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Intensive and Extensive Margins of South–South–North Trade: Firm-Level Evidence

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Abstract*: The main value added of our paper is twofold. First, we construct a theoretical framework on how South–South trade will affect productivity cut-offs. Second, we present empirical exercises using highly disaggregated data. Our model is based on the South–South–North trade framework. Using a vertical integration among Southern countries (Indonesia and China) and testing it by employing merged Chinese firms and customs trade data, we find that three types of tariff reductions—foreign tariff reductions, home output tariff reductions, and home input tariff reductions—significantly increase home country firm productivity and exports via extensive and intensive margins. Our findings are robust using ex-ante and ex-post productivity.*

Keywords: China, Indonesia, Tariff, Exports, Manufacturing

JEL Classification: F1, F13, F14

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1. Introduction

How much can a country expand its exports? It could either export more in terms of quantity of goods (intensive margins), more in terms of the variety of goods (extensive margins), or could move to a higher level quality of goods (Hummels and Klenow, 2005). The conventional trade theorem predicts that a country will export the good that uses its abundant factor intensively. In the North–South trade framework, this implies that developed countries will export capital-intensive goods while developing countries will export labour-intensive goods.

As tariff declines, trade grows not only between countries with different levels of intensity of factors of production but also between countries with similar levels. The Linder hypothesis claims that countries of similar income per capita should trade more intensely with one another (Linder, 1961). Taking an example of trade between two big developing countries, China and Indonesia, exports of goods (excluding oil and gas) from China to Indonesia increased thirteen fold, from US$2.8 billion in 2000 to US$36.9 billion in 2014, and exports of goods (excluding oil and gas) from Indonesia to China increased eightfold, rising from US$1.7 billion to US$14.5 billion over the same period, with the average purchasing power parity–based-income per capita of China of US$7,200 being comparable with the US$7,224 of Indonesia in 2000–2014.

Our paper mainly focuses on, first, how the interaction of South–South trade affects countries' intensive and extensive margins. Second, how South–South trade affects the production and export decisions in their North–South trade, aiming to illustrate how falling trade costs strengthen a country's comparative advantage in the global supply chain.

Section 2 illustrates a theoretical framework. Section 3 details data and data sources. Section 4 presents empirical findings. Section 5 concludes.

2. Theoretical Framework

Framework of the Model

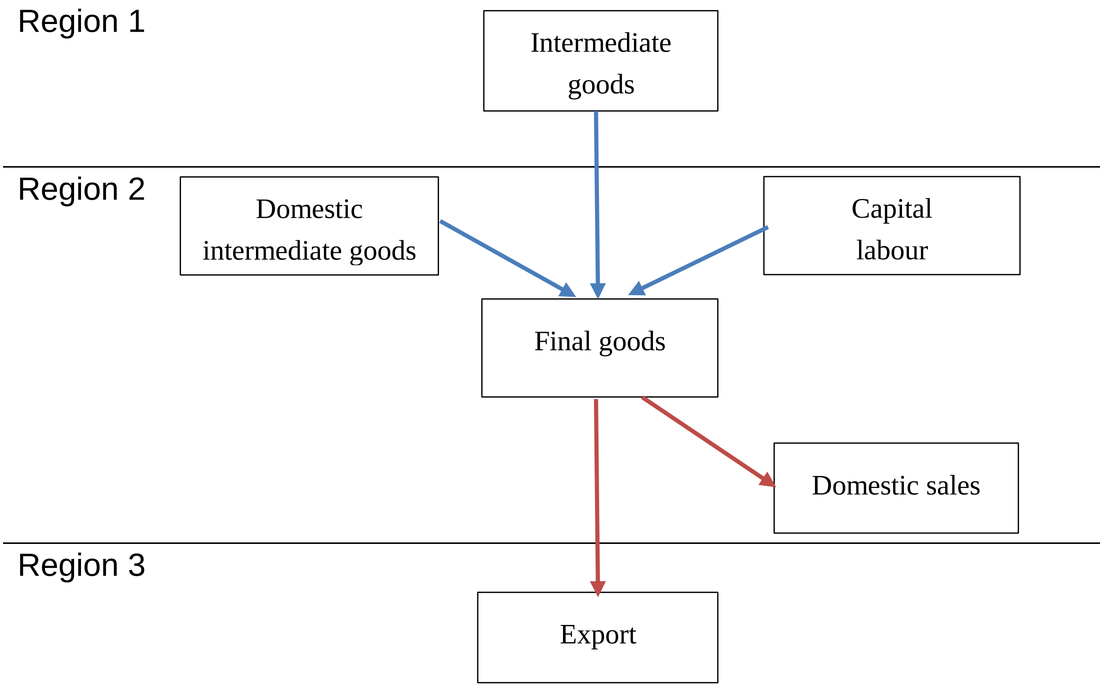
The main idea of the model is as follows. We consider a following trade pattern: a labour-abundant country such as China imports raw materials or intermediate inputs from Indonesia, combines these with domestic capital and labour factors to produce and export labour-intensive products such as textile and garments. Our main interest is to see how falling trade costs strengthen the comparative advantage of the domestic country (i.e. China) in the global supply chain.

To fully capture the impact of trade liberalisation and fit with related empirical literature, we consider the following three dimensions of trade liberalisation: (i) home (i.e. China) tariffs cut in final products such as textile and garments in China; (ii) tariffs cut in textile and garments of the foreign destination country (i.e. United States [US]); and (iii) China's tariffs cut on its intermediate inputs imported from Indonesia (e.g. cotton). The first two types of tariffs are bilateral trade liberalisation on final goods. The last one is trade liberalisation on intermediate inputs, a la Goldberg et al. (2010) and Topalova and Khandelwal (2011).

Our model has the following features. First, it is able to govern both comparative advantage along with Heckscher-Ohlin and firm heterogeneity as in Melitz (2003). Second, similar to Bernard-Redding-Schott (2007), we are able to show that when firms possess heterogeneous productivity, countries differ in relative factor abundance, and industries vary in factor intensity, then falling trade costs induce reallocations of resources both within and across industries and countries. But we extend the Bernard-Redding-Schott's model by allowing international fragmentation and vertical integration, following Yi (2010). In terms of trade liberalisation, most of the existing literature consider only bilateral tariff reductions on final goods, but here we also consider trade liberalisation in intermediate inputs to better fit with the reality.

Our model can be sketched by the following model as in Yi (2010) where region 1 represents Indonesia, region 2 refers to China, and region 3 refers to the US.

