i.e., a higher $\widetilde{a}_k$), a trade liberalization in imported intermediate inputs enhances the initial comparative advantage of the sector and induces more Home firms to enter in the industry (the mass of entrants in the sector at Home n_k increases, and the one in Foreign n_k^* decreases). [17]

[16] There are two cutoffs a_{k_1} and a_{k_2} as shown in Appendix A.1, such that Home will not produce in sector k if $a_k \leq a_{k_1}$; and Foreign will not produce in sector k if $a_k \geq a_{k_2}$. In the data, due to the level of aggregation (CIC 4-digit industries), we do have China exporting and importing in all industries. Thus we only focus on the sectors in which both country produce, a.k.a. sectors with $a_{k_1} < a_k < a_{k_2}$.

[17] The domestic mass of entrants satisfies: $n_k = \theta_{dk} \left(\overline{\varphi}_{dk}\right)^{\gamma} = D_1 D_2 \left[\frac{B_{1k}}{B_{1k} - \widetilde{a}_k^{\gamma}} L - \frac{1}{B_{2k}\widetilde{a}_k^{\gamma} - 1} L^*\right]$, The foreign mass of entrants satisfies: $n_k^* = \theta_{dk}^* \left(\overline{\varphi}_{dk}^*\right)^{\gamma} = D_1 D_2 \left[\frac{B_{2k}}{B_{2k} - \widetilde{a}_k^{-\gamma}} L^* - \frac{1}{B_{1k}\widetilde{a}_k^{-\gamma} - 1} L\right]$.

3. **The IRA effect reinforces the Melitz selection effect.** Due the Melitz selection effect, there is more resources reallocated to the high-productivity firms which expand to capture a larger share in the less competitive foreign market, in the expense of surviving firms that just produce to serve the domestic market. As n_k^* decreases, Foreign's market becomes less competitive and so $r_{xk}(\varphi)$ increases for all φ. **This creates pressure for a decrease in** $\overline{\varphi}_{xk}$ (i.e. the Home firms which were marginally unprofitable in exporting before now become profitable in exporting). As n_k increases, θ_{dk} also increases. This leads to the shrinking of the sizes of the surviving Home firms. Thus, $r_{dk}(\varphi)$ decreases for all φ. **This creates pressure for an increase in** $\overline{\varphi}_{dk}$ as some less productive firms which were expected to be marginally profitable before can be expected to be unprofitable now and then would exit the market. The IRA effect is stronger, the stronger is the initial comparative advantage of a sector. In a sector with stronger initial comparative advantage, n_k increases more and n_k^* decreases more; more resources are re-allocated towards the sector and the reallocation favors the exporting firms more when compared to the non-exporters as a result of the less competitive foreign market. Consequently, the increase in the fraction of firms that export is larger in a sector with stronger initial comparative advantage.

The change in the fraction of firms that export is not the only interesting effect of imported-input trade liberalization on export performance. We have derived two more testable hypotheses as described below. They are intimately related to how $\left(\frac{\overline{\varphi}_{dk}}{\overline{\varphi}_{xk}}\right)^{\gamma}$ is affected by the reduction of τ_{ik}. Thus, the signs of the derivatives are the same. After trade liberalization, the marginal firms whose productivity is right below the cutoff of exporting (the most productive firms among the non-exporters) will start to export. As to the probability of entry into the export market for a previously non-exporting firm, we have the following proposition (detail proofs are given in the Appendix B):

Proposition 2 *Consider the sectors in which both countries produce. Following trade liberalization in imported inputs, the probability of entry into the export market for a previously non-exporting firm is higher in the sector with higher initial comparative advantage.*

In the appendix B, we also show that, as to the change in the revenue share from exporting, we have the following proposition:

Proposition 3 *Consider the sectors in which both countries produce. Following trade liberalization in imported inputs, the change in the revenue share from exporting is larger in the sector with higher initial comparative advantage.*

3.2 Reduction of tariffs on exported-outputs, exported-inputs and imported-outputs

Compared with imported-input trade liberalization, how do trade liberalization in exported final goods ($\tau_{xk}\downarrow$), exported intermediate goods ($\tau_{ik}^*\downarrow$) and imported final goods ($\tau_{xk}^*\downarrow$) affect the productivity cutoffs for survival and exporting, and the fraction of firms that export? From equations (5) and (7), the effect of trade liberalization in exported final goods, exported intermediate goods and imported final goods on $\overline{\varphi}_{dk}$, $\overline{\varphi}_{xk}$ and $\left(\frac{\overline{\varphi}_{dk}}{\overline{\varphi}_{xk}}\right)^{\gamma}$ in the two-way trade sectors can be easily calculated. As before, the effects on $\left(\frac{\overline{\varphi}_{dk}}{\overline{\varphi}_{xk}}\right)^{\gamma}$ are intimately related to how the three export performance variables stated in the last three propositions are affected by reduction of tariffs. The detailed expressions for the derivatives are relegated to the appendix. Here we just state the signs of the derivatives below.

$$\frac{d\ln\left(\overline{\varphi}_{dk}\right)}{d\tau_{xk}}<0;\ \frac{d\ln\left(\overline{\varphi}_{dk}\right)}{d\tau_{ik}^{*}}>0;\ \frac{d\ln\left(\overline{\varphi}_{dk}\right)}{d\tau_{xk}^{*}}>0$$

$$\frac{d\ln\left(\overline{\varphi}_{xk}\right)}{d\tau_{xk}}>0;\ \frac{d\ln\left(\overline{\varphi}_{xk}\right)}{d\tau_{ik}^{*}}<0;\ \frac{d\ln\left(\overline{\varphi}_{xk}\right)}{d\tau_{xk}^{*}}<0$$

$$\frac{d\left(\frac{\overline{\varphi}_{dk}}{\overline{\varphi}_{xk}}\right)^{\gamma}}{d\tau_{xk}}<0;\ \frac{d\left(\frac{\overline{\varphi}_{dk}}{\overline{\varphi}_{xk}}\right)^{\gamma}}{d\tau_{ik}^{*}}>0;\ \frac{d\left(\frac{\overline{\varphi}_{dk}}{\overline{\varphi}_{xk}}\right)^{\gamma}}{d\tau_{xk}^{*}}>0$$

In each case in the last line, the magnitude of the effect on $\left(\frac{\overline{\varphi}_{dk}}{\overline{\varphi}_{xk}}\right)^{\gamma}$ is larger in the sector with higher initial comparative advantage (i.e., a higher $\widetilde{a}_k$).

Besides the effects of trade liberalization in imported intermediate inputs, the trade liberalization in exported final goods, exported intermediate goods and imported final goods all have impacts on the firms' exporting performance. The effects of trade liberalization in exported final goods are similar to those for imported intermediate goods. Both effects raise the productivity cutoff for survival, $\overline{\varphi}_{dk}$, and lower the cutoff for exporting, $\overline{\varphi}_{xk}$; moreover, the fraction of firms that export increases and the effect is larger in the sector with higher initial comparative advantage (i.e., a higher $\widetilde{a}_k$).

However, the effects of trade liberalization in exported intermediate goods and imported final goods are different. They would lower the productivity cutoff for survival and raise the cutoff for exporting. This is because trade liberalization in exported intermediate goods and imported final goods increases Foreign's firms competitiveness in Home's market and hence $r_{xk}^{*}\left(\varphi\right)$ increases for all φ. This induces more firms to enter in Foreign (i.e. n_k^{*} increases) and raises the competitiveness of Foreign's market. As a result, Home firm's export revenue $r_{xk}\left(\varphi\right)$ falls for all φ, which creates pressure for a increase in $\overline{\varphi}_{xk}$. As the exporting firms are the most productive ones, their contraction bids down Home's wage, which allows the less productive firms to expand. Thus, $r_{dk}\left(\varphi\right)$ increases for all φ. The previously unprofitable marginal firm now becomes profitable. This creates pressure for a decrease in $\overline{\varphi}_{dk}$. Thus the trade liberalization in exported intermediate goods or imported final goods lowers the fraction of exporting firms in sector k. The magnitudes of the effects are also larger in the sector with higher initial comparative advantage.

3.3 Quantification

In this subsection, we carry out a quantitative analysis based on data to support the theoretical predictions on the effects of trade liberalization of our model.

We start the quantitative exercise by identifying the relationship between the variables in our model. In the empirical analysis, we focus on the effect of input trade liberalization on two key variables, r_{1k}, the share of firms who export in sector k at Home, and r_{2k}, the share of export revenue in total revenue in sector k at Home.[18] From the model, we have

$$r_{1k} = \left(\frac{\overline{\varphi}_{dk}}{\overline{\varphi}_{xk}}\right)^{\gamma} = \frac{B_{2k}\widetilde{a}_k^{\gamma} - 1}{B_{1k}B_{2k} - B_{2k}\widetilde{a}_k^{\gamma}} \cdot \frac{f}{f_x}, \tag{13}$$

$$r_{2k} = \frac{f_x \cdot \theta_{xk}}{f \cdot \theta_{dk} + f_x \cdot \theta_{xk}} = \frac{B_{2k}\widetilde{a}_k^{\gamma} - 1}{B_{1k}B_{2k} - 1}. \tag{14}$$

Thus the ratio of fixed cost of exporting to the fixed cost of entry into production is

$$\frac{f_x}{f} = \frac{r_{2k}}{r_{1k}\left(1 - r_{2k}\right)}. \tag{15}$$

We calculate this value among all the CIC (Chinese Industrial Classification) 4-digit industries and obtain the average value 1.207396. We then use this value for the ratio f_x/f in the rest of the exercise.

Similarly, in the Foreign country (the rest of the world), we also have the share of export revenue in total revenue in sector k at Foreign

$$r_{2k}^{*} = \frac{f_x \cdot \theta_{xk}^{*}}{f \cdot \theta_{dk}^{*} + f_x \cdot \theta_{xk}^{*}} = \frac{B_{1k}\widetilde{a}_k^{-\gamma} - 1}{B_{1k}B_{2k} - 1}. \tag{16}$$

Putting (14) and (16) together, we have

$$B_{1k}\widetilde{a}_k^{-\gamma} = \frac{1 - r_{2k}^{*}}{r_{2k}}, \tag{17}$$

$$B_{2k}\widetilde{a}_k^{\gamma} = \frac{1 - r_{2k}}{r_{2k}^{*}}, \tag{18}$$

which are calculated based on a harmonized system recording trade volumes across countries, the Release 2016 of the World Input-Output Database (WIOD).[19] In the WIOD database, it provides time series of world input-output table from 2000 to 2014. In the data, not only the trade volumes in intermediate goods, as well as the final goods, but also the national accounts information, are provided in a harmonized system for the 56 2-digit ISIC industries. We then focus on the 18 manufacturing industries in the database for the period 2001 to 2006. We obtain the gross export from China to the rest of the world (Row) and the total production of China in each of the 18 manufacturing industries, and calculate the ratio of these two as r_{2k}. Similarly, we obtain the gross export from the rest of the world to China and the total production of the rest of the world in each of the 18 manufacturing industries, and calculate the ratio of these two as r_{2k}^{*}. Then we can simply calculate the values of $B_{1k}\widetilde{a}_k^{-\gamma}$ and $B_{2k}\widetilde{a}_k^{\gamma}$ for each industry, which leads to

$$B_{1k}B_{2k} = \frac{\left(1 - r_{2k}\right)\left(1 - r_{2k}^{*}\right)}{r_{2k}r_{2k}^{*}}.$$

The next challenge is to estimate the total trade barriers for the intermediate goods trade. According to our model, the trade of intermediate goods follows the Eaton and Kortum (2002) framework. The

[18] It is hard to distinguish gross production of final goods and intermediate goods in the Chinese firm-level data. Thus in the calculation of r_{1k}, r_{2k} and r_{2k}^{*}, we use the number (total sales) of all firms and the number (total sales) of all exporting firms.

[19] We could not obtain the value of r_{2k} and r_{2k}^{*} in the Chinese firm-level data simultaneously.

share of intermediate goods from China used in sector k production in China, $\pi_{CC,k}$, the share of intermediate goods from RoW used in sector k production in China, $\pi_{CR,k}$, the share of intermediate goods from RoW used in sector k production in Row, $\pi_{RR,k}$, the share of intermediate goods from China used in sector k production in Row, $\pi_{RC,k}$, are given by, respectively

$$\pi_{CC,k} = \frac{T}{T + T^* \left(\tau_{ik}\right)^{-\lambda}},$$
$$\pi_{CR,k} = \frac{T^* \left(\tau_{ik}\right)^{-\lambda}}{T + T^* \left(\tau_{ik}\right)^{-\lambda}},$$
$$\pi_{RR,k} = \frac{T^*}{T^* + T \left(\tau_{ik}^*\right)^{-\lambda}},$$
$$\pi_{RC,k} = \frac{T \left(\tau_{ik}^*\right)^{-\lambda}}{T^* + T \left(\tau_{ik}^*\right)^{-\lambda}},$$

The four trade shares can be easily calculated from the WIOD database, so does $\tau_{ik}\tau_{ik}^*$. The overall trade costs can be proxied by the widely used Head-Ries index ($\sqrt{\tau_{ik}\tau_{ik}^*} = \left(\frac{\pi_{RC,k}\pi_{CR,k}}{\pi_{CC,k}\pi_{RR,k}}\right)^{-\frac{1}{2\lambda}}$).[20] The trade cost for imported input faced by sector k Chinese firms

$$\tau_{ik} = t_{ik} d_{ik},$$

which consists two parts, the import tariff for intermediate goods t_{ik}, and the non-tariff trade barrier d_{ik}. We follow a similar approach used by Caliendo and Parro (2015), by assuming that τ_{ik} is different from τ_{ik}^* only from the difference in tariff from RoW to China, t_{ik}, and the tariff from China to the RoW, t_{ik}^*. We match the HS 6-digit sectors to the 18 ISIC 2-digit manufacturing industries and obtained the average import and export tariff line of China within each ISIC 2-digit industry k as t_{ik} and t_{ik}^* respectively. We then use the reduction of import tariff as the measure of input trade liberalization, for which we have

$$d \ln \tau_{ik} = d \ln t_{ik} \Rightarrow d\tau_{ik} = \frac{\tau_{ik}}{t_{ik}} dt_{ik}$$

while holding the non-tariff barrier d_{ik} fixed.

