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Entrepreneurship and Welfare Gains from Trade

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ABSTRACT

This paper investigates the implications of heterogeneous entrepreneurs for the welfare gains from trade in a monopolistic competition model with a demand system of constant elasticity of substitution (CES). An agent selects her occupation between entrepreneur and worker according to her level of entrepreneurial capability, which determines the productivity of her launched firm. Although this model is isomorphic to Melitz's heterogeneous firm model in terms of the aggregate welfare gains from trade, it enables us to see the inequality in welfare gains from trade among heterogeneous agents. We find that firm owners always benefit more than workers due to an entrepreneurship premium, which is also a measure to quantify the disparity in welfare gains from trade between entrepreneurs and workers within a country. We also prove that globalization and agent heterogeneity make this disparity more severe.

1. INTRODUCTION

How to measure the impact of trade on welfare more precisely has been an important issue in international economics in the last three decades. Arkolakis et al. (2012)–henceforth, ACR–claim that the welfare gains from trade in a large class of trade models actually depend on only two sufficient statistics: a country's domestic expenditure share and the elasticity of trade with respect to the variable trade costs.[1] Therefore, they give their paper the title "new trade models, same old gains." In other words, these trade models derive the same welfare gains from trade if these models satisfy three macro-level restrictions: R1–trade in goods is balanced; R2–aggregate profits are a constant share of revenues; and R3–the import demand system is specified by CES. Inspired by their statement, the literature appears to be taking three main directions. One questions the completeness of these macro-level restrictions (see Behrens et al., 2014b). Another examines how the ACR formula changes when we relax some assumptions of quantitative trade models (see Behrens et al., 2014c; Head et al., 2014; Arkolakis et al., 2015; Melitz and Redding, 2015; Yang and Zeng, 2015). The other focuses on the different empirical implications of the estimated value of trade elasticity even though the analytical formulation of gains from trade is the same (see Simonovska and Waugh, 2014a, 2014b).

However, all the papers mentioned above are limited to measuring welfare gains at an aggregate level since they specify that the workers in the production sector are identical. The inequality in welfare gains from trade is ignored in their studies. Thus, this study moves to investigate the disparity in welfare gains from trade among heterogeneous agents. Instead of relaxing ACR's three macro-level restrictions to find new mechanisms affecting aggregate welfare gains from trade, we measure welfare gains from trade at the group level in terms of occupations.[2] Specifically, we introduce agent heterogeneity in entrepreneurial capability to a heterogeneous firm model. In a conventional Melitz (2003) heterogeneous firm model, there is no specification for entrepreneurs, since firms are owned by all agents (homogeneous workers). Each entrant firm pays a sunk entry cost to start up, and takes a draw to decide its productivity,

[1] This class of trade models includes the Armington model, Eaton and Kortum (2002), Krugman (1980), and multiple variations and extensions of Melitz (2003) featuring firm heterogeneity in productivity by Pareto distributions.

[2] In terms of the aggregate welfare gains from trade, our model is actually isomorphic to Melitz (2003).

which determines whether this firm can produce profitably.[3]

Based on the specification developed by Lucas (1978), we assume that each agent is endowed with two types of capabilities: a "homogeneous workforce" and a "heterogeneous talent for managing." She self-selects her occupation from being either a worker or an entrepreneur. Therefore, in this model, the firm heterogeneity sources from agent heterogeneity in their talent for managing. Entrepreneurs (as the firms' owners) take all the profits of their firms, while workers receive local wages as firms' employees. Then, the occupational selection of an agent is determined by whether operating a firm is more profitable than just being employed as a worker. Other settings on the preferences follow Melitz's (2003) specification. By choosing worker as the numéraire and holding all other parameters constant, we compare welfares derived from this model and that of Melitz (2003).

Thus, our objectives are twofold: first, verify that our model is isomorphic to Melitz's (2003) regarding the aggregate welfare gains from trade; second, measure the welfare gains from trade at the group level and make a comparison (i.e., entrepreneurs vs. workers). Given the same aggregate welfare gains from trade, confirmed in the first task, our second task quantifies the contribution of the entrepreneurship premium and the disparity in welfare gains from trade between workers and entrepreneurs. The effects of trade costs and agent heterogeneity on this disparity within a country are also respectively examined.

We find that entrepreneurs always enjoy greater welfare gains than workers when the economy is more open (i.e., when trade costs are lower). Besides, the more dispersed the agents' capability distribution is, the greater the contribution of entrepreneurship to welfare gains from trad e will be. We also calibrate the model to illustrate the disparity in welfare gains from trade for some countries, including the United States, Japan, and Taiwan.

1.1 Related Literature

This paper is related to the literature responding to ACR. In these papers as follows, various assumptions on the preference or production side are changed to investigate new implications for welfare gains from trade. On the preference side, Behrens et al. (2014c) use subutilities of a constant-absolute-risk-aversion (CARA) function to see

[3] A subset of entrants immediately exit. Hence, in equilibrium, the expected profit of an entrant is zero. Aggregate profit rebates to each consumer are therefore also zero (see Simonovska, 2015, p. 1616).

the impact of the pro-competitve effect on the ACR formula. Fajgelbaum and Khandelwal (2016) investigate non-homothetic preferences. Behrens et al. (2014b) explore the affine transformation of a CES utility. Arkolakis et al. (2015) employ a general utility of variable elasticity of substitution (VES) to examine variable markups. On the production side, Head et al. (2014) analyze a log normal productivity distribution. Melitz and Redding (2015) consider a truncated Pareto productivity distribution. Yang and Zeng (2015) incorporate mobile capital as the fixed production input to break down the restriction of trade balance in goods.

In addition, we are not the first to employ the setup of entrepreneurship in a heterogeneous firm model. Nocke (2006) presents a theory of entrepreneurial entry and exit decisions. Knowing their own managerial talent, agents self-select into markets and occupations. By this setup, Nocke (2006) highlights a striking sorting result: each entrant in the larger market is more efficient than any entrepreneur in the smaller one. Behrens et al. (2014a) use this setup in a framework of urban economics to elaborate why cities are more productive due to talent sorting, firm selection, and agglomeration. Behrens and Robert-Nicoud (2014) extend it further to explain why large cities are not only more productive but also more unequal than small towns. However, the implications of entrepreneurship for welfare gains from trade have not been highlighted in these papers of urban economics. Behrens et al. (2014d) employ this specification of agent heterogeneity to explore the effect of market size on income inequality in a closed economy. They do not consider the case of an open economy.

Furthermore, there is also a huge literature on the relationship between trade and inequality. Krugman and Venables (1995) examine how globalization affects the location of manufacturing and the gains from trade across countries. Goldberg and Pavcnik (2007) discuss recent empirical research on how trade liberalization has affected income inequality in developing countries. They summarize that globalization affects individuals through three main channels: changes in their labor income, changes in relative prices and hence consumption, and changes in household production decisions. Among these, the first channel always links to the increase in the skill premium. However, if we extend their first channel to “changes in income” without merely focusing on wages, our study can be seen as belonging to their first and third channels since we suggest that agents’ self-selection into entrepreneurs also reinforces the inequality in real income within a country. Regarding the disparity in welfare gains, Behrens and Murata (2012) also analyze how welfare gains from trade are distributed in their model of heterogeneous agents, in which individuals have identical preferences of CARA type but differ in labor efficiency. Without firm heterogeneity, their model shows that the heterogeneity in agents' incomes results from the heterogeneity in agents' efficiency since they assume agents are all employed as workers (only one kind of occupation). Thus, they measure welfare gains at the individual level. In their framework of variable markup, they find that the richer consumers in the higher-income country may lose from trade because the relative importance of variety versus qua ntity increases with income.

In contrast to these studies, we link firm heterogeneity to agent heterogeneity in terms of capability of entrepreneurship, and highlight its implications for welfare gains from trade. By doing so, we provide a measure to estimate the disparity in welfare gains from trade between workers and entrepreneurs within a country.

The remainder of this paper is organized as follows. We introduce heterogeneous firm models with and without entrepreneurship in Section 2. Then, Section 3 compares the welfare gains from trade at an aggregate level between these two models. Furthermore, we decompose the aggregate welfare gains in terms of occupation. We calibrate the model in Section 4. Finally, Section 5 concludes the paper.

2. HETEROGENEOUS FIRM MODELS WITH AND WITHOUT ENTREPRENEURSHIP

By choosing a worker as the numéraire and holding all other parameters constant, we compare a heterogeneous firm model with entrepreneurial choice, as developed by Lucas (1978), to a standard heterogeneous firm model without entrepreneurship, as shown in Melitz (2003).

2.1 Model with Entrepreneurship in a Closed Economy

First, consider a closed economy with a population L. Although individuals have identical preferences and each of them is endowed with one efficiency unit of labor, they differ in their innate entrepreneurial capability level, denoted by φ. An individual with a higher capability φ can organize a more efficient firm that requires lower marginal costs per unit of output. They are fully aware of their entrepreneurial capability when they decide either to operate a firm as an entrepreneur or just to be employed by a firm as a worker. Being a worker, the individual receives the local wages, w, by supplying her labor efficiency. If her entrepreneurial capability is high enough to set up a firm that earns her more returns than the local wages, the individual will choose to be an entrepreneur and launch her own firm, which employs $1/\varphi$ efficiency units of labor to produce one unit of a variety of differentiated goods.[4]

The specification of preferences is the same as Melitz's (2003). All individuals have identical preferences, and the utility derived from the consumption of differentiated goods is given by a CES function. Specifically, consumers solve the following utility maximization problem:

$$\max_{M_A \geq 0} U_A \equiv M_A,$$
$$\text{s.t.} \quad Y_A = \int_{i \in \Omega_A} p_A(i) q_A(i) di,$$

where the subscript A represents variables in autarky;

$$M_A \equiv \left[\int_{i \in \Omega_A} [q_A(i)]^{\frac{\sigma-1}{\sigma}} di \right]^{\frac{\sigma}{\sigma-1}}.$$

is a CES bundle of differentiated goods with elasticity of substitution $\sigma > 1$; Ω_A means the whole variety set in this closed economy; $q_A(i)$ denotes the aggregate consumption of variety i; $p_A(i)$ is its price; and Y_A represents the aggregate income.

A continuum of potential entrepreneurs are heterogeneous in terms of their entrepreneurial capability $\varphi \in [1, \infty)$ distributed as an untruncated Pareto cumulative density function $G(\varphi) \equiv 1 - \varphi^{-\kappa}$, where $\kappa > \sigma - 1$. Lower values of κ imply greater agent heterogeneity, and the homogeneous agent model corresponds to the limiting case in which $\kappa \to \infty$. As a result, there is a continuum of firms that are heterogeneous in their productivity $\varphi \in [\varphi_A, \infty)$ in the same untruncated Pareto distribution. Here, φ_A stands for not only a cutoff for occupational selection of individuals but also a cutoff for entry of firms.

Given that all firms of type-φ apply identical optimal pricing rules, we can index each variety by the productivity, which allows us to express aggregate consumer demand in this closed economy as follows:

[4] In contrast to Melitz's (2003) setting, there is no sunk cost to create a firm and receive a productivity draw. Appendix 1 analyzes how the model will change if we explicitly assume that an entrepreneur needs to pay $f_e > 0$ efficiency units of labor as the sunk entry costs to start up her firm.

$$q_A(\varphi) = \frac{Y_A}{P_A}\left[\frac{P_A}{p_A(\varphi)}\right]^{\sigma}, \text{ where } P_A = \left[\int_{i\in\Omega_A} [p_A(i)]^{1-\sigma} di\right]^{\frac{1}{1-\sigma}}.$$

is the CES price index.

