Estimating Disparity in Welfare Gains from Trade between Firm Owners and Workers

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Abstract

This study quantifies the uneven welfare gains from trade between firm owners and workers in a multi-country model of monopolistic competition under a demand system of constant elasticity of substitution (CES). An agent decides to start up her own firm or to be employed as a worker according to her level of innate capability, which determines the productivity of her potential launched firm. Although keeping this model isomorphic to Melitz's (2003) heterogeneous firm model in terms of the aggregate welfare gains from trade, we are able to to examine the welfare gains for firm owners and workers, respectively. Theoretically, we find that countries with lower domestic expenditure shares display higher disparities in welfare gains from trade between firm owners and workers. Taking the model to data, we illustrate the application of the methodology by calculating the respective average welfare gains (compared to autarky) of firm owners and of workers for 14 countries, including G7, BRIC, Korea, Singapore, and Taiwan. Among them, Singapore has relatively lower domestic expenditure shares and shows dramatically large disparity in welfare gains between these two occupations. Taking the year of 2006 as an example, the gap in welfare gains in Singapore reaches to 445.03%, while the same measure in the United States is only 9.95%.

Keywords: heterogeneous agents, disparity, welfare gains from trade, trade integration, globalization

JEL classifications D43, F12, F15, F21, R12

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1 Introduction

Although the economic proposition that countries benefit from international trade in their aggregate welfare have been one of the most fundamental results in international economics (see Samuelson, 1939; Helpman and Krugman, 1985, Chapter 9), it is hard to claim that trade brings equal welfare gains across heterogeneous individuals. Some may benefit more while the other benefit less since trade changes the distribution of income across some classes or groups, such as workers and firm owners. Uneven welfare gains from trade has also been recognized as an important driver to cause inequality.[1]

How large are the welfare gains from trade? Recent quantitative trade models based on the gravity equation are developed to measure the aggregate welfare gains from trade.[2] In the influential paper of Arkolakis, Costinot, and Rodríguez-Clare (2012), henceforth ACR, it is proved that in a large class of trade models, the welfare gains from trade at the national aggregate level 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.[3] By using these two variables, the aggregate welfare gains from trade can be easily inferred. However, how welfare gains from trade are distributed across heterogeneous agents can not be examined by these quantitative trade models since agents are always assumed homogeneous.

To see the uneven consequence in welfare gains, under a demand system of constant elasticity of substitution (CES), we develop a methodology to measure the unequal welfare gains from trade between firm owners and workers within countries. To the best of our knowledge, this study is the first attempt to quantify welfare gains from trade for firm owners and workers, respectively. Based on a multi-country monopolistic competition trade model rather than a simple two-country version, it can therefore be implemented across many countries.

In the theoretical part, we modify the original Melitz (2003) model and follow ACR's (2012) approach, which allows us to predict the impact of a foreign shock by employing

[1]There is a vast literature on the relationship between trade and inequality. Goldberg and Pavcnik (2007) survey recent empirical researches 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.

[2]Welfare gains from international trade are defined as the percentage change in real income that would be associated with moving one country from the current observed trade equilibrium to a counterfactual equilibrium with no trade. See Costinot and Rodríguez-Clare (2014) for a detailed review.

[3]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.

only few sufficient statistics. By doing so, we keep our model isomorphic to Melitz's (2003) on the aggregate welfare gains from trade but we are able to examine the gap in welfare gains between agents at different occupations. Using Lucas's (1978) specification, we assume that each agent is endowed with two types of capabilities: a "homogeneous workforce" and a "heterogeneous talent for managing." The latter was determined by luck when the agent was born. Subsequently, each agent selects her career from either starting her own firm or being hired as a worker. If the agent chooses to be a firm owner, she takes all the net profits of her firms. Otherwise, if she decides to be a worker, she receives a local wage rate paid by her firm owner. Then, the decision 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. We derive the formulas to calculate welfare gains for firm owners and workers, which only need three sufficient statistics: the trade elasticity, the elasticity of substitution, and the domestic expenditure share.

To take the model to data, we use data (in the period from 1997 to 2006) on bilateral trade flows for 185 countries and a set of proxies for bilateral trade costs to estimate the trade elasticity. For the issue of the presence of zero trade data, we employ the Poisson pseudo-maximum likelihood estimation (P-PMLE), which is suggested by Santos Silva and Tenreyro (2006). Subsequently, based on the assumption that the productivity distributions of firms are identical across countries, we run a rank-size OLS regression on Taiwan's manufacturing firm-level data to derive the tail index of its firm-size distribution, which also gives the relationship linking the trade elasticity and the elasticity of substitution.[4] After constructing the gross expenditure data, we calculate the share of domestic expenditure for 14 countries, including G7, BRIC, Korea, Singapore, and Taiwan. Last, setting the counterfactual case under autarky ($\lambda = 100\%$) as the benchmark, we present the time series of λ and the derived welfare gains from trade for workers and for firm owners in each country. We find that countries associated with lower domestic expenditure shares feature higher disparities in welfare gains from trade between firm owners and workers.

This paper follows a recent literature in international trade, including ACR (2012), Melitz and Redding (2014), and Feenstra and Weinstein (2010), measuring welfare gains from trade by first estimating model parameters from a gravity equation and then combining these parameters with aggregate statistics to calculate the impact of trade on aggregate real income. Our novelty lies in linking firm heterogeneity to agent heterogeneity in terms of capability of managing and quantifying the uneven welfare gains for

[4]The assumption about identical firm productivity distribution across countries is borrowed from Melitz (2003).

firm owners and workers, respectively, under the same structure and magnitude of the aggregate welfare gains proposed by the standard ACR formula. By doing so, we provide a measure to estimate the disparity in welfare gains from trade between firm owners and workers within a country.

Regarding measuring uneven welfare gains, this paper share a similar motivation to Behrens and Murata's (2012) and Fajgelbaum and Khandelwal's (2016). Behrens and Murata (2012) explore the impact of globalization on individual gains from trade by assuming workers are heterogeneous in terms of their labor efficiency in a variable-elasticity-of-substitution (VES) model, featuring agents' income heterogeneity. Based on the Almost-Ideal Demand System, Fajgelbaum and Khandelwal (2016) estimate model parameters from a non-homothetic gravity equation (the elasticity of imports with respect to both trade costs and income) to calculate the impact of trade on the real income of consumers with different expenditures within the economy. Deviating from their income heterogeneity among workers, we emphasize the income distribution resulted from agents' occupational selections in a framework of Lucas (1978).

In addition, we are not the first to employ Lucas's (1978) setup of entrepreneurship in a heterogeneous firm model, either. 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 by 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. By using the same setup that allowing heterogeneous individuals to choose between different occupations: workers and executives, Ma (2015) shows that access to the global market is associated with a higher manager-to-worker pay ratio within the firm. By calibrating his parameters instead of empirically estimate them, his counterfactural exercises based on a two-country framework are used to explain the observed surge in top income shares in the United States between 1988 and 2008. In contrast, we not only develop a multi-country methodology in the ACR format to quantify the uneven welfare gains from trade between firm owners and workers within a country, but also estimate our parameters from a gravity equation and readily available bilateral trade data.

The remainder of this paper is organized as follows. We introduce the theoretical model in Section 2. Then, Section 3 focuses on estimation. Finally, Section 4 concludes the paper.

