Efficiency differentials and Intra-industry Trade

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Abstract

This paper constructs a trade model with heterogeneous firm and cross-country efficiency differences to investigate the impact of trade on asymmetric countries. We show that the trade pattern and composition of trade is determined by the trade off between cross-country size variation and efficiency difference. Opening up to trade increases the productivity threshold to survive and the aggregate industry efficiency in both more efficient and less efficient countries, while the productivity threshold, probability of death and proportion of exporting firms are higher in the more efficient country. As a consequence, trade leads to industry rationalization and consumer welfare gains in both countries but the magnitude is stronger in the more efficient country.

Key words: firm heterogeneity, country efficiency gaps , intra-industry trade

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1 Introduction

"New" trade theory models such as (Krugman (1980) and Helpman and Krugman (1985) rest on the assumption of efficiency symmetry between monopolistically competitive firms. As a consequence, since love of variety and scale economies lead to two-way trade , all existing firms export and firms from each country are of identical size, exports and market share in the world, even in the presence of transport costs and different market size. Recently, however, a substantial empirical literature has identified robust firm level evidence on productivity heterogeneity and its link to exports (Bernard and Jensen 1995, 1999a,b, 2001; Bernard and Wagner 1997; Aw, Chung and Roberts 1998; Bigsten, Collier, Dercon et al. 2000; Clerides, Lach and Tybout 1998; Girma, Greenaway and Kneller 2003a, 2003b). As was summarised by Bernard, Eaton, Jensen and Kortman(2000): "Most strikingly, exporters are in the minority; they tend to be more productive and larger; yet they usually export only a small fraction of their outputs. This heterogeneity of performance diminishes only modestly when attraction is restricted to producers within a given industry." On the other hand, there is a growing body of empirical evidence that trade may lead to substantial *industry* efficiency gains through inter-firm reallocation and rationalisation effect. (Tybout and Westbrook 1995 , Bernard and Jensen 2001, Pavcnik, 2002 and see Tybout 2001 for a survey). All these stylised facts highlight the importance of incorporating firm efficiency heterogeneity into new trade theory.

A recent wave of "heterogeneous firm trade models" has emerged, led by Bernard, Eaton, Jensen and Kortman (2000), Melitz(2002), Helpman and Melitz and Yeaple (2002), Jean (2002) and Montagna (2002), which extend the new trade theory to incorporate firm productivity differences. In the pioneering model, Melitz (2002) based on Dixit-Stiglitz monopolistic competition, firm heterogeneity is generated from an un-parameterised distribution which characterises firms' pre-entry efficiency uncertainty. In the presence of fixed export costs, more productive firms self-select into both the domestic market and the export market. Therefore survivors are those whose productivities are higher than a threshold, whereas exporters are those whose productivities are above a higher threshold . Trade liberalisation forces the least efficient firms to leave by raising the domestic entry threshold, and reallocates market share towards more efficient exporting firms by lowering the export threshold. Melitz (2002) shows how trade generates industry efficiency improvement and welfare gains for all identical countries involved. An important contribution of the Melitz model was the emphasis of firm heterogeneity as an underlying pre-requisite for the welfare enhancing effect of trade. In order to focus on the role of with-in industry firm productivity differences, Melitz considers only trade between countries with identical size and firm productivity distributions. As a consequence the impact of trade is symmetric between countries. However at the country level there is also significant evidence on the cross-country efficiency differences in the advanced industrial nations.

What happens to the model if we allow trade between asymmetric countries with different industry efficiency levels and market sizes? Montagna (2002) shows that free trade will equalise the productivity threshold in countries with different productivity distribution, so that the trade-induced rationalisation effect only occurs in the less efficient country. However Jean (2002) demonstrates in both countries self-selection is stronger after opening to trade, if trade costs are low and the cross-country efficiency gap is small.

This paper extends the Melitz (2002) and Helpman, Melitz and Yeaple (2002) model to investigate the impact of trade on asymmetric countries， with a special focus on the role of cross-country efficiency gaps in the determination of the composition of trade and overall welfare. We construct a two country, two sector model with both with-in industry firm productivity differentials and cross-country efficiency differences. The differentiated good sector is characterized by Dixit-Stiglitz monopolistic competition , while the constant return to scales homogenous good sector adjusts to compensate the labour supply and trade balance. The pre-entry productivity uncertainty is modelled by an exogenous distribution over firm costs. In the closed economy , free entry leads to an endogenous efficiency cut off required for firms to survive . In equilibrium, countries which differ in both size and efficiency levels exhibit similar characteristics in the differentiated good sector: the probability of death and survival, the average firm size and profit are identical across countries , though the productivity threshold and aggregate productivity is higher in the more efficient country. In the open economy, the trade pattern and the composition of trade depend on the trade off between countries' relative market size and efficiency gaps. In the case of intra-industry trade, the probability of death, the proportion of exporting firms, and the average firm size and profit are all higher in the more efficient country. In contrast to Montagna (2002), we find that opening up to trade raises the productivity threshold required to survive and the aggregate industry efficiency in *both* countries but the rationalisation effect is stronger in the more efficient country. As a consequence, exposure to trade generates welfare gains for both more efficient and less efficient countries, but the more efficient country enjoys a higher degree of efficiency and welfare improvement.

The rest of the paper is organised as follows. Section 2 sets up the model. The closed economy equilibrium is derived in section 3. Section 4 discusses the open economy equilibrium and analyses the impact of trade. Section 5 draws some concluding remarks.

2 Model Setup

Consider two countries , home ( ) and foreign(*) , endowed with a single factor labour which is used to produce in two sectors H and D. Sector H produces a homogenous good and sector D produces a differentiated good.

Demand and production

The preferences of a representative consumer are characterised by a Cobb-Douglas utility function across goods H and D. As a result, the fraction of expenditure spent on good D is assumed to be a constant β with $1-\beta$ spent on good H. Production in the homogeneous good sector H exhibits constant returns to scale. Sector H is the numeraire and we normalise the common wage rate to one.[1] In sector D, market structure is assumed to be "Dixit-Stiglitz" monopolistic competition. Preferences across varieties of sector D are of a standard CES "love of variety" form.[2] The cost function of an individual firm *i* is

$$C_i = a_i q_i + F_D$$

where a_i denotes the marginal units of labour input required to produce one unit of output and F_D denotes the fixed production costs which is the same across firms. Thus the firm-specific efficiency level is defined as $x=a^{-1}$. This market structure yields a constant elasticity of demand function for each variety produced by a corresponding unique firm :

$$q_i = A p_i^{-\varepsilon}$$

where the demand shifter $A= \beta L P^{\frac{1}{\varepsilon-1}}$, and $P = \left(\int_{v\in V} p(v)^{1-\varepsilon}\, dv\right)^{\frac{1}{1-\varepsilon}}$ denotes the aggregate price index. Notice that A captures market conditions exogenous to an individual firm , since P reflects the degree of competitiveness of the market and βL represents the strength of demand. Taking A as given, the price rule of a profit-maximising firm with cost a is

[1] The units of labour required to produce one unit of H is chosen as one and the price of sector H is set as the numeraire. Sector H adjusts to compensate the labour supply and trade volume. We assume each country has positive production in this sector. As a result , wage rate is common across countries.

[2] The utility function is

$$U = H^{1-\beta} D^{\beta}$$

$$D = \left(\int_{v\in V} q^{\rho}(v)\, dv\right)^{1/\rho}$$

where the elasticity of substitution $\varepsilon = \frac{1}{1-\rho}$, v and V denotes the individual varieties and the available variety set in market,respectively. $q(v)$ denotes the consumption quantity of variety v .Consumption of good D can be treated as consuming an aggregate quantity D with an aggregate price P.

$$p(a) = \frac{a}{\rho}$$

Note that the price mark-up ρ^{-1} is constant and is independent of the aggregate market variables . As was shown in Helpman,Melitz and Yeaple(2002), the domestic sales and operating profit of a firm can then be written as functions of its own cost level *a* :

$$r(a) = A\left(\frac{a}{\rho}\right)^{1-\varepsilon}$$

$$\pi(a) = Ba^{1-\varepsilon} - F_D$$

where $B = (1-\rho)A/\rho^{1-\varepsilon}$ is the transformed demand shifter. This implies that firm revenue and operating profit is monotonically decreasing(increasing) in a firm's own cost(efficiency) level.