Firms maximize the profits. Therefore, in autarky, firms' optimal prices and operating profits are given by

$$p_A(\varphi) = \frac{\sigma}{\sigma-1}\frac{w}{\varphi} \text{ and}$$
$$\pi_A(\varphi) = \frac{Y_A}{\sigma}\left[\frac{\sigma-1}{\sigma}\frac{P_A\varphi}{w}\right]^{\sigma-1}. \tag{1}$$

Then, the equilibrium in the closed economy is determined by the following three relationships. First, as in Lucas (1978), an individual self-selects into entrepreneurship when operating a firm is more profitable than being a worker. Thus, the cutoff φ_A is defined by equating the operating profit to the local wage rate as follows:[5]

$$\pi_A(\varphi_A) = \frac{Y_A}{\sigma}\left[\frac{\sigma-1}{\sigma}\frac{P_A\varphi_A}{w}\right]^{\sigma-1} = w. \tag{2}$$

Second, the aggregate income is the sum of the income from all individuals, including entrepreneurs and workers. Each entrepreneur collects all the profit of her own firm. Thus, the averag e operating profit of firms, denoted by $\overline{\pi_A}$, is the average rewards of entrepreneurs. The masses of workers and entrepreneurs are $LG(\varphi_A)$ and $L[1-G(\varphi_A)]$, respectively.[6] Then, by using the relationship linking relative firm operating profit to relative firm productivity (1) and the condition (2) above, the aggregate income in this closed economy is given by

$$\begin{aligned} Y_A &= LG(\varphi_A)w + L[1-G(\varphi_A)]\overline{\pi_A} \\ &= Lw\left\{G(\varphi_A) + [1-G(\varphi_A)]\left(\frac{\widetilde{\varphi_A}}{\varphi_A}\right)^{\sigma-1}\right\}, \end{aligned} \tag{3}$$

[5] Note that this is identical to the zero-cutoff-profit condition in Melitz (2003) when the fixed production cost $f_d = 1$. However, our interpretation on f_d is different from Melitz's (2003). We interpret f_d as the number of entrepreneurs required to set up a firm. We prove in Appendix 2 that the assumption $f_d = 1$ is innocuous.

[6] The mass of firms (varieties) n_A is equal to the mass of entrepreneurs $L[1-G(\varphi_A)]$.

where

$$\overline{\pi_A} \equiv \int_{\varphi_A}^{\infty} \pi_A(\varphi) \frac{dG(\varphi)}{1-G(\varphi_A)} = w\left(\frac{\widetilde{\varphi_A}}{\varphi_A}\right)^{\sigma-1};$$

$$\widetilde{\varphi_A} \equiv \left[\int_{\varphi_A}^{\infty} \varphi^{\sigma-1} \frac{dG(\varphi)}{1-G(\varphi_A)}\right]^{\frac{1}{\sigma-1}} = \left(\frac{\kappa}{\kappa-\sigma+1}\right)^{\frac{1}{\sigma-1}} \varphi_A. \tag{4}$$

is a weighted average of firm productivity, corresponding to the harmonic mean weighted by output shares as in Melitz (2003).

Third, in aggregate, the sum of all workers' incomes, $LG(\varphi_A)w$, accounts for a $1-1/\sigma$ share of the sum of all firms' revenues. The aggregate income equals the total expenditure, which is also the total revenues of firms, due to balance of payment. Then, combining this with the expression of the aggregate income (3) yields

$$G(\varphi_A) = (\sigma-1)[1-G(\varphi_A)]\left(\frac{\widetilde{\varphi_A}}{\varphi_A}\right)^{\sigma-1}. \tag{5}$$

Thus, by taking $G(\varphi) \equiv 1-\varphi^{-\kappa}$ and the weighted average of productivity (4) into (5), we have the closed-economy equilibrium cutoff of productivity:

$$\varphi_A = \left[\frac{\sigma(\kappa-1)+1}{\kappa-\sigma+1}\right]^{\frac{1}{\kappa}}. \tag{6}$$

Then, by taking the closed-economy equilibrium cutoff (6) into the aggregate income and the price index, the closed-economy aggregate welfare is given by:

$$W_A = \frac{Y_A}{P_A} = L^{\frac{\sigma}{\sigma-1}}(\sigma-1)\kappa^{\frac{\sigma}{\sigma-1}}[\sigma(\kappa-1)+1]^{\frac{-\sigma\kappa+\sigma-1}{\kappa(\sigma-1)}}(\kappa-\sigma+1)^{-\frac{1}{\kappa}}. \tag{7}$$

2.2 Model with Entrepreneurship in an Open Economy

Next, let us move to the case of trade between two symmetric countries, in each of which there is a continuum of immobile individuals with mass L. Since a firm that exports needs to pay $f_x > 0$ efficiency units of labor as the fixed exporting costs, only firms that are productive enough find it profitable to export. Besides, we assume an iceberg variable trade cost, whereby $\tau > 1$ units of a variety must be shipped from one country in order to ensure that one unit of the variety will arrive at the other country.

Individuals consume domestic (labeled by subscript d) and foreign (labeled by subscript x) goods and face the following utility maximization problem:

$$\max_{M \geq 0} \; U \equiv M,$$
$$\text{s.t.} \quad Y = \int_{i \in \Omega_d} p_d(i) q_d(i) di + \int_{j \in \Omega_x} p_x(j) q_x(j) dj.$$

Then, the CES bundle of differentiated goods is given by

$$M \equiv \left[\int_{i \in \Omega_d} [q_d(i)]^{\frac{\sigma-1}{\sigma}} di + \int_{j \in \Omega_x} [q_x(j)]^{\frac{\sigma-1}{\sigma}} di \right]^{\frac{\sigma}{\sigma-1}}.$$

Due to $M = Y/P$, the price index is

$$P = \left[\int_{i \in \Omega_d} [p_d(i)]^{1-\sigma} di + \int_{j \in \Omega_x} [p_x(j)]^{1-\sigma} dj \right]^{\frac{1}{1-\sigma}}.$$

Subsequently, by indexing each variety by its productivity and origin of production, we have aggregate demands as follows:

$$q_d(\varphi) = \frac{Y}{P} \left[\frac{P}{p_d(\varphi)} \right]^{\sigma}, \qquad q_x(\varphi) = \frac{Y}{P} \left[\frac{P}{p_x(\varphi)} \right]^{\sigma}.$$

By maximizing the profits, firms find their optimal prices and operating profits, given by

$$p_d(\varphi) = \frac{\sigma}{\sigma-1} \frac{w}{\varphi}, \qquad p_x(\varphi) = \frac{\sigma}{\sigma-1} \frac{\tau w}{\varphi},$$
$$\pi_d(\varphi) = \frac{Y}{\sigma} \left[\frac{\sigma-1}{\sigma} \frac{P\varphi}{w} \right]^{\sigma-1}, \qquad \pi_x(\varphi) = \frac{Y}{\sigma} \left[\frac{\sigma-1}{\sigma} \frac{P\varphi}{\tau w} \right]^{\sigma-1}. \tag{8}$$

Determined by conditions similar to those in autarky, open economy equilibrium is characterized by productivity cutoffs for entering the domestic market φ_d and export market φ_x. While the former is given by equating the operating profits in the domestic market to the local wages, the latter is determined by equating the operating profits in the export market to the required fixed exporting costs.

$$\begin{aligned} \pi_d(\varphi_d) &= \frac{Y}{\sigma}\left[\frac{\sigma-1}{\sigma}\frac{P\varphi_d}{w}\right]^{\sigma-1} = w, \\ \pi_x(\varphi_x) &= \frac{Y}{\sigma}\left[\frac{\sigma-1}{\sigma}\frac{P\varphi_x}{\tau w}\right]^{\sigma-1} = wf_x. \end{aligned} \tag{9}$$

For a firm, it is impossible to export before the firm is launched by an entrepreneur. Thus, we find that $\varphi_x > \varphi_d$ should always hold, which naturally ensures the selection of firms into the export market. Combining these two zero-cutoff-profit conditions implies that the export cutoff is a constant multiple of the domestic cutoff, where this multiple depends on the variable and fixed trade costs as follows:

$$\varphi_x = \tau(f_x)^{\frac{1}{\sigma-1}}\varphi_d. \tag{10}$$

Therefore, we impose the restriction $\tau(f_x)^{1/(\sigma-1)} > 1$ through the context from now on to guarantee $\varphi_x > \varphi_d$.[7] Then, the mass of firms n_d and the mass of exporting firms n_x are respectively given by

$$n_d = L[1-G(\varphi_d)], \qquad n_x = L[1-G(\varphi_x)]. \tag{11}$$

Next, summing up the incomes of all workers and all entrepreneurs and using the expressions of firms' operating profits (8) and zero-cutoff-profit conditions (9) yields the aggregate income:

$$\begin{aligned} Y = {} & LG(\varphi_d)w + L[1-G(\varphi_d)]\int_{\varphi_d}^{\infty}\pi_d(\varphi)\frac{dG(\varphi)}{1-G(\varphi_d)} \\ & + L[1-G(\varphi_x)]\left[\int_{\varphi_x}^{\infty}\pi_x(\varphi)\frac{dG(\varphi)}{1-G(\varphi_x)} - wf_x\right] \end{aligned}$$

[7] In Melitz (2003), an assumption that $\tau(f_x/f_d)^{1/(\sigma-1)} > 1$ is necessary to guarantee firm selection into the export market.

$$= Lw\left\{G(\varphi_d)+[1-G(\varphi_d)]\left(\frac{\widetilde{\varphi_d}}{\varphi_d}\right)^{\sigma-1}+[1-G(\varphi_x)]f_x\left[\left(\frac{\widetilde{\varphi_x}}{\varphi_x}\right)^{\sigma-1}-1\right]\right\}, \quad (12)$$

where

$$\widetilde{\varphi_d} \equiv \left[\int_{\varphi_d}^{\infty}\varphi^{\sigma-1}\frac{dG(\varphi)}{1-G(\varphi_d)}\right]^{\frac{1}{\sigma-1}} = \left(\frac{\kappa}{\kappa-\sigma+1}\right)^{\frac{1}{\sigma-1}}\varphi_d, \quad (13)$$

$$\widetilde{\varphi_x} \equiv \left[\int_{\varphi_x}^{\infty}\varphi^{\sigma-1}\frac{dG(\varphi)}{1-G(\varphi_x)}\right]^{\frac{1}{\sigma-1}} = \left(\frac{\kappa}{\kappa-\sigma+1}\right)^{\frac{1}{\sigma-1}}\varphi_x. \quad (14)$$

are the weighted averages of firm productivity among all firms and exporting firms, respectively.

As documented in the closed economy, the sum of all marginal costs, $Lw\{G(\varphi_d)-[1-G(\varphi_x)]f_x\}$, accounts for a $1-1/\sigma$ share of the sum of all firms' revenues. By using the expression of the aggregate income (12), we have the relationship linking φ_d and φ_x as follows:

$$G(\varphi_d)-[1-G(\varphi_x)]f_x=(\sigma-1)\left\{[1-G(\varphi_d)]\left(\frac{\widetilde{\varphi_d}}{\varphi_d}\right)^{\sigma-1}+[1-G(\varphi_x)]f_x\left(\frac{\widetilde{\varphi_x}}{\varphi_x}\right)^{\sigma-1}\right\}. \quad (15)$$

Thus, by substituting the function $G(\varphi)$, equation (10), and the weighted averages of firm productivity (13) and (14) into equation (15), we obtain the open-economy equilibrium cutoffs of firm productivity as follows:

$$\varphi_d = \left(1+\tau^{-\kappa}f_x^{\frac{-\kappa+\sigma-1}{\sigma-1}}\right)^{\frac{1}{\kappa}}\varphi_A, \quad (16)$$

$$\varphi_x = \left[f_x(1+\tau^{\kappa}f_x^{\frac{\kappa-\sigma+1}{\sigma-1}})\right]^{\frac{1}{\kappa}}\varphi_A. \quad (17)$$

Subsequently, by taking equilibrium cutoffs (6), (16), and (17) into the aggregate income (12) and the CES price index, we obtain the open-economy aggregate welfare:

$$W = \frac{Y}{P}$$

$$= L^{\frac{\sigma}{\sigma-1}}(\sigma-1)\kappa^{\frac{\sigma}{\sigma-1}}(\kappa-\sigma+1)^{-\frac{1}{\kappa}}[(\kappa-1)\sigma+1]^{-\frac{(\kappa-1)\sigma+1}{\kappa(\sigma-1)}}\left(1+\tau^{-\kappa}f_x^{\frac{-\kappa+\sigma-1}{\sigma-1}}\right)^{\frac{1}{\kappa}}. \quad (18)$$

Now, we move to examine some properties of these equilibrium cutoffs. Combining the restriction $\tau(f_x)^{1/(\sigma-1)} > 1$ and expressions (16) as well as (17), we know the inequalities between these cutoffs: $\varphi_A < \varphi_d < \varphi_x$, which are consistent with those in Melitz (2003).

Then, by differentiating these cutoffs with respect to κ and τ in turn, we have comparative statistics shown in Proposition 1, which are also the same as those in Melitz (2003).

