On Measuring the Welfare Gains from Trade under Consumer Heterogeneity

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Table: Survey among AEA members

Survey Year	Question	Agree
2007	The U.S. should eliminate remaining tariffs and other barriers to trade.	83%
2005	The U.S. should eliminate all tariffs and other barriers to trade.	88%
2000	Tariffs and import quotas usually reduce the general welfare of society.	93%
1990	Tariffs and import quotas usually reduce the general welfare of society.	98%

Whaples (2006, 2009), Fuller and Geide-Stevenson (2007).

Table: Survey among non-economists in the US

Survey Year	Question	Agree
2006	The impact of free trade on the country is good.	44%
2005	The impact of free trade on the country is good.	44%
2003	The impact of free trade on the country is good.	34%
1997	The impact of free trade on the country is good.	47%

Source: Pew Research Center Survey.

Who wins from globalization?

% of respondents who "feels helped by free trade agreements."

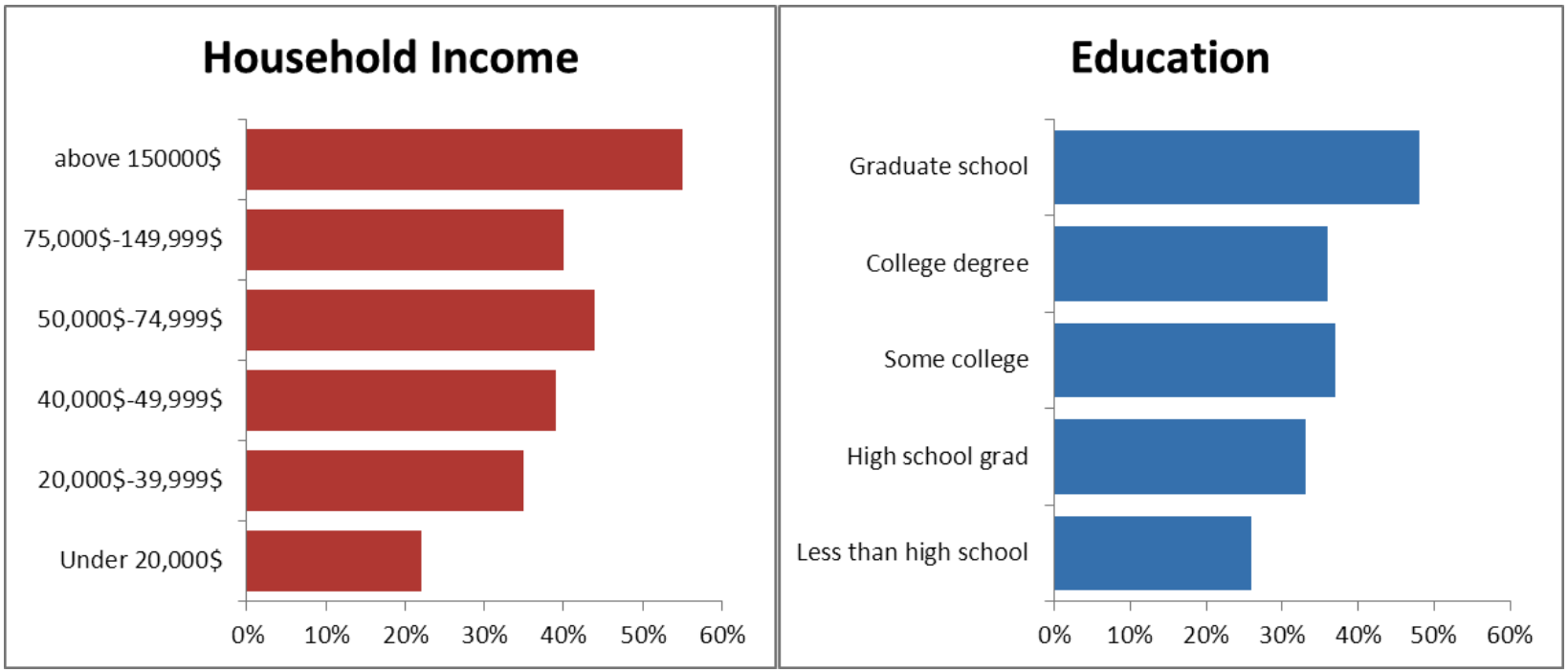

Figure: Winners of Globalization

Source: Pew Research Center Survey (December, 2006)

Basic Idea

This paper argues that welfare gains calculated under the assumption of *a representative consumer* (ARC) do not reflect true welfare gains for many consumers.

To demonstrate this I combine the following:

- Non-homothetic preferences
- Heterogeneous consumers
- General Equilibrium model of trade

Basic Idea

This paper argues that welfare gains calculated under the assumption of *a representative consumer* (ARC) do not reflect true welfare gains for many consumers.

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These ingredients make sure that:

- Consumption bundles vary across individuals and countries.
- Trade related effects (income and price effects) are heterogeneous across consumers.

Discussion of the Related Literature:

Worker Heterogeneity:

Labor market frictions in heterogeneous firms model (as in Melitz, 2003):

- Egger and Kreickermeier (2009)
- Helpman, Itskhoki and Redding (2008, 2010)
- Davies and Harrigan (2011)

Skill premium:

- Harrigan and Reshef (2011)
- Burstein and Vogel (2012)
- Parro (2013)

Discussion of the Related Literature:

Non-homothetic Preferences and Trade:

- Jackson (1984)
- Hunter (1991)
- Matsuyama (2000)
- Markusen (2010)

New Trade Theories and Non-homotheticity:

- Fieler (2010)
- Simonovska (2010)

Consumer Problem:

Utility function:

$$U(c_{ni}, c_{mi}, c_{ai}) = (c_{ni}^{\beta} c_{mi}^{1-\beta} + \mu)^{\alpha} c_{ai}^{1-\alpha} \tag{1}$$

Income of consumer of type d in country i:

$$y_{id} = (l_i w_i + k_{id} r_i) + v_i. \tag{2}$$

Income shares: $s_{n,id} = c_{ni}/y_{id}$, $s_{m,id} = c_{mi}/y_{id}$, $s_{a,id} = c_{ai}/y_{id}$.

Total spending: $Y_i = \sum_d L_{id} y_{id}$

Demand side of trade: $f_{ni} \times Y_i$, $f_{mi} \times Y_i$, $f_{ai} \times Y_i$.