We now have the values of all the key variables we need. For the parameter values, we adopt $\lambda = \sigma - 1 = 4$, which is the value commonly used for the elasticity of trade. We then use the size distribution of the Chinese firms from data to obtain $\gamma - (\sigma - 1) = 0.6335885$, and obtain $\gamma = 4.6335885$. For the shares of intermediate inputs used in the production of each sector k, μ_k, we directly calculate the value from the WIOD for China. Following the model, the effect of import tariff reduction on the

[20] We simply obtain

$$\tau_{ik} = \sqrt{\tau_{ik}\tau_{ik}^* \frac{t_{ik}}{t_{ik}^*}},$$
$$\tau_{ik}^* = \sqrt{\tau_{ik}\tau_{ik}^* \frac{t_{ik}^*}{t_{ik}}}.$$

share of firms who export and the share of export revenue in total revenue in sector k are

$$\frac{dr_{1k}}{dt_{ik}} = \frac{\tau_{ik}}{t_{ik}} \cdot \frac{dr_{1k}}{d\tau_{ik}} = -\frac{\left(B_{1k}B_{2k}-1\right)B_{2k}\widetilde{a}_k^{\gamma}}{\left(B_{1k}B_{2k}-B_{2k}\widetilde{a}_k^{\gamma}\right)^2} \cdot \frac{\pi_{RC,k}}{t_{ik}}\mu_k\gamma \cdot \frac{f}{f_x}$$

$$\frac{dr_{2k}}{dt_{ik}} = \frac{\tau_{ik}}{t_{ik}} \cdot \frac{dr_{2k}}{d\tau_{ik}} = -\frac{B_{2k}\widetilde{a}_k^{\gamma}}{B_{1k}B_{2k}-1} \cdot \frac{\pi_{RC,k}}{t_{ik}}\mu_k\gamma$$

respectively. All the values are known and we calculate the partial effect of import tariff reduction for each industry as shown below

Industry	$\frac{dr_{1k}}{dt_{ik}}$	$\frac{dr_{2k}}{dt_{ik}}$
	Change in export firms ratio	Change in export revenue ratio
Food, beverages and tobacco	-0.0046	-0.0050
Textiles, apparel and leather	-0.1340	-0.0826
Wood and cork	-0.0050	-0.0055
Paper	-0.0072	-0.0081
Printing	-0.0077	-0.0084
Coke and refined petroleum	-0.0164	-0.0176
Chemicals	-0.0231	-0.0240
Pharmaceutical	-0.0060	-0.0065
Rubber and plastic	-0.0392	-0.0366
Non-metallic mineral	-0.0069	-0.0076
Metals	-0.0093	-0.0102
Fabricated metal	-0.0232	-0.0222
Computer and electronic	-0.5313	-0.2641
Electrical equipment	-0.0899	-0.0665
Machinery and equipment	-0.0168	-0.0173
Motor vehicles	-0.0042	-0.0048
Other transport equipment	-0.0486	-0.0425
Furniture	-0.0792	-0.0485

If we assume that the gross export barrier B_{1k} is the same for the Chinese firms in these manufacturing sectors, $\widetilde{a}_k^{\gamma}/B_{1k}$ will be proportional to $\widetilde{a}_k^{\gamma}$, which is the measure of comparative advantage of each sector in our model.[21] We then plot dr_{1k}/dt_{ik} and dr_{2k}/dt_{ik} against the calculated $\widetilde{a}_k^{\gamma}/B_{1k}$ and

[21] We can calculate $\widetilde{a}_k^{\gamma}/B_{1k}$ based on Equation (17).

obtain the plots as below

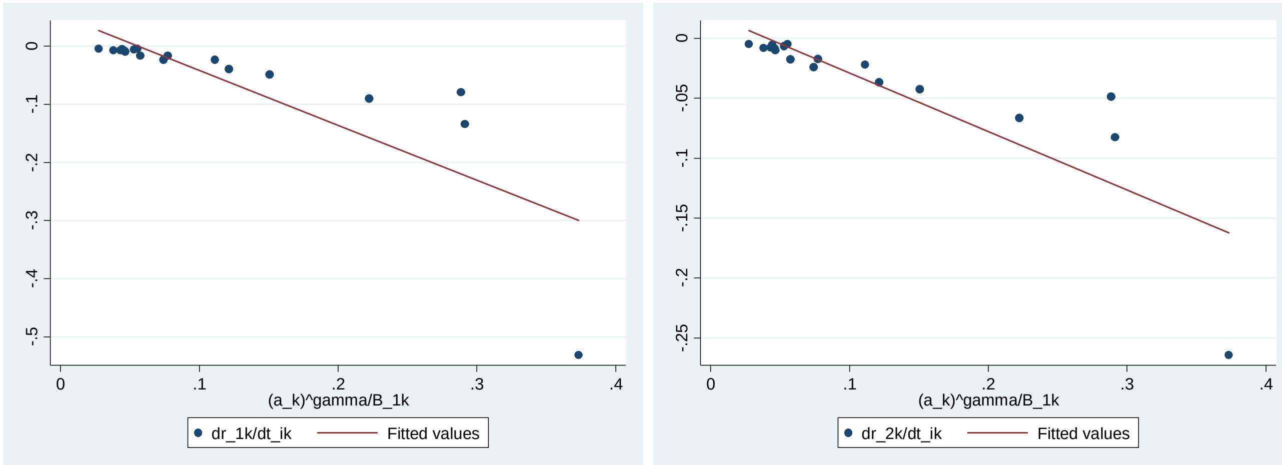

Figure: The Relationship of Effect of Trade Liberalization with Comparative Advantage across Sector

It is clear that the magnitude of the partial effects on both ratios increase with the comparative advantage of the sectors, with the slope of the fitted lines to be -0.94 (with $s.e. = 0.17$) and -0.49 (with $s.e. = 0.08$) respectively. The negative relationships are consistent with the theoretical prediction of the model.

4 Empirical Specification, Data and Measurement

In this section, we specify our econometric models and describe the data and measurements of the main variables that are used in the estimation.

4.1 Estimating Equations

To examine Proposition 2, we estimate the impact on the probability of entry into the export market using logistic regressions. Based on our theory, the probability of entry into the exporting market for previously non-exporting firms in industry k between year t and year $t+1$ can be written as:

$$\begin{aligned}&\Pr\left(\text{Export}_{f,t+1} = 1 \middle| \text{Export}_{f,t} = 0\right)\\&\qquad = \Phi\left(\beta_1 \Delta\text{duty}_{ik,t} + \beta_2 \Delta\text{duty}_{ik,t} \times \text{RCA}_{k,t} + \beta_3 \Delta\text{duty}_{ok,t} + \beta_4 \text{RCA}_{k,t} + \lambda \text{X}_{f,t} + \delta_s + \delta_t\right),\end{aligned}$$

where $\text{Export}_{f,t}$ is a dummy which equals 1 if firm f exports in year t and 0 otherwise; $\Delta\text{duty}_{ik,t}$ is the change in the tariff on imported intermediate goods (imported-input tariff) in the 4-digit CIC industry k to which firm f belongs, between year t and year $t+1$; $\text{RCA}_{k,t}$ is the revealed comparative advantage of the 4-digit CIC industry k in year t; $\Delta\text{duty}_{ik,t} \times \text{RCA}_{k,t}$ is an interactive term of the change in imported-input tariff and the revealed comparative advantage of industry k; $\Delta\text{duty}_{ok,t}$ is the change in the tariff of imported final goods (i.e. imported-output tariff) of the 4-digit CIC industry k between year t and year $t+1$; $\text{X}_{f,t}$ is a vector of firm characteristics of firm f in year t including firm productivity, labor employment, capital-labor ratio and the wage per worker, δ_s is a set of 2-digit CIC industry dummies to control for the unobserved heterogeneity and δ_t is a set of time dummies.

Propositions 1 and 3 can be tested according to the following two equations:

$$\Delta\left(\frac{\theta_{xk,t}}{\theta_{dk,t}}\right) = \gamma_1 \Delta \text{duty}_{ik,t} + \gamma_2 \Delta \text{duty}_{ik,t} \times \text{RCA}_{k,t} + \gamma_3 \Delta \text{duty}_{ok,t} + \gamma_4 \text{RCA}_{k,t} + \mu \text{X}_{k,t} + \delta_s + \delta_t + \varepsilon_{k,t}$$

$$\Delta\left(\frac{V_{xk,t}}{V_{k,t}}\right) = \delta_1 \Delta \text{duty}_{ik,t} + \delta_2 \Delta \text{duty}_{ik,t} \times \text{RCA}_{k,t} + \delta_3 \Delta \text{duty}_{ok,t} + \delta_4 \text{RCA}_{k,t} + \nu \text{X}_{k,t} + \delta_s + \delta_t + \eta_{k,t}$$

where $\theta_{xk,t}$ and $\theta_{dk,t}$ denote respectively the number of exporting firm and the total number of producing firms in industry k in year t; $V_{xk,t}$ and $V_{k,t}$ respectively represent the exporting revenue and the total revenue in industry k at time t; Δ denotes the change of a variable from year t to year $t+1$; $\text{X}_{k,t}$ is a vector of industry characteristics including the firm-revenue-weighted average TFP, labor employment, capital-labor ratio and the wage per worker in industry k; δ_s is a set of CIC 2-digit industry dummies and δ_t is a set of the time dummies. $\varepsilon_{k,t}$ and $\eta_{k,t}$ are error terms.

4.2 Firm-level Data and Firm-product-level Trade Data

In the empirical test, we use data extracted from four sources. First, firm-level data are from the National Bureau of Statistics of China (NBSC). Second, firm-product-level import and export data are obtained from China's General Administration of Customs. Third, the import tariffs data are obtained from the WTO website, available as MFN (most-favored-nation) tariffs at the HS 8-digit level from the year 2001 to 2006.[22] Finally, we obtain trade flows data from CEPII, which is used to measure revealed comparative advantage.

The first two data sources deserve more explanation. The firm-level production data covers all state-owned enterprises (SOEs), and non-state-owned enterprises with annual sales of at least 5 million RMB (Chinese currency).[23] This database has been widely used in previous studies of the Chinese economy (e.g., Cai and Liu (2009), Feenstra, Li and Yu (2014), Brandt, Biesebroeck and Zhang (2012), among others) as it contains detailed firm-level information of manufacturing enterprises in China, such as ownership structure, employment, capital stock, gross output, value-added, and complete information on the three major accounting statements (i.e., balance sheets, profit and loss accounts, and cash flow statements). Of all the information in the NBSC Database, we are mostly interested in the variables related to the measures of the dependent variables which we are interested in (the probability of entry into the foreign market, the fraction of exporting firms and the export revenue share) and firm characteristics. As there are some reporting errors in the NBSC Database, we clean it by following Cai and Liu (2009), Fan, Li and Yeaple (2015) and the Generally Accepted Accounting Principles, and discard observations for which one of the following criteria is violated: (i) the total assets must be higher than the liquid assets; (ii) the total assets must be larger than the total fixed assets; (iii) the total assets must be larger than the net value of the fixed assets; (iv) a firm's identification number

[22] The tariff data are available at http://tariffdata.wto.org/ReportersAndProducts.aspx.

[23] It equals US$640,000 approximately, according to the official end-of-period exchange rate in 2006, reported by the central bank of China.

cannot be missing and must be unique; and (v) the time of establishment must be valid. In addition, we also discard the observations if firms changed the industry they belong to.[24]

China's General Administration of Customs provides us with the universe of all Chinese trade transactions by importing and exporting firm at the HS 8-digit level for the years 2001-2006. Each trade transaction includes import and export values, quantities, products, source and destination countries, customs regime (e.g. "Processing and Assembling"and "Processing with Imported Materials"), type of enterprise (e.g. state-owned, domestic private firm, foreign-invested, and joint ventures), and contact information for the firm (e.g. company name, phone number, zip code, contact person). We aggregate the trade data to firm-product-year level. In order to calculate the imported intermediate-goods tariff and imported final-goods tariff in each industry, we need to use the contact information of manufacturing firms to match the firm-product level trade data from the Chinese Customs Database to the NBSC Database.[25], [26] Compared with all the exporting and importing firms under the ordinary-trade regime 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.[27]

4.3 Measurement

In what follows, we will describe how to measure the main variables in which we are interested: import tariffs, export tariffs, revealed comparative advantage (RCA) and the firm productivity.

4.3.1 Measures of Tariffs

Estimation of Import Tariffs

Method 1: Input Tariffs and Output Tariffs

To be consistent with the literature, we mainly use the industry-level input tariffs to measure the tariffs of imported inputs, and the industry-level output tariffs to measure the tariffs on imported outputs, where these tariffs are estimated with the help of the input-output table. We shall call them "input tariffs" and "output tariffs". We first extract the import tariff rate charged by Chinese customs

[24] Whether discarding the observations or not if firms change industry they belong to would not affect our results.

[25] 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.