Proposition 1 (Comparative statistics)

1. In either a closed or open economy, the φ_A, φ_d, and φ_x are all decreasing in κ.
2. In an open economy, φ_d is decreasing in τ, whereas φ_x is increasing in τ.

Proof:

$$\begin{aligned}
\frac{d\varphi_A}{d\kappa} &= -\frac{1}{\kappa^2}\left[\frac{\sigma(\kappa-1)+1}{\kappa-\sigma+1}\right]^{\frac{1}{\kappa}}\left\{\frac{\kappa(\sigma-1)^2}{(\kappa-\sigma+1)[\sigma(\kappa-1)+1]}\right. \\
&\qquad \left. +\ln\left[\frac{\sigma(\kappa-1)+1}{\kappa-\sigma+1}\right]\right\} < 0, \\
\frac{d\varphi_d}{d\kappa} &= \left(1+\tau^{-\kappa}f_x^{\frac{-\kappa+\sigma-1}{\sigma-1}}\right)^{\frac{1}{\kappa}} \\
&\quad \times\left\{\frac{d\varphi_A}{d\kappa} - \frac{\ln\left[1+\tau^{-\kappa}f_x^{\frac{-\kappa+\sigma-1}{\sigma-1}}\right] + \frac{\kappa\{(\sigma-1)\ln[\tau]+\ln[f_x]\}f_x^{\frac{\sigma}{\sigma-1}}}{(\sigma-1)\tau^{\kappa}f_x^{\frac{\kappa+1}{\sigma-1}}\left[1+\tau^{-\kappa}f_x^{\frac{-\kappa+\sigma-1}{\sigma-1}}\right]}}{\frac{\kappa^2}{\varphi_A}}\right\} < 0.
\end{aligned}$$

In addition, since $\varphi_x = \varphi_d \tau f_x^{1/(\sigma-1)}$,

$$\frac{d\varphi_x}{d\kappa} = \frac{d\varphi_d}{d\kappa} < 0.$$

With respect to τ, the derivatives of φ_d and φ_x are given by

$$\frac{d\varphi_d}{d\tau} = (-\tau^{-\kappa-1}) f_x^{\frac{-\kappa+\sigma-1}{\sigma-1}} \left(\tau^{-\kappa} f_x^{\frac{-\kappa+\sigma-1}{\sigma-1}} + 1\right)^{\frac{1-\kappa}{\kappa}} \varphi_A < 0,$$

$$\frac{d\varphi_x}{d\tau} = \tau^{\kappa-1} f_x^{\frac{\kappa}{\sigma-1}} \left(\tau^{\kappa} f_x^{\frac{\kappa}{\sigma-1}} + f_x\right)^{\frac{1-\kappa}{\kappa}} \varphi_A > 0.$$

Note that κ is the tail index of the distribution of agents' managerial talent, where a smaller κ implies a fatter tail and thus greater dispersion of agent capability.[8] Thus, from the analysis of comparative statics in Proposition 1, we know that in both the closed economy and the open economy, when agents' entrepreneurial capability is more dispersed, the cutoff for being an entrepreneur increases. Put differently, the presence of more productive firms (operated by the more talented agents) in the right tail reinforces the competition between firms so that the threshold for a firm to be profitable enough (for an agent to become an entrepreneur) is raised. By the same token, in the open economy, the greater the dispersion of firm productivity is, the higher the cutoff for firms to enter the export market will be. Regarding the impact of trade costs, decreasing trade costs lower the cutoff for entering the export market. However, when trade across countries is freer, the cutoff for being an entrepreneur rises due to more severe competition between firms. This implies that only entrepreneurs with higher capability can launch their firms and compete in the market when trade becomes more open.

2.3 Model without Entrepreneurship

By contrast, in a heterogeneous firm model without entrepreneurship, as specified by Melitz (2003), the closed-economy equilibrium cutoff φ_{AM} is given by the zero-cutoff-profit condition as follows:

$$\pi_{AM}(\varphi_{AM}) = \frac{Y_{AM}}{\sigma}\left[\frac{\sigma-1}{\sigma}\frac{P_{AM}\varphi_{AM}}{w}\right]^{\sigma-1} = wf_d.$$

where subscript AM denotes the related variables in the closed economy of the Melitz (2003) model. Subsequently, free entry requires that the probability of successful entry times average profits conditional on successful entry equals the sunk entry cost:

[8] The variance of φ is $\kappa/[(\kappa-1)^2(\kappa-2)]$ if $\kappa > 2$.

$$[1 - G(\varphi_{AM})]\overline{\pi_{AM}} = wf_e.$$

Using the relationship linking relative firm revenues to relative firm productivity and the free-entry condition, the mass of surviving firms is given by

$$n_{AM} = \frac{L}{\sigma\left[\dfrac{f_e}{1 - G(\varphi_{AM})} + f_d\right]}. \tag{19}$$

Then, taking the cumulative distribution $G(\varphi)$ into the free-entry condition yields the equilibrium cutoff in the closed economy as follows:

$$\varphi_{AM} = \left[\frac{f_d}{f_e}\left(\frac{\sigma - 1}{\kappa - \sigma + 1}\right)\right]^{\frac{1}{\kappa}}. \tag{20}$$

Thus, by employing the CES price index, the mass of firms (19), and the cutoff in the closed-economy equilibrium (20), we obtain the closed-economy aggregate welfare:

$$W_{AM} = \frac{Lw}{P_{AM}} = L^{\frac{\sigma}{\sigma-1}}\sigma^{-\frac{\sigma}{\sigma-1}}(\sigma - 1)^{\frac{\kappa+1}{\kappa}}(\kappa - \sigma + 1)^{\frac{-1}{\kappa}} f_e^{\frac{-1}{\kappa}} f_d^{\frac{-\kappa+\sigma-1}{\kappa(\sigma-1)}}. \tag{21}$$

In the case of open-economy equilibrium in Melitz (2003), the cutoffs in equilibrium are, respectively, determined by the following zero-cutoff-profit conditions:

$$\pi_{dM}(\varphi_{dM}) = \frac{Y_M}{\sigma}\left[\frac{\sigma - 1}{\sigma}\frac{P_M\varphi_{dM}}{w}\right]^{\sigma-1} = wf_d, \tag{22}$$

$$\pi_{xM}(\varphi_{xM}) = \frac{Y_M}{\sigma}\left[\frac{\sigma - 1}{\sigma}\frac{P_M\varphi_{xM}}{\tau w}\right]^{\sigma-1} = wf_x, \tag{23}$$

where subscript M denotes the related variables in the open economy of the Melitz (2003) model; π_{dM} (resp., π_{xM}) denotes the operating profit from the domestic (resp., export) market in Melitz (2003); and φ_{dM} (resp., φ_{xM}) denotes the productivity cutoff for entering the domestic (resp., export) market in Melitz (2003). The free-entry condition again equates the expected operating profit of entry to the sunk entry cost:

$$[1-G(\varphi_{dM})]\overline{\pi_{dM}}+[1-G(\varphi_{xM})]\overline{\pi_{xM}}=wf_e. \tag{24}$$

Then, the masses of producing and exporting firms are determined by:

$$\begin{aligned} n_{dM} &= \frac{L}{\sigma\left[\dfrac{f_e}{1-G(\varphi_{dM})}+f_d+\dfrac{1-G(\varphi_{xM})}{1-G(\varphi_{dM})}f_x\right]}, \quad \text{and} \\ n_{xM} &= \frac{1-G(\varphi_{xM})}{1-G(\varphi_{dM})}n_{dM}. \end{aligned} \tag{25}$$

Plugging the cumulative distribution $G(\varphi)$ and the relationship linking the cutoffs φ_{dM} and φ_{xM}, which are derived from zero-cutoff-profit conditions (22) and (23), into the free-entry condition (24), the open-economy equilibrium cutoffs are, respectively, given by

$$\varphi_{dM} = \left[1+\tau^{-\kappa}\left(\frac{f_x}{f_d}\right)^{\frac{-\kappa+\sigma-1}{\sigma-1}}\right]^{\frac{1}{\kappa}}\varphi_{AM}, \tag{26}$$

$$\varphi_{xM} = \tau\left(\frac{f_x}{f_d}\right)^{\frac{1}{\sigma-1}}\varphi_{dM}. \tag{27}$$

Thus, by using the CES price index and the mass of firms (25), we obtain the open-economy aggregate welfare in Melitz (2003) as follows:

$$\begin{aligned} W_M &= \frac{Lw}{P_M} \\ &= L^{\frac{\sigma}{\sigma-1}}(\sigma-1)^{\frac{\kappa+1}{\kappa}}\sigma^{\frac{-\sigma}{\sigma-1}}\left[1+\tau^{-\kappa}\left(\frac{f_x}{f_d}\right)^{\frac{-\kappa+\sigma-1}{\sigma-1}}\right]^{\frac{1}{\kappa}} f_d^{\frac{-\kappa+\sigma-1}{\kappa(\sigma-1)}} f_e^{\frac{-1}{\kappa}}(\kappa-\sigma+1)^{\frac{-1}{\kappa}}. \end{aligned} \tag{28}$$

3. COMPARISONS

3.1 Welfare Gains from Trade at the Aggregate Level

Labor (worker) is chosen as the numéraire, and some agents are workers while the others are entrepreneurs. Therefore, the minimum of agents' returns is 1, which equals the income of each homogeneous agent in Melitz (2003). We immediately find that the aggregate income in the entrepreneurship model is always higher than that in Melitz's (2003) model. Proposition 2 shows the proofs for the closed and open economy, respectively.

Proposition 2 (Comparison of the aggregate incomes)
Either in the closed economy or open economy, the aggregate income in the entrepreneurship model is always higher than that in Melitz's (2003) model.

Proof: In the closed economy equilibrium, the aggregate income is given by

$$Y_A = Lw\left\{G(\varphi_A) + [1 - G(\varphi_A)]\left(\frac{\widetilde{\varphi_A}}{\varphi_A}\right)^{\sigma-1}\right\},$$

where

$$\left(\frac{\widetilde{\varphi_A}}{\varphi_A}\right)^{\sigma-1} = \frac{\kappa}{\kappa-\sigma+1} > 1.$$

Thus, $G(\varphi_A) + [1 - G(\varphi_A)](\widetilde{\varphi_A}/\varphi_A)^{\sigma-1} > 1$ must hold.
As a result, by using (6), we have

$$\begin{aligned} Y_A &= Lw\frac{\sigma\kappa}{\sigma(\kappa-1)+1} \\ &> Lw = Y_{AM}. \end{aligned} \tag{29}$$

In the open economy, taking (15) back into the aggregate income (12) gives

$$Y = Lw\sigma\left\{[1-G(\varphi_d)]\left(\frac{\widetilde{\varphi_d}}{\varphi_d}\right)^{\sigma-1} + [1-G(\varphi_x)]f_x\left(\frac{\widetilde{\varphi_x}}{\varphi_x}\right)^{\sigma-1}\right\},$$

where

$$\left(\frac{\widetilde{\varphi_d}}{\varphi_d}\right)^{\sigma-1} = \left(\frac{\widetilde{\varphi_x}}{\varphi_x}\right)^{\sigma-1} = \frac{\kappa}{\kappa-\sigma+1}.$$

Then, by using (6), (16), and (17), the aggregate income can be re-written as:

$$\begin{aligned} Y &= Lw\frac{\sigma\kappa}{\sigma(\kappa-1)+1} \\ &> Lw = Y_M. \end{aligned} \tag{30}$$

Therefore, the aggregate income in the entrepreneurship model is always higher than that in the Melitz (2003) model.

This result is not too surprising. An agent chooses to be an entrepreneur because she finds that she can earn more income than just being a worker. Thus, the aggregate income in this model, where some agents are workers while others are entrepreneurs, must be higher than that in Melitz's (2003), where all agents are workers. However, based on the same CES demand system and the same numéraire, the aggregate income in this model is also a constant independent of τ even though the cutoff for being an entrepreneur is a function of τ in an open economy. As a result, when τ changes, the change in the aggregate welfare depends only on the change in the price index: $d\ln W = d\ln Y - d\ln P = -d\ln P$, which is the same as the case of Melitz (2003). Therefore, we know that the welfare gains from trade at the aggregate level derived in this model are equivalent to those in the Melitz (2003) model.[9] To illustrate this result, we explicitly calculate the welfare gains from trade at the aggregate level.

