Why do some firms solely export?
Theory and Implications*

Bo Gao   Mich Tvede

Abstract

The present paper introduces heterogeneity of fixed market cost and demand shocks in both domestic and foreign markets to explain the existence of firms that solely export, i.e. pure exporters. A firm solely exports if it has lower demand-adjusted fixed export cost than demand-adjusted domestic cost and its productivity level makes it profitable in foreign market but non-profitable in domestic market. This is attributed to a higher demand or lower fixed market cost in foreign market than in domestic market. Due to pure exporters, the average productivity of exporters can be lower than non-exporters. This paper also finds that the effect of trade on overall productivity can be both positive and negative, because trade not only forces the least productive firms with high demand-adjusted fixed export cost to exit the market, but also induces even less productive firms with low demand-adjusted fixed export cost to enter the market as pure exporters. However, the effect on welfare is always positive, indicating the dominant source of trade gains is the access to more varieties. Furthermore, this paper explores the effects of trade liberalization and innovation. Among them, a decrease in fixed export cost and innovation across all firms are studied by shifting the distributions of fixed export cost and productivity.

Keywords: Pure exporters, Heterogeneous firms, Demand-adjusted fixed market cost, Trade liberalization, Innovation

JEL: F12, F13, L1

*We thank Scott Baier, Jeffrey Bergstrand, Nils Braakmann, Diemo Dietrich, Francis Kiraly, Michael Koch, Gary Lyn, Sara Maioli, Hugh Metcalf, Bin Qiu, Zhihong Yu and other conference participants of Midwest international trade group, SAET and EEA as well as seminar participants at Newcastle University, Nottingham University and Southeast University for helpful comments. This paper was circulated as "Heterogeneous fixed export cost: explaining the existence of export-only firms". Bo Gao acknowledges the support from the Economic and Social Research Council [ES/J500082/1].

1 Introduction

A dominant share of research in international trade is conducted on the premise that firms either solely serve the domestic market, i.e. non-exporters or serve both the domestic market and the foreign market, i.e.ordinary exporters. However, some firms solely serve the foreign market, i.e. pure exporters. In China 6.7% of all firms and 27.4% of all exporting firms are pure exporters. Pure exporters exist in 88.4% of all sectors and in 90.5% of the sectors with exporting firms. Moreover, pure exporters contribute 29.1% to the total exports and have larger average value of exports than ordinary exporters. In Eaton *et al.* (2011) it is found that in France a small number of exporting firms are pure exporters. In the present paper we provide a theoretical explanation for the coexistence of pure exporters, ordinary exporters and non-exporters. We show that exceptional exporter performance in productivity is no longer ensured, and productivity gains from trade can be negative while welfare gains always positive.

This paper considers a general equilibrium model with a continuum of heterogeneous firms and identical countries à la Melitz (2003). Every firm faces fixed market costs for serving the domestic and foreign markets, i.e. fixed domestic cost and fixed export cost. At the same time, every firm has different demand shocks in domestic and foreign markets. As in Eaton *et al.* (2011), simply using firm productivity leaves much unexplained on patterns of firms entry and sales across markets. Idiosyncratic interaction between firms and markets, e.g. firm heterogeneity in fixed market costs and demand shocks, plays an important role. They introduce market entry shocks into Arkolakis (2010) formulation of market entry cost , and assume entry shocks and demand shocks are jointly distributed independent of productivity. Instead, the present paper assumes fixed market costs, demand shocks and productivity are jointly distributed and uses these heterogeneity to investigate a firm's behavior into markets, e.g. as a non-exporter, ordinary exporter or pure exporter.

In this paper firms are heterogeneous in productivity, fixed market costs and demand shocks in domestic and foreign markets. A firm solely exports if it has lower demand-adjusted fixed export cost than demand-adjusted domestic cost and its productivity level makes it profitable in foreign market but non-profitable in domestic market. This is attributed to a higher demand, lower fixed market cost in foreign market than in domestic market or both. In China, regional provinces (even cities) compete with each other and develop local protectionism for some products of their own origins (e.g. Young, 2000). This leads to a highly segmented domestic market, which causes some firms to have relatively high fixed domestic cost. In addition firms participating in the global production fragmentation can have relatively low fixed export cost because they have obtained a lot of experience through their close contacts in foreign markets. When exporting, these firms pay less for marketing research, establishing distribution channels, negotiations and so on. Lu *et al.* (2014) exogenously assume that fixed export cost is higher than fixed domestic cost for pure exporters, therefore pure exporters only exist if foreign market is sufficiently large.

As in Defever and Riaño (2012), 38.56% (16.85%) of exporters that (do not) benefit preferential income tax policies, including processing trade firms, foreign invested firms or firms located in a free trade zone, are pure exporters (defined as firms exporting more than 90% of output). Therefore they use subsidy to explain the pure exporters. A firm gets *ad valorem* subsidy if it solely exports. Pure exporters give up domestic market in return for subsidy. However, if the subsidy is computable into a lump sum, it can be treated as a source of heterogeneity in fixed export cost, which then fits in our model. Admittedly, a large proportion of pure exporters are processing trade firms, which import intermediate materials and export processed goods. They can be explained as well in our model because they exhibit following properties: low fixed export cost due to subsidy as a lump sum or close relationship with foreign multinational firms and markets, and/or high fixed domestic entry cost, e.g.penalty for the breach of contract and/or high demand in foreign markets due to production of relation-specific products. Any of these properties tends to cause a higher demand-adjusted fixed export cost than fixed domestic cost. Hence firms become pure exporters when they can only cover fixed export cost.

In this paper productivity, fixed market costs and demand shocks are drawn from a joint distribution, which altogether assure the co-existence of non-exporters, ordinary exporters and pure exporters. As for firms with higher demand-adjusted export cost than demand-adjusted domestic cost, they become non-exporters if they can only cover demand-adjusted domestic cost. The most productive firms that can cover both demand-adjusted export and domestic costs will become ordinary exporters while least productive firms are not able to survive in neither market. The paper shows that some pure exporters are lower productive than non-exporters, therefore exceptional exporter performance in productivity is no longer ensured. The overall productivity of exporters (pure exporters and ordinary exporters) can be lower than non-exporters if the joint distribution gives a large portion of low productive pure exporters. Moreover, international trade not only forces the least productive firms with high demand-adjusted fixed export cost to exit the market, but also induces even less productive firms with low demand-adjusted fixed export cost into the market as pure exporters. Therefore, the effect of trade on overall productivity can be both positive and negative. However welfare gains from trade is always positive, indicating that the dominant source of trade gains is the access to more varieties.

The paper also explores the effects of innovation and trade liberalization in terms of decreasing fixed and variable export cost. A decrease in fixed export cost, as well as innovation across all firms shifts the distribution and raises the cut-off productivity for both domestic and foreign markets. As a result,the least productive pure exporters and non-exporters exit the markets while the least productive ordinary exporters become either pure exporters or non-exporters. A decrease in variable export cost raises the cut-off productivity for the domestic market and decreases the cut-off productivity for the foreign market. Hence it forces the least productive firms out of domestic market, and induces firms which are otherwise non-active or ordinary exporters to be pure exporters. The effects of trade liberalization and innovation are channeled through labor markets, where competition for labor becomes intensive to bid up real wage à la Melitz (2003).

In addition to Defever and Riaño (2012) and Lu *et al.* (2014), Lu (2010) explains pure exporters in a model with comparative advantage. In a country's comparative advantage sector, low productive firms can become pure exporters as they are relatively more competitive in foreign markets. This paper relates to a rich body of literatures that documents an exceptional performance of exporters than non-exporters in productivity (e.g. Bernard and Jensen, 1999; Bernard et al., 2003; De Loecker, 2007; Lileeva and Trefler, 2010; Bustos, 2011). However, using Chinese firm-level data, Lu (2010) and Dai *et al.* (2011) find productivity of exporters is lower than non-exporters while Ma *et al.* (2014) find the same pattern in terms of capital per capita. This paper suggests that these contrasting results depend on if there exists large amount of pure exporters.

A large and established research agenda has documented that the least productive firms exit the market due to trade and the overall productivity becomes higher (e.g. Pavcnik, 2002; Melitz, 2003; Trefler, 2004; Bernard *et al.*, 2007, 2011; Melitz and Ottaviano, 2008; Eckel and Neary, 2010; Mayer *et al.*, 2014). This result holds in this paper if the distribution of firms skews to high demand-adjusted fixed export cost. This paper also adds an novel insight that the low productive firms with low demand-adjusted fixed export cost now can survive by serving foreign market. The paper also contributes to literature on/assuming the heterogeneity in fixed export cost (e.g. Schmitt and Yu, 2001; Jørgensen and Schröder, 2006, 2008; Das *et al.*, 2007; Kasahara and Lapham, 2013). However this paper studies the consequences of heterogeneity of fixed export cost on firms export behavior, instead of where heterogeneity stems from (e.g. Arkolakis, 2010; Eaton *et al.*, 2011; Krautheim, 2012).

The rest of this paper is organized as follows. Section 2 is the set up of the model. Section 3 describes the properties of the equilibrium. Section 4 explores the effect of trade liberalization. Section 5 studies the effect of innovation. Section 6 extends the model by allowing heterogeneous fixed domestic cost. Section 7 concludes the paper.

2 Set Up

We consider an economy with two identical countries, which can be easily extend to symmetric multi-countries. The two countries have the same labor and wage. Labor is the only input factor of firms and fixed in both countries. Consumers and firms face domestic and foreign market. Firms pay entry cost to enter, and then choose to serve domestic market solely, foreign market solely or both markets. In either market, there are demand shocks to firms. To serve the market, firms have to pay fixed market cost (fixed domestic cost and fixed export cost). In each period a portion of firms die but the same amount of firms successfully enter. There is a dynamic process of free entry and exit for firms. Therefore, in the equilibrium the profit is zero.

2.1 Commodities

There are labor and a continuum of goods. Let Ω be the set of goods with $\omega \in \Omega$. The price of labor (wage) is normalized to one.

2.2 Consumers

There is a continuum of identical consumers with mass one in both countries. Every consumer has one unit of labour, that is supplied inelastically, and a CES utility function:

$$U((q(\omega))_{\omega\in\Omega}) = \left(\int_{\omega\in\Omega} [A(\omega)q(\omega)\,]^{\rho}\,\mathrm{d}\omega\right)^{\frac{1}{\rho}}$$

with $0 < \rho < 1$. For every good ω all consumers in a country have the same taste shock $A(\omega)$, but consumers in different countries can have different taste shocks. In addition consumers have shares in firms. However, since there is free entry, average profit of firms is zero so ownership of firms can be disregarded. The problem of a consumer is to maximize utility subject to the budget constraint.