[26] Our matching procedure is done in three steps. First, the vast majority of firms (89.3%) are matched by company names exactly. Second, an additional 10.1% are matched by telephone number and zip code exactly. Finally, the remaining 0.6% of firms are matched by telephone number and contact person name exactly.

[27] Compared with all the manufacturing exporting firms in the NBSC Database, the matching rate of our sample (in terms of the number of firms) varies from 54% to 63% between 2001 and 2006, which covers more than 60% of total value of firm exports in the manufacturing sector reported by the NBSC Database.

for each harmonized system (HS) 8-digit good from the WTO data base. In order to use the Input-Output (IO) table of Chinese industries to establish the linkage between inputs and outputs, we map the harmonized system (HS) 8-digit tariff onto the 3-digit IO industries.[28] We then compute the output tariffs at the 3-digit IO industry level by taking the simple average of the import tariffs of the HS 8-digit codes within each 3-digit IO industry. Following Amiti and Konings (2007), we use an input-cost-weighted average output tariffs to calculate the input tariff for each industry i as

$$\tau_{i,t}^{input} = \sum_{k} s_{ki} \tau_{k,t}^{output}$$

where $\tau_{k,t}^{output}$ is the tariff in industry k at time t, and s_{ki} is the weight of industry k in the input cost of industry i from the IO table. Since our production data utilize the CIC 4-digit code, we map the input and output tariffs at the IO 3-digit industry level onto the CIC 4-digit industries. We then obtain a set of input and output tariffs at CIC 4-digit level, which will serve as the major measures of tariffs of imported intermediate goods and imported final goods respectively, for the empirical tests in our paper.

The advantage of these input and output tariffs measurements is that they can account for the input-output linkage between the industries. These measures of tariffs are comprehensive in capturing the effect of imported inputs since firms might acquire some of the foreign intermediate goods from other Chinese importing firms and this kind of indirect importing behavior can be well captured by the IO table.

Method 2: Imported intermediate-goods Tariffs and Imported final-goods Tariffs

An alternative way to estimate the imported-input tariffs and imported-output tariffs is to calculate them directly using firm-level data. To do this, we use the merged data built upon the NBSC firm-level database and the Customs database to calculate the industry-level "imported intermediate-goods tariffs" and "imported final-goods tariffs".[29] We construct imported intermediate-goods tariffs using information on the exact initial bundle of intermediate goods imported by firms. Based on the Broad Economic Categories (BEC) classification, we can distinguish between imported intermediate goods and imported final goods. Thus, we can compute a weighted average industry-level measure of tariff on imported intermediate goods in final-goods sector k in year t as $duty_{ik,t} = \sum_{h \in Z} w_{hk,t} \tau_{hk,t}$, where the weight $w_{hk,t}$ is the share of imported intermediate HS6 product h in the total imported value of intermediate goods for ordinary (non-processing) trade imported by the firms in industry k in year t, $\tau_{hk,t}$ is the tariff on intermediate HS6 product h imported by firms in industry k in year t.[30] The imported final-goods tariffs should be the average of all relevant tariffs weighted by the share of each final product's domestic sales. However, data on product-level domestic sales are unavailable. Thus, we adopt a less satisfactory approach by using the share of a firms' export of the product h in the industry k to substitute for the share of its domestic sales, as in Yu (2015). Then, the weighted average

[28] As our data sample covers the time between 2001 and 2006, we adopt the input-output table from 2002. There are 122 sectors, in which 71 sectors are manufacturing sectors.

[29] The shortcoming of this method is that the NBSC firm-level database only includes large firms and there are information losses during the matching process. This may lead to sample selection bias.

[30] Imported intermediate goods for processing trade are not subject to tariffs.

industry-level measure of tariff on imported final-goods (i.e. imported outputs) in sector k in year t is computed as $duty_{ok,t} = \sum_{h \in Z} v_{hk,t} \tau_{hk,t}$, where the weight $v_{hk,t}$ is the share of exported HS6 final goods h in the total exported value of final goods by the matched ordinary-trade firms in sector k in year t, $\tau_{hk,t}$ is the tariff on imported HS6 final goods h in industry k in year t.

Estimation of Export Tariffs

As a robustness check, we also control for the export tariffs, as it can be argued that they also affect the left hand side variables in our regressions. To calculate the export tariff, $duty_{ek,t}$, we first use the export value to each country to calculate the weighted average export tariff for each HS6 product faced by Chinese exporting firms. Here, we use the *ad valorem* tariff imposed by the destination country when Chinese firms export. Then we calculate the simple average of the export tariffs within each 3-digit IO industry and then map the IO 3-digit export tariffs onto the CIC 4-digit industries. In contrast to the import tariffs, export tariffs did not change too much. On average, they decreased from 8.227% to 6.465% during the period 2001-2006.

Our main estimation results are based on import tariff estimation Method 1, the industry-level "input tariffs" and "output tariffs" calculated based on the input-output table. For robustness check, we also use import tariff estimation Method 2: industry-level "imported intermediate-goods tariffs" and "imported final-goods tariffs" estimated from the merged firm-level data. Figure 1 below presents the time trend of the average magnitude across 4-digit CIC sectors of each type of tariff we described above during 2001-2006. It shows that there were relatively large drops in the imported-input and import-output tariff rates since China joined WTO in 2001. However, the export tariff rate has not dropped much.

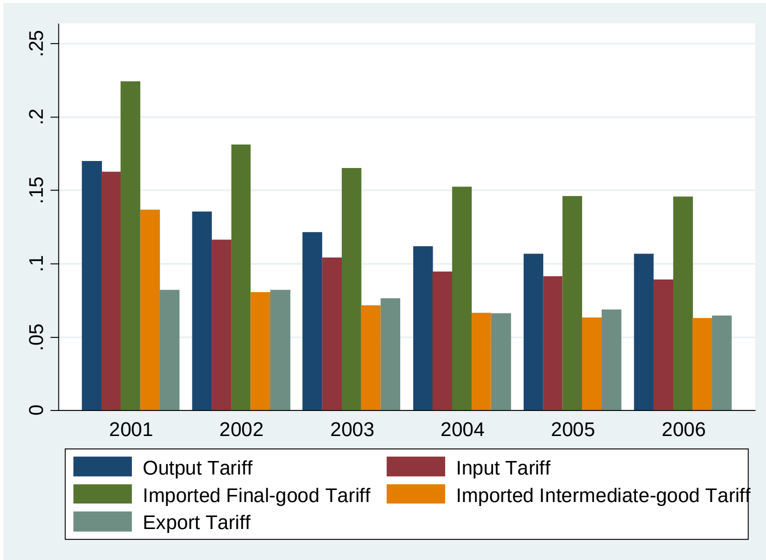

Figure 1: Average Magnitude across the CIC 4-digit Industries of Each Type of Tariff (Input tariff and output tariff based on Input-Output tables; Imported intermediate-good tariffs and imported final-good tariffs based on the merged firm-level data; and export tariffs)

4.3.2 Measures of RCAs

The second most important variable we need to proxy for is the measure of comparative advantage of a sector. The Balassa (1965) index provides a measure of the "revealed" comparative advantage (RCA) of a sector in a country. Since then, the Balassa index has undergone several modifications. In what follows, we shall explain the different measures of revealed comparative advantage developed by Balassa and others. In what follows, we shall explain the different measures of revealed comparative advantage developed by Balassa and others. The Balassa (1965) index in industry i is expressed as:

$$\text{RCA}_1 = \frac{X_{ck}}{X_c} / \frac{X_{wk}}{X_w}$$

where X_{ck} and X_{wk} represent the exports from China and that from the rest of world in the industry k respectively; X_c and X_w represent the exports from China and that from the rest of world in all industries respectively. The index RCA_1 is the ratio of China's exports in industry k relative to its total exports, to the corresponding measure for the rest of world. Therefore, a higher RCA_1 means stronger revealed comparative advantage. However, the Balassa index is criticized for omitting imports in its analysis. To address this issue, we use a second index, which is expressed as:

$$\text{RCA}_2 = \frac{X_{ck}}{X_c} / \frac{X_{wk}}{X_w} - \frac{M_{ck}}{M_c} / \frac{M_{wk}}{M_w}$$

where M_{ck} and M_{wk} represent respectively the imports by China and the rest of world in industry k; M_c and M_w represent respectively the imports by China and the rest of world in all industries. The construction of this index requires the data of exports and imports of China and those of the rest of world. Another index of RCA, which is based only on China's exports and imports, is expressed as:

$$\text{RCA}_3 = \frac{X_{ck} - M_{ck}}{X_{ck} + M_{ck}}$$

Two more indexes of RCA, which are based only on China's exports and imports, are:

$$\text{RCA}_4 = \frac{X_{ck}}{X_c} / \frac{M_{ck}}{M_c}$$
$$\text{RCA}_5 = \ln\left(\frac{X_{ck}}{X_c} / \frac{M_{ck}}{M_c}\right) * 100$$

There is some concern that the above measures of revealed comparative advantage is related to the current tariffs. In order to address the potential endogeneity issue, we use the trade flows data from CEPII in the year 2000 to calculate the above five RCA indexes. We also use the log of ranks of the RCA indexes instead of the RCA indexes themselves for further robustness checks. It turns out that the ranks of RCA_3, RCA_4 and RCA_5 are same. Panel A in Table A2 in the appendix shows the correlation coefficient among the above five RCA indexes and Panel B shows the correlation coefficients among the log ranks of different RCA indexes. From the table we can see that the above five RCA indexes are highly correlated. Panel C of Table A2 reports the summary statistics of these RCA indexes. Since the range of RCA values varies when the measures of RCA are different. The value of some RCA measure is always larger than zero, while the value of some RCA can be either positive or negative. We minus RCA by their maximum and use it in our regressions. Thus, the coefficients of duty reflects the impact of import-tariff reduction on the sector with the strongest measured comparative advantage.

4.3.3 Measures of TFP

As we need to control for firm productivity, we use the augmented Olley-Pakes method (Olley and Pakes, 1996) to estimate firm's productivity (TFP).[31] The augmentation takes into account a number of additional firm level decisions. As in Amiti and Konings (2007), we include an export dummy (equal to one for exporters and zero otherwise) and a WTO dummy (i.e., one for a year in or after 2002 and zero otherwise) in the Olley-Pakes estimation.[32] We use value-added to measure production output, and deflate firms' inputs (e.g., capital) and value-added using the input price deflators and output price deflators from Yang (2015). Yang improves the price deflators by using officially reported price deflators, whereas Brandt, Biesebroeck and Zhang (2012) use nominal and real output reported by enterprises to construct the deflators. In order to consider the changes over time, Yang (2015) uses the input–output tables from 1997, 2002, and 2007 for the corresponding years, whereas Brandt, Biesebroeck and Zhang (2012) only used the table for a single year. In the spirit of Lu and Xiang (2016), we also attain more accurate estimates of firm-level capital stock base on Yang (2015)'s approach.

[31] Our results are robust for different approaches of estimating TFP, including the OLS method, the Levinsohn-Petrin method (Levinsohn and Petrin, 2003), and the Ackerberg-Caves-Frazer augmented O-P and L-P methods (Ackerberg, Caves and Frazer, 2015), and value added per worker. These results are available upon request.

[32] We do not add any import dummy since the NBSC firm-level database does not have a firm's import-decision information.

5 Empirical Results

In this section, we report our main empirical results with regard to Propositions 1-3. Considering the fact that China's trade liberalization prompted by the accession to WTO mainly led to reduction in import tariffs (for both intermediate goods and final goods) and that the majority of Chinese imports were intermediate goods rather than final goods, our study focuses on the effects of imported-input trade liberalization.

5.1 Main Results

5.1.1 Testing Proposition 2

Table 1 reports the regression results regarding the probability of entry into the export market.[33] According to our Proposition 2, the probability of entry into the export market for previously non-exporting firms should be higher in sectors with stronger initial comparative advantage following trade liberalization in imported intermediate goods. As predicted, the coefficients of the interactive term "input tariff change x RCA" in columns 1 to 8 in Table 1 are significantly negative. In Table 1, we control for the changes of input- and output-tariffs, revealed comparative advantage, and some firm-level characteristic such as, TFP, capital intensity, average wage and firm size (measured by total employment). Columns 1-5 correspond to regressions using RCA_1, RCA_2, RCA_3, RCA_4, RCA_5, respectively as the RCA index. Moreover, we also use the log ranks of the RCA indexes instead of the RCA indexes themselves for robustness check. Columns 6-8 correspond to regressions using the log ranks of RCA_1, RCA_2 and RCA_3 as the RCA index. The ranks of RCA_4 and RCA_5 are the same as the rank of RCA_3.[34] Table 1 shows that the LHS variable increases with a firm's productivity, employment, capital-labor ratio, and wage per worker. All in all, the results in Table 1 offer support for Proposition 2. Column 1 shows that a standard deviation increase in the RCA index raises the impact of imported input tariff reductions on the probability of entry into the export market by 16.33%. Columns 2-8 shows that if we use other measures of RCA, the magnitudes become 12.81%; 17.99%; 10.87%; 17.19%; 22.71%; 14.08%; 22.07% respectively.[35] This means that the impacts of imported-input tariff changes are economically significant besides being statistically significant.

[33] To judge whether or not the firms in two consecutive years are same firm, we first link the firms by firm ID. Then, we use additional information to link them. We create new codes that use various combinations of firm name (in Chinese), name of legal person representative (in Chinese), geographic code, phone number.

[34] If we use the ranks of RCA indexes or the dummy variables which equals one when it is larger than median and equals zero otherwise, all results continue to hold.

