The Gains from International Trade with Increasing Marginal Costs

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I. Context: Measuring Welfare Effects of Trade-Cost Changes

Arkolakis, Costinot, and Rodriguez-Clare (*AER*, 2012) showed for a large class of trade models satisfying a certain set of (micro) assumptions and a set of (macro) restrictions that the welfare (or real wage rate) gains from an *ad valorem* trade-cost change – such as a tariff-rate change – could be measured by a “sufficient-statistic” using only two statistics:

$$\hat{W}_j = \widehat{w_j/P_j} = \hat{\lambda}_{jj}^{-1/\epsilon} \tag{1}$$

where $\hat{W}_j$ denotes the *gross* change in welfare (or the real wage rate) from the initial value of W_j to the new value $W_j^{'}$, i.e., $\hat{W}_j = W_j^{'}/W_j$, w_j is the nominal wage rate, P_j is the (ideal) price index, λ_{jj} is the share of j's expenditures on home goods (or intra-national trade), and ϵ (> 0) is the “trade elasticity.” The trade elasticity (ϵ) refers typically to the elasticity of bilateral trade with respect to (w.r.t.) a change in *ad valorem* trade-cost measures from an estimated gravity equation.

I.A.1. Key Micro Assumptions

Constant-Elasticity-of-Substitution (CES) Preferences:

$$U_j = \left[\int_{\nu \in \Omega_j} q_j(\nu)^{\frac{\sigma-1}{\sigma}} d\nu \right]^{\frac{\sigma}{\sigma-1}} \quad (2)$$

Constant Marginal Cost Function for Production:

$$C_{ij} = c_{ij} q_{ij} + f_{ij} \quad (3)$$

Market Structure:

Perfect competition or monopolistic competition

I.A.2. Key Macro Restrictions

R1: Multilateral Trade Balance

R2: Aggregate Profits are a Constant Share of Aggregate Revenues in Every Country

Under perfect competition, this always holds, Under monopolistic competition, this holds given CES preferences.

R3: The Import Demand System is CES, or

R3': The Import Demand System Follows a Gravity Equation

$$X_{ij} = \frac{L_i w_i^{-\epsilon} \tau_{ij}^{-\epsilon} Y_j \chi_{ij}}{\sum_{k=1}^{N} L_k w_k^{-\epsilon} \tau_{kj}^{-\epsilon} \chi_{kj}} \equiv \frac{L_i w_i^{-\epsilon} \tau_{ij}^{-\epsilon} Y_j \chi_{ij}}{P_j^{-\epsilon}} \tag{4}$$

I.B. Illustration: A Simple Armington Model

In a simple Armington model:

$$X_{ij} = \frac{L_i w_i^{1-\sigma} \tau_{ij}^{1-\sigma} Y_j}{\sum_{k=1}^{N} L_k w_k^{1-\sigma} \tau_{kj}^{1-\sigma}} = \frac{L_i w_i^{1-\sigma} \tau_{ij}^{1-\sigma} Y_j}{P_j^{1-\sigma}}. \quad (5)$$

Letting $\tau_{jj} = 1$, $Y_j = E_j$, $\lambda_{ij} = X_{ij}/Y_j$, and rewriting (5) for $\lambda_{jj} = X_{jj}/Y_j$, then:

$$\lambda_{jj} = \frac{L_j w_j^{1-\sigma}}{P_j^{1-\sigma}} \quad (6)$$

or

$$(w_j/P_j)^{\sigma-1} = \lambda_{jj}^{-1} L_j \Rightarrow W_j = w_j/P_j = \lambda_{jj}^{-1/(\sigma-1)} L_j^{1/(\sigma-1)}. \quad (7)$$

Ruling out any change in the home country's labor endowment, then any foreign shock leads to:

$$W_j'/W_j \equiv \hat{W}_j = \widehat{w_j/P_j} = \hat{\lambda}_{jj}^{-1/(\sigma-1)}. \quad (8)$$