Let $\sigma = 1/(1-\rho)$ so $\sigma > 1$ because $0 < \rho < 1$. The price index P and the quantity index Q are defined as follows:

$$P = \left(\int_{\omega\in\Omega} [\frac{p(\omega)}{A(\omega)}\,]^{1-\sigma}\,\mathrm{d}\omega\right)^{\frac{1}{1-\sigma}} \text{ and } Q = \left(\int_{\omega\in\Omega} [A(\omega)q(\omega)\,]^{\rho}\,\mathrm{d}\omega\right)^{\frac{1}{\rho}}.$$

The solution to the consumer problem derives the aggregate demand $(q(\omega))_{\omega\in\Omega}$:

$$q(\omega) = A(\omega)^{\sigma-1}\,Q\left(\frac{p(\omega)}{P}\right)^{-\sigma}. \tag{1}$$

Let $r(\omega) = p(\omega)q(\omega)$ for all ω and $R = PQ = \int_{\omega\in\Omega} r(\omega)\,\mathrm{d}\omega$.

2.3 Firms

Firm ω uses labor to produce good ω. Firms face an entry cost $F_e > 0$. If a firm enters, then its cost parameters and demand shocks is revealed. The cost parameters and demand shocks are $(\varphi, F_d, F_x, A_d, A_x)$ where: φ is the productivity; F_d the fixed domestic cost; F_x the fixed export cost; A_d demand shock in the domestic market and A_x demand shock in the foreign market. For simplicity we assume that the entry costs are identical for all firms. Therefore a firm is characterized by its productivity, fixed market costs and demand shocks $(\varphi, F_d, F_x, A_d, A_x)$. We assume that the parameters are drawn from a common distribution described by a probability distribution with density $\lambda : \mathbb{R}^5_+ \to \mathbb{R}_+$ and cumulative distribution $\Lambda : \mathbb{R}^5_+ \to [0,1]$.

There is a continuum of active firms. Let Ω be the set of active firms with $\omega \in \Omega$.

Production

Every firm has probability $\delta > 0$ of dying in every period. Let $f_d = \delta F_d$ and $f_x = \delta F_x$ be the amortized per period fixed market costs. In the sequel we use amortized per period fixed market costs and calculate profit per period rather than fixed market costs and expected lifetime profit.

In order to supply $q > 0$ units of good ω to the domestic market the firm uses $f_d + q/\varphi$ units of labor. There is a variable export cost $\tau \geq 1$, so in order to supply $q > 0$ units of the good to the export market the firm uses $f_x + q\tau/\varphi$ units of labor.

There is monopolistic competition in both countries. Therefore for given price and quantity indices, every firm faces the demand function described in (1). A firm supplying the domestic market maximizes its profit on that market:

$$\max_p \; pA_d^{\sigma-1} Q\left(\frac{p}{P}\right)^{-\sigma} - \frac{1}{\varphi} A_d^{\sigma-1} Q\left(\frac{p}{P}\right)^{-\sigma}$$

The solution is $p_d(\varphi) = 1/(\rho\varphi)$, the total revenue is $r_d(\varphi, A_d, P) = R(A_d P \rho \varphi)^{\sigma-1}$ and the profit is $\pi_d(P, \varphi, f_d, A_d) = r_d(P, \varphi, A_d)/\sigma - f_d$. A firm supplying the foreign market maximizes its profit on that market:

$$\max_p \; pA_x^{\sigma-1} Q\left(\frac{p}{P}\right)^{-\sigma} - A_x^{\sigma-1} Q\left(\frac{p}{P}\right)^{-\sigma} \frac{\tau}{\varphi}$$

The solution is $p_x(\varphi) = \tau/(\rho\varphi)$, the total revenue is $r_x(P, \varphi, A_x) = R(PA_x\rho\varphi/\tau)^{\sigma-1}$ and the profit is $\pi_x(P, \varphi, f_x, A_x) = r_x(P, \varphi, A_x)/\sigma - f_x$.

Behavior

Firms can be: a non-exporters; ordinary exporters; pure exporters; or, non-producing. For any combinations of fixed market costs f_i and demand shocks A_i, there are cut-off productivities $\varphi_i^*(P, f_i, A_i)$ such that a firm is active in market i if and only if $\varphi \geq \varphi_i^*(P, f_i, A_i)$ for $i \in \{d, x\}$. The cut-off productivities are determined by $\varphi \geq \varphi_i^*(P, f_i, A_i)$ if and only if $\pi_i(P, \varphi_i^*, f_i, A_i) = 0$. Therefore for $\Theta = (\sigma/R)^{1/(\sigma-1)}/\rho$ the cut-off productivities are:

$$\begin{cases} \varphi_d^*(P, f_d, A_d) = \dfrac{\Theta}{P} \dfrac{f_d^{1/(\sigma-1)}}{A_d} \\[2ex] \varphi_x^*(P, f_x, A_x) = \tau \dfrac{\Theta}{P} \dfrac{f_x^{1/(\sigma-1)}}{A_x}. \end{cases} \tag{2}$$

Hence the behavior of firms can be characterized as follows:

Non-producing firm: A firm is non-producing provided

$$\varphi < \varphi_d^*(P, f_d, A_d) \text{ and } \varphi < \varphi_x^*(P, f_x, A_x).$$

Non-exporter: A firm is a non-exporter provided

$$\varphi_d^*(P, f_d, A_d) < \varphi < \varphi_x^*(P, f_x, A_x).$$

Ordinary exporter: A firm is an ordinary exporter provided

$$\varphi > \varphi_d^*(P, f_d, A_d) \text{ and } \varphi > \varphi_x^*(P, f_x, A_x).$$

Pure exporter: A firm is a pure exporter provided

$$\varphi_x^*(P, f_x, A_x) < \varphi < \varphi_d^*(P, f_d, A_d).$$

From equation (2), we see that cut-off productivities are linear in demand-adjusted fixed market cost $z_i = f_i^{1/(\sigma-1)}/A_i$ for both i. Figure 1 illustrates the different kinds of behavior with demand-adjusted fixed market costs for both i and productivity as axes. There are two hyperplanes of cut-off productivities defined by $\varphi = \varphi_d^*(P, f_d, A_d)$ and $\varphi = \varphi_x^*(P, f_x, A_x)$. The two planes divide the space into four parts non-exporters (NE), ordinary exporters (OE), pure exporters (PE) and non-producing firms (N).

Behavior is illustrated in Figure 2 for fixed demand-adjusted fixed market costs: in Figure 2.a for fixed demand-adjusted fixed domestic cost; and, in Figure 2.b for fixed demand-adjusted fixed export cost. For fixed demand-adjusted fixed domestic cost, pure exporters are characterized by low productivity and low demand-adjusted fixed export cost. Indeed pure exporters have lower productivities than non-exporters. However pure exporters have lower demand-adjusted export cost than other active firms. For fixed demand-adjusted fixed export cost, pure exporters are characterized by higher productivities and demand-adjusted fixed domestic costs than non-exporters.

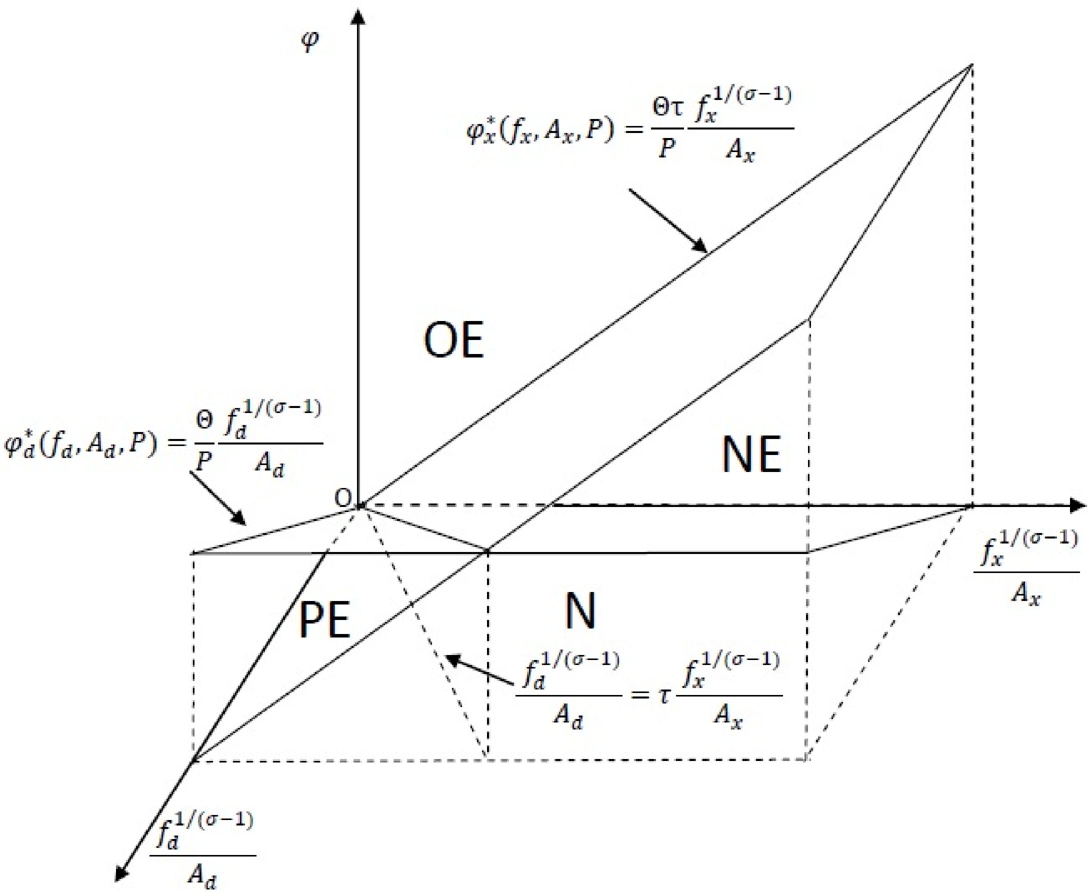

Fig 1: Firm behavior based on fixed market costs and demand shocks

Firm Entry and Exit

There is a pool of potential entrants. After paying entry cost $F_e > 0$, the firm draws its parameters. All firms randomly draw productivity φ, fixed market costs f_d, f_x and demand shocks A_d, A_x from a joint distribution $\mu(\varphi, f_d, f_x, A_d, A_x)$. Based on these parameters, firms choose to serve the market or exit. For firms serving the market, they have a probability δ in every period to die. Without assuming time discounting, it is indifferent to use amortized per period fixed market cost to calculate profit per period and to use fixed market cost to calculate expected lifetime profit. The expected profit opportunity drives firms to pay entry cost. If the expected profit is lower than entry cost, no firm will enter the market. Otherwise a large potential entrants will continue to enter the market until the last firm enters with zero profit. Moreover, entry and exit will not affect the distribution as new entrants exactly replace dead firms.