Figure 1: Three Regions and Three Factors of Production



Prediction of the Model

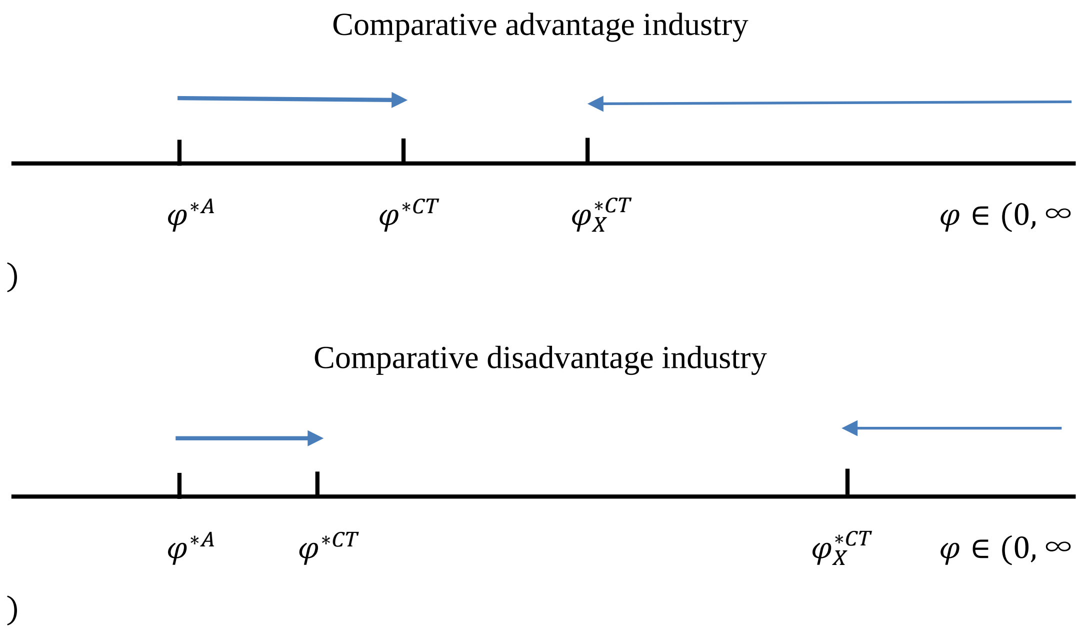
Similar to Bernard-Redding-Schott (2007), we predict the following:

(1) With trade liberalisation on final goods, the domestic productivity cut-off points in the home country will increase in both industries. Moreover, the industry with a comparative advantage increases more. Thus, this confirms the effect of tougher international competition.

(2) With trade liberalisation on final goods, the exporting productivity cut-off points in the home country will decrease in both industries. Moreover, the industry with a comparative advantage decreases more. This leads to the idea of the access to larger foreign markets due to foreign tariff reductions (Lileeva and Trefler, 2010).

These two findings can be illustrated in Figure 2:

Figure 2: Productivity Cut-off as a Function of Variable Cost



A = autarky *CT*=costly trade

Moreover, we also propose new hypotheses which are completely differ from the existing literature:

(3) Trade in both industries increases. If we restrict our research scope to single-product firms, we should expect both extensive and intensive margins to increase, along with total industrial trade value.

(4) With trade liberalisation on intermediate goods, if imported intermediate inputs are complemented with labour, labour-intensive industries will expand and export more.

The assumption that imported intermediate inputs are complementary with labour fits with reality well: when Foxcom imports more intermediate inputs, it will hire more workers to expand its production. Thus, the increase in imported intermediate inputs results in an increase in labour endowment. As usual, by holding output price unchanged, an increase in a factor endowment will increase the industrial production using such factor intensively, as suggested by the Rybczynski theorem in theory and supported by the real world as in the phenomenon of the Dutch disease.

Set up

Our model draws heavily from Bernard-Redding-Schott (2007, RES) with an extension incorporating intermediate inputs. Consider a world of three countries (US, China, and Indonesia), three factors (capital, labour, and materials), two industries, and a continuum of heterogeneous firms. The trade pattern is as follows: China imports materials from Indonesia, combines it with domestic labour and capital to produce, and then exports a final good to the US. Countries are identical in terms of preferences and technologies but differ in terms of factor endowments. Factors of production are mobile between industries within countries but immobile across countries. Each industry uses three factors in production.

2.1. Consumption

The representative consumer's utility depends on consumption of the output of two industries (i=1, 2), each of which contains a large number of differentiated varieties (ω) produced by heterogeneous firms. We assume that the upper tier of utility determining consumption of the two industries' output takes the Cobb-Douglas form and the lower tier of utility determining consumption of varieties takes the CES form,

$$U = C_1^{\alpha_1} C_2^{\alpha_2}, \;\; \alpha_1 + \alpha_2 = 1 \tag{1}$$

where C_i is a consumption index defined over consumption of individual varieties $q_i(\omega)$ with dual price index P_i, defined over prices of varieties $p_i(\omega)$,

$$C_i = \left(\int_{\omega \in \Omega_i} q_i(\omega)^{\rho} d\omega \right)^{1/\rho}, \;\; P_i = \left(\int_{\omega \in \Omega_i} p_i(\omega)^{1-\sigma} d\omega \right)^{1/1-\sigma} \tag{2}$$

where $\sigma = 1/(1-\rho) > 1$ is a constant elasticity of substitution across varieties. We assume that the elasticity of substitution between varieties is the same in the two industries.

2.2. Production

To produce a variety of goods, a firm uses all three factors: capital (K), labour (L), and material (M). Let r, w, v denote the price of capital, labour, and material, respectively. Material is assumed to complement labour which is supported by recent empirical evidence (Chen, Yu and Yu, 2014). As labour and material are supposed to be complementary, we could reduce the three factors into two: K and N, where $N = \min\{L, M\}$. Accordingly, the equilibrium price of factor N is denoted u=w+v.

Production involves a fixed and variable cost in each period. Both fixed and variable costs use multiple factors of production whose intensity of use varies across industries. All firms share the same overhead cost, but variable cost varies with firm productivity, $\varphi \in (0, \infty)$. The cost function takes the Cobb-Douglas form,

$$\Gamma_i = (f_i + \frac{q_i}{\varphi}) u^{\beta_i} r^{1-\beta_i} \tag{3}$$

Assume $1 > \beta_1 > \beta_2 > 0$, so that industry 2 is assumed to be capital intensive relative to industry 1. Let C denote China and A denote the US, We also assume that $\bar{N}^C / \bar{K}^C > \bar{N}^A / \bar{K}^A$, so that the US is relatively capital abundant. It is easy to see that, to China, industry 1 is the industry with comparative advantage. Let the price for factor N in China be numeraire, $u^C = 1$.

Firms can choose to sell in a domestic market *d*, or export to a foreign market *x*. International trade incurs fixed and variable costs. The fixed cost of export uses both factor N and capital K with the same factor intensities as production. In addition, the firm may also face variable trade costs, which take the standard iceberg form, whereby a fraction of $\tau_i > 1$ units of a good must be shipped in industry *i* in order for 1 unit to arrive.

Profit maximisation that implies the equilibrium prices in the two markets satisfy:

$$p_{id}^C(\varphi) = \frac{(u^C)^{\beta_i} (r^C)^{1-\beta_i}}{\rho\varphi} \tag{4}$$

$$p_{ix}^C(\varphi) = \tau_i p_{id}^C(\varphi) = \tau_i \frac{(u^C)^{\beta_i} (r^C)^{1-\beta_i}}{\rho\varphi} \tag{5}$$

With this pricing rule, we can derive firms' equilibrium revenue in the domestic and export markets:

$$r_{id}^{C}(\varphi)=\alpha_i R^{C}\left(\frac{P_i^{C}\rho\varphi}{(u^{C})^{\beta_i}(r^{C})^{1-\beta_i}}\right)^{\sigma-1} \tag{6}$$

$$r_{ix}^{C}(\varphi)=\alpha_i R^{A}\left(\frac{P_i^{A}\rho\varphi}{\tau_i(u^{C})^{\beta_i}(r^{C})^{1-\beta_i}}\right)^{\sigma-1} \tag{7}$$

where α_i stands for the share of expenditure allocation to an industry. R^C and R^A denote aggregate expenditure (equals aggregate revenue) in China and the US. P_i^C and P_i^A denote the industry price index in China and the US.