Firm entry , exit and heterogeneity

There are a large number, strictly speaking a continuum. of potential entrants into sector D. Entry is unrestricted but each entrant has to make an irreversible investment F_E *i.e.* a sunk fixed entry cost to enter. After entry, entrants draw their initial marginal unit cost *a* from a common *ex-ante* exogenous cumulative distribution *G(a)*.In line with Helpman,Melitz and Yeaple(2002), we use the Pareto distribution to parameterise the distribution of productivity *x*. [3] Then the distribution of cost draws is:

$$G(a) = \left(\frac{a}{\bar{a}}\right)^k$$

where $\bar{a}$ is the upper bound of the marginal cost *a* and $\frac{1}{\bar{a}}$ is the lower bound of the productivity x. Once an entrant's cost is revealed, it will decide whether to stay or exit depending on whether the operating profit $\pi(a)$ is positive. Since the profit is increasing in its own productivity, a less productive firm which incurs a negative profit will immediately exit , whereas a more productive firm earning a positive profit will choose to stay. Let a_D denote the zero profit cutoff cost level such that

$$\pi(a_D) = Ba_D^{1-\varepsilon} - F_D = 0 \qquad [1]$$

then a_D ($x_D = a_D^{-1}$) is the maximum(minimum) cost (productivity) level required to survive in the market. Hence firm entry and exit follow a self-selection process : more

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[3] The cumulative distribution of firm productivity F(x) is assumed to be Pareto ,i.e. $F(x) = 1 - (\frac{1}{x\bar{a}})^k$ and $x > \frac{1}{\bar{a}}, k > \varepsilon + 1$.

efficient (luckier) firms survive and less efficient(unlucky) firms fail. Therefore the ex-ante probability of successful entry and of failure , denoted as p_{in} and p_{out} are :

$$p_{in} = G(a_D) \quad , \quad p_{out} = 1 - G(a_D)$$

Therefore successful surviving firms exhibit heterogeneous efficiency levels above the efficiency cutoff x_D. Recall that firm revenue and profit are increasing in their own efficiency levels, the asymmetric performances across firms such as profit, size, market share and price can all be attributed to the heterogeneity of the firm-specific efficiency level . The more efficient firms with lower a have lower price, larger sales, higher market share and higher profits.

Furthermore, we assume that the two countries differ not only in terms of country size but also the firm cost distributions. We assume that $G(a)$ and $G^*(a)$ share common k but differ in $\bar{a}$ *i.e.*

$$G(a) = \left(\frac{a}{\bar{a}} \right)^k \quad , \quad G^*(a^*) = \left(\frac{a}{\bar{a}^*} \right)^k$$

$$\text{and} \qquad \bar{a} \leq \bar{a}^*$$

This assumption implies both countries get access to the best technology practice ,but the lower productivity bound is higher in the home country . As depicted in figure 1 panel 1, the home cost(productivity) distribution is dominated by (dominates) the foreign country , indicating that the home country is the more efficient.

3 The Closed Economy

Equilibrium

As was shown in Melitz (2002) and Helpman, Melitz and Yeaple (2002), the equilibrium in a close economy should satisfy two conditions: the zero profit cut off condition and zero expected profit condition. For a given demand shifter B, the cut off cost a_D is determined by equation [1]. But B is determined by the degree of competitiveness of the whole market. Since entry is free, potential entrants will enter and try their luck, until the number of incumbent firms is so large and the market is so competitive that the expected net profit [4] for an outsider falls to zero. Hence a stationary equilibrium is reached when the expected net profit of a potential firm is zero, since there is no more entry and exit. The zero expected profit condition can be expressed as :

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[4] Since the operating profit is non-negative: $\pi_i = \max\{0, \pi(a)\}$, where $\pi(a) = Ba^{1-\varepsilon} - F_D$, then the expected net profit can be expressed as $E(\pi) = \int_0^{a_D} (Ba^{1-\varepsilon} - F_D) dG(a) - F_E$

$$E(\pi) = BV(a_D) - F_D G(a_D) - F_E = 0 \qquad [2]$$

where $V(y) = \int_0^y a^{1-\varepsilon} dG(a) = \frac{k}{k-(\varepsilon-1)} \bar{a}^{-k} y^{k-(\varepsilon-1)}$

From Eq.[1] and [2] , the endogenous cut off cost a_D and the transformation of demand shifter B can be solved as :

$$a_D = (\frac{F_E}{F_D})^{\frac{1}{k}} (K-1)^{\frac{-1}{k}} \bar{a} \qquad [3]$$

$$B = F_D a_D{}^{\varepsilon-1} = F_D (\frac{F_E}{F_D})^{\frac{\varepsilon-1}{k}} (K-1)^{\frac{1-\varepsilon}{k}} \bar{a} \qquad [4]$$

where $K = \frac{k}{k-(\varepsilon-1)} > 1$

Equation [3] implies that the cut off is jointly determined by the levels of fixed costs and the distribution of marginal costs. Interestingly, a change in F_E and F_D have opposite effects on the cut off. High entry costs lead to higher (lower) cost (efficiency) cutoff, which *weakens* the self-selection effect. This is consistent with the stylized facts from a firm level comparison of self-selection effect in Taiwanese and Korea manufactures (Bee Yan Aw et al, 2003).[5] On the other hand, a higher level of fixed production cost corresponds to a lower (higher) cost (efficiency) cut off, which *strengthens* the self-selection effect. Note that the same proportional changes in F_E and F_D have no net effect on the cut off. Furthermore, the cut off cost(productivity) is decreasing(increasing) in ε. This implies that self-selection is stronger for industries in which the degree of substitution across products are higher i.e. the varieties are more similar. If the fixed costs and elasticity of substitution are symmetric between countries, the more efficient home country has proportionally higher level of efficiency cut off relative to its lower bound *i.e.* $\frac{a_D}{a_D*} = \frac{\bar{a}}{\bar{a}*} \leq 1$.

Does the superior efficiency cut off in the more efficient country make its domestic market more risky for entrants, in terms of probability of survival and failure? Inspection of the ex-ante probability of survival reveals:

$$p_{in} = p_{in}* = \frac{F_E}{F_D(K-1)} \quad , \frac{F_E}{F_D(K-1)} \leq 1 \qquad [5]$$

where $p_{in} = G(a_D)$ and $p_{in}* = G*(a_D*)$

Hence the probability of survival is increasing in the degree of dispersion parameter k but independent of the upper cost bound $\bar{a}$. This implies that the market is more risky

[5] The empirical findings from Bee Yan Aw(2003) is that compared to Korea , a country with significantly higher entry costs , Taiwanese industries exhibit stronger self-selection effects: they are characterised by smaller within-industry productivity dispersion and smaller proportion of low productivity plants.

in a country with a lower degree of firm level cost (productivity) dispersion. As depicted in figure 1 panel 2, the probabilities of survival and death are the same for the two countries, which means the chance for successful entry is not inferior in the more efficient home country, though it requires a higher efficiency level to survive.

Equation [4] implies that in equilibrium B is independent of market size, but is increasing in $\bar{a}$. The market size does not affect the equilibrium demand shifter because, as will be shown below, under free entry the number of firms will be greater in a larger country. A larger country spends more on the differentiated good but also attracts more firms to compete for demand. These two effects offset each other so that an individual firm is indifferent to the size of the market it is competing in. However, the demand shifter is lower in the more efficient country. This indicates that for a firm with given cost a, it will be smaller and earn less profit if located in the more efficient country.