[35] In the logit model, we have $\Pr(Export_{f,t+1} = 1 \,|Export_{f,t} = 0) = \Phi(\mathbf{X}\beta)$, where $\mathbf{X}\beta$ represents the linear combination of dependent variables on the right hand side of the estimation equation. A standard deviation increase in the RCA index raises the impact of imported input tariff reductions on the probability of entry into the export market by $\Phi(\mathbf{X}\beta)[1-\Phi(\mathbf{X}\beta)]\,\beta_2 RCA_{sd}$, where RCA_{sd} denotes a standard deviation of RCA.

Table 1: Probability of entry into the export market								
RCA index	RCA_1	RCA_2	RCA_3	RCA_4	RCA_5	$Rank_1$	$Rank_2$	$Rank_3$
Regressor	Logit	Logit	Logit	Logit	Logit	Logit	Logit	Logit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Δduty_{ik}	-13.070***	-10.043***	-4.015***	-9.628***	-5.817***	-3.011**	-3.420***	-3.743***
	(1.832)	(1.527)	(0.901)	(1.665)	(0.978)	(1.186)	(0.882)	(0.944)
$\boldsymbol{\Delta \text{duty}_{ik} \times \text{RCA}}$	-1.706***	-1.113***	-5.036***	-0.408***	-0.017***	-3.785*	-2.275***	-3.546**
	(0.298)	(0.238)	(1.721)	(0.082)	(0.004)	(2.100)	(0.806)	(1.796)
Δduty_{ok}	-1.727	-0.285	-0.646	-0.228	-1.231	-3.388	1.507	0.122
	(3.250)	(3.123)	(3.414)	(3.055)	(3.410)	(3.933)	(2.996)	(3.325)
RCA	0.124***	0.110***	0.426***	0.057*	0.002***	0.312***	0.234***	0.217***
	(0.046)	(0.030)	(0.141)	(0.029)	(0.001)	(0.076)	(0.060)	(0.073)
TFP	0.036*	0.037*	0.036*	0.036*	0.037*	0.036*	0.037*	0.036*
	(0.020)	(0.020)	(0.019)	(0.019)	(0.019)	(0.019)	(0.020)	(0.019)
log(Empl)	0.298***	0.303***	0.304***	0.296***	0.303***	0.301***	0.307***	0.303***
	(0.019)	(0.018)	(0.018)	(0.019)	(0.019)	(0.019)	(0.018)	(0.018)
log(K/L)	0.025	0.027	0.027	0.025	0.027	0.028	0.027	0.026
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)
log(Wage)	0.296***	0.291***	0.292***	0.294***	0.292***	0.299***	0.288***	0.294***
	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.025)	(0.026)	(0.026)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	370102	370102	370102	370102	370102	370102	370102	370102
Note: ***Significant at the 1% level; **Significant at the 5% level; *Significant at the 10% level.								
Robust standard errors is corrected at industry-level in parentheses.								

Using alternative measures of imported-input and imported-output tariffs

In Table 1, all results are based on import tariff estimation Method 1: input tariffs and output tariffs as described in section 4.3.1. As a robustness check, we use import tariff estimation Method 2: imported intermediate-goods tariffs and imported final-goods tariffs to estimate the import tariffs and re-run the regressions. The results are reported in Table A3 in Appendix C. As shown in Table A3, the coefficients of the interaction of imported-input tariff change and RCA are negative in all columns. All of them are significant except for Column 7. Thus, the robustness checks further support our Proposition 2.

5.1.2 Testing Propositions 1 and 3

In a similar format as in Tables 1, Tables 2 and 3 report the regression results regarding the change in the fraction of exporting firms and the change in the share of exporting revenue in total revenue, respectively. The theory predicts that these impacts are larger in the sectors with stronger initial comparative advantage. As predicted, the coefficients of the interactive term "input tariff change x RCA" are negative in all columns in both tables. In Tables 2 and 3, we control for the change of input and output tariffs, revealed comparative advantage, and some **industry-level** characteristics such as average TFP, capital intensity, average wage and average firm size (measured by total employment). Columns 1-5 correspond to regressions using RCA_1, RCA_2, RCA_3, RCA_4, RCA_5, respectively as the RCA index. Columns 6-8 correspond to regressions using the log ranks of RCA_1, RCA_2 and RCA_3 as the RCA index.[36]

Table 2: Change in the fraction of exporting firms

RCA index	RCA_1	RCA_2	RCA_3	RCA_4	RCA_5	$Rank_1$	$Rank_2$	$Rank_3$
Regressor	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta duty_{ik}$	-0.955***	-0.881***	-0.208***	-0.979***	-0.301***	-0.230***	-0.234***	-0.200***
	(0.259)	(0.233)	(0.057)	(0.368)	(0.081)	(0.057)	(0.056)	(0.054)
$\mathbf{\Delta duty_{ik} \times RCA}$	-0.104***	-0.088***	-0.116**	-0.036**	-0.001***	-0.092***	-0.123***	-0.065**
	(0.031)	(0.026)	(0.046)	(0.015)	(0.000)	(0.030)	(0.035)	(0.026)
$\Delta duty_{ok}$	-0.093	-0.078	-0.023	-0.051	-0.041	-0.058	-0.002	-0.003
	(0.108)	(0.106)	(0.110)	(0.107)	(0.109)	(0.126)	(0.105)	(0.108)
RCA	-0.002	-0.000	0.006*	-0.000	0.000	-0.001	0.003	0.003*
	(0.001)	(0.001)	(0.004)	(0.001)	(0.000)	(0.002)	(0.002)	(0.002)
TFP	0.010***	0.011***	0.011***	0.011***	0.011***	0.011***	0.010***	0.011***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
log(Empl)	-0.003***	-0.003***	-0.003***	-0.003***	-0.003***	-0.003***	-0.003***	-0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
log(K/L)	0.000	0.000	0.001	0.000	0.001	0.000	0.001	0.001
	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)
log(Wage)	-0.009	-0.009	-0.008	-0.009	-0.009	-0.008	-0.008	-0.008
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2065	2065	2065	2065	2065	2065	2065	2065
R-squared	0.064	0.064	0.061	0.062	0.061	0.060	0.062	0.061

Note: ***Significant at the 1% level; **Significant at the 5% level; *Significant at the 10% level.

Robust standard errors is corrected at industry-level in parentheses.

[36] Column 1 in Tables 2 and 3 imply that a standard deviation increase in RCA raises the impact of imported-input tariff reductions on the fraction of exporting firms and the share of export revenue in total revenue both by 17.77%.

Table 3: Change in the share of export revenue in total revenue								
RCA index	RCA_1	RCA_2	RCA_3	RCA_4	RCA_5	$Rank_1$	$Rank_2$	$Rank_3$
Regressor	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta duty_{ik}$	-0.957***	-0.870***	-0.228***	-0.859***	-0.330***	-0.258***	-0.254***	-0.220***
	(0.295)	(0.271)	(0.088)	(0.263)	(0.1153)	(0.094)	(0.094)	(0.085)
$\mathbf{\Delta duty_{ik} \times RCA}$	-0.105***	-0.088***	-0.157***	-0.031***	-0.001***	-0.127***	-0.157***	-0.091***
	(0.032)	(0.027)	(0.058)	(0.010)	(0.0002)	(0.044)	(0.053)	(0.034)
$\Delta duty_{ok}$	-0.123	-0.101	-0.081	-0.060	-0.096	-0.164	-0.046	-0.056
	(0.103)	(0.101)	(0.106)	(0.108)	(0.1053)	(0.124)	(0.102)	(0.106)
RCA	0.000	0.001	0.010**	0.001	0.00004**	0.001	0.003*	0.004**
	(0.002)	(0.001)	(0.004)	(0.001)	(0.0000)	(0.001)	(0.002)	(0.002)
TFP	0.003	0.003	0.003	0.003	0.003	0.004	0.003	0.003
	(0.004)	(0.004)	(0.004)	(0.004)	(0.0042)	(0.004)	(0.004)	(0.004)
log(Empl)	-0.005***	-0.005***	-0.005***	-0.005***	-0.005***	-0.005***	-0.005***	-0.005***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.0010)	(0.001)	(0.001)	(0.001)
log(K/L)	0.007***	0.008***	0.008***	0.007***	0.008***	0.007***	0.008***	0.008***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.0023)	(0.002)	(0.002)	(0.002)
log(Wage)	-0.002	-0.002	-0.002	-0.003	-0.002	-0.002	-0.002	-0.002
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2065	2065	2065	2065	2065	2065	2065	2065
R-squared	0.062	0.062	0.061	0.060	0.062	0.060	0.061	0.060

Note: ***Significant at the 1% level; **Significant at the 5% level; *Significant at the 10% level.

Robust standard errors is corrected at industry-level in parentheses.

Using alternative measures of imported-input and imported-output tariffs

In Tables 2 and 3, all results are based on the input- and output-tariffs described in section 4.3.1. Similar robustness checks as reported in Table A3 are carried out and reported in Tables A4 and A5 in Appendix C. We can see that the coefficients of the interaction term of imported-input tariff reduction and RCA in all columns are negative. All of them are significant except for column 8 in Tables A4 and A5. Thus, the robustness checks further support our Propositions 1 and 3.

5.2 Further Tests

In Table 4, we report the results when we further control export tariff and its interaction term with RCA, $\mathbf{\Delta duty_{ek} \times RCA}$. In Table 4, we only report the results based on the index RCA_1. For other indexes, the results are qualitatively the same. Columns 1-2 correspond to the probability of exporting (Proposition 2); columns 3-4 correspond to the change in fraction of exporting firms (Proposition 1);

columns 5- 6 correspond to the change in share of export revenue (Proposition 3). The coefficients of the term "imported-input tariff change x RCA", $\mathbf{\Delta duty}_{ik}\times\mathbf{RCA}$**,** are still significantly negative in all columns. The coefficients of the interaction between export tariff change and RCA are insignificant, as the variations in changes of export tariff are too small. The above results by and large further support our theoretical predictions.

Table 4: Controlling for More Tariff Changes						
	The probability of entry		Change in export firms ratio		Change in export revenue ratio	
Regressor	Logit	Logit	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)
Δduty_{ik}	-13.220***	-13.153***	-0.818***	-0.819***	-0.807***	-0.807***
	(1.855)	(1.991)	(0.251)	(0.250)	(0.291)	(0.291)
$\mathbf{\Delta duty}_{ik}\times\mathbf{RCA}$	-1.729***	-1.721***	-0.090***	-0.090***	-0.092***	-0.092***
	(0.305)	(0.316)	(0.031)	(0.031)	(0.032)	(0.032)
Δduty_{ok}	-2.138	-2.182	0.006	0.002	-0.140	-0.138
	(3.220)	(3.242)	(0.110)	(0.111)	(0.097)	(0.097)
Δduty_{ek}	0.633	-0.356	-0.010	-0.221	0.026	0.089
	(0.478)	(4.792)	(0.026)	(0.259)	(0.020)	(0.465)
$\mathbf{\Delta duty}_{ek}\times\mathbf{RCA}$		-0.117		-0.024		0.007
		(0.565)		(0.029)		(0.052)
RCA	0.125***	0.125***	-0.002**	-0.002**	0.000	0.000
	(0.046)	(0.046)	(0.001)	(0.001)	(0.001)	(0.001)
TFP	0.036*	0.036*	0.008**	0.008**	0.004	0.004
	(0.020)	(0.020)	(0.004)	(0.004)	(0.004)	(0.004)
log(Empl)	0.298***	0.298***	-0.003***	-0.003***	-0.004***	-0.004***
	(0.019)	(0.019)	(0.001)	(0.001)	(0.001)	(0.001)
log(K/L)	0.025	0.025	0.000	0.000	0.006***	0.006***
	(0.018)	(0.018)	(0.002)	(0.002)	(0.002)	(0.002)
log(Wage)	0.295***	0.295***	-0.008	-0.008	-0.003	-0.003
	(0.026)	(0.026)	(0.005)	(0.005)	(0.006)	(0.006)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	370102	370102	2065	2065	2065	2065
R-squared			0.054	0.054	0.055	0.055
Note: ***Significant at the 1% level; **Significant at the 5% level; *Significant at the 10% level.						
Robust standard errors is corrected at industry-level in parentheses.						

6 More Robustness Checks

In this section, we run a battery of robustness checks to see whether our results continue to hold across various types of alternative specifications. Here, we report the results based on the index RCA_1. In some tables, we also report the results based on the log rank of the index RCA_1. For other RCA indexes, the results are qualitatively the same.[37]

6.1 Difference for Long Time

Table 5: Difference for Long Time

	The probability of entry			Change in export firms ratio			Change in export revenue ratio		
Regressor	Logit	Logit	Logit	OLS	OLS	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Year-difference	2-yr	3-yr	4-yr	2-yr	3-yr	4-yr	2-yr	3-yr	4-yr
Δduty_{ik}	-12.038***	-13.671***	-7.126**	-0.687**	-0.983***	-0.769**	-0.717***	-0.997***	-0.809*
	(2.600)	(2.912)	(2.949)	(0.280)	(0.251)	(0.348)	(0.263)	(0.340)	(0.414)
$\mathbf{\Delta duty}_{ik}\times\mathbf{RCA}$	-1.572***	-1.733***	-0.898**	-0.063*	-0.100***	-0.070*	-0.072**	-0.114***	-0.098**
	(0.356)	(0.385)	(0.371)	(0.034)	(0.030)	(0.041)	(0.032)	(0.041)	(0.046)
Δduty_{ok}	-2.710	-2.001	-3.020	-0.287*	-0.312*	-0.288	-0.160	-0.314**	-0.358**
	(2.887)	(2.856)	(2.787)	(0.157)	(0.165)	(0.183)	(0.141)	(0.151)	(0.162)
RCA	0.128***	0.143***	0.149***	-0.003	-0.002	-0.006	0.002	0.005	0.002
	(0.045)	(0.047)	(0.051)	(0.003)	(0.005)	(0.006)	(0.003)	(0.005)	(0.007)
TFP	0.078***	0.106***	0.128***	0.014**	0.023**	0.027*	0.005	0.006	0.002
	(0.023)	(0.024)	(0.028)	(0.006)	(0.011)	(0.015)	(0.007)	(0.010)	(0.017)
log(Empl)	0.287***	0.279***	0.257***	-0.007***	-0.013***	-0.012***	-0.011***	-0.017***	-0.021***
	(0.020)	(0.022)	(0.024)	(0.002)	(0.003)	(0.004)	(0.002)	(0.003)	(0.004)
log(K/L)	0.060***	0.093***	0.096***	0.003	-0.003	-0.006	0.012***	0.017***	0.021***
	(0.021)	(0.024)	(0.023)	(0.004)	(0.006)	(0.007)	(0.004)	(0.006)	(0.007)
log(Wage)	0.238***	0.234***	0.183***	-0.020*	-0.027*	-0.027	-0.001	-0.003	0.002
	(0.029)	(0.031)	(0.036)	(0.011)	(0.016)	(0.020)	(0.010)	(0.016)	(0.022)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	224581	116715	63646	1652	1239	826	1652	1239	826
R-squared				0.098	0.140	0.160	0.127	0.184	0.234

Note: ***Significant at the 1% level; **Significant at the 5% level; *Significant at the 10% level.