According to (6) and (7), equilibrium revenue in the export market is proportional to that in the domestic market:

$$r_{ix}^{C}(\varphi)=\tau_i^{1-\sigma}\left(\frac{P_i^{A}}{P_i^{C}}\right)^{\sigma-1}\left(\frac{R^{A}}{R^{C}}\right)r_{id}^{C}(\varphi) \tag{8}$$

Then the total revenue received by a firm in China is:

$$r_i^{C}(\varphi)=\begin{cases} r_{id}^{C}(\varphi) & \text{if it does not export} \\ r_{id}^{C}(\varphi)\left(1+\tau_i^{1-\sigma}\left(\frac{P_i^{A}}{P_i^{C}}\right)^{\sigma-1}\left(\frac{R^{A}}{R^{C}}\right)\right) & \text{if it exports} \end{cases} \tag{9}$$

The fixed production costs imply that firms that export also sell their products in the domestic market. Therefore, we may separate each firm's profit into components earned from domestic sales, $\pi_{id}^{C}(\varphi)$, and foreign sales, $\pi_{ix}^{C}(\varphi)$, where we apportion the entire fixed production cost to domestic profit and the fixed exporting cost to foreign profit:

$$\pi_{id}^{C}(\varphi)=\frac{r_{id}^{C}(\varphi)}{\sigma}-f_i(u^{C})^{\beta_i}(r^{C})^{1-\beta_i} \tag{10}$$

$$\pi_{ix}^{C}(\varphi)=\frac{r_{ix}^{C}(\varphi)}{\sigma}-f_{ix}(u^{C})^{\beta_i}(r^{C})^{1-\beta_i} \tag{11}$$

where the fixed cost of exporting requires both factors which are a complementary of labour and material N, and capital K, $f_{ix}(u^C)^{\beta_i}(r^C)^{1-\beta_i}$. Total firm profit is given by:

$$\pi_i^C(\varphi) = \pi_{id}^C(\varphi) + \max\left\{0, \pi_{ix}^C(\varphi)\right\} \tag{12}$$

2.3. Decision to produce and export

To produce in an industry, firms should invest a fixed entry cost, which is thereafter sunk. The entry cost also uses factors N and K, so that the industry-sunk entry cost takes the form $f_{ei}(u^C)^{\beta_i}(r^C)^{1-\beta_i}$.

After firms invest a sunk cost to enter an industry, they draw their productivity, φ, from a distribution $g(\varphi)$, which is assumed to be common across industries and countries. As in Melitz (2003), firms then face an exogenous probability of death in each period, δ.

There are two productivity cut-offs, the producing productivity cut-off, φ_i^{*C}, above which firms produce for the domestic market, and the exporting productivity cut-off, φ_{ix}^{*C}, above which firms produce for both the domestic and export markets:

$$r_{id}^C(\varphi_i^{*C}) = \sigma f_i (u^C)^{\beta_i}(r^C)^{1-\beta_i} \tag{13}$$

$$r_{ix}^C(\varphi_{ix}^{*C}) = \sigma f_{ix} (u^C)^{\beta_i}(r^C)^{1-\beta_i} \tag{14}$$

There is an equilibrium relationship between the two productivity cut-offs (see the proof in the Appendix):

$$\varphi_{ix}^{*C} = \Lambda_i^C \varphi_i^{*C}, \text{ where } \Lambda_i^C = \tau_i \left(\frac{P_i^C}{P_i^A}\right)\left(\frac{R^C}{R^A}\frac{f_{ix}}{f_i}\right)^{1/\sigma-1} \tag{15}$$

Firms' decisions concerning production for the domestic and foreign markets are summarised as follows. Of the mass of firms, M_{ei}^C, that enter the industry each period, a fraction, $G(\varphi_i^{*C})$, attain a productivity level sufficiently low that they are unable to cover fixed production costs and exit the industry immediately; a fraction,

$G(\varphi_{ix}^{*C})-G(\varphi_i^{*C})$, realise an intermediate productivity level such that they are able to cover fixed production costs and serve the domestic market but are not profitable to export; and a fraction, $1-G(\varphi_{ix}^{*C})$, reach a productivity level sufficiently high that it is profitable to serve both domestic and foreign markets in equilibrium. Note that $G(\varphi)$ is a cumulative distribution function for $g(\varphi)$.

The ex-ante probability of successful entry is $1-G(\varphi_i^{*C})$, and the ex-ante probability of exporting conditional on successful entry is:

$$\chi_i^H=\frac{1-G(\varphi_{ix}^{*C})}{1-G(\varphi_i^{*C})} \tag{16}$$

2.4. Free entry

There is an unbounded competitive fringe of potential entrants, and in an equilibrium with positive production of both goods, we require the expected value of entry, V_i^C, to equal the sunk entry cost in each industry.

$$V_i=\frac{1-G(\varphi_i^*)}{\delta}(\bar{\pi}_{id}^C+\chi_i^C\bar{\pi}_{ix}^C)=f_{ei}(u^C)^{\beta_i}(r^C)^{1-\beta_i} \quad , \tag{17}$$

where $\bar{\pi}_{id}^C$ and $\bar{\pi}_{ix}^C$ denote the average profitability in the domestic and export markets. It can be demonstrated that $\bar{\pi}_{id}^C=\pi_{id}^C(\Phi_i^C)$, $\bar{\pi}_{ix}^C=\pi_{ix}^C(\Phi_{ix}^C)$, where Φ_i^C is the weighted average productivity of firms that sell domestically and Φ_{ix}^C is the weighted average productivity of firms that export:

$$\Phi_i^C(\varphi_i^*)=\Big(\frac{1}{1-G(\varphi_i^*)}\int_{\varphi_i^*}^{\infty}\varphi^{\sigma-1}g(\varphi)d\varphi\Big)^{1/(\sigma-1)} \tag{18}$$

$$\Phi_{ix}^C(\varphi_{ix}^*)=\Big(\frac{1}{1-G(\varphi_{ix}^*)}\int_{\varphi_{ix}^*}^{\infty}\varphi^{\sigma-1}g(\varphi)d\varphi\Big)^{1/(\sigma-1)} \tag{19}$$

Then we can write the free entry condition as a function of the two productivity cut-offs and model parameters (see the proof in the Appendix):

$$V_i^C = \frac{f_i}{\delta}\int_{\varphi_i^{*C}}^{\infty}((\frac{\varphi}{\varphi_i^{*C}})^{\sigma-1}-1)g(\varphi)d\varphi + \frac{f_{ix}}{\delta}\int_{\varphi_{ix}^{*C}}^{\infty}((\frac{\varphi}{\varphi_{ix}^{*C}})^{\sigma-1}-1)g(\varphi)d\varphi = f_{ei} \qquad (20)$$

2.5. Goods markets

The steady state equilibrium is characterised by a constant mass of firms entering an industry in each period, M_{ei}, and a constant mass of firms producing within the industry, M_i. Thus, in steady-state equilibrium, the mass of firms that enter and attain a productivity level sufficiently high to produce must equal the mass of firms that die:

$$(1-G(\varphi_i^*))M_{ei} = \delta M_i \qquad (21)$$

Using the equilibrium pricing rule, the industry price indices can be written as:

$$P_i^C = (M_i^C(p_{id}^C(\Phi_i^C))^{1-\sigma} + \chi_i^A M_i^A(\tau_i p_{id}^A(\Phi_{ix}^A))^{1-\sigma})^{1/(1-\sigma)} \qquad (22)$$

In equilibrium, we also require that the sum of domestic and foreign expenditures on domestic varieties equals the value of domestic production (total industry revenue, R_i) for each industry and country:

$$R_i^C = \alpha_i R^C M_i^C(\frac{p_{id}^C(\Phi_i^C)}{P_i^C})^{1-\sigma} + \alpha_i R^A \chi_i^C M_i^C(\frac{\tau_i p_{id}^C(\Phi_{ix}^C)}{P_i^A})^{1-\sigma} \qquad (23)$$

With free trade into each industry, total industry revenue equals total labour payments:

$$R_i^C = u^C N^C + r^C K^C \qquad (24)$$

Requiring that equation (23) holds for all countries and industries implies that the goods markets clear at the world level.