In equilibrium, firms drawing a higher cost level than a_D will not produce and quit. The remaining firms must have lower cost levels than a_D . Thus the equilibrium distribution or *ex-post* distribution over firm cost , denoted by $W(a)$, is different from the ex-ante distribution :

$$W(a) = \frac{G(a)}{G(a_D)} = \left(\frac{a}{a_D}\right)^k, a \le a_D$$

$$= 0, a > a_D \qquad [6]$$

Using the ex-post cost distribution, to solve for the number of existing firms N in equilibrium, note that B is given by[6]:

$$B = \frac{(1-\rho)\beta L G(a_D)}{N\,V(a_D)}$$

substitute it into [4] and rearrange we get the solution for N:

$$N = \frac{(1-\rho)\beta L}{KF_D} \qquad [7]$$

The number of existing firms is proportionally increasing in country size L, but is independent of the entry costs and the lower bound of the cost distribution. Thus in the closed economy the relative number of firms between the two countries equals their relative country size: $\frac{N}{N^*} = \frac{L}{L^*}$

Average firm performance

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[6] Recall that $B = \frac{1-\rho}{\rho^{1-\varepsilon}} A = \frac{(1-\rho)\beta L}{\rho^{1-\varepsilon}} (\int_{v \in V} p^{1-\varepsilon}(v) dv)^{-1}$ and $\int_{v \in V} p^{1-\varepsilon}(v) dv = \int_0^{a_D} p^{1-\varepsilon}(a) N \, dW(a)$.

From equation [1] , the performance of an individual firm can be written as a function of its own cost a and the cut off a_D[7].Hence the average firm performance of the industry, including average efficiency, average market price, average output quantity , revenue and profit can be written as :

$$\hat{a} = \int_0^{a_D} a dW(a) = \frac{k}{k+1} a_D$$

$$\hat{q} = \int_0^{a_D} q(a) dW(a) = \frac{K\rho}{(1-\rho)} F_D a_D^{-1}$$

$$\hat{r} = \int_0^{a_D} r(a) dW(a) = \frac{K}{1-\rho} F_D$$

$$\hat{\pi} = \int_0^{a_D} \pi(a) dW(a) = \frac{\hat{r}}{\rho} - F_D = \left(\frac{K}{(1-\rho)\rho} - 1 \right) F_D$$

The average industry efficiency is proportionally increasing in the cost cut off. This indicates that the average industry efficiency is higher in the home country $\frac{\hat{a}}{\hat{a}*} = \frac{\overline{a}}{\overline{a}*} \leq 1$. The average firm size and profit , however, do not depend on the cut off and thus are equal between home and foreign countries. These two measures are only determined by the fixed production costs F_D , the degree of firm cost dispersion and elasticity of substitution.

The above average measures reflect the mean of firm performance. However a growing body of empirical literature investigating industry productivity dynamics focus on the weighted or aggregate industry productivity. [8] Departing from Melitz(2003)[9]. We define the weighted average cost as :

$$\tilde{a} = \int_0^{a_D} Ns(a) a dW(a) \qquad [8]$$

where

$$s(a) = \frac{r(a)}{R} \quad \text{and} \quad R = \int_0^{a_D} r(a) N_0 dW(a) = \beta L \qquad [9]$$

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[7] Eq.[1] implies $A = a_D^{\varepsilon-1} F_D \frac{\rho^{1-\varepsilon}}{1-\rho}$, substitute this into $r(a)$, $q(a)$ and $\pi(a)$ we get

$$r(a) = \frac{F_D}{1-\rho}\left(\frac{a_D}{a}\right)^{\varepsilon-1}, \pi(a) = \left(\frac{1}{(1-\rho)\rho}\left(\frac{a_D}{a}\right)^{\varepsilon-1} - 1\right) F_D \ , \ q(a) = \frac{\rho F_D}{1-\rho} \frac{a_D^{\ \varepsilon-1}}{a^{\varepsilon}}$$

[8] See for example Levinsohn and Petrin (1999), Bee Yan Aw (2001), Fernandes (2003), Tybout and Westbrook (1995) and Pavcnik (2002).

[9] Melitz (2002) uses the weighted harmonic mean of the productivity levels to represent the aggregate industry productivity, where the weights index the relative output shares.

The weights *s(a)* index the firms' share of total output and *R* denotes the total output of the domestic market. Substitute [7] and [9] into [8] and rearrange , yielding the aggregate industry cost :

$$\tilde{a} = \frac{k - \varepsilon + 1}{k - \varepsilon + 2} a_D \qquad [10]$$

Equation [10] implies that the aggregate industry efficiency is proportionally increasing in the efficiency cut off . Thus the aggregate industry efficiency is also superior in the home country: $\frac{\tilde{a}}{\tilde{a}*} = \frac{\bar{a}}{\bar{a}*}$.

Welfare

Welfare, measured by the utility of the representative consumer, is determined by the consumption quantity of the homogenous good and the sub-utility or aggregate quantity of the differentiated good. The quantity of H is straightforward : H=$(1-\beta)L$, since the price is one and the expenditure spent on H is βL. The aggregate quantity of the differentiated good $D=\frac{\beta L}{P}$. The aggregate price *P* can be written as a function of $\bar{a}$ [10]:

$$P = \bar{a}(\beta L)^{\frac{-1}{\varepsilon-1}} F_E^{\frac{1}{k}} F_D^{\frac{1}{\varepsilon-1}-\frac{1}{k}} (K-1)^{-\frac{1}{k}} \sigma$$

where $\sigma = \frac{1}{(1-\rho)^{\varepsilon-1}\rho}$, which yields

$$U = \bar{a}^{-1} L^{1+\beta\left(\frac{1}{\rho}-1\right)} F_E^{-\frac{\beta}{k}} F_D^{-\beta\left(\frac{1}{\varepsilon-1}-\frac{1}{k}\right)} Z$$

where $Z=(K-1)^{\frac{\beta}{k}} \sigma^{-\beta} (1-\beta)^{1-\beta} \beta^{\frac{\beta}{\rho}}$. The welfare is increasing in country size *L* and the country level efficiency $\bar{a}^{-1}$, but is decreasing in the entry costs and fixed production costs. This is because welfare is negatively related to the aggregate price, which is decreasing in country size and industry efficiency. A larger country attracts a greater number of producers and thus the aggregate price is driven down, while firms in a more efficient country charge a lower aggregate price. The welfare will thus be greater in a larger and more efficient country as a result of the decline of the good's price.

[10] Recall that $B=F_D a_D^{\varepsilon-1} = \sigma^{-1} \beta L P^{\varepsilon-1}$, which yields $P=a_D(\beta L)^{\frac{-1}{\varepsilon-1}} F_D^{\frac{1}{\varepsilon-1}} \sigma$ .So P is increasing in the cost cut off , but decreasing in L. Substitute [3] into it we get the expression of *P*.

3 Open economy

Superior average and aggregate industry efficiency in the home country implies that it has a comparative advantage in the differentiated good sector[11]. At the industry level, under perfect competition, comparative advantage predicts the pattern of inter-industry trade : the home will export *D* and import *A*. However, as was demonstrated in Abd-el-Rahman (1991), in conditions of monopolistic competition with heterogeneous firms, there exist firm level competitive advantages (disadvantages) against the collective industry level comparative advantages (disadvantages). The composition of trade is jointly determined by the macro level comparative advantages and the micro level within-industry heterogeneity. This distinction between firms' competitive and national comparative where the advantages explains "minority trade flows in two-way trade" where the direction of trade is opposite to that predicted by the collective industry comparative advantage. For example, in a comparative disadvantage industry of country A, the "majority trade flow" is imports. But one might also observe "minority trade flow" exports in the same industry, because some "best" or "over-competitive" firms will manage to export despite the collective industry comparative disadvantage. This "firm competitive advantage VS National comparative advantage" hypothesis raises interesting questions for intra-industry modelling: How the dispersion of firm level heterogeneity, in conjunction with the comparative aggregate industry performance, determines the composition of intra-industry trade? What is the key factor of the firms' competitive advantage[12]? What is the role of country size in the trade volume in a heterogeneous firm framework? In this section we study the nature of trade between the home and foreign country in equilibrium, once the two heterogeneous countries are open to trade in both sectors.

Entry , Export and Trade costs

In an open economy , the successful entry conditions remain unchanged : firms face uncertainty about their productivity before entry , after entry they decide whether to stay or exit depending on whether their revealed productivity levels are higher than the domestic entry cut off a_D, which is given by:

$$(a_D)^{1-\varepsilon} B = F_D \qquad [11]$$

$$(a_D{*})^{1-\varepsilon} B{*} = F_D \qquad [12]$$

On the other hand, all entrants are provided with the opportunity to export. In the trade of the differentiated sector, there exist two types of trade costs: melting ice-berg trade costs $t>1$[13] and fixed export costs F_X[14]. Thus for a successful entrant there is an opportunity to earn additional export profit on top of its domestic profit. The export profit of a firm in the home and foreign country is thus given by:

[11] Recall that the productivity in the homogenous good sector is one in both countries.