▸ More on Demand

Importance of Non-homotheticity

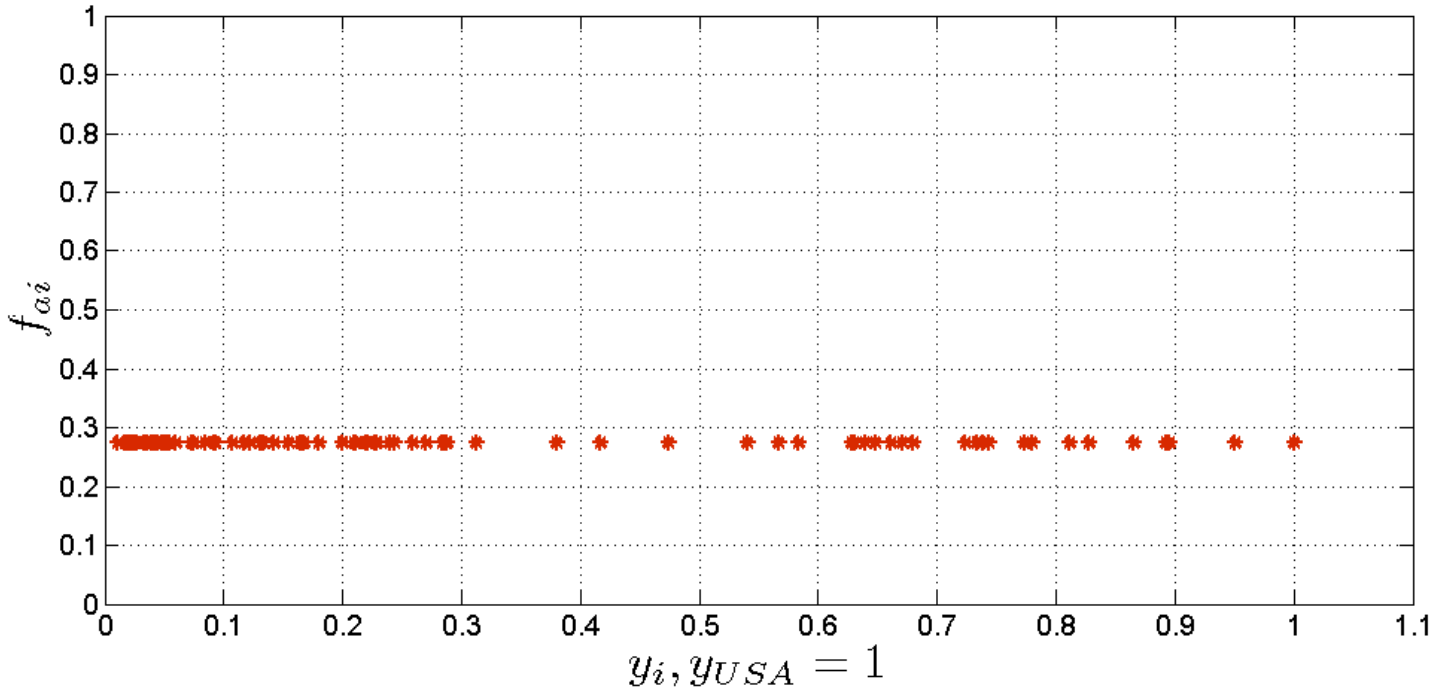

Figure: Share of Country's Total Expenditure on Food.

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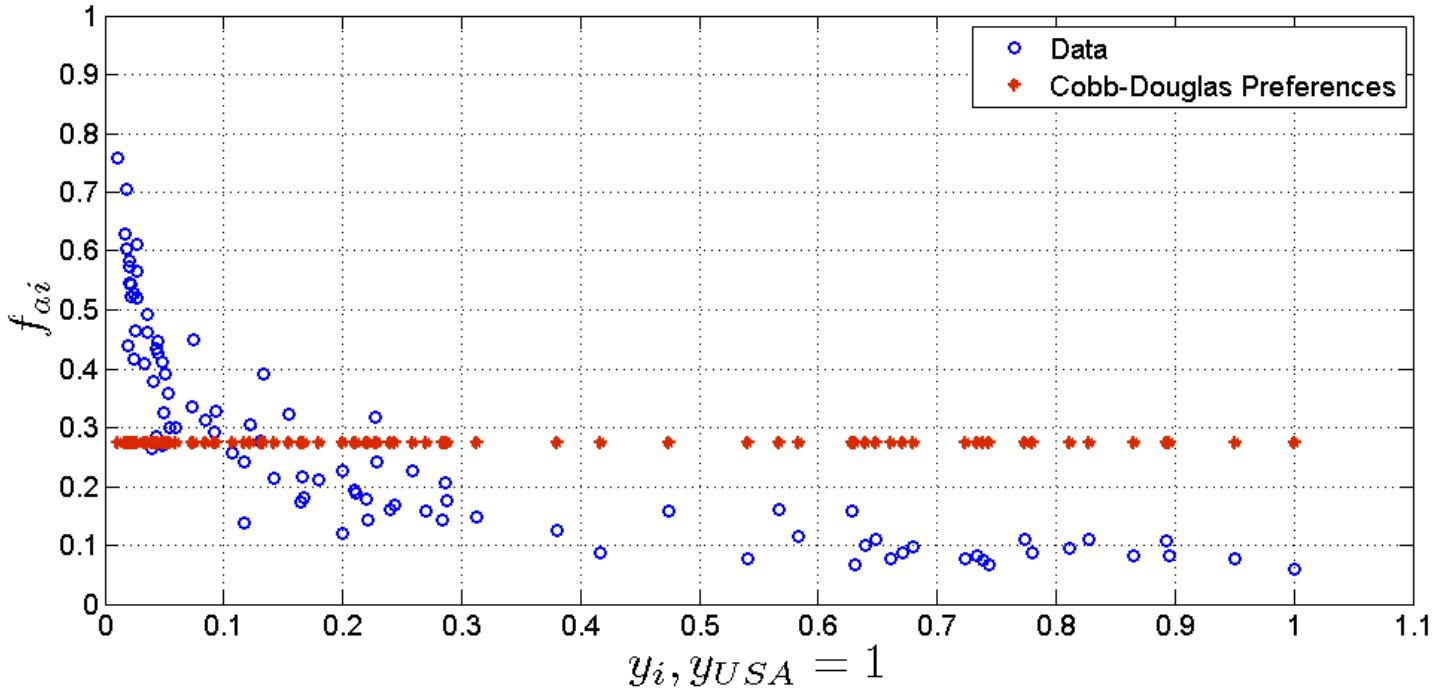

Figure: Share of Country's Total Expenditure on Food.

Importance of Heterogeneity:

Consumer homogeneity would imply:

$$s_{id} = \mathbf{s}_i \text{ for all } d \tag{3}$$

In 1996, $y_i < 500 USD$ for Angola and Benin. If consumer heterogeneity did not matter than in very poor countries we would observe zero import flows (and zero consumption) of cars, most of electronics, premium wines etc.