2.6. Factor markets

Factor market clearing requires the demand for labour used in production, export and entry equal factor supply as determined by countries' endowments:

$$N_1 + N_2 = \bar{N}, \quad N_i = N_i^p + N_i^x + N_i^e$$

$$K_1 + K_2 = \bar{K}, \quad K_i = K_i^p + K_i^x + K_i^e \tag{25}$$

where superscript *p* refers to a factor used in production, superscript *x* refers to a factor used in export, and superscript *e* refers to a factor used in entry. Here we omit the country index for simplicity.

2.7. Costly trade equilibrium

The costly trade equilibrium is referenced by a vector of 13 variables in China and the US: $\{\varphi_1^{*k}, \varphi_2^{*k}, \varphi_{1x}^{*k}, \varphi_{2x}^{*k}, P_1^k, P_2^k, p_1^k(\varphi), p_2^k(\varphi), p_{1x}^k(\varphi), p_{2x}^k(\varphi), u^k, r^k, R^k\}$ for $k \in \{C, A\}$. All other endogenous variables can be written as functions of these quantities. The equilibrium vector is determined by the following equilibrium conditions for each country: firms' pricing rule (equations [4] and [5] for each industry), free entry conditions (equation [20] for each sector), the relationship between the two productivity cut-offs (equation [15] for each sector), factor market clearing conditions (equation [25] for factor N and capital K), the values for the equilibrium price indices implied by consumer and producer optimization (equation [22] for each sector), and the world's expenditure on country's varieties equals the value of their production (equation [23] for each sector).

Proposition 1. There exists a unique costly trade equilibrium referenced by the pair of equilibrium vectors,

$\{\hat{\varphi}_1^{*k}, \hat{\varphi}_2^{*k}, \hat{\varphi}_{1x}^{*k}, \hat{\varphi}_{2x}^{*k}, \hat{P}_1^k, \hat{P}_2^k, \hat{p}_1^k(\varphi), \hat{p}_2^k(\varphi), \hat{p}_{1x}^k(\varphi), \hat{p}_{2x}^k(\varphi), \hat{u}^k, \hat{r}^k, \hat{R}^k\}$ for $k \in \{C, A\}$.

Proposition 2. Assuming that China's import from Indonesia is not affected by the trade liberalisation between China and the US, then the opening of costly trade between China and the US increases the steady-state zero-profit productivity cut-off in both industries.

(a) Other things being equal, the increases in the steady-state zero-profit productivity cut-off is greater in a country's industry that has a comparative advantage: $\Delta\varphi_1^{*C} > \Delta\varphi_2^{*C}$ and $\Delta\varphi_2^{*A} > \Delta\varphi_1^{*A}$.

(b) Other things being equal, the exporting productivity cut-off is closer to the zero-profit productivity cut-off in a country's industry that has a comparative advantage: $\varphi_{1x}^{*C} / \varphi_1^{*C} < \varphi_{2x}^{*C} / \varphi_2^{*C}$ and $\varphi_{2x}^{*A} / \varphi_2^{*A} < \varphi_{1x}^{*A} / \varphi_1^{*A}$.

(c) When trade is costly, only a subset of firms will export. As a result, trade has a differential effect on the profits of exporting and non-exporting firms. Along with moving from autarky to costly trade, the ex post profits of more productive exporting firms rise. This increases the expected value of entry in each industry because there is a positive ex-ante probability of achieving a productivity sufficiently high to export. This induces more entry, and so raises the mass of active firms in the industry. The industry becomes more competitive, and the ex post profits of low-productivity firms that only serve the domestic market are reduced. As a result, some low-productivity domestic firms no longer receive enough revenue to cover fixed production costs and exit the industry. The zero-profit productivity cut-off rises.

Profits in the export market are relatively larger to profits in the domestic market in industries that have a comparative advantage. Therefore, along with the opening of trade, the ex post profits of more productive exporting firms rise more in industries that have a comparative advantage. As a result, the expected value of entering the industry rises further in industries that have a comparative advantage, which induces relatively more entry and leads to a larger increase in the zero-profit productivity cut-off in industries that have a comparative advantage. Last, since exporting is relatively more attractive in industries that have a comparative advantage, the exporting productivity lies closer to the zero-profit productivity cut-off.

For China, industry 1 is the industry that has a comparative advantage. Our model predicts that the zero-profit productivity cut-off will increase more and the exporting productivity cut-off will be closer to the zero-profit productivity cut-off in industry 1.

3. Data and data sources

Our study focuses only on manufactured goods.

Our data set is constructed by means of a merger of the Indonesia Survey of Industry and Export and Import at the firm and product levels with China's customs data (imports of China by products from Indonesia). Below we present a brief introduction to our Chinese firm-level production data and customs transaction-level trade data.

3.1. Chinese firm-level production data

The sample is derived from a rich firm-level panel data set that covers between 162,885 firms (in 2000) and 301,961 firms (in 2006). The data are collected and maintained by China's National Bureau of Statistics (NBS) in an annual survey of manufacturing enterprises. Complete information on the three major accounting statements (i.e. balance sheet, profit and loss account, and cash flow statement) is available. In brief, the data set covers two types of manufacturing firms – all state-owned enterprises (SOEs) and non-SOEs whose annual sales exceed RMB5 million ($830,000). The data set includes more than 100 financial variables listed in the main accounting statements of these firms.

Although the data contain rich information, some samples are still noisy and are therefore misleading, largely because of misreporting by some firms. Following Feenstra, Li, and Yu (2014), we clean the sample and omit outliers by using the following criteria. First, observations with missing key financial variables (such as total assets, net value of fixed assets, sales, and gross value of the firm's output productivity) are excluded. Second, we drop firms with fewer than eight workers since they fall under a different legal regime, as mentioned in Brandt, van Biesebroeck, and Zhang (2012).

We delete observations according to the basic rules of the Generally Accepted Accounting Principles (GAAP) if any of the following are true: (1) liquid assets are greater than total assets; (2) total fixed assets are greater than total assets; (3) the net value of fixed assets is greater than total assets; (4) the firm's identification number is missing; or (5) an invalid established time exists (e.g. the opening month is later than December or earlier than January). After applying such a stringent filter to guarantee the quality of the production data, the filtered firm data are reduced by about 50 percent in each year.

To ensure the preciseness of the estimations, we exclude such trading companies from the sample in all estimations. In particular, firms with names including any Chinese characters for trading company or importing and exporting company are excluded from the sample.

3.2. Chinese production-level trade data

The extremely disaggregated product-level trade transaction data are obtained from China's General Administration of Customs. It records a variety of information for each trading firm's product list, including trading price, quantity, and value at the HS eight-digit level. More importantly, the data include not only both import and export data but also break down the data into several specific types of processing trade, such as processing with assembly and processing with inputs.

Overall, when focusing on the highly disaggregated HS eight-digit level, approximately 35 percent of the 18,599,507 transaction-level observations are ordinary trade, and 65 percent refer to processing trade. Similar proportions are obtained when measuring by trade volume: around 43 percent of trade volume comprises ordinary trade. Processing with inputs accounts for around 30 percent, whereas processing with assembly only is around 10 percent. The remaining 17 percent represents other types of processing trade, aside from assembly and processing with inputs.