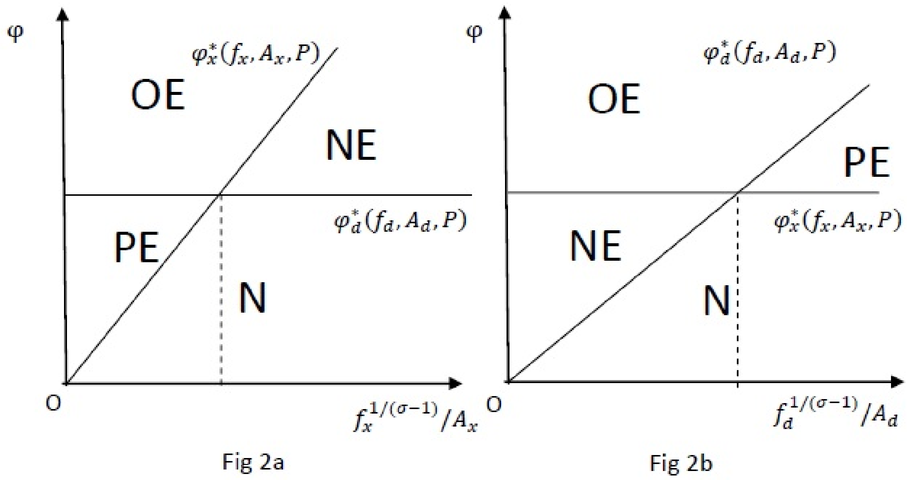

Fig 2: Firm behavior for given demand-adjusted fixed market cost

2.4 Equilibrium

We consider a stationary equilibrium where all aggregate variables are constant over time. In equilibrium consumers maximize their utilities, firms maximize their profits and markets clear. Since there is free entry, the expected lifetime profit of firms is equal to the entry cost. Let Π be the expected profit per period, then the *zero profit condition* is:

$$\frac{\Pi}{\delta} = F_e. \tag{3}$$

3 Equilibrium

There is a unique equilibrium where all aggregate variables are constant over time.

Theorem 1 *There is a unique equilibrium.*

Proof: Let $z = (f_d, f_x, A_d, A_x)$ to ease notation. For price index P and parameters (φ, z) let $\pi(P, \varphi, z)$ be the profit per date. Then the expected profit per date is:

$$\Pi(P) = \int_{(\varphi,z)} \pi(P, \varphi, z)\, \lambda(\varphi, z)\, \mathrm{d}(\varphi, z) = \int_z \pi(P|z)\, \lambda(z)\, \mathrm{d}z \tag{4}$$

where $\lambda(z) = \int_\varphi \lambda(\varphi, z)\, \mathrm{d}\varphi$ is the marginal density of z and $\pi(P|z) = \int_\varphi \pi(P, \varphi, z)\, \lambda(\varphi, z)\, \mathrm{d}\varphi$ is expected profit conditional on z. The profit π consists of profit from domestic market π_d and profit from export market π_x:

$$\pi(P|z) = \int_{\varphi_d^*(P, f_d, A_d)}^{\infty} \pi_d(P, \varphi, f_d, A_d)\, \lambda(\varphi|z)\, \mathrm{d}\varphi + \int_{\varphi_x^*(P, f_x, A_x)}^{\infty} \pi_x(\varphi, f_x, A_x, P)\, \lambda(\varphi|z)\, \mathrm{d}\varphi \tag{5}$$

Therefore for $\Phi : \mathbb{R}_+ \to \mathbb{R}_+$ and $k : \mathbb{R}_+ \to \mathbb{R}_+$ defined by

$$\Phi(x) = \left(\frac{1}{1-\Lambda(x|z)} \int_x^\infty \varphi^{\sigma-1} \lambda(\varphi|z)\,\mathrm{d}\varphi \right)^{\frac{1}{\sigma-1}} \tag{6}$$

$$k(x) = (1-\Lambda(x|z)) \left(\left(\frac{\Phi(x)}{x} \right)^{\sigma-1} - 1 \right) \tag{7}$$

the expected profit conditional on z is

$$\pi(P|z) = f_d k(\varphi_d^*(P, f_d, A_d)) + f_x k(\varphi_x^*(P, f_x, A_x)). \tag{8}$$

$\Lambda(x|z)$ is conditional cumulative distribution. We now prove $\Pi(P)$ is a increasing function of P. From equation (7) and (6), $k'(x) = (1-\sigma) \int_x^\infty \varphi^{\sigma-1} \lambda(\varphi|z)\,\mathrm{d}\varphi / x^\sigma < 0$. From equation (2), with respect to P, $\varphi_d^{*\prime}(f_d, A_d, P) < 0$ and $\varphi_x^{*\prime}(f_x, A_x, P) < 0$. Hence $\pi'(P|z) > 0$. Differentiating function $\Pi(P)$, we have $\Pi'(P) > 0$. As P approaches to zero (infinity), $\Pi(P)$ approaches to zero (infinity). Therefore there is a unique equilibrium. ||

Corollary 1 *In equilibrium non-exporters, pure exporters and ordinary exporters co-exist.*

Given the distribution $\lambda(\varphi, z)$, the firms which can afford both demand-adjusted fixed domestic and export cost will become ordinary exporters. The firms that can only cover demand-adjusted fixed domestic cost will become non-exporters, while those only able to cover demand-adjusted fixed export cost will be pure exporters. Pure exporters emerge due to either relatively lower fixed export cost than fixed domestic cost or higher foreign demand than domestic demand. Fig 1 illustrates all the combinations of parameters for different firm behavior.

In equilibrium, all the economic variables are determined, including number of non-exporters, ordinary exporters and pure exporters, as well as price index and welfare.

labor L consists of labor for production (incumbents) L_p and labor for investment (entrants) L_e. Let Π^t be the total profit earned by incumbents, the total revenue R is equal to $L_p + \Pi^t$. Let M_e denote the number of entrants and M the number of incumbents. Because successful entrants will replace the dead firms, hence we have:

$$\delta \cdot M = M_e \cdot \Delta \tag{9}$$

where $\Delta = \int_z \int_{\varphi^*(z)} \lambda(\varphi, z)\,\mathrm{d}(\varphi, z)$ is the ex-ante probability of successful entry. $\varphi^*(z) = min\{\varphi_d^*(f_d, A_d, P), \varphi_x^*(f_x, A_x, P)\}$. From equation (2), we see $\varphi^*(z) = \varphi_d^*(f_d, A_d, P)$ if $z_d < \tau z_x$ and $\varphi^*(z) = \varphi_x^*(f_x, A_x, P)$ if $z_d < \tau z_x$. Then average profit earned by incumbents then is Π/Δ.

The labor for entrants L_e is:

$$L_e = M_e \cdot F_e = \frac{\delta \cdot M}{\Delta} \cdot \frac{\Pi}{\delta} = M \cdot \frac{\Pi}{\Delta} = \Pi^t$$

Therefore $R = L_p + \Pi^t = L_p + L_e = L$. The total revenue is equal to total labor. Let r denote the average revenue of incumbents, the number of incumbents M can be determined by:

$$M = \frac{R}{r} = \frac{L}{\sigma(\Pi/\Delta + F/\Delta)} \tag{10}$$

where $F = \int_z [f_d(1 - \Lambda(\varphi_d^*(f_d, A_d, P)|z) + f_x(1 - \Lambda(\varphi_x^*(f_x, A_x, P)|z)]\lambda(z)\,\mathrm{d}z$. F/Δ is the average fixed market cost of incumbents. Note that the distribution of incumbents is scaled as $\lambda(\varphi, z)/\Delta$. Appendix 1 shows an alternative way to find equation (10) using labor market.

The number of non-exporters is determined by:

$$M_{ne} = \frac{M}{\Delta} \cdot \int_{z_d < \tau z_x} \int_{\varphi_d^*(f_d, A_d, P)}^{\varphi_x^*(f_x, A_x, P)} \lambda(\varphi, z)\,\mathrm{d}(\varphi, z)$$

while number of pure exporters determined by:

$$M_{pe} = \frac{M}{\Delta} \cdot \int_{z_d > \tau z_x} \int_{\varphi_x^*(f_x, A_x, P)}^{\varphi_d^*(f_d, A_d, P)} \lambda(\varphi, z)\,\mathrm{d}(\varphi, z)$$

With regards to equation (6), let $\tilde{\varphi}_d = A_d \tilde{\varphi}(\varphi_d^*(f_d, A_d, P))$ and $\tilde{\varphi}_x = A_x \tilde{\varphi}(\varphi_x^*(f_x, A_x, P))$. $\tilde{\varphi}_d$ and $\tilde{\varphi}_x$ are representative productivity across firms serving domestic market and firms serving foreign markets conditional on (f_d, f_x, A_d, A_x) à la Melitz (2003). Therefore the representative productivity of all varieties $\tilde{\varphi}_t$ is denoted as:

$$\tilde{\varphi}_t = \left(\int_z \frac{M_d(z) \cdot \tilde{\varphi}_d^{\sigma-1} + M_x(z) \cdot (\tilde{\varphi}_x/\tau)^{\sigma-1}}{M_t} \mathrm{d}z \right)^{\frac{1}{\sigma-1}}$$

where $M_d(z) = M \int_{\varphi_d^*(f_d, A_d, P)}^{\infty} \frac{\lambda(\varphi, z)}{\Delta} \mathrm{d}\varphi$ is the number of varieties from domestic firms conditional on z and is also the number of firms serving domestic market while $M_x(z) = M \int_{\varphi_x^*(f_x, A_x, P)}^{\infty} \frac{\lambda(\varphi, z)}{\Delta} \mathrm{d}\varphi$ is the number of imported varieties conditional on z and is also the number of exporters in a symmetric tow-country model. $M_t = \int_z (M_d(z) + M_x(z))\,\mathrm{d}z$ is the total number of varieties for the domestic consumers. As in Melitz(2003), the price level can be in turn expressed as $P = M_t^{1/1-\sigma} \cdot p(\tilde{\varphi}_t) = M_t^{1/1-\sigma}/(\rho\tilde{\varphi}_t)$, which completes characterization of the equilibrium. Welfare, equal to utility, is defined as:

$$W = R/PL = 1/P \tag{11}$$

Theorem 2 *The average productivity of exporters (ordinary exporters and pure exporters) can be lower than non-exporters.*

It is obvious from Fig 1 that some pure exporters and a portion of exporters have lower productivity than non-exporters. Whether the average productivity of exporters is higher or lower than non-exporters depends on relative amount of pure exporters compared with non-exporters, which further depends on the joint distribution of productivity, fixed market costs and demand shocks.