Differences in Consumption Patterns

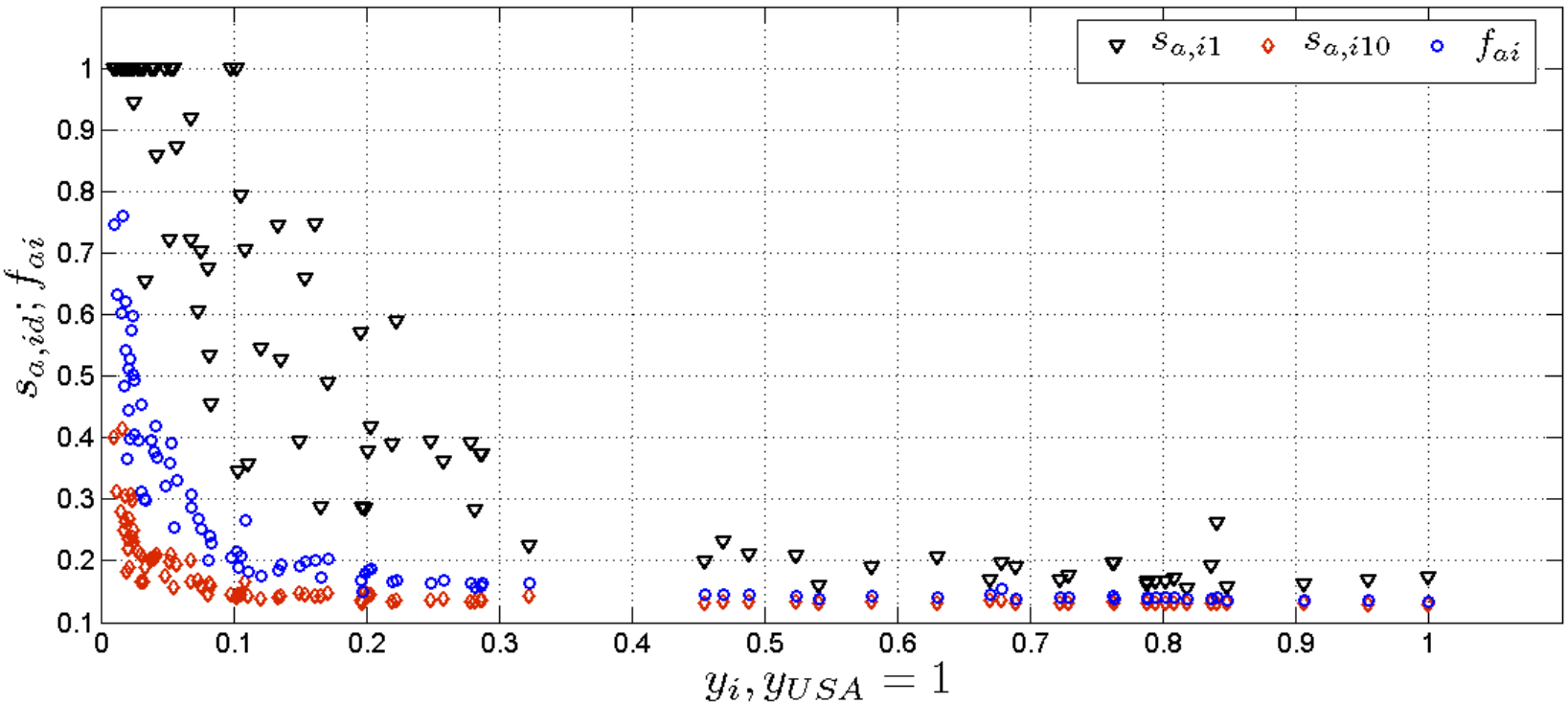

Figure: Share of Income Spent on Food: Calibrated Model

Measuring welfare: basic idea

Let $V(y_{id}, p_{ni}, p_{mi}, p_{ai})$ be the indirect utility function. Use Marshallian demands to get:

$$V(y_{id}, p_{ni}, p_{mi}, p_{ai}) = \begin{cases} \left(\frac{B(y_{id} - \mathbf{y_i^*})}{p_{ni}^{\beta} p_{mi}^{1-\beta}} + \mu\right)^{\alpha} \left(\frac{y_{id} - \alpha(y_{id} - \mathbf{y_i^*})}{p_{ai}}\right)^{1-\alpha} & \text{if } y_{id} > \mathbf{y_i^*} \\ \mu^{\alpha} \left(\frac{y_{id} - \alpha(y_{id} - \mathbf{y_i^*})}{p_{ai}}\right)^{1-\alpha} & \text{if } y_{id} \leq \mathbf{y_i^*}, \end{cases}$$

Suppose there is a trade liberalization such that y_{id} becomes y'_{id} and/or p_{qi} becomes p'_{qi} for $q = \{n, m, a\}$. Then, the following holds:

$$\frac{V(y'_{id}, p_{ni}, p_{mi}, p_{ai})}{V(y_{id}, p_{ni}, p_{mi}, p_{ai})} \neq \frac{V(y'_{i\tilde{d}}, p_{ni}, p_{mi}, p_{ai})}{V(y_{i\tilde{d}}, p_{ni}, p_{mi}, p_{ai})} \; \forall \; y_{id} \neq y_{i\tilde{d}}.$$

$$\frac{V(y_{id}, p'_{ni}, p'_{mi}, p'_{ai})}{V(y_{id}, p_{ni}, p_{mi}, p_{ai})} \neq \frac{V(y_{i\tilde{d}}, p'_{ni}, p'_{mi}, p'_{ai})}{V(y_{i\tilde{d}}, p_{ni}, p_{mi}, p_{ai})} \; \forall \; y_{id} \neq y_{i\tilde{d}}.$$

Hence, trade liberalization effects are heterogeneous across d's.

Production:

Each economy subsumes three broad sectors. Manufacturing and agricultural sectors are populated with heterogeneous firms in the spirit of Eaton and Kortum (2002).

Non-tradable sector:

$$n_i = \left[l_i(n)^{\nu} k_i(n)^{1-\nu}\right]^{\phi} \left[n_i(n)^{\varrho} m_i(n)^{1-\varrho}\right]^{1-\phi}. \tag{4}$$

Manufacturing sector:

$$m_i(q) = z_{mi}(q) \left[l_i(q)^{\nu} k_i(q)^{1-\nu}\right]^{\xi} \left[n_i(q)^{\zeta} m_i(q)^{1-\zeta}\right]^{1-\xi}. \tag{5}$$

Agricultural sector:

$$a_i(h) = z_{ai}(h) \left[l(h)_i^{\nu} k(h)_i^{1-\nu}\right]^{\gamma} \left[n(h)_i^{\epsilon} m(h)_i^{\rho} a_i^{1-\epsilon-\rho}\right]^{1-\gamma}. \tag{6}$$

▸ More on Production

Supply side of trade

For brevity, define an average variable cost of firms in sector ℓ, country i as $\kappa_{\ell,i}$. Then, the supply side of trade can be recovered as:

$$x_{m,in} = \frac{\left(\kappa_{mn}\tau_{m,in}t_{m,in}\right)^{-\theta_m}}{\sum_{\ell}^{N}\left(\kappa_{m\ell}\tau_{m,i\ell}t_{m,i\ell}\right)^{-\theta_m}}, x_{a,in} = \frac{\left(\kappa_{an}\tau_{a,in}t_{a,in}\right)^{-\theta_a}}{\sum_{\ell}^{N}\left(\kappa_{a\ell}\tau_{a,i\ell}t_{a,i\ell}\right)^{-\theta_a}}, \quad (7)$$

where $\tau_{a,in}$, $\tau_{m,in}$, $t_{a,in}$ for $t_{m,in}$ are total trade costs and tariffs, respectively;

θ_a and θ_m are dispersion productivity parameters.