3.3. Indonesian production-level trade data

Our paper aims to see the impact of imported intermediates on a ‘southern’ importing country (i.e., China) from another ‘southern’ country (i.e. Indonesia) affecting the intensive and extensive margins of the hosting ‘southern’ country (i.e. China). To this purpose, we also need firm-level production data for Indonesia. We are able to access such data for Indonesia for the same sample period of 2000–2006 covered by the China data.

However, as in other papers, we face a serious challenge when we try to match China's transaction-level customs data and Indonesia's product-level data sets. Admittedly, we know that specific Indonesian firms export to China; unfortunately, we do not know to which Chinese firms they export. Thus, we are not able to match the Indonesian manufacturing exporting firms and Chinese manufacturing importing firms one by one.

To work around this data challenge, we instead rely on Chinese transaction-level customs data in this paper. As the Chinese transaction-level customs data also report the importing origins, we thus focus on all imports from Indonesia, the largest developing country in the ASEAN countries. We first select all sample members with any imports from Indonesia. To make sure import from Indonesia plays an important role for Chinese importers, we focus on firms with large imports from Indonesia, especially those firms with import shares of more than 5 and 10 percent from Indonesia, respectively.

Last, to calculate and estimate firms' total factor productivity (TFP), we need to merge manufacturing firm data and customs data. The detailed approach has been introduced in Yu and Tian (2012) and Yu (2015). In particular, we use the Chinese firm's name-year, zip code, and the last seven digit of the telephone number to merge the two datasets. As discussed in Yu (2015), our merged data skew toward larger trading firms as the matched sample has more export, more sales, and even larger number of employees.

4. Empirical findings

Before formally examining the nexus between trade liberalisation and firm exports, we look at Table 1, which reports the performance of overall exporters and exporters with large import shares from Indonesia. By comparing all Chinese exporting firms, those exporting firms with a significant import share from Indonesia (i.e. imports from Indonesia as a proportion of their total imports) tend to have better performance in terms of export value, number of employees, and sales. In particular, of a total of 70,369 Chinese exporting firms during 2000–2006, 1,387 exporting firms had more than a 5 percent import share from Indonesia and 995 firms had more than a 10 percent import share from Indonesia. Although firms with significant imports from Indonesia have better performance than those without, this does not imply that the larger the import share from Indonesia, the better the firm's performance will be. For example, Chinese firms with more than a 10 percent import share from Indonesia apparently export less to other countries than those with more than a 5 percent import share, suggesting that firm performance has no simple linear relationship with its import share from Indonesia.

Table 1: Overall Exporters and Exporters with Large Import Shares from Indonesia

	All Exporting Firms		**>5% Import Share from Indonesia**		**>10% Import Share from Indonesia**	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Log Exports	9.664	1.694	10.515	1.683	10.466	1.720
Log Number of Employees	5.456	1.167	5.876	1.249	5.853	1.283
Log Sales	10.802	1.337	11.504	1.564	11.465	1.584
Number of Firms	70369		1387		995	

Note: Chinese exporters reported in this table are large exporters by matching Chinese firm-level data and customs data from 2000 to2006.

Table 2 presents the summary statistics for some key variables used in the estimations. We report simple-average Chinese-industry-classification (CIC) two-digit industry-level output import tariffs, and external tariffs imposed by China's trading partners. The external tariffs are smaller than output tariffs, as China's major trading partners are developed countries that tend to have lower import tariffs due partly to the World Trade Organization's discipline and partly to international trade agreements. We measure input tariffs at the firm-level to capture the feature of zero import tariff of processing imports. It is important to stress that firm-level input tariffs are much lower than output tariffs (see Yu, 2015 for detailed discussions). To this end, we also construct the dummy of processing indicator and find that around 27 percent of firms are processing importers. Last, we report the firm's export scope and import scope by counting the HS eight-digit product lines reported in China's customs data. On average, Chinese firms export around 7 products to, but import more than 21 products from, the rest of the world.

Table 2: Statistics Summary of Key Variables

	All Exporters		>5% Import Shares from Indonesia		>10% Import Shares from Indonesia	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Exports	9.664	1.694	10.515	1.683	10.466	1.720
Home Output Tariffs (industry-level)	11.71	0.056	11.80	0.058	11.74	0.057
Foreign Industry Tariffs	9.60	0.048	10.13	0.050	10.02	0.049
Home Input Tariffs (firm-level)	2.554	4.255	1.536	3.135	1.561	3.256
Firm TFP (Olley-Pakes)	1.072	0.668	1.196	0.863	1.202	0.862
Foreign Indicator	0.569	0.495	0.774	0.419	0.763	0.426
SOE Indicator	0.021	0.142	0.013	0.113	0.013	0.114
Log Labour	5.456	1.167	5.876	1.249	5.853	1.283
Processing Indicator	0.271	0.445	0.513	0.500	0.490	0.500
Export Scope	7.421	10.990	8.640	11.127	8.254	10.855
Import Scope	20.595	37.301	26.358	41.646	23.819	39.358

By way of comparison, firm TFP increases from 1.07 for all Chinese exporters to 1.19 for Chinese exporters with more than a 5 percent import share from Indonesia and 1.20 for those with more than a 10 percent import share from Indonesia, suggesting that the higher the import share from Indonesia, the higher the firm productivity will be.

It is also important to stress that the share of 'processing' (indicated by processing indicator) is higher for firms with higher import shares from Indonesia than that of the average exporting firms. The firms with higher more than a 5 percent of import share from Indonesia have 50 percent of processing activities compared to 27 percent for the average of all Chinese exporters.

4.1. Trade liberalisation and firm export

Table 3 shows the estimations of the impact of trade liberalisation on firm exports. Columns (1)–(4) include Chinese exporters with more than a 10 percent import share from Indonesia whereas Columns (5)–(7) include those firms with more than a 5 percent import share. Several important findings deserve to be highlighted.

First, the coefficients of firm productivity are positive and significant in all estimates, indicating that firms with high productivity tend to export more. More importantly, the magnitude of firm TFP increases with the import shares from Indonesia, suggesting that the effect of TFP on firm exports is more pronounced for firms with more imports from main developing countries like Indonesia. The economic rationale is reasonably clear. As Chinese firms import more intermediate inputs or raw materials from Indonesia, they are more likely to engage in processing trade (as confirmed in Table 2) and hence export more. With more imported intermediate goods, firms are able to employ the advantage of the combination of domestic inputs and imported inputs, as suggested by Halpern et al. (2011).

Table 3: Estimates of Trade Liberalisation on Firm Exports

Regress and: Log Firm Exports	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Import Share from Indonesia	>10%				>5%		
Home Output Tariffs	-2.218*	-2.699**	-2.048*	-2.005	-2.509***	-1.845*	-2.062*
(Industry Level)	(-1.65)	(-2.50)	(-1.81)	(-1.56)	(-2.74)	(-1.93)	(-1.95)
Foreign Tariffs	-2.914**	-2.299**	-2.042**	-1.863*	-2.12***	-1.88**	-1.749**
(Industry Level)	(-2.19)	(-2.36)	(-2.09)	(-1.81)	(-2.62)	(-2.32)	(-2.04)
Home Input Tariffs	-0.051	-0.055**	-0.056**	-0.059**	-0.06***	-0.05***	-0.060***
(Firm Level)	(-1.60)	(-2.16)	(-2.13)	(-2.28)	(-2.78)	(-2.70)	(-2.83)
Firm TFP (Olley-Pakes)	0.304***	0.158***	0.140***	0.144***	0.108**	0.091*	0.099**
	(3.86)	(3.03)	(2.71)	(2.75)	(2.26)	(1.94)	(2.07)
Foreign Indicator		0.033	0.086	0.100	0.185*	0.234**	0.238**
		(0.29)	(0.75)	(0.85)	(1.80)	(2.27)	(2.29)
SOE Indicator		0.749***	0.920***	0.939***	0.833***	1.013***	1.031***
		(4.54)	(4.84)	(4.38)	(5.61)	(6.10)	(5.67)
Log Firm Labour		0.891***	0.895***	0.903***	0.890***	0.890***	0.897***
		(23.59)	(24.00)	(23.97)	(25.77)	(26.02)	(26.11)
Processing Indicator		0.240**	0.253**	0.272**	0.213**	0.236***	0.253***
		(2.35)	(2.42)	(2.58)	(2.44)	(2.66)	(2.83)
Year Fixed Effects	No	No	Yes	Yes	No	Yes	Yes
Industry Fixed Effects	No	No	No	Yes	No	No	Yes
Observations	743	743	743	743	1008	1008	1008
R-squared	0.04	0.47	0.48	0.49	0.46	0.47	0.47

Note: Numbers in parentheses are robust t-value. *(**, ***) denotes significance at 10% (5%, 1%).