Example 1: To quantitatively see that the average productivity of exporters can be lower than non-exporters, we simplify the calculation by using a specific form of the distribution as an example. Given a distribution $\lambda(\varphi, z)$ such that 1) marginal density distribution of productivity φ is $g(\varphi)$, 2) demand-adjusted fixed export cost z_x is under distribution $\gamma(z_x)$ and 3) demand-adjusted fixed domestic cost z_d is under distribution $\psi(z_d)$.

As widely used, productivity distribution is Pareto distribution on $(\underline{\varphi}, \infty)$, with density distribution $g(\varphi) = \theta \underline{\varphi}^{\theta} \varphi^{-\theta-1}$ and cumulative distribution $G(\varphi)$, where $\underline{\varphi}$ is assumed very small and $\theta > 1$. We also assume that distribution $\gamma(z_x) = \beta {Z_x}^{\beta} {z_x}^{-\beta-1}$ with support on (Z_x, ∞) and $\psi(z_d) = \beta {Z_d}^{\alpha} z_d^{-\alpha-1}$ with support on (Z_d, ∞), $\beta > 1$ and $\alpha > 1$. We assume $\tau Z_x < Z_d$ to assure existence of pure exporters. These distributions tend to give a high portion of pure exporters, thereby more likely giving lower average productivity of exporters than non-exporters. Then in the equilibrium, average productivity of exporters and non-exporters are (see appendix 2 for proof):

$$\Psi_e = \frac{\theta}{\theta-1} \cdot \frac{\theta+\beta}{\theta+\beta-1} \cdot \frac{\Theta}{P} \cdot \tau Z_x$$

$$\Psi_{ne} = \frac{\theta+\beta}{\theta+\beta-1} \frac{\theta+\beta+\alpha}{\theta+\beta+\alpha-1} \cdot \frac{\Theta}{P} \cdot Z_d$$

Therefore, the ratio between average productivity of exporters and non-exporters is:

$$\frac{\Psi_e}{\Psi_{ne}} = \frac{\theta}{\theta-1} \cdot \frac{\theta+\beta+\alpha-1}{\theta+\beta+\alpha} \cdot \frac{\tau Z_x}{Z_d}$$

The ratio is an increasing function with $\tau Z_x / Z_d$. And we can see

$$\frac{\Psi_e}{\Psi_{ne}} < 1 \quad \text{if} \quad \frac{\tau Z_x}{Z_d} < \frac{1+(\beta+\alpha)/\theta}{1+(\beta+\alpha)/(\theta-1)} < 1$$

The lower Z_x is compared to Z_d, the larger portion of pure exporters in the market is. So there exists distributions such that average productivity of exporters is lower than non-exporters. ||

4 Trade Liberalization

4.1 From Autarky to Trade

In autarky, firms solely serve domestic market, so the average profit of firms conditional on fixed export cost is determined as:

$$\pi(P_a|z) = \int_{\varphi_d^*(f_d,A_d,P_a)}^{\infty} \pi_d(\varphi, f_d, A_d, P_a)\lambda(\varphi|z)\,\mathrm{d}\varphi = f_d k(\varphi_d^*(f_d,A_d,P_a))$$

where P_a is the price level in autarky. In autarky, fixed export cost and foreign demand shock play no role on firms' profit and cut-off productivity. We use $\lambda(f_d,A_d|f_x,A_x)$ to denote the conditional distribution on (f_x,A_x),

$$\lambda(f_d,A_d|f_x,A_x) = \lambda(f_d,f_x,A_d,A_x)/\int_{f_d,A_d} \lambda(z)\mathrm{d}(f_d,A_d)$$

Therefore the expected profit in autarky $\Pi(P_a)$ is :

$$\Pi(P_a) = \frac{1}{\delta}\int_{f_d,A_d} f_d k(\varphi_d^*(f_d,A_d,P_a))\lambda(f_d,A_d|f_x,A_x)\mathrm{d}(f_d,A_d) \tag{12}$$

Equation (12) and equation (3) determine a unique price level P_a because $k(\varphi)$ is monotonically increasing from zero to infinity.

Theorem 3 *The effect of trade on overall productivity can be both positive and negative.*

Proof: The expected profit in autarky $\Pi(P_a)$ in equation (12) is less than the expected profit in open economy $\Pi(P)$ determined by equations (3), (4) and (5). Since $V(\cdot)$ is a monotonically increasing function, we have:

$$P_a > P$$

Therefore the plane $\varphi_d^*(f_d,A_d,P_a)$ is underneath the plane $\varphi_d^*(f_d,A_d,P)$ shown as Fig 3. From Fig 3, we see trade not only forces the least productive firms with relatively high demand-adjusted fixed export cost ($\tau z_x > z_d$) out of the market, as shown in O space, but also induces even less productive firms with relatively low demand-adjusted fixed export cost ($\tau z_x < z_d$) into the market pure exporters, shown as in PE space. The effect of trade on overall productivity can be both positive and negative. ||

Example 2: Using the same distributions of productivity and fixed export cost as in *Example 1*, the overall productivity in autarky and trade are (see appendix 3 for proof):

$$\Psi_a = \frac{\theta}{\theta-1}\cdot\frac{\theta+\alpha}{\theta+\alpha-1}\cdot\frac{\Theta}{P_a}\cdot Z_d$$

$$\Psi = \frac{\theta}{\theta-1}\cdot\frac{\theta+\beta}{\theta+\beta-1}\cdot\frac{\frac{\alpha(\theta-1)}{\theta+\beta+\alpha-1}Z_d\left(\frac{\tau Z_x}{Z_d}\right)^{\theta+\beta}+\beta\tau Z_x}{\frac{\alpha\theta}{\theta+\beta+\alpha}\left(\frac{\tau Z_x}{Z_d}\right)^{\theta+\beta}+\beta}\cdot\frac{\Theta}{P}$$

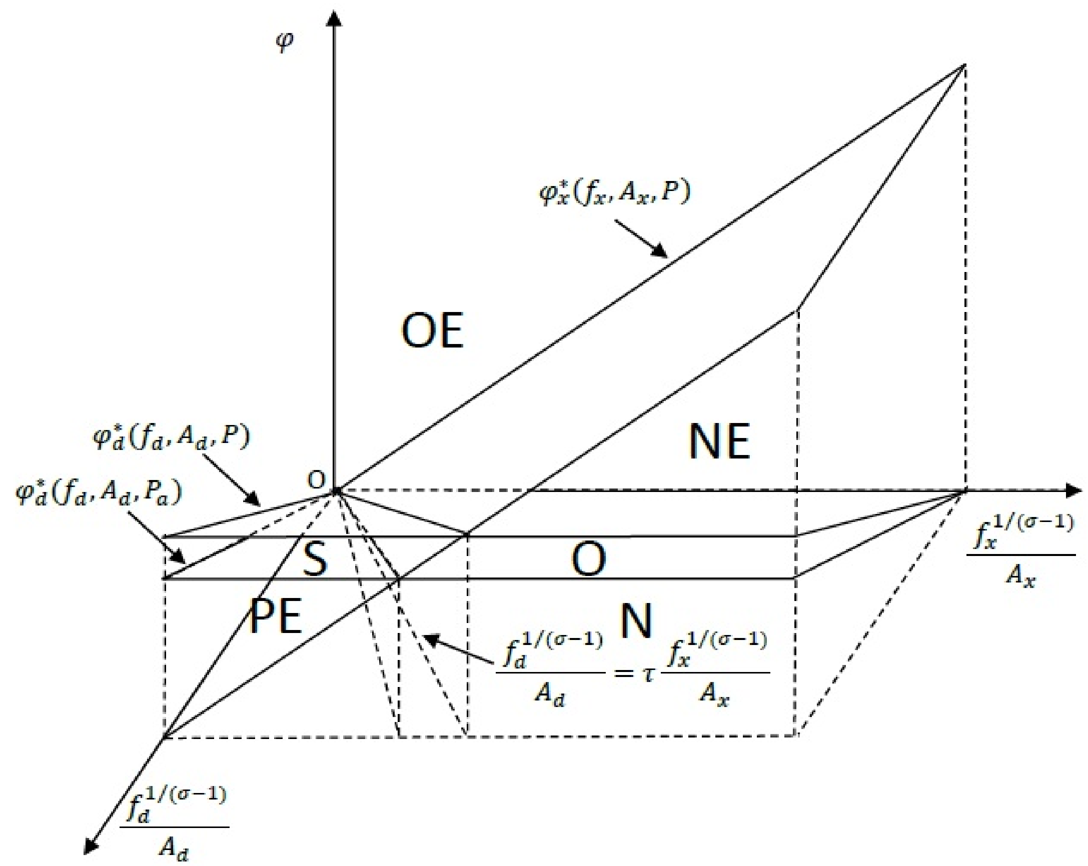

Fig 3: Firm behavior from autarky to trade

Therefore the ratio between overall productivity after trade and autarky is:

$$\frac{\Psi}{\Psi_a} = \frac{\theta+\beta}{\theta+\beta-1}\frac{\theta+\alpha-1}{\theta+\alpha}\frac{\frac{\alpha(\theta-1)}{\theta+\beta+\alpha-1}\left(\frac{\tau Z_x}{Z_d}\right)^{\theta+\beta}+\beta\left(\frac{\tau Z_x}{Z_d}\right)}{\frac{\alpha\theta}{\theta+\beta+\alpha}\left(\frac{\tau Z_x}{Z_d}\right)^{\theta+\beta}+\beta}\cdot\frac{P_a}{P}$$

Because $0 < \tau Z_x/Z_d < 1$, it is straight forward that

$$\lim_{\tau Z_x/Z_d \to 0}\frac{\Psi}{\Psi_a} = 0 \text{ and } \lim_{\tau Z_x/Z_d \to 1}\frac{\Psi}{\Psi_a} = \frac{1+\beta/(\alpha+\theta)}{1+\beta/(\alpha+\theta-1)}\cdot\frac{P_a}{P}$$

Because P_a/P is larger than 1, average productivity after trade can easily be higher than in autarky as $\tau Z_x/Z_d$ becomes higher. However as $\tau Z_x/Z_d$ becomes lower, there are higher portion of pure exporters, leading to lower overall productivity than in autarky. ||

In the open economy, the opportunity for some firms to get extra profit by exporting makes the competition for labor more intensive than in autarky, thereby bidding up the real wage. The least productive firms which cannot export due to high demand-adjusted fixed export cost, attributed to low foreign demand or high fixed export cost, are not able to afford the higher wage in domestic market. Therefore they are forced out (O space in Fig 3). Less productive firms can still afford the new wage and will serve domestic market only (NE space). High productive firms will serve both markets (OE space).