First, let λ denote the domestic share of expenditure, which is given by [10]

[9] We follow ACR (p. 94) to define the welfare gains from trade as the relative change in real income associated with any foreign shock, i.e., $d\ln W$ or W'/W, where W' denotes the real income after the shock.

[10] In Melitz (2003), the domestic share of expenditure is given by $\lambda = \left[1+\tau^{-\kappa}(f_x/f_d)^{\frac{-\kappa+\sigma-1}{\sigma-1}}\right]^{-1}$.

$$\lambda = \frac{\int_{i \in \Omega_d} p_d(\varphi) q_d(\varphi) di}{Y} = n_d \left[\frac{(\sigma-1)P}{\sigma w} \right]^{\sigma-1} \int_{\varphi_d}^{\infty} \frac{\varphi^{\sigma-1} dG(\varphi)}{1-G(\varphi_d)}$$
$$= \left(1 + \tau^{-\kappa} f_x^{\frac{-\kappa+\sigma-1}{\sigma-1}} \right)^{-1}. \tag{31}$$

Note that λ depends on τ, f_x, σ, and κ, which are all exogenously given. For the same set of these parameters plus $f_d = 1$ in Melitz (2003), these two models derive the same value of λ, which is observable from empirical data. Consider a lowering of trade costs from τ to τ', by which the aggregate welfare level changes from W to W' (resp., from W_M to W'_M in the Melitz (2003) model). Consequently, by using expressions (18) and (28), we are able to express the welfare gains from change in τ in the open economy in terms of λ for these two models as follows:

$$\frac{W'_M}{W_M} = \left[\frac{1 + (\tau')^{-\kappa} \left(\frac{f_x}{f_d} \right)^{\frac{-\kappa+\sigma-1}{\sigma-1}}}{1 + \tau^{-\kappa} \left(\frac{f_x}{f_d} \right)^{\frac{-\kappa+\sigma-1}{\sigma-1}}} \right]^{\frac{1}{\kappa}} = \left(\frac{\lambda'}{\lambda} \right)^{-\frac{1}{\kappa}}, \tag{32}$$

$$\frac{W'}{W} = \left[\frac{1 + (\tau')^{-\kappa} f_x^{\frac{-\kappa+\sigma-1}{\sigma-1}}}{1 + \tau^{-\kappa} f_x^{\frac{-\kappa+\sigma-1}{\sigma-1}}} \right]^{\frac{1}{\kappa}} = \left(\frac{\lambda'}{\lambda} \right)^{-\frac{1}{\kappa}}. \tag{33}$$

Referring to the closed-economy aggregate welfares (7) and (21), it is obvious that the welfare gains from opening the closed economy to trade in these two models are respective special cases of (32) and (33), where $\tau = \infty$ and thus $\lambda = 1$:

$$\frac{W'_M}{W_{AM}} = \left[1 + (\tau')^{-\kappa} \left(\frac{f_x}{f_d} \right)^{\frac{-\kappa+\sigma-1}{\sigma-1}} \right]^{\frac{1}{\kappa}} = (\lambda')^{-\frac{1}{\kappa}},$$
$$\frac{W'}{W_A} = \left[1 + (\tau')^{-\kappa} f_x^{\frac{-\kappa+\sigma-1}{\sigma-1}} \right]^{\frac{1}{\kappa}} = (\lambda')^{-\frac{1}{\kappa}}.$$

Consequently, in ACR's format, we see that $d\ln[W] = d\ln[W_M] = -\ln[\lambda]/\kappa$. Actually, combining Appendix 1 and 2, we know that the ACR formula $d\ln[W] = -\ln[\lambda]/\kappa$ still holds if we introduce a sunk entry cost wf_e and a more general f_d (i.e., f_d can be any positive number) in our model. Accordingly, we prove that our model with entrepreneurship is isomorphic to Melitz's (2003) in terms of the aggregate welfare gains from trade, which is highlighted in Proposition

Proposition 3 (Isomorphism to the Melitz (2003) model regarding the aggregate welfare gains from trade)
Given the same set of parameters $\{f_e, f_d, f_x, L, \sigma, \kappa, \tau\}$ across these two models, we then have $d\ln[W] = d\ln[W_M] = -\ln[\lambda]/\kappa$.

However, even though these two models are isomorphic in terms of the aggregate welfare gains from trade, they have different mechanisms to determine their masses of (active) firms. By taking equilibrium cutoffs (A2), (A8), and (A9) into the mass of all firms $n_d = L[1 - G(\varphi_d)]$, we find that the larger the value of f_e is, the smaller the mass of firms will be. By contrast, in the case of Melitz's (2003) model, the mass of surviving firms is independent of the value of f_e. We can immediately see that f_e has been cancelled out when substituting equilibrium cutoffs (20), (26), and (27) into the mass of surviving firms, n_{dM}, in (25). The difference in the mass of firms in turn results in the differences in the price index and in the aggregate welfare level between these two models.

3.2 Decomposing Welfare Gains from Trade

Although there is no difference in welfare gains from trade at the aggregate level between these two models, it is still worth examining the distribution of these welfare gains in this model. An entrepreneur collects all the net profits of her own firm. Therefore, the sum of all firms' net profits divided by the mass of firms (entrepreneurs) is equal to the average income of entrepreneurs, which is given by

$$\begin{aligned}
\overline{y_e} &= \overline{\pi_d} + \frac{1 - G(\varphi_x)}{1 - G(\varphi_d)}(\overline{\pi_x} - wf_x) \\
&= w\left\{\left(\frac{\widetilde{\varphi_d}}{\varphi_d}\right)^{\sigma-1} + \frac{1 - G(\varphi_x)}{1 - G(\varphi_d)} f_x \left[\left(\frac{\widetilde{\varphi_x}}{\varphi_x}\right)^{\sigma-1} - 1\right]\right\}.
\end{aligned}$$

Thus, we find that the income inequality between entrepreneurs and workers within a country becomes severe when trade costs decrease, as shown in Proposition 4.

Proposition 4 (The income inequality)
In an open economy, the income inequality between entrepreneurs and workers becomes severe when trade costs decrease.

Proof: By using equilibrium cutoffs (6), (16), and (17), we measure the income inequality between entrepreneurs and workers as follows:

$$\frac{\overline{y_e}}{w} = \frac{1}{\kappa-\sigma+1}\left(\kappa + \frac{\sigma-1}{\tau^{\kappa} f_x^{\frac{\kappa-\sigma+1}{\sigma-1}}}\right),$$

which is decreasing in τ.

Next, using equilibrium cutoffs (6), (16), and (17) yields the average welfare of all entrepreneurs as follows:

$$\overline{W_e} = \frac{\overline{y_e}}{P} = L^{\frac{1}{\sigma-1}}\left(\frac{\sigma-1}{\sigma}\right)\left(\frac{\kappa}{\kappa-\sigma+1}\right)^{\frac{\sigma}{\sigma-1}}\left[\frac{\sigma(\kappa-1)+1}{\kappa-\sigma+1}\right]^{\frac{-\kappa+\sigma-1}{\kappa(\sigma-1)}}$$
$$\times\left(1+\tau^{-\kappa} f_x^{\frac{-\kappa+\sigma-1}{\sigma-1}}\right)^{\frac{1}{\kappa}}\left(1+\frac{\sigma-1}{\kappa}\tau^{-\kappa} f_x^{\frac{-\kappa+\sigma-1}{\sigma-1}}\right). \tag{34}$$

In contrast, the average welfare of workers is equal to the welfare of an individual worker:

$$\overline{W_w} = \frac{w}{P} = L^{\frac{1}{\sigma-1}}\left(\frac{\sigma-1}{\sigma}\right)\left(\frac{\kappa}{\kappa-\sigma+1}\right)^{\frac{1}{\sigma-1}}\left[\frac{\sigma(\kappa-1)+1}{\kappa-\sigma+1}\right]^{\frac{-\kappa+\sigma-1}{\kappa(\sigma-1)}}$$
$$\times\left(1+\tau^{-\kappa} f_x^{\frac{-\kappa+\sigma-1}{\sigma-1}}\right)^{\frac{1}{\kappa}}. \tag{35}$$

Then, consider a lowering of trade costs from τ to τ', by which the average welfare of entrepreneurs changes from $\overline{W_e}$ to $\overline{W_e}'$ while the average welfare of workers changes from $\overline{W_w}$ to $\overline{W_w}'$. By using expressions (34) and (35), the average welfare gains from change in τ for different types of occupations are given by

$$\frac{\overline{W_w}'}{\overline{W_w}} = \left[\frac{1 + (\tau')^{-\kappa} f_x^{\frac{-\kappa+\sigma-1}{\sigma-1}}}{1 + \tau^{-\kappa} f_x^{\frac{-\kappa+\sigma-1}{\sigma-1}}} \right]^{\frac{1}{\kappa}} = \left(\frac{\lambda'}{\lambda}\right)^{-\frac{1}{\kappa}}, \tag{36}$$

$$\begin{aligned}
\frac{\overline{W_e}'}{\overline{W_e}} &= \left[\frac{1 + (\tau')^{-\kappa} f_x^{\frac{-\kappa+\sigma-1}{\sigma-1}}}{1 + \tau^{-\kappa} f_x^{\frac{-\kappa+\sigma-1}{\sigma-1}}} \right]^{\frac{1}{\kappa}} \frac{1 + \frac{\sigma-1}{\kappa}\left[(\tau')^{-\kappa} f_x^{\frac{-\kappa+\sigma-1}{\sigma-1}}\right]}{1 + \frac{\sigma-1}{\kappa}\left(\tau^{-\kappa} f_x^{\frac{-\kappa+\sigma-1}{\sigma-1}}\right)} \\
&= \left(\frac{\lambda'}{\lambda}\right)^{-\frac{1}{\kappa}} \frac{1 + \dfrac{\sigma-1}{\kappa}\left(\dfrac{1-\lambda'}{\lambda'}\right)}{1 + \dfrac{\sigma-1}{\kappa}\left(\dfrac{1-\lambda}{\lambda}\right)}.
\end{aligned} \tag{37}$$

Comparing expressions (33, (36), and (37), we obtain that $\overline{W_e}'/\overline{W_e} > \overline{W_w}'/\overline{W_w} = W'/W$ because of $\lambda > \lambda'$. To decompose the aggregate welfare gains from trade, by using $W = L\{G(\varphi_d)\overline{W_w} + [1 - G(\varphi_d)]\overline{W_e}\}$, we can also express the relative welfare change as follows:

$$\frac{W'}{W} = \frac{LG(\varphi_d')\overline{W_w}' + L[1 - G(\varphi_d')]\overline{W_e}'}{LG(\varphi_d)\overline{W_w} + L[1 - G(\varphi_d)]\overline{W_e}},$$

which can be re-arranged as

$$\begin{aligned}
&\frac{W'}{W} \times \Bigg\{ \underbrace{LG(\varphi_d)\overline{W_w}}_{\text{total } W_w \text{ bf. shock}} + \underbrace{L[1-G(\varphi_d)]\overline{W_e}}_{\text{total } W_e \text{ bf. shock}} \Bigg\} \\
&= \underbrace{\left[\frac{G(\varphi_d')}{G(\varphi_d)}\right] \frac{\overline{W_w}'}{\overline{W_w}} \times \underbrace{LG(\varphi_d)\overline{W_w}}_{\text{total } W_w \text{ bf. shock}}}_{\text{total } W_w \text{ aft. shock}} + \underbrace{\left[\frac{1-G(\varphi_d')}{1-G(\varphi_d)}\right] \frac{\overline{W_e}'}{\overline{W_e}} \times \underbrace{L[1-G(\varphi_d)]\overline{W_e}}_{\text{total } W_e \text{ bf. shock}}}_{\text{total } W_e \text{ aft. shock}},
\end{aligned} \tag{38}$$

where

$$\frac{G(\varphi_d')}{G(\varphi_d)} = \frac{\sigma(\kappa-1) + 1 - (\kappa - \sigma + 1)\lambda'}{\sigma(\kappa-1) + 1 - (\kappa - \sigma + 1)\lambda} > 1, \qquad \frac{1 - G(\varphi_d')}{1 - G(\varphi_d)} = \frac{\lambda'}{\lambda} < 1.$$

The notation "total W_w (resp., W_e) bf./aft. shock" means the total welfare value of all workers (resp., entrepreneurs) before/after the shock. Then, the left-hand side (LHS) of equation (38) shows the aggregate welfare level after the shock, while the right-hand side (RHS) breaks down the aggregate welfare level after the shock into total welfare values of these two groups (after the shock). From equation (38), we see that the total welfare value of all workers increases through not only individual welfare gains (i.e., $\overline{W_w}'/\overline{W_w} = W'/W > 1$) but also the increase in the mass of workers (i.e., $G(\varphi_d')/G(\varphi_d) > 1$). Hence, the total welfare value of all entrepreneurs after the shock on the RHS is lower than the product of W'/W times the total welf are value of all entrepreneurs before the shock on the LHS. Given that each entrepreneur, on average, enjoys a higher individual welfare growth rate than the aggregate welfare growth rate (i.e., $\overline{W_e}'/\overline{W_e} > W'/W$), the mass of entrepreneurs greatly shrinks (i.e., $[1 - G(\varphi_d')]/[1 - G(\varphi_d)] < 1$). In other words, when trade becomes freer, the mass of entrepreneurs greatly shrinks while they enjoy superior growth in real income. We illustrate in this framework that trade liberalization reinforces inequality by allocating higher welfare gains to fewer talented agents.