Second and equally important, we find that trade liberalisation will boost exports. This is firm for all aspects of trade liberalisation, including output tariff reductions, input tariff reductions, and foreign tariff reductions. With input trade liberalisation, firms are able to save costs in intermediate inputs, and thus earn more profit. Similarly, with lower trading partners' tariffs, firms gain easier access to foreign markets and have more exports. By contrast, the role of output trade liberalisation is different. A large degree of output tariff reductions suggests tough import competition effects from international markets. Thus, only efficient firms are able to survive in the markets. As efficient firms are larger and export more, we see negative coefficients of output tariffs.

Last, SOEs tend to have more exports, and larger firms tend to export more. Also, processing firms have more exports, which makes good sense as processing firms, by definition, will export all products to the foreign markets.

4.2. Trade liberalisation and export and import scope

Table 3 examines the intensive margin of trade liberalisation on firm exports. We now move to explore the impact of trade liberalisation on the extensive margin of exports. In particular, we focus on the change in export and import scopes. By definition, following Qiu and Yu (2014), we define a firm's export scope as the number of HS eight-digit product exported by a Chinese manufacturing firm. We consider the following empirical specification:

$$es_{it} = \beta_0 + \beta_1 TFP_{it} + \beta_2 OT_{it} + \beta_3 IT_{it} + \beta_4 ET_{it} + \theta X_{it} + \varepsilon_{it}$$

where es_{it} is firm *i*'s export product scope, TFP_{it} is total factor productivity, OT_{it} is (Chinese) tariff level faced by the firm i, IT_{it} is input import tariff level faced by the firm, and ET_{it} is the foreign tariff level faced by firm *i* at year t. X is a vector of control variables, including firm's size, ownership type (SOE, multinational firm, or others), and trade mode (processing or ordinary trade).

Table 4 reports the count-data estimates of trade liberalisation on firm export scope. As before, columns (1)–(3) include a sample of Chinese exporters with more than 10 percent import share from Indonesia and columns (4)–(6) cover observations of firms with more than 5 percent import share from Indonesia.

We start from the Poisson estimates in which the mean of export scope is presumed to equal its variance. The Poisson estimate in column (1) suggests that both home output tariffs and foreign trade liberalisation decrease a firm's export scope. In addition, a firm's input tariffs overall decrease export scope. Such findings are exactly consistent with the findings of Qiu and Yu (2014) which covered the whole sample of Chinese exporters. The economic rationale of the positive coefficient of output tariff is straightforward. Lower output tariffs lead to tougher import competition, which in turn makes firm focus on their competitive products. However, at first glance, the positive coefficient of foreign tariffs is counter-intuitive. However, this is just because of the trade-off between positive shock and negative shock raised by a trading partner's tariff reductions. As clearly presented in Qiu and Yu (2014), lower foreign tariffs has both positive and negative shock effects on a firm's export scope. Once the negative competition impact dominates the positive one, export scope falls.

However, the assumption that the mean of the export scope equal its variance seems too strong. Instead, we adopt the negative binomial estimates in column (2) for Chinese exporters with more than a 10 percent import share from Indonesia and those in column (5) with more than a 5 percent import share from Indonesia. The negative binomial estimates are more attractive here as they allow the sample to exhibit a pattern of over-dispersion. However, one may have a concern that some other macro-economic fluctuations such as Renminbi appreciation during the sample period, particularly, after 2005 may affect a firm's export scope. In addition, other unspecified factors such as a firm's managerial efficiency, as introduced in Qiu and Yu (2014), may also affect said firm's extensive margin. We thus control for firm-specific fixed effects and year-specific fixed effects in columns (3) and (6). It turns out that the binomial estimation results in columns (2)–(3) and (5)–(6) are qualitatively identical to their counterparts in columns (1) and (4) with Poisson estimates. Thus, our estimations are insensitive to different empirical specifications.

Table 4: Count-Data Estimates of Trade Liberalisation on Firm Export Scope

Regression: Export Scope	(1)	(2)	(3)	(4)	(5)	(6)
Econometric Method	Poisson	Negative Binomial		Poisson	Negative Binomial	
Import Share from Indonesia		> 10%			>5%	
Home Output Tariffs	0.724***	1.100**	0.942**	1.102***	1.347***	0.871***
(Industry Level)	(4.75)	(2.57)	(2.36)	(9.05)	(3.79)	(2.71)
Foreign Tariffs	5.078***	4.189***	1.709***	4.472***	3.848***	1.782***
(Industry Level)	(21.68)	(6.97)	(3.05)	(23.17)	(7.60)	(3.78)
Home Input Tariffs	-0.006	-0.007	0.004	-0.016***	-0.013*	-0.001
(Firm Level)	(-1.64)	(-0.85)	(0.45)	(-4.87)	(-1.90)	(-0.13)
Firm TFP (Olley-Pakes)	0.353***	0.425***	0.226***	0.324***	0.397***	0.233***
	(14.31)	(5.53)	(2.96)	(15.37)	(6.02)	(3.84)
Foreign Indicator	-0.200***	-0.114	-0.047	-0.128***	-0.067	-0.036
	(-7.73)	(-1.55)	(-0.56)	(-5.78)	(-1.05)	(-0.49)
SOE Indicator	0.093	-0.043	0.138	-0.071	-0.138	-0.046
	(1.20)	(-0.17)	(0.42)	(-1.02)	(-0.64)	(-0.16)
Log Firm Labour	0.187***	0.187***	0.202***	0.222***	0.222***	0.201***
	(20.87)	(8.06)	(7.11)	(28.75)	(10.92)	(8.02)
Processing Indicator	-0.259***	-0.27***	-0.12***	-0.14***	-0.17***	-0.10***
	(-10.82)	(-4.50)	(-2.63)	(-7.40)	(-3.41)	(-2.65)
Year-specific Fixed Effects	No	No	Yes	No	No	Yes
Firm-specific Fixed Effects	No	No	Yes	No	No	Yes
Observations	948	948	948	1323	1323	1323

Note: Numbers in parentheses are robust t-value. *(**, ***) denotes significance at 10% (5%, 1%).

In addition to the above findings, we also observe that large-sized firms have relatively more export scope than average firms. Interestingly, compared to non-processing firms (i.e. ordinary firms), processing firms seem to have less export scope. Combined with the above findings that processing firms have relatively higher export value, as shown in Table 3, the implication is clear: processing exporters reduce the variety of their trade products but focus on their core competitive products. Last, the negative sign of ‘foreign indicator’ suggests that multinational companies based in China have less export scope. Such a finding is consistent with the fact that processing firms also have less export scope, as processing firms generally are subsidiaries of multinational companies, as documented in Dai et al. (2012).