II. *Are Marginal Costs Constant... or Increasing?*

A. Feenstra (*AER*, 1994)

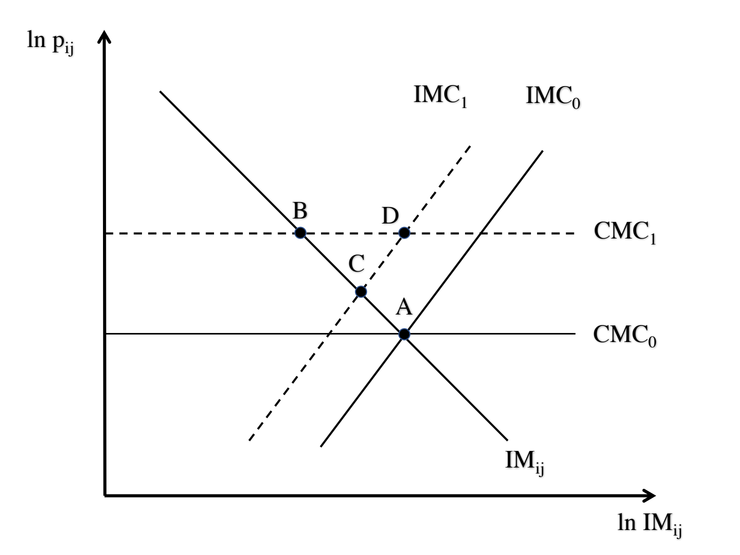
B. Broda and Weinstein (*QJE*, 2006)

C. Hottman, Redding, and Weinstein (*QJE*, 2016)

Using firm-level data, Hottman, Redding and Weinstein find:

1. 10th percentile estimate of the elasticity of marginal costs of 0.06.
2. median estimate of the elasticity of marginal costs of 0.16.
3. 90th percentile estimate of the elasticity of marginal costs of 0.30.

II. *One* Possible Implication of Increasing Marginal Costs (IMC)



III. Theoretical Framework

A. Demand: CES Preferences

B. Technology: The amount of labor required by a country-i firm with productivity φ to produce q_{ij} units of output for sale in country j is given by:

$$l_{ij}(\varphi) = f_{ij} + \frac{q_{ij}^{1+\frac{1}{\gamma}}}{\varphi}, \tag{9}$$

where f_{ij} denotes fixed costs and $\gamma > 0$ determines the marginal cost elasticity of output; for brevity (for a value of w), we will refer to γ as the inverse marginal cost elasticity or $1/\gamma$ as the marginal cost elasticity. When γ goes to infinity, we obtain the constant marginal cost (CMC) case.

C. Domestic Firms Maximize Profits

$$\pi_{ii}(\varphi) \equiv p_{ii}(\varphi)q_{ii}(\varphi) - w_i l_{ii}(\varphi) = E_i \left(\frac{p_{ii}(\varphi)}{P_i}\right)^{1-\sigma} - w_i \left[f_{ii} + \frac{q_{ii}(\varphi)^{\frac{1+\gamma}{\gamma}}}{\varphi}\right]. \quad (10)$$

Firm profit maximization yields the first-order condition:

$$p_{ii}(\varphi) = \left(\frac{1+\gamma}{\gamma}\right)\left(\frac{\sigma}{\sigma-1}\right)\left(\frac{w_i}{\varphi}\right) q_{ii}(\varphi)^{\frac{1}{\gamma}}. \quad (11)$$

Let φ_{ii}^* denote the minimum level of productivity required for non-negative profits. We can then use the zero-profit cutoff (ZPC) condition $\pi_{ii}(\varphi_{ii}^*) = 0$ to determine the quantity of output of the least productive firm:

$$q_{ii}(\varphi_{ii}^*) = \left[\frac{\gamma(\sigma-1)}{\gamma+\sigma} f_{ii}\varphi_{ii}^*\right]^{\frac{\gamma}{1+\gamma}}. \quad (12)$$

Contrast to the result from a standard Melitz model with CMC.

D. Exporting Firms Maximize Profits

Additional profits for a firm in i to export to j are:

$$\pi_{ij}(\varphi) = \left(\frac{p_{ij}(\varphi)}{P_j}\right)^{1-\sigma} E_j - w_i f_{ij} - \frac{w_i \tau_{ij} q_{ij}(\varphi)^{1+\frac{1}{\gamma}}}{\varphi}. \quad (13)$$

As standard to these models, an exporting firm can maximize profits separately for each market, obtaining an equilibrium price of:

$$p_{ij}(\varphi) = \left(\frac{1+\gamma}{\gamma}\right)\left(\frac{\sigma}{\sigma-1}\right)\frac{w_i \tau_{ij}}{\varphi} q_{ij}(\varphi)^{\frac{1}{\gamma}}. \quad (14)$$