2 Model

2.1 Preferences and productions

Consider a world with J countries, indexed by $j = 1, 2, ..., J$. In a specific country j, there are L_j immobile consumers. Therefore, $L \equiv \sum_{j=1}^{J} L_j$ denotes the population of the whole world. With identical preferences, each country consumes and produces a continuum of horizontally differentiated varieties. Let $p_{ij}(\zeta)$ and $q_{ij}(\zeta)$ denote the price and the aggregate consumption of variety ζ when it is produced in country i and consumed in country j. Then, the utility maximization problem of country j is given by

$$\max_{q_{ij}(\zeta)\geq 0} U_j \equiv \left[\sum_{i=1}^{J} \int_{\zeta\in\Omega_{ij}} [q_{ij}(\zeta)]^{\frac{\sigma-1}{\sigma}} \mathrm{d}\zeta\right]^{\frac{\sigma}{\sigma-1}}, \quad \text{s.t.} \quad Y_j = \sum_{i=1}^{J} \int_{\zeta\in\Omega_{ij}} p_{ij}(\zeta) q_{ij}(\zeta) \mathrm{d}\zeta. \tag{1}$$

where Ω_{ij} means the endogenously determined set of varieties produced in country i and consumed in country j; Y_j represents country j's aggregate income, which is equal to its total expenditure; and $\sigma > 1$ denotes the elasticity of substitution, which is identical across countries. Optimizing the problem (1) yields the following demand functions:

$$q_{ij}(\zeta) = \frac{Y_j}{P_j} \left[\frac{P_j}{p_{ij}(\zeta)}\right]^{\sigma}, \quad \forall \zeta \in \Omega_{ij}.$$

where

$$P_j = \left[\sum_{i=1}^{J} \int_{\zeta\in\Omega_{ij}} [p_{ij}(\zeta)]^{1-\sigma} \mathrm{d}\zeta\right]^{\frac{1}{1-\sigma}}$$

is the price index in country j.

Although individuals are identical and each of them is endowed with one efficiency unit of labor, they differ in their innate capability level, denoted by φ, which was determined by luck when they were born. An individual with a higher φ can organize a more efficient firm that requires lower marginal costs per output. They are aware of their capability when they decide whether to operate a firm as a firm owner or to just be employed by a firm as a worker. Being a worker, the individual earns the local wage rate, w_j, by inelastically supplying her labor efficiency. As a firm owner, the individual collects all the net profits of her firm. If her capability is high enough to set up a firm that earns her returns more than the local wages, the individual will choose to launch her own firm, which employs $1/\varphi$ efficiency units of labor to produce one unit of a variety of differentiated goods.

Thus, in each country, a continuum of potential firm owners are heterogeneous in terms of their 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 $\kappa \to \infty$. We assume this distribution function is the same in all countries.[5] As a result, in each country there is a continuum of firms that are heterogeneous in their productivity $\varphi \in [\hat{\varphi}_j, \infty)$ in the untruncated Pareto distribution. Here, $\hat{\varphi}_j$ stands for not only a cutoff for occupational selection of individuals but also a cutoff for entry of firms in country j.

Consider a symmetric equilibrium where all firms of type-φ apply identical optimal pricing rules, we can index each variety by the productivity and its origin. This allows us to express the aggregate consumer demands of varieties produced in country i and consumed in country j as follows:

$$q_{ij}(\varphi) = \frac{Y_j}{P_j}\left[\frac{P_j}{p_{ij}(\varphi)}\right]^{\sigma}, \quad \forall \varphi \in [\hat{\varphi}_i, \infty).$$

If a producer in country i seeks to sell its product in country j, it has to bear a fixed trade cost of serving country j, which equals $w_i f_{ij}$, and an iceberg-form variable trade cost τ_{ij} to deliver the goods. It means that τ_{ij} units of a product have to be shipped from country i to j for one unit to arrive. We assume that $f_{jj} = 0$ and $\tau_{jj} = 1$ for every j, and $f_{ij} > 0$ and $\tau_{ij} > 1$ for $i \neq j$.

Then, by maximizing the profits, firms of type-φ in country i find their optimal prices, revenues, and operating profits in market j as follows:

$$\begin{aligned} p_{ij}(\varphi) &= \frac{\sigma}{\sigma-1}\frac{\tau_{ij} w_i}{\varphi}, \quad R_{ij}(\varphi) = p_{ij}(\varphi) q_{ij}(\varphi) = Y_j \left[\frac{\sigma-1}{\sigma}\frac{P_j \varphi}{\tau_{ij} w_i}\right]^{\sigma-1}, \\ \pi_{ij}(\varphi) &= \frac{Y_j}{\sigma}\left[\frac{\sigma-1}{\sigma}\frac{P_j\varphi}{\tau_{ij} w_i}\right]^{\sigma-1}, \quad \forall \varphi \in [\hat{\varphi}_i, \infty). \end{aligned} \tag{2}$$

2.2 Equilibrium

An individual selects to start up a firm when operating a firm is more profitable than being a worker. After the firm is established, it will export only if it is productive enough.

[5] We do not relate the heterogeneity in agent's capability to the acquired human capital (e.g., learning and education) in each country. Instead, we assume that the distribution of φ is determined by a random process, which is identical across countries. Thus, the dispersion of agent's capability (the value of κ) is not a country-specific parameter.

Both decisions depend on the firm owner's capability level φ. Thus, the equilibrium in country i is characterised by agents' capability cutoffs for entering the domestic market φ_{ii} and export market φ_{ij} for $i \neq j$. While the former is given by equating the operating profits in the domestic market to the local wage rate, the latter is determined by equating the operating profits in the export market to the required fixed costs, shown as follows:

$$\pi_{ii}(\varphi_{ii}) = \frac{Y_i}{\sigma}\left[\frac{\sigma-1}{\sigma}\frac{P_i\varphi_{ii}}{w_i}\right]^{\sigma-1} = w_i, \quad \pi_{ij}(\varphi_{ij}) = \frac{Y_j}{\sigma}\left[\frac{\sigma-1}{\sigma}\frac{P_j\varphi_{ij}}{\tau_{ij}w_i}\right]^{\sigma-1} = w_i f_{ij}, \quad (3)$$

where φ_{ii} also represents individuals' capability cutoff $\hat{\varphi}_i$ for occupational selection; φ_{ij} means firms' productivity cutoff for exporting.

Combining the above two 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, the ratio of total expenditures in domestic and foreign markets, and the ratio of price indexes in domestic and foreign markets:

$$\varphi_{ij} = \tau_{ij}\left(f_{ij}\right)^{\frac{1}{\sigma-1}}\left(\frac{Y_i}{Y_j}\right)^{\frac{1}{\sigma-1}}\left(\frac{P_i}{P_j}\right)\varphi_{ii}.$$

For a firm, it is impossible to export before the firm is launched by an agent. Thus, we assume that $\varphi_{ij} > \varphi_{ii}$ always holds, which naturally ensures the selection of firms into the export market. This restriction is justified by that the fixed trade cost f_{ij} is relatively larger for entering markets with high total income and high price indexes. As a result, the following condition about this multiple always holds:

$$\tau_{ij}\left(f_{ij}\right)^{\frac{1}{\sigma-1}}\left(\frac{Y_i}{Y_j}\right)^{\frac{1}{\sigma-1}}\left(\frac{P_i}{P_j}\right) > 1.$$

Given those cutoffs and the population L_i in country i, only some individuals choose to be firm owners and establish their own firms, which are productive enough to sell at least in their domestic market. The mass of firms (firm owners) is given by $n_{ii} = L_i[1 - G(\varphi_{ii})]$, while the mass of exporting firms (firm owners) is $n_{ij} = L_i[1 - G(\varphi_{ij})]$. Mirror expressions hold for country j. Therefore, the total incomes of all workers in country j are $L_j G(\varphi_{jj}) w_j$. For all firm owners in country j, they receive the total operating profits in the domestic market, given by $L_j[1 - G(\varphi_{jj})]\overline{\pi_{jj}}$, where $\overline{\pi_{jj}}$ denotes the average of the total operating profits in the domestic market. Furthermore, regarding firms in country j which are productive enough to export, their firm owners can also collect profits in all export markets, given by $\sum_{i\neq j}^{J} L_j[1 - G(\varphi_{ji})](\overline{\pi_{ji}} - w_j f_{ji})$, where $\overline{\pi_{ji}}$ denotes the average of the total operating profits in the export market i for $i \neq j$.