Robust standard errors is corrected at industry-level in parentheses.

[37] Here, we use input and output tariffs as measures of imported-input tariff and imported-output tariffs. If we use the imported intermediate-goods tariff and imported final-good tariff built on the merged data to carry out a robust check, our results still hold qualitatively. The results are available upon request.

Our main results are based on one-year difference, i.e. the change is between t and $t+1$. In Table 5, we report the impacts on the LHS variables based on two-year difference, three-year difference and four-year difference. In the corresponding columns, the change in duties, $\Delta\text{duty}_{ik}$and Δduty_{ok} are also based on two-year difference, three-year difference and four-year difference respectively. Here, we only report the results based on the index RCA_1. For other indexes, the results are qualitatively the same. Columns 1-3 correspond to the probability of exporting; columns 4-6 corresponds to the change in the fraction of exporting firms; columns 7-9 corresponds to the change in the share of export revenue. The coefficients of the interaction of input tariff change and RCA are significantly negative in all columns. Thus, the robustness checks further support Propositions 1-3.

6.2 Processing and Ordinary Trade

We may want to focus on only non-processing trade firms in our empirical estimation, as tariff reduction of imported intermediate goods should have little impact on processing-trade firms, whose imported inputs were tariff-free. It is only possible to distinguish between processing and ordinary trade when using the customs data set. To carry out this robustness check, we use the merged data of the firm-level manufacturing survey data set with the customs data set to distinguish between firms that engage in processing trade, ordinary trade and hybrid trade (firms engaged in both processing trade and ordinary trade). Thus, the processing-trade and hybrid-trade firms are dropped from our sample and the regressions are rerun.[38] Table 6 shows that the results continue to hold when we eliminate the processing-trade and hybrid-trade firms. In Table 6, columns 1 and 4 correspond to the probability of exporting; columns 2 and 5 correspond to the change in the fraction of exporting firms; columns 3 and 6 correspond to the change in share of export revenue. In columns 1-3, we use RCA_1 to proxy for revealed comparative advantage. In columns 4-6, we use the log rank of RCA_1 as the proxy.

[38] When the merged data is used, many observations are lost due to mismatch and only the large firms are left. As a result, the changes in the fraction of exporting firms and changes in the share of export revenue that we compute based on the merged data may not reflect a representative picture of the impacts of changes in imported-inputs and imported-outputs. It would not be proper to use the entire merged data set to test Propositions 1-3 since these propositions concern resource allocations across sectors, which highly depend on the behavior of small firms. Therefore, we purged the processing-trade and hybrid-trade firms from the merged data set before we re-test our Propositions 1-3.

Table 6: Eliminating processing trade and hybrid trade firms						
	RCA			Rank_{RCA}		
	Prob	Frac	Share	Prob	Frac	Share
Regressor	Logit	OLS	OLS	Logit	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)
Δduty_{ik}	-13.318***	-1.060***	-1.085***	-2.824**	-0.216***	-0.256***
	(1.824)	(0.320)	(0.314)	(1.230)	(0.061)	(0.088)
$\Delta\text{duty}_{ik}\times$RCA	-1.742***	-0.118***	-0.123***	-3.486*	-0.086***	-0.136***
	(0.297)	(0.039)	(0.036)	(1.939)	(0.032)	(0.043)
Δduty_{ok}	-2.269	-0.065	-0.172	-3.877	-0.003	-0.194
	(3.354)	(0.114)	(0.119)	(4.061)	(0.130)	(0.142)
RCA	0.125***	-0.001	-0.001	0.313***	-0.001	0.000
	(0.046)	(0.001)	(0.002)	(0.072)	(0.002)	(0.001)
TFP	0.039**	0.012***	-0.000	0.038**	0.012***	0.001
	(0.020)	(0.003)	(0.005)	(0.019)	(0.003)	(0.005)
log(Empl)	0.264***	-0.003***	-0.004***	0.266***	-0.003***	-0.004***
	(0.020)	(0.001)	(0.001)	(0.020)	(0.001)	(0.001)
log(K/L)	0.007	-0.001	0.005*	0.010	-0.002	0.005*
	(0.018)	(0.003)	(0.003)	(0.018)	(0.003)	(0.003)
log(Wage)	0.248***	-0.008	0.002	0.252***	-0.007	0.002
	(0.027)	(0.005)	(0.007)	(0.026)	(0.005)	(0.007)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	364038	2065	2065	364038	2065	2065
R-squared		0.056	0.058		0.051	0.055
Note: *** Significant at the 1% level; ** Significant at the 5% level; *Significant at the 10% level.						
Robust standard errors is corrected at industry-level in parentheses.						

6.3 RCA based on final goods only

In the benchmark, we use the traditional methods to measure RCA indexes. However, it might be argued that it is more appropriate to use only the data on trade values of final goods to calculate the revealed comparative advantage index. As a robustness check, we eliminate intermediate goods and capital goods which are used as production inputs from the bilateral trade flow data from CEPII, based on the Broad Economic Categories (BEC) classification. Then we recalculate the revealed comparative advantage index.[39] Table 7 shows that the results continue to hold after such a modification. In Table 7, columns 1 and 4 correspond to the probability of exporting; columns 2 and 5 correspond to the change in fraction of exporting firms; columns 3 and 6 correspond to the change in share of export revenue. In

[39] If we only delete the intermediate goods when recalculating the revealed comparative advantage, the results would be similar.

columns 1-3, we use RCA_1 to proxy for revealed comparative advantage. In columns 4-6, we use the log rank of RCA_1 as the proxy.

Table 7: RCA based on final goods only						
RCA index	RCA			$Rank_{RCA}$		
	Prob	Frac	Share	Prob	Frac	Share
Regressor	Logit	OLS	OLS	Logit	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta duty_{ik}$	-8.760**	-0.875***	-1.076***	-1.403	-0.223***	-0.245**
	(3.566)	(0.253)	(0.365)	(1.087)	(0.056)	(0.096)
$\Delta duty_{ik} \times RCA$	-1.144**	-0.089***	-0.116***	-0.088	-0.052***	-0.068**
	(0.481)	(0.029)	(0.039)	(0.527)	(0.018)	(0.027)
$\Delta duty_{ok}$	5.388	-0.055	-0.160	5.232	0.040	-0.106
	(3.522)	(0.114)	(0.122)	(3.727)	(0.130)	(0.142)
RCA	0.075	-0.001	-0.000	0.448***	-0.004	0.002
	(0.056)	(0.002)	(0.002)	(0.110)	(0.003)	(0.003)
TFP	0.027	0.009**	0.003	0.029	0.009**	0.004
	(0.020)	(0.004)	(0.005)	(0.020)	(0.004)	(0.005)
log(Empl)	0.312***	-0.004***	-0.005***	0.318***	-0.004***	-0.006***
	(0.019)	(0.001)	(0.001)	(0.019)	(0.001)	(0.001)
log(K/L)	0.020	0.001	0.007***	0.025	0.001	0.007***
	(0.020)	(0.003)	(0.002)	(0.019)	(0.003)	(0.002)
log(Wage)	0.296***	-0.008	0.000	0.295***	-0.008	-0.001
	(0.026)	(0.006)	(0.008)	(0.025)	(0.006)	(0.008)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	297262	1800	1800	297262	1800	1800
R-squared		0.070	0.064		0.068	0.061
Note: ***Significant at the 1% level; **Significant at the 5% level; *Significant at the 10% level.						
Robust standard errors is corrected at industry-level in parentheses.						

6.4 Sensitivity to Currency Appreciation and Multi-Fibre Arrangement

Our main results show the effect of imported-input trade liberalization on exporting behavior in China. It should be noted that prices of imported goods were mostly denominated in US dollars. One may be concerned that the appreciation of *Renminbi* (Chinese currency, hereafter RMB) would affect firms' export behavior. It is possible that a stronger RMB reduces firms' costs of purchasing imported inputs with the local currency, and hence improves firms' competitiveness in the foreign market. To test the sensitivity of our results to RMB appreciation, we only use the data during the period before the appreciation to test propositions 1-3. As RMB appreciated in late 2005, we dropped data for 2005 and 2006, and use the sample in the years 2001-2004 to test our propositions. We use RCA_1 to proxy for revealed comparative advantage. Column 1-3 in Table 8 reports the results and all coefficients on $\Delta\text{duty}_{ik}\times\text{RCA}$ are significantly negative, consistent with the prediction of the theory. In Table 8, columns 1 and 4 correspond to the probability of exporting; columns 2 and 5 corresponds to the change in the fraction of exporting firms; columns 3 and 6 corresponds to the change in the share of export revenue.

In columns 4-6, we test the sensitivity of our results to Multi-Fibre Arrangement (MFA). In order to do this, we delete the textile sectors.[40] The rationale behind this robustness check is that under the MFA, developed countries were allowed to impose quotas on the amount of textile and garments imported from the developing countries. Before the expiration of the MFA on January 1 2005, the quotas served as higher trade barriers when compared to the tariff rates in these textile sectors. The tariff-equivalent measures of these quotas are not easy to obtain and might not be precise. In order to prevent the bias caused by the MFA, we delete the textile sectors, re-run the regressions and obtain the results in columns 4 to 6 of Table 8. All coefficients on $\Delta\text{duty}_{ik}\times\text{RCA}$ are negative and mostly significant and consistent with the prediction of the theory.

[40] We delete sectors 17, 18 and 19. Sector 17 is Manufacture of Textile; sector 18 is Manufacture of Textile Wearing Apparel, Footware, and Caps; sector 19 is Manufacture of Leather, Fur, Feather and Related Products.

Table 8: Sensitivity to Currency Appreciation and Multi-fibre Agreement						
	No Currency Appreciation			Without Multi-fibre Agreement		
	Prob	Frac	Share	Prob	Frac	Share
Regressor	Logit	OLS	OLS	Logit	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)
Δduty_{ik}	-13.078***	-0.777***	-0.755**	-20.741***	-1.150	-1.206**
	(2.013)	(0.275)	(0.335)	(4.436)	(0.744)	(0.486)
$\Delta \text{duty}_{ik} \times \text{RCA}$	-1.727***	-0.084**	-0.081**	-2.535***	-0.123	-0.132**
	(0.311)	(0.033)	(0.037)	(0.475)	(0.083)	(0.054)
Δduty_{ok}	-1.640	-0.111	-0.111	-0.923	-0.067	-0.113
	(3.735)	(0.116)	(0.120)	(3.544)	(0.110)	(0.100)
RCA	0.134***	-0.001	0.001	0.126**	-0.001	0.000
	(0.044)	(0.002)	(0.002)	(0.061)	(0.002)	(0.002)
TFP	0.072***	0.008*	0.001	0.057***	0.011***	0.003
	(0.021)	(0.004)	(0.005)	(0.017)	(0.004)	(0.004)
log(Empl)	0.283***	-0.004***	-0.005***	0.301***	-0.003***	-0.005***
	(0.019)	(0.001)	(0.001)	(0.022)	(0.001)	(0.001)
log(K/L)	0.029	0.002	0.006**	0.051***	0.000	0.008***
	(0.019)	(0.003)	(0.002)	(0.018)	(0.003)	(0.002)
log(Wage)	0.240***	-0.008	-0.002	0.292***	-0.008	-0.003
	(0.027)	(0.006)	(0.008)	(0.029)	(0.006)	(0.007)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	270407	1652	1652	327495	1900	1900
R-squared		0.035	0.050		0.050	0.052
Note: ***Significant at the 1% level; **Significant at the 5% level; *Significant at the 10% level.						
Robust standard errors is corrected at industry-level in parentheses.						

6.5 Endogeneity Issue

Although we use the measurements in the year 2000 trying to avoid the endogeneity issue, these RCA variables are still the outcomes of domestic policies at regional and/or industrial level. To alleviate the endogeneity issue, we compute the RCA measure of a similar country in terms of location, population and development level.[41] This RCA measure should be highly correlated to China's measurement, but not affected by Chinese policies. We choose the country, which have the similar GDP per capita and population, among the countries sharing the common border with China. Based on this principle, we choose India and use the Indian RCA instead of the RCA of China to check for the robustness of our results. The RCA measure of India is highly correlated to China's measurement, and it affects firm's export performance only though its impact on China's RCA. The empirical results based on Indian

[41] Thanks to the referee for the suggestion.

