Measuring the Unequal Gains From Trade

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Motivation

- What is the distributional impact of international trade?
  - Predominant focus has been on the effects of trade on earnings
- Distributional effects also work through the expenditure channel
  - Differences in consumption patterns between rich and poor consumers
    - E.g., food share is larger for the poor
  - Trade changes the price distribution, differentially affecting individuals with different consumption patterns
    - E.g., in a food-importing country, shutting down trade may hurt poor consumers
- Research questions
  - How important are the distributional effects of trade through the expenditure channel?
  - How do they vary across countries?

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This Paper

- Develop a methodology to measure unequal gains from trade across consumers through the expenditure channel
  - Applicable over countries and time
  - Based on aggregate statistics and model parameters estimated from bilateral trade and production data
    - aggregate expenditure shares by sector and country of origin
    - moments from the income distribution within a country

- Similar spirit as literature on aggregate gains from trade (Costinot and Rodriguez-Clare, 2013)
  - Typically, estimate parameters from a gravity equation (price elasticity of imports) to determine the aggregate gains from trade
  - We estimate parameters from a non-homothetic gravity equation (price and income elasticity of imports) to determine unequal gains from trade

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Overview

1. Demand-side result
   - Use Almost-Ideal Demand, which allows for good-specific Engel curves
   - Aggregate statistics and parameters sufficient to measure unequal welfare changes from price shocks
2. Embed into a quantitative trade environment
   - Multi-sector Armington Model + Almost-Ideal Demand
   - Unequal gains measured by aggregate import shares and demand parameters
3. Estimate a non-homothetic gravity equation implied by the model
   - Richer countries export high-income elastic goods
4. Measure the unequal gains from autarky to trade (single sector)
   - U-shaped gains from trade across consumers
   - Cross-country variation in pro-poor bias of trade based on income elasticity of exports and imports
5. Multi-sector analysis
   - Gains strongly pro-poor relative to single-sector estimation

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Literature

- Measuring gains from trade
  - Aggregate: Arkolakis et al. (2011), Feenstra and Weinstein (2010), Melitz and Redding (2014).
  - Multi-Sector: Costinot and Rodriguez-Clare (2013), Ossa (2012)
- Patterns of trade with non-homothetic demand
  - Theory: Fajgelbaum et al. (2011), Flam and Helpman (1987), Markusen (1986), Matsuyama (2000).
  - Empirics: Caron et al. (2012), Feenstra and Romalis (2014), Fieler (2011), Hallak (2006, 2010).
- Translog and AIDS demand in trade
  - Translog: Arkolakis (2012), Feenstra (2010), Feenstra and Weinstein (2010), Novy (2012).
  - AIDS: Atkin (2013), Chaudhuri, Goldberg and Gia (2016).
- Country studies on the expenditure channel
  - Broda and Romalis (2009), Faber (2013), Porto (2006).
- Trade and inequality through earnings channel
  - Goldberg and Pavnick (2007),
  - Feenstra and Hanson (1996), Helpman et al. (2012), Frias et al. (2012), Burstein and Vogel (2012),...

Outline

1. Demand-side result
2. Embed into a quantitative trade environment (single sector)
3. Estimate the non-homothetic gravity equation
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Environment

- J final consumption goods $j = 1, \ldots, J$ with price vector $\mathbf{p} = \{p_j\}_{j=1}^{J}$
  - Good = "manufactures from China"
- $h = 1, \ldots, H$ consumers
  - Expenditure level x_h
  - $s_{j,h}$: expenditure share of consumer h in good j
- S_j: Aggregate expenditure share in good j
- Assumptions about supply come later

Decomposition: Individual and Aggregate Effects

- $\widehat{w}_h$: equivalent variation of consumer h due to $\{\widehat{p}_j\}_{j=1}^{J}$: det. CES

$$\widehat{w}_h = \sum_{j=1}^{J} (-\hat{p}_j)\, s_{j,h}$$

Rewrite as

$$\hat{w}_h = \underbrace{\sum_{j=1}^{J} (-\widehat{p}_j)\, S_j}_{\widehat{W}} + \underbrace{\sum_{j=1}^{J} (-\widehat{p}_j)\,(s_{j,h} - S_j)}_{\widehat{\psi}_h}$$

- Need to measure the price changes $\{\hat{p}_j\}$ caused by trade
  - Use a trade model to generate $\{\hat{p}_j\}$ from $\{S_j\}$ and parameters
- Need to measure $\{s_{j,h} - S_j\}$ across income groups
  - Rarely available when j varies by origin
  - Impose non-homothetic demand to generate $\{s_{j,h} - S_j\}$ from x_h and parameters

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Almost-Ideal Demand

- Indirect utility of consumer h with expenditure level x_h

$$v(x_h, \mathbf{p}) = F\left[\left(\frac{x_h}{a(\mathbf{p})}\right)^{\frac{1}{b(\mathbf{p})}}\right]$$

where

- $b(\mathbf{p}) = exp\left(\sum_{j=1}^{J} \beta_j \ln p_j\right)$ (rel. price of high-income elastic goods)
- $a(\mathbf{p})$ = price index if preferences are homothetic (translog form) det

- Expenditure share in good j for consumer h:

$$s_{j,h} = s_j(x_h, \mathbf{p}) = \alpha_j + \sum_{k=1}^{J} \gamma_{jk} \ln p_k + \beta_j \ln\left(\frac{x_h}{a(\mathbf{p})}\right)$$

- First-order approximation to arbitrary demand structure
- $\frac{ds_{j,h}}{dx_h} > 0 \leftrightarrow \beta_j > 0$
- Representative consumer: $S_j = s_j(\widetilde{x}, \mathbf{p})$ where $\widetilde{x} = \overline{x}e^{theil\{x\}}$

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Almost-Ideal Demand

Summary Statistics for Unequal Welfare Changes

- Welfare change of consumer h from price changes $\widehat{\mathbf{p}}$

$$\widehat{w}_h = \widehat{W} + \widehat{\psi}_h$$

- $\hat{b}$ summarizes unequal welfare changes through expenditure channel

$$\begin{aligned}
\widehat{\psi}_h &= \sum_{j=1}^{J} (-\widehat{p}_j) \left(s_{j,h} - S_j \right) \\
&= \sum_{j=1}^{J} (-\widehat{p}_j) \, \beta_j \ln \left(\frac{x_h}{\widetilde{x}} \right) \\
&= -\underbrace{\mathbb{COV}\left[\{\beta_j\}_{j=1}^{J}, \{\hat{p}_j\}_{j=1}^{J} \right]}_{\hat{b}} \times \ln \left(\frac{x_h}{\widetilde{x}} \right)
\end{aligned}$$

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Summary Statistics for Unequal Welfare Changes

- Welfare change of consumer h from price changes $\widehat{\mathbf{p}}$

$$\widehat{w}_h = \widehat{W} - \hat{b} \times \ln\left(\frac{x_h}{\widetilde{x}}\right)$$

- Vector notation for the aggregate shares:

$$\mathbf{S} = \alpha + \Gamma \ln \mathbf{p} + \beta y$$

where $y = \ln\left(\frac{\tilde{x}}{a(\mathbf{p})}\right)$

  - Implies $\widehat{\mathbf{p}} = \Gamma^{-1}(d\mathbf{S} - \beta dy)$

- $\{\mathbf{S}, d\mathbf{S}, dy\}$ and $\{\beta, \Gamma\}$ are sufficient to measure $\left\{\widehat{W}, \hat{b}\right\}$

$$\widehat{W} = \mathbf{S}'\Gamma^{-1}(d\mathbf{S} - \beta dy),$$
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International Trade Environment