International Trade:

The total trade flows are then:

$$X_{q,in} = \underbrace{x_{q,in}}_{\text{supply side}} \times \underbrace{\underbrace{f_{qi}}_{\text{expenditure share}} \times \underbrace{Y_i}_{\text{market size}}}_{\text{demand side}} . \quad (8)$$

The expenditure share f_{qi} depends on the average real income per capita and income distribution parameters that govern $s_{q,id}$ for $q = \{m, a\}$.

Predictions of the Model:

Recall the demand side of trade:

$$f_{mi} \times Y_i = Z \times \sum_{d}^{D} \mathbf{1}_{y_{id} > \mathbf{y_i^*}} L_{id} \left(\omega_{id} y_i - \mathbf{y_i^*} \right), \tag{9}$$

where ω_{id} is income inequality parameter. How total income, Y_i, is divided between ,y_i, and L_i shapes total import demand.

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Prediction 1. *Total import demand for manufacturing goods increases in average real income per capita, y_i, and decreases in population, L_i, ceteris paribus.*

Prediction 2. *There is a positive relationship between income inequality and total import demand for manufacturing goods ceteris paribus.*

Calibration and Solution of the Model

- The model is calibrated to 92 countries in the world. Reference year is 1996.
- All parameters were structurally estimated from the data.
- The solution is in the spirit of Dekle, Eaton and Kortum (2007).
- Capital endowments, k_{id}, were calibrated to the data on income inequality.
- Government transfers subsume tariff revenues and balance of payments (in the benchmark year).

▸ More on Calibration

Global Abolishment of Tariffs:

In the counterfactual experiment, all bilateral tariffs go to zero. To measure change in welfare define:

- Change in welfare under ARC:

$$\Delta \bar{V}_i = 100 \times \left(\frac{\bar{V}_i'}{\bar{V}_i} - 1 \right) \tag{10}$$

- Change in welfare under consumer heterogeneity:

$$\Delta V_{id} = 100 \times \left(\frac{V_{id}'}{V_{id}} - 1 \right) \tag{11}$$

Global Abolishment of Tariffs:

Predictions of the model under ARC:

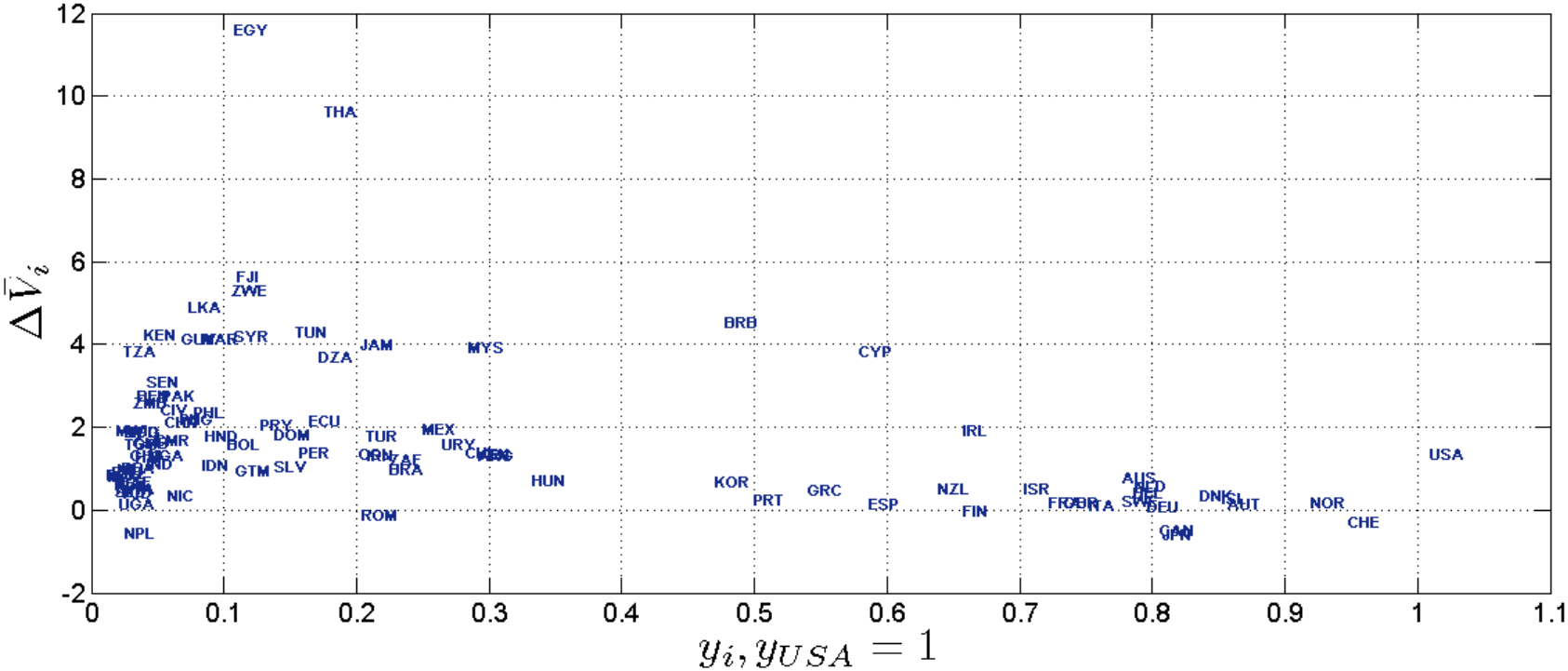

Figure: Trade Liberalization and a Representative Consumer Welfare

Global Abolishment of Tariffs:

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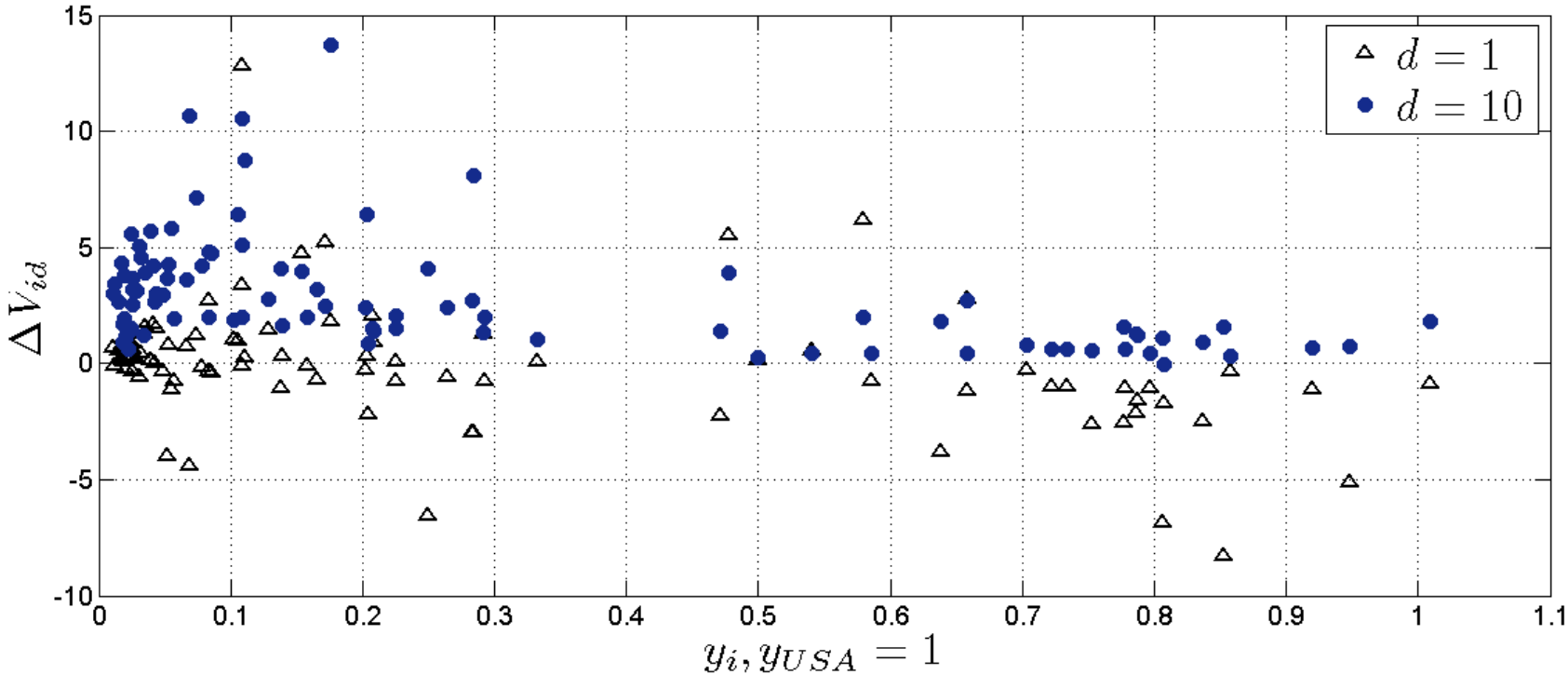
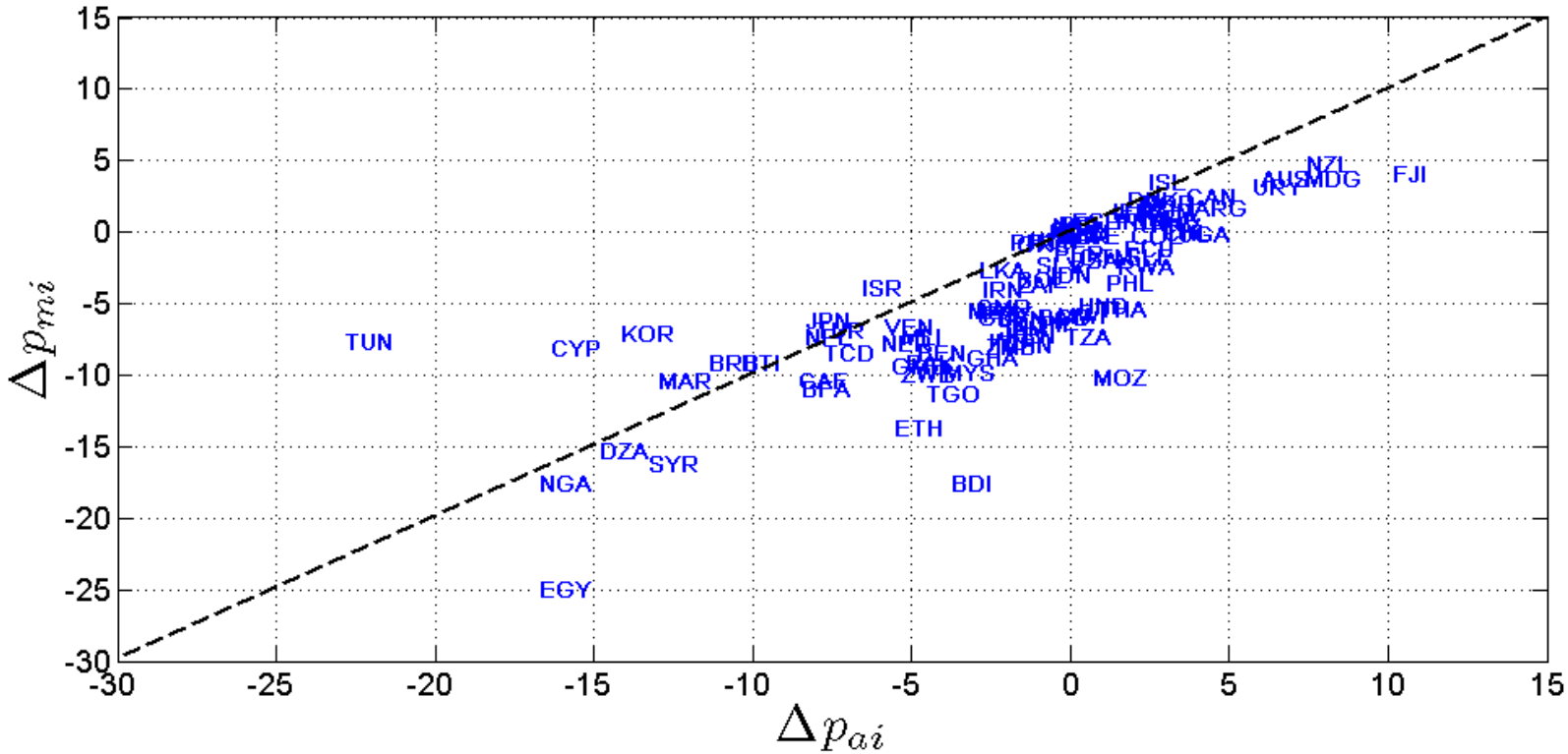


Figure: Trade Liberalization and Heterogeneous Consumers

Relative Price Effects.

Different trade elasticities ($\theta_m = 6.5$, $\theta_a = 12.1$).