Let φ_{ij}^* denote the minimum level of productivity required for non-negative export profits. We can then use the ZPC condition $\pi_{ij}(\varphi_{ij}^*) = 0$ to solve for the ZPC output level:

$$q_{ij}(\varphi_{ij}^*) = \left[\frac{\gamma}{\gamma+\sigma}(\sigma-1)\tau_{ij}^{-1} f_{ij} \varphi_{ij}^*\right]^{\frac{\gamma}{\gamma+1}}. \quad (15)$$

E. Full-Employment Assumption

F. Multilateral Trade Balance

Assume the aggregate national income constraint:

$$Y_j = w_j L_j = L_j \sum_{i=1}^{N} \int_{\nu \varepsilon \nu} p_{ij}(\nu) q_{ij}(\nu) \mathrm{d}\nu = E_j \tag{16}$$

One result implied by the model is the mass of firms that export from country i to country j in equilibrium (M_{ij}), or extensive margin (EM_{ij}):

$$EM_{ij} \equiv M_{ij} = \frac{L_i}{f^E (\varphi_{ij}^*)^\theta \delta \frac{1+\gamma}{\gamma} \frac{\sigma}{\sigma-1} \theta} \tag{17}$$

where δ is the (assumed constant) fraction of existing firms that exit the industry in any period. In the case of $\gamma = \infty$, M_i^E, $M_{ii} (\equiv M_i)$, and M_{ij} simplify to the respective terms in a standard Melitz-Chaney-Redding model, such as Redding(2011).

A. Gravity Equation and Export-Fixed-Cost Effects on Trade

1. The trade flow from country i to country j can be defined as the product of two margins:

$$X_{ij} = M_{ij} \int_{\varphi_{ij}^*}^{\infty} r_{ij}(\varphi)\, \mu_{ij}(\varphi) \mathrm{d}\varphi = EM_{ij} \times IM_{ij} \tag{18}$$

We can solve for the gravity equation:

$$X_{ij} = \left(\frac{L_i w_i^{1-\theta \frac{1+\gamma}{\gamma} \frac{\sigma}{\sigma-1}} \tau_{ij}^{-\theta} f_{ij}^{1-\frac{\theta}{\frac{\gamma}{\gamma+\sigma}(\sigma-1)}}}{\sum_{k=1}^{N} L_k w_k^{1-\theta \frac{1+\gamma}{\gamma} \frac{\sigma}{\sigma-1}} \tau_{kj}^{-\theta} f_{kj}^{1-\frac{\theta}{\frac{\gamma}{\gamma+\sigma}(\sigma-1)}}} \right) w_j L_j. \tag{19}$$

2. Contrast the Export-Fixed-Cost Elasticity between CMC and IMC

B. Trade, Intensive-Margin, and Extensive-Margin Variable Trade-Cost Elasticities

1. Trade Elasticity: $-\theta$
2. Intensive-Margin Elasticity: $-\frac{\gamma}{\gamma+\sigma}(\sigma-1)$
3. Extensive-Margin Elasticity: $-[\theta-\frac{\gamma}{\gamma+\sigma}(\sigma-1)]$

Discuss Figure 1.

C. Welfare

Modifying equation (19) for λ_{jj}, we can write:

$$\lambda_{jj} = \frac{L_j w_j^{1-\theta\frac{\sigma}{\sigma-1}\frac{1+\gamma}{\gamma}-\theta\frac{1+\gamma}{\gamma}+\theta\frac{1+\gamma}{\gamma}} f_{jj}^{1-\frac{\theta}{\frac{\gamma}{\gamma+\sigma}(\sigma-1)}}}{\sum_{k=1}^{N} L_k w_k^{1-\theta\frac{\sigma}{\sigma-1}\frac{1+\gamma}{\gamma}} \tau_{ik}^{-\theta} f_{kj}^{1-\frac{\theta}{\frac{\gamma}{\gamma+\sigma}(\sigma-1)}}} \qquad (20)$$

noting $\tau_{jj} = 1$ and $1 - \theta\frac{\sigma}{\sigma-1}\frac{1+\gamma}{\gamma} - \theta\frac{1+\gamma}{\gamma} + \theta\frac{1+\gamma}{\gamma} = 1 - \theta\frac{\sigma}{\sigma-1}\frac{1+\gamma}{\gamma}$. Equation (20) can be rewritten as:

$$w_j^{\theta\frac{1+\gamma}{\gamma}} = \frac{1}{\lambda_{jj}} \frac{L_j w_j^{1-\frac{\theta}{\sigma-1}\frac{1+\gamma}{\gamma}} f_{jj}^{1-\frac{\theta}{\frac{\gamma}{\gamma+\sigma}(\sigma-1)}}}{\sum_{k=1}^{N} L_k w_k^{1-\theta\frac{\sigma}{\sigma-1}\frac{1+\gamma}{\gamma}} \tau_{ik}^{-\theta} f_{kj}^{1-\frac{\theta}{\frac{\gamma}{\gamma+\sigma}(\sigma-1)}}} \qquad (21)$$

where $1 - \frac{\theta}{\sigma-1}\frac{1+\gamma}{\gamma} = 1 - \theta\frac{\sigma}{\sigma-1}\frac{1+\gamma}{\gamma} + \theta\frac{1+\gamma}{\gamma}$.

C. Welfare (cont.)

We can also solve for the price index P_j:

$$P_j^{-\theta(1+\frac{1}{\gamma})} = \frac{A}{w_j^{1-\frac{\theta}{\sigma-1}\frac{1+\gamma}{\gamma}} L_j^{1-\frac{\theta}{\sigma-1}\frac{1+\gamma}{\gamma}}} \left[\sum_{k=1}^{N} L_k w_k^{1-\theta\frac{\sigma}{\sigma-1}\frac{1+\gamma}{\gamma}} \tau_{kj}^{-\theta} f_{kj}^{1-\frac{\theta}{\frac{\gamma}{\gamma+\sigma}(\sigma-1)}} \right] \tag{22}$$

where A is a nonlinear function of parameters.

Using equations (21) and (22), we can write:

$$\left(\frac{w_j}{P_j}\right)^{\theta(1+\frac{1}{\gamma})} = A\lambda_{jj}^{-1} L_j^{\frac{\theta}{\sigma-1}\frac{1+\gamma}{\gamma}} f_{jj}^{1-\frac{\theta}{\frac{\gamma}{\gamma+\sigma}(\sigma-1)}}.$$

Hence, the level of welfare for country j, W_j, can be written as:

$$W_j \equiv \frac{w_j}{P_j} = A^{1/[\theta(1+\frac{1}{\gamma})]} \lambda_{jj}^{-1/[\theta(1+\frac{1}{\gamma})]} \left(L_j^{\frac{\theta}{\sigma-1}\frac{1+\gamma}{\gamma}} f_{jj}^{1-\frac{\theta}{\frac{\gamma}{\gamma+\sigma}(\sigma-1)}} \right)^{1/[\theta(1+\frac{1}{\gamma})]}. \tag{23}$$

C. Welfare (cont.)

For any foreign shock that leaves home labor L_j, τ_{jj} (=1), and f_{jj} unchanged:

$$\hat{W}_j = \hat{\lambda}_{jj}^{-1/[\theta(1+\frac{1}{\gamma})]}. \tag{24}$$

D. Production-Side Intuition

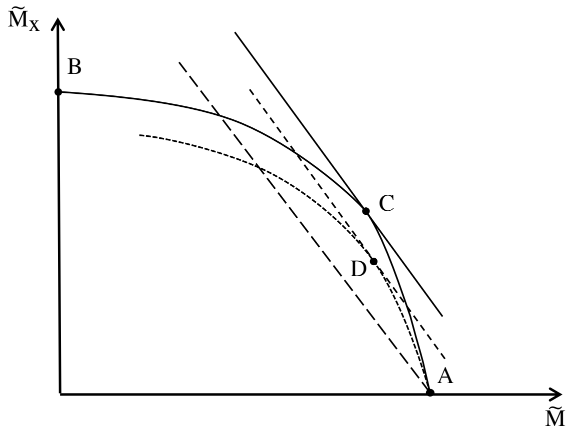
1. Constant-Elasticity-of-Transformation Curve under CMC and IMC

Feenstra (2010a, 2010b) argued that the gains to trade reflect the increase in real wage rates due to the productivity improvement as exporting firms drive out less productive domestic firms, raising average productivity. Moreover, under an untruncated Pareto distribution, there are no additional consumption-side gains; gains due to new import varieties are exactly offset by the losses from fewer domestic varieties.