Then, summing up the incomes of all individuals in country j gives the aggregate income Y_j. Using the expressions of firms' operating profits (2) and zero-profit conditions

(3) yields

$$
\begin{aligned}
Y_j =& L_j G(\varphi_{jj}) w_j + L_j[1-G(\varphi_{jj})]\overline{\pi_{jj}} + \sum_{i\neq j}^{J} L_j[1-G(\varphi_{ji})](\overline{\pi_{ji}} - w_j f_{ji}) \\
=& L_j\Bigg\{ G(\varphi_{jj}) w_j + [1-G(\varphi_{jj})] \int_{\varphi_{jj}}^{\infty} \pi_{jj}(\varphi) \frac{\mathrm{d}G(\varphi)}{1-G(\varphi_{jj})} \\
&+ \sum_{i\neq j}^{J} [1-G(\varphi_{ji})] \left[\int_{\varphi_{ji}}^{\infty} \pi_{ji}(\varphi) \frac{\mathrm{d}G(\varphi)}{1-G(\varphi_{ji})} - w_j f_{ji} \right] \Bigg\} \\
=& L_j w_j \Bigg\{ G(\varphi_{jj}) + [1-G(\varphi_{jj})] \left(\frac{\tilde{\varphi_{jj}}}{\varphi_{jj}} \right)^{\sigma-1} + \sum_{i\neq j}^{J} [1-G(\varphi_{ji})] f_{ji} \left[\left(\frac{\tilde{\varphi_{ji}}}{\varphi_{ji}} \right)^{\sigma-1} - 1 \right] \Bigg\},
\end{aligned}
\tag{4}
$$

where

$$
\tilde{\varphi_{jj}} \equiv \left[\int_{\varphi_{jj}}^{\infty} \varphi^{\sigma-1} \frac{\mathrm{d}G(\varphi)}{1-G(\varphi_{jj})} \right]^{\frac{1}{\sigma-1}} = \left(\frac{\kappa}{\kappa-\sigma+1} \right)^{\frac{1}{\sigma-1}} \varphi_{jj}, \tag{5}
$$

$$
\tilde{\varphi_{ji}} \equiv \left[\int_{\varphi_{ji}}^{\infty} \varphi^{\sigma-1} \frac{\mathrm{d}G(\varphi)}{1-G(\varphi_{ji})} \right]^{\frac{1}{\sigma-1}} = \left(\frac{\kappa}{\kappa-\sigma+1} \right)^{\frac{1}{\sigma-1}} \varphi_{ji}. \tag{6}
$$

are the weighted averages of firm productivity among all firms in country j and all exporting firms from j to i, respectively.

Meanwhile, in aggregate, the sum of all marginal inputs accounts for a $(1-1/\sigma)$ share of the sum of all firms' revenues in each country. Since the sum of all firms' revenue equals to the aggregate income, we have another expression about the aggregate income:

$$
L_j w_j \left\{ G(\varphi_{jj}) - \sum_{i\neq j}^{J} [1-G(\varphi_{ji})] f_{ji} \right\} = \frac{\sigma-1}{\sigma} Y_j. \tag{7}
$$

By combining these two expressions about the aggregate income, (4) and (7), and using the function $G(\varphi)$ and the expressions of average productivity, (5) and (6), we have the relationship linking φ_{jj} and φ_{ji} as follows:

$$
\varphi_{jj}^{-\kappa} + \sum_{i\neq j}^{J} \varphi_{ji}^{-\kappa} f_{ji} = \frac{\kappa-\sigma+1}{\kappa\sigma-\sigma+1}. \tag{8}
$$

Then, taking this expression (8) back to the aggregate income (7), we obtain the aggregate income in country j as follows:

$$
Y_j = L_j w_j \left(\frac{\kappa\sigma}{\kappa\sigma-\sigma+1} \right), \tag{9}
$$

which is independent of trade costs and always larger than the aggregate income $L_j w_j$ derived in Melitz's (2003) model.

2.3 Welfare gains from trade at an aggregate level

In this subsection, we prove that this model is isomorphic to Melitz (2003) on welfare gains from trade at an aggregate level.[6] In other words, the aggregate welfare gains from trade can be expressed by the ACR formula.

Following ACR (2012), we consider a foreign shock in country j that affects populations $\boldsymbol{L} \equiv \{L_i\}$ and trade costs $\boldsymbol{\tau} \equiv \{\tau_{ij}\}$ around the world, but leaves unchanged country j's population L_j as well as its ability to serve its own domestic market τ_{jj}. Let a worker in country j as the numéraire and note that $\mathrm{dln}[Y_j] = \mathrm{dln}[w_j] = 0$ as a result of equation (9). Then, the change in real income, $W_j \equiv Y_j/P_j$, is given by

$$\mathrm{dln}[W_j] = \mathrm{dln}[Y_j] - \mathrm{dln}[P_j] = -\mathrm{dln}[P_j] = -\frac{1}{P_j}\mathrm{d}P_j.$$

By using optimal prices p_{ij} in (2), the expressions of n_{ij}, zero-profit conditions (3), averages of firm productivities (5) and (6), the aggregate income (9), and the function of $G(\varphi)$, the price index in country j becomes

$$\begin{aligned} P_j = &\left(\frac{\sigma}{\sigma-1}\right)\left(\frac{\kappa}{\kappa-\sigma+1}\right)^{-\frac{1}{\kappa}}\left(\frac{\kappa}{\kappa\sigma-\sigma+1}\right)^{\frac{-\kappa+\sigma-1}{\kappa(\sigma-1)}}(L_j w_j)^{\frac{-\kappa+\sigma-1}{\kappa(\sigma-1)}} && (10)\\ &\times\left(\sum_{i=1}^{J} L_i w_i^{\frac{-\kappa\sigma+\sigma-1}{\sigma-1}}\tau_{ij}^{-\kappa} f_{ij}^{\frac{-\kappa+\sigma-1}{\sigma-1}}\right)^{-\frac{1}{\kappa}} \\ = &\left(\frac{\sigma}{\sigma-1}\right)\left(\frac{\kappa}{\kappa-\sigma+1}\right)^{-\frac{1}{\kappa}}\left(\frac{\kappa}{\kappa\sigma-\sigma+1}\right)^{\frac{-\kappa+\sigma-1}{\kappa(\sigma-1)}}(L_j w_j)^{\frac{-\kappa+\sigma-1}{\kappa(\sigma-1)}} L^{-\frac{1}{\kappa}}\theta_j, && (11)\end{aligned}$$

where

$$\theta_j \equiv \left(\sum_{i=1}^{J} s_i w_i^{\frac{-\kappa\sigma+\sigma-1}{\sigma-1}}\tau_{ij}^{-\kappa} f_{ij}^{\frac{-\kappa+\sigma-1}{\sigma-1}}\right)^{-\frac{1}{\kappa}}$$

is an aggregate index of country j's remoteness from the rest of the world, which takes into account both the impacts of variable and of fixed trade costs; and $s_i \equiv L_i/L$ is country i's population share in the world (Chaney, 2008).

Let $\overline{R_{ij}}$ denote the average revenues of all exporting firms from country i to country j. The bilateral trade flow from country i to country j is equal to

$$\begin{aligned} X_{ij} = &n_{ij}\overline{R_{ij}} = L_i[1-G(\varphi_{ij})]\int_{\varphi_{ij}}^{\infty} R_{ij}(\varphi)\frac{\mathrm{d}G(\varphi)}{1-G(\varphi_{ij})} \\ = &\left(\frac{\kappa}{\kappa-\sigma+1}\right)\left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma} Y_j P_j^{\sigma-1} L_i(\tau_{ij}w_i)^{1-\sigma}\varphi_{ij}^{-\kappa+\sigma-1}. && (12)\end{aligned}$$

[6] This result is not surprising since this model still satisfies ACR's (2012) three macro-level restrictions.

