ECO 442: Quantitative Trade Models

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Asymmetric Trade Costs

In most of the models we've looked at, welfare gains from trade relatively small

- Look at cases where importance of trade is amplified

Asymmetric trade costs

- Poor countries have systematically higher trade costs, which reduces their TFP and welfare

Asymmetric Trade Costs

Waugh (2010) investigates whether differences in trade costs can explain differences in cross-country income per capita

- Uses an Eaton-Kortum (2003) framework
- Shows symmetric trade costs does a poor job fitting the data, while leaving little room for trade to matter
- Finds systematically asymmetric trade costs between rich and poor countries: eliminating these asymmetries would reduce cross-country inequality by one third

Taking Model to Data

In model have an expressions for wages, trade shares, and price indices for tradable goods.

Countries are characterized by labor supply, L_i, capital supply, K_i, technology parameter, λ_i, and trade costs $\{\tau_{ij}, \tau_{ji}\}_{j=1,\ldots,N}$

- Take L_i and K_i directly from data
- Trade costs often modeled using a symmetric gravity equation (distance, shared language, border, etc)
    - Use price data to show enforced symmetry is at odds with data
- λ_i backed out from model

Trade Data and Expenditure Shares

Sample of 76 countries

- Account for 90 percent of world GDP in base year, 1996
- Data on imports, exports, and gross production for 34 BEA manufacturing industries

Compute expenditure shares as

$$X_{ij} = \frac{\text{Imports}_{ij}}{\text{Gross Mfg. Production}_i - \text{Total Exports}_i + \text{Imports}_i}$$

Where Total Exports is for world, and Imports is just for sample. Can compute domestic expenditures as

$$X_{ii} = 1 - \sum_{\substack{j=1 \\ j \neq i}}^{N} X_{ij}$$

Computed Expenditure Shares

TABLE 1—1996 TRADE SHARE DATA, X_{ij}, IN PERCENT FOR SELECTED COUNTRIES

	US	Canada	Japan	Mexico	China	Senegal	Malawi	Zaire
US	83.25	39.73	2.27	31.62	3.63	2.16	1.57	2.93
Canada	3.78	49.21	0.21	0.72	0.32	0.56	0.67	0.51
Japan	3.04	2.01	92.56	1.59	6.99	1.34	2.65	0.82
Mexico	1.88	1.33	0.02	61.09	0.057	0.01	0	0.007
China	1.78	1.41	1.44	0.30	77.61	2.69	2.50	6.81
Senegal	0*	0*	0*	0	0*	52.68	0	0
Malawi	0*	0*	0*	0	0	0	41.52	0
Zaire	0.003	0.005	0.003	0*	0*	0	0	51.53

Notes: Entry in row i, column j, is the fraction of goods country j imports from country i. Zeros with stars indicate the value is less than 10^{-4}. Zeros without stars are zeros in the data.

Waugh (2010)

Computed Expenditure Shares

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Observation 1:"Home bias" for both rich and poor countries

Waugh (2010)

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Observation 2: Poor country expenditure shares high for goods from rich countries
(Rich) (low) (poor)

Waugh (2010)

Computed Expenditure Shares

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Observation 2A: Disparity in trade shares larger, the higher disparity is in relative income

- Run regression $\log X_{ji}/X_{ij} = \text{constant} + \beta_y \log y_j/y_i$. Constant is zero, $\beta_y = 2.40$

Waugh (2010)

Price Data

In model p_i are aggregate price indices for tradable goods

- Non-traded goods, plus not all tradable goods actually traded in equilibrium

Data from United Nations International Comparison Program (ICP)

- Collect prices on standardized basket of goods and services across countries
- Construct tradable price indices in 1996 using Penn World Table