He argued that – while the transformation curve (CET) between the masses of domestic firms and exporting firms is linear – that between (correctly) "output-adjusted" masses of varieties is concave.

See Figure 2.

Fig 2. CET Curves for CMC and IMC



D. Production-Side Intuition

2. Proof that the CET under IMC (η) is larger than under CMC (ω)

$$\eta = \frac{\theta\sigma}{\sigma - 1} - 1 + \frac{\theta\sigma}{\sigma - 1}\left(\frac{1}{\gamma}\right) = \omega + (\omega + 1)\frac{1}{\gamma}. \tag{25}$$

3. Diminishing Marginal Returns and the Welfare "Diminution" Effect

Following Feenstra (2010a), we can show in the context of our model:

$$\hat{W}_j = \left(\widehat{\tilde{\varphi}}_j\right)^{\frac{\gamma}{1+\gamma}} \tag{26}$$

since the ratio of average productivities ($\widehat{\tilde{\varphi}}_j$) is equal to the ratio of ZPC productivities and the latter can be determined using equations (12) and (15) from earlier. In Feenstra (2010a), $\hat{W}_j = \widehat{\tilde{\varphi}}_j$.

In summary, real wage gains from a trade liberalization can be traced to changes in average productivity. However, with diminishing marginal product to labor, $\gamma < \infty$. Consequently, the gains to average productivity are diminished at a rate of $\gamma/(1+\gamma)$. Hence, the welfare effect of a trade liberalization with IMC is

$\hat{W}_j = \hat{\lambda}_{jj}^{-1/[\frac{1+\gamma}{\gamma}\theta]} = \hat{\lambda}_{jj}^{-1/[(1+\frac{1}{\gamma})\theta]}$.

V. Econometric Methodology

The goal is to estimate the elasticity of substitution (σ) and the inverse marginal cost elasticity (γ) simultaneously – controlling for heterogeneity of firms' productivities in each industry.

A. The Demand Equation

Aggregate demand as a share of expenditures (λ_{ij}) is:

$$\lambda_{ij} = M_{ij}\bar{r}_{ij} = M_{ij}P_j^{\sigma-1}\tilde{p}_{ij} \tag{27}$$

where

$$\tilde{p}_{ij} \equiv \int_{\varphi_{ij}^*}^{\infty} p(\varphi)^{1-\sigma}\mu_{ij}(\varphi)d\varphi \tag{28}$$

is an unobervable average export price. Because the average price $\tilde{p}_{ij}$ is not observed in the data, we cannot use equation (27) to estimate the parameters of the model. To make progress, we need to define this average price in terms of observables.

Using our data, we can compute average unit values defined as

$$\bar{p}_{ij} \equiv \frac{M_{ij} \int_{\varphi_{ij}^*}^{\infty} r_{ij}(\varphi)\mu_{ij}(\varphi)d\varphi}{M_{ij} \int_{\varphi_{ij}^*}^{\infty} q_{ij}(\varphi)\mu_{ij}(\varphi)d\varphi} = \frac{\int_{\varphi_{ij}^*}^{\infty} p_{ij}(\varphi)^{1-\sigma}\mu_{ij}(\varphi)d\varphi}{\int_{\varphi_{ij}^*}^{\infty} p_{ij}(\varphi)^{-\sigma}\mu_{ij}(\varphi)d\varphi} = \frac{\tilde{p}_{ij}}{\hat{p}_{ij}} \tag{29}$$

where

$$\hat{p}_{ij} \equiv \int_{\varphi_{ij}^*}^{\infty} p(\varphi)^{-\sigma}\mu_{ij}(\varphi)d\varphi \tag{30}$$

is another unobserved average price. We use the theoretical model to obtain analytical expressions for each of the unobserved average prices, $\tilde{p}_{ij}$ and $\hat{p}_{ij}$. We then show that, by combining these two expressions in the ratio, we can express the aggregate import demand as a function of the observable average unit value, $\bar{p}_{ij}$:

$$\lambda_{ij} = B\delta f^E L_i \left(\frac{w_j L_j P_j^{\sigma-1}}{w_i^{\sigma}} \right)^{\frac{2\theta}{\sigma-1}\left(\frac{1+\gamma}{\gamma}\right)} P_j^{\sigma-1} f_{ij}^{\frac{-2\theta}{\sigma-1}} \tau_{ij}^{-2\theta} \bar{p}_{ij}^{1-\sigma}. \tag{31}$$

