Per-Capita Incomes and the Extensive Margin of Bilateral Trade: A Quantitative Ricardian Model

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Introduction

Per-Capita Income and the Extensive Margin - I

- Extensive margin of a bilateral trade flow = Number of goods categories (e.g. HS6, SITC) with positive volumes

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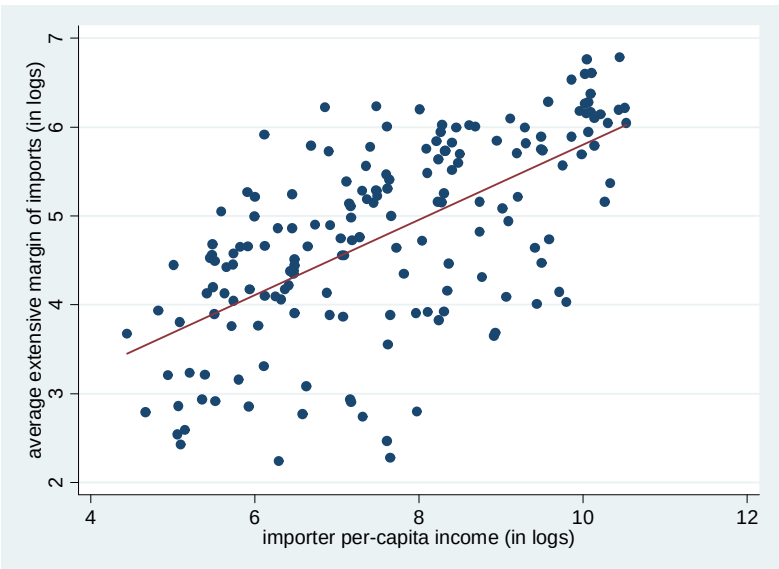
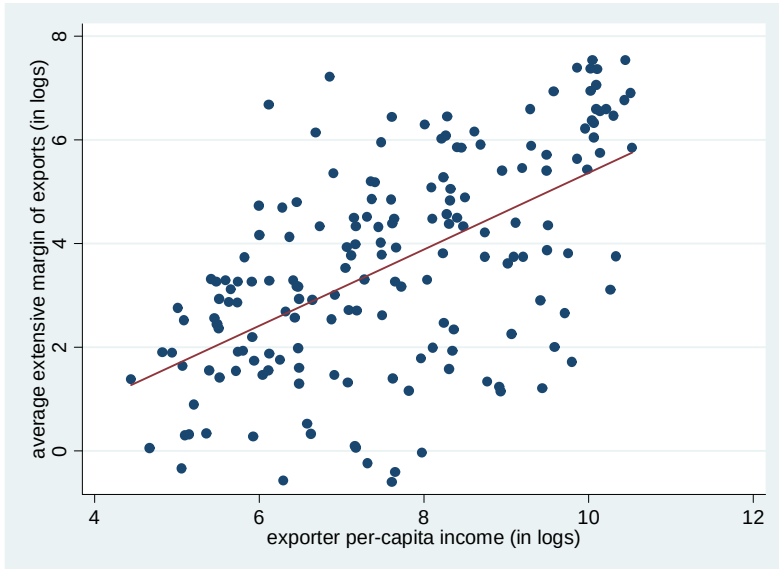
Introduction

Per-Capita Income and the Extensive Margin - I

- Extensive margin of a bilateral trade flow = Number of goods categories (e.g. HS6, SITC) with positive volumes
- take average of the extenisve margin a country's import/export flows
- plot against per-capita income





Introduction

Per-Capita Income and the Extensive Margin - II

- Dependent Variable - bilateral extensive margin (HS6) in 2000

	log-log OLS
i_pc_gdp	0.540^{***}
e_pc_gdp	0.866^{***}
i_pop	0.387^{***}
e_pop	0.723^{***}
gravity vars	*YES*

- *Richer countries import* **and** *export more varieties*
- *Strong positive correlation between extensive margin of bilateral trade and the per-capita incomes of the trading partners*

Introduction

This Paper...

- I show that an augmented version of the new Ricardian framework due to Eaton and Kortum (2002) provides an intuitive explanation for these facts
- key extension: non-homothetic consumer behavior (richer agent consume from a broader set of varieties)
- calibrated version of the new model is able to qualitatively and quantitatively capture the key features of the data

	Data	EK	new model
Importer per capita gdp	0.54	-0.40	0.48
Exporter per capita gdp	0.87	0.60	0.60

- counterfactual experiments to highlight the quantitative importance of income effects

Introduction

Related Literature

- Empirical investigation of extensive margin:

  Hummels and Klenow (2005), Broda and Weinstein (2006), ...