Tradable Price Indices

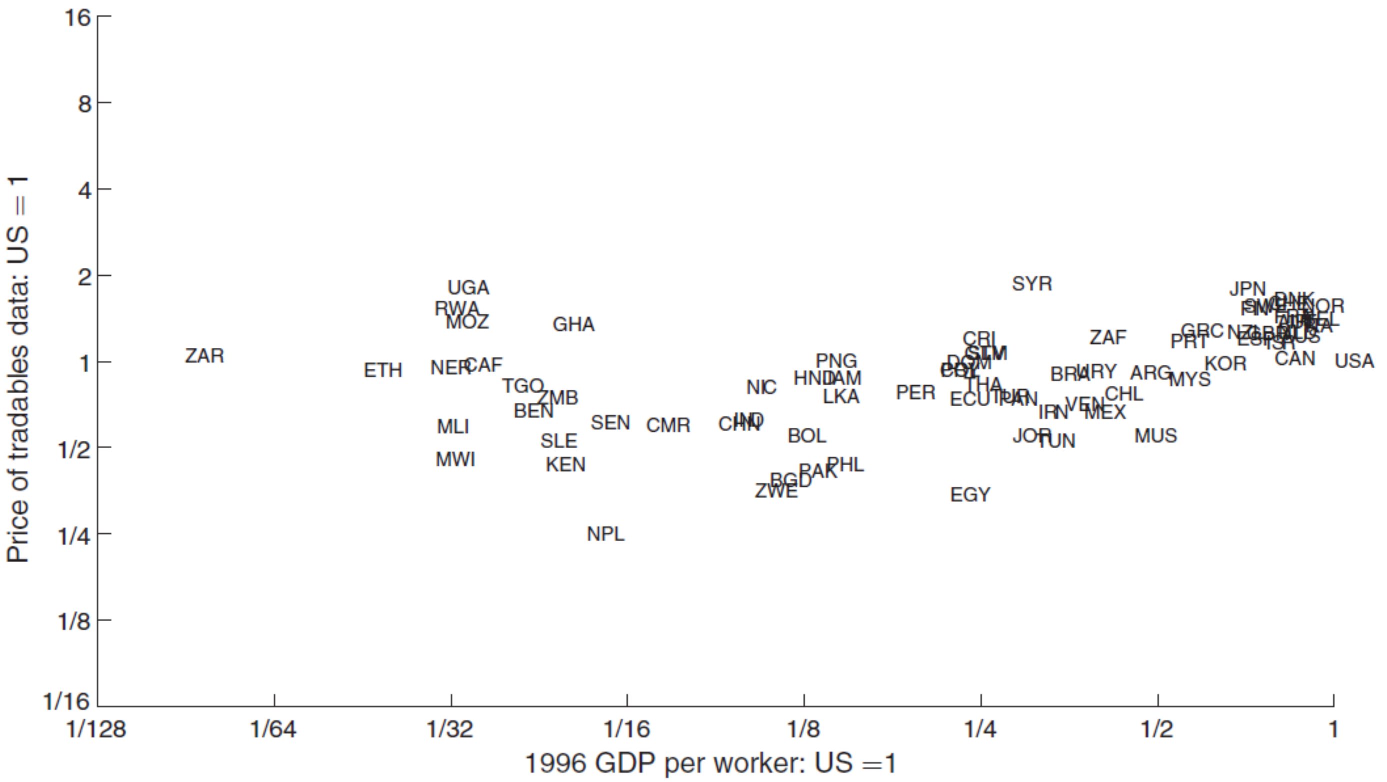

FIGURE 1. PRICE OF TRADABLE GOODS: SIMILAR BETWEEN RICH AND POOR COUNTRIES

Waugh (2010)