Therefore, simplifying (37) in ACR's format highlights the impact of entrepreneurship on the welfare gains from trade, shown in Proposition 5.

Proposition 5 (The welfare gains from trade by entrepreneurship)
In an open economy, the welfare gains from trade contributed by entrepreneurship are given by

$$\Delta \equiv d\ln[\overline{W_e}] - d\ln[\overline{W_w}] = d\ln\left[1 + \left(\frac{\sigma - 1}{\kappa}\right)\left(\frac{1-\lambda}{\lambda}\right)\right].$$

Proof: By expressions (34) and (35), the change rates of welfare for entrepreneurs and workers are given by:

$$\frac{d\overline{W_e}}{\overline{W_e}} = d\ln[\overline{W_e}] = \underbrace{-\frac{1}{\kappa}d\ln[\lambda]}_{\text{selection}}\underbrace{+d\ln\left[1 + \left(\frac{\sigma - 1}{\kappa}\right)\left(\frac{1-\lambda}{\lambda}\right)\right]}_{\text{entrepreneurship}},$$

$$\frac{d\overline{W_w}}{\overline{W_w}} = d\ln[\overline{W_w}] = \underbrace{-\frac{1}{\kappa}d\ln[\lambda]}_{\text{selection}}.$$

Since there is no difference in the specifications of workers between this model and Melitz's (2003) model, $d\ln[\overline{W_w}]$ is naturally driven by the same mechanism as in Melitz (2003), i.e., firm selection. However, in the case of entrepreneurs, we find that $d\ln[\overline{W_e}]$ can be decomposed into two terms. The first term equals $d\ln[\overline{W_w}]$, which represents the impact of firm selection on welfare gains from trade, while the second term represents the extra impact caused by the premium of entrepreneurship. Hence, we have the welfare gains from trade contributed by entrepreneurship as shown in the second term of $d\ln[\overline{W_e}]$.

Note that the average welfare gains from trade of workers include only the first term; the second term also represents the differential in welfare gains from trade between an entrepreneur and a worker. In other words, this term specifies not only the entrepreneurship premium but also the disparity in welfare gains from trade between these two occupations within a country. Proposition 6 shows how this disparity evolves when agent heterogeneity or trade costs change.

Proposition 6 (Comparative analysis on the disparity in welfare gains from trade within a country)
In an open economy, when trade costs τ decrease, the following arguments are true:
1. The more open the economy is, the greater the contribution of entrepreneurship on welfare gains of trade will be.
2. Entrepreneurs always enjoy a higher welfare growth rate than workers do.
3. The greater the dispersion of agent capability of entrepreneurship (smaller κ) is, the greater the contribution of entrepreneurship on welfare gains from trade will be.

Proof: As a result of $d\lambda/d\tau > 0$, the following is true:

$$\frac{d\left[\left(\frac{\sigma-1}{\kappa}\right)\left(\frac{1-\lambda}{\lambda}\right)\right]}{d\tau} = -\frac{(\sigma-1)\dfrac{d\lambda}{d\tau}}{\kappa\lambda^2} < 0.$$

Consequently, Δ increases as τ falls. Thus, we conclude that the freer the trade, the greater the contribution of entrepreneurship on welfare growth.

Consider that trade costs drop from τ to τ', by which the domestic expenditure share decreases from λ to λ'. Then, we immediately obtain that

$$\frac{1+\dfrac{\sigma-1}{\kappa}\left(\dfrac{1-\lambda'}{\lambda'}\right)}{1+\dfrac{\sigma-1}{\kappa}\left(\dfrac{1-\lambda}{\lambda}\right)} > 1,$$

since $\lambda > \lambda'$. Putting this inequality back into (36) and (37), we know that

$$\left(\frac{\overline{W_e}'}{\overline{W_e}}\right)\Big/\left(\frac{\overline{W_w}'}{\overline{W_w}}\right) = \frac{1+\dfrac{\sigma-1}{\kappa}\left(\dfrac{1-\lambda'}{\lambda'}\right)}{1+\dfrac{\sigma-1}{\kappa}\left(\dfrac{1-\lambda}{\lambda}\right)} > 1.$$

always holds. In other words, $\Delta \equiv d\ln[\overline{W_e}] - d\ln[\overline{W_w}]$ is always positive. Thus, entrepreneurs always have a greater welfare growth rate than workers.

According to expression (31), we obtain

$$\frac{d\lambda}{d\kappa} = \frac{\tau^{\kappa} f_x^{\frac{\kappa+\sigma+1}{\sigma-1}}\{\ln[f_x] + (\sigma-1)\ln[\tau]\}}{(\sigma-1)(\tau^{\kappa} f_x^{\frac{\kappa+1}{\sigma-1}} + f_x^{\frac{\sigma}{\sigma-1}})^2} > 0,$$

which supports

$$\frac{d\left[\left(\dfrac{\sigma-1}{\kappa}\right)\left(\dfrac{1-\lambda}{\lambda}\right)\right]}{d\kappa} = -\frac{(\sigma-1)\left[\lambda(1-\lambda)+\kappa\dfrac{d\lambda}{d\kappa}\right]}{\kappa^2\lambda^2} < 0.$$

As a result, when κ gets smaller, the term $[(\sigma-1)(1-\lambda)]/(\kappa\lambda)$ becomes larger. In turn, Δ becomes larger as well. Thus, the greater the dispersion of agent capability of entrepreneurship is, the greater the contribution of entrepreneurship on welfare gains from trade will be.

In summary, the contribution of entrepreneurship on welfare gains from trade becomes more significant when the economy is more open and agents are more heterogeneous in their entrepreneurial capability. Meanwhile, when the welfare gains from trade by entrepreneurship increase, the disparity in welfare gains between workers and entrepreneurs is enlarged. Proposition 6 explicitly highlights some testable arguments for further empirical studies. We claim that the favorable welfare growth for entrepreneurs also accounts for the inequality in the era of globalization.

4. CALIBRATION

To calibrate the model, we need to determine the value of σ. Krugman and Venables (1995, p. 870) use 3, 5, and 7, respectively, for illustrating their results. In this study, we pick $\sigma = 4$, which is quite standard for monopolistic-competition models with the CES. Since we assume firm productivity is distributed as an untruncated Pareto distribution with a shape parameter κ, firm size distribution is also an untruncated Pareto with a tail index governed by σ and κ. We first derive the tail index of firm size distribution as follows, which is employed for calculating the parameter κ conditional on a given value of σ.

Let $l(\varphi)$ denote the required workers of a firm with productivity φ, given by

$$\begin{aligned} l &= \frac{\sigma-1}{\sigma w} p(\varphi) q(\varphi) = \frac{\sigma-1}{\sigma w} [p_d(\varphi) q_d(\varphi) + p_x(\varphi) q_x(\varphi)] \\ &= Y \left(\frac{\sigma-1}{\sigma w} \right)^{\sigma} (\varphi P)^{\sigma-1} (1+\tau^{1-\sigma}). \end{aligned}$$

Subsequently, we obtain the expression of φ as follows:

$$\varphi = \left(\frac{\sigma w}{\sigma-1} \right)^{\frac{\sigma}{\sigma-1}} P^{-1} [Y(1+\tau^{1-\sigma})]^{\frac{1}{1-\sigma}} l^{\frac{1}{\sigma-1}}.$$

Then, taking the above expression into the cumulative density function of firm productivity $G(\varphi) = 1 - \varphi^{-\kappa}$ yields the cumulative density function of firm size as follows:

$$\begin{aligned} G_{size}(l) &= 1 - \left\{ \left(\frac{\sigma w}{\sigma-1} \right)^{\frac{\sigma}{\sigma-1}} P^{-1} [Y(1+\tau^{1-\sigma})]^{\frac{1}{1-\sigma}} \right\}^{-\kappa} l^{\frac{-\kappa}{\sigma-1}}, \\ Pr[\text{size} > l] &= 1 - G_{size}(l) = \text{constant} \times l^{\frac{-\kappa}{\sigma-1}}, \end{aligned}$$

where $\kappa/(\sigma-1)$ is the tail index of this distribution.

This tail index gives the relationship of σ and κ and has been estimated from firm-level data in the literature (e.g., Luttmer, 2007; Chaney, 2008; Eaton et al., 2011).

We choose $\kappa/(\sigma-1) = 1.06$ in Luttmer (2007) to derive $\kappa = 3.18$, which represents the absolute value of trade elasticity. Simonovska and Waugh (2014b, p. 35) develop a new estimator to disaggregate price and trade-flow data for the year 2004, which span 123 countries that account for 98% of world GDP. Their benchmark estimate for the absolute value of trade elasticity is 4.14. Applying their estimator to alternative data sets and conducting several robustness exercises allows them to establish a range for the absolute value of trade elasticity between 2.79 and 4.46. Thus, it looks acceptable that we set κ as 3.18.

Then, we construct the gross expenditure of a country as: $E = \mathrm{GO} + \mathrm{Im} - \mathrm{Ex}$, where GO denotes the gross output; Im means the total imports; and Ex stands for the total exports. Thus, we specify the share of domestic expenditure as follows:

$$\lambda_t = \frac{E_t - \mathrm{Im}_t}{E_t},$$

where the subscript t specifies the year t.

In order to make a comparison based on the same criteria, we only employ officially announced data across countries. Due to the public availability of the gross output data, we select the United States, Japan, and Taiwan to construct their gross expenditure data from 1997 to 2014.[11] Based on the constructed gross expenditure data, we calculate the values of domestic expenditure share for each of these three countries year by year. Table 1 lists the time series of λ and the derived welfare gains from trade for workers and entrepreneurs in each country.

We set the counterfactual case under autarky ($\lambda = 100\%$) as the benchmark to calculate the welfare gains from trade in each year. For instance, the value of $d\ln\overline{W_e}$ in the United States for the year 2014 being 12.33% implies that the US entrepreneurs' average real income for 2014 has increased 12.33% compared to their average real income under autarky. Due to $d\ln W = d\ln\overline{W_w}$, the magnitude of $d\ln\overline{W_w}$ can be also regarded as the aggregate welfare gains from trade. Therefore, the aggregate welfare level of the United States for 2014 has increased 2.87% over its aggregate welfare under autarky. From Table 1, a similar decreasing trend of λ (the domestic expenditure share) across countries is shown, since it is generally accepted that trade gets freer over time. As a result, workers' and entrepreneurs' average welfare gains

[11] We directly download these data from the websites of the United Nations Statistics Division, the US Bureau of Economic Analysis, the Japan Cabinet Office, and the Department of Statistics, Directorate General of Budget, Accounting and Statistics (DGBAS) of Taiwan.