  Bernasconi (2009), Baldwin and Harrigan (2007), Kang (2004), Debaere and Mostashari (2005)

- Framework: Eaton and Kortum (2002)

- Procedure for calibration: Fieler (2008)

- Extensive margin + non-homothetic:

  Matsuyama (2000), Sauré (2009), Foellmi et al (2009)

The Model

General Structure - Standard Eaton and Kortum (2002)

- Time: Static
- Countries: $1, ..., N$
- One industry: Tradeable consumption good, trade costs: d_{ni}
- Continuum of varieties $j \in [0, 1]$
- Labor is only input factor: Immobile across countries, perfectly mobile within
- Trade emerges if $\min \{p_{ni}(j)\}_{i \neq n} < p_{nn}(j)$
- All markets are competitive $\rightarrow$ $p_{ni}(j) = w_i \frac{d_{ni}}{z_i(j)}$

The Model

Supply Side - Standard Eaton and Kortum (2002)

- Country-variety specific productivity is a Fréchet random variable ↪ details
- Location of distribution is country specific (T_i)
- θ governs variability in the productivity draws
- Probability that country is i is the cheapest supplier in country n for a given variety

$$\pi_{ni} = \frac{T_i \left(w_i d_{ni}\right)^{-\theta}}{\Phi_n} \qquad \Phi_n = \sum_{i=1}^{N} T_i \left(w_i d_{ni}\right)^{-\theta}$$

- If country n consumes M_n varieties the extensive margin m_{ni} of the flow from i to n is

$$m_{ni} = M_n \pi_{ni}$$

The Model

The Extensive Margin and Per-Capita Income

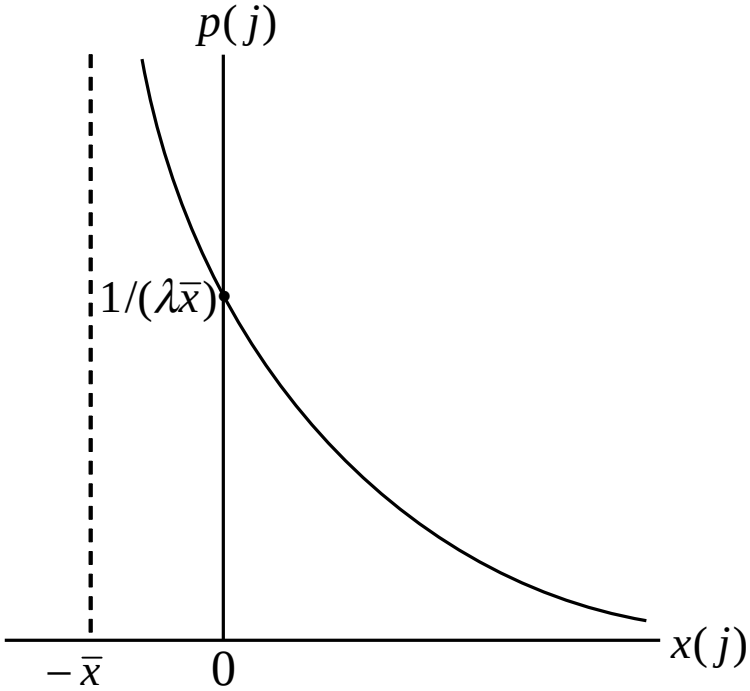
- Good technology ($T_k \uparrow$) $\longrightarrow$ high factor productivity $\longrightarrow$ high per-capita incomes
- Exports: Good technology in $k \longrightarrow \pi_{nk} \uparrow$
  Exporter income$\uparrow \longrightarrow$ extensive margin$\uparrow$
- What about imports?
  Standard model: $M_k = 1 \Longrightarrow m_{ki} = \pi_{ki}$
  Good technology in $k \longrightarrow \pi_{kk} \uparrow \longrightarrow (1 - \pi_{kk}) \downarrow$
- New model: M_k rising in income due to non-homothetic preferences
  Negative effect still present, but dominated by positive effect coming from demand side