The interesting areas in Fig 3 are spaces PE and S, where firms have a relative lower demand-adjusted fixed export cost than fixed domestic cost. In PE space, firms cannot survive in domestic market in autarky, but after trade they are induced into the foreign market as pure exporters. In S space, these firms can survive in autarky, but they cannot earn profit in domestic market due to higher wage after trade. However they can switch to be pure exporters due to relative low demand-adjusted fixed export cost. The effect of trade on overall productivity is ambiguous. The outcome depends on distribution $\lambda(\varphi, z)$, which determines the portfolio of firms that exit and enter the market.

Theorem 4 *The effect of trade on welfare is always positive.*

Proof: According to equation (11) we know welfare in autarky and after trade as:

$$W_a = \frac{1}{P_a} \quad \text{and} \quad W = \frac{1}{P} \tag{13}$$

Together with inequality shown in Theorem 3, $P_a > P$, we have $W_a < W$. $||$

The effect of trade on the overall productivity can be positive or negative, but the welfare gains from trade is always positive. This indicates that the dominant source of trade gains here is the access to more varieties.

4.2 A Decrease in Fixed Export Cost

If fixed export cost of a single firm is changed, it has no effect on the distribution of fixed export cost. In such case, the effect on this firm is straight forward from Fig 1. Here we consider a decrease in fixed export cost across all firms due to some beneficial export shocks. For example, development of Internet facilitated the market searching and negotiations of all firms in the foreign market, the opening of embassy gives all firms easier access to foreign information, enlargement of EU in 2004 weakened regulatory environment when German firms exporting to Poland and vice versa. Next we study decrease in fixed export cost in form of movement of the conditional distribution of fixed export cost. Fig 4a shows an example by assuming that there is only one intersection between the ex-ante and ex-post conditional distributions.

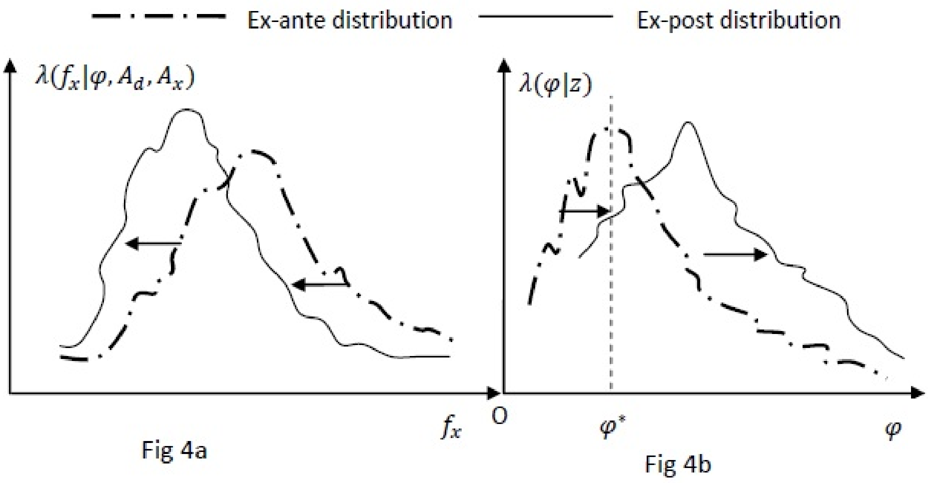

Fig 4: Movements of distributions

Theorem 5 *Suppose there is only one intersection between the ex-ante and ex-post conditional distributions of fixed export cost, then the decrease in fixed export cost will force the least productive pure exporters and non-exporters out of the market, and force the least productive ordinary exporters to be either pure exporters or non-exporters.*

Proof: We have pointed that, instead of cut-off productivity $\varphi_i^*(f_i, A_i, P)$, $\pi_i(\varphi, f_i, A_i, P) = 0$ can alternatively determine cut-off fixed market cost $f_i^*(\varphi, A_i, P)$, $i \in \{d, x\}$. In particular, $f_d^*(\varphi, A_d, P) = (A_d P\varphi/\Theta)^{\sigma-1}$ and $f_x^*(\varphi, A_x, P) = (A_x P\varphi/\Theta\tau)^{\sigma-1}$. Then the firms with fixed market cost lower than the cut-off will serve the markets. Therefore, the expected profit determined by equation (4) can be expressed as $\Pi(P) = \int_{\varphi, A_d, A_x} \pi(P|\varphi, A_d, A_x)\lambda(\varphi, A_d, A_x)\,\mathrm{d}(\varphi, A_d, A_x)$, where $\lambda(\varphi, A_d, A_x) = \int_{f_d, f_x} \lambda(\varphi, z)\mathrm{d}(f_d, f_x)$ is the marginal distribution. Conditional on (φ, A_d, A_x), profits in domestic and foreign markets will be $f_d^*(\varphi, A_d, P) - f_d$ and $f_x^*(\varphi, A_x, P) - f_x$ respectively. Hence we have

$$\begin{aligned}\pi(P|\varphi, A_d, A_x) \quad = \quad & \int_0^{f_d^*(\varphi, A_d, P)} (f_d^*(\varphi, A_d, P) - f_d)\lambda(f_d|\varphi, A_d, A_x)\mathrm{d}f_d \\ & + \int_0^{f_x^*(\varphi, A_x, P)} (f_x^*(\varphi, A_x, P) - f_x)\lambda(f_x|\varphi, A_d, A_x)\mathrm{d}f_x\end{aligned}$$

where $\lambda(f_d|\varphi, A_d, A_x)$ and $\lambda(f_x|\varphi, A_d, A_x)$ are conditional distributions. Equilibrium is determined by equation (3). We have shown that $\Pi(P)$ is an monotonically increasing function. Here a decrease in fixed export cost across firms will shift conditional distribution $\lambda(f_x|\varphi, A_d, A_x)$ while leaving $\lambda(f_d|\varphi, A_d, A_x)$ and $\lambda(\varphi, A_d, A_x)$ unchanged. Suppose there is only one intersection between the ex-ante and ex-post conditional distributions of fixed export cost, $\pi(P, f_d, f_x|\varphi, A_d, A_x)$ will become higher. The reason is that the density of higher export profit is higher while the density of lower export profit is lower. As a result, $\Pi(P)$ is higher. Therefore price level P is decreased, leading to higher cut-off productivity for both domestic and foreign markets. As shown in Fig 5, the least pure exporters and non-exporters are forced out of the market,while the least productive ordinary exporters are forced to be either pure exporters or non-exporters. $||$

A decrease in fixed export cost across firms raises average profit and intensifies the competition for labor, thereby bidding up real wage. As a result, the least productive firms are forced out of the market and some firms that serve both markets exit the non-profitable market. These effects are shown in Fig 5. The planes of cut-off productivity move up. The least productive firms with relative low demand-adjusted fixed export cost that serve both markets exit domestic market and become pure exporters, while the least productive firms with relative high demand-adjusted fixed export cost exit foreign market and become non-exporters. After a decrease in fixed export cost, overall productivity is increased as least productive firms exit. Meanwhile, according to equation(13) welfare is improved because price level P is decreased.

If here is more than one intersection between the ex-ante and ex-post conditional distributions of fixed export cost, it will be ambiguous that whether shifting the distribution raises or decreases conditional expected profit $\pi(P|\varphi,A_d,A_x)$, the expected profit $\Pi(P)$ as well as price level P.

4.3 A Decrease in Variable Export Cost

Theorem 6 *A decrease in variable export cost τ will force the least productive firms out of domestic market, allow more firms export and induce firms which are otherwise non-active or ordinary exporters to be pure exporters.*

Proof: Equilibrium determination (3) can be written as $\Pi(P,\tau) = F_e\delta$. Hence we have:

$$\frac{\mathrm{d}P}{\mathrm{d}\tau} = -\frac{\partial\Pi(P,\tau)/\partial\tau}{\partial\Pi(P,\tau)/\partial P} = \frac{\int_z \frac{\partial\pi(P|z)}{\partial\tau}\lambda(z)\,\mathrm{d}z}{\int_z \frac{\partial\pi(P|z)}{\partial P}\lambda(z)\,\mathrm{d}z}$$

According to equation (8), we have

$$\begin{aligned}
\frac{\partial\pi(P|z)}{\partial\tau} &= f_x k'(\varphi_x^*(f_x,A_x,P))\frac{\partial\varphi_x^*(f_x,A_x,P)}{\partial\tau} < 0 \\
\frac{\partial\pi(P|z)}{\partial P} &= f_d k'(\varphi_d^*(f_d,A_d,P))\frac{\partial\varphi_d^*(f_d,A_d,P)}{\partial P} + f_x k'(\varphi_x^*(f_x,A_x,P))\frac{\partial\varphi_x^*(f_x,A_x,P)}{\partial P} > 0
\end{aligned}$$