Table 1 Welfare Gains from Trade ($\sigma = 4$, $\kappa = 3.18$)

unit: %	United States			Japan			Taiwan		
year	λ	$d\ln\overline{W_w}$	$d\ln\overline{W_e}$	λ	$d\ln\overline{W_w}$	$d\ln\overline{W_e}$	λ	$d\ln\overline{W_w}$	$d\ln\overline{W_e}$
1997	93.17	2.15	9.06	94.72	1.66	6.92	78.43	6.78	32.72
1998	93.17	2.15	9.06	95.06	1.55	6.46	77.77	6.99	33.96
1999	92.87	2.24	9.49	95.23	1.50	6.22	78.12	6.88	33.31
2000	92.22	2.44	10.40	94.81	1.63	6.79	75.89	7.58	37.55
2001	92.74	2.28	9.66	94.62	1.69	7.06	77.96	6.93	33.61
2002	92.71	2.29	9.71	94.53	1.72	7.18	77.66	7.02	34.16
2003	92.52	2.35	9.98	94.37	1.77	7.40	76.68	7.33	36.02
2004	91.93	2.54	10.82	93.84	1.94	8.13	74.17	8.12	40.98
2005	91.62	2.63	11.26	93.11	2.17	9.15	74.29	8.09	40.74
2006	91.24	2.75	11.81	92.16	2.47	10.49	73.17	8.44	43.02
2007	91.13	2.79	11.97	91.64	2.63	11.23	72.47	8.66	44.49
2008	90.69	2.93	12.61	91.16	2.78	11.92	72.30	8.71	44.86
2009	92.08	2.49	10.60	93.35	2.09	8.81	75.66	7.65	38.00
2010	91.11	2.80	12.00	92.50	2.36	10.00	72.63	8.61	44.17
2011	90.45	3.00	12.97	91.65	2.63	11.22	72.54	8.63	44.34
2012	90.54	2.97	12.83	91.40	2.71	11.58	73.03	8.48	43.32
2013	90.79	2.90	12.47	90.33	3.04	13.15	73.41	8.36	42.53
2014	90.88	2.87	12.33	89.48	3.31	14.39	73.26	8.41	42.84

from trade both increase as λ decreases. Since we apply the same values of σ and κ to each country, the difference in welfare gains from trade across countries only results from the different values of λ across countries. Taiwan enjoys higher welfare gains from trade, and features higher disparity in this welfare growth between workers and entrepreneurs due to its lower domestic expenditure share. In contrast, the welfare gains from trade for the United States and Japan are not very different. Figure 1 plots the time-series magnitude of entrepreneurship premium on welfare gains from trade, which is given by $\Delta \equiv d\ln\overline{W_e} - d\ln\overline{W_w}$ for these three countries. We see that Taiwan shows higher values of this measure, so its disparity in welfare gains from trade between entrepreneurs and workers is greater than the United States and Japan.

Note that our results in Table 1 present only a partial picture of how trade liber-

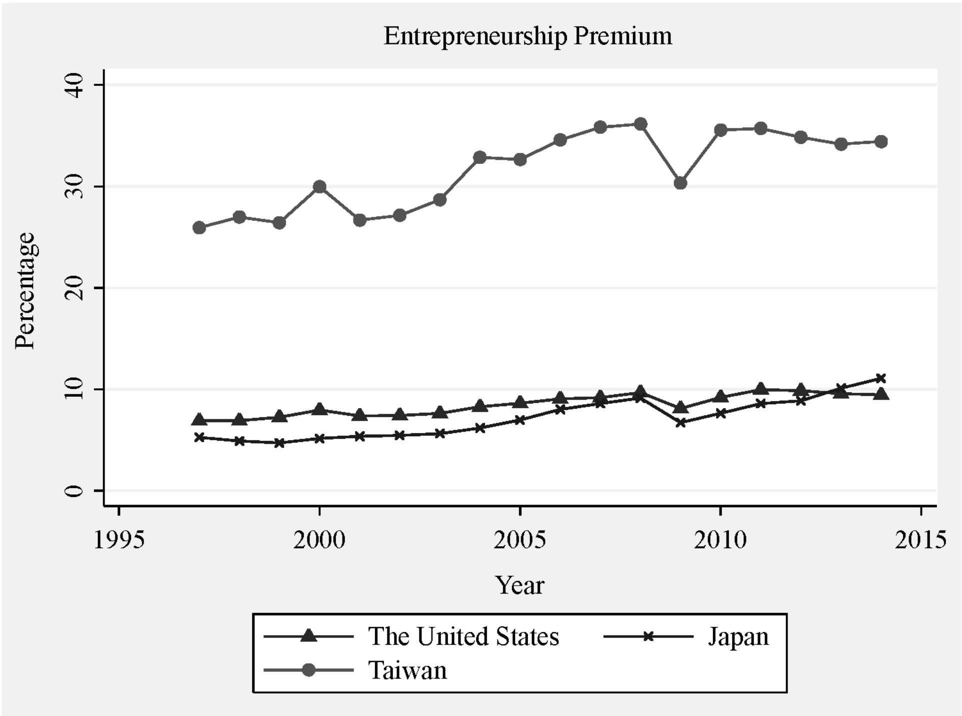

Figure 1　Comparison of the Entrepreneurship Premium

alization affects the inequality within a country. Goldberg and Pavcnik (2007) review a body of literature and summarize that globalization influences individuals through three main channels: changes in their labor income, changes in relative prices and hence consumption, and changes in household production decisions. In contrast, our study quantifies the contribution of entrepreneurship premium to welfare growth, which is driven by agents' self-selection into entrepreneurs. We suggest that the entrepreneurship premium acts as an extra mechanism to reinforce inequality of real income within a country.

5. CONCLUDING REMARKS

Inspired by ACR, this paper investigates the implications of entrepreneur heterogeneity for welfare gains from trade in a monopolistic competition model with a CES demand system. We follow Lucas' (1978) framework to incorporate entrepreneurship in a heterogeneous firm model. An a gent selects her occupation between entrepreneur and worker according to her capability level of entrepreneurship, which in turn determines the productivity of her launched firm. Therefore, the source of firm heterogeneity lies in the entrepreneur heterogeneity in their talent for managing. The occupational selection of an agent is determined by whether running a firm is more profitable than being a worker. Other settings on the preferences follow Melitz (2003). By choosing worker as the numéraire and holding all other parameters constant, we first make a comparison on welfare gains from trade at an aggregate level between heterogeneous firm models with and without entrepreneurship (i.e., this model vs. Melitz (2003)). Subsequently, we decompose the aggregate welfare gains from trade in terms of occupation (i.e., workers vs. entrepreneurs) and examine the impact of trade costs as well as agent heterogeneity on the disparity in welfare gains from trade.

We find that this heterogeneous firm model associated with entrepreneurship derives the same aggregate welfare gains from trade as those in Melitz (2003) without entrepreneurship. Both are expressed as the ACR formula. However, considering the average welfare gains from trade for entrepreneurs, we find an extra term, which is contributed by entrepreneurship, which is not present in the original ACR-formula. Comparing this to the average welfare gains from trade for workers, which only contains the ACR formula, we highlight that this extra term quantifies the impact of the entrepreneurship premium on welfare gains from trade. In other words, we can estimate the disparity in welfare gains from trade between workers and entrepreneurs within a country by simply using this term. We also prove that globalization and agent heterogeneity in entrepreneurial capability make this disparity more severe.

APPENDIX 1: THE IMPACT OF ENTRY COST f_e

In this Appendix, we examine whether the results will change if we assume that $f_e > 0$ efficiency units of labor are required as the entry cost for an entrepreneur to start up her firm. In other words, the entrepreneur needs to pay a sunk entry cost, wf_e, to launch her firm.

1.1 Closed Economy

Thus, in a closed economy, the mass of firm n_A is still $L[1-G(\varphi_A)]$ but the cutoff for being an entrepreneur is determined by

$$\pi_A(\varphi_A) = \frac{Y_A}{\sigma}\left[\frac{\sigma-1}{\sigma}\frac{P_A\varphi_A}{w}\right]^{\sigma-1} = w(1+f_e),$$

which means that the entrepreneur earns herself a return (the net profit of her firm) no less than the local wage rate. Then, the operating profit of a firm with productivity φ is given by

$$\pi_A(\varphi) = w(1+f_e)\left(\frac{\varphi}{\varphi_A}\right)^{\sigma-1}.$$

Summing up all agents' incomes yields the aggregate income in this closed economy as follows:

$$Y_A = LG(\varphi_A)w + L[1-G(\varphi_A)](\overline{\pi_A} - wf_e), \tag{A1}$$

where

$$\overline{\pi_A} \equiv \int_{\varphi_A}^{\infty} \pi_A(\varphi)\frac{dG(\varphi)}{1-G(\varphi_A)} = w(1+f_e)\left(\frac{\widetilde{\varphi_A}}{\varphi_A}\right)^{\sigma-1}.$$

Last, since the sum of all firms' marginal costs, $Lw\{G(\varphi_A) - [1-G(\varphi_A)]f_e\}$, accounts for a $1 - 1/\sigma$ share of the sum of all firms' revenues, we obtain the following equation to determine the equilibrium:

$$G(\varphi_A) = [1 - G(\varphi_A)] \left[(\sigma - 1)(1 + f_e) \left(\frac{\widetilde{\varphi_A}}{\varphi_A} \right)^{\sigma-1} + f_e \right].$$

Consequently, we obtain the closed-economy equilibrium cutoff

$$\varphi_A = \left[\frac{\sigma(\kappa - 1) + 1}{\kappa - \sigma + 1} (1 + f_e) \right]^{\frac{1}{\kappa}}, \tag{A2}$$

which is obviously increasing in f_e. The threshold of φ for an agent to be an entrepreneur becomes higher if the sunk cost requirement is higher.

Taking the closed-economy equilibrium cutoff (2) back into the closed-economy aggregate income yields

$$Y_A = Lw \frac{\sigma\kappa}{\sigma(\kappa - 1) + 1}, \tag{A3}$$

in which f_e has been cancelled out. The closed-economy aggregate income is identical to that (29) derived in the case where $f_e = 0$ in the text.

Because φ_A increases in f_e, the CES price index also increases in f_e, given by

$$P_A = L^{\frac{1}{1-\sigma}} w \frac{\sigma}{\sigma - 1} \left(\frac{\kappa}{\kappa - \sigma + 1} \right)^{\frac{1}{1-\sigma}} \left[\frac{\sigma(\kappa - 1) + 1}{\kappa - \sigma + 1} \right]^{\frac{\kappa-\sigma+1}{\kappa(\sigma-1)}} (1 + f_e)^{\frac{\kappa-\sigma+1}{\kappa(\sigma-1)}}. \tag{A4}$$

As a result of (A3) and (A4), the closed-economy aggregate welfare becomes

$$W_A = \frac{Y_A}{P_A} = L^{\frac{\sigma}{\sigma-1}} (\sigma - 1) \kappa^{\frac{\sigma}{\sigma-1}} [\sigma(\kappa - 1) + 1]^{\frac{-\sigma\kappa+\sigma-1}{\kappa(\sigma-1)}} (\kappa - \sigma + 1)^{-\frac{1}{\kappa}} (1 + f_e)^{\frac{-\kappa+\sigma-1}{\kappa(\sigma-1)}}.$$

1.2 Open Economy

Since each firm is owned and operated by an entrepreneur, the mass of firms and the mass of exporting firms remains $n_d = L[1 - G(\varphi_d)]$ and $n_x = L[1 - G(\varphi_x)]$, respectively. The cutoffs are determined by the zero-cutoff-profit conditions as follows:

$$\pi_d(\varphi_d) = \frac{Y}{\sigma}\left[\frac{\sigma-1}{\sigma}\frac{P\varphi_d}{w}\right]^{\sigma-1} = w(1+f_e),$$
$$\pi_x(\varphi_x) = \frac{Y}{\sigma}\left[\frac{\sigma-1}{\sigma}\frac{P\varphi_x}{\tau w}\right]^{\sigma-1} = wf_x, \tag{A5}$$

where the restriction $\tau[f_x/(1+f_e)]^{1/(\sigma-1)} > 1$ is necessary to guarantee firms' selection into the export market.