RCA are reported in Table 9, which is consistent with our predictions. In Table 9, columns 1 and 4 correspond to the probability of exporting; columns 2 and 5 correspond to the change in fraction of exporting firms; columns 3 and 6 correspond to the change in share of export revenue. In columns 1-3, we use RCA of India to proxy for revealed comparative advantage. In columns 4-6, we use the log rank of Indian RCA as the proxy.

Table 9: Endogeneity Issue based on India RCA

RCA index	RCA			Rank_{RCA}		
	Prob	Frac	Share	Prob	Frac	Share
Regressor	Logit	OLS	OLS	Logit	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)
Δduty_{ik}	-4.728*	-0.360***	-0.468**	-1.844*	-0.178***	-0.197**
	(2.511)	(0.111)	(0.201)	(1.107)	(0.052)	(0.083)
$\Delta\text{duty}_{ik}\times$RCA	-0.258*	-0.013**	-0.019**	-1.016*	-0.028*	-0.043*
	(0.140)	(0.005)	(0.009)	(0.591)	(0.016)	(0.022)
Δduty_{ok}	1.792	0.011	-0.033	2.316	0.045	0.012
	(3.072)	(0.109)	(0.104)	(3.073)	(0.106)	(0.107)
RCA	0.014	-0.000	0.000	0.113	0.002	0.004*
	(0.020)	(0.000)	(0.001)	(0.082)	(0.002)	(0.002)
TFP	0.035*	0.011***	0.003	0.035*	0.011***	0.003
	(0.019)	(0.004)	(0.004)	(0.019)	(0.004)	(0.004)
log(Empl)	0.294***	-0.003***	-0.005***	0.296***	-0.003***	-0.005***
	(0.020)	(0.001)	(0.001)	(0.020)	(0.001)	(0.001)
log(K/L)	0.023	0.000	0.007***	0.023	0.000	0.007***
	(0.018)	(0.002)	(0.002)	(0.018)	(0.003)	(0.002)
log(Wage)	0.295***	-0.008	-0.002	0.295***	-0.008	-0.002
	(0.027)	(0.006)	(0.007)	(0.027)	(0.006)	(0.007)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	297262	1800	1800	297262	1800	1800
R-squared		.0595	.0592		.0596	.0593

Note: ***Significant at the 1% level; **Significant at the 5% level; *Significant at the 10% level.

Robust standard errors is corrected at industry-level in parentheses.

7 Conclusion

We have built a trade model to capture the special characteristics of the Chinese economy, namely that Chinese firms imported mostly intermediate goods and exported mostly final goods in the year just before and some years just after China's accession to the WTO in 2001. We use this as a natural experiment to test how final-goods producers' entry, exit, output and exporting decisions respond to trade liberalization in imported intermediate goods, and how these responses differ across sectors.

Our theoretical model incorporates Ricardian comparative advantage into a multi-sector, two-country version of Melitz's (2003) monopolistic competition model with heterogeneous final-goods firms, which produce using intermediate goods and labor. We use the model to explain how comparative advantage, economies of scale and firm heterogeneity interact to give rise to inter-industry trade and intra-industry trade. We then analyze the effects of imported-input trade liberalization in the intra-industry trade sectors. We decompose the total effect of imported-input trade liberalization into those caused by inter-sectoral resource allocation (which we call IRA effect) and by the within-sector selection of firms according to productivity (which we call Melitz selection effect).

We argue that it is the IRA effect that drives the differential impacts of imported-input trade liberalization in different sectors with regard to variables such as the probability of entry into export market, the fraction of firms that export and the share of export revenue. To test our hypotheses, we carry out both quantitative analysis and empirical analysis by using Chinese firm-level data. The results are consistent with our theoretical predictions.

Appendixes

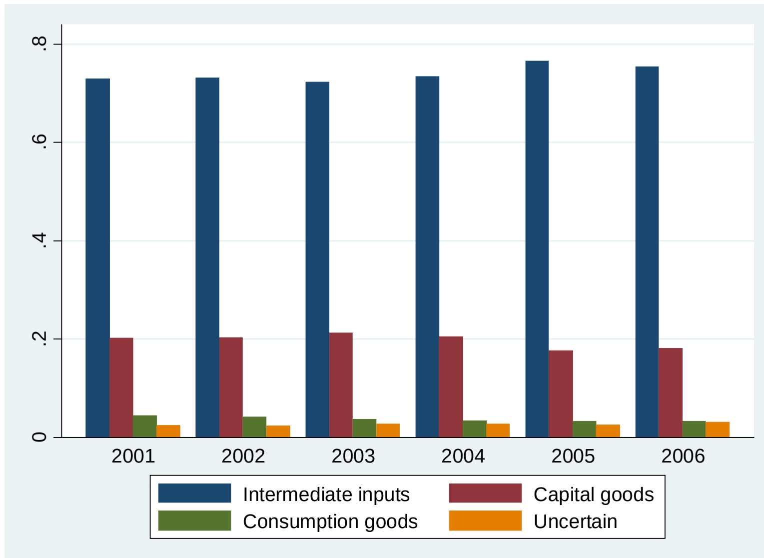

Figure A1. The percentages of types of goods imported by China by year.

A Solving the System

In this appendix, we will show how to solve the model for the sectors in which both countries produce. In other words, we solve for $(\overline{\varphi}_{dk},\ \overline{\varphi}^*_{dk},\ \overline{\varphi}_{xk},\ \overline{\varphi}^*_{xk},\ \theta_{dk},\ \theta^*_{dk})$ from the system constituted of the four ZCP conditions and two FE conditions. Combining the two ZCP conditions for firms serving the Home market, (21) and (24), we have

$$\frac{\overline{\varphi}^*_{xk}}{\overline{\varphi}_{dk}} = \widetilde{a}_k \left(\frac{B_{2k} f_x}{f}\right)^{\frac{1}{\gamma}} \tag{19}$$

Similarly, combining ZCP for firms serving Foreign's market, (22) and (23), we can get

$$\frac{\overline{\varphi}_{xk}}{\overline{\varphi}^*_{dk}} = \frac{1}{\widetilde{a}_k} \left(\frac{B_{1k} f_x}{f}\right)^{\frac{1}{\gamma}} \tag{20}$$

The ZCP conditions are given by

$$r_{dk}(\overline{\varphi}_{dk}) = \beta_k L \left[P_k \frac{\widetilde{\rho} A_k}{(c_k)^{\mu}} \overline{\varphi}_{dk} \right]^{\sigma-1} = \sigma f \tag{21}$$

$$r^*_{dk}(\overline{\varphi}^*_{dk}) = \beta_k L^* \left[P^*_k \frac{\widetilde{\rho} A^*_k}{(c^*_k)^{\mu}} \overline{\varphi}^*_{dk} \right]^{\sigma-1} = \sigma f \tag{22}$$

$$r_{xk}(\overline{\varphi}_{xk}) = \beta_k L^* \left[\frac{P^*_k}{\tau_{xk}} \frac{\widetilde{\rho} A_k}{(c_k)^{\mu}} \overline{\varphi}_{xk} \right]^{\sigma-1} = \sigma f_x \tag{23}$$

$$r^*_{xk}(\overline{\varphi}^*_{xk}) = \beta_k L \left[\frac{P_k}{\tau^*_{xk}} \frac{\widetilde{\rho} A^*_k}{(c^*_k)^{\mu}} \overline{\varphi}^*_{xk} \right]^{\sigma-1} = \sigma f_x \tag{24}$$

Let $\widetilde{\pi}_k$ and $\widetilde{\pi}^*_k$ denote the average profit flow of a surviving firm in sector k in Home and Foreign respectively. It can be easily shown that[42]

$$\widetilde{\pi}_k = \pi_{dk}(\widetilde{\varphi}_{dk}) + \left[\frac{1 - G(\overline{\varphi}_{xk})}{1 - G(\overline{\varphi}_{dk})} \right] \pi_{xk}(\widetilde{\varphi}_{xk}) = \frac{\sigma - 1}{\gamma - \sigma + 1} \left[f + \left(\frac{\overline{\varphi}_{dk}}{\overline{\varphi}_{xk}} \right)^{\gamma} f_x \right]$$

$$\widetilde{\pi}^*_k = \pi^*_{dk}(\widetilde{\varphi}^*_{dk}) + \left[\frac{1 - G(\overline{\varphi}^*_{xk})}{1 - G(\overline{\varphi}^*_{dk})} \right] \pi^*_{xk}(\widetilde{\varphi}^*_{xk}) = \frac{\sigma - 1}{\gamma - \sigma + 1} \left[f + \left(\frac{\overline{\varphi}^*_{dk}}{\overline{\varphi}^*_{xk}} \right)^{\gamma} f_x \right].$$

A firm will enter if its expected post-entry profit is above the fixed cost of entry. The free entry (FE) condition determines that the entry cost is equal to the post-entry expected economic profits. Hence, the FE conditions for Home and Foreign are, respectively

$$f_e = [1 - G(\overline{\varphi}_{dk})] \widetilde{\pi}_k = \left(\frac{\sigma - 1}{\gamma - \sigma + 1} \right) \left[f \cdot (\overline{\varphi}_{dk})^{-\gamma} + f_x \cdot (\overline{\varphi}_{xk})^{-\gamma} \right] \tag{25}$$

$$f_e = [1 - G(\overline{\varphi}^*_{dk})] \widetilde{\pi}^*_k = \left(\frac{\sigma - 1}{\gamma - \sigma + 1} \right) \left[f \cdot (\overline{\varphi}^*_{dk})^{-\gamma} + f_x \cdot (\overline{\varphi}^*_{xk})^{-\gamma} \right] \tag{26}$$

Equations (19), (20), and the FE conditions (25) and (26) now form a system of four equations and four unknowns, $\overline{\varphi}_{dk}$, $\overline{\varphi}_{xk}$, $\overline{\varphi}^*_{dk}$ and $\overline{\varphi}^*_{xk}$. Solving, we obtain (5), (6), (7) and (8).

Then, recall that the aggregate price indexes for final goods are given by $P_k = (\theta_k)^{\frac{1}{1-\sigma}} p_{dk}(\widetilde{\varphi}_k)$ and $P^*_k = (\theta^*_k)^{\frac{1}{1-\sigma}} p^*_{dk}(\widetilde{\varphi}^*_k)$. Substituting these price indexes into ZCP conditions (21) and (22), and, with the help of equations (2) and (3), we have

$$\sigma f = \frac{\beta_k L}{\theta_k} \left(\frac{\overline{\varphi}_{dk}}{\widetilde{\varphi}_k} \right)^{\sigma-1} = \left(\frac{\gamma - \sigma + 1}{\gamma} \right) \cdot \frac{\beta_k L}{\theta_{dk} + \theta^*_{xk} \frac{f_x}{f}} \tag{27}$$

$$\sigma f = \frac{\beta_k L^*}{\theta^*_k} \left(\frac{\overline{\varphi}^*_{dk}}{\widetilde{\varphi}^*_k} \right)^{\sigma-1} = \left(\frac{\gamma - \sigma + 1}{\gamma} \right) \cdot \frac{\beta_k L^*}{\theta^*_{dk} + \theta_{xk} \frac{f_x}{f}} \tag{28}$$

[42] $\widetilde{\pi}_{dk} \equiv \pi_{dk}(\widetilde{\varphi}_{dk}) = \frac{r_{dk}(\widetilde{\varphi}_{dk})}{\sigma} - f = \frac{1}{\sigma} \left(\frac{\widetilde{\varphi}_{dk}}{\overline{\varphi}_{dk}} \right)^{\sigma-1} r_{dk}(\overline{\varphi}_{dk}) - f = f \left[\left(\frac{\widetilde{\varphi}_{dk}}{\overline{\varphi}_{dk}} \right)^{\sigma-1} - 1 \right] = f \cdot \frac{\sigma-1}{\gamma-\sigma+1}$. The third equality arises from the fact that $\left(\frac{\widetilde{\varphi}_{dk}}{\overline{\varphi}_{dk}} \right)^{\sigma-1} = \frac{r_{dk}(\widetilde{\varphi}_{dk})}{r_{dk}(\overline{\varphi}_{dk})}$. The fourth equality comes from the fact that $\sigma f = r_{dk}(\overline{\varphi}_{dk})$, which is the ZCP condition above. The fifth equality comes from equation (4). Furthermore, $\widetilde{\pi}_{xk} = f_x \left(\frac{\sigma-1}{\gamma-\sigma+1} \right)$ can be derived from similar steps as above by replacing the subscript "d" by "x" and the variable f by f_x. Finally, note that $1 - G(\varphi) = \varphi^{-\gamma}$.

From the equilibrium productivity cutoffs (5) and (6) in both countries, we get

$$\left(\frac{\overline{\varphi}_{dk}}{\overline{\varphi}^*_{dk}}\right)^{\gamma} = \frac{B_{1k}}{B_{2k}}\left[\frac{B_{2k}-\widetilde{a}_k^{-\gamma}}{B_{1k}-\widetilde{a}_k^{\gamma}}\right] \tag{29}$$

Therefore, the number of exporting firms in Home and Foreign are respectively

$$\theta_{xk} = \left(\frac{\overline{\varphi}_{dk}}{\overline{\varphi}_{xk}}\right)^{\gamma}\theta_{dk} = \left(\widetilde{a}_k\frac{\overline{\varphi}_{dk}}{\overline{\varphi}^*_{dk}}\right)^{\gamma}\left(\frac{f}{B_{1k}f_x}\right)\theta_{dk} \tag{30}$$

$$\theta^*_{xk} = \left(\frac{\overline{\varphi}^*_{dk}}{\overline{\varphi}^*_{xk}}\right)^{\gamma}\theta^*_{dk} = \left(\frac{\overline{\varphi}^*_{dk}}{\widetilde{a}_k\overline{\varphi}_{dk}}\right)^{\gamma}\left(\frac{f}{B_{2k}f_x}\right)\theta^*_{dk} \tag{31}$$

Equations (27), (28), (29), (30), (31) then imply (9) and (10).