Putting the expression of φ_{ij} in (3) into the above equation (12), we are able to derive the share of country j's total expenditure that is devoted to goods from country i as follows:

$$\lambda_{ij} = \frac{X_{ij}}{Y_j} = \left(\frac{\kappa}{\kappa-\sigma+1}\right)\left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma} P_j^{\sigma-1} L_i (\tau_{ij} w_i)^{1-\sigma} \varphi_{ij}^{-\kappa+\sigma-1} \tag{13}$$

$$= \left(\frac{\kappa}{\kappa-\sigma+1}\right)\left(\frac{\sigma}{\sigma-1}\right)^{-\kappa} P_j^{\kappa} L_i \tau_{ij}^{-\kappa} (w_i)^{\frac{-\kappa\sigma+\sigma-1}{\sigma-1}} \left(\frac{\sigma f_{ij}}{Y_j}\right)^{\frac{-\kappa+\sigma-1}{\sigma-1}}. \tag{14}$$

Subsequently, due to

$$\frac{\lambda_{ij}}{\lambda_{jj}} = \frac{L_i}{L_j}\left(\frac{w_i}{w_j}\right)^{\frac{-\kappa\sigma+\sigma-1}{\sigma-1}} \tau_{ij}^{-\kappa} f_{ij}^{\frac{-\kappa+\sigma-1}{\sigma-1}},$$

changes in relative imports are such that

$$\begin{aligned}
&\mathrm{dln}[\lambda_{ij}] - \mathrm{dln}[\lambda_{jj}] \\
&= \mathrm{dln}[L_i] - \kappa \mathrm{dln}[\tau_{ij}] + \left(\frac{-\kappa\sigma+\sigma-1}{\sigma-1}\right)\mathrm{dln}[w_i] + \left(\frac{-\kappa+\sigma-1}{\sigma-1}\right)\mathrm{dln}[f_{ij}].
\end{aligned} \tag{15}$$

Differentiating the aggregate price index (10) gives

$$\begin{aligned}
\mathrm{d}P_j =& \frac{-1}{\kappa}\left(\frac{\kappa}{\kappa-\sigma+1}\right)\left(\frac{\sigma}{\sigma-1}\right)^{-\kappa}\left(\frac{\kappa\sigma-\sigma+1}{\kappa}\right)^{\frac{-\kappa+\sigma-1}{\sigma-1}} L_j^{\frac{\kappa-\sigma+1}{\sigma-1}} P_j^{1+\kappa} \\
&\times \sum_{i=1}^{J}\Bigg\{ L_i f_{ij}^{\frac{-\kappa+\sigma-1}{\sigma-1}} \tau_{ij}^{-\kappa} w_i^{\frac{-\kappa\sigma+\sigma-1}{\sigma-1}} \\
&\quad \times \left[\frac{\mathrm{d}L_i}{L_i} - \kappa\frac{\mathrm{d}\tau_{ij}}{\tau_{ij}} + \left(\frac{-\kappa\sigma+\sigma-1}{\sigma-1}\right)\frac{\mathrm{d}w_i}{w_i} + \left(\frac{-\kappa+\sigma-1}{\sigma-1}\right)\frac{\mathrm{d}f_{ij}}{f_{ij}}\right]\Bigg\}.
\end{aligned}$$

Therefore, using the aggregate income (9), the expenditure share λ_{ij} in (14), the expression of (15), and the expression of $\mathrm{d}p_j$ above yields

$$\begin{aligned}
\mathrm{dln}[W_j] =& -\frac{1}{P_j}\mathrm{d}P_j \\
=& \left(\frac{1}{\kappa}\right)\sum_{i=1}^{J}\lambda_{ij}\left\{\mathrm{dln}[\lambda_{ij}] - \mathrm{dln}[\lambda_{jj}]\right\} = \left(\frac{1}{\kappa}\right)\left[\sum_{i=1}^{J}\lambda_{ij}\frac{\mathrm{d}\lambda_{ij}}{\lambda_{ij}} - \mathrm{dln}[\lambda_{jj}]\sum_{i=1}^{J}\lambda_{ij}\right] \\
=& -\frac{\mathrm{dln}[\lambda_{jj}]}{\kappa},
\end{aligned}$$

where the last equality holds because $\sum_{i=1}^{J}\lambda_{ij} = 1$ and $\sum_{i=1}^{J}\mathrm{d}\lambda_{ij} = 0$.

2.4 Welfare gains by occupation

Now, we are ready to calculate the welfare gains from trade for agents by different occupations. Let $\overline{W_{wj}} \equiv w_j/P_j$ and $\overline{W_{ej}} \equiv \overline{y_{ej}}/P_j$ denote the average welfare gains of workers and of firm owners, respectively, where $\overline{y_{ej}}$ denotes the average nominal income of all firm owners. Thus, their corresponding percentage changes in real income are, respectively, given by

$$\text{dln}[\overline{W_{wj}}] = -\text{dln}[P_j] \quad \text{and} \quad \text{dln}[\overline{W_{ej}}] = \text{dln}[\overline{y_{ej}}] - \text{dln}[P_j].$$

From the previous subsection, we obtain $\text{dln}[\overline{W_{wj}}] = -\text{dln}[\lambda_{jj}]/\kappa$, which is equal to the percentage change in the country's aggregate welfare. Regarding $\text{dln}[\overline{W_{ej}}]$, we need to derive $\overline{y_{ej}}$ first.

Taking the aggregate income (9) and the second expression of the price index (11) back to the occupation-selection condition in (3) gives

$$s_j^{\frac{1}{\kappa}}\theta_j = \left(\frac{\kappa\sigma - \sigma + 1}{\kappa - \sigma + 1}\right)^{\frac{1}{\kappa}} w_j^{\frac{\kappa\sigma-\sigma+1}{\kappa(\sigma-1)}} \varphi_{jj}^{-1}. \tag{16}$$

Then, by putting (16) and the second expression of the price index (11) into the expression of λ_{jj} in (13), we obtain the relationship linking φ_{jj} and λ_{jj} as follows:

$$\varphi_{jj} = \left(\frac{\kappa\sigma - \sigma + 1}{\kappa - \sigma + 1}\right)^{\frac{1}{\kappa}} \lambda_{jj}^{\frac{-1}{\kappa}}. \tag{17}$$

We break down the aggregate income into the total incomes of all workers and the total incomes of all firm owners as follows:

$$Y_j = L_j G(\varphi_{jj}) w_j + L_j[1 - G(\varphi_{jj})]\overline{y_{ej}}. \tag{18}$$

As a result, substituting the function of $G(\varphi)$, the aggregate income (9), and the expression (17) into the above equation (18) immediately gives

$$\overline{y_{ej}} = w_j \left(1 + \frac{\sigma - 1}{\kappa\sigma - \sigma + 1}\varphi_{jj}^{\kappa}\right) = w_j \left[1 + \left(\frac{\sigma - 1}{\kappa - \sigma + 1}\right)\frac{1}{\lambda_{jj}}\right].$$

Thus, the average welfare gains from trade of firm owners in country j is given by

$$\text{dln}[\overline{W_{ej}}] = -\text{dln}[P_j] + \text{dln}[\overline{y_{ej}}] = -\frac{\text{dln}[\lambda_{jj}]}{\kappa} + \text{dln}\left[1 + \left(\frac{\sigma - 1}{\kappa - \sigma + 1}\right)\frac{1}{\lambda_{jj}}\right].$$

Accordingly, on average, the gap in welfare gains between firm owners and workers is

$$\Delta_j \equiv \text{dln}[\overline{W_{ej}}] - \text{dln}[\overline{W_{wj}}] = \text{dln}[\overline{y_{ej}}] = \text{dln}\left[1 + \left(\frac{\sigma - 1}{\kappa - \sigma + 1}\right)\frac{1}{\lambda_{jj}}\right],$$

which is addressed in Proposition 1. This gap Δ_j also measures the rate of change in income inequality within country j (i.e., $\overline{y_{ej}}/w_j$) because

$$\mathrm{dln}\left[\frac{\overline{y_{ej}}}{w_j}\right] = \mathrm{dln}[\overline{y_{ej}}] = \mathrm{dln}\left[1 + \left(\frac{\sigma-1}{\kappa-\sigma+1}\right)\frac{1}{\lambda_{jj}}\right].$$

Proposition 1 *In country j, the disparity in welfare gains from trade between firm owners and workers is given by*

$$\Delta_j \equiv dln[\overline{W_{ej}}] - dln[\overline{W_{wj}}] = dln\left[1 + \left(\frac{\sigma-1}{\kappa-\sigma+1}\right)\frac{1}{\lambda_{jj}}\right].$$

□

Note that Δ_j depends on one aggregate statistic λ_{jj} and two parameters σ and κ. Once parameters σ and κ are given, Δ_j is a strictly decreasing function of λ_{jj}. In other words, a country with lower λ_{jj} shows higher value of Δ_j. Proposition 2 documents this peoperty.