[12] Abd-el-Rahman(1991) outlines productivity, size and mark-up as the firm level performance.

[13] The melting ice-berg trade cost assumption implies the firm level "efficiency" is defined in terms of both good production and transportation.

[14] For simplicity we assume the fixed export costs depreciate immediately and are incurred at the beginning of each export period ----like production fixed costs.

$$\pi_X(a) = (a\,t)^{1-\varepsilon} B^* - F_X \quad , \quad \pi_X{}^*(a) = (at)^{1-\varepsilon} B - F_X$$

Since the decision to enter an export market is made after a is revealed , the existence of fixed export costs leads to the co-existence of exporters and non-exporters in the same industry. Reasoning analogously to the determination of the domestic cut off a_D , there also exists a export cutoff cost a_X such that the export revenue of a firm with marginal cost a_X just covers its export costs:

$$(a_X t)^{1-\varepsilon} B^* = F_X \qquad [13]$$

$$(a_X{}^* t)^{1-\varepsilon} B = F_X \qquad [14]$$

The difference between a_D and a_X will induce partitioning of exporters and non-exporters. Howevr $a_X > a_D$, all successful entrants will find it profitable to export . Thus all existing firms export. Since this scenario is generally not consistent with the well documented co-existence of exporters and non-exporters within the same industry[15], we rule out the “all firms export” scenario by assuming[16]:

$$\theta \equiv \left(\frac{F_X}{F_D}\right)^{\frac{1}{\varepsilon-1}} t > 1 \qquad [15]$$

and

$$\mu = \left(\frac{\bar{a}^*}{\bar{a}}\right)^k < \phi = \left(\frac{1+\theta^{-2k(\ )}\bar{F}_X}{1+\bar{F}_X}\right)\theta^k \qquad [16]$$

where $\bar{F}_X \equiv \dfrac{F_X}{F_D}$

θ reflects the relative trade costs compared to fixed production costs, while μ represents the efficiency difference between countries. The first equation therefore ensures that trade costs are sufficiently high so that a proportion of successful entrants will not find it profitable to operate in the foreign market and remain purely domestic. The second condition gives an upper bound of the efficiency gap between the two countries. As will be shown below, if either of the above two conditions does not hold, at least in one of the two countries all successful entrants will export. The combination of equations [15] and [16] ensures that in *both* countries exporting is conditional on successful entry into the domestic market and there will be no firms that just export.

[15] See for example , among others, Bernard and Wagner(1997) for Germany and Bernard and Jensen(1995) for US.

[16] Please see Eq.[23] and footnote 19 for the reasoning of these two assumptions.

Equilibrium

From [11]-[14],the domestic and export cut off levels are determined by the exogenous fixed production costs and trade costs, as well as the transformed demand shifter *B*. Though *B* is exogenous to individual firms, it is endogenous to the whole economy as a result of the zero expected profit condition. In the open economy, this condition still holds. Nonetheless the potential entrants include both domestic and foreign firms. In particular foreign entrants are those who have successfully survived in their domestic economy and are seeking additional profit in export markets. Entrants from home and abroad enter simultaneously, then more productive entrants stay and less productive ones exit. Entry and exit continues until the expected profit for a potential entrant is driven to zero. The zero expected profit condition in the home and foreign country can be expressed as [17]:

$$BV(a_D) + t^{1-\varepsilon} B^* V(a_X) - F_D G(a_D) - F_X G(a_X) = F_E \qquad [17]$$

$$B^* V^*(a_D^*) + t^{1-\varepsilon} BV(a_X^*) - F_D G^*(a_D^*) - F_X G^*(a_X^*) = F_E \qquad [18]$$

Similar to the case of the closed economy, equilibrium is characterised by both cut off conditions (Eq.11-14) and the zero expected profit condition (Eq.17-18) , as summarised below:

$$(a_D)^{1-\varepsilon} B = F_D \quad , \quad (a_D^*)^{1-\varepsilon} B^* = F_D$$

$$(a_X t)^{1-\varepsilon} B^* = F_X \quad , \quad (a_X^* t)^{1-\varepsilon} B = F_X$$

$$BV(a_D) + t^{1-\varepsilon} B^* V(a_X) - F_D G(a_D) - F_X G(a_X) = F_E$$

$$B^* V^*(a_D^*) + t^{1-\varepsilon} BV(a_X^*) - F_D G^*(a_D^*) - F_X G^*(a_X^*) = F_E$$

From the above six equations, the equilibrium cutoff cost levels and the demand shifters can then be solved as:

$$a_D = a_D^A \left(\frac{1-\mu\Omega}{1-\Omega^2} \right)^{\frac{1}{k}} \qquad [19] \qquad a_D^* = a_D^{A*} \left(\frac{1-\mu^{-1}\Omega}{1-\Omega^2} \right)^{\frac{1}{k}} \qquad [20]$$

$$a_X = \theta^{-1} a_D^A \left(\frac{\mu-\Omega}{1-\Omega^2} \right)^{\frac{1}{k}} \qquad [21] \qquad a_X^* = \theta^{-1} a_D^{A*} \left(\frac{\mu^{-1}-\Omega}{1-\Omega^2} \right)^{\frac{1}{k}} \qquad [22]$$

$$B = a_D^{\varepsilon-1} F_D \qquad\qquad B^* = a_D^{*\varepsilon-1} F_D$$

[17] Since Expected profit = Expected domestic profit + Expected export profit , we get

$$E(\pi) = E_D(\pi) + E_X(\pi) = \int_0^{a_D} (Ba^{1-\varepsilon} - F_D) dG(a) + \int_0^{a_X} (B^*(ta)^{1-\varepsilon} - F_X) dG(a) = F_E$$

where $\Omega = \left(\frac{F_D}{F_X}\right)^{\frac{k}{\varepsilon-1}-1} t^{-k}$ is negatively related with the trade costs , a_D^A and a_D^{A*} denotes the cut off in the closed economy given by [3]. To ensure the co-existence of exporters and non-exporters, the following conditions must be satisfied:

$$\frac{a_D}{a_X} = \theta\left(\frac{1-\mu\Omega}{\mu-\Omega}\right) > 1 \quad \text{and} \quad \frac{a_D^*}{a_X^*} = \theta\left(\frac{1-\mu\Omega}{\mu-\Omega}\right)^{-1} > 1 \qquad [23]$$

Eq.[23] leads to the two assumptions set in Eq.[15] and [16][18]. Following this condition:

$$\frac{a_D}{a_D^*} = \frac{a_X^*}{a_X} = \left(\frac{1-\mu\Omega}{\mu-\Omega}\right)^{\frac{1}{k}} < 1 \qquad [24]$$

Hence in both countries there exist positive domestic and export productivity cut off levels , which leads to a self-selection effect in both domestic and export markets. However, the more efficient home country has a higher domestic productivity threshold but a lower export threshold. Does this indicate that it is more “difficult” to survive but “easier” to export in the more efficient country, in terms of the probabilities of survival and export ? Let $p_{ex} = G(a_x)$ and $p'_{ex} = \frac{p_{ex}}{p_{in}} = W(a_X)$ represent the *ex-ante* and *ex-post* probability of export. Comparing p_{in} and p_{ex} for home and foreign , we have:

$$\frac{p_{in}}{p_{in}^*} = \frac{1-\mu\Omega}{1-\mu^{-1}\Omega} \le 1 \qquad [25]$$

$$\frac{p_{ex}}{p_{ex}^*} = \frac{\mu-\Omega}{\mu^{-1}-\Omega} \ge 1 \qquad [26]$$

$$\frac{p'_{ex}}{p'^*_{ex}} = \left(\frac{\mu-\Omega}{1-\mu\Omega}\right)^2 \ge 1 \qquad [27]$$

As depicted in figure 1 panel 3, a firm is more likely to export but less likely to survive in the more efficient country. The more efficient home country is thus more risky for entrants but more favourable for exporting. Note that p'_{ex} also represents the share of exporting firms. Therefore Eq.[27] implies that in contrast to other studies under a representative firm framework (Medin 2002), under firm heterogeneity the relative share of exporting firms is determined by the relative cut off , rather than the

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[18] For $\mu=1$, Eq.[23] yields $\theta>1$. As a result , $\Omega = \theta^{-k+(\varepsilon-1)} t^{1-\varepsilon} < 1$. For $\mu>1$, Eq.[23] implies

$$\theta^{-1} < \frac{1-\mu\Omega}{\mu-\Omega} < \theta$$

This generate the second assumption in Eq.[16].

relative market size. The more efficient country ,whether it is the smaller or the larger, will have a larger fraction of exporting firms.