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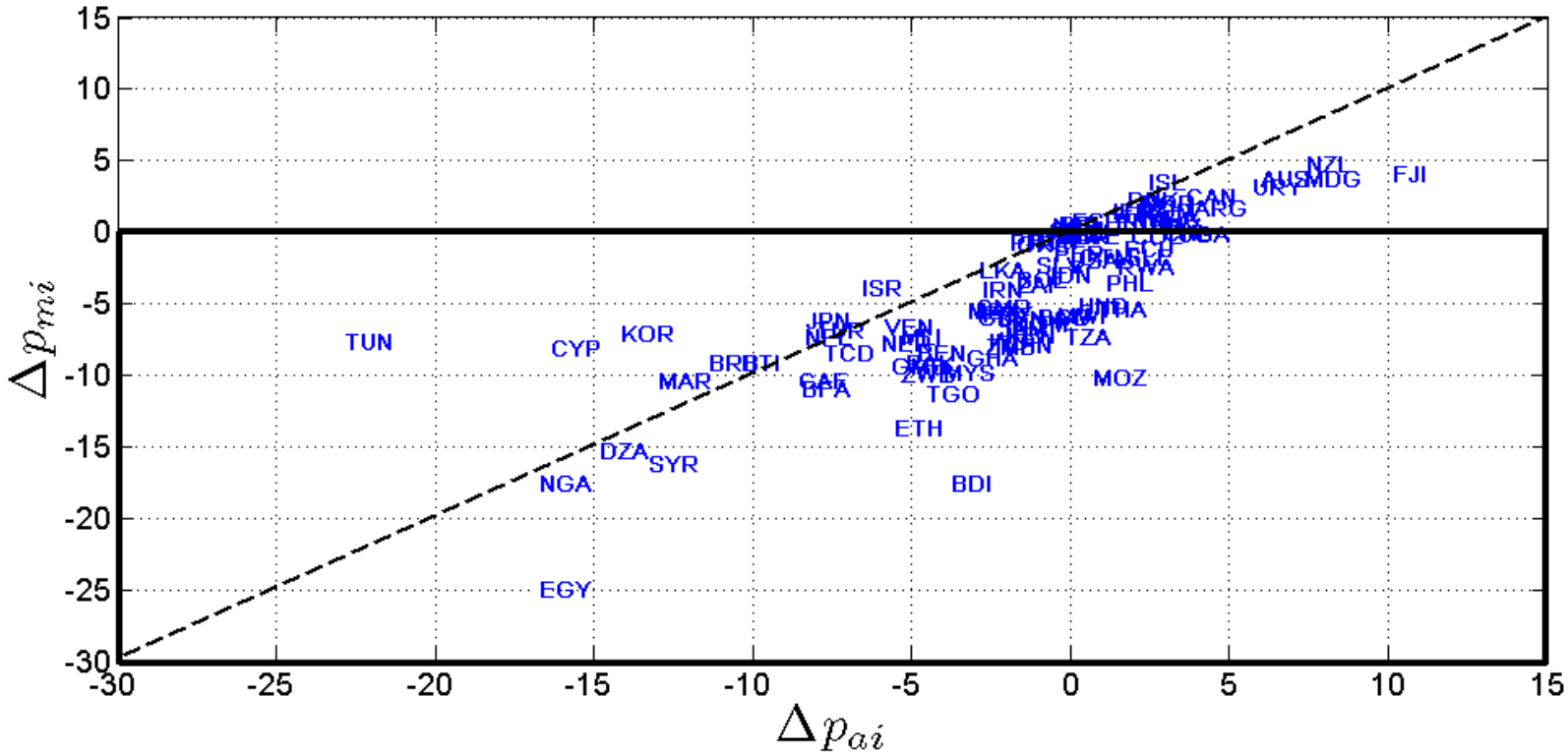
Relative Price Effects.

Manufacturing prices decline more ($|\Delta p_{ai}| \leq |\Delta p_{mi}|$).



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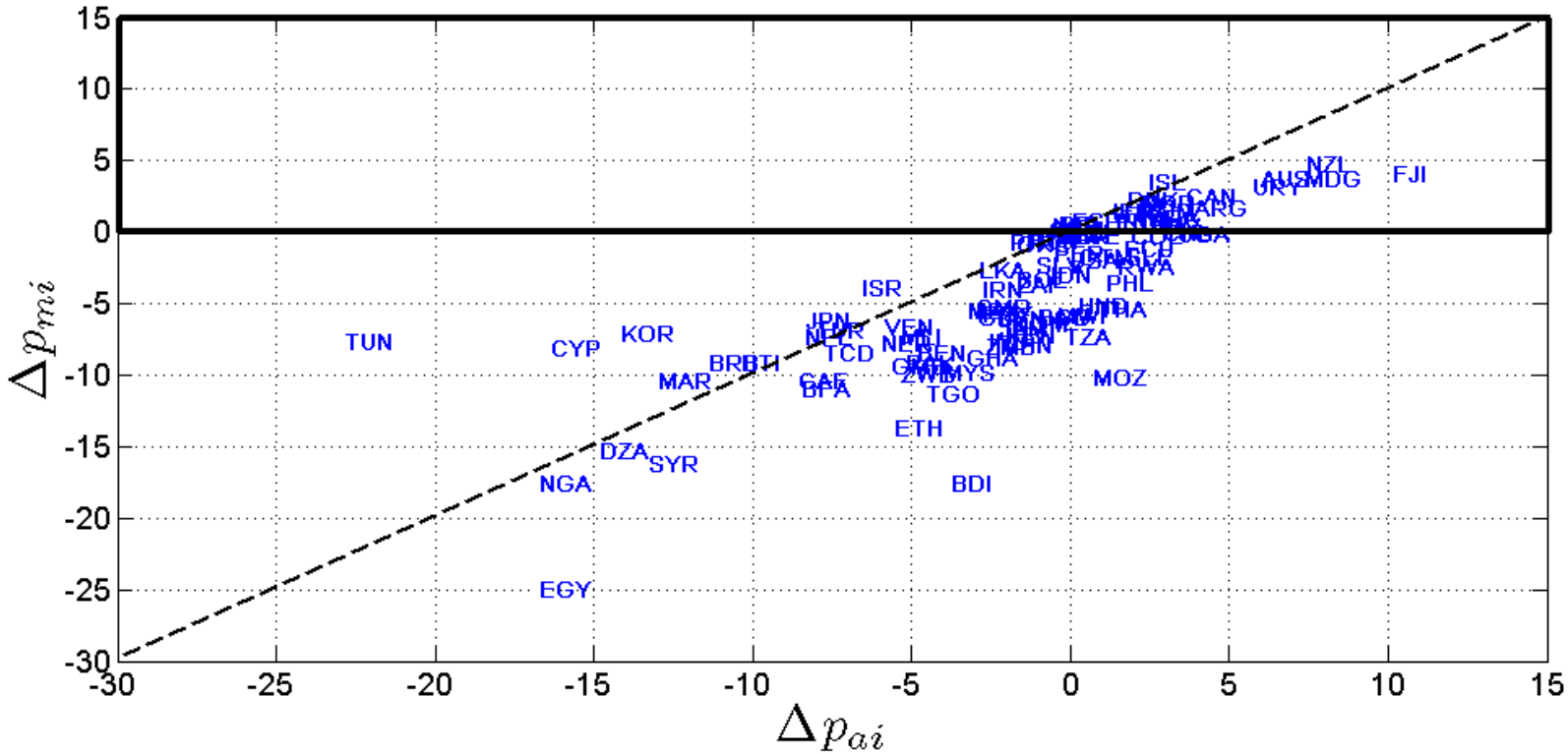