θ_{xk} and θ^*_{xk} can be obtained by substituting (29), (9), (10) into (30) and (31) respectively.

A.1 Solutions for One-way Trade Sectors

In sector k, Home will not produce *iff* $a_k \leq a_{k1}$, where

$$(a_{k1})^{\gamma} = \left[\frac{T^* + T\cdot(\tau^*_{ik})^{-\lambda}}{T + T^*\cdot(\tau_{ik})^{-\lambda}}\right]^{\mu\gamma/\lambda}\left[\frac{B_{1k}\left(\frac{L}{L^*}+1\right)}{B_{1k}B_{2k}\frac{L}{L^*}+1}\right]; \tag{32}$$

and Foreign will not produce in sector k *iff* $a_k \geq a_{k_2}$, where[43]

$$(a_{k2})^{\gamma} = \left[\frac{T^* + T\cdot(\tau^*_{ik})^{-\lambda}}{T + T^*\cdot(\tau_{ik})^{-\lambda}}\right]^{\mu\gamma/\lambda}\left[\frac{B_{1k}B_{2k}\frac{L^*}{L}+1}{B_{2k}\left(\frac{L^*}{L}+1\right)}\right]. \tag{33}$$

Therefore, the solutions to (5)-(10) are valid if and only if $a_k \in (a_{k1},\, a_{k2})$.

When $a_k \notin (a_{k1},\, a_{k2})$, the number of surviving firms in one of the countries solved from the system (5)-(10) is negative. In that case, there is no interior solution to some of the equations in the system. This reflects the fact that no firm from that country enters in sector k, which means that the other country completely dominates that sector. Therefore, a different set of equations need to be solved for this case. Without loss of generality, we consider the **Home-dominated sectors**. Because only Home's firms sell in each country, the aggregate price indexes become

$$P_k = (\theta_{dk})^{\frac{1}{1-\sigma}}\frac{(c_k)^{\mu}}{\widetilde{\rho}A_k\widetilde{\varphi}_{dk}}$$

$$P^*_k = (\theta_{xk})^{\frac{1}{1-\sigma}}\frac{\tau_{xk}\,(c_k)^{\mu}}{\widetilde{\rho}A_k\widetilde{\varphi}_{xk}}$$

Nonetheless, the two zero cutoff profit conditions for Home, (21) and (23), continue to hold.

[43] Because $\frac{B_{1k}B_{2k}\frac{L^*}{L}+1}{B_{2k}\left(\frac{L^*}{L}+1\right)} > \frac{B_{1k}\left(\frac{L}{L^*}+1\right)}{B_{1k}B_{2k}\frac{L}{L^*}+1}$ holds, we always have $a_{k_1} < a_{k_2}$.

Moreover, the free entry condition (25) for Home's firms continues to hold. Thus, solving the diminished system of three equations (21), (23), (25) for three unknowns, we have

$$\theta_{dk} = \frac{\beta_k L}{\sigma f}\left(\frac{\gamma-\sigma+1}{\gamma}\right) = D_2(k)\,L$$
$$\theta_{xk} = \frac{\beta_k L^*}{\sigma f_x}\left(\frac{\gamma-\sigma+1}{\gamma}\right) = D_2(k)\,\frac{f}{f_x}L^*$$
$$(\overline{\varphi}_{dk})^\gamma = \frac{L+L^*}{L}D_1.$$

Furthermore, we can easily obtain $(\overline{\varphi}_{xk})^\gamma = \left(\frac{L+L^*}{L^*}\right)\frac{f_x}{f}D_1$ by noting that $\theta_{xk} = \frac{1-G(\overline{\varphi}_{xk})}{1-G(\overline{\varphi}_{dk})}\theta_{dk}$. An analogous set of solutions for the Foreign-dominated sectors can be obtained.[44]

Thus we can sort the sectors into three types according to Home's strength of comparative advantage. When $a_k \geq a_{k2}$ ($a_k \leq a_{k1}$), only Home (Foreign) produces in sector k, and there is one-way trade. When $a_k \in (a_{k1}, a_{k2})$, both countries produce in sector k, and there is two-way trade. Assuming that $a'(k) > 0$, that τ_{xk}, τ_{ik}, τ^*_{xk}, τ^*_{ik} and β_k are equal across sectors, and that $L < L^*$, we obtain three zones of international specialization as shown in Figure A2. The upward sloping curve (including the dotted portions) corresponds to equation (9), while the downward sloping curve (including the dotted portions) corresponds to equation (10). The horizontal portion of θ_{dk} in the diagram corresponds to the equation for θ_{dk} above when Home dominates sector k completely. The horizontal portion of θ^*_{dk} corresponds to the analogous equation for Foreign.

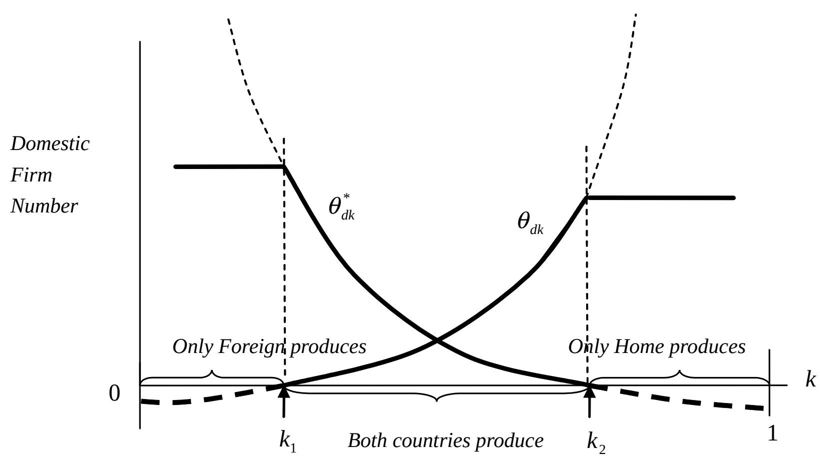

Figure A2. Three Zones of International Specialization (assumption: (i) a_k increases in k, (ii) tariffs on imported-inputs, imported-outputs, exported-inputs and exported-outputs and expenditure shares β_k are equal across sectors; (iii) $L < L^*$).

[44] The uniqueness of the above equilibrium is proved in an appendix posted on the corresponding author's homepage at http://ihome.ust.hk/~elai/ or upon request.

Table A1 below summarizes the equilibrium values of the endogenous variables of the system.

Table A1: Solution of the System

Sector type	Foreign-dominated	Two-way trade	Home-dominated
	$k < k_1$	$k_1 < k < k_2$	$k > k_2$
$(\overline{\varphi}_{dk})^{\gamma}$	$\varnothing$	$D_1 \left[\frac{B_{1k}-B_{2k}^{-1}}{B_{1k}-\widetilde{a}_k^{\gamma}}\right]$	$D_1 \frac{L+L^*}{L}$
$(\overline{\varphi}_{xk})^{\gamma}$	$\varnothing$	$D_1 \left[\frac{B_{2k}-B_{1k}^{-1}}{B_{2k}-\widetilde{a}_k^{-\gamma}}\right] \frac{1}{\widetilde{a}_k^{\gamma}} \left(\frac{B_{1k} f_x}{f}\right)$	$D_1 \frac{f_x}{f} \left(\frac{L+L^*}{L^*}\right)$
$(\overline{\varphi}^*_{dk})^{\gamma}$	$D_1 \frac{L+L^*}{L^*}$	$D_1 \left[\frac{B_{2k}-B_{1k}^{-1}}{B_{2k}-\widetilde{a}_k^{-\gamma}}\right]$	$\varnothing$
$(\overline{\varphi}^*_{xk})^{\gamma}$	$D_1 \frac{f_x}{f} \frac{L+L^*}{L}$	$D_1 \left[\frac{B_{1k}-B_{2k}^{-1}}{B_{1k}-\widetilde{a}_k^{\gamma}}\right] \widetilde{a}_k^{\gamma} \left(\frac{B_{2k} f_x}{f}\right)$	$\varnothing$
θ_{dk}	0	$D_2(k) \left[\frac{B_{1k} L - \frac{B_{1k}-\widetilde{a}_k^{\gamma}}{B_{2k}\widetilde{a}_k^{\gamma}-1} L^*}{B_{1k}-B_{2k}^{-1}}\right]$	$D_2(k)\, L$
θ_{xk}	0	$\left(\frac{\overline{\varphi}_{dk}}{\overline{\varphi}_{xk}}\right)^{\gamma} \theta_{dk}$	$D_2(k) \frac{f}{f_x} L^*$
θ^*_{dk}	$D_2(k)\, L^*$	$D_2(k) \left[\frac{B_{2k} L^* - \frac{B_{2k}\widetilde{a}_k^{\gamma}-1}{B_{1k}-\widetilde{a}_k^{\gamma}} L}{B_{2k}-B_{1k}^{-1}}\right]$	0
θ^*_{xk}	$D_2(k) \frac{f}{f_x} L$	$\left(\frac{\overline{\varphi}^*_{dk}}{\overline{\varphi}^*_{xk}}\right)^{\gamma} \theta^*_{dk}$	0
P_k	$\left[D_2(k) \frac{f}{f_x} L\right]^{\frac{1}{1-\sigma}} \frac{\tau^*_{xk}(c^*_k)^{\mu}}{\widetilde{\rho} A^*_k \widetilde{\varphi}^*_{xk}}$	$[D_2(k)\, L]^{\frac{1}{1-\sigma}} \frac{(c_k)^{\mu}}{\widetilde{\rho} A_k \widetilde{\varphi}_{dk}}$	$[D_2(k)\, L]^{\frac{1}{1-\sigma}} \frac{(c_k)^{\mu}}{\widetilde{\rho} A_k \widetilde{\varphi}_{dk}}$
P^*_k	$[D_2(k)\, L^*]^{\frac{1}{1-\sigma}} \frac{(c^*_k)^{\mu}}{\widetilde{\rho} A^*_k \widetilde{\varphi}^*_{dk}}$	$[D_2(k)\, L^*]^{\frac{1}{1-\sigma}} \frac{(c^*_k)^{\mu}}{\widetilde{\rho} A^*_k \widetilde{\varphi}^*_{dk}}$	$\left[D_2(k) \frac{f}{f_x} L^*\right]^{\frac{1}{1-\sigma}} \frac{\tau_{xk}(c_k)^{\mu}}{\widetilde{\rho} A_k \widetilde{\varphi}_{xk}}$

$$D_1 = \left(\frac{\sigma-1}{\gamma-\sigma+1}\right)\frac{f}{f_e}\ ; \quad D_2(k) = \left(\frac{\gamma-\sigma+1}{\gamma}\right)\frac{\beta_k}{\sigma f}\ ;$$

$$(a_{k_1})^{\gamma} = \left[\frac{T^* + T\cdot(\tau^*_{ik})^{-\lambda}}{T + T^*\cdot(\tau_{ik})^{-\lambda}}\right]^{\mu\gamma/\lambda} \left[\frac{B_{1k}\left(\frac{L}{L^*}+1\right)}{B_{1k}B_{2k}\frac{L}{L^*}+1}\right]$$

$$(a_{k_2})^{\gamma} = \left[\frac{T^* + T\cdot(\tau^*_{ik})^{-\lambda}}{T + T^*\cdot(\tau_{ik})^{-\lambda}}\right]^{\mu\gamma/\lambda} \left[\frac{B_{1k}B_{2k}\frac{L^*}{L}+1}{B_{2k}\left(\frac{L^*}{L}+1\right)}\right]$$

B Proofs of Propositions 2 and 3

Proof of Proposition 2:

Following trade liberalization in year t, firms with total factor productivity in the interval $\left[\overline{\varphi}_{xk,t+1}, \overline{\varphi}_{xk,t}\right]$ may enter the export market between year t and year $t+1$. The probability of entry into the export market at $t+1$ for a firm in sector k that does not export at t is given by

$$\Pr(\text{Export entry}) = \frac{\left(\overline{\varphi}_{xk,t+1}\right)^{-\gamma} - \left(\overline{\varphi}_{xk,t}\right)^{-\gamma}}{\left(\overline{\varphi}_{dk,t}\right)^{-\gamma} - \left(\overline{\varphi}_{xk,t}\right)^{-\gamma}} = -\left[\frac{\left(\overline{\varphi}_{xk,t}\right)^{-\gamma}}{\left(\overline{\varphi}_{dk,t}\right)^{-\gamma} - \left(\overline{\varphi}_{xk,t}\right)^{-\gamma}}\right] d\left[\ln\left(\overline{\varphi}_{xk}\right)^{\gamma}\right].$$

Hence, the effect of trade liberalization on the probability of a firm entering the export market is equal to - $\left[\frac{(\overline{\varphi}_{xk,t})^{-\gamma}}{(\overline{\varphi}_{dk,t})^{-\gamma}-(\overline{\varphi}_{xk,t})^{-\gamma}}\right]\frac{d[\ln(\overline{\varphi}_{xk})^{\gamma}]}{d\tau_{ik}}d\tau_{ik} = -\left[\frac{\widetilde{a}_k^{\gamma}}{\frac{f_x}{f}B_{1k}+B_{2k}^{-1}-\frac{f_x+f}{f}\widetilde{a}_k^{\gamma}}\right]\left[\frac{\mu\gamma T^*(\tau_{ik})^{-\lambda-1}}{T+T^*(\tau_{ik})^{-\lambda}}\right]d\tau_{ik}$, which is negative and decreases with $\widetilde{a}_k$ (as its magnitude increases with $\widetilde{a}_k$). Pr(Export entry) will be higher for the firms in the sector with higher initial comparative advantage (i.e., a higher $\widetilde{a}_k$). Thus, we have Proposition 2. We use the logit model to test this proposition. We set a dummy variable to be equal to one if the firm becomes exporter from year t to year $t+1$ and zero otherwise, and use it as the dependent variable in the regression.