- Armington Trade Environment
  - $i = 1, \ldots, N$ countries, each country produces a different good
    - ★ $p_{in} = \tau_{in} p_{nn}$ price in i for good from n
  - Labor is the only factor of production
    - ★ z_h = effective units of labor of consumer h, has Theil index Σ_i
    - ★ earnings of consumer h in country i: $x_h = z_h * p_{ii}$
- Aggregate import share of importer i on goods from exporter n

$$S_{in} = \alpha_n + \sum_{n'=1}^{N} \gamma_{nn'} \ln (p_{in'}) + \beta_n y_i,$$

where $y_i = \ln \left(\frac{\bar{x}_i e^{\Sigma_i}}{a(\mathbf{p}_i)} \right)$

- We assume symmetric $\gamma_{nn'}$:

$$\gamma_{nn'} = \begin{cases} \frac{\gamma}{N} & \text{if } n \neq n' \\ -\left(1 - \frac{1}{N}\right)\gamma & \text{if } n = n' \end{cases}$$

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Changes in Trade Costs

- Consider moving from $\{\tau_{in}^{A}\}$ to $\{\tau_{in}^{B}\}$
  - Welfare change of individual h in country i

$$\omega^{A \to B}(x_h) = \left(\frac{W_i^B}{W_i^A}\right)\left(\frac{x_h}{\tilde{x}_i}\right)^{-\ln\left(\frac{b_i^B}{b_i^A}\right)}$$

Changes in Trade Costs: Aggregate Effect

- Consider moving from $\{\tau_{in}^{A}\}$ to $\{\tau_{in}^{B}\}$
  - Welfare change of individual h in country i first-order

$$\omega^{A\to B}(x_h) = \left(\frac{W_i^B}{W_i^A}\right)\left(\frac{x_h}{\tilde{x}_i}\right)^{-\ln\left(\frac{b_i^B}{b_i^A}\right)}$$

  - Welfare change to the representative consumer:

$$\frac{W_i^B}{W_i^A} = \left(\frac{W_{H,i}^B}{W_{H,i}^A}\right)\left(\frac{W_{NH,i}^B}{W_{NH,i}^A}\right)$$

where

$$\frac{W_{H,i}^B}{W_{H,i}^A} = e^{\frac{1}{2\gamma}\left(\sum_{n=1}^{N}\left(S_{in}^B\right)^2 - \sum_{n=1}^{I}\left(S_{in}^A\right)^2\right) - \frac{1}{\gamma}\left(S_{ii}^B - S_{ii}^A\right)}$$

$$\frac{W_{NH,i}^B}{W_{NH,i}^A} = e^{\frac{1}{\gamma}\beta_i\left(y_i^B - y_i^A\right) - \frac{1}{\gamma}\sum_n \beta_n \int_A^B S_{in} dy_i(\{S_{in}\})}$$

where y_i^B is a closed-form function of y_i^A, $\{S_{in}\}$ and parameters

Changes in Trade Costs: Unequal Gains

- Consider moving from $\{\tau_{in}^{A}\}$ to $\{\tau_{in}^{B}\}$
  - Welfare change of individual h in country i first-order

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  - Change in relative price of high-income elastic goods

$$\ln\left(\frac{b_i^B}{b_i^A}\right) = \frac{1}{\gamma}\left[\left(y_i^B - y_i^A\right)\sigma_\beta^2 - \sum_{n=1}^{N}\beta_n\left(S_{in}^B - S_{in}^A\right)\right]$$

    - ★ y_i^B is a closed-form function of $y_i^A, \{S_{in}\}$ and parameters
    - ★ σ_β^2 is the variance of the $\{\beta_n\}$
  - Autarky counterfactual:

$$\ln\left(\frac{b_i^{au}}{b_i^{tr}}\right) = \frac{1}{\gamma}\left[\left(y_i^{au} - y_i^{tr}\right)\sigma_\beta^2 - \left(\beta_i - \sum_{n=1}^{N}\beta_n S_{in}^{tr}\right)\right]$$

Changes in Trade Costs: Unequal Gains

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$$\ln\left(\frac{b_i^{au}}{b_i^{tr}}\right) = \frac{1}{\gamma}\left[\left(y_i^{au} - y_i^{tr}\right)\sigma_\beta^2 - \left(\beta_i - \sum_{n=1}^{N}\beta_n S_{in}^{tr}\right)\right]$$

Non-Homothetic Gravity Equation

- Impose market clearing to get the gravity equation:

$$\frac{X_{in}}{Y_i} = \frac{Y_n}{Y_W} - \gamma T_{in} + \beta_n \Omega_i$$

  - T_{in} is function of $\{\tau_{in}\}$ and $\{Y_n\}$ detail
    - ★ captures resistance to trade through geography
  - Ω_i is function of $\left\{\frac{\tilde{x}_n}{a_n}\right\}$ and $\{Y_n\}$ detail
    - ★ captures resistance to trade through non-homothetic tastes

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Data

- World Input-Output Database, *WIOD*
  - Bilateral trade and production data
    - Same source as Costinot and Rodriguez Clare (2014 Handbook Ch.)
  - 27 EU countries and 13 other major economies
  - Can distinguish between total and final consumption expenditures
- CEPII's *Gravity* database
  - Bilateral distance
- Penn World Table
  - Price levels, GDPPC, population
- World Income Inequality Database
  - Gini coefficients across countries (maps to Theil index under lognormal)

Estimating Equation

- Introduce iid error and estimate:

$$S_{in} = \frac{Y_n}{Y_W} - \gamma T_{in} + \beta_n \Omega_i + \epsilon_{in}$$

  - Assume $\tau_{in} = d_{in}^{\rho}$, set $\rho = 0.177$ following Novy (2012)
  - construct Ω_i from data using the Gini and assuming log-normal expenditure distribution details

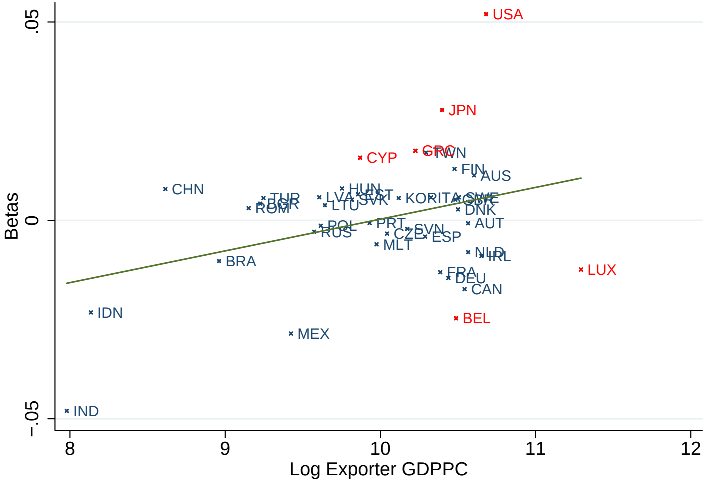
Baseline Estimates

	(1)	(2)	(3)	(4)
$-D_{ni}$	0.095 ***	0.043 ***	0.053 ***	0.045 ***
	(0.004)	(0.005)	(0.006)	(0.005)
L_{ni}		0.131 ***	0.159 ***	0.137 ***
		(0.021)	(0.031)	(0.022)
$Border_{ni}$		0.135 ***	0.115 ***	0.139 ***
		(0.023)	(0.027)	(0.024)
Ω_i x Exporter Dummies		not displayed		
Exporter FEs	no	no	yes	no
Observations	1,600	1,600	1,600	1,600
R-squared	0.35	0.47	0.52	0.46
Implied γ	0.54	0.24	0.30	0.26

(1),(2): Baseline
(3): Exporter FEs instead of $\frac{Y_n}{Y_W}$
(4): Final Expenditures