Proposition 2 *Given parameters σ and κ, countries associated with lower domestic expenditure share feature higher disparity in welfare gains from trade between firm owners and workers.* □

3 Estimation

According to the analysis in the previous section, we prove that the disparity in welfare gains between firm owners and workers in a specific country j depends on only three sufficient statistics: (i) the trade elasticity, $\epsilon = -\kappa$; (ii) the elasticity of substitution, σ; and (iii) the share of expenditure on domestic goods, λ_{jj}. We first articulate our strategy for estimating these parameters. Subsequently, a description of data and the results are presented.

3.1 Empirical strategy

3.1.1 Estimating the trade elasticity

To estimate the trade elasticity, we use a gravity equation to describe the relationship between bilateral trade flows and trade costs. By using the aggregate income (9), the price index (11), and the zero-profit condition to determine φ_{ij} in (3), we can re-write the bilateral trade flow (19) as follows:

$$X_{ij} = \frac{\kappa\sigma}{\kappa\sigma-\sigma+1}\frac{(L_i w_i)(L_j w_j)}{L} w_i^{\frac{-\kappa\sigma}{\sigma-1}} \left(\frac{\tau_{ij} f_{ij}^{\frac{\kappa-\sigma+1}{\kappa(\sigma-1)}}}{\theta_j}\right)^{-\kappa}, \tag{19}$$

which is a gravity equation in the form as follows:

$$X_{ij} = \Theta A_i B_j T_{ij}^{-\kappa} \tag{20}$$

where Θ denotes a common factor determining trade; A_i represents the index of exporter i's attributes; B_j means the index of importer j's attributes; and $T_{ij} \equiv \tau_{ij} f_{ij}^{\frac{\kappa-\sigma+1}{\kappa(\sigma-1)}}$ captures the dyadic effect of variable and fixed trade costs for the country pair i and j.

Following the literature (see Head and Mayer (2014) for a detailed review of various methods), we approximate the log of the dyadic term T_{ij} as a linear combination of all observed trade cost proxies and the unobserved trade costs u_{ij}:

$$\begin{aligned} \ln T_{ij} \equiv& \beta_0 \ln Dist_{ij} + \beta_1 Contig_{ij} + \beta_2 Landl_{ij} + \beta_3 ComLeg_{ij} \\ &+ \beta_4 ComLan_{ij} + \beta_5 Colony_{ij} + \beta_6 ComCur_{ij} + u_{ij}, \end{aligned} \tag{21}$$

where β_0 is the elasticity of trade costs with respect to distance; $Dist_{ij}$ is population-weighted bilateral distance in kilometer; $Contig_{ij}$ is the common border indicator, which equals 1 if two countries are contiguous; $Landl_{ij}$ equals 1 if both countries are landlocked; $ComLeg_{ij}$ is the indicator of common legal system, which equals 1 if both countries have common legal origin; $ComLan_{ij}$ is the common language indicator, which equals 1 if they use common official or primary language; $Colony_{ij}$ equals 1 for pairs who have ever been in colonial relationship; and $ComCur_{ij}$ is the common currency indicator, which equals 1 if they use common currency.

Plugging (21) back into the above gravity equation (20) gives

$$X_{ij} = \exp(\ln\Theta + \ln A_i + \ln B_j - \kappa\beta_0 \ln Dist_{ijt} + \boldsymbol{Z'_{ij}}\boldsymbol{\gamma})\eta_{ij},$$

where $\eta_{ij} \equiv \exp(u_{ij})$; $\boldsymbol{Z_{ij}} \equiv (1, Contig_{ij}, Landl_{ij}, ComLeg_{ij}, ...)$ is a vector containing a constant and all trade cost proxies except $\ln Dist_{ij}$; and $\boldsymbol{\gamma} \equiv (\gamma_0, \gamma_1, \gamma_2, \gamma_3, ...)$ is a vector of coefficients corresponding to the elements in $\boldsymbol{Z'_{ij}}$.

Under the assumption $\mathrm{E}(\eta_{ij}|\Theta, A_i, B_j, T_{ij}) = 1$, the parameters can be estimated consistently using the P-PMLE method (Santos Silva and Tenreyro, 2006). The coefficient of $\ln Dist_{ijt}$, therefore, gives us the value of $-\kappa\beta_0$. Then, according to Novy (2013, Table 2, p. 111), the value of β_0 ranges from 0.220 to 0.313 across his various OLS estimations. Thus, we pick $\beta_0 = 0.26$ to further estimate the value of κ from $-\kappa\beta_0$.

3.1.2 Estimating the elasticity of substitution

After obtaining the estimate of κ, we subsequently calculate σ from the tail index of firm size distribution. Since we assume firm productivity distribution is 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 σ conditional on a given the value of κ.

Let $l_i(\varphi)$ denote the number of required workers for a firm with productivity φ in country i, given by

$$\begin{aligned} l_i(\varphi) =& \frac{\sigma-1}{\sigma w_i}\sum_{j=1}^{J} R_{ij}(\varphi) = \frac{\sigma-1}{\sigma w_i}\left[\sum_{j=1}^{J} Y_j\left(\frac{\sigma-1}{\sigma}\frac{P_j\varphi}{\tau_{ij}w_i}\right)^{\sigma-1}\right] \\ =& \left(\frac{\sigma-1}{\sigma w_i}\right)^{\sigma}(\varphi)^{\sigma-1}\left[\sum_{j=1}^{J} Y_j\left(\frac{P_j}{\tau_{ij}}\right)^{\sigma-1}\right]. \end{aligned}$$

Thus, we can reversely express φ in terms of l_i as follows:

$$\varphi = \left(\frac{\sigma w_i}{\sigma-1}\right)^{\frac{\sigma}{\sigma-1}}\left[\sum_{j=1}^{J} Y_j\left(\frac{P_j}{\tau_{ij}}\right)^{\sigma-1}\right] l_i^{\frac{1}{\sigma-1}}.$$

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:

$$\begin{aligned} &G_{size}(l_i) = 1 - \left\{\left(\frac{\sigma w_i}{\sigma-1}\right)^{\frac{\sigma}{\sigma-1}}\left[\sum_{j=1}^{J} Y_j\left(\frac{P_j}{\tau_{ij}}\right)^{\sigma-1}\right]\right\}^{-\kappa} l_i^{\frac{-\kappa}{\sigma-1}}, \\ &\Pr[size > l_i] = 1 - G_{size}(l_i) = constant \times l_i^{\frac{-\kappa}{\sigma-1}}, \end{aligned}$$

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). To estimate the tail index $\kappa/(\sigma-1)$ from a firm size distribution, we follow Gabaix and Ibragimov's (2011) method to run an OLS regression as follows:

$$\ln[Rank_\nu - \frac{1}{2}] = constant + \frac{-\kappa}{\sigma-1}\ln[size_\nu],$$

where $size_\nu$ means the number of employees of firm ν; and $Rank_\nu$ represents the size rank of firm ν. Based on the estimate of $-\kappa/(\sigma-1)$, we can calculate the value of σ according to the estimate of κ obtained in the P-PMLE.

3.1.3 Calculating the domestic expenditure share

Last, we construct the gross expenditure of a country as $E = GO + Im - Ex$, where GO is the gross output; Im denotes the total imports; and Ex stands for the total exports. Subsequently, we calculate the share of domestic expenditure for country j as follows:

$$\lambda_{jj} = \frac{E_j - Im_j}{E_j}.$$

3.2 Data

The data used in this paper comprise four main components: bilateral trade flows, GDP and proxies for bilateral trade costs, a firm size distribution, as well as the gross expenditure of each country.

3.2.1 Bilateral trade flows

We use the Bilateral Trade Data V.3.0 from the Correlates of War (CoW) Project (Barbieri and Keshk, 2012), which is based mainly on the Direction of Trade Statistics (DoTS) database of the IMF but extended to include Taiwan and historical data back to 1870.[7] They are recorded in the current U.S. million dollars. We study the data for 185 countries during the 10-year period from 1997 to 2006.