B. The Supply Equation

In an analogous manner, we can use the optimal pricing function from the theoretical model to find the relationship between (observable) average unit values $\overline{p}_{ij}$ and (observable) import shares λ_{ij}:

$$\overline{p}_{ij} = \left[\frac{D\delta f^E E_j^{1-\frac{(1+\gamma)(2\theta-\gamma)}{\gamma(\sigma-1)}} w_i^{\gamma+\frac{(1+\gamma)\sigma(2\theta-\gamma)}{\gamma(\sigma-1)}} \tau_{ij}^{2\theta} f_{ij}^{\frac{2\theta-\gamma}{\sigma-1}} \lambda_{ij}}{L_i P_j^{\sigma-1}} \right]^{\frac{\gamma}{1+\gamma}} . \qquad (32)$$

V. Econometric Methodology

To obtain an estimating equations, we first remove time-invariant and exporter-specific effects by double-differencing. The demand equation and supply equation become, respectively:

$$\Delta \ln \lambda_{ij,t} = \Delta \ln L_{i,t} - 2\theta \left(\frac{1+\gamma}{\gamma}\right)\left(\frac{\sigma}{\sigma-1}\right)\Delta \ln w_{i,t} - \left(\frac{2\theta}{\sigma-1}\right)\Delta \ln f_{ij,t} - 2\theta \Delta \ln \tau_{ij,t} - (\sigma-1)\Delta \ln \overline{p}_{ij,t} + \Delta \phi_{ij,t}, \quad (33)$$

and

$$\Delta \ln \overline{p}_{ij,t} = \left(\frac{\gamma}{\gamma+\sigma}\right)\left[1 - \left(\frac{1+\gamma}{\gamma}\right)\left(\frac{\sigma}{\sigma-1}\right)\right]\Delta \ln w_{i,t} - \left[\frac{\gamma}{(\gamma+\sigma)(\sigma-1)}\right]\Delta \ln f_{ij,t} + \left(\frac{1}{\gamma+\sigma}\right)\Delta \phi_{ij,t} + \Delta \psi_{ij,} \quad (34)$$

where $\phi_{ij,t}$ is a demand-side residual, $\psi_{ij,t}$ is a supply-side residual, and for any a: $\Delta \ln a_{ij,t} \equiv (\ln a_{ij,t} - \ln a_{ij,t-1}) - (\ln a_{hj,t} - \ln a_{hj,t-1})$.

V. Econometric Methodology

Assuming $E(\Delta\phi_{ijt}\Delta\psi_{ijt}) = 0$, we use (33) and (34) to solve for $\Delta\phi_{ij,t}$ and $\Delta\psi_{ijt}$, then multiply the two expressions, and rearrange to obtain:

$$\overline{Y}_{ij} = \sum_{k=1}^{20} \beta_k \overline{Z}_{ij,k} + \overline{\xi}_{ij} \tag{35}$$

where

$$Y_{ijt} = \left(\Delta \ln \overline{p}_{ijt}\right)^2 \qquad Z_{ijt,1} = (\Delta \ln \lambda_{ijt})^2, \qquad Z_{ijt,2} = \Delta \ln \lambda_{ijt} \Delta \ln \overline{p}_{ijt}$$

$$Z_{ijt,3} = (\Delta \ln \tau_{ijt})^2 \qquad Z_{ijt,4} = \Delta \ln \tau_{ijt} \Delta \ln \overline{p}_{ijt} \qquad Z_{ijt,5} = \Delta \ln \tau_{ijt} \Delta \ln \lambda_{ijt}$$

$$Z_{ijt,6} = \Delta \ln \tau_{ijt} \Delta \ln L_{it} \qquad Z_{ijt,7} = \Delta \ln \tau_{ijt} \Delta \ln w_{it} \qquad Z_{ijt,8} = \Delta \ln L_{it} \Delta \ln \overline{p}_{ijt}$$

$$Z_{ijt,9} = \Delta \ln L_{it} \Delta \ln \lambda_{ijt} \qquad Z_{ijt,10} = \Delta \ln w_{it} \Delta \ln \overline{p}_{ijt} \qquad Z_{ijt,11} = \Delta \ln w_{it} \Delta \ln \lambda_{ijt}$$