Feenstra and Weinstein (2010): $\gamma = 0.19$; Novy (2012): $\gamma = 0.17$

Richer Countries Export High-Income Elastic Goods



Red denotes statistically significant coefficient

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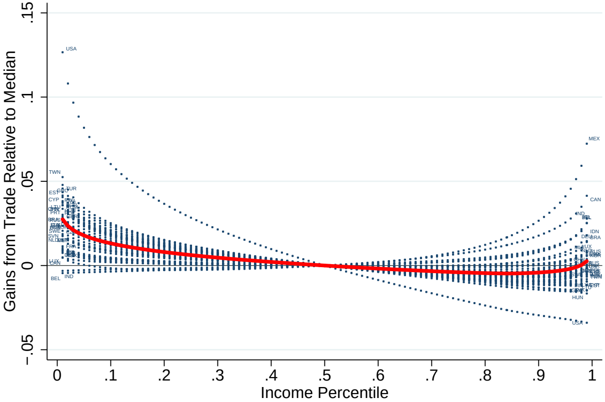
The Unequal Gains from Trade

Real Income Loss from Going to Autarky for Percentile h in country i agg.

$$1 - \frac{w_h^{au}}{w_h^{tr}} = 1 - \frac{W_{i,h}^{au}}{W_{i,h}^{tr}} \left(\frac{b_{i,h}^{au}}{b_{i,h}^{tr}} \right)^{\sigma_i(1-z_h)}$$



The deviations are relative to the median individual.
The red line is the average across countries

+median final exp +non-services only

Determinants of the Unequal Gains

- What determines the cross-country heterogeneity in the pro-poor bias of trade?

$$\ln\left(\frac{b_i^{au}}{b_i^{tr}}\right) = \frac{1}{\gamma}\left[\left(y_i^{au} - y_i^{tr}\right)\sigma_\beta^2 - \left(\beta_i - \sum_{n=1}^{N}\beta_n S_{in}^{tr}\right)\right]$$

  - Income Elasticity of Exports (Specialization)
    - ★ Trade is more pro-poor in more positive-beta exporters bhat 9010
  - Income Elasticity of Imports (Geography)
    - ★ Trade is less pro-poor closer to positive-beta exporters bhat 9010

Outline

1. Demand-side result
2. Embed into a quantitative trade environment (single sector)
3. Estimate the non-homothetic gravity equation
4. Measure the unequal gains from trade
5. Multi-sector analysis

Multi-Sector Model

- Extended Environment
  - $i = 1, .., N$ countries, $s = 1, .., S$ sectors, $N * S$ goods
- Expenditure share in country i in sector s from exporter n

$$S_{in}^{s} = \alpha_{in}^{s} + \sum_{s'=1}^{S} \sum_{n'=1}^{N} \gamma_{nn'}^{ss'} \ln p_{in'}^{s'} + \beta_{n}^{s} y_i$$

  - Income elasticity β_n^s varies by exporter n and sector s
  - Price elasticity γ^s varies by sector:

$$\gamma_{nn'}^{ss'} = \begin{cases} \frac{\gamma^s}{N} & \text{if } s = s' \text{and } n' \neq n \\ -\left(1 - \frac{1}{N}\right)\gamma^s & \text{if } s = s' \text{ and } n' = n \\ 0 & \text{if } s \neq s' \end{cases}$$

  - "Cobb-Douglas" shares:

$$\alpha_{in}^{s} = \alpha_n \left(\alpha^s + \varepsilon_i^s\right)$$

Sectoral Non-Homothetic Gravity Equation

- Sector-level non-homothetic gravity for $s = 1, .., S$

$$\frac{X_{in}^s}{Y_i} = \frac{Y_n^s}{Y_W} + (S_i^s - S_W^s)\,\alpha_n - \gamma^s T_{in}^s + \tilde{\beta}_n^s \Omega_i$$

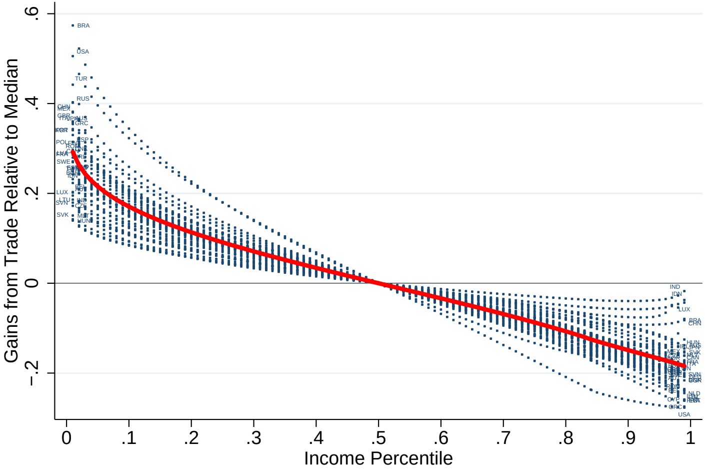
  - Aggregates to gravity equation from single-sector model
  - Only $\tilde{\beta}_n^s = \beta_n^s - \alpha_n \bar{\beta}^s$ is identified
  - Engel curve identifies non-homotheticity across sectors:

$$S_i^s = \alpha^s + \bar{\beta}^s y_i + \varepsilon_i^s$$

- We estimate $\{\beta_n^s\}_{n,s}$ and $\{\gamma^s\}_s$
  - betas
  - gammas

- We develop formulas for the unequal gains with multiple sectors detail

The Unequal Gains from Trade (Multi-Sector Model)

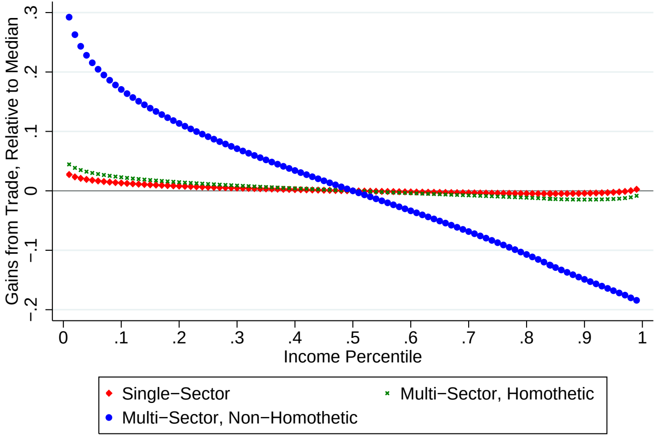


The deviations are relative to the median individual.
The red line is the average across countries

table non-services non-services vs all final exp 9010

Unequal Gains from Trade: Single- vs Multi-Sector

- Average GFT by percentile across countries in 3 cases
  - Single-Sector: $\bar{\beta}^s = 0$ and $\gamma^s = \frac{1}{S}\gamma$ for all s,
  - Multi-Sector, homothetic: $\bar{\beta}^s = 0$ for all s, $\{\gamma^s\}$ varies by sector,
  - Multi-Sector, non-homothetic: $\bar{\beta}^s$ and $\{\gamma^s\}$ vary by sector



The deviations are relative to the median individual.
Figure shows averages across countries, by percentile

Why Does Sectoral Heterogeneity Matter?

- Under sectoral heterogeneity
  - Relative effects across percentile larger (relative to single-sector)
  - Gains from trade favor the poor
    - 10^{th} percentile: GFT=70%
    - 90^{th} percentile: GFT=27%
- Main differences between single-sector and multi-sector
  - Low-income consumers spend more on tradable sectors fig
  - Low-income consumers spend more on sectors with lower γ_s fig

Conclusion

- Develop a methodology to measure unequal welfare changes across consumers through the expenditure channel
  - Applicable to many countries over time
  - Welfare changes measured with aggregate statistics and model parameters
- Measure of the unequal gains from trade
  - Gains from trade are typically U-shaped
  - Specialization patterns and geography shape these patters
  - Sector non-homotheticities bias gains from trade toward the poor

Appendix

Equivalent Variation

- $\hat{v}_h$: change in indirect utility of consumer h due to $\{\widehat{p}_j\}_{j=1}^J$

$$\hat{v}_h = \sum_{j=1}^{J} \frac{\partial \ln v(x_h, \mathbf{p})}{\partial \ln p_j} \hat{p}_j$$

- $\hat{w}_h$: equivalent variation to consumer h

$$\widehat{v}_h = \frac{\partial \ln v(x_h, \mathbf{p})}{\partial \ln x_h} \widehat{w}_h$$