Table 5 shows the impact of trade liberalisation on a firm’s import scope. Once again, trade liberalisation is measured over three dimensions: output tariffs reductions, input tariffs reductions, and foreign tariff reductions. Columns (1) and (3) of Table 5 are Poisson estimates whereas the rest are negative binomial estimates. Meanwhile, columns (1)–(3) are estimates for Chinese exporters with more than a 10 percent import share from Indonesia whereas columns (4)–(6) are firms with more than a 5 percent import share.

Table 5: Count-Data Estimates of Trade Liberalisation on Firm Import Scope

Regression: Import Scope	(1)	(2)	(3)	(4)	(5)	(6)
Econometric Method	Poisson		Neg. Binomial	Poisson		Neg. Binomial
Import Share from Indonesia	> 10%			>5%		
Home Output Tariffs	-0.073	-1.419***	-0.601***	-0.977***	-1.183***	-1.038**
(Industry Level)	(-0.49)	(-13.96)	(-5.98)	(-8.10)	(-14.87)	(-2.52)
Foreign Tariffs	-2.214***	-1.164***	-0.439***	-2.415***	-1.469***	-0.135
(Industry Level)	(-13.57)	(-7.79)	(-3.45)	(-18.30)	(-12.32)	(-0.24)
Home Input Tariffs	0.014***	0.023***	0.019***	0.022***	0.029***	0.046***
(Firm Level)	(7.41)	(12.20)	(10.28)	(13.92)	(18.86)	(3.92)
Firm TFP (Olley-Pakes)	0.260***	0.271***	0.192***	0.340***	0.346***	0.540***
	(16.36)	(17.43)	(11.70)	(26.06)	(27.68)	(7.67)
Foreign Indicator	1.221***	1.249***	1.143***	1.168***	1.224***	1.116***
	(54.47)	(55.68)	(46.68)	(63.41)	(65.98)	(16.19)
SOE Indicator	-0.846***	-0.865***	-0.932***	-0.860***	-0.810***	-0.727***
	(-8.66)	(-10.33)	(-7.93)	(-10.33)	(-11.50)	(-2.92)
Log Firm Labour	0.497***	0.473***	0.475***	0.468***	0.454***	0.455***
	(94.06)	(93.53)	(78.49)	(107.16)	(107.85)	(20.67)
Processing Indicator	-0.108***	-0.128***	-0.096***	-0.074***	-0.097***	-0.067
	(-7.31)	(-8.93)	(-9.13)	(-6.18)	(-8.42)	(-1.14)
Year-specific Fixed Effects	No	No	Yes	No	No	Yes
Firm-specific Fixed Effects	No	No	Yes	No	No	Yes
Observations	948	948	948	1323	1323	1323

Note: Numbers in parentheses are robust t-value. *(**, ***) denotes significance at 10% (5%, 1%).

Table 5 illustrates that foreign tariff reductions increase a firm's import scope due to stimulated foreign demand and larger access to foreign markets. We also find that home output tariff reductions will increase a firm's import scope. The implication is straightforward. With a tougher import competition, firms import more foreign (Indonesian) varieties possibly due to better quality. Strikingly enough, home input tariff reductions are found to decrease firm's import scope. As input trade liberalisation may have cost-saving effects, it in turn increases firm profitability and hence push firms to import more – one possible reason to interpret such a counter-intuitive finding. The first one is due to the sample restriction as our sample only covers large exporting firms. With large profitability, large firms could instead use mode domestic varieties or import less number of varieties but of a higher volume.

4.3. More robustness checks

Table 6: Estimates of Trade Liberalisation on Firm Productivity

Import Share from Indonesia	>10%		>5%	
Regressand:				
Firm TFP (system GMM)	(1)	(2)	(3)	(4)
Home Output Tariffs	-1.177***	-0.666**	-1.343***	-0.925***
(Industry Level)	(-4.76)	(-2.08)	(-6.46)	(-3.42)
Foreign Tariffs	-0.770***	-1.089***	-0.768***	-1.034***
(Industry Level)	(-2.70)	(-3.17)	(-3.24)	(-3.57)
Home Input Tariffs	0.237	0.412	0.249	0.329
(Firm Level)	(0.71)	(0.95)	(0.83)	(0.84)
Foreign Indicator	0.138	0.357**	0.064	0.209
	(0.70)	(2.22)	(0.43)	(1.63)
SOE Indicator	-0.002	0.028	0.016	0.038
	(-0.05)	(0.76)	(0.60)	(1.20)
Log Firm Labour	0.067***	0.067***	0.069***	0.063***
	(6.92)	(5.61)	(8.27)	(5.94)
Processing Indicator	-0.092***	-0.087***	-0.085***	-0.084***
	(-3.61)	(-2.62)	(-3.89)	(-2.98)
Year-specific Fixed Effects	No	Yes	No	Yes
Firm-specific Fixed Effects	No	Yes	No	Yes
Observations	828	828	1156	1156
R-squared	0.15	0.21	0.15	0.19

Note: Numbers in parentheses are robust t-value. *(**, ***) denotes significance at 10% (5%, 1%).

So far we have used the augmented Olley-Pakes TFP to measure firm productivity. Although such a measured TFP has many advantages compared to other alternative measures of productivity, as discussed in Yu (2015), it also has two main disadvantages. First, the Olley-Pakes TFP assumes that firms adjust capital input when facing an exogenous shock. However, this may not happen in China, as China is a labour-abundant country and, hence, Chinese firms find it much easier to adjust labour than capital. Second, the Olley-Pakes TFP does not allow output to have any serial correlations, which are very likely to occur. For these reasons, the system-GMM TFP measure seems an ideal complementary, as it has enough flexibility to allow for possible serial autocorrelations. We hence use system-GMM TFP to check whether our results will remain robust even when using other measures of TFP. Table 6 picks up this comparison.

Following Yu (2015), we now move to discuss whether trade liberalisation boosts firm productivity for Chinese exporters with significant import shares from Indonesia. Once again, we consider firms with 10 and 5 percent import shares from Indonesia, respectively. As in other studies, we find that both output trade liberalisation and external trade liberalisation boost firm productivity. However, we do not find that input trade liberalisation raises firm productivity. The impact of home input trade liberalisation on firm productivity is insignificant. Such findings are robust even we control for year-specific fixed-effects and firm-specific fixed-effects in Table 6 column (2) for firms with 10 percent import shares from Indonesia and in column (4) for those firms with 5 percent corresponding import shares.

This raises a concern over the previous estimates of the effects of trade liberalisation on firm productivity. One may worry that our estimates above have some estimation bias. To address this concern, following Feenstra, Li, and Yu (2014), we distinguish between ex-ante TFP and ex-post TFP measures.