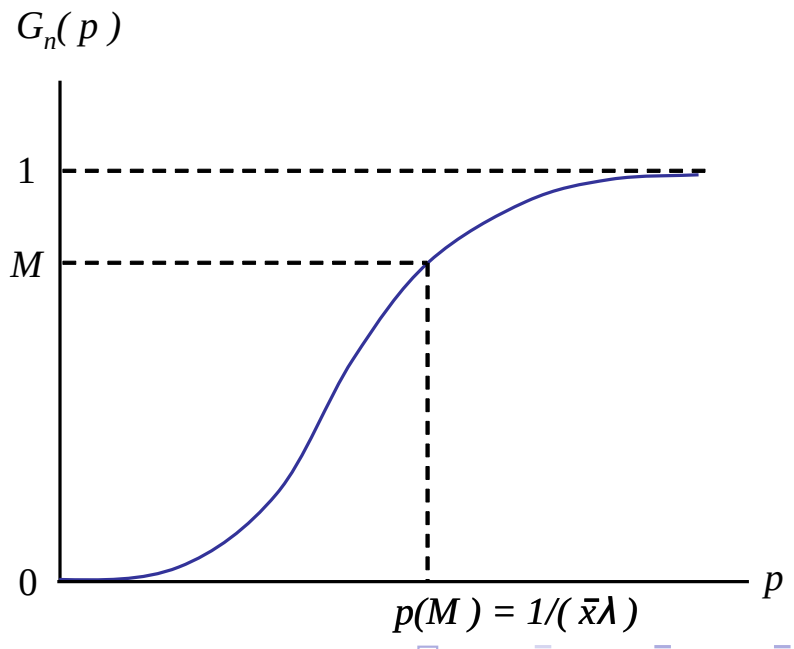
The Model

Non-Nomothetic Consumer Behavior

- Stone-Geary utility $U = \int_{j=0}^{1} \log\left(\bar{x} + x\left(j\right)\right) dj$
- First order conditions for variety j

$$\begin{aligned} 1/\left(\bar{x} + x\left(j\right)\right) &= \lambda p\left(j\right) \quad \text{if } x\left(j\right) > 0 \\ 1/\bar{x} &\leq \lambda p\left(j\right) \quad \text{if } x\left(j\right) = 0 \end{aligned}$$





The Model

The General Equilibrium

- Model parameter
  - Country specific technologies, T_i
  - bilateral trade costs, d_{ni}
  - population sizes, L_i
  - variability in productivites, θ
  - Preference parameter, $\bar{x}$
- Given these parameter there is a unique set of equilibrium wage rates $\{w_i\}_{i=1}^{N}$ and extensive margins of consumption $\{M_n\}_{n=1}^{N}$
- Bilateral trade is characterized by

$$\begin{aligned} X_{ni} &= \pi_{ni} w_n L_n \\ m_{ni} &= \pi_{ni} M_n \end{aligned}$$

The Model

The General Equilibrium - Key Features

- Aggregate bilateral volumes governed by same equation as in standard model

$$X_{ni} = \pi_{ni} w_n L_n$$

- Separability of supply and demand side, i.e. X_{ni} is independent of specific functional form of the utility function
- Closed form expression for the country specific price distribution

$$G_n(p) = 1 - \exp\left\{-\Phi_n p^{-\theta}\right\}$$

- Insert into budget constraint to get extensive margin of consumption

$$\frac{w_n}{\bar{x}} (\Phi_n)^{\frac{1}{\theta}} = \left(M_n \left(-\log(1 - M_n)\right)^{\frac{1}{\theta}} - \gamma\left(\tfrac{1}{\theta} + 1, -\log(1 - M_n)\right)\right)$$

Empirical Analysis

Calibration Strategy

- I calibrate model targeting aggregate trade volumes and consumer expenditure data
- Check how well the calibrated model's extensive margins line up with the data
- θ from EK
- T_i, d_{ni} using the Fieler (2008) procedure
- $\bar{x}$ from US consumption data

Empirical Analysis

Calibrating technolgies and trade costs

- Use aggregate bilateral trade volumes
- structural estimation procedure introduced by Fieler (2008)
- model unobserved trade costs as a function of observable proxies