Numbers of firms and the pattern of trade

In the closed economy, the number of firms N is proportionally increasing in its own country size but independent of the upper cost bound $\bar{a}$. However as will be shown below, once we consider an open economy N will depend on both country size and relative country-level efficiency μ. To solve the equilibrium number of firms, note that expenditure on the differentiated good in either country is shared by domestic firms and foreign firms:

$$\begin{aligned} \beta L &= R_X * + R_D \\ \beta L* &= R_X + R_D * \end{aligned} \qquad [28]$$

where $R_X = \int_0^{a_X} r_x(a)N\, dW(a)$, $R_D = \int_0^{a_D} r_D(a)NdW(a)$, $R_X* = \int_0^{a_X*} r_x*(a)N*dW*(a)$ and $R_D* = \int_0^{a_D*} r_D*(a)N*dW*(a)$ represent the gross export revenues , domestic revenues of all producers in home and foreign countries, respectively. From Eq. [28] N and $N*$ can be determined by:

$$N\frac{V(a_D)}{G(a_D)} + N*\frac{V*(a_X*)t^{1-\varepsilon}}{G*(a_D*)} = \frac{(1-\rho)\beta}{B}L \qquad \textbf{[29]}$$

$$N*\frac{V*(a_D*)}{G*(a_D*)} + N\frac{V(a_X)t^{1-\varepsilon}}{G(a_D)} = \frac{(1-\rho)\beta}{B*}L* \qquad [30]$$

which yields:

$$N = \frac{N^A}{(1-\Omega^2)}\left(1-(\upsilon\gamma)^{-1}\Omega\right) \qquad [31]$$

$$N* = \frac{N^A*}{(1-\Omega^2)}(1-\upsilon\gamma\Omega) \qquad [32]$$

where N^A and N^A* denote the number of firms in the closed economy given by Eq.[7], $\gamma = L/L*$ denote the relative country size and $\upsilon = \left(\frac{a_D*}{a_D}\right)^k = \frac{\mu-\Omega}{1-\mu\Omega}$ denotes the relative cut off , which is increasing in μ. [31] and [32] then imply N>0 and $N*$>0 if and only if :

$$\Omega < \upsilon\gamma < \Omega^{-1} \qquad [33]$$

[33] being satisfied , there will be intra-industry trade between countries. Otherwise in one country the number of firms will be zero , which indicates that there will be purely inter-industry trade : If the first inequality does not hold, the home country specialises in good H and imports good D; If the second inequality is violated, the foreign country will specialise in good H and import D from the home country. This

suggests the pattern of trade depends on the relationship between relative country size and the cross-country efficiency gap, for given trade costs. More clearly, Eq. [33] can be equivalently written as *either* of the following two inequalities:

$$\underline{Y}(\mu;\Omega) < \gamma < \overline{Y}(\mu;\Omega) \qquad [34]$$

$$\underline{Z}(\gamma;\Omega) < \mu < \overline{Z}(\gamma;\Omega) \qquad [35]$$

where $\underline{Y}(\mu;\Omega) = \frac{1-\mu\Omega}{\mu\Omega^{-1}-1}$, $\overline{Y}(\mu;\Omega) = \frac{\Omega^{-1}-\mu}{\mu-\Omega}$, $\underline{Z}(\gamma;\Omega) = \frac{\Omega(\gamma+1)}{\gamma+\Omega^2}$ and $\overline{Z}(\gamma;\Omega) = \frac{\gamma\Omega^2+1}{(\gamma+1)\Omega}$. As is summarised in figure 2 panel 1 , intra-industry trade corresponds to area B, where the combination of μ and γ fall within the "intra-industry trade boundary" $\underline{Z}(\gamma;\Omega)$ and $\overline{Z}(\gamma;\Omega)$, whereas purely inter-industry trade corresponds to area A and C. Figure 2 highlights the importance of relative country size in the determination of the pattern of trade. An extreme country size difference i.e. γ falls out of the range $[\theta^{-k}\Omega, \Omega^{-1}]$, will induce the cessation of the small country's production in sector D, whatever the country-level efficiency gap is. However, if the country size difference is not too large, i.e. γ is within the range $[\theta^{-k}\Omega, \Omega^{-1}]$, the trade pattern is jointly determined by μ and γ. Note that if the country size is identical i.e. γ=1, and there is no transportation costs i.e. t=1 , then the more efficient country will specialise in good D if the efficiency gap is greater than a threshold: $\mu > \overline{Z}(1;\Omega) = \frac{1+\Omega^2}{2\Omega}$, otherwise , if the efficiency gap is small ,there will be two way trade in sector D .

Another question is which country has a greater number of domestic producers in the open economy. In the closed economy a larger country has a proportionally larger number of firms, but in the open economy where there is intra-industry trade, the relative number of operating firms is given by :

$$\frac{N}{N^*} = \frac{\gamma - v^{-1}\Omega}{1-\gamma v\Omega} \qquad [36]$$

Substitute [24] into [36] and set it to unity , we derive the relationship between γ and μ which equalises *N* and *N* :*

$$\gamma = \frac{1-\mu\Omega}{1-\mu^{-1}\Omega} = N(\mu;\Omega) \qquad [37]$$

The schedule is drawn in figure 2 panel 2. On the γ=*N*(μ;Ω) curve both countries have the same number of domestic firms. The curve slopes downward since γ is monotonically decreasing in μ. This indicates that whether a country has more domestic firms depends on the trade off between its relative market size and its relative country efficiency level. To the right of the *N* curve (Area E and C)the more efficient home country has a larger number of domestic firms ; to the left (area A and D)the more efficient home country has a smaller number of firms . Note that for L=L*, the more efficient home country will always have a larger number of domestic firms.

Intra-industry Trade balance

As was shown in Helpman, Melitz and Yeaple (2002), if the cost distributions are identical across countries, a larger country will have more than proportional domestic sales and foreign sales. This implies that in our two-country model if μ=1, a larger country will run a trade surplus in the differentiated good sector as a result of the "home market effect". However, if there is cross-country efficiency differences i.e μ>1 , then in the case of intra-industry trade the relative trade volume E in sector D is given by :

$$E = \frac{R_X}{R_X *} = v^2 \frac{N}{N *} = \frac{v\gamma - \Omega}{v^{-1} - \gamma\Omega} \quad \textbf{[39]}$$

Setting Eq.[37] to unity , we derive the " intra-industry trade balance curve" :

$$\gamma = \frac{\mu^{-1} - \Omega}{\mu - \Omega} = E(\mu;\Omega) \qquad [40]$$

As depicted in figure 2- panel 3. On the E curve there is purely intra-industry trade, trade is balanced in the differentiated good sector for both countries and there is no trade in the homogenous good sector. To the right of the curve (area G and C) there is trade surplus and to the left (area A and F) there is trade deficit. Note that the E curve is downward sloping, which indicates the trade balance depends on the trade off between γ and μ. For L=L*, trade balance depends only on μ for given trade costs. The more efficient country will be a net exporter of the differentiated good sector. Note that [39] is increasing in v , so the greater the efficiency gap, the larger(less) the trade surplus(deficit) is in the home country.

Hence under the heterogeneous firm framework, in addition to country size we have investigated another important factor on the determination of the pattern of trade and intra-industry trade balance: the cross-country efficiency gap or the degree of comparative advantage. If the country size difference is not too large , then the pattern of trade and the trade balance in the differentiated good sector is determined by the trade off between the efficiency gap and relative market size .