- Roy's identity implies

$$\widehat{w}_h = \sum_{j=1}^{J} (-\hat{p}_j) s_{j,h}$$

back

Welfare with CES Demand and No Heterogeneity

$$\widehat{w} \equiv \sum_{j=1}^{J} (-\widehat{p}_j) \, S_j$$

- With CES demand,

$$(-\widehat{p}_j) = \frac{\widehat{S}_j - \widehat{S}_k}{\sigma - 1} - \widehat{p}_k$$

  leading to

$$\widehat{w} \equiv -\frac{1}{\sigma - 1}\widehat{S}_k - \widehat{p}_k$$

- Only one expenditure share and price matters
  - In Armington, implies the formula in Arkolakis et al. (2012) for the welfare change in country k

back

Almost-Ideal Demand

- Indirect utility of consumer h with expenditure level x_h

$$v(x_h, \mathbf{p}) = F\left[\left(\frac{x_h}{a(\mathbf{p})}\right)^{\frac{1}{b(\mathbf{p})}}\right]$$

  where

  - $b(\mathbf{p}) = exp\left(\sum_{j=1}^{J} \beta_j \ln p_j\right)$ (rel. price of high-income elastic goods)
  - $a(\mathbf{p}) = exp\left(\underline{\alpha} + \sum_{j=1}^{J} \alpha_j \ln p_j + \frac{1}{2}\sum_{j=1}^{J}\sum_{k=1}^{J} \gamma_{jk} \ln p_j \ln p_k\right)$ back

First-Order Approximation to Aggregate Welfare Change

- Welfare change of individual h in country i

$$\widehat{w}_h = \widehat{W}_i - \hat{b}_i \times \ln\left(\frac{x_h}{\widetilde{x}}\right)$$

  - Welfare change to the representative consumer:

$$\widehat{W}_i = \sum_n S_{in}\left(-\hat{p}_{in}\right)$$

  - Terms-of-trade changes ($\hat{p}_{ii} \equiv 0$):

$$\hat{p}_{in} = -\frac{1}{\gamma}\left(dS_{in} - dS_{ii}\right) + \frac{1}{\gamma}\left(\beta_n - \beta_i\right) dy_i$$

- Leads to

$$\widehat{W}_i = \underbrace{\frac{1}{\gamma}\left(\sum_{n=1}^{N} S_{in} dS_{in} - dS_{ii}\right)}_{\widehat{W}_{H,i}} + \underbrace{\frac{1}{\gamma}\left(\beta_i - \sum_n \beta_n S_{in}\right) dy_i}_{\widehat{W}_{NH,i}}$$

where

$$dy_i = \frac{\sum_{n=1}^{N} S_{in} dS_{in} - dS_{ii} - y_i \sum_n \beta_n dS_{in}}{\sum_n \beta_n S_{in} - \beta_i + \gamma - \sigma_\beta^2 y_i}$$

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back

First-Order Approximation to Individual Welfare Change

- Welfare change of individual h in country i

$$\widehat{w}_h = \widehat{W}_i - \hat{b}_i \times \ln\left(\frac{x_h}{\widetilde{x}}\right)$$

  - Change in non-homothetic price index:

$$\hat{b}_i = \sum_n \beta_n \left(-\hat{p}_{in}\right)$$

  - Terms-of-trade changes ($\hat{p}_{ii} \equiv 0$):

$$\hat{p}_{in} = -\frac{1}{\gamma}\left(dS_{in} - dS_{ii}\right) + \frac{1}{\gamma}\left(\beta_n - \beta_i\right) dy_i$$

- Leads to:

$$\hat{b}_i = \frac{1}{\gamma}\left(\sigma_\beta^2 dy_i - \sum_n \beta_n dS_{in}\right)$$

where

$$dy_i = \frac{\sum_{n=1}^{N} S_{in} dS_{in} - dS_{ii} - y_i \sum_n \beta_n dS_{in}}{\sum_n \beta_n S_{in} - \beta_i + \gamma - \sigma_\beta^2 y_i}$$

back

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$$dy_i = \frac{\sum_{n=1}^{N} S_{in} dS_{in} - dS_{ii} - y_i \sum_n \beta_n dS_{in}}{\sum_n \beta_n S_{in} - \beta_i + \gamma - \sigma_\beta^2 y_i}$$

back

Zeros in Counterfactual Scenario

- Restriction $s_{in} \geq 0$ may bind. Follow Feenstra (2010):
  - Treat negative-share goods as not consumed, find consumer-specific reservation prices.
  - Define effective prices for each consumer
    - ★ deliver same welfare to the consumer as actual prices
    - ★ effective price changes between trade and autarky necessarily vary across consumers
- To read consumer-h effective prices, use aggregate shares:

$$S_{in,h} = s_{in,h} - \beta_n \ln \left(\frac{x_h}{\tilde{x}_i} \right)$$

back

Zeros in 2x2 Example

- 2 countries (US and CH) with $\beta_{CH} < 0 < \beta_{US}$
  - 3 consumer groups in CH, $x_P < \tilde{x}_{CH} < x_R$
  - Normalize $p_{CH,CH} = 1$
  - $p^{tr}_{CH,US}, p^{au}_{CH,US}$ are relative price of US goods in CH under tr and au

- Actual autarky prices satisfy $s_H\left(x_R, p^{au}_{CH,US}\right) = 0$
  - For consumer x_P, effective autarky price is $p^{au}_{CH,US}(x_P) \in \left(p^{tr}_{CH,US}, p^{au}_{CH,US}\right)$
  - $p > p^{au}_{CH,US}(x_P)$ has same welfare implications for x_P than $p^{au}_{CH,US}(x_P)$

- Therefore, effective price changes are consumer-specific
  - Effectively, x_R faces actual price changes $p^{au}_{CH,US}/p^{tr}_{CH,US} > 1$
  - Effectively, x_P faces $p^{au}_{CH,US}(x_P)/p^{tr}_{CH,US} \in \left(1, p^{au}_{CH,US}/p^{tr}_{CH,US}\right)$
  - To read the latter, use that, by construction,

$$S^{au}_{CH,US} = s^{au}_{CH,US} - \beta_{US} \ln\left(\frac{x_P}{\tilde{x}_{CH}}\right)$$

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  - To read the latter, use that, by construction,

$$S^{au}_{CH,US} = s^{au}_{CH,US} - \beta_{US} \ln\left(\frac{x_P}{\tilde{x}_{CH}}\right)$$

Non-Homothetic Gravity Equation

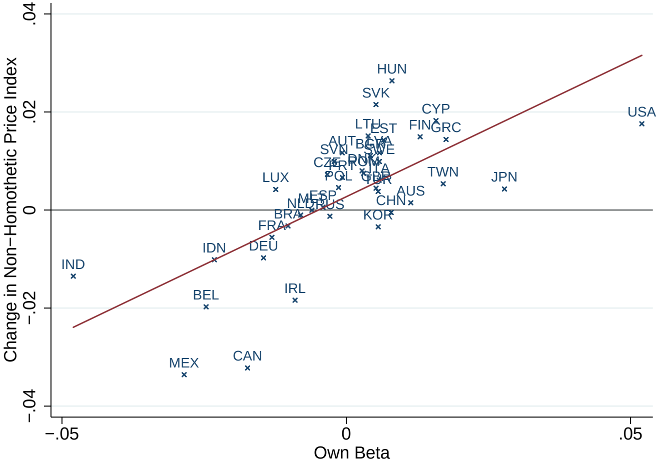
- Impose market clearing to get the gravity equation:

$$\frac{X_{in}}{Y_i} = \frac{Y_n}{Y_W} - \gamma T_{in} + \beta_n \Omega_i$$

  - $T_{in} = \ln\left(\frac{\tau_{in}}{\bar{\tau}_i}\right) - \sum_{n'=1}^{N}\left(\frac{Y_{n'}}{Y_W}\right)\ln\left(\frac{\tau_{n'n}}{\bar{\tau}_{n'}}\right)$ back
    - ★ captures resistance to trade through geography
  - $\Omega_i = \ln\left(\frac{\tilde{x}_i}{a_i}\right) - \sum_{n=1}^{N}\left(\frac{Y_n}{Y_W}\right)\ln\left(\frac{\tilde{x}_n}{a_n}\right)$ back
    - ★ captures resistance to trade through non-homothetic tastes