$$Z_{ijt,12} = (\Delta \ln L_{it})^2 \qquad Z_{ijt,13} = \Delta \ln L_{it} \Delta \ln w_{it} \qquad Z_{ijt,14} = (\Delta \ln w_{it})^2$$

$$Z_{ijt,15} = (\Delta \ln f_{ijt})^2 \qquad Z_{ijt,16} = \Delta \ln f_{ijt} \Delta \ln \overline{p}_{ijt} \qquad Z_{ijt,17} = \Delta \ln f_{ijt} \Delta \ln \lambda_{ijt}$$

$$Z_{ijt,18} = \Delta \ln f_{ijt} \Delta \ln \tau_{ijt} \qquad Z_{ijt,19} = \Delta \ln f_{ijt} \Delta \ln w_{it} \qquad Z_{ijt,20} = \Delta \ln f_{ijt} \Delta \ln L_{it}$$

$\xi_{ijt} = \frac{(\gamma+\sigma)\Delta\phi_{ijt}\Delta\psi_{ijt}}{(1+\gamma)(\sigma-1)}$, and over-bars denote time averages.

TABLE 1
DISTRIBUTION OF PARAMETER ESTIMATES

Percentile	Method 1		Method 2		Method 3		Method 4	
	σ	γ	σ	γ	σ	γ	σ	γ
1	2.53	0.62	1.89	0.63	3.03	0.91	2.32	0.63
5	3.13	1.46	3.07	1.34	3.97	1.76	3.54	1.66
10	3.74	1.86	3.72	1.91	4.47	2.42	4.30	2.18
25	4.70	3.35	4.79	3.54	5.40	3.60	5.48	3.57
50	6.49	6.11	6.58	6.37	7.11	5.69	7.49	5.97
75	9.55	11.84	9.70	12.77	9.62	9.47	10.39	9.62
90	18.24	26.15	19.10	26.40	14.26	16.88	16.50	16.80
95	29.23	47.71	29.85	49.26	20.54	29.94	22.79	24.85
99	89.48	284.46	102.54	246.34	79.07	115.26	71.03	87.93
Nb. of obs.	642	642	618	618	621	621	554	554

Notes: This table presents the distributions of the estimated structural parameters of the model obtained from estimating equation (85) separately for each industry of the 775 industries in the sample using each of our four specifications. The parameter σ is the elasticity of substitution and the parameter γ is the inverse elasticity of marginal costs. We do not include industries for which we obtain estimates of γ and σ that do not conform to the restrictions of the theoretical model. The number of industries for which the parameters do not conform to the model varies across estimation technique as shown at the bottom of the table. The share ranges from about 17 to 28 percent, which is in line with Broda and Weinstein (2006) 35 percent.

VI. Empirical Results

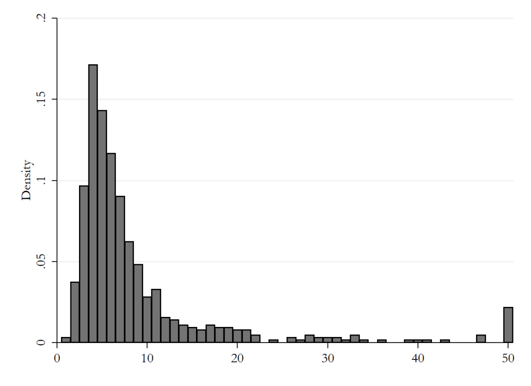


Figure 3
Frequency distribution for the elasticity of substitution (σ) using Specification 1

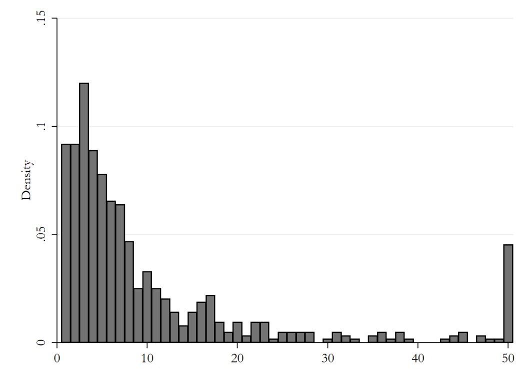


Figure 4
Frequency distribution for the inverse marginal cost elasticity (γ) using Specification 1

TABLE 2
WELFARE GAINS FROM TRADE, 2010

	(1)	(2)	(3)	(4)
	∞	12	6	3
3	16.53	15.41	14.43	12.81
5	10.45	9.71	9.06	8.00
7	7.64	7.09	6.61	5.82

Notes: This table presents the absolute value of the percentage change in real income associated with moving from the initial equilibrium to autarky given by $1 - \lambda_{ii}^{-1/\varepsilon}$, where λ_{ii} is domestic absorption. In our sample, the mean trade share is 39.3. We compute gains from trade under 12 different scenarios, each with different values for the structural parameters of the model as indicated in the table. The values for the Pareto distribution parameter (θ) varies across row, whereas the values for the inverse elasticity of marginal costs varies across columns. The benchmark is the constant marginal cost case, which corresponds to $\gamma = \infty$ reported in column (1).