Table 7: Estimates of Trade Liberalisation with Ex-ante Firm Productivity

Regress and:	Log Exports	Export Scope		Import Scope
Import Share from Indonesia	>5%	>5%	>10%	>5%
	(1)	(2)	(2)	(4)
Home Output Tariffs	-0.708	0.682*	0.826*	-1.218***
(Industry Level)	(-0.78)	(1.89)	(1.95)	(-2.86)
Foreign Tariffs	-1.936**	2.806***	4.164***	0.734
(Industry Level)	(-2.36)	(5.30)	(6.97)	(1.16)
Home Input Tariffs	-0.059***	-0.002	-0.005	0.063***
(Firm Level)	(-3.24)	(-0.23)	(-0.64)	(5.36)
Firm TFP (Olley-Pakes)	-0.064	0.749***	0.666***	0.025
	(-0.49)	(9.16)	(6.89)	(0.27)
Foreign Indicator	0.280***	-0.035	-0.115	1.134***
	(2.82)	(-0.57)	(-1.58)	(16.22)
SOE Indicator	0.304	0.052	0.061	-0.512**
	(0.83)	(0.26)	(0.25)	(-2.04)
Log Firm Labour	0.893***	0.247***	0.236***	0.471***
	(28.39)	(12.65)	(10.05)	(20.61)
Processing Indicator	0.258***	-0.171***	-0.281***	-0.056
	(3.26)	(-3.38)	(-4.60)	(-0.95)
Year-specific Fixed Effects	No	Yes	Yes	Yes
Firm-specific Fixed Effects	No	Yes	Yes	Yes
Observations	1192	1324	949	1324

Note: Numbers in parentheses are robust t-value. *(**, ***) denotes significance at 10% (5%, 1%).

The conventional measures of TFP, including our above TFP measure (inclusive of both Olley-Pakes and Sytem-GMM), is a Solow residual that includes both unspecified factors and production productivity. In this way, the measured TFP certainly correlates with the error term. To avoid such a shortcoming and to be closer with the spirit of Melitz (2003) that emphasises more on the ex-ante random draw of firm productivity, we exactly follow Feenstra, Li, and Yu (2014) and Qiu and Yu (2015) to construct an ex-ante TFP.

Table 7 reports the estimation results using the ex-ante TFP measure. The regressand in column (1) is firm exports, whereas those in columns (2) and (3) are export scope, and that in column (4) is import scope. Estimates in column (1) show that all types of trade liberalisation boost firm exports, which make good economic senses. Meanwhile, all estimates on export scope and import score are consistent with estimates with ex post firm productivity presented in Tables 4 and 5. Thus, our main findings are robust when using different measures of TFP.

5. Conclusions

The main value added of our paper is twofold. First, we construct a theoretical model to incorporate North–South–South trade pattern. Our theoretical model predicts that trade liberalisation in North and South production countries can boost firm exports. Second, we provide empirical exercises using very detailed and highly disaggregated Chinese data to test such predictions. In particular, we use both Chinese firm-level production and transaction-level trade data to examine the effects of three types of tariff reduction on firm export, firm productivity, and firm export and import scope by considering vertical integration among South, production South and Consumption north.

Our findings assert that trade liberalisation significantly boosts firm productivity, and hence raises firm exports via both extensive margin (i.e. export scope and import scope) and intensive margin. Such findings are consistent with our theoretical findings. Moreover, our findings provide insightful policy implications. First, if deeper integration between North and South can increase trade flows, governments in the South and North should provide more trade facilitation to make trade integration possible. Second and equally important, we find that trade liberalisation in the destination countries (most likely in the North) and in the production countries (most likely in the South) boosts firm productivity and raises trade flows. Thus, it would be a wise strategy for trading countries to cut their tariffs, phase out other non-tariff barriers, and improve transparency of non-tariff measures.

To understand the exact channel or mechanism of the correlation between home input trade liberalisation and import scope will be an interesting issue to explore in a future study.

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Appendix

Proof of equation (15):

Combining equation (6) and (13), we have:

$$r_{id}^{C}(\varphi_i^{*C}) = \alpha_i R^C \left(\frac{P_i^C \rho \varphi_i^{*C}}{(u^C)^{\beta_i}(r^C)^{1-\beta_i}}\right)^{\sigma-1} = \sigma f_i (u^C)^{\beta_i}(r^C)^{1-\beta_i} \quad \text{(A1)}$$

Combining equation (7) and (14), we have:

$$r_{ix}^{C}(\varphi_{ix}^{*C}) = \alpha_i R^A \left(\frac{P_i^A \rho \varphi_{ix}^{*C}}{\tau_i (u^C)^{\beta_i}(r^C)^{1-\beta_i}}\right)^{\sigma-1} = \sigma f_{ix} (u^C)^{\beta_i}(r^C)^{1-\beta_i} \quad \text{(A2)}$$

Comparing equation (A1) and (A2), we can find:

$$\left(\frac{\varphi_{ix}^{*C}}{\varphi_i^{*C}}\right)^{\sigma-1}\left(\frac{P_i^A}{\tau_i P_i^C}\right)^{\sigma-1}\frac{R^A}{R^C} = \frac{f_{ix}}{f_i} \quad \text{(A3)}$$

Rearranging (A3), we get equation (15):

$$\varphi_{ix}^{*C} = \Lambda_i^C \varphi_i^{*C}, \text{ where } \Lambda_i^C = \tau_i \left(\frac{P_i^C}{P_i^A}\right)\left(\frac{R^C}{R^A}\frac{f_{ix}}{f_i}\right)^{1/(\sigma-1)} \quad (15)$$

Proof of equation (20):

In equilibrium, the expected profit of entry should equal the entry cost, so we have:

$$V_i = \frac{1}{\delta}\left(\int_{\varphi_i^{*C}}^{\infty} \pi_{id}^C(\varphi) g(\varphi) d\varphi\right) + \frac{1}{\delta}\left(\int_{\varphi_{ix}^{*C}}^{\infty} \pi_{ix}^C(\varphi) g(\varphi) d\varphi\right) = f_{ei}(u^C)^{\beta_i}(r^C)^{1-\beta_i} \quad \text{(A4)}$$

Where according to equation (10):

$$\pi_{id}^C(\varphi) = \frac{r_{id}^C(\varphi)}{\sigma} - f_i (u^C)^{\beta_i}(r^C)^{1-\beta_i} \quad (10)$$

From equation (6), it is easy to see:

$$\frac{r_{id}^C(\varphi)}{r_{id}^C(\varphi_i^{*C})} = \left(\frac{\varphi}{\varphi_i^{*C}}\right)^{\sigma-1} \quad \text{(A5)}$$

Combining equation (A5) and (13), we have:

$$r_{id}^C(\varphi) = \left(\frac{\varphi}{\varphi_i^{*C}}\right)^{\sigma-1} \sigma f_i (u^C)^{\beta_i}(r^C)^{1-\beta_i} \quad \text{(A6)}$$

Insert equation (A6) into equation (10), then:

$$\pi_{id}^{C}(\varphi) = ((\frac{\varphi}{\varphi_i^{*C}})^{\sigma-1} - 1) f_i (u^C)^{\beta_i} (r^C)^{1-\beta_i} \tag{A7}$$

Similarly,

$$\pi_{id}^{C}(\varphi) = ((\frac{\varphi}{\varphi_{ix}^{*C}})^{\sigma-1} - 1) f_{ix} (u^C)^{\beta_i} (r^C)^{1-\beta_i} \tag{A8}$$

Insert equation (A7) and (A8) into equation (A4), and after some simple calculation, we can find:

$$V_i^C = \frac{f_i}{\delta}\int_{\varphi_i^{*C}}^{\infty}((\frac{\varphi}{\varphi_i^{*C}})^{\sigma-1} - 1)g(\varphi)d\varphi + \frac{f_{ix}}{\delta}\int_{\varphi_{ix}^{*C}}^{\infty}((\frac{\varphi}{\varphi_{ix}^{*C}})^{\sigma-1} - 1)g(\varphi)d\varphi = f_{ei} \tag{20}$$

Proof of equation (22):

Equation (22) comes directly from the definition of the price index (i.e. equation(2)), where Φ_i^C represents the weighted average productivity of Chinese firms that serve the domestic market, and Φ_{ix}^A represents the weighted average productivity of the US firms that export.

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