Specialization and the Bias of Trade

Trade is more pro-poor in more positive-beta exporters



back

Specialization and the Bias of Trade

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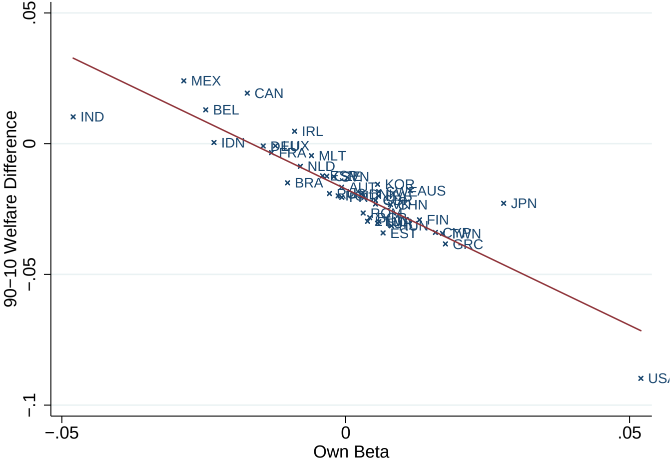
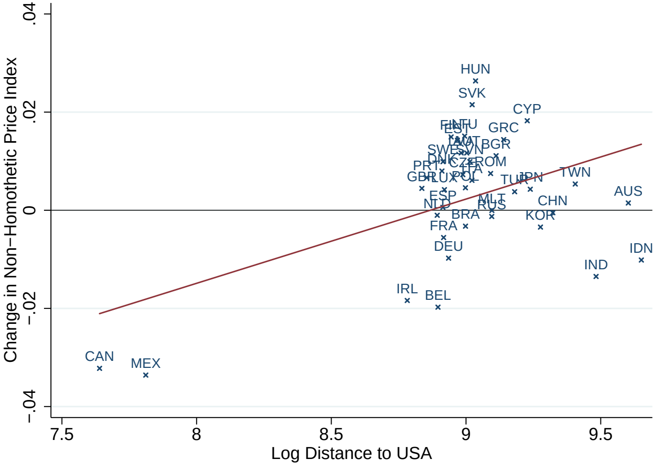


Geography and the Bias of Trade

Trade is less pro-poor closer to the US



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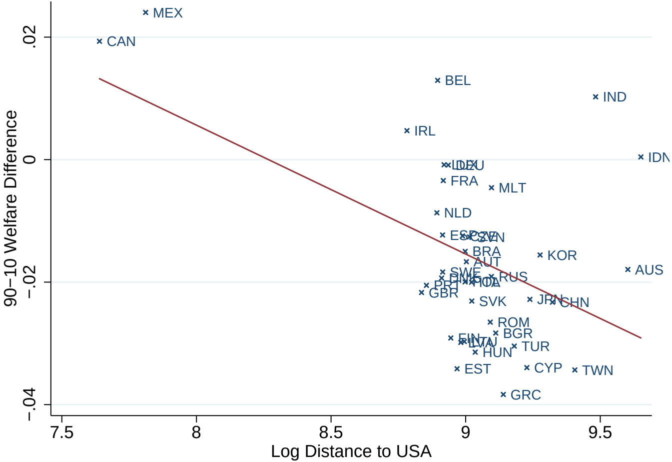


back

Varieties

- The analysis carries through allowing for varieties within each sector
- Upper-tier AIDS, lower-tier CES
  - M_n^s firms in country n pay f_n^s units of labor to enter in sector $s = 1, .., S$
  - Elasticity of substitution σ^s across varieties within sector s
- Change in non-homothetic price index:

$$\hat{b}_i = \hat{b}_i^{\{\sigma^s\}=\infty} - \sum_{s=1}^{S} \frac{\bar{\beta}^s}{\sigma^s - 1} \hat{M}_i^s$$

  - $\hat{b}_i = \hat{b}_i^{\{\sigma^s\}=\infty}$ if there is a single sector
  - $\hat{b}_i < \hat{b}_i^{\{\sigma^s\}=\infty}$ if specialization increases in high-β sectors

back

Constructing Ω_i

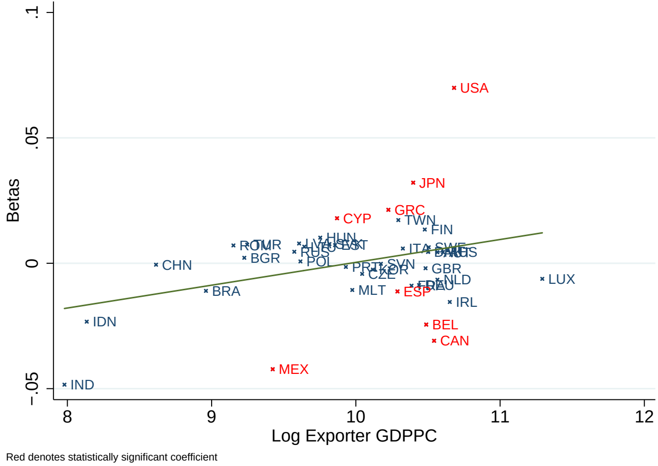
Recall

$$\Omega_i = \left[\ln\left(\frac{\bar{x}_i}{a_i}\right) + \Sigma_i\right] - \sum_{n=1}^{N}\left(\frac{Y_n}{Y_W}\right)\left[\ln\left(\frac{\bar{x}_n}{a_n}\right) + \Sigma_n\right]$$

- Under lognormal distribution, $\Sigma_i = \frac{\sigma_i^2}{2}$ where $\sigma_i^2 = 2\left[\Phi^{-1}\left(\frac{gini_i+1}{2}\right)\right]^2$
- Use Stone approximation $a_i = \sum_n S_{in} \ln p_{in}$, where $p_{in} = d_{in}^{\rho} p_n$ (Deaton and Muellbauer (1980), Atkin (2013))
    - p_n comes from the Penn World Tables
- Construct $\bar{x}_i$ as total expenditure divided by population
    - (Also experiment with using GDPPC for $\bar{x}_i/a_i$)

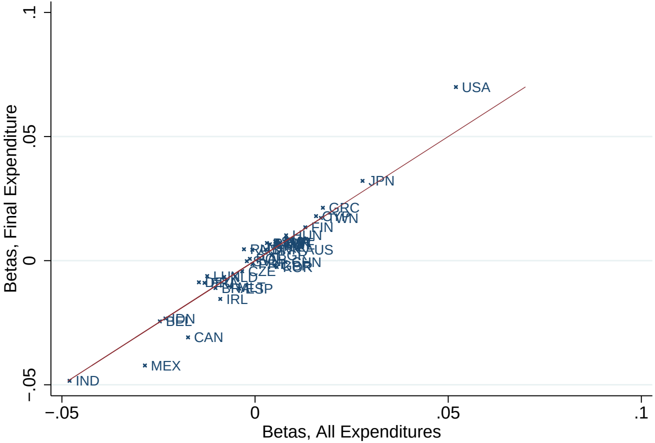
back

β_n's Against GDPPC, Final Expenditures



back CHN flips from (+) to (-), USA becomes more (+), MEX becomes more (-)

β_n's: Final Expenditures vs. All Expenditures



Line denotes 45 degrees

back CHN flips from (+) to (-), USA becomes more (+), MEX becomes more (-)

β_n's Against GDPPC, Final Expenditures (Multi-Sector)