Figure: Relative Price Effects

Nominal income effect:

Nominal income **before** and **after** trade liberalization:

Before liberalization: $y_{id} = l_i w_i + k_{id} r_i + v_i$

After liberalization: $y'_{id} = l_i w'_i + k_{id} r'_i$

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ARC induces measurement errors at two margins:

- Quantitative bias: the extent by how much ARC overstates welfare gains from trade for consumers in decile d, $(\Delta \bar{V}_i - \Delta V_{id})$.

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ARC induces measurement errors at two margins:

- Quantitative bias: the extent by how much ARC overstates welfare gains from trade for consumers in decile d, $(\Delta \bar{V}_i - \Delta V_{id})$.
- Qualitative bias: predictions under ARC and under Consumer Heterogeneity have opposite signs such that $(\Delta \bar{V}_i \times \Delta V_{id}) < 0$.

Measurement Errors from ARC:

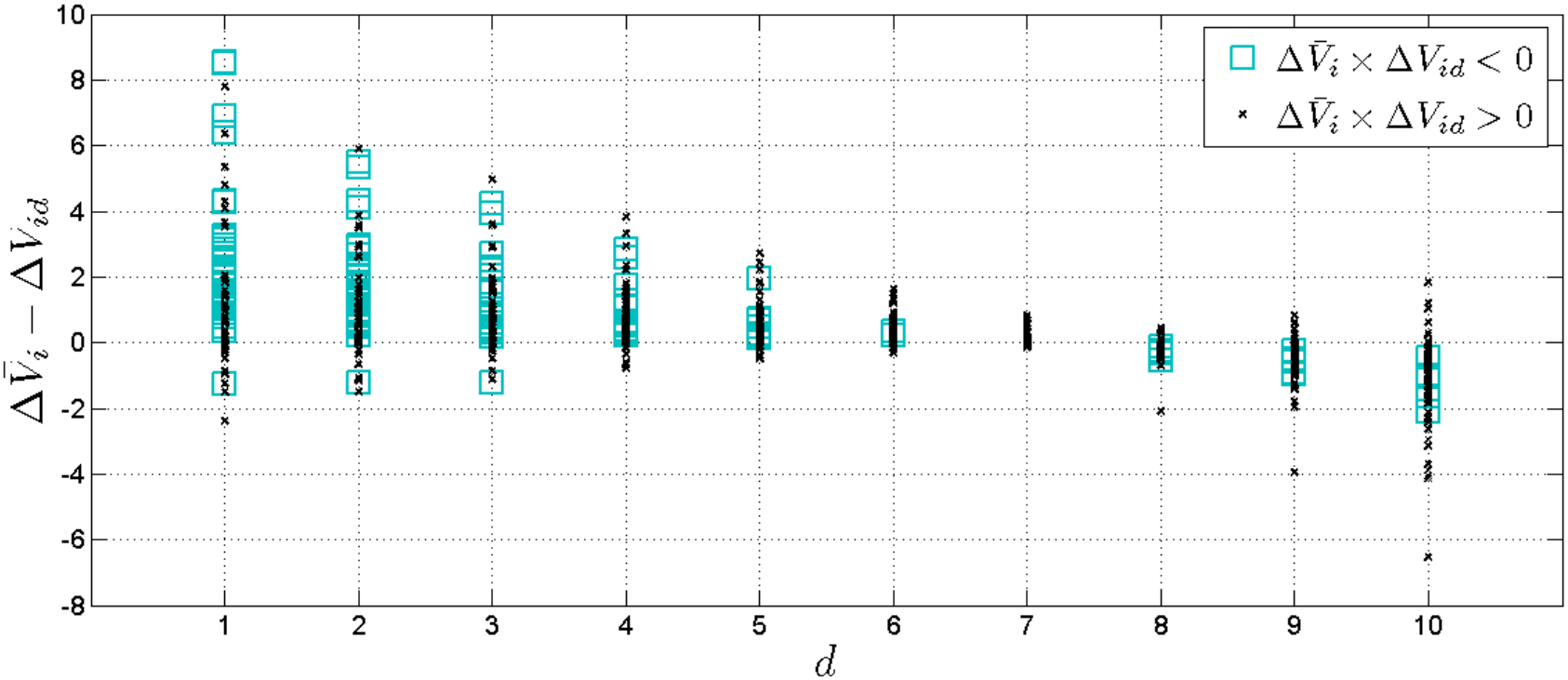

Figure: Measurement errors

Some population-weighted statistics:

For how many people the predictions under ARC are wrong?

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Table: Trade Liberalization and Qualitative Bias

	d=1	d=2	d=3	d=4	d=5	d=6	d=7	d=8	d=9	d=10	$\sum_{d=1}^{D}$
$\tilde{E}_d$	60.89	48.67	14.42	8.46	7.89	0.49	0.00	1.45	1.85	1.85	14.59

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How many people lose from trade liberalization?

Table: Consequences of Trade Liberalization

	d=1	d=2	d=3	d=4	d=5	d=6	d=7	d=8	d=9	d=10	$\sum_{d=1}^{D}$
$\tilde{W}_d$	65.47	53.25	19.00	13.84	13.27	5.87	5.38	3.93	3.53	3.53	18.71

Conclusion:

- Consumer heterogeneity together with non-homotheticity are vital for coming to grips with the empirical findings on the link between trade, average real income and income inequality.
- Trade liberalization exerts heterogeneous welfare effects.
- ARC is a restrictive assumption that tends to overstate the gains of the poor and understate the gains of the rich.
- Welfare gains calculated under ARC are not good predictors of true welfare gains, especially for the poor.