3.2.2 GDP and proxies for bilateral trade costs

We use the GDP data and the proxies for bilateral trade costs from the CEPII's gravity dataset.[8] The GDP data are recorded in the current million U.S. dollars, too.

3.2.3 Firm size distribution

We use the pooled firm-level data in the manufacturing sector in "Taiwan's Industry, Commerce and Service Census" dataset for 1996, 2001, and 2006 to estimate the tail index of the firm size distribution. Take the data for 2006 as an example, the 4-digit standard industry codes (SICs) in the manufacturing sector range from 0811 to 3400, and the number of employees is recored in the variable named *sum_peo*.

3.2.4 Gross expenditure

For illustration, we select 14 countries, including G7 (the United States, Canada, the United Kingdom, France, Germany, Italy, and Japan), BRIC (Brazil, Russia, India, and China), Korea, Singapore, and Taiwan, to construct the gross expenditure data. Their gross outputs, total imports, and total exports data are directly downloaded from OECD.Stat or the websites of their national authority of statistics.[9,10] All these datasets are employed to calculated the domestic expenditure share of each country.

[7] http://correlatesofwar.org/

[8] https://sites.google.com/site/hiegravity/data-sources

[9] OECD.Stat. http://stats.oecd.org/

[10] The Department of Statistics, Directorate General of Budget, Accounting and Statistics (DGBAS) of Taiwan. http://eng.stat.gov.tw/ct.asp?xItem=37408&CtNode=5347&mp=5

Table 1: Results of the Poisson pseudo-maximum likelihood estimation

Variables	**Coef.**	**Std. Err.**[a]	**t-statistics**
Constant	19.9291**[b]	0.1090	182.8848
ln(*Dist*)	-0.8620**	0.0106	-81.2866
Contig	0.4201**	0.0244	17.2171
Landl	0.4246**	0.0509	8.3482
ComLeg	0.2366**	0.0167	14.1974
ComLan	0.0450	0.0292	1.5392
Colony	-0.0746	0.0366	-2.0381
ComCur	-0.0632	0.0292	-2.1683
fixed effects[c]	YES		
No. of observations	267,773		

Note: (a) robust standard errors; (b) $**$ indicates significance at the 1% level in a two-tailed test; (c) importer, exporter, and year fixed effects.

3.3 Results of estimation

First, Table 1 lists the coefficients estimated by the P-PMLE. Except *ComLan*, *Colony*, and *ComCur*, all proxy variables of trade costs are significant at the 1% level in a two-tailed test. The weak effects of *ComLan*, *Colony*, and *ComCur* on bilateral trade flows might result from that we only use data of relatively recent years (1997–2006). In particular, the result of *ComCur* corresponds to de Sousa's (2012) paper, which also documents the decreasing effect of currency union on trade over time. Most importantly, the coefficient of ln*Dist* is -0.8620, which gives a value of $\kappa = 3.3154$ when $\beta_0 = 0.26$.

Second, Table 2 shows the result of the rank-size regression on firm-level data when firm sizes are no smaller than 10 employees while Figure 1 plots the scattering points of observations and its fitted line. The coefficient of ln(*size*) gives the tail index of the firm-size distribution, i.e., $-\kappa/(\sigma - 1) = -1.0549$. Given that $\kappa = 3.3154$ derived from the previous estimation, we get the value of $\sigma = 4.1428$.

Our estimates of σ and κ are close to those in the literature. In Santos Silva and Tenreyro's (2006) paper, the coefficients of *Log distance* in their two P-PMLEs are -0.776 and -0.784, respectively (see Table 3 on page 650). Our result does not deviate from theirs much. Regarding the trade elasticity, $-\kappa$, Simonovska and Waugh (2014b, p. 35) develop a new estimator to disaggregate price and trade-flow data for 2004, which span 123 countries that account for 98% of world GDP. Their benchmark estimate for the elasticity

Table 2: The result of the rank-size regression on firm-level data

ln[Rank-1/2]	Coef.	Std. Err.[a]	t-statistics
Constant	14.6326**[b]	0.0007	2.2e+04
ln(*size*)	-1.0549**	0.0002	-5303.05

Note: (a) robust standard errors; (b) ∗∗ indicates significance at the 1% level in a two-tailed test.

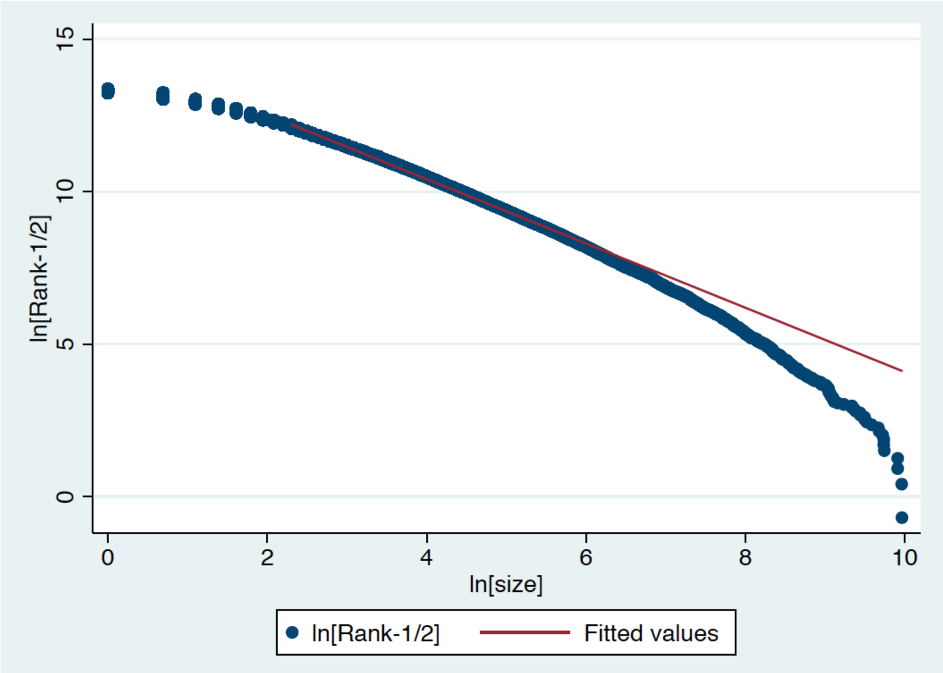

Figure 1: The rank-size regression on firm-level data when firm size >= 10

of trade is -4.14. Applying their estimator to alternative data sets and conducting several robustness exercises allows them to establish a range for the elasticity of trade between -2.79 and -4.46. Our estimate of $\kappa = 3.3154$ lies in the middle of their range. With respect to the tail index of firm-size distribution, Axtell (2001) and Luttmer (2007) obtain -1.06 while we have -1.0549. As to the value of σ, Krugman and Venables (1995, p.870) use 3, 5, and 7, respectively, to illustrate their results. For monopolistic-competition models with CES, it is quite standard to set $\sigma = 4$. Our estimate of $\sigma = 4.1428$ looks reasonable.

Last, based on the constructed gross expenditure data, we calculate the values of domestic expenditure share for the selected 14 countries, respectively, year by year. Table

A in Appendix lists the time series of λ and the derived welfare gains from trade for workers and firm owners for 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 $\mathrm{dln}\overline{W_e}$ in the United States for the year 2006 being 12.81% implies that the US firm owners' average real income for 2006 has increased 12.81% than their average real income under autarky. Due to $\mathrm{dln}W = \mathrm{dln}\overline{W_w}$, the magnitude of $\mathrm{dln}\overline{W_w}$ can be also regarded as the aggregate welfare gains from trade. Therefore, the aggregate welfare level of the United States for the year 2006 has increased 2.86% than its aggregate welfare under autarky. From Table A in Appendix, it is shown that works' and firm owners' average welfare gains from trade both increase as λ decreases. Since we apply the same values of σ and κ to each country, the difference of welfare gains from trade across countries only depends on their values of λ. As relatively smaller open economies, Singapore and Taiwan enjoy higher welfare gains from trade and features higher disparity in this welfare growth between workers and firm owners due to its lower domestic expenditure share. In particular, the domestic expenditure share of Singapore for the year 2006 is as low as 17.56%. Compared to autarky, the firm owners in Singapore for that year have enjoyed a great growth (469.90%) in their average real income. Besides, the gaps in average welfare gains (compared to autarky) between firm owners and workers during these 10 years are always higher than 130%. In contrast, in the same period, the disparities in welfare gains (compared to autarky) between firm owners and workers in other countries have never been greater than 40%. Figures 2 and 3 both plot the the gaps in welfare gains from trade between firm owners and workers, which is given by $\mathrm{dln}\overline{W_e} - \mathrm{dln}\overline{W_w}$, for all these countries. While Figure 2 puts all 14 countries together to contrast the distinctive magnitude of Singapore's numbers, Figure 3 illustrates other 13 countries, except Singapore, to show their relatively minor fluctuations.