Next, by summing up all agents' incomes, we obtain the aggregate income in the open economy as follows:

$$\begin{aligned} Y &= LG(\varphi_d)w + L[1-G(\varphi_d)](\overline{\pi_d} - wf_e) + L[1-G(\varphi_x)](\overline{\pi_x} - wf_x) \\ &= Lw\left\{G(\varphi_d) + [1-G(\varphi_d)]\left[(1+f_e)\left(\frac{\widetilde{\varphi_d}}{\varphi_d}\right)^{\sigma-1} - f_e\right]\right. \\ &\quad \left. + [1-G(\varphi_x)]f_x\left[\left(\frac{\widetilde{\varphi_x}}{\varphi_x}\right)^{\sigma-1} - 1\right]\right\}, \end{aligned} \tag{A6}$$

where

$$\overline{\pi_d} \equiv \int_{\varphi_d}^{\infty} \pi_d(\varphi)\frac{dG(\varphi)}{1-G(\varphi_d)} = w(1+f_e)\left(\frac{\widetilde{\varphi_d}}{\varphi_d}\right)^{\sigma-1} \quad \text{and}$$
$$\overline{\pi_x} \equiv \int_{\varphi_x}^{\infty} \pi_x(\varphi)\frac{dG(\varphi)}{1-G(\varphi_x)} = wf_x\left(\frac{\widetilde{\varphi_x}}{\varphi_x}\right)^{\sigma-1}.$$

As in the closed economy, the sum of all marginal costs, $Lw\{G(\varphi_d) - [1 - G(\varphi_d)]f_e - [1-G(\varphi_x)]f_x\}$, accounts for a $1 - 1/\sigma$ share of the sum of all firms' revenues. Therefore, we obtain one equation about the relationship linking φ_d and φ_x, given by

$$\begin{aligned} &G(\varphi_d) - [1-G(\varphi_d)]f_e - [1-G(\varphi_x)]f_x \\ &= (\sigma-1)\left\{[1-G(\varphi_d)](1+f_e)\left(\frac{\widetilde{\varphi_d}}{\varphi_d}\right)^{\sigma-1} + [1-G(\varphi_x)]f_x\left(\frac{\widetilde{\varphi_x}}{\varphi_x}\right)^{\sigma-1}\right\}. \end{aligned} \tag{A7}$$

Combining equation (A7) and $\varphi_x = \tau[f_x/(1-f_e)]^{1/(\sigma-1)}\varphi_d$, which is derived from the zero-cutoff-profit conditions (A5), gives the open-economy equilibrium cutoffs as follows:

$$\varphi_d = \left[1+\tau^{-\kappa}\left(\frac{f_x}{1+f_e}\right)^{\frac{-\kappa+\sigma-1}{\sigma-1}}\right]^{\frac{1}{\kappa}}\varphi_A, \tag{A8}$$

$$\varphi_x = \left[\left(\frac{f_x}{1+f_e}\right)\left(1+\tau^{\kappa}\left(\frac{f_x}{1+f_e}\right)^{\frac{\kappa-\sigma+1}{\sigma-1}}\right)\right]^{\frac{1}{\kappa}}\varphi_A. \tag{A9}$$

We see f_e affects not only the closed-economy equilibrium cutoff φ_A but also the open-economy equilibrium cutoffs φ_d and φ_x according to (A2), (A8), and (A9).

However, after taking these equilibrium cutoffs (A2), (A8), and (A9) into the aggregate income (A6), we find that f_e has been cancelled out again and that the aggregate income here is identical to that derived in the case of $f_e = 0$:

$$Y = Lw\frac{\sigma\kappa}{\sigma(\kappa-1)+1}.$$

Thus, the following Proposition A1 concludes the effect of f_e on the aggregate income.

Proposition A1 The aggregate income is independent of the value of f_e.

Then, by using the equilibrium cutoffs, we obtain the CES price index, given by

$$P = L^{\frac{1}{1-\sigma}}w\frac{\sigma}{\sigma-1}\left(\frac{\kappa}{\kappa-\sigma+1}\right)^{\frac{1}{1-\sigma}}\left[\frac{\sigma(\kappa-1)+1}{\kappa-\sigma+1}\right]^{\frac{\kappa-\sigma+1}{\kappa(\sigma-1)}}(1+f_e)^{\frac{\kappa-\sigma+1}{\kappa(\sigma-1)}}$$
$$\times\left[1+\tau^{-\kappa}\left(\frac{f_x}{1+f_e}\right)^{\frac{-\kappa+\sigma-1}{\sigma-1}}\right]^{-\frac{1}{\kappa}}.$$

Subsequently, based on the aggregate income and the price index above, we derive the open-economy aggregate welfare as follows:

$$W = \frac{Y}{P} = L^{\frac{\sigma}{\sigma-1}}(\sigma-1)\kappa^{\frac{\sigma}{\sigma-1}}(\kappa-\sigma+1)^{-\frac{1}{\kappa}}[(\kappa-1)\sigma+1]^{-\frac{(\kappa-1)\sigma+1}{\kappa(\sigma-1)}}(1+f_e)^{\frac{-\kappa+\sigma-1}{\kappa(\sigma-1)}}$$

$$\times \left[1+\tau^{-\kappa}\left(\frac{f_x}{1+f_e}\right)^{\frac{-\kappa+\sigma-1}{\sigma-1}}\right]^{\frac{1}{\kappa}}.$$

Note that in this case the domestic share of expenditure is given by

$$\lambda = \frac{\int_{i\in\Omega_d} p_d(\varphi)q_d(\varphi)di}{Y} = \left[1+\tau^{-\kappa}\left(\frac{f_x}{1+f_e}\right)^{\frac{-\kappa+\sigma-1}{\sigma-1}}\right]^{-1}.$$

Then, consider a lowering of trade costs from τ to τ', by which the aggregate welfare level changes from W to W'. We are able to express the welfare gains in terms of λ as follows:

$$\frac{W'}{W} = \left[\frac{1+(\tau')^{-\kappa}\left(\frac{f_x}{1+f_e}\right)^{\frac{-\kappa+\sigma-1}{\sigma-1}}}{1+\tau^{-\kappa}\left(\frac{f_x}{1+f_e}\right)^{\frac{-\kappa+\sigma-1}{\sigma-1}}}\right]^{\frac{1}{\kappa}} = \left(\frac{\lambda'}{\lambda}\right)^{-\frac{1}{\kappa}},$$

which is also isomorphic to Melitz (2003), as summarized in Proposition A2.

Proposition A2 In a firm heterogeneity model with entrepreneurship where $f_e > 0$, the aggregate welfare gains from trade can be expressed as the ACR formula: $d\ln[W] = -\ln[\lambda]/\kappa$.

Next, by using the equilibrium cutoffs (A2), (A8), and (A9), we calculate the average income of all entrepreneurs as follows:

$$\begin{aligned}\overline{y_e} &= \overline{\pi_d} - wf_e + \frac{1-G(\varphi_x)}{1-G(\varphi_d)}(\overline{\pi_x} - wf_x)\\ &= w\left\{(1+f_e)\left(\frac{\widetilde{\varphi_d}}{\varphi_d}\right)^{\sigma-1} - f_e + \frac{1-G(\varphi_x)}{1-G(\varphi_d)}f_x\left[\left(\frac{\widetilde{\varphi_x}}{\varphi_x}\right)^{\sigma-1} - 1\right]\right\}.\end{aligned}$$

Thus, the average welfare of all entrepreneurs is given by

$$\overline{W_e} = \frac{\overline{y_e}}{P} = L^{\frac{1}{\sigma-1}}\left(\frac{\sigma-1}{\sigma}\right)\left(\frac{\kappa}{\kappa-\sigma+1}\right)^{\frac{\sigma}{\sigma-1}}\left[\frac{\sigma(\kappa-1)+1}{\kappa-\sigma+1}\right]^{\frac{-\kappa+\sigma-1}{\kappa(\sigma-1)}}(1+f_e)^{\frac{\kappa\sigma-2\kappa+\sigma-1}{\kappa(\sigma-1)}}$$

$$\times \left[1+\tau^{-\kappa}\left(\frac{f_x}{1+f_e}\right)^{\frac{-\kappa+\sigma-1}{\sigma-1}}\right]^{\frac{1}{\kappa}}$$

$$\times \left[1+\frac{\sigma-1}{\kappa}\tau^{-\kappa}\left(\frac{f_x}{1+f_e}\right)^{\frac{-\kappa+\sigma-1}{\sigma-1}}-\left(\frac{f_e}{1+f_e}\right)\left(\frac{\kappa-\sigma+1}{\kappa}\right)\right].$$

Accordingly, when trade costs change from τ to τ', the average welfare growth rate of all entrepreneurs can be expressed as follows:

$$\frac{\overline{W_e}'}{\overline{W_e}} = \left[\frac{1+(\tau')^{-\kappa}\left(\frac{f_x}{1+f_e}\right)^{\frac{-\kappa+\sigma-1}{\sigma-1}}}{1+\tau^{-\kappa}\left(\frac{f_x}{1+f_e}\right)^{\frac{-\kappa+\sigma-1}{\sigma-1}}}\right]^{\frac{1}{\kappa}}$$

$$\frac{1+\frac{\sigma-1}{\kappa}(\tau')^{-\kappa}\left(\frac{f_x}{1+f_e}\right)^{\frac{-\kappa+\sigma-1}{\sigma-1}}-\left(\frac{f_e}{1+f_e}\right)\left(\frac{\kappa-\sigma+1}{\kappa}\right)}{1+\frac{\sigma-1}{\kappa}\tau^{-\kappa}\left(\frac{f_x}{1+f_e}\right)^{\frac{-\kappa+\sigma-1}{\sigma-1}}-\left(\frac{f_e}{1+f_e}\right)\left(\frac{\kappa-\sigma+1}{\kappa}\right)}$$

$$= \left(\frac{\lambda'}{\lambda}\right)^{-\frac{1}{\kappa}} \frac{1+\frac{\sigma-1}{\kappa}\left(\frac{1-\lambda'}{\lambda'}\right)-\left(\frac{f_e}{1+f_e}\right)\left(\frac{\kappa-\sigma+1}{\kappa}\right)}{1+\frac{\sigma-1}{\kappa}\left(\frac{1-\lambda}{\lambda}\right)-\left(\frac{f_e}{1+f_e}\right)\left(\frac{\kappa-\sigma+1}{\kappa}\right)},$$

which is different from expression (37), where $f_e = 0$. The larger the value of f_e is, the smaller the value of $\overline{W_e}'/\overline{W_e}$ will be. The entry cost requirement f_e plays a role in restraining entrepreneurs' average welfare growth. Proposition A3 displays the result in ACR's format.

Proposition A3 In a firm heterogeneity model with entrepreneurship where $f_e > 0$, the average change rate of welfare for entrepreneurs is given by:

$$\frac{d\overline{W_e}}{\overline{W_e}} = d\ln[\overline{W_e}] = -\frac{1}{\kappa}d\ln[\lambda] + d\ln\left[1+\left(\frac{\sigma-1}{\kappa}\right)\left(\frac{1-\lambda}{\lambda}\right)-\left(\frac{f_e}{1+f_e}\right)\left(\frac{\kappa-\sigma+1}{\kappa}\right)\right]. \tag{A10}$$

Note that the second term of the RHS in equation (A10) decreases in f_e. Thus, the disparity in welfare gains from trade between workers and entrepreneurs within a country will be moderated by larger entry cost requirements.

APPENDIX 2: THE EFFECT OF f_d

In this Appendix, we examine whether we will obtain qualitatively different results when the assumption $f_d = 1$ is released. Other things remaining unchanged, now we assume that $f_d > 0$ agents (entrepreneurs) of the same type-φ are needed to start up a firm, of which the productivity is given by φ. As the firm's owners (shareholders), these agents evenly share the firm's net profit.

2.1 Closed Economy

Thus, in a closed economy, the mass of firm n_A becomes $L[1 - G(\varphi_A)]/f_d$ and the cutoff for being an entrepreneur is determined by

$$\pi_A(\varphi_A) = \frac{Y_A}{\sigma}\left[\frac{\sigma-1}{\sigma}\frac{P_A\varphi_A}{w}\right]^{\sigma-1} = wf_d,$$

which is exactly identical to Melitz's (2003) zero-cutoff-profit condition.

Summing up all agent's incomes yields the aggregate income in this closed economy as follows:

$$Y_A = LG(\varphi_A)w + L[1 - G(\varphi_A)]\frac{\overline{\pi_A}}{f_d}, \tag{A11}$$

where

$$\overline{\pi_A} \equiv \int_{\varphi_A}^{\infty} \pi_A(\varphi)\frac{dG(\varphi)}{1 - G(\varphi_A)} = wf_d\left(\frac{\widetilde{\varphi_A}}{\varphi_A}\right)^{\sigma-1}.$$

We see f_d has been cancelled out so that expression (A11) is identical to (3).