The Marshallian Demands are: For consumers with income more than cut-off $\mathbf{y_i^*}$:

$$c_{ni,d}\,p_{ni} = \alpha\beta\,(y_{id} - \mathbf{y_i^*})\,, \tag{12}$$

$$c_{mi,d}\,p_{mi} = \alpha(1-\beta)\,(y_{id} - \mathbf{y_i^*})\,, \tag{13}$$

$$c_{ai,d}\,p_{ai} = (1-\alpha)y_{id} + \alpha\mathbf{y_i^*}, \tag{14}$$

Otherwise, $c_{ni,d}\,p_{ni} = c_{mi,d}\,p_{mi} = 0$ and $c_{ai}\,p_{ai} = y_{id}$. ◂ Back to main text

The price of the non-tradable good is:

$$p_{ni} = \Gamma_n (w_i^{\nu} r_i^{1-\nu})^{\phi} (p_{ni}^{\varrho} p_{mi}^{1-\varrho})^{1-\phi}, \tag{15}$$

The price of the manufacturing good is:

$$p_{mi} = \left(\sum_{\ell}^{N} (\kappa_{m\ell} \tau_{m,i\ell} t_{m,i\ell})^{-\theta_m} \right)^{-\frac{1}{\theta_m}}. \tag{16}$$

The price of the agricultural good is:

$$p_{ai} = \left(\sum_{\ell}^{N} (\kappa_{a\ell} \tau_{a,i\ell} t_{a,in})^{-\theta_a} \right)^{-\frac{1}{\theta_a}}. \tag{17}$$

◂ Back to main text

Parameters of the utility function:

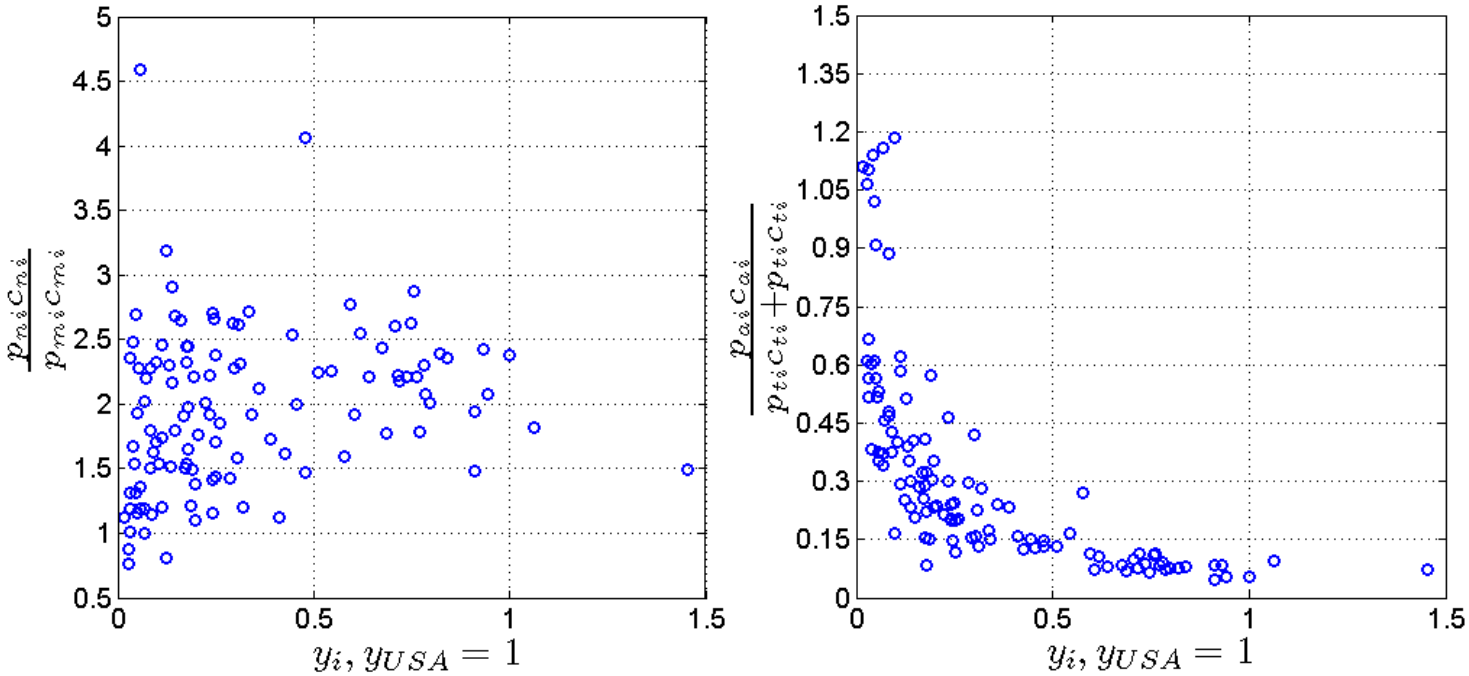

Figure: Expenditure Ratios versus Average Real Income per Capita

$$\frac{\beta}{1-\beta} = \frac{1}{N}\sum_{i=1}^{N}\frac{p_{ni}\sum_d c_{ni,d}}{p_{mi}\sum_d c_{mi.d}} \tag{18}$$

Parameters of the utility function:

I calibrate α and μ to match the data on country level spending shares s_{ai} as follows:

$$\min_{\alpha,\mu} \sum_{i=1}^{N} \left[s_{ai} - \mathbf{s}_{ai}(\alpha, \mu)\right]^2 \text{ s.t. } \alpha \in [0, 1], \tag{19}$$

Solving (19) yields $\alpha = 0.8739$ and $\mu = 0.0036$. The implied subsistence level is approximately 1 dollar per day.

Parameters of the production function: Cross-country averages and standard deviations of the production parameters:

Table: PRODUCTION PARAMETERS

	ϕ	ξ	γ	ϱ	ζ	ϵ	ρ
mean	0.5474	0.2919	0.4995	0.6822	0.3154	0.2780	0.3829
std.deviation	0.0574	0.0363	0.1101	0.1046	0.0842	0.0778	0.1243
N	39	39	39	39	39	39	39

Notes: The parameters were calculated using the data on Argentina, Australia, Austria, Belgium, Brazil, Canada, Chile, China, Czech Rep., Denmark, Estonia, Finland, France, Germany, Greece, Hungary, India, Indonesia, Ireland, Italy, Japan, Korea, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, UK, USA, Vietnam. The data for other countries in the sample were unavailable.

Trade dispersion parameters:

Parameters θ_m and θ_a are estimated from the structural gravity equation using data on tariffs:

$$\frac{X_{m,in}}{X_{m,ii}} = \left(\frac{\kappa_n \tau_{m,in} t_{m,in}}{\kappa_i} \right)^{\theta_m} \quad \text{where } \tau_{m,in} = (\tau_{m,i} \tilde{\tau}_{m,in} \tau_{m,n}). \qquad (20)$$

The stochastic counterpart to (20):

$$\frac{X_{m,in}}{X_{m,ii}} = \exp[\log(ex_n) + \log(im_i) - \theta_m \log(t_{m,in}) - \theta_m \log(\tilde{\tau}_{m,in})] + error_{in},$$

The estimates are $\hat{\theta}_m = 6.53(1.23)$ and $\hat{\theta}_a = 12.07(1.16)$. ◂ Back to main text