Average performance

In the open economy the firm performance y includes not only its domestic performance y_D but also its export performance y_X such as sales and profit in the export markets. As such the average performance can be written as $\hat{y} = \int_0^{a_D} y_D(a)dW(a) + \int_0^{a_X} y_x(a)dW(a)$. Thus the average output quantity, revenue and profit are given by:

$$\hat{r} = \frac{K}{1-\rho}\left(F_D + t^{-1}F_X p_{ex}\right) \qquad [41]$$

$$\hat{\pi} = \left(\frac{K}{(1-\rho)\rho} - 1\right)\left(F_D + t^{-1}F_X p'_{ex}\right) \qquad [42]$$

$$\hat{q} = \frac{K\rho}{(1-\rho)} a_D^{-1}\left[F_D + F_X \theta t^{-1}\left(\frac{a_D{}^*}{a_D}\right)^{k-1}\right] \qquad [43]$$

Recall that p'_{ex} and $a_D{}^*/a_D$ are all determined by μ and Ω, so the average performances are increasing functions of the cross-country efficiency gap but are independent of market size. Since $p'_{ex} > p_{ex}'^*$, we have $\hat{r} > \hat{r}^*$, $\hat{\pi} > \hat{\pi}^*$ and $\hat{q} > \hat{q}^*$. In the more efficient country the domestic firms are on average larger and earn more profit than their counterparts in the less efficient country. This is because average revenue is the sum of its average domestic sales and its average export sales $\hat{r} = \int_0^{a_D} r_D(a)dW(a) + \int_0^{a_X} r_x(a)dW(a)$. Just like in the case of the closed economy , the first part $\int_0^{a_D} r(a)dW(a) = \frac{K}{1-\rho}F_D$ is independent of the cut off and is therefore identical across countries , but the second part can be written as $p_{ex}\int_0^{a_X} r_x(a)dW_X(a) = p_{ex}\frac{KF_X}{1-\rho}$ which depends on the share of exporting firms, where $W_X(a) = \left(\frac{a}{a_X}\right)^k$ denotes the cost distribution of all exporting firms. Thus the average revenue and profit is larger in the more efficient country since its proportion of firms who export is higher.

Next we consider the average and aggregate industry efficiency in the open economy. Departing from Melitz(2002), we define the average and aggregate efficiency as the un-weighted and weighted sum of firm efficiency levels for all *domestic producers* , where the weights represent the share of a firm's gross output in the total output of all domestic producers. Under this definition, the arithmetic average efficiency $\hat{a} = \int_0^{a_D} a dW(a) = \frac{k}{k+1}a_D$ is again determined by its own cut off level. However the aggregate industry efficiency is given by:

$$\begin{aligned}\tilde{a} &= \int_0^{a_D} s(a)aNdU(a) \\ &= \int_0^{a_D} S_D(a)aNdW(a) + \int_0^{a_X} S_X(a)aNdW(a) \qquad [44]\end{aligned}$$

where $s_x(a)$ and $s_D(a)$ denotes the share of an individual firm's export sales of the total output and the share of an individual firm's domestic sales of the total output:

$$s_x(a) = \frac{r_X(a)}{\widetilde{R}} \quad \text{and} \quad s_D(a) = \frac{r_D(a)}{\widetilde{R}} \qquad [45]$$

where $\widetilde{R}$ denotes the total output ,including export sales , of all domestic producers:

$$\widetilde{R} = \int_0^{a_X} r_x(a)N\ dW(a) + \int_0^{a_D} r_D(a)NdW(a) \qquad [46]$$

Substitute [45] into [44] and rearrange, aggregate efficiency is a function of trade costs and cut off efficiency levels:

$$\widetilde{a} = \widetilde{a}^{A}\left(\frac{1 + v\hat{\Omega}}{1 + v\Omega}\right) \qquad [47]$$

$$\widetilde{a}^* = \widetilde{a}^{A*}\left(\frac{1 + v^{-1}\hat{\Omega}^*}{1 + v^{-1}\Omega}\right)$$

where $\hat{\Omega} = \Omega\theta^{-1}\left(\frac{a_D^*}{a_D}\right) < \Omega$ and $\hat{\Omega}^* = \Omega\theta^{-1}\left(\frac{a_D}{a_D^*}\right) < \hat{\Omega}$. $\widetilde{a}^A, \widetilde{a}^{A*}$ denote the autarky aggregate efficiency levels in home and foreign country, respectively.

Therefore like the closed economy, $\widetilde{a} < \widetilde{a}^*$. The average and aggregate efficiency of the more efficient country are all higher than the less efficient country.

Welfare

The aggregate price of good D in the open economy can be written in the same form as in the closed economy, which is a function of its own domestic cut off :

$$P = a_D(\beta L)^{\frac{-1}{\varepsilon-1}} F_D^{\frac{1}{\varepsilon-1}} \sigma \qquad [48]$$

where a_D is given by [19]. P is independent of the size of its trade partner but increasing in efficiency gap because a_D is increasing in μ. If $L=L^*$, price is lower in the more efficient country $P<P^*$, since $a_D<a_D^*$ the cost cut off is lower in it. Welfare is thus given by

$$U = ((1-\beta)L)^{1-\beta}\left(\frac{\beta L}{P}\right)^{\beta} = L^{\frac{\beta}{\varepsilon-1}+1-\beta}\left(\frac{1-\Omega^2}{1-\mu\Omega}\right)^{\frac{1}{k}} F_E^{\frac{-1}{k}} F_D^{\frac{1}{k}-\frac{1}{\varepsilon-1}}\Theta \qquad [49]$$

where $\Theta = \sigma(1-\beta)^{1-\beta}\beta^{\frac{\beta}{\varepsilon-1}}(K-1)^{\frac{1}{k}}$. Welfare is decreasing in the entry costs, production costs and trade costs, but increasing in country size and the relative industry efficiency μ. This means the widening of the efficiency gap between the home and foreign country will make the home country better off and the foreign country worse off. If $L=L^*$, $U>U^*$ the economic welfare is higher in the more efficient country due to the lower market price.

The impact of trade

What are the gains and losses for a country moving from autarky to an open economy under our heterogeneous firm trade framework? If the trading countries are asymmetric, who are the winners and losers? We investigate this by comparing the domestic cut off and the probability of death of entrants, average firm performance, number of domestic firms, aggregate industry efficiency and the welfare between the closed and open economy.

Exposure to trade lowers the cost cut off level in both countries, but the proportional decrease in entry cut off cost is bigger in the more efficient country $\dot{a}_D > \dot{a}_D*$,where $\dot{a}_D = \frac{a_D{}^A - a_D}{a_D{}^A}$ and $\dot{a}_D* = \frac{a_D{}^A* - a_D*}{a_D{}^A*}$ represent the proportional change in a_D and a_D* [19]. This implies opening up to trade strengthens the efficiency self-selection effect in both countries, but the magnitude of such strengthening is greater in the more efficient country. As a consequence, the death rates of entrants $p_{out}=1-p_{in}$ also increase in both countries and the proportional increase is bigger in the more efficient country : $\dot{p}_{out} > \dot{p}_{out}*$ [20]. The higher death rate leads to a reduction of the number of domestic firms: $\frac{N}{N^A} = \frac{1-(\upsilon\gamma)^{-1}\Omega}{1-\Omega^2}$ <1 and $\frac{N*}{N^A*} = \frac{1-(\upsilon\gamma)\Omega}{1-\Omega^2}$ <1. In the case of identical country size *i.e.* $\gamma=1$, the proportional reduction $\dot{N} < \dot{N}*$, indicating that the more efficient country loses less domestic firms and varieties than the less efficient country.

Moving from autarky to an open economy, the average efficiency of domestic producers $\hat{a}$ is proportionally increasing in a_D. Therefore average industry efficiency levels also increase in both countries but faster in the more efficient country. The changes in the aggregate efficiency follow the same pattern. However the increase in aggregate efficiency in both countries is driven by both an increase in the minimum surviving efficiency level and the reallocation of the output share towards the more efficient firms. Since the more efficient country has a larger proportion of exporting firms and a greater increase in the domestic efficiency cut off, the reallocation effect is stronger there. Hence the rationalisation effect is stronger in the more efficient country, which reaps proportionally larger efficiency gains from openness: $\dot{\tilde{a}} > \dot{\tilde{a}}*$, where $\dot{\tilde{a}} = \frac{\tilde{a}^A - \tilde{a}}{\tilde{a}^A}$ and $\dot{\tilde{a}}* = \frac{\tilde{a}^A* - \tilde{a}*}{\tilde{a}^A*}$ denote the proportional increase in aggregate industry efficiency.