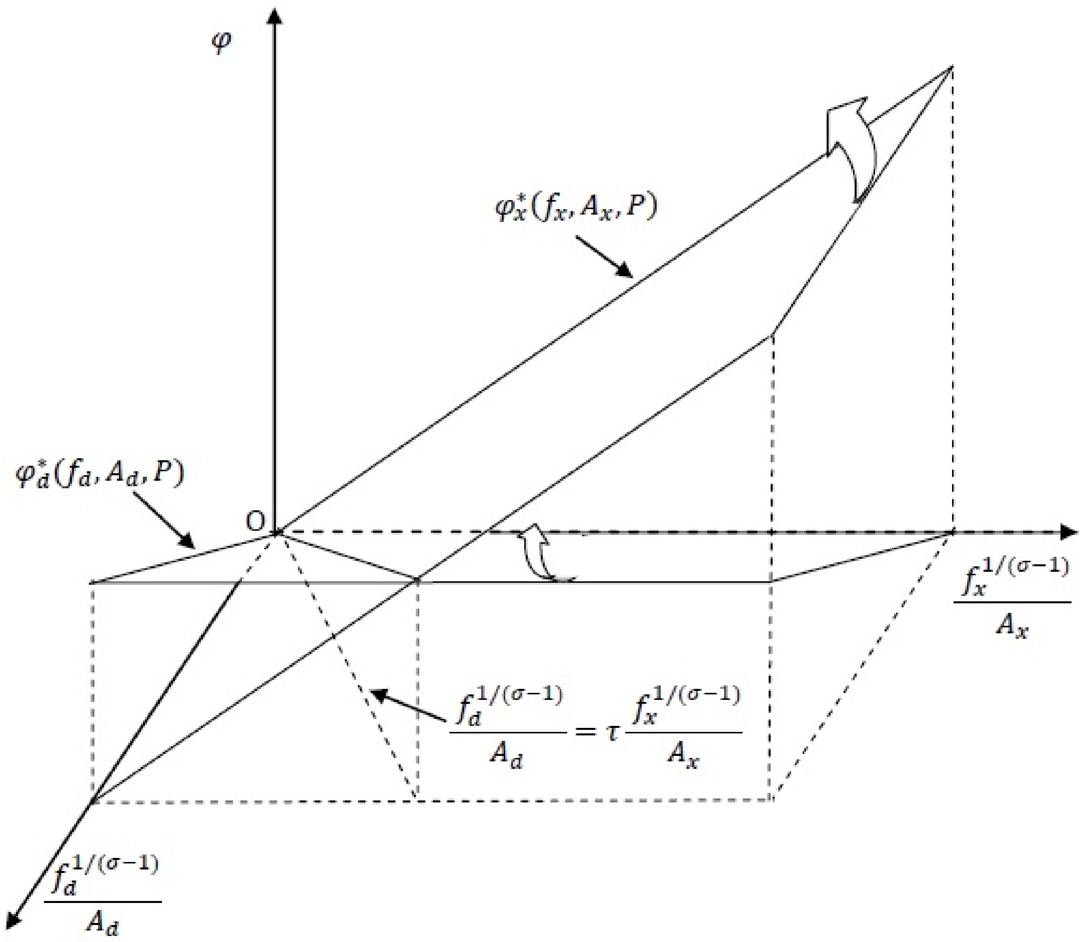

Fig 5: A decrease in fixed export cost

Therefore, $\mathrm{d}P/\mathrm{d}\tau > 0$. A decrease in variable export cost τ will decrease the price level P, which will increase cut-off productivity in domestic market to force the least productive firms out of domestic market. However, to see the effect of τ on cut-off productivity to export, we assume $P/\tau = r$, equation (2) becomes $\varphi_d^*(f_d, A_d, P) = \varphi_d^*(f_d, A_d, r) = \Theta/(r\tau) \cdot f_d^{1/(\sigma-1)}/A_d$ and $\varphi_x^*(f_x, A_x, P) = \varphi_x^*(f_x, A_x, r) = \Theta/r f_x^{1/(\sigma-1)}/A_x$. Equation (8) becomes a function of r, $\pi(P|z) = \pi(r|z)$. Therefore, we have

$$\begin{aligned}
\frac{\partial \pi(r|z)}{\partial \tau} &= f_d k'(\varphi_d^*(f_d, A_d, r)) \frac{\partial \varphi_d^*(f_d, A_d, r)}{\partial \tau} > 0 \\
\frac{\partial \pi(r|z)}{\partial r} &= f_d k'(\varphi_d^*(f_d, A_d, r)) \frac{\partial \varphi_d^*(f_d, A_d, r)}{\partial r} + f_x k'(\varphi_x^*(f_x, A_x, r)) \frac{\partial \varphi_x^*(f_x, A_x, r)}{\partial r} > 0
\end{aligned}$$

Equilibrium determination (3) can be written as $\Pi(r, \tau) = F_e \delta$. Hence we have $\mathrm{d}r/\mathrm{d}\tau = -(\partial \Pi(r, \tau)/\partial \tau)/(\partial \Pi(r, \tau)/\partial r) < 0$. Therefore, the cut-off productivity to export is decreased by a decrease in variable export cost, allowing more firms export and induce firms which are otherwise non-active or ordinary exporters to be pure exporters. ||

A decrease in variable export cost will make firms that serve foreign market get more profit, thereby increasing the demand for labor. The real wage will be higher. So the least productive firms in domestic market will be forced out of domestic market. As shown in Fig 6, the plane of cut-off productivity for domestic market is shifted up. Therefore, low productive non-exporters exit the market while low productive ordinary exporters with relative low demand-adjusted fixed export cost exit domestic market and solely export. However, even though the real wage is higher, the exporters still benefit from a lower variable export cost in the foreign market. The plane of cut-off productivity to export becomes lower to induce more firms to export. In particular, some firms with relative low demand-adjusted fixed export cost will become pure exporters, which are otherwise non-active.

5 Innovation

If a single firm adopts an innovation to have higher productivity, it does not affect the equilibrium. Here we consider an innovation across all firms, e.g. a new computer technology. The productivity of all firms become higher because of the innovation. As a result, the conditional distribution of productivity is changed. In this section, we assume innovation shifts the conditional distribution of productivity to the right. An example is given in Fig 4b.

Theorem 7 *Suppose there is no or only one intersection between the ex-ante and ex-post conditional distributions of productivity on* (φ^*, ∞)*, where* $\varphi^* = min\{\varphi_d^*(f_d, A_d, P), \varphi_x^*(f_X, A_X, P)\}$*, then innovation will force the least productive pure exporters and non-exporters out of the market, and force the least productive ordinary exporters to be either pure exporters or non-exporters.*

Proof: Rearrange equation (7) to get:

$$k(x) = \int_x^\infty [(\frac{\varphi}{x})^{\sigma-1} - 1]\lambda(\varphi|z)\mathrm{d}\varphi$$

Suppose an innovation shifts the productivity to the right, if there is no intersection between the ex-ante and ex-post conditional distributions of productivity on (φ^*, ∞), e.g. widely used Pareto distribution, the density of any productivity higher than φ^* becomes higher. As a result, $k(\varphi_d^*(f_d, A_d, P))$ and $k(\varphi_x^*(f_x, A_x, P))$ become higher. If there is only one intersection shown as in Fig 4b, the density of higher value of $[(\frac{\varphi}{x})^{\sigma-1} - 1]$ is higher while the density of lower value is lower, $x \in \{\varphi_d^*(f_d, A_d, P), \varphi_x^*(f_X, A_X, P)\}$. Hence $k(\varphi_d^*(f_d, A_d, P))$

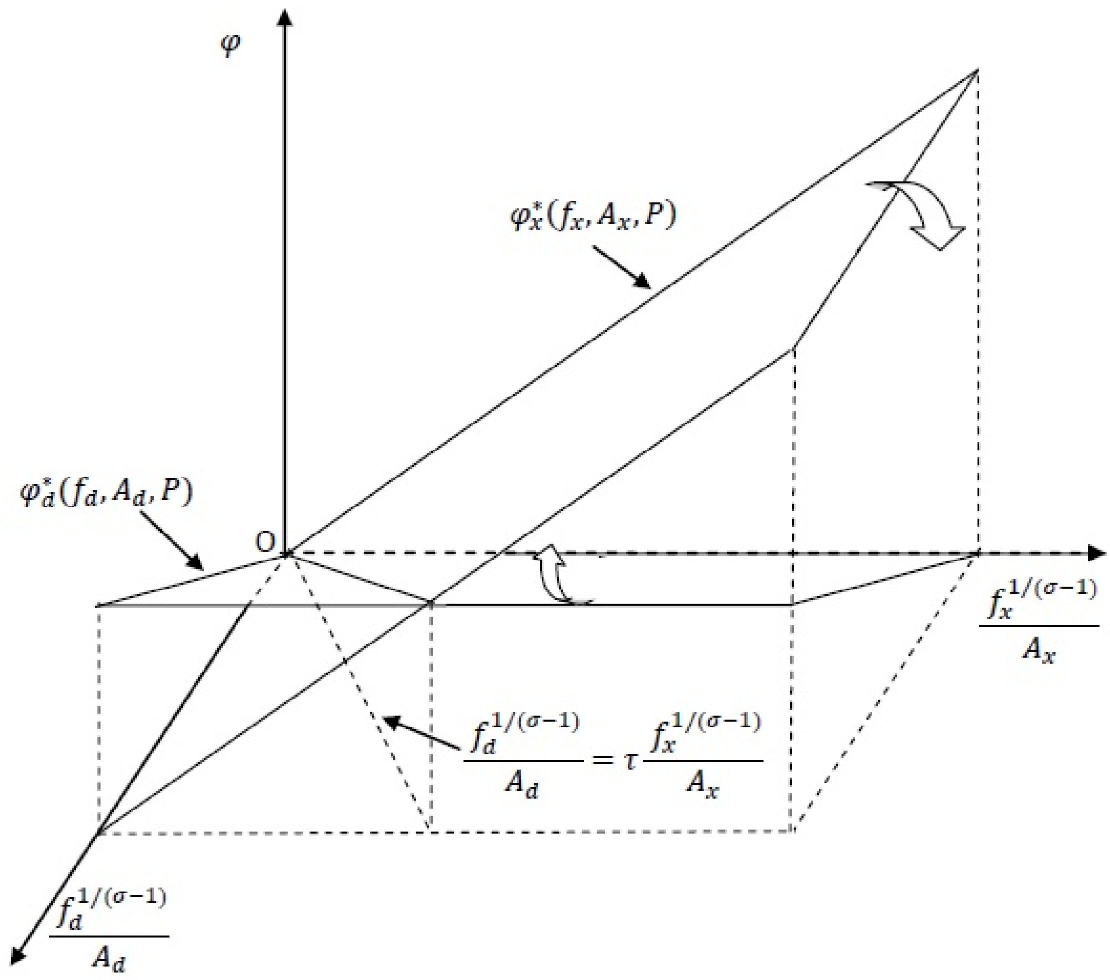

Fig 6: A decrease in variable export cost

and $k(\varphi_x^*(f_x, A_x, P))$ become higher as well. Therefore $\pi(P, \varphi|z)$ in equation (5) becomes higher, so does the expected profit $\Pi(P)$. Therefore, price level is decreased, leading to the same results as a shift of conditional distribution of fixed export cost in Theorem 5. ||

Innovation will increase the average productivity of incumbents and increase the average profit, thereby intensify the competition for labor. Real wage is increased. The least productive pure exporters and non-exporters will be forced out of the market, while the least productive ordinary exporters will become either pure exporters or non-exporters. The effect of innovation is channeled through active firms. The distribution of non-active firms, i.e. firms with productivity lower than φ^* makes no difference to the results.