Last, since the sum of all workers' incomes accounts for a $1 - 1/\sigma$ share of the sum of all firms' revenues, we obtain the same equation as (5) to determine the equilibrium:

$$G(\varphi_A) = (\sigma - 1)[1 - G(\varphi_A)] \left(\frac{\widetilde{\varphi_A}}{\varphi_A}\right)^{\sigma-1}.$$

Consequently, we obtain the closed-economy equilibrium cutoff

$$\varphi_A = \left[\frac{\sigma(\kappa-1)+1}{\kappa-\sigma+1}\right]^{\frac{1}{\kappa}},$$

which is definitely identical to the result derived in the case of $f_d = 1$ (see equation (6)).

Since f_d changes the mass of firms, n_A, which in turn affects the CES price index, the closed-economy aggregate welfare becomes

$$W_A = \frac{Y_A}{P_A} = L^{\frac{\sigma}{\sigma-1}}(\sigma-1)\kappa^{\frac{\sigma}{\sigma-1}}[\sigma(\kappa-1)+1]^{\frac{-\sigma\kappa+\sigma-1}{\kappa(\sigma-1)}}(\kappa-\sigma+1)^{-\frac{1}{\kappa}} f_d^{-\frac{1}{\sigma-1}}.$$

2.2 Open Economy

By the same token, the mass of firms and the mass of exporting firms become $n_d = L[1-G(\varphi_d)]/f_d$ and $n_x = L[1-G(\varphi_x)]/f_d$, respectively. The cutoffs are determined by the zero-cutoff-profit conditions as follows:

$$\begin{aligned} \pi_d(\varphi_d) &= \frac{Y}{\sigma}\left[\frac{\sigma-1}{\sigma}\frac{P\varphi_d}{w}\right]^{\sigma-1} = wf_d, \\ \pi_x(\varphi_x) &= \frac{Y}{\sigma}\left[\frac{\sigma-1}{\sigma}\frac{P\varphi_x}{\tau w}\right]^{\sigma-1} = wf_x, \end{aligned} \tag{A12}$$

where the restriction $\tau(f_x/f_d)^{1/(\sigma-1)} > 1$ is necessary to guarantee firm selection into the export market.

Next, by summing up all agents' incomes, we obtain the aggregate income in the open economy as follows:

$$
\begin{aligned}
Y &= LG(\varphi_d)w + L[1-G(\varphi_d)]\frac{\overline{\pi_d}}{f_d} + L[1-G(\varphi_x)]\frac{(\overline{\pi_x} - wf_x)}{f_d} \\
&= Lw\left\{G(\varphi_d) + [1-G(\varphi_d)]\left(\frac{\widetilde{\varphi_d}}{\varphi_d}\right)^{\sigma-1} + [1-G(\varphi_x)]\frac{f_x}{f_d}\left[\left(\frac{\widetilde{\varphi_x}}{\varphi_x}\right)^{\sigma-1} - 1\right]\right\},
\end{aligned}
\tag{A13}
$$

where

$$
\begin{aligned}
\overline{\pi_d} &\equiv \int_{\varphi_d}^{\infty} \pi_d(\varphi)\frac{dG(\varphi)}{1-G(\varphi_d)} = wf_d\left(\frac{\widetilde{\varphi_d}}{\varphi_d}\right)^{\sigma-1} \quad \text{and} \\
\overline{\pi_x} &\equiv \int_{\varphi_x}^{\infty} \pi_x(\varphi)\frac{dG(\varphi)}{1-G(\varphi_x)} = wf_x\left(\frac{\widetilde{\varphi_x}}{\varphi_x}\right)^{\sigma-1}.
\end{aligned}
$$

As in the closed economy, the sum of all marginal costs accounts for a $1 - 1/\sigma$ share of the sum of all firms' revenues. Therefore, we obtain one equation about the relationship linking φ_d and φ_x, given by

$$
\begin{aligned}
G(\varphi_d) - [1-G(\varphi_x)]\frac{f_x}{f_d} = (\sigma-1)\Bigg\{&[1-G(\varphi_d)]\left(\frac{\widetilde{\varphi_d}}{\varphi_d}\right)^{\sigma-1} \\
&+ [1-G(\varphi_x)]\frac{f_x}{f_d}\left(\frac{\widetilde{\varphi_x}}{\varphi_x}\right)^{\sigma-1}\Bigg\}.
\end{aligned}
\tag{A14}
$$

Combining equation (A14) and $\varphi_x = \tau(f_x/f_d)^{1/(\sigma-1)}\varphi_d$, which is derived from the zero-cutoff-profit conditions (A12), gives the open-economy equilibrium cutoffs as follows:

$$
\begin{aligned}
\varphi_d &= \left[1 + \tau^{-\kappa}\left(\frac{f_x}{f_d}\right)^{\frac{-\kappa+\sigma-1}{\sigma-1}}\right]^{\frac{1}{\kappa}} \varphi_A, \\
\varphi_x &= \left[\left(\frac{f_x}{f_d}\right)\left(1 + \tau^{\kappa}\left(\frac{f_x}{f_d}\right)^{\frac{\kappa-\sigma+1}{\sigma-1}}\right)\right]^{\frac{1}{\kappa}} \varphi_A.
\end{aligned}
\tag{A15}
$$

We see f_d affects the open-economy equilibrium cutoffs φ_d and φ_x according to (A15). It is not surprising at all that the productivity cutoff for a firm to survive must be higher when its profit is going to be divided into more shares (i.e. larger f_d) and each share cannot be less than the local wage rate. However, after taking these equilibrium cutoffs (A15) into the aggregate income (A13), we find that f_d has been cancelled out again and that the aggregate income here is identical to that derived in the case of $f_d = 1$:

$$Y = Lw\frac{\sigma\kappa}{\sigma(\kappa-1)+1}.$$

Thus, the following Proposition A4 concludes the effect of f_d on the aggregate income.

Proposition A4 The aggregate income is independent of the value of f_d.

Subsequently, based on the equilibrium cutoffs and the aggregate income, we derive the open-economy aggregate welfare as follows:

$$W = \frac{Y}{P} = L^{\frac{\sigma}{\sigma-1}}(\sigma-1)\kappa^{\frac{\sigma}{\sigma-1}}(\kappa-\sigma+1)^{-\frac{1}{\kappa}}[(\kappa-1)\sigma+1]^{-\frac{(\kappa-1)\sigma+1}{\kappa(\sigma-1)}} f_d^{-\frac{1}{\sigma-1}} \times \left[1+\tau^{-\kappa}\left(\frac{f_x}{f_d}\right)^{\frac{-\kappa+\sigma-1}{\sigma-1}}\right]^{\frac{1}{\kappa}}.$$

When $f_d > 0$, the domestic share of expenditure is given by

$$\lambda = \frac{\int_{i\in\Omega_d} p_d(\varphi)q_d(\varphi)di}{Y} = \left[1+\tau^{-\kappa}\left(\frac{f_x}{f_d}\right)^{\frac{-\kappa+\sigma-1}{\sigma-1}}\right]^{-1}.$$

Then, consider a lowering of trade costs from τ to τ', by which the aggregate welfare level changes from W to W'. We are able to express the welfare gains in terms of λ as follows:

$$\frac{W'}{W} = \left[\frac{1+(\tau')^{-\kappa}\left(\frac{f_x}{f_d}\right)^{\frac{-\kappa+\sigma-1}{\sigma-1}}}{1+\tau^{-\kappa}\left(\frac{f_x}{f_d}\right)^{\frac{-\kappa+\sigma-1}{\sigma-1}}}\right]^{\frac{1}{\kappa}} = \left(\frac{\lambda'}{\lambda}\right)^{-\frac{1}{\kappa}},$$

which is also isomorphic to Melitz (2003), as summarized in Proposition A5.

Proposition A5 In a firm heterogeneity model with entrepreneurship where $f_d > 0$, the aggregate welfare gains from trade can be expressed as the ACR formula: $d\ln[W] = -\ln[\lambda]/\kappa$.

Next, the sum of all firms' net profits divided by the mass of entrepreneurs gives the average income of all entrepreneurs:

$$\begin{aligned}\overline{y_e} &= \frac{\overline{\pi_d}}{f_d} + \frac{1-G(\varphi_x)}{1-G(\varphi_d)}\left(\frac{\overline{\pi_x} - wf_x}{f_d}\right)\\ &= w\left\{\left(\frac{\widetilde{\varphi_d}}{\varphi_d}\right)^{\sigma-1} + \frac{1-G(\varphi_x)}{1-G(\varphi_d)}\left(\frac{f_x}{f_d}\right)\left[\left(\frac{\widetilde{\varphi_x}}{\varphi_x}\right)^{\sigma-1} - 1\right]\right\}.\end{aligned}$$

Thus, the average welfare of all entrepreneurs is given by

$$\begin{aligned}\overline{W_e} = \frac{\overline{y_e}}{P} &= L^{\frac{1}{\sigma-1}}\left(\frac{\sigma-1}{\sigma}\right)\left(\frac{\kappa}{\kappa-\sigma+1}\right)^{\frac{\sigma}{\sigma-1}}\left[\frac{\sigma(\kappa-1)+1}{\kappa-\sigma+1}\right]^{\frac{-\kappa+\sigma-1}{\kappa(\sigma-1)}} f_d^{-\frac{1}{\sigma-1}}\\ &\times\left[1+\tau^{-\kappa}\left(\frac{f_x}{f_d}\right)^{\frac{-\kappa+\sigma-1}{\sigma-1}}\right]^{\frac{1}{\kappa}}\left[1+\frac{\sigma-1}{\kappa}\tau^{-\kappa}\left(\frac{f_x}{f_d}\right)^{\frac{-\kappa+\sigma-1}{\sigma-1}}\right].\end{aligned}$$

Accordingly, when trade costs change from τ to τ', the average welfare growth rate of all entrepreneurs can be expressed as follows:

$$\begin{aligned}\frac{\overline{W_e}'}{\overline{W_e}} &= \left[\frac{1+(\tau')^{-\kappa}\left(\frac{f_x}{f_d}\right)^{\frac{-\kappa+\sigma-1}{\sigma-1}}}{1+\tau^{-\kappa}\left(\frac{f_x}{f_d}\right)^{\frac{-\kappa+\sigma-1}{\sigma-1}}}\right]^{\frac{1}{\kappa}}\frac{1+\frac{\sigma-1}{\kappa}\left[(\tau')^{-\kappa}\left(\frac{f_x}{f_d}\right)^{\frac{-\kappa+\sigma-1}{\sigma-1}}\right]}{1+\frac{\sigma-1}{\kappa}\left[\tau^{-\kappa}\left(\frac{f_x}{f_d}\right)^{\frac{-\kappa+\sigma-1}{\sigma-1}}\right]}\\ &= \left(\frac{\lambda'}{\lambda}\right)^{-\frac{1}{\kappa}}\frac{1+\frac{\sigma-1}{\kappa}\left(\frac{1-\lambda'}{\lambda'}\right)}{1+\frac{\sigma-1}{\kappa}\left(\frac{1-\lambda}{\lambda}\right)},\end{aligned}$$

which is identical to expression (37), where $f_d = 1$. The value of f_d does not affect our main result. Proposition A6 concludes the isomorphism.

Proposition A6 In a firm heterogeneity model with entrepreneurship where $f_d > 0$, the average change rate of welfare for entrepreneurs is given by:

$$\frac{d\overline{W_e}}{\overline{W_e}} = d\ln[\overline{W_e}] = -\frac{1}{\kappa}d\ln[\lambda] + d\ln\left[1 + \left(\frac{\sigma-1}{\kappa}\right)\left(\frac{1-\lambda}{\lambda}\right)\right].$$

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企業家與貿易福利增益

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摘　要

本文研究異質性企業家在獨占型競爭與固定替代彈性的架構下，對於貿易福利增益的影響與意涵。假設廠商的生產力取決於企業家的企業管理能力，則模型中的行為人便依據自己企業管理能力的高下，來選擇所從事的職業：企業家或工人。研究結果顯示，在總體貿易福利增益幅度上，本模型雖然與 Melitz 的異質性廠商模型得到相同的結果。但因本研究異質性行為人的模型設定，讓我們可以分別檢視異質性行為人間，個別貿易福利增益的不均程度。企業家總是比勞工享受到較高的貿易福利增益幅度。兩者的差我們稱之為企業家在貿易福利增益上的溢價，也作為貿易福利增益在兩種職業之間分配不均的指標。我們也證明了全球化程度越高，以及行為人能力分佈越異質，將使此一貿易福利增幅差異越大。