4 Concluding remarks

Under a CES demand system, we develop a methodology to quantify the unequal welfare gains from trade between firm owners and workers within a specific country. To the best of our knowledge, this study is the first attempt to measure welfare gains from trade for firm owners and workers, respectively, in a format of the ACR's (2012) formula. This approach requires aggregate data on the share of expenditure on domestic goods and two parameters (the trade elasticity and the elasticity of substitution) estimated from a gravity equation and readily available bilateral trade data. Based on a multi-country monopolistic competition trade model rather than a simple two-country version, it can

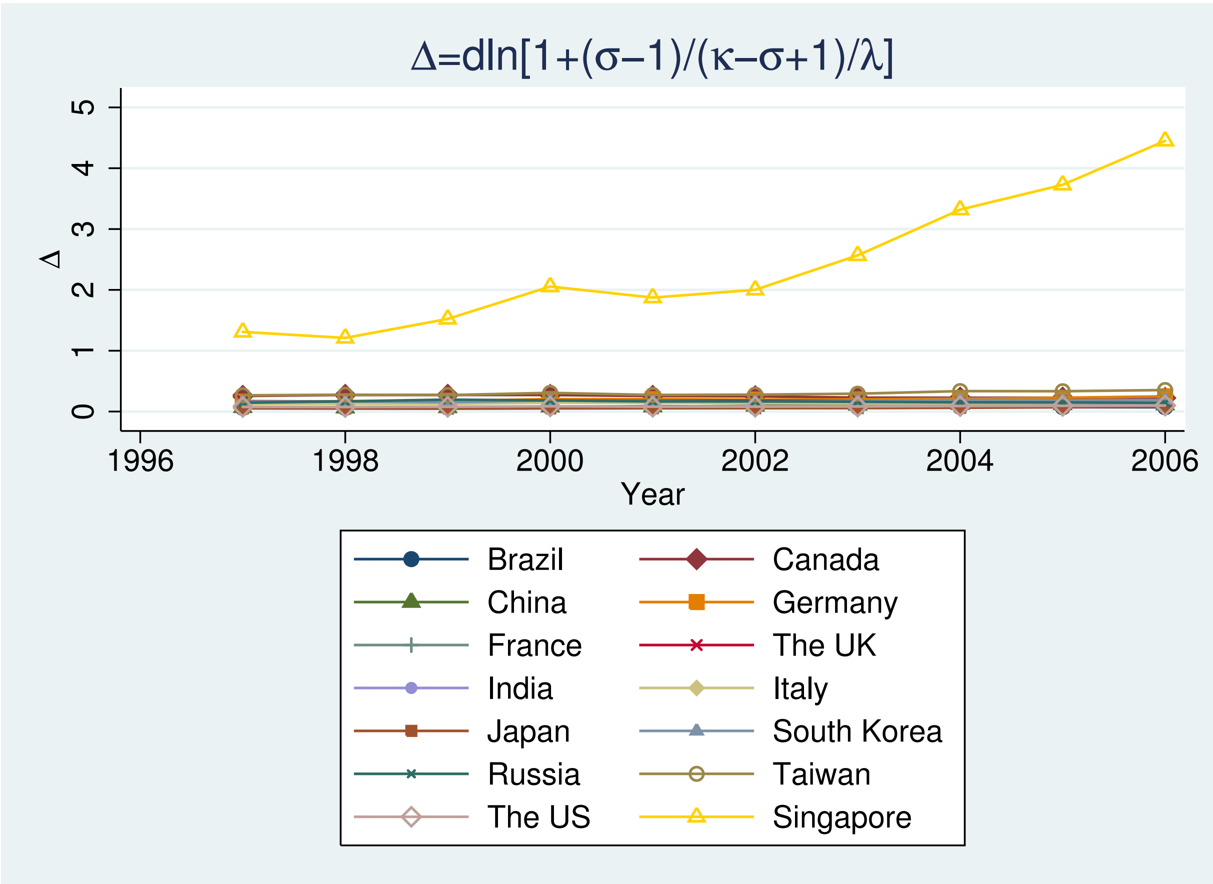

Figure 2: The gaps in welfare gains from trade (compared to autarky) for 14 countries

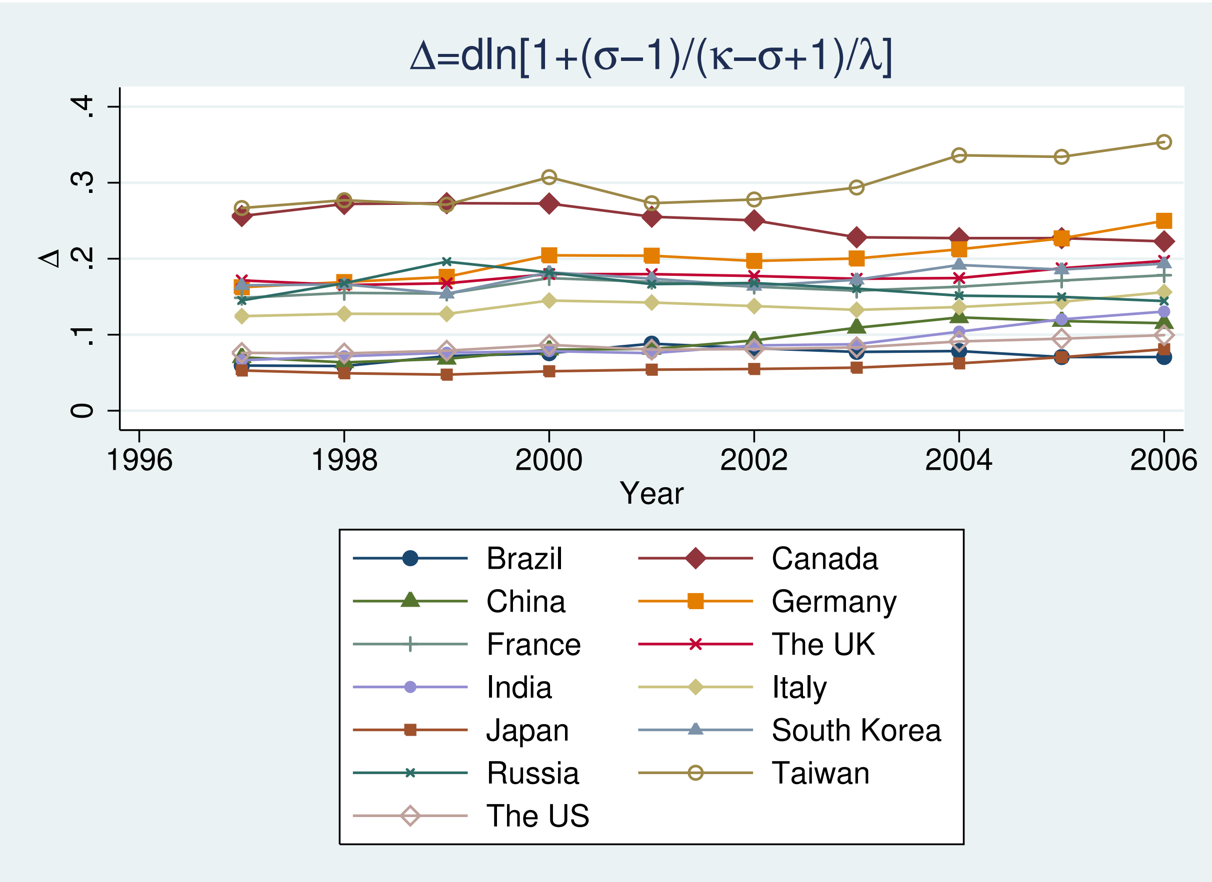

Figure 3: The gaps in welfare gains from trade (compared to autarky) for 13 countries except Singapore

therefore be implemented across many countries.