6 Conclusion

This paper has analyzed why some firms become pure exporters. These pure exporters are especially relevant in developing countries due to their trade regimes and patterns of participating globalization. Ordinary exporters, pure exporters and non-exporters co-exist, which can be theoretically explained with heterogeneity in productivity, fixed market costs and demand shocks. A firm solely exports if it has lower demand-adjusted fixed export cost than demand-adjusted domestic cost and its productivity level makes it profitable in foreign market but non-profitable in domestic market.

The paper shows that exceptional exporter performance in productivity is no longer ensured and productivity gains from trade can be negative. The results are subject to how many pure exporters in the market, which is revealed by the joint distribution of productivity, fixed market costs and demand shocks. This paper implies the variation of distribution across countries may bring different effects of trade and trade gains. This paper also explores how trade liberalization (in terms of decreasing fixed and variable export cost) and innovation affect cut-off productivity, and consequently affect firms' entry and exit in the market. The decrease in fixed export cost and innovation are studied by shifting the distributions of fixed export cost and productivity.

Although this paper shows overall productivity is affected ambiguously by trade, the welfare gains from trade is always positive due to the access to more varieties. This paper introduces heterogeneous fixed export cost, but ignores that the firms with high enough fixed export cost may select to invest in foreign market directly. The heterogeneity of fixed export cost provides a potential unified framework to include foreign direct investment, which is an interesting area in the future study.

Table A 1: Descriptive statistics of pure exporters from 1999 to 2008 in China

	1999	2001	2003	2005	2007	2008	All years
# number of pure exporters	9,193	11,676	14,592	20,473	22,556	22,306	145,415
Ratio to all exporting firms	0.266	0.287	0.287	0.271	0.285	0.253	0.274
Ratio to all firms	0.059	0.070	0.076	0.076	0.067	0.054	0.067
# number of sectors with pure exporters	394	408	394	433	440	410	732
Ratio to all exporting firms	0.697	0.722	0.773	0.841	0.861	0.865	0.905
Ratio to all firms	0.656	0.674	0.750	0.825	0.838	0.858	0.884
Exports							
Percentage in total exports	0.310	0.291	0.294	0.281	0.302	0.292	0.291
Average exports ratio to ordinary exporters	1.242	1.023	1.032	1.050	1.084	1.221	1.091
Gross sales							
Ratio to all exporting firms	0.105	0.101	0.109	0.109	0.122	0.115	0.112
Average gross sales ratio to ordinary exporters	0.325	0.281	0.302	0.329	0.346	0.386	0.335
Ratio to all firms	0.051	0.051	0.057	0.054	0.056	0.050	0.053
Asset							
Ratio to all exporting firms	0.057	0.059	0.069	0.077	0.084	0.083	0.074
Average asset ratio to ordinary exporters	0.167	0.157	0.183	0.223	0.231	0.267	0.212
Ratio to all firms	0.025	0.027	0.031	0.035	0.037	0.034	0.033
Employment							
Ratio to all exporting firms	0.139	0.168	0.201	0.219	0.222	0.219	0.196
Average employment ratio to ordinary exporters	0.447	0.503	0.625	0.753	0.712	0.826	0.648
Ratio to all firms	0.056	0.072	0.090	0.104	0.101	0.093	0.087

Notes: Source from China Industrial Firm-level database which covers manufacturing firms with sales more than 5 million RMB and accounts for more than 90% of Chinese industrial output. We do not include data of year 2004 as some data is missing in our database.

Appendix

Appendix 1: An alternative way to find number of incumbents M

The distribution of incumbents is $\lambda(\varphi, z)/\Delta$, so the conditional distribution of productivity on z is $\lambda(\varphi|z)/\Delta$. Labor for incumbent to serve the domestic market is $f_d + q/\varphi = f_d + \rho p q = f_d + \sigma\rho(\pi_d + f_d) = (\sigma - 1)\pi_d + \sigma f_d$, where q is the output in the market. By analogy, the labor used to export is $(\sigma - 1)\pi_x + \sigma f_x$. The total labor for incumbents L_p is

$$\begin{aligned} L_p &= \int_z \int_{\varphi_d^*}^{\infty} [(\sigma - 1)\pi_d + \sigma f_d\,] M \frac{\lambda(\varphi, z)}{\Delta}\, \mathrm{d}(\varphi, z) \\ &\quad + \int_z \int_{\varphi_x^*}^{\infty} [(\sigma - 1)\pi_x + \sigma f_x\,] M \frac{\lambda(\varphi, z)}{\Delta}\, \mathrm{d}(\varphi, z) \end{aligned}$$

Combine with equation (4) and (5), we get

$$L_p = \frac{M}{\Delta} \cdot ((\sigma - 1)\Pi + \sigma\, F)$$

where

$$F = \int_z [f_d(1 - \Lambda(\varphi_d^*|z) + f_x(1 - \Lambda(\varphi_x^*|z)]\lambda(z)\, \mathrm{d}z$$

The labor for entrants L_e is:

$$Le = M_e \cdot F_e = \frac{\delta M}{\Delta} \cdot \frac{\Pi}{\delta} = \frac{M\Pi}{\Delta}$$

Then total labor L is:

$$L = L_p + L_e = \frac{M}{\Delta} \cdot (\sigma\Pi + \sigma\, F)$$

This equation determines the number of incumbents as shown in equation (10).

Appendix 2: Average productivity of exporters and non-exporters

The ex-ante probability to successfully enter the market Δ is determined as:

$$\Delta = \int_{z_d, z_x} \int_{\varphi^*(z_d, z_x)} g(\varphi)\gamma(z_x)\psi(z_d)\, \mathrm{d}(\varphi, z_d, z_x)$$

where $\varphi^*(z_d, z_x) = min\{\varphi_d^*(z_d), \varphi_x^*(z_x)\}$. According to Fig 1 or equation (2), $\varphi^*(z_d, z_x) = \varphi_d^*(z_d)$ if $z_d < \tau z_x$ and $\varphi^*(z_x, z_d) = \varphi_x^*(z_x)$ if $z_d > \tau z_x$.The distribution of incumbents is then $g(\varphi)\gamma(z_x)\psi(z_d)/\Delta$.

Therefore the average productivity of exporters can be denoted as:

$$\begin{aligned}\Psi_e &= \frac{\int_{z_d,z_x}\int_{\varphi_x^*(z_x)}^{\infty}\varphi\frac{g(\varphi)\gamma(z_x)\psi(z_d)}{\Delta}M\,\mathrm{d}(\varphi,z_d,z_x)}{\int_{z_d,z_x}\int_{\varphi_x^*(z_x)}^{\infty}\frac{g(\varphi)\gamma(z_x)\psi(z_d)}{\Delta}M\,\mathrm{d}(\varphi,z_d,z_x)}\\ &= \frac{\int_{z_d}\int_{z_x}\int_{\varphi_x^*(z_x)}^{\infty}\varphi g(\varphi)\gamma(z_x)\psi(z_d)\,\mathrm{d}\varphi\mathrm{d}z_x\mathrm{d}z_d}{\int_{z_d}\int_{z_x}(1-G(\varphi_x^*(z_x)))\gamma(z_x)\psi(z_d)\,\mathrm{d}z_x\mathrm{d}z_d}\end{aligned}$$

In equilibrium, P is determined. Together with equation (2), we can get:

$$\begin{aligned}\Psi_e &= \frac{\theta}{\theta-1}\cdot\frac{\int_{z_x}\varphi_x^*(z_x)^{1-\theta}\gamma(z_x)\,\mathrm{d}z_x}{\int_{z_x}\varphi_x^*(z_x)^{-\theta}\gamma(z_x)\,\mathrm{d}z_x}\\ &= \frac{\theta}{\theta-1}\cdot\frac{\theta+\beta}{\theta+\beta-1}\cdot\frac{\Theta}{P}\cdot\tau Z_x\end{aligned}$$

Average productivity of non-exporters is :

$$\begin{aligned}\Psi_{ne} &= \frac{\int_{\tau z_x>z_d}\int_{\varphi_d^*(z_d)}^{\varphi_x^*(z_x)}\varphi\frac{g(\varphi)\gamma(z_x)\psi(z_d)}{\Delta}M\,\mathrm{d}(\varphi,z_d,z_x)}{\int_{\tau z_x>z_d}\int_{\varphi_d^*(z_d)}^{\varphi_x^*(z_x)}\frac{g(\varphi)\gamma(z_x)\psi(z_d)}{\Delta}M\,\mathrm{d}(\varphi,z_d,z_x)}\\ &= \frac{\int_{z_d}\int_{z_d/\tau}^{\infty}\int_{\varphi_d^*(z_d)}^{\varphi_x^*(z_x)}\varphi g(\varphi)\gamma(z_x)\psi(z_d)\,\mathrm{d}\varphi\mathrm{d}z_x\mathrm{d}z_d}{\int_{z_d}\int_{z_d/\tau}^{\infty}(G(\varphi_x^*(z_x))-G(\varphi_d^*(z_d)))\gamma(z_x)\psi(z_d)\,\mathrm{d}z_x\mathrm{d}z_d}\end{aligned}$$

In equilibrium, P is determined. Together with equation (2), we can get:

$$\begin{aligned}\Psi_{ne} &= \frac{\theta}{\theta-1}\cdot\frac{\int_{z_d}\int_{z_d/\tau}^{\infty}(\varphi_d^*(z_d)^{1-\theta}-\varphi_x^*(z_x)^{1-\theta})\gamma(z_x)\psi(z_d)\,\mathrm{d}z_x\mathrm{d}z_d}{\int_{z_d}\int_{z_d/\tau}^{\infty}(\varphi_d^{*-\theta}-\varphi_x^{*-\theta})\gamma(z_x)\psi(z_d)\,\mathrm{d}z_x\mathrm{d}z_d}\\ &= \frac{\theta+\beta}{\theta+\beta-1}\frac{\theta+\beta+\alpha}{\theta+\beta+\alpha-1}\cdot\frac{\Theta}{P}\cdot Z_d\end{aligned}$$