Proof of Proposition 3:

The share of export revenue in total revenue is given by $\frac{f_x\cdot\theta_{xk}}{f\cdot\theta_{dk}+f_x\cdot\theta_{xk}} = \frac{(\overline{\varphi}_{xk})^{-\gamma}}{(\overline{\varphi}_{dk})^{-\gamma}f/f_x+(\overline{\varphi}_{xk})^{-\gamma}} = \frac{\widetilde{a}_k^{\gamma}-B_{2k}^{-1}}{B_{1k}-B_{2k}^{-1}}$. The effect of trade liberalization on this share is therefore given by

$$\frac{d\left[\frac{\widetilde{a}_k^{\gamma}-B_{2k}^{-1}}{B_{1k}-B_{2k}^{-1}}\right]}{d\tau_{ik}} = -\left[\frac{\widetilde{a}_k^{\gamma}}{B_{1k}-B_{2k}^{-1}}\right]\frac{\mu\gamma T^*(\tau_{ik})^{-\lambda-1}}{T+T^*(\tau_{ik})^{-\lambda}} \tag{34}$$

which is negative and decreases with $\widetilde{a}_k$. Thus we have Proposition 3.

C Reduction of tariffs on exported-outputs, exported-inputs and imported-outputs

$$\frac{d\ln(\overline{\varphi}_{dk})}{d\tau_{xk}} = -\left[\frac{B_{1k}}{B_{1k}-\widetilde{a}_k^{\gamma}} - \frac{B_{1k}}{B_{1k}-B_{2k}^{-1}}\right]\frac{1}{\tau_{xk}} < 0 \tag{35}$$

$$\frac{d\ln(\overline{\varphi}_{dk})}{d\tau_{ik}^*} = \left[\frac{\widetilde{a}_k^{\gamma}}{B_{1k}-\widetilde{a}_k^{\gamma}}\right]\frac{\mu T(\tau_{ik}^*)^{-\lambda-1}}{T^*+T(\tau_{ik}^*)^{-\lambda}} > 0 \tag{36}$$

$$\frac{d\ln(\overline{\varphi}_{dk})}{d\tau_{xk}^*} = \left(\frac{1}{B_{1k}B_{2k}-1}\right)\frac{1}{\tau_{xk}^*} > 0 \tag{37}$$

$$\frac{d\ln(\overline{\varphi}_{xk})}{d\tau_{xk}} = \left(\frac{B_{2k}}{B_{2k}-B_{1k}^{-1}}\right)\frac{1}{\tau_{xk}} > 0 \tag{38}$$

$$\frac{d\ln(\overline{\varphi}_{xk})}{d\tau_{ik}^*} = -\left[\frac{B_{2k}}{B_{2k}-\widetilde{a}_k^{-\gamma}}\right]\frac{\mu T(\tau_{ik}^*)^{-\lambda-1}}{T^*+T(\tau_{ik}^*)^{-\lambda}} < 0 \tag{39}$$

$$\frac{d\ln(\overline{\varphi}_{xk})}{d\tau_{xk}^*} = -\left[\frac{B_{2k}}{B_{2k}-\widetilde{a}_k^{-\gamma}} - \frac{B_{2k}}{B_{2k}-B_{1k}^{-1}}\right]\frac{1}{\tau_{xk}^*} < 0 \tag{40}$$

$$\frac{d\left(\frac{\overline{\varphi}_{dk}}{\overline{\varphi}_{xk}}\right)^{\gamma}}{d\tau_{xk}} = -\frac{f}{f_x}\left[\frac{B_{1k}\left(\widetilde{a}_k^{\gamma} - B_{2k}^{-1}\right)}{\left(B_{1k} - \widetilde{a}_k^{\gamma}\right)^2}\right]\frac{\gamma}{\tau_{xk}} < 0$$

$$\frac{d\left(\frac{\overline{\varphi}_{dk}}{\overline{\varphi}_{xk}}\right)^{\gamma}}{d\tau_{ik}^{*}} = \frac{f}{f_x}\left[\frac{\left(B_{1k} - B_{2k}^{-1}\right)\widetilde{a}_k^{\gamma}}{\left(B_{1k} - \widetilde{a}_k^{\gamma}\right)^2}\right]\frac{\mu\gamma T\left(\tau_{ik}^{*}\right)^{-\lambda-1}}{T^{*} + T\left(\tau_{ik}^{*}\right)^{-\lambda}} > 0$$

$$\frac{d\left(\frac{\overline{\varphi}_{dk}}{\overline{\varphi}_{xk}}\right)^{\gamma}}{d\tau_{xk}^{*}} = \frac{f}{f_x}\left[\frac{B_{2k}^{-1}}{B_{1k} - \widetilde{a}_k^{\gamma}}\right]\frac{\gamma}{\tau_{xk}^{*}} > 0$$

In each case, the magnitude of the effect on $\left(\frac{\overline{\varphi}_{dk}}{\overline{\varphi}_{xk}}\right)^{\gamma}$ is larger, the larger is $\widetilde{a}_k$.

D Other Tables

Table A2: The correlation among different RCA

Panel A – correlation coefficients						Panel B – log rank correlation coefficients					
	RCA_1	RCA_2	RCA_3	RCA_4	RCA_5		RCA_1	RCA_2	RCA_3	RCA_4	RCA_5
RCA_1	1.000					RCA_1	1.000				
RCA_2	0.939	1.000				RCA_2	0.551	1.000			
RCA_3	0.588	0.748	1.000			RCA_3	0.687	0.946	1.000		
RCA_4	0.802	0.847	0.571	1.000		RCA_4	0.687	0.946	1.000	1.000	
RCA_5	0.687	0.837	0.972	0.735	1.000	RCA_5	0.687	0.946	1.000	1.000	1.000

Table A2: Panel C				
Summary statistics of the RCA				
Variable	Mean	Median	Min	Max
RCA_1	1.365	0.756	0.029	9.254
RCA_2	0.416	-0.004	-3.314	9.029
RCA_3	0.283	0.363	-0.864	0.965
RCA_4	2.610	1.010	0.034	26.50
RCA_5	5.269	1.006	-337.21	327.72

Table A3: Probability of entry into the export market								
RCA index	RCA_1	RCA_2	RCA_3	RCA_4	RCA_5	$Rank_1$	$Rank_2$	$Rank_3$
Regressor	Logit	Logit	Logit	Logit	Logit	Logit	Logit	Logit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta duty_{ik}$	-8.867**	-8.605**	-2.604**	-19.394***	-5.303**	-3.458***	-1.408	-2.208**
	(4.128)	(4.325)	(1.256)	(2.476)	(2.347)	(1.293)	(1.187)	(1.054)
$\boldsymbol{\Delta duty_{ik} \times RCA}$	-1.026**	-0.955**	-2.549**	-0.758***	-0.013**	-1.432***	-1.293	-1.408**
	(0.454)	(0.454)	(1.235)	(0.095)	(0.006)	(0.540)	(0.893)	(0.666)
$\Delta duty_{ok}$	1.187	1.327	1.025	1.151	1.036	0.290	1.376	1.213
	(0.868)	(0.864)	(0.914)	(0.878)	(0.906)	(1.029)	(0.891)	(0.907)
RCA	0.106**	0.110***	0.452***	0.050*	0.002***	0.314***	0.262***	0.234***
	(0.047)	(0.033)	(0.152)	(0.029)	(0.001)	(0.085)	(0.066)	(0.081)
TFP	-0.137	-0.144	-0.146	-0.152	-0.138	-0.089	-0.175	-0.148
	(0.114)	(0.112)	(0.113)	(0.108)	(0.111)	(0.116)	(0.114)	(0.112)
log(Empl)	0.294***	0.298***	0.300***	0.294***	0.299***	0.299***	0.302***	0.299***
	(0.019)	(0.018)	(0.019)	(0.019)	(0.019)	(0.018)	(0.018)	(0.019)
log(K/L)	0.024	0.025	0.025	0.024	0.025	0.025	0.027	0.025
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)
log(Wage)	0.318***	0.316***	0.315***	0.318***	0.316***	0.318***	0.313***	0.317***
	(0.029)	(0.029)	(0.029)	(0.029)	(0.029)	(0.028)	(0.028)	(0.029)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	364827	364827	364827	364827	364827	364827	364827	364827

Note: ***Significant at the 1% level; **Significant at the 5% level; *Significant at the 10% level.

Robust standard errors is corrected at industry-level in parentheses.

Table A4: Change in the fraction of exporting firms								
RCA index	RCA_1	RCA_2	RCA_3	RCA_4	RCA_5	$Rank_1$	$Rank_2$	$Rank_3$
Regressor	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta duty_{ik}$	-0.912***	-0.867***	-0.113**	-1.25**	-0.206**	-0.156***	-0.125**	-0.085*
	(0.318)	(0.312)	(0.056)	(0.533)	(0.093)	(0.057)	(0.056)	(0.047)
$\Delta duty_{ik} \times RCA$	-0.099***	-0.090***	-0.073*	-0.047**	-0.0004*	-0.049**	-0.082**	-0.031
	(0.035)	(0.033)	(0.044)	(0.021)	(0.0002)	(0.020)	(0.041)	(0.022)
$\Delta duty_{ok}$	-0.013	-0.007	-0.013	-0.018	-0.0128	-0.015	-0.001	-0.007
	(0.037)	(0.037)	(0.037)	(0.036)	(0.0373)	(0.040)	(0.037)	(0.037)
RCA	-0.002*	-0.000	0.008*	-0.000	0.0000*	-0.001	0.003**	0.004**
	(0.001)	(0.001)	(0.004)	(0.001)	(0.0000)	(0.002)	(0.002)	(0.002)
TFP	0.012***	0.012***	0.011***	0.012***	0.0116***	0.012***	0.011***	0.012***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.0039)	(0.004)	(0.004)	(0.004)
log(Empl)	-0.003***	-0.003***	-0.003***	-0.003***	-0.0034***	-0.003***	-0.003***	-0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.0011)	(0.001)	(0.001)	(0.001)
log(K/L)	0.000	0.001	0.001	0.001	0.0013	0.000	0.001	0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.0025)	(0.002)	(0.002)	(0.002)
log(Wage)	-0.009	-0.009	-0.009	-0.009	-0.0087	-0.009	-0.009	-0.009
	(0.006)	(0.006)	(0.006)	(0.006)	(0.0059)	(0.006)	(0.006)	(0.006)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2018	2018	2018	2018	2018	2018	2018	2018
R-squared	0.064	0.064	0.060	0.064	0.061	0.059	0.060	0.059

Note: ***Significant at the 1% level; **Significant at the 5% level; *Significant at the 10% level.

Robust standard errors is corrected at industry-level in parentheses.

Table A5: Change in the share of export revenue in total revenue								
RCA index	RCA_1	RCA_2	RCA_3	RCA_4	RCA_5	$Rank_1$	$Rank_2$	$Rank_3$
Regressor	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta duty_{ik}$	-0.846***	-0.845***	-0.145**	-1.18***	-0.258***	-0.165**	-0.156***	-0.114**
	(0.304)	(0.280)	(0.061)	(0.395)	(0.0971)	(0.073)	(0.060)	(0.050)
$\boldsymbol{\Delta duty_{ik} \times RCA}$	-0.091***	-0.088***	-0.104**	-0.045***	-0.0005**	-0.052**	-0.112**	-0.050**
	(0.033)	(0.029)	(0.048)	(0.015)	(0.0002)	(0.023)	(0.044)	(0.024)
$\Delta duty_{ok}$	0.014	0.022	0.012	0.011	0.0118	0.005	0.030	0.021
	(0.054)	(0.054)	(0.054)	(0.054)	(0.0543)	(0.057)	(0.054)	(0.054)
RCA	-0.000	0.001	0.011***	0.001	0.0000***	0.001	0.004**	0.005***
	(0.002)	(0.001)	(0.004)	(0.001)	(0.0000)	(0.002)	(0.002)	(0.002)
TFP	0.004	0.004	0.004	0.004	0.0038	0.005	0.003	0.004
	(0.004)	(0.004)	(0.004)	(0.004)	(0.0043)	(0.004)	(0.004)	(0.004)
log(Empl)	-0.005***	-0.005***	-0.005***	-0.005***	-0.0051***	-0.005***	-0.005***	-0.005***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.0010)	(0.001)	(0.001)	(0.001)
log(K/L)	0.007***	0.007***	0.008***	0.007***	0.0079***	0.007***	0.008***	0.008***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.0023)	(0.002)	(0.002)	(0.002)
log(Wage)	-0.002	-0.002	-0.002	-0.003	-0.0020	-0.002	-0.002	-0.002
	(0.007)	(0.007)	(0.007)	(0.007)	(0.0073)	(0.007)	(0.007)	(0.007)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2018	2018	2018	2018	2018	2018	2018	2018
R-squared	0.061	0.062	0.059	0.061	0.061	0.057	0.059	0.058

Note: ***Significant at the 1% level; **Significant at the 5% level; *Significant at the 10% level.

Robust standard errors is corrected at industry-level in parentheses.

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