Theoretically, we find that countries associated with lower domestic expenditure share display higher disparities in welfare gains from trade between firm owners and workers. Taking the model to data, we illustrate the application of the methodology by calculating the respective average welfare gains (compared to autarky) of firm owners and of workers for 14 countries, including G7, BRIC, Korea, Singapore, and Taiwan. Among these examples, Singapore has relatively lower domestic expenditure shares since it is a smaller open economy. Accordingly, both of its firm owners and workers enjoy much higher welfare gains from trade. Moreover, the disparity in welfare gains between these two occupations is also dramatically large. Taking the year of 2006 as an example, the gap in welfare gains in Singapore reaches to 445.03%, while the same measure in the United States is only 9.95%.

Appendix

Table A: Welfare gains from trade compared to autarky ($\sigma = 4.1428$, $\kappa = 3.3154$)

unit: %	**Brazil**			**Canada**		
year	λ	**dln**$\overline{W_w}$	**dln**$\overline{W_e}$	λ	**dln**$\overline{W_w}$	**dln**$\overline{W_e}$
1997	94.10	1.78	7.72	78.73	6.42	32.03
1998	94.17	1.76	7.63	77.70	6.73	33.93
1999	92.95	2.13	9.32	77.64	6.75	34.05
2000	92.61	2.23	9.80	77.67	6.74	34.00
2001	91.49	2.57	11.39	78.79	6.40	31.92
2002	92.01	2.41	10.64	79.10	6.30	31.35
2003	92.46	2.27	10.01	80.60	5.85	28.67
2004	92.35	2.31	10.16	80.68	5.83	28.53
2005	93.07	2.09	9.15	80.67	5.83	28.54
2006	93.06	2.09	9.16	80.97	5.74	28.02
unit: %	**China**			**Germany**		
year	λ	**dln**$\overline{W_w}$	**dln**$\overline{W_e}$	λ	**dln**$\overline{W_w}$	**dln**$\overline{W_e}$
1997	93.10	2.08	9.11	85.37	4.41	20.66
1998	93.72	1.90	8.25	84.85	4.57	21.50
1999	93.28	2.03	8.85	84.33	4.73	22.34
2000	92.19	2.36	10.39	82.26	5.35	25.80
2001	92.10	2.38	10.51	82.29	5.34	25.74
2002	91.12	2.68	11.93	82.79	5.19	24.89
2003	89.68	3.11	14.02	82.56	5.26	25.29
2004	88.53	3.46	15.74	81.70	5.52	26.76
2005	88.93	3.34	15.13	80.70	5.82	28.50
2006	89.17	3.27	14.78	79.14	6.29	31.27

Table A (cont.): Welfare gains from trade compared to autarky ($\sigma = 4.1428$, $\kappa = 3.3154$)

unit: %	**France**			**United Kingdom**		
year	λ	**dln**$\overline{W_w}$	**dln**$\overline{W_e}$	λ	**dln**$\overline{W_w}$	**dln**$\overline{W_e}$
1997	86.45	4.09	18.94	84.68	4.62	21.77
1998	85.94	4.24	19.74	85.15	4.48	21.01
1999	86.02	4.22	19.63	84.97	4.53	21.30
2000	84.46	4.69	22.13	84.06	4.81	22.79
2001	84.83	4.58	21.53	84.06	4.81	22.78
2002	85.31	4.43	20.75	84.24	4.75	22.48
2003	85.72	4.31	20.10	84.52	4.67	22.02
2004	85.32	4.43	20.74	84.45	4.69	22.15
2005	84.70	4.62	21.74	83.49	4.98	23.72
2006	84.17	4.78	22.60	82.79	5.19	24.90
unit: %	**India**			**Italy**		
year	λ	**dln**$\overline{W_w}$	**dln**$\overline{W_e}$	λ	**dln**$\overline{W_w}$	**dln**$\overline{W_e}$
1997	93.45	1.97	8.61	88.40	3.50	15.94
1998	92.97	2.12	9.29	88.14	3.58	16.33
1999	92.56	2.25	9.87	88.16	3.57	16.30
2000	92.36	2.30	10.15	86.74	4.00	18.49
2001	92.60	2.23	9.80	86.95	3.94	18.17
2002	91.69	2.51	11.09	87.32	3.82	17.59
2003	91.55	2.55	11.30	87.72	3.70	16.97
2004	90.11	2.98	13.38	87.42	3.79	17.43
2005	88.74	3.40	15.42	86.87	3.96	18.28
2006	87.90	3.65	16.70	85.86	4.26	19.87

Table A (cont.): Welfare gains from trade compared to autarky ($\sigma = 4.1428$, $\kappa = 3.3154$)

unit: %	**Japan**			**South Korea**		
year	λ	$\mathbf{dln}\overline{W_w}$	$\mathbf{dln}\overline{W_e}$	λ	$\mathbf{dln}\overline{W_w}$	$\mathbf{dln}\overline{W_e}$
1997	94.71	1.59	6.89	85.18	4.47	20.97
1998	95.06	1.49	6.42	85.08	4.50	21.12
1999	95.23	1.44	6.19	86.04	4.21	19.59
2000	94.81	1.57	6.75	83.89	4.86	23.06
2001	94.61	1.62	7.02	84.51	4.67	22.05
2002	94.52	1.65	7.14	85.25	4.45	20.86
2003	94.36	1.70	7.36	84.62	4.64	21.87
2004	93.83	1.86	8.10	83.17	5.08	24.25
2005	93.09	2.08	9.12	83.62	4.94	23.50
2006	92.14	2.37	10.46	83.04	5.11	24.47
unit: %	**Russia**			**Taiwan**		
year	λ	$\mathbf{dln}\overline{W_w}$	$\mathbf{dln}\overline{W_e}$	λ	$\mathbf{dln}\overline{W_w}$	$\mathbf{dln}\overline{W_e}$
1997	86.73	4.00	18.51	78.04	6.62	33.29
1998	84.96	4.54	21.31	77.39	6.82	34.52
1999	82.85	5.17	24.79	77.77	6.71	33.81
2000	83.91	4.85	23.04	75.52	7.38	38.11
2001	85.06	4.51	21.16	77.64	6.74	34.05
2002	84.94	4.54	21.35	77.33	6.84	34.63
2003	85.51	4.37	20.43	76.35	7.13	36.50
2004	86.23	4.15	19.29	73.82	7.90	41.51
2005	86.35	4.12	19.10	73.94	7.86	41.26
2006	86.79	3.98	18.41	72.84	8.19	43.55

Table A (cont.): Welfare gains from trade compared to autarky ($\sigma = 4.1428$, $\kappa = 3.3154$)

unit: %	**United States**			**Singapore**		
year	λ	$\mathbf{dln}\overline{W_w}$	$\mathbf{dln}\overline{W_e}$	λ	$\mathbf{dln}\overline{W_w}$	$\mathbf{dln}\overline{W_e}$
1997	92.57	2.24	9.85	41.99	17.50	148.44
1998	92.63	2.22	9.76	43.92	16.91	137.93
1999	92.31	2.32	10.22	38.36	18.59	170.90
2000	91.63	2.53	11.19	31.56	20.64	226.17
2001	92.19	2.36	10.39	33.60	20.03	207.36
2002	92.12	2.38	10.48	32.14	20.47	220.61
2003	91.92	2.44	10.77	26.97	22.03	278.78
2004	91.23	2.65	11.76	22.21	23.46	355.38
2005	90.91	2.74	12.22	20.27	24.05	396.83
2006	90.51	2.86	12.81	17.56	24.87	469.90

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