Next we consider changes in average firm performance. Compared to their autarky measures, Eq.[41] and [42] implies that exposure to trade increases the average firm

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[19] $\frac{a_D{}^A}{a_D} = \frac{1-\Omega^2}{1-\mu\Omega} > 1$ and $\frac{a_D{}^A*}{a_D*} = \frac{1-\Omega^2}{1-\mu^{-1}\Omega} > 1$, but $\frac{a_D{}^A}{a_D} > \frac{a_D{}^A*}{a_D*}$

[20] Note that $\frac{p_{in}{}^A}{p_{in}} = \left(\frac{a_D{}^A}{a_D}\right)^k > 1$, and in autarky $p_{in}{}^A = p_{in}{}^A*$ but in the open economy $p_{in} < p_{in}*$.

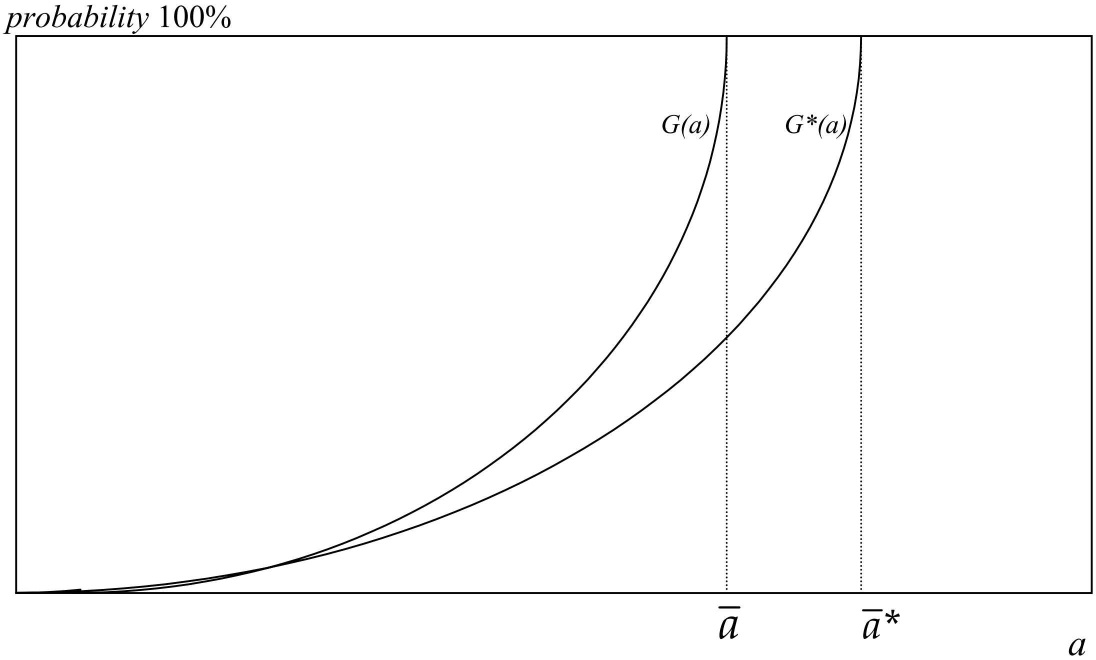
size in both countries and the magnitude of the increase depends on the share of exporting firms p_{ex} .This is because the average domestic sales of all surviving domestic producers $\hat{r} = \int_0^{a_D} r_D(a)dW(a) = \frac{KF_D}{1-\rho}$ remain unchanged moving from autarky to an open economy but average export sales are increasing in the proportion of exporting firms. It is somewhat surprising that exposure to trade does not reduce the average domestic sales of all surviving domestic producers, since the domestic sales of all existing domestic producers will shrink as a result of import competition. However notice that openness also eliminates the least productive producers whose domestic sales are the smallest. Thus openness also has a positive effect on average domestic sales. In this model these two effects offset each other so that the net effect of openness on average domestic sales is zero. On the other hand, exposure to trade bring the opportunity of earning additional export sales and profits. Thus the overall effect of openness on firm size and profit is positive, but stronger for the more efficient country as a consequence of its higher share of exporting firms.

On the consumer side, the aggregate prices decreases in both countries after opening to trade, since the cut off costs are lower in the open economy. But we have $\dot{P} > \dot{P}*$, *i.e.* price is decreasing faster in the more efficient country because $\dot{a}_D > \dot{a}_D*$. Recall that Eq.[49] , the welfare is decreasing in *P*. As a consequence , we have $\dot{U} > \dot{U}* > 0$, exposure to trade increases welfare in both countries , since consumers enjoy higher aggregate quantity of the differentiated good with a lower price. But the magnitude of the welfare improvement is greater in the more efficient one, since the aggregate price is decreasing more sharply in it.

5 Conclusion

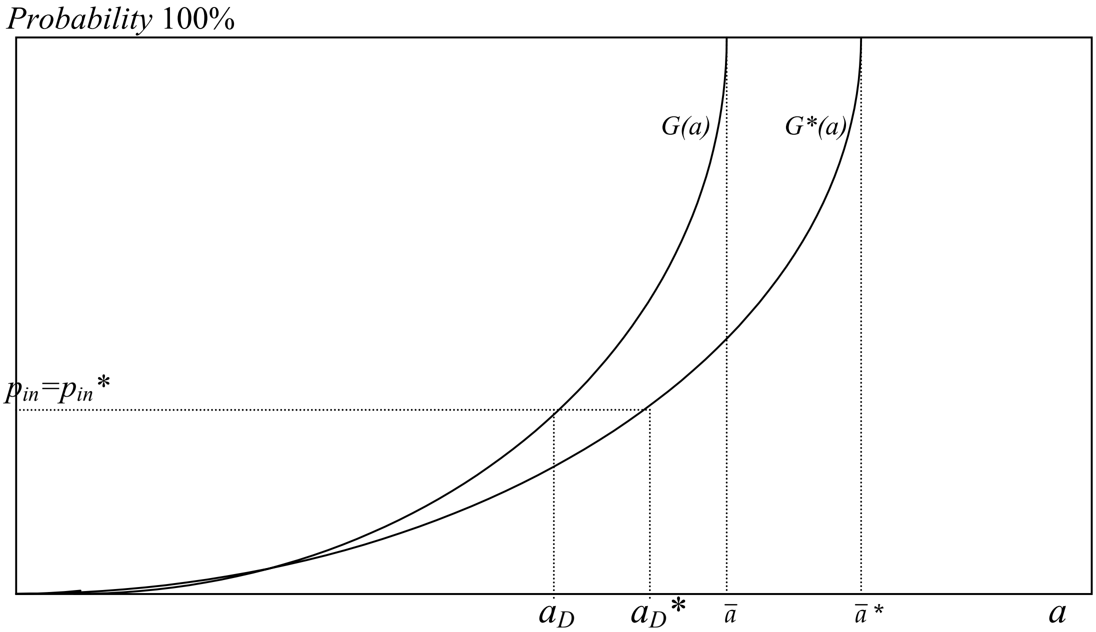
Figure 1 Firm cost distributions and the probabilities of survival

Panel 1 Cumulative cost distributions



p: probability *a: marginal labour cost*
G(a): cost distribution in home country *G*(a):* cost distribution in foreign country
$\bar{a}$: upper bound of *a* in home country , $\bar{a}$* *:* upper bound of a in foreign country

Panel 2 Successful entry cut off and the probability of survival in the close economy