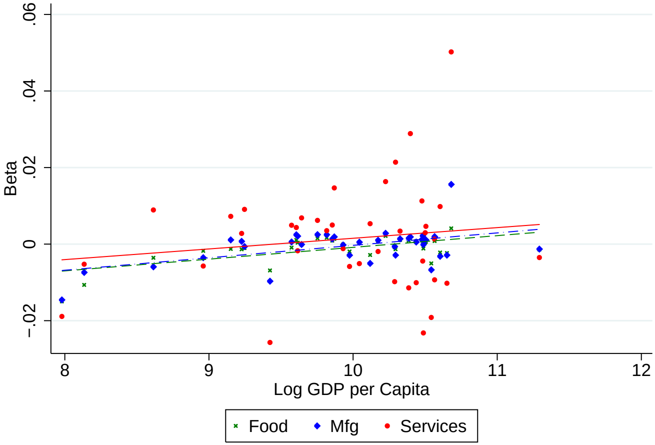
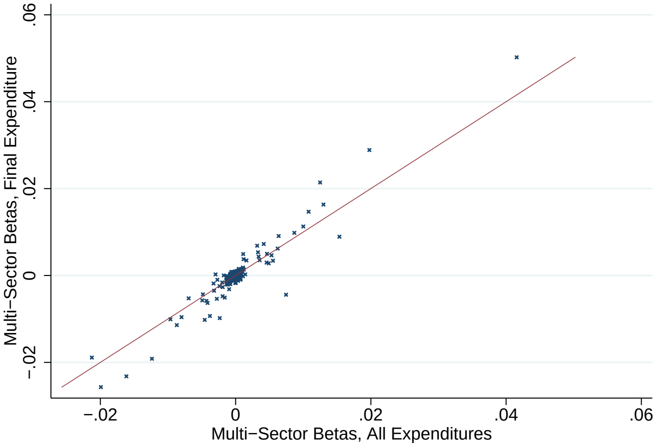


Figure sums betas across broad sectors for each country

back

β_n's: Final Expenditures vs. All Expenditures (Multi-Sector)



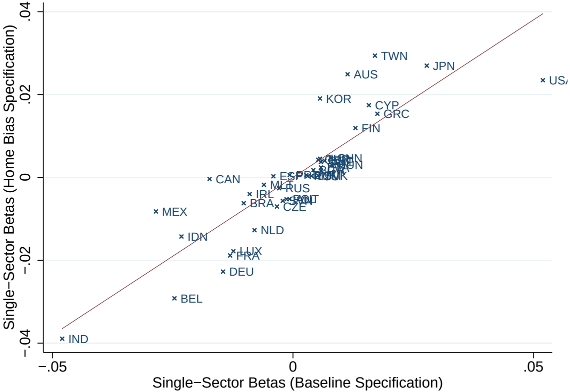
Line denotes 45 degrees

back

β_n's: Fixed-Effects vs. Baseline Estimation

Use fixed effects ζ_n to capture exporter size $\frac{Y_n}{Y_W}$:

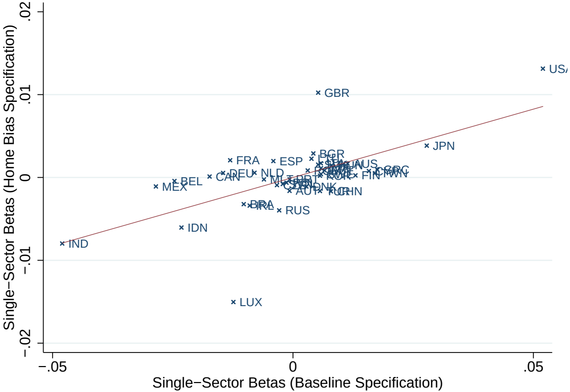
$$S_{in} = \zeta_n - \gamma T_{in} + \beta_n \Omega_i + \epsilon_{in}$$



β_n's: Home-Bias vs. Baseline Estimation

Suppose $\alpha_{in} = \alpha_i + 1_{(i=n)}\zeta$, then:

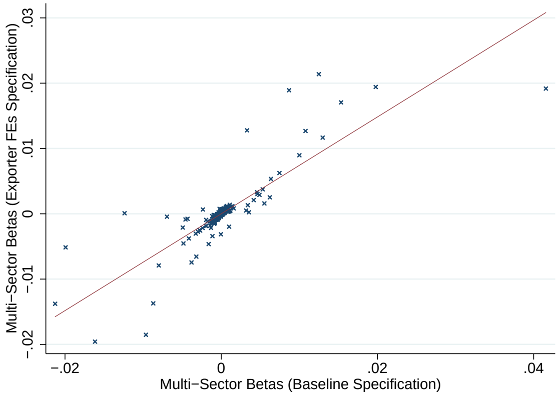
$$\frac{X_{in}}{Y_i} = \frac{X_n}{X_W} + \left(1_{i=n} - \frac{X_n}{X_W}\right)\zeta - \gamma T_{in} + \beta_n \Omega_i + \epsilon_{in}$$



β_n's: Fixed-Effects vs. Baseline Estimation (Multi-Sector)

Use fixed effects ζ_n^s to capture exporter size $\frac{Y_n^s}{Y_W}$:

$$\frac{X_{in}^s}{Y_i} = \zeta_n^s + (S_i^s - S_W^s)\,\alpha_n - \gamma^s\, T_{in}^s + \tilde{\beta}_n^s \Omega_i + \epsilon_{in}^s$$



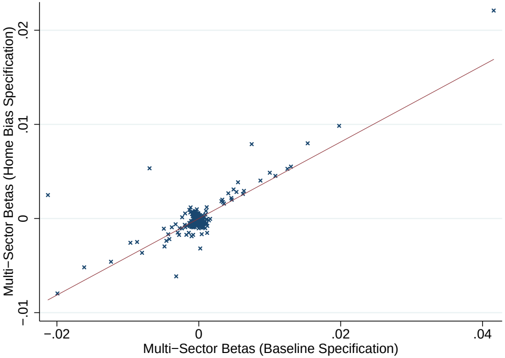
back

β_n's: Home-Bias vs. Baseline Estimation (Multi-Sector)

Suppose $\alpha_{in} = \alpha_i + 1_{(i=n)}\zeta$,then:

$$\frac{X_{in}^s}{Y_i} = \frac{X_n^s}{X_W} + \left(S_i^s - S_W^s\right)\alpha_n + b_{in}^s\zeta - \gamma^s T_{in}^s + \tilde{\beta}_n^s\Omega_i + \epsilon_{in}^s$$

where $b_{in}^s = 1_{(i=n)}\left(S_i^s - \bar{\beta}^s y_i\right) - \frac{X_n}{X_W}\left(S_n^s - \bar{\beta}^s y_n\right)$



back

Translog vs AIDS

$$\text{Aggregate gains } \frac{W_i^{au}}{W_i^{tr}} = \left(\frac{W_{H,i}^{au}}{W_{H,i}^{tr}}\right)\left(\frac{W_{NH,i}^{au}}{W_{NH,i}^{tr}}\right)$$

Country	Aggregate Gains (AIDS) (1)	Aggregate Gains (Translog) (2)	Country	Aggregate Gains (AIDS) (3)	Aggregate Gains (Translog) (4)
AUS	1.4%	1.4%	IRL	21.9%	22.3%
AUT	12.4%	12.5%	ITA	2.5%	2.5%
BEL	16.3%	16.6%	JPN	0.5%	0.5%
BGR	12.7%	12.7%	KOR	3.0%	3.1%
BRA	0.4%	0.4%	LTU	16.0%	16.1%
CAN	7.0%	7.0%	LUX	42.9%	43.6%
CHN	1.2%	1.2%	LVA	10.8%	10.8%
CYP	10.3%	10.3%	MEX	5.3%	5.3%
CZE	14.4%	14.5%	MLT	23.8%	24.1%
DEU	6.1%	6.2%	NLD	10.0%	10.1%
DNK	10.4%	10.5%	POL	7.1%	7.2%
ESP	3.5%	3.5%	PRT	6.6%	6.6%
EST	15.0%	15.0%	ROM	8.0%	8.0%
FIN	6.6%	6.6%	RUS	1.9%	1.9%
FRA	3.0%	3.0%	SVK	19.1%	19.1%
GBR	3.1%	3.2%	SVN	16.3%	16.4%
GRC	5.3%	5.3%	SWE	8.1%	8.1%
HUN	20.5%	20.4%	TUR	2.1%	2.1%
IDN	1.4%	1.4%	TWN	9.5%	9.5%
IND	0.8%	0.8%	USA	0.9%	0.9%
Average	9.2%	9.3%			