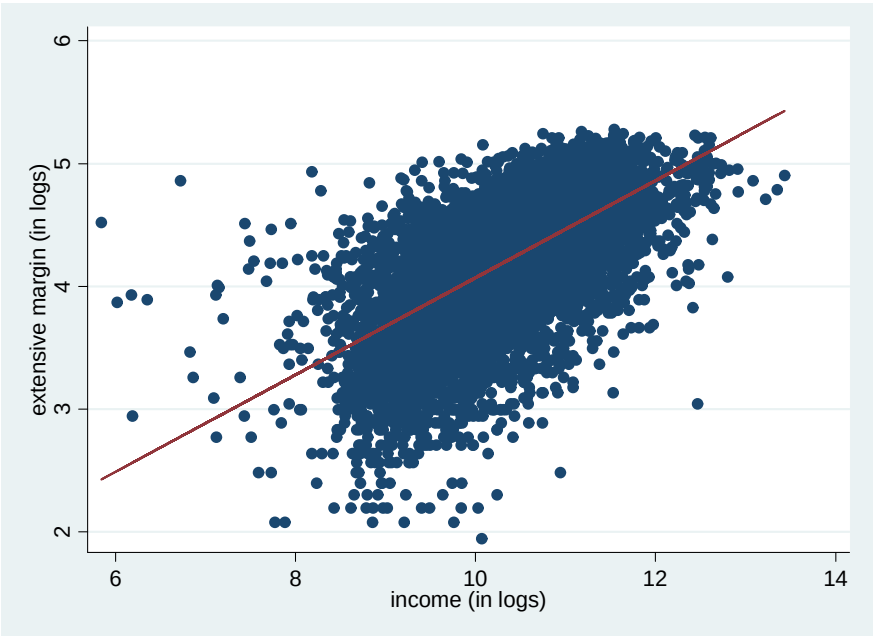
$$d_{ni} = 1 + \left(\gamma_0 + \gamma_1 \delta_{ni} + \gamma_2 \left(\delta_{ni}\right)^2\right) S_{ni} B_{ni} F_{ni}$$

- Iterate over $\gamma_0, \gamma_1, \ldots$ until quadratic distance between the simulated model's aggregate volumes and the data is minimized ↪ details
- The procedure yields estimates for the transporation costs d_{ni} and the countries' technologies T_i

Empirical Analysis

Calibrating the preference parameter

- From the US consumer expenditure survey I know income and consumption basket for around $7'500$ agents



- The income elasticity of the extensive margin of consumption is 0.40
- Choose $\bar{x}$ such that this elasticity is matched ($\bar{x} = 4.42$)

↪ alternative calibration method

Empirical Analysis

Results - I

- We calibrated the model using aggregate volumes and US consumption data
- We assess the calibrated model comparing its extensive margin to the data and the homothetic model
- Homothetic model is special case: $\bar{x} = 0$
- Repeat regression from introduction

	Data	EK	new model
Importer per capita gdp	0.53	−0.40	0.48
Exporter per capita gdp	0.86	0.60	0.60

Empirical Analysis

Results - II

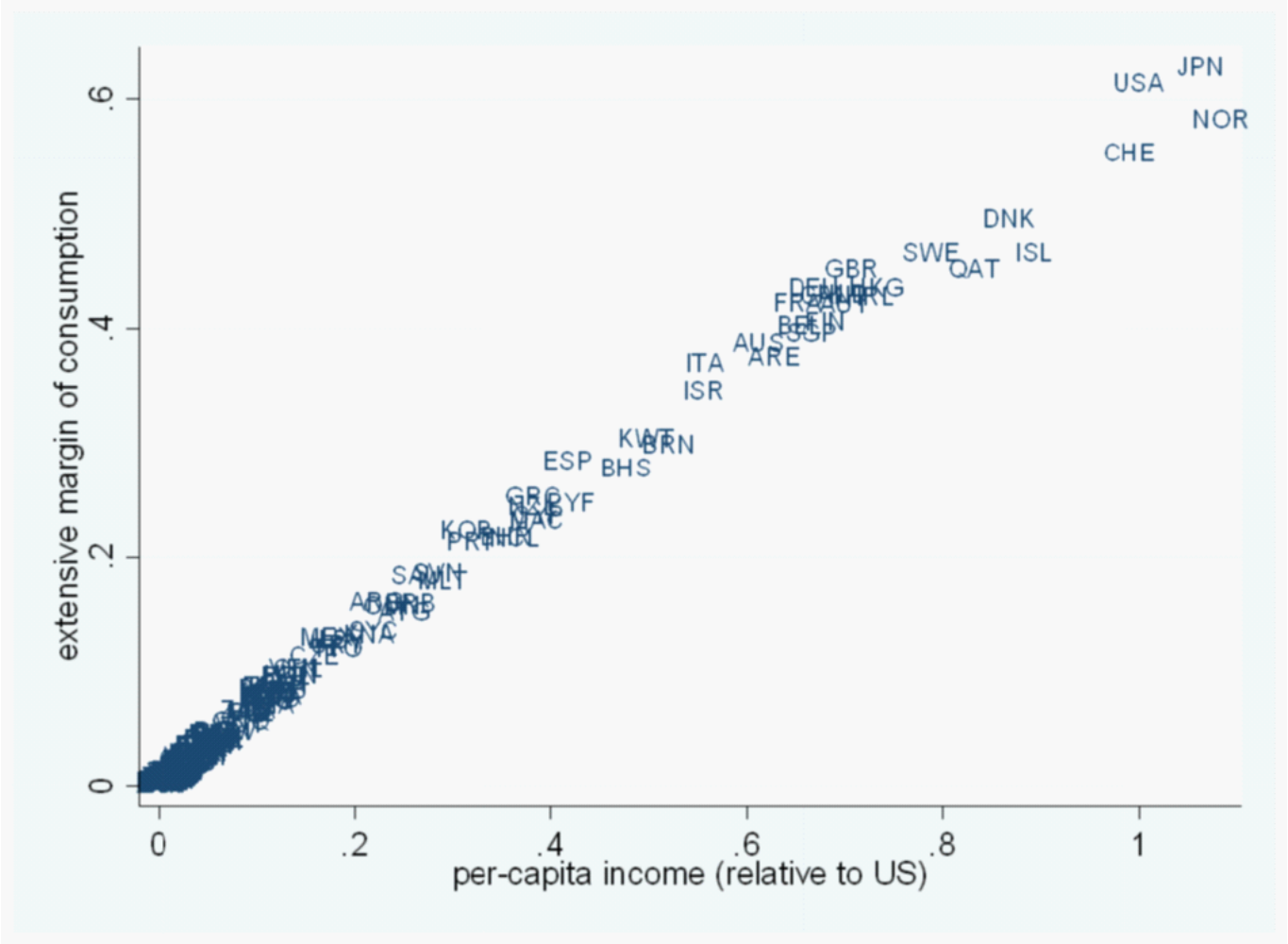
- Average extensive margin among the richest $x\%$ relative to average among poorest $x\%$

$x\%$	data	model	EK
10	413	352	3
20	132	143	3
30	35	70	2
40	19	37	2
50	13	21	2

- Demand side seems to be much more important to explain the higher extensive margin of trade among rich countries

Empirical Analysis

Results - III - Extensive Margin of Consumption



Counterfactuals

The Rise of China and India

- Between 1985 and 2000 per-capita incomes rose by 250% and 170%
- How looks global trade different if per-capita incomes rises by another 250% and 170%?
- Avergage change in extensive margin of...
  - exports: 58% and 31%
  - imports: 52% and 28% (vs. -37% and -23%)

Counterfactuals

Global Trade Liberalization

- Decrease transportation costs by 10%, 25%, and 50%
- 2 channels
  - Traditional: trade worthwhile for more varieties
  - New: Prices fall $\longrightarrow$ rising extensive margins of consumption
- Predicted increases of extensive margin about twice as high in new model

Conclusions

This Paper...

- Developed an intuitive modification of the EK framework
- Understand positive correlations between the extensive margin of trade and the per-capita incomes of trading partners
- Calibrated the model using aggregate volumes and CEX data
- Good performance w.r.t. the *untargeted* extensive margin of trade
- Two counterfactual experiments showed that accounting for income effects is quantitatively important for the extensive margin of trade

THANKS!

Details

First Stage Procedure - II

- Often traded, also imported by poor countries are
  - 490199 - Printed reading books, except dictionaries etc
  - 610910 - T-shirts, singlets and other vests, of cotton, knit
- Rarely traded, mostly imported by rich countries
  - 960110 - Worked ivory, articles of ivory
  - 880211 - Helicopters of an unladen weight $<$ 2,000 kg

Details

The Armenter and Koren (2008) Critique - I

- Armenter and Koren (2008) argue that many patterns on the extensive margin can be produced using a simple purely statistical model
- Given a fixed number of balls n_{ni} that are randomly assigned to bins s_j the expected number of non-empty bins m_{ni} is

$$E\left[