Panel 3 Cut off levels and probabilities of survival and export in open economy

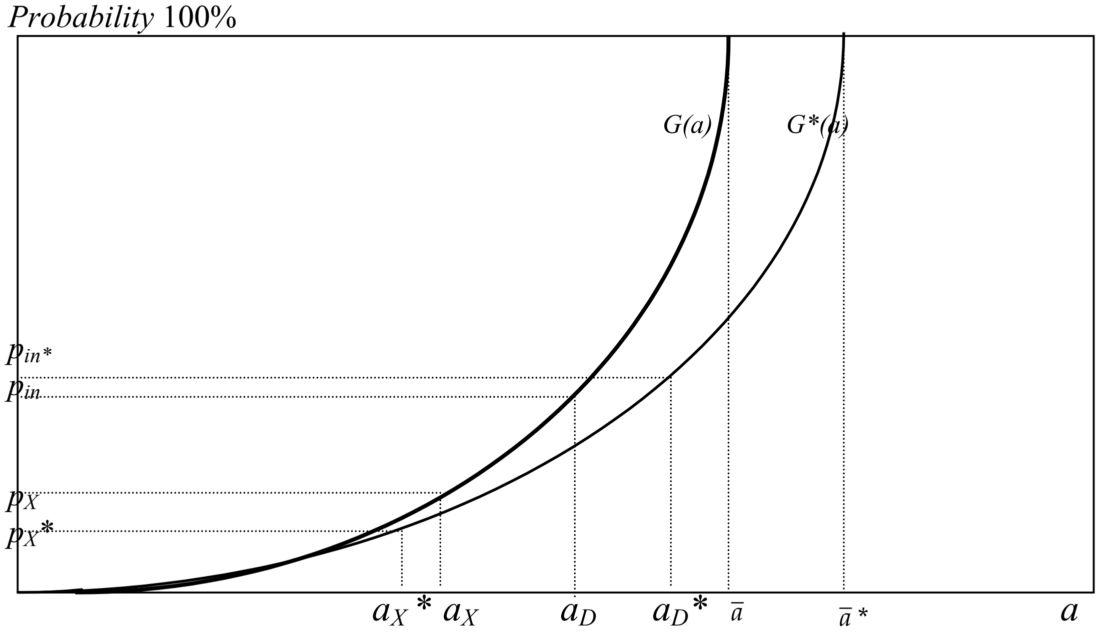
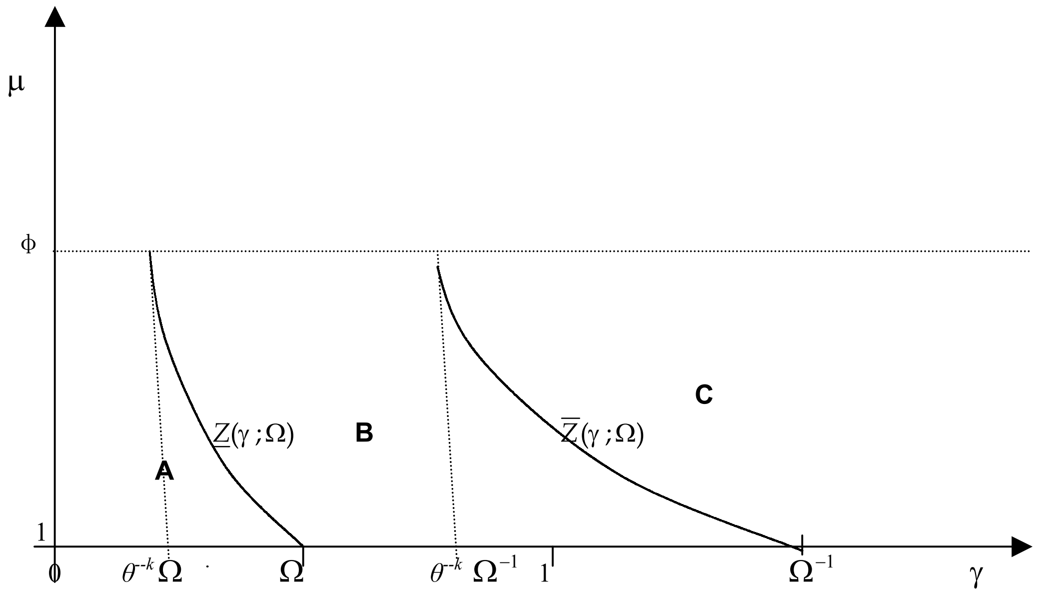


Figure 2 Efficiency gap , country size and international trade

Panel 1 Trade pattern

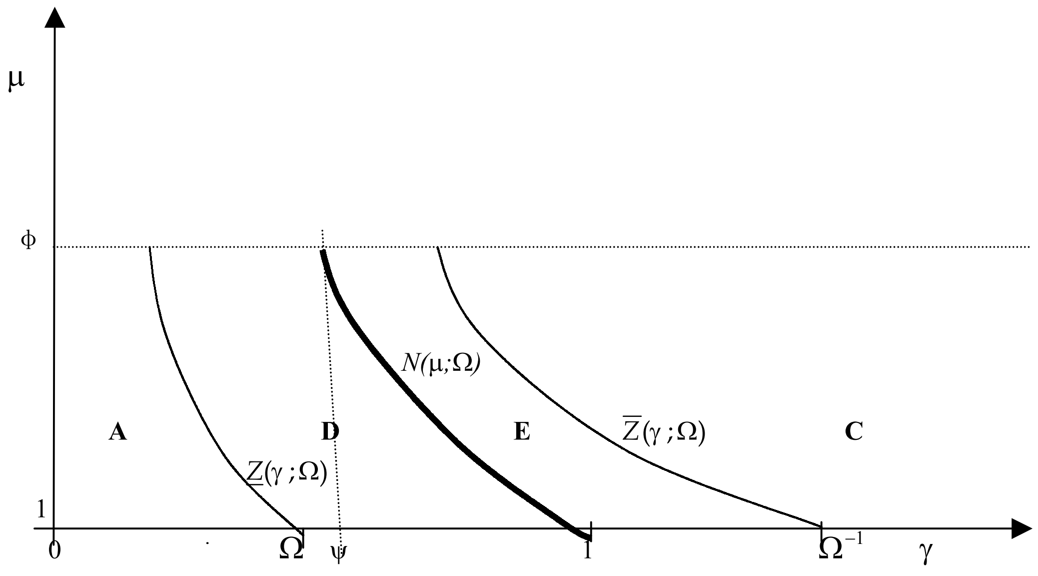


Area A: Inter-industry trade , home country specialise in homogenous good

Area B: Intra-industry trade , Area C: Inter-industry trade , home country specialise in the differentiated good

Note : $\theta^{-k}\ \Omega^{-1}$ <(>)1 , if F_X/F_D>(<)1

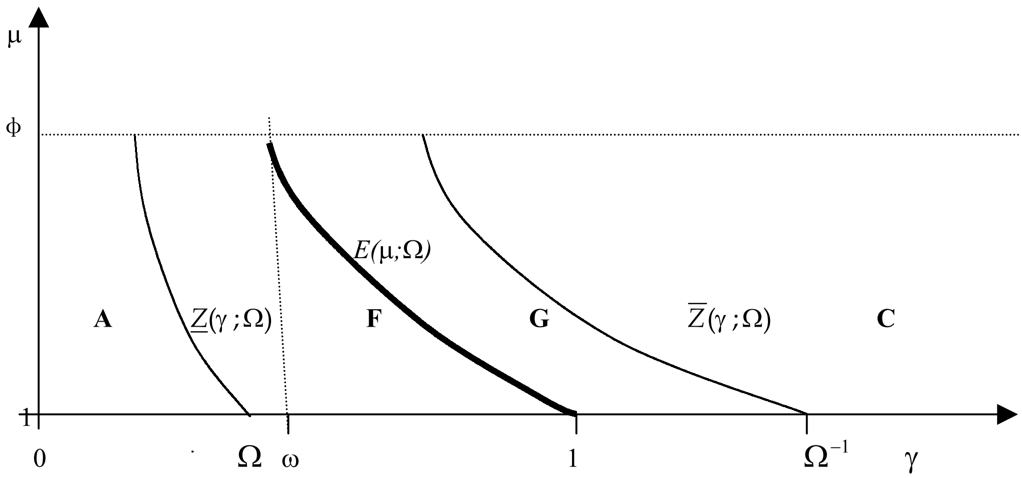
Panel 2 Relative number of firms



$\psi = \dfrac{1+\theta^{-k}\Omega}{1+\theta^{k}\Omega} < 1$

Area A and D: home country has greater number of firms ,
Area E and C: home country has smaller number of firms

Panel 3 **T**rade balance



$\omega = \dfrac{\theta^{-k} + \Omega}{\theta^{k} + \Omega} < \psi$: Trade balance curve

Area A and F: home country runs trade deficit in the differentiated good sector
Area C and G: home country runs trade surplus in the differentiated good sector

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