VII. Numerical Analysis

TABLE 3
Welfare Gains from Trade for Selected Countries, 2010

Name	GDPPC	Trade Share	γ			
			∞	12	6	3
D.R. of the Congo	650	41.1	10.0	9.3	8.7	7.6
Nepal	1,807	9.6	2.0	1.8	1.7	1.5
Tajikistan	2,287	26.8	6.0	5.6	5.2	4.6
Republic of Moldova	3,737	39.2	9.5	8.8	8.2	7.2
Guatemala	6,293	25.8	5.8	5.4	5.0	4.4
China	9,423	26.3	5.9	5.5	5.1	4.5
Thailand	13,109	66.5	19.6	18.3	17.1	15.1
Gabon	13,151	57.7	15.8	14.7	13.7	12.1
Brazil	13,623	10.7	2.2	2.1	1.9	1.7
Argentina	16,043	18.9	4.1	3.8	3.5	3.1
Malaysia	20,192	86.9	33.4	31.3	29.4	26.3
Equatorial Guinea	24,971	85.8	32.3	30.2	28.4	25.3
Israel	30,538	35.0	8.3	7.6	7.1	6.3
Bahamas	31,413	35.0	8.2	7.6	7.1	6.2
Canada	39,877	29.1	6.6	6.1	5.7	5.0
Germany	40,481	42.3	10.4	9.6	9.0	7.9
Saudi Arabi	41,482	49.6	12.8	11.9	11.1	9.8
United States	49,907	12.3	2.6	2.4	2.2	2.0
Norway	57,900	39.7	9.6	8.9	8.3	7.3
Bermuda	62,290	49.7	12.8	11.9	11.1	9.8

Notes: This table presents the average change in welfare associated with moving autarky to free trade computed from (49) for the case of $\theta = 5$. We selected 20 countries that cover the range of GDPPC and geographical regions. To the extend possible, we choose the same countries as in Table 3.1 of Feenstra (2010) to facilite comparison.

VIII. Conclusions

TABLE 4
TRADE ELASTICITIES AND WELFARE MEASURES BY MODELS

Model	*Ad valorem* elasticity	Fixed cost elasticity	Welfare measure
Armington differentiation (Anderson, 1979)	$1-\sigma$	n.a.	n.a.
Armington differentiation and CET (Bergstrand, 1985)	$\frac{\gamma}{\gamma+\sigma}(1-\sigma)$	n.a.	n.a.
Monopolistic Competition (Krugman, 1980)	$1-\sigma$	n.a.	$\hat{\lambda}_{jj}^{-\frac{1}{\sigma-1}}$
Heterogeneity without fixed export costs (Eaton-Kortum, 2002)	$-\theta$	n.a.	$\hat{\lambda}_{jj}^{-\frac{1}{\theta}}$
Heterogeneity with fixed export costs (Melitz, 2003)	$-[\theta+(1-\sigma)]+(1-\sigma)$ $=-\theta$	$-\dfrac{\theta}{\sigma-1}$	$\hat{\lambda}_{jj}^{-\frac{1}{\theta}}$
Heterogeneity with fixed export costs and IMC (Current paper)	$-[\theta+\frac{\gamma}{\gamma+\sigma}(1-\sigma)]+\frac{\gamma}{\gamma+\sigma}(1-\sigma)$ $=-\theta$	$-\dfrac{\theta}{\frac{\gamma}{\gamma+\sigma}(\sigma-1)}$	$\hat{\lambda}_{jj}^{-\frac{1}{(1+\frac{1}{\gamma})\theta}}$

Notes: This table reports the *Ad valorem* trade elasticity, the fixed cost trade elasticity, and the measure of welfare under various theoretical assumptions as indicated in the first column.

Thank you