Tradable Price Indices

Observation 3: Tradable price indices similar between rich and poor countries

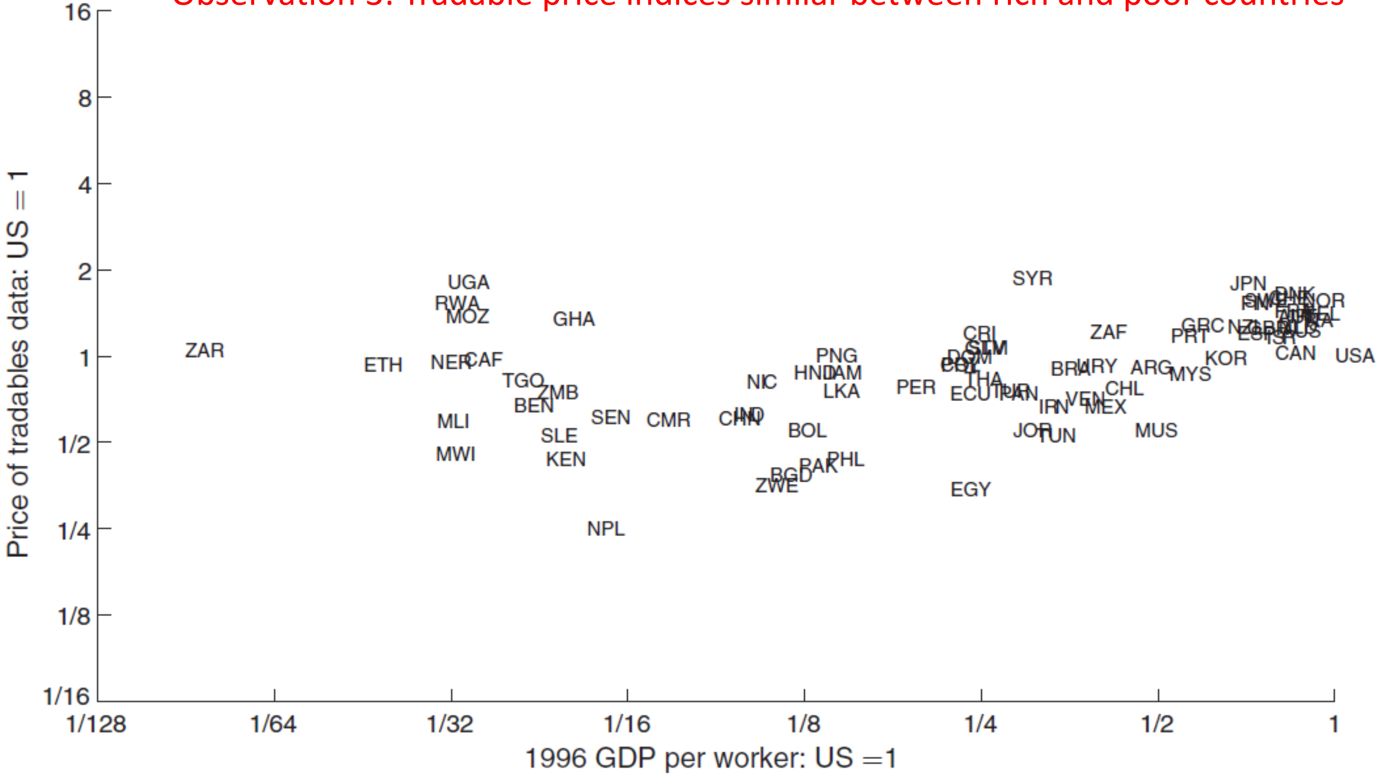

FIGURE 1. PRICE OF TRADABLE GOODS: SIMILAR BETWEEN RICH AND POOR COUNTRIES

Waugh (2010)

Implications and Arbitrage Condition

From equations for price indices and trade shares in model have

$$\frac{X_{ij}}{X_{jj}} = \tau_{ij}^{-\frac{1}{\theta}} \left(\frac{p_j}{p_i}\right)^{-\frac{1}{\theta}}$$

Which says that if $p_i > p_j$ then country i should purchase relatively more goods from country j

- Conversely, if trade costs high, should purchase relatively less goods from country j

Implications and Arbitrage Condition

Using previous equation twice

$$\left(\frac{X_{ij}}{X_{ji}}\frac{X_{ii}}{X_{jj}}\right)\left(\frac{p_j}{p_i}\right)^{\frac{2}{\theta}} = \left(\frac{\tau_{ij}}{\tau_{ji}}\right)^{-\frac{1}{\theta}}$$

- In symmetric world $(X_{ij}/X_{ji})(X_{ii}/X_{jj}) = 1$
- Deviations from symmetric trade shares occur because of asymmetries in prices or in trade costs
  - Didn't see evidence of systematic asymmetries in price indices of tradable goods
  - Indicates likely systematic asymmetries in trade costs

Modeling Asymmetric Trade Costs: General Problem

In model with N countries, have N^2 parameters to estimate, but only $N^2 - N$ informative moments

Parameters:

- Trade costs: τ_{ij}. Impose $\tau_{ii} = 1 \Rightarrow N^2 - N$ parameters
- Productivities: λ_i. N parameters

Informative Moments:

- Bilateral normalized trade share matrix: X_{ij}/X_{ii}. Identity $X_{ii}/X_{ii} = 1 \Rightarrow N^2 - N$ moments

Modeling Asymmetric Trade Costs, Option 1: Export Effects

Suppose trade costs determined by **exporter** effects

- $\{\tau_{21}, \tau_{31}\} = \bar{\tau}$, so cost for countries 2 and 3 to import from country 1 is same

Implication 1: Since normalized trade shares equal $(X_{21}/X_{22} = X_{31}/X_{33})$, therefore $w_2^{-\frac{1}{\theta}}\lambda_2 = w_3^{-\frac{1}{\theta}}\lambda_3$

- Cost of producing a good is the same on average across middle income and poor country

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- Cost of producing a good is the same on average across middle income and poor country

Implication 2: Since U.S. imports more from country 2 than country 3 $(X_{12} > X_{13})$, therefore $\tau_{12} < \tau_{13}$

- Higher trade costs for poor country (relative to middle income country) to export to rich country

Modeling Asymmetric Trade Costs, Option 1: Export Effects

Suppose trade costs determined by **exporter** effects

- $\{\tau_{21}, \tau_{31}\} = \bar{\tau}$, so cost for countries 2 and 3 to import from country 1 is same

Implication 3: Suppose unit costs (depend on wages and productivity) equal across countries 2 and 3.

- Balanced Trade implies

$$\frac{X_{12}}{X_{21}} = w_2 > \frac{X_{13}}{X_{31}} = w_3$$

- Therefore country 2 is more productive than country 3 $(\lambda_2 > \lambda_3)$, and also richer than country 3.

Modeling Asymmetric Trade Costs, Option 2: Importer Effects

Suppose trade costs determined by **importer** effects

- $\{\tau_{13}, \tau_{13}\} = \bar{\tau}$, so cost for countries 2 and 3 to export to country 1 is same

Implication 1: Since U.S. imports more from country 2 than country 3 $(X_{12} > X_{13})$, $\Rightarrow w_2^{-\frac{1}{\theta}}\lambda_2 > w_3^{-\frac{1}{\theta}}\lambda_3$

- Cost of producing a good is less on average in middle income country compared to poor country

Implication 2: Since normalized trade shares equal $(X_{21}/X_{22} = X_{31}/X_{33})$, therefore $\tau_{21} < \tau_{31}$

- Higher trade costs for poor country (relative to middle income country) to import from rich country

Modeling Asymmetric Trade Costs, Option 1: Import Effects

Suppose trade costs determined by **importer** effects

- $\{\tau_{13}, \tau_{13}\} = \bar{\tau}$, so cost for countries 2 and 3 to export to country 1 is same

Implication 3: Unit cost no longer equal across countries.

- Still have country 2 is more productive than country 3 $(\lambda_2 > \lambda_3)$

- To fit observed trade shares, need difference in productivities to be even larger

$$\underbrace{\lambda_2/\lambda_3}_{\text{import effects}} > \underbrace{\lambda_2/\lambda_3}_{\text{export effects}} > 1$$

Estimating Technology and Trade Costs: Benchmark

Benchmark is structural gravity equation as in Eaton-Kortum (2003)

$$\log\left(\frac{X_{ij}}{X_{ii}}\right) = S_j - S_i - \frac{1}{\theta}\log\tau_{ij}$$

Where S_i is a country fixed effect, and trade costs are modeled as

$$\log\tau_{ij} = d_k + b_{ij} + ex_j + \epsilon_{ij}$$

Where d_k is one of six distance intervals, b_{ij} is shared border dummy, ϵ_{ij} is trade costs from other factors

- ex_j is exporter fixed effect. In simple example $\{\tau_{21}, \tau_{31}\} = \bar{\tau} = \exp[ex_1]$

Estimating $\boldsymbol{\theta}$

Benchmark approach is to follow Eaton and Kortum (2002)

- Note that $\tau_{ij} \geq p_i(x)/p_j(x)\ \forall x$, otherwise arbitrage opportunity, therefore can estimate trade costs as

$$\log \hat{\tau}_{ij} = \underset{x}{\text{2ndmax}} \left\{ \log\left(p_i(x)\right) - \log\left(p_j(x)\right) \right\}$$

- Get the prices from the Penn World Table database

- Combine with normalized trade shares to back out θ

$$\frac{X_{ij}}{X_{jj}} = \tau_{ij}^{-\theta} \left(\frac{p_j}{p_i}\right)^{-\frac{1}{\theta}}$$

Recovering Technology

Country fixed effects are written as

$$S_i \equiv \log\left[r_i^{\alpha\beta/-\theta} w_i^{(1-\alpha)\beta/-\theta} p_i^{(1-\beta)/-\theta} \lambda_i\right]$$

Estimated gravity equation to get estimated $\hat{S}_i$ and $\hat{\tau}_{ij}$.

- α and β are from a Cobb-Douglas production function:

$$\alpha = \frac{\text{capital}}{\text{capital+labor}};\ \ \beta = \frac{\text{capital+labor}}{\text{capital+labor} + \text{intermediate inputs}}$$

- Get wages from bilateral trade shares $w_i = \sum_{j=1}^{N} \frac{L_j}{L_i} w_j X_{ji}$

- Get rental rates from capital-labor ratio. Then can back out technology parameters: λ_i

Exporter Effects Results

Estimate gravity equation with exporter effects

Summary statistics			
Observations	TSS	SSR	σ_ϵ^2
4,242	4,924	851	2.08

Geographic barriers

Barrier	Parameter estimate	Standard error	% effect on cost
[0, 375)	−4.66	0.21	133.3
[375, 750)	−5.60	0.14	177.1
[750, 1,500)	−6.16	0.09	206.3
[1,500, 3,000)	−7.22	0.06	271.3
[3,000, 6,000)	−8.44	0.04	363.9
[6,000, maximum]	−9.37	0.05	449.7
Shared border	0.77	0.16	−13.0

Note: All parameters were estimated by OLS. For an estimated parameter $\hat{b}$, the implied percentage effect on cost is $100 \times (e^{-\theta\hat{b}} - 1)$ with $\theta = 0.1818$.

Exporter Effects Results

Estimate gravity equation with exporter effects

TABLE 3—COUNTRY-SPECIFIC ESTIMATES (*benchmark model*)

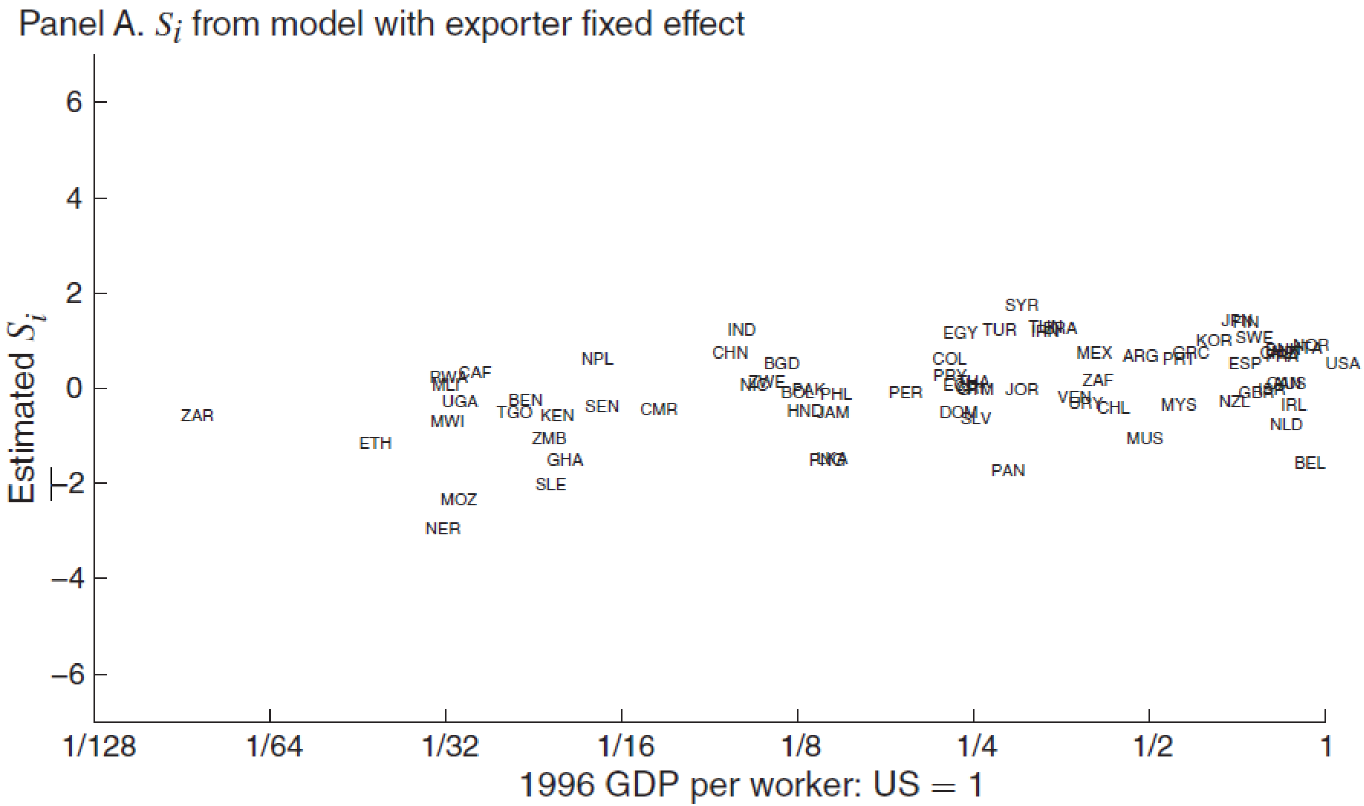
Country	ex_i	Standard error	Percent cost	$\hat{S}_i$	Standard error	$\left(\frac{\lambda_{us}}{\lambda_i}\right)^\theta$
United States	5.40	0.24	−62.5	0.54	0.17	1.00
Argentina	1.62	0.26	−25.5	0.69	0.19	1.60
Australia	2.50	0.25	−36.4	0.11	0.18	1.42
Austria	1.35	0.24	−21.8	0.77	0.17	0.93
Belgium	5.13	0.24	−60.7	−1.55	0.17	1.21
Benin	−3.71	0.41	96.3	−0.25	0.23	10.40
Bangladesh	−0.43	0.27	8.03	0.54	0.21	2.92
Bolivia	−2.61	0.31	60.7	−0.09	0.21	3.83
Brazil	2.21	0.25	−33.0	1.27	0.18	1.30
Central African Republic	−4.04	0.52	109	0.33	0.24	3.46
Canada	3.32	0.24	−45.2	0.11	0.17	0.99
Switzerland	2.19	0.24	−32.8	0.75	0.17	0.75
Chile	2.40	0.26	−35.2	−0.39	0.18	1.89

Exporter Fixed Effects Higher for Poorer Countries

Figure 2. Exporter Fixed Effect: Easy for Rich Countries to Export, Difficult for Poor Countries

Waugh (2010)

Implied Prices for Exporter Fixed Effects



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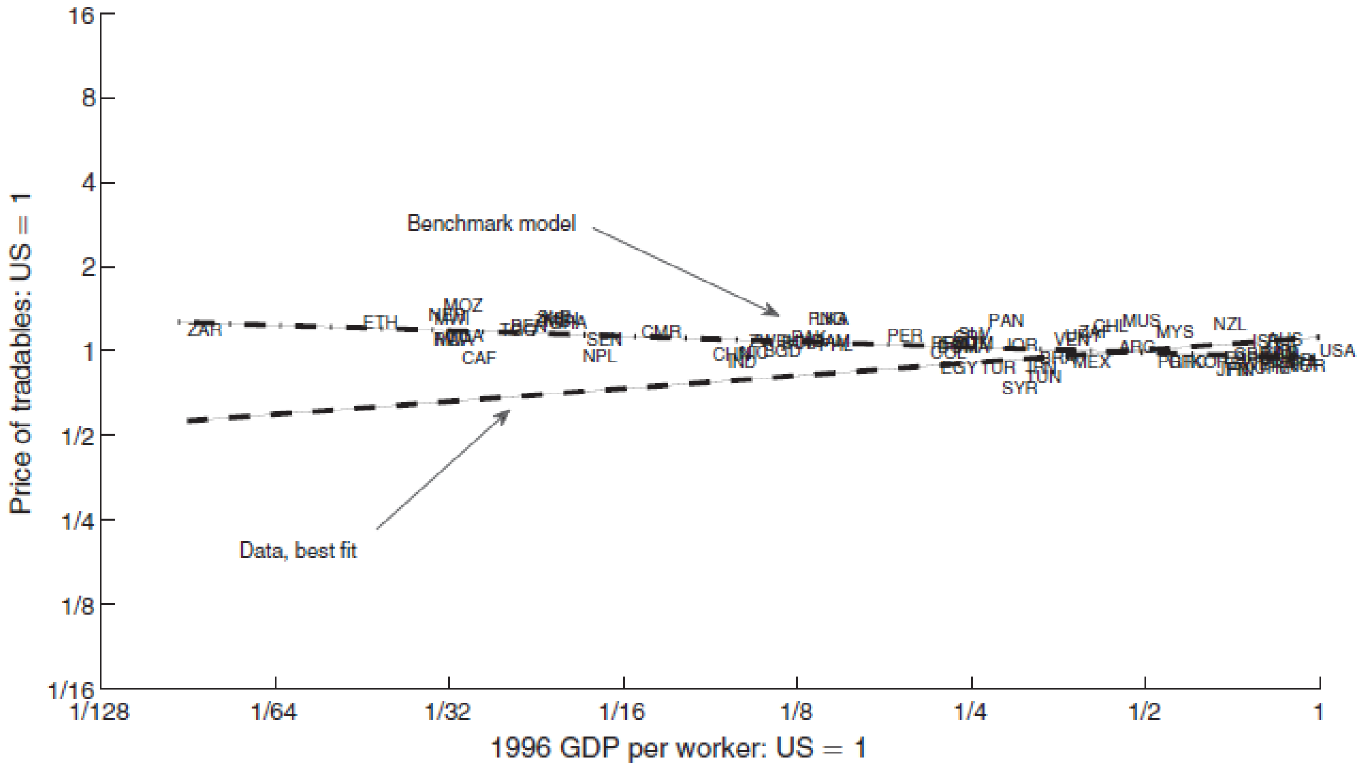
Implied Prices for Exporter Fixed Effects

Panel A. Price data and benchmark model



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Income in Model vs Data

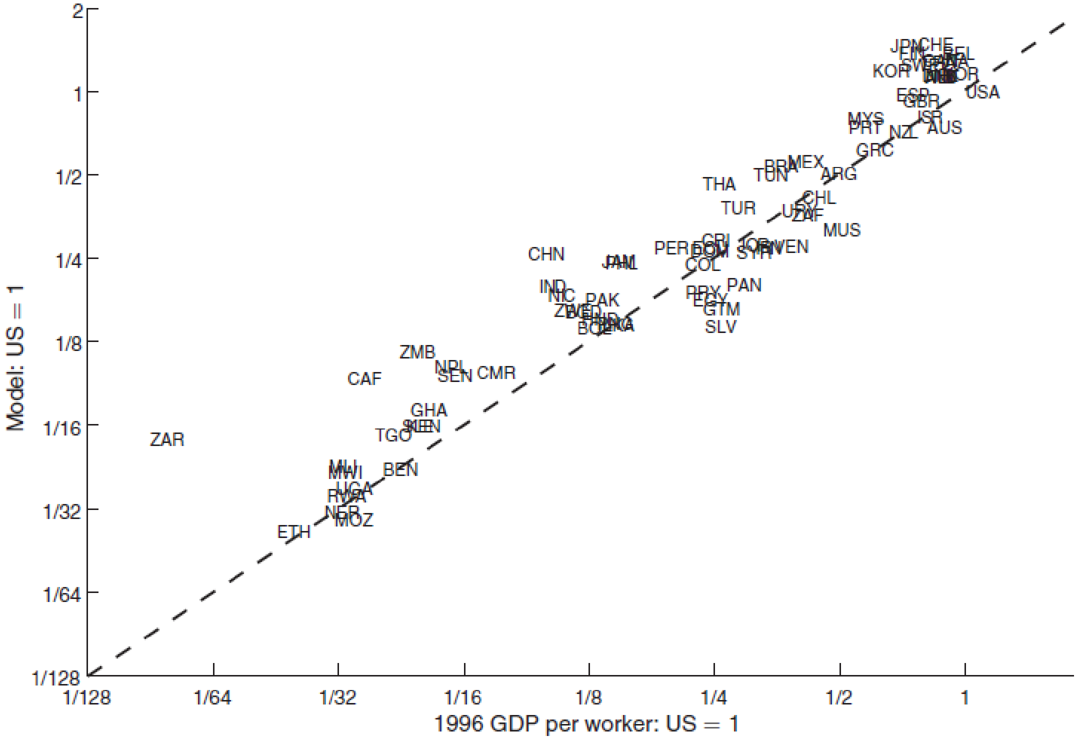

FIGURE 5. INCOME PER WORKER: DATA AND BENCHMARK MODEL

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Welfare Gains From Trade

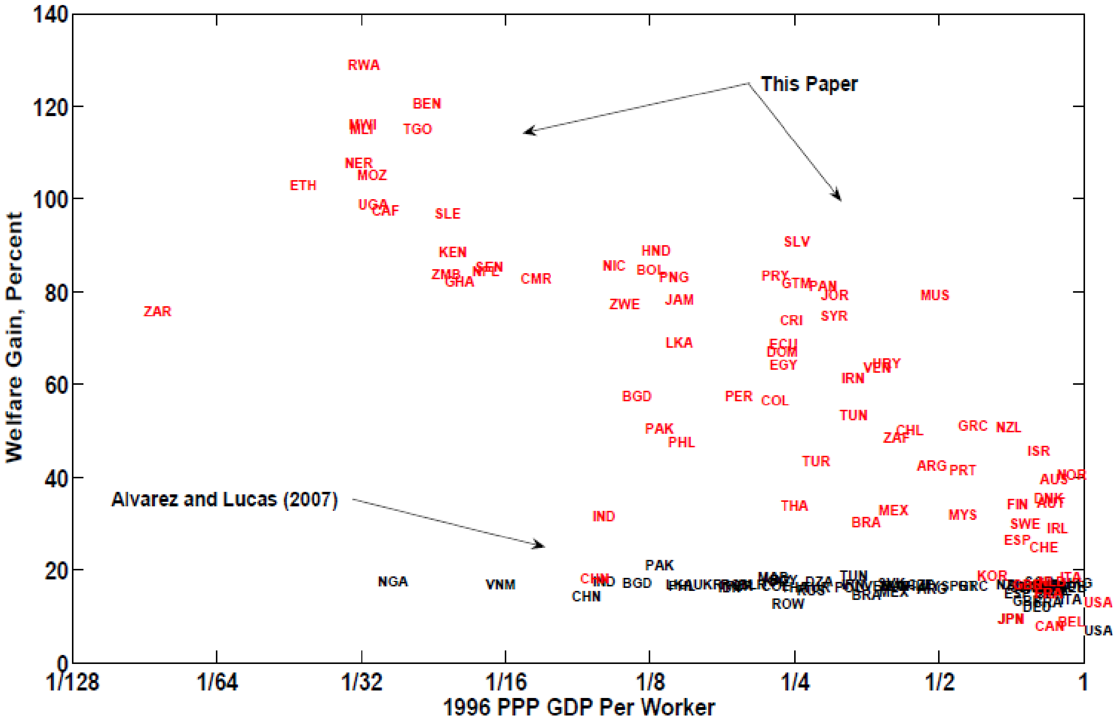

Figure 8: Welfare Gains: Calibrated Model to Frictionless Trade

Waugh (2010)