Correlation=0.96 with CES (Costinot and Rodriguez-Clare, 2013)

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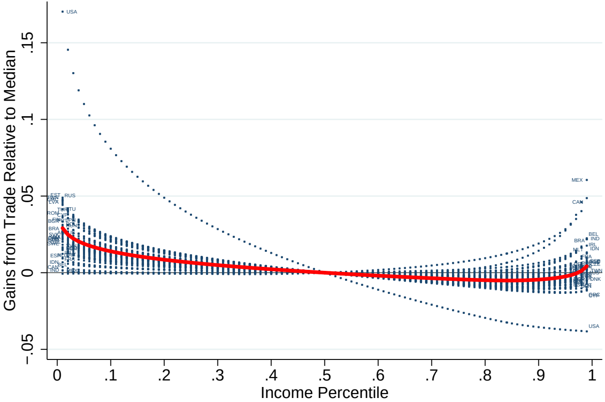
Median Gains from Trade

Country	Gains at Median (AIDS) (1)	Country	Gains at Median (AIDS) (2)
AUS	2%	IRL	21%
AUT	13%	ITA	3%
BEL	16%	JPN	1%
BGR	14%	KOR	3%
BRA	1%	LTU	17%
CAN	6%	LUX	43%
CHN	2%	LVA	12%
CYP	11%	MEX	4%
CZE	15%	MLT	24%
DEU	6%	NLD	10%
DNK	11%	POL	8%
ESP	4%	PRT	7%
EST	16%	ROM	9%
FIN	8%	RUS	2%
FRA	3%	SVK	20%
GBR	4%	SVN	17%
GRC	7%	SWE	9%
HUN	22%	TUR	3%
IDN	1%	TWN	10%
IND	0%	USA	4%
Average	10%		

The Unequal Gains from Trade (Final Expenditures)

Real Income Loss from Going to Autarky for Percentile h in country i

$$1 - \frac{w_h^{au}}{w_h^{tr}} = 1 - \frac{W_{i,h}^{au}}{W_{i,h}^{tr}} \left(\frac{b_{i,h}^{au}}{b_{i,h}^{tr}} \right)^{\sigma_i (1 - z_h)}$$



The deviations are relative to the median individual.
The red line is the average across countries

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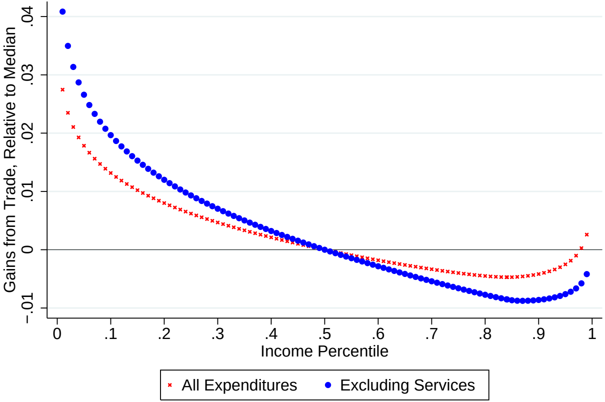
Unequal Gains: Non-Service and All Expenditures

Real Income Loss from Going to Autarky for Percentile h in country i

$$1 - \frac{w_h^{au}}{w_h^{tr}} = 1 - \frac{W_{i,h}^{au}}{W_{i,h}^{tr}} \left(\frac{b_{i,h}^{au}}{b_{i,h}^{tr}} \right)^{\sigma_i (1 - z_h)}$$



The deviations are relative to the median individual.
Figure shows averages across countries, by percentile

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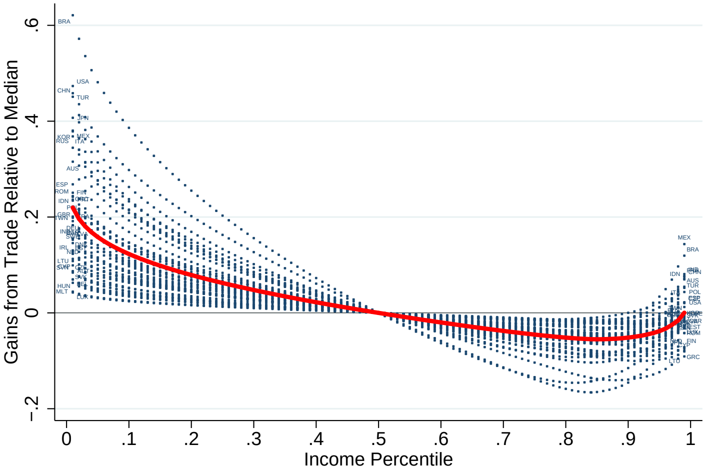
The Unequal Gains from Trade (Multi-Sector)

Non-Service Expenditures Only



The deviations are relative to the median individual.
The red line is the average across countries

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Betas in Multi-Sector Model

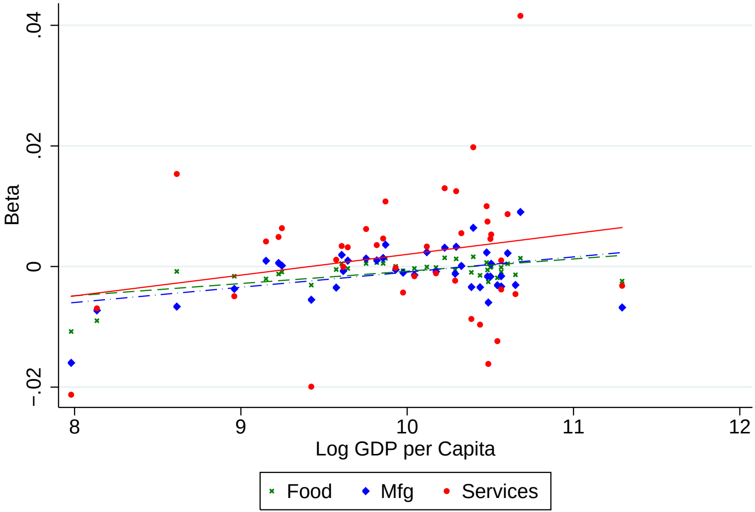


Figure sums betas across broad sectors for each country

Multi-Sector Gravity Estimates

Distance coefficients sum exactly to single-sector estimate

	Sector (ρ*γ) Coefficients (1A)	Sector β's from Engel Curve Regression (2A)		Sector (ρ*γ) Coefficients (1B)
	Ω_i X		$-D_{ni}$ X	
	0.0010 ***	-0.0218 ***	Rubber and Plastics	0.0005 **
	(0.000)	(0.002)		(0.000)
	0.0006 ***	-0.0080 ***	Other Non-Metallic Minerals	0.0005 **
	(0.000)	(0.002)		(0.000)
o	0.0016 ***	-0.0125 ***	Basic Metals and Fabricated Metal	0.0019 **
	(0.000)	(0.003)		(0.000)
	0.0003 ***	-0.0063 ***	Machinery	0.0009 **
	(0.000)	(0.001)		(0.000)
	0.0001 ***	-0.0009 ***	Electrical and Optical Equipment	0.0016 **
	(0.000)	(0.000)		(0.000)
	0.0002 ***	-0.0008	Transport Equipment	0.0011 **
	(0.000)	(0.001)		(0.000)
	0.0007 ***	0.0014 *	Manufacturing, nec	0.0003 **
	(0.000)	(0.001)		(0.000)
l Nuclear Fuel	0.0008 ***	-0.0056 ***	Services	0.0293 **
	(0.000)	(0.002)		(0.004)
lucts	[illegible]	[illegible]		