Appendix 3: Average productivity in autarky and trade

In autarky, the ex-ante probability to successfully enter the market Δ_a is

$$\Delta_a = \int_{z_d}\int_{\varphi_d^*(z_d)} g(\varphi)\psi(z_d)\,\mathrm{d}(\varphi,z_d)$$

The the average productivity in autarky is:

$$
\begin{aligned}
\Psi_a &= \frac{\int_{z_d}\int_{\varphi_d^*(z_d)}^{\infty}\varphi\frac{g(\varphi)\psi(z_d)}{\Delta_a}M\,\mathrm{d}(\varphi,z_d)}{M} \\
&= \frac{\int_{z_d}\int_{\varphi_d^*(z_d)}^{\infty}\varphi g(\varphi)\psi(z_d)\,\mathrm{d}\varphi\mathrm{d}z_d}{\int_{z_d}(1-G(\varphi_d^*(z_d)))\psi(z_d)\,\mathrm{d}z_d} \\
&= \frac{\theta}{\theta-1}\cdot\frac{\theta+\alpha}{\theta+\alpha-1}\cdot\frac{\Theta}{P_a}\cdot Z_d
\end{aligned}
$$

As we used in appendix 2, $\Delta=\int_{z_d,z_x}\int_{\varphi^*(z_d,z_x)} g(\varphi)\gamma(z_x)\psi(z_d)\,\mathrm{d}(\varphi,z_d,z_x)$, and $\varphi^*(z_x,z_d)=\varphi_d^*(z_d)$ if $z_d<\tau z_x$ and $\varphi^*(z_x,z_d)=\varphi_x^*(z_x)$ if $z_d>\tau z_x$. Then the average productivity after trade can be expressed as:

$$
\begin{aligned}
\Psi &= \frac{\int_{z_x,z_d}\int_{\varphi^*(z_x,z_d)}^{\infty}\varphi\frac{g(\varphi)\gamma(z_x)\psi(z_d)}{\Delta}M\,\mathrm{d}(\varphi,z_d,z_x)}{M} \\
&= \frac{\int_{\tau z_x>z_d}\int_{\varphi_d^*(z_d)}^{\infty}\varphi g(\varphi)\gamma(z_x)\psi(z_d)\,\mathrm{d}\varphi\mathrm{d}z_x\mathrm{d}z_d+\int_{\tau z_x<z_d}\int_{\varphi_x^*(z_x)}^{\infty}\varphi g(\varphi)\gamma(z_x)\psi(z_d)\,\mathrm{d}\varphi\mathrm{d}z_x\mathrm{d}z_d}{\int_{\tau z_x>z_d}(1-G(\varphi_d^*(z_d)))\gamma(z_x)\psi(z_d)\,\mathrm{d}\varphi\mathrm{d}z_x\mathrm{d}z_d+\int_{\tau z_x<z_d}(1-G(\varphi_x^*(z_x)))\gamma(z_x)\psi(z_d)\,\mathrm{d}\varphi\mathrm{d}z_x\mathrm{d}z_d} \\
&= \frac{\theta}{\theta-1}\cdot\frac{\int_{Z_d}^{\infty}\int_{z_d/\tau}^{\infty}\varphi_d^*(z_d)^{1-\theta}\gamma(z_x)\psi(z_d)\,\mathrm{d}z_x\mathrm{d}z_d+\int_{Z_d}^{\infty}\int_{Z_x}^{z_d/\tau}\varphi_x^*(z_x)^{1-\theta}\gamma(z_x)\psi(z_d)\,\mathrm{d}z_x\mathrm{d}z_d}{\int_{Z_d}^{\infty}\int_{z_d/\tau}^{\infty}\varphi_d^*(z_d)^{-\theta}\gamma(z_x)\psi(z_d)\,\mathrm{d}\varphi\mathrm{d}z_x\mathrm{d}z_d+\int_{Z_d}^{\infty}\int_{Z_x}^{z_d/\tau}\varphi_x^*(z_x)^{-\theta}\gamma(z_x)\psi(z_d)\,\mathrm{d}\varphi\mathrm{d}z_x\mathrm{d}z_d} \\
&= \frac{\theta}{\theta-1}\cdot\frac{\Theta}{P}\frac{\frac{\alpha}{\theta+\beta+\alpha-1}Z_d^{1-\theta-\beta}Z_x^{\beta}\tau^{\beta}+\frac{\alpha\beta}{(\theta+\beta+\alpha-1)(1-\theta-\beta)}Z_d^{1-\theta-\beta}Z_x^{\beta}\tau^{\beta}-\frac{\beta}{(1-\theta-\beta)}Z_x^{1-\theta}\tau^{1-\theta}}{\frac{\alpha}{\theta+\beta+\alpha}Z_d^{-\theta-\beta}Z_x^{\beta}\tau^{\beta}+\frac{\alpha\beta}{(\theta+\beta+\alpha)(-\theta-\beta)}Z_d^{-\theta-\beta}Z_x^{\beta}\tau^{\beta}-\frac{\beta}{(-\theta-\beta)}Z_x^{-\theta}\tau^{-\theta}} \\
&= \frac{\theta}{\theta-1}\cdot\frac{\theta+\beta}{\theta+\beta-1}\cdot\frac{\frac{\alpha(\theta-1)}{\theta+\beta+\alpha-1}Z_d(\frac{\tau Z_x}{Z_d})^{\theta+\beta}+\beta\tau Z_x}{\frac{\alpha\theta}{\theta+\beta+\alpha}(\frac{\tau Z_x}{Z_d})^{\theta+\beta}+\beta}\cdot\frac{\Theta}{P}
\end{aligned}
$$

References

Arkolakis, Costas, 2010. "Market Penetration Costs and the New Consumers Margin in International Trade", *Journal of Political Economy*, 118(6), 1151-99.

Bernard, Andrew B., Jonathan Eaton, J. Bradford Jensen, and Samuel Kortum, 2003. "Plants and Productivity in International Trade", *American Economic Review*, 93(4), 1268-90.

Bernard, Andrew B., and J. Bradford Jensen, 1999. "Exceptional Exporter Performance: Cause, Effect, or Both?" *Journal of International Economics*, 47(1), 1-25.

———, 2011. "Multiproduct Firms and Trade Liberalization", *Quarterly Journal of Economics*, 126(3), 1271-318.

Bustos, Paula, 2011. "Trade Liberalization, Exports, and Technology Upgrading: Evidence on the Impact of MERCOSUR on Argentinian Firms", *American Economic Review*, 101(1), 304-40.

Dai, Mi, Madhura Maitra, and Miaojie Yu, 2011. "Unexceptional Exporter Performance in China? The Role of Processing Trade", Available at SSRN1963652.

Das, Sanghamitra, Mark J. Roberts, and James R. Tybout, 2007. "Market Entry Costs, Producer Heterogeneity and Export Dynamics", *Econometrica*, 75(3), 837-73.

De Loecker, Jan, 2007. "Do Exports Generate Higher Productivity? Evidence from Slovenia", *Journal of International Economics*, 73(1), 69-98.

Defever, Fabrice, and Alejandro Riaño, 2012. "China's pure exporter subsidies", *CESifo Working Paper Series No. 4054*.

Dixit, Avinash K., and Joseph E. Stiglitz, 1977. "Monopolistic Competition and Optimum Product Diversity", *American Economic Review*, 67(3), 297-308.

Eckel, Carsten, and J. Peter Neary, 2010. "Multi-Product Firms and Flexible Manufacturing in the Global Economy", *Review of Economic Studies*, 77(1), 188-217.

Eaton, Jonathan, Samuel Kortum, and Francis Kramarz, 2011. "An Anatomy of International Trade: Evidence from French Firms", *Econometrica*, 79(5), 1453-98.

Jørgensen, Jan Guldager, and Philipp JH Schröder, 2006. "Tariffs and Firm-level Heterogeneous Fixed Export Costs", *Contributions to Economic Analysis and Policy*, 5(1), 1-17.

———, 2008. “Fixed Export Cost Heterogeneity, Trade and Welfare”, *European Economic Review*, 52(7), 1256-74.

Kasahara, Hiroyuki, and Beverly Lapham, 2013. “Productivity and the Decision to Import and Export: Theory and Evidence”, *Journal of International Economics*, 89(2), 297-316.

Krautheim, Sebastian, 2012. “Heterogeneous Firms, Exporter Networks and the Effect of Distance on International Trade”, *Journal of International Economics*, 87(1), 27-35.

Lileeva, Alla, and Daniel Trefler, 2010. “Improved Access to Foreign Markets Raises Plant-Level Productivity... for Some Plants”, *Quarterly Journal of Economics*, 125(3), 1051-99.

Lu, Dan, 2010. “Exceptional Exporter Performance? Evidence from Chinese Manufacturing Firms”, Manuscript, University of Chicago.

Lu, Jiangyong, Yi Lu, and Zhigang Tao, 2014. “Pure Exporter: Theory and Evidence from China”, *The World Economy*, 37(9), 1219-1236.

Ma, Yue, Heiwai Tang, and Yifan Zhang, 2014. “Factor Intensity, Product Switching, and Productivity: Evidence from Chinese Exporters”, *Journal of International Economics*, 92(2), 349-62.

Mayer, Thierry, Marc J. Melitz, and Gianmarco IP Ottaviano, 2014. “Market Size, Competition, and the Product Mix of Exporters”, *American Economic Review*, 104(2), 495-536.

Melitz, Marc J., 2003. “The Impact of Trade on Intra-industry Reallocations and Aggregate Industry Productivity”, *Econometrica*, 71(6), 1695-1725.

Melitz, Marc J., and Gianmarco IP Ottaviano, 2008. “Market Size, Trade, and Productivity”, *Review of Economic Studies*, 75(1), 295-316.

Pavcnik, Nina, 2002. “Trade Liberalization, Exit, and Productivity Improvements: Evidence from Chilean Plants”, *Review of Economic Studies*, 69(1), 245-76.

Schmitt, Nicolas, and Zhihao Yu, 2001. “Economics of Scale and the Volume of Intra-industry Trade”, *Economics Letters*, 74(1), 127-32.

Trefler, Daniel, 2004. “The Long and Short of the Canada-U.S. Free Trade Agreement”, *American Economic Review*, 94(4), 870-95.

Young, Alwyn, 2000. "The Razor's Edge: Distortions and Incremental Reform in the People's Republic of China", *Quarterly Journal of Economics*, 115 (4), 1091-135.