Welfare Effects with Multiple Sectors

- Aggregate-homothetic effect (first-order approximation)

$$\widehat{W}_i \equiv \sum_{s=1}^{S} \widehat{W}_{H,i}^{s} + \sum_{s=1}^{S} \widehat{W}_{NH,i}^{s}$$

where

$$\widehat{W}_{H,i}^{s} = \frac{1}{\gamma^s} \left(\sum_{n=1}^{N} S_{in}^{s} dS_{in}^{s} - dS_{ii}^{s} \right),$$

$$\widehat{W}_{NH,i}^{s} = \frac{1}{\gamma^s} \sum_{n=1}^{N} S_{in}^{s} \left(\beta_i^s - \beta_n^s \right) dy_i.$$

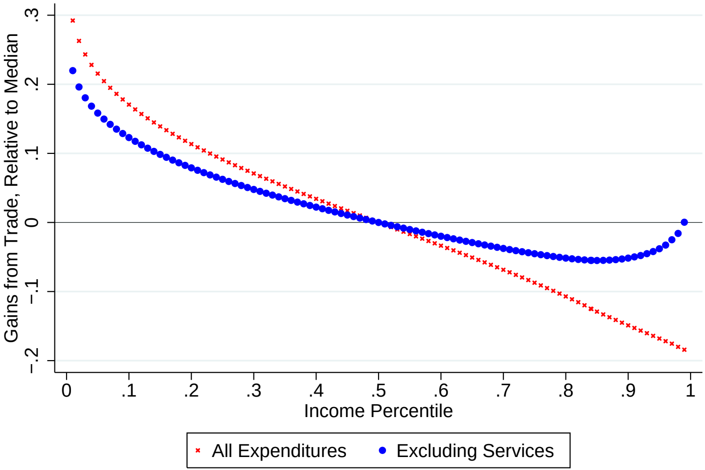
- Individual effect

$$\ln\left(\frac{b_i^{au}}{b_i^{tr}}\right) = \sum_s \sum_n \frac{\beta_n^s}{\gamma^s} \left(S_{in}^{s,tr} - S_{ii}^{s,tr} \right) + a_0 y_i^{tr} + a_1 y_i^{au} + a_2$$

- Analysis goes through allowing for product differentiation within sectors details back

The Unequal Gains from Trade (Multi-Sector)

Non-Service Expenditures and All Expenditures



The deviations are relative to the median individual.
Figure shows averages across countries, by percentile

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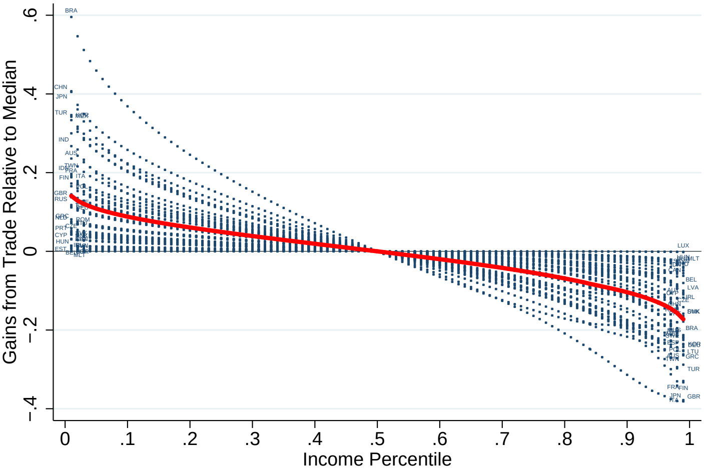
The Unequal Gains from Trade (Multi-Sector)

Final Expenditures Only



The deviations are relative to the median individual.
The red line is the average across countries

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Determinants of Unequal Gains (Multi-Sector)

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The Unequal Gains from Trade (Sector Heterogeneity)

Country	10th percentile (1)	50th Percentile (2)	Aggregate Change (3)	90th Percentile (4)	Country	10th percentile (5)	50th Percentile (6)	Aggregate Change (7)	90th Percentile (8)
AUS	38%	18%	6%	4%	IRL	58%	41%	29%	28%
AUT	61%	48%	37%	34%	ITA	45%	25%	10%	7%
BEL	70%	58%	46%	43%	JPN	38%	17%	3%	2%
BGR	69%	55%	44%	41%	KOR	45%	26%	12%	10%
BRA	52%	18%	1%	1%	LTU	84%	73%	62%	59%
CAN	55%	39%	27%	25%	LUX	59%	48%	41%	41%
CHN	35%	15%	6%	5%	LVA	66%	49%	34%	30%
CYP	66%	51%	37%	34%	MEX	62%	37%	22%	20%
CZE	66%	55%	46%	43%	MLT	80%	70%	62%	59%
DEU	50%	35%	22%	19%	NLD	55%	39%	26%	22%
DNK	53%	36%	23%	20%	POL	56%	37%	24%	21%
ESP	47%	28%	14%	12%	PRT	62%	42%	25%	21%
EST	75%	60%	46%	42%	ROM	63%	46%	33%	29%
FIN	56%	38%	24%	20%	RUS	53%	30%	15%	13%
FRA	40%	24%	12%	10%	SVK	78%	70%	62%	60%
GBR	48%	27%	11%	9%	SVN	72%	61%	52%	49%
GRC	57%	37%	20%	17%	SWE	49%	34%	23%	20%
HUN	80%	71%	64%	62%	TUR	51%	26%	10%	8%
IDN	22%	9%	3%	3%	TWN	67%	51%	37%	35%
IND	19%	10%	6%	6%	USA	62%	29%	5.6%	3%
Average	57%	40%	27%	25%					

Notes: Table reports gains from trade for the multi-sector case and uses the parameters reported in Table 3. The columns report welfare changes associated at the 10th, 50th, the representative consumer, and the 90th percentiles.

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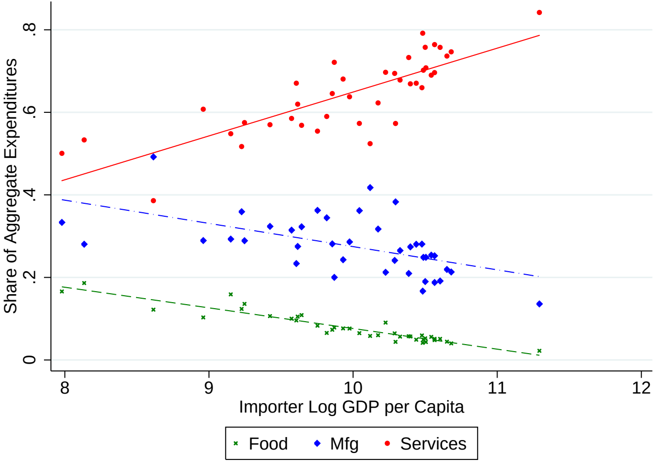
Engel Curves

Three broad sectors: Food, Manufacturing and Services



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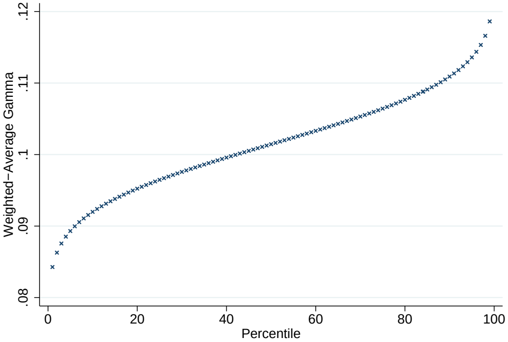
Why Does Sectoral Heterogeneity Matter?

The Poor Consume Less Elastic Sectors Relative to the Rich

$$\gamma_h^{av} = \frac{1}{N}\sum_{i=1}^{N}\left(\sum_{j=1}^{S} s_{i,h}^{j} * \gamma^{j}\right)$$



Weighted−average gamma calculated for multi−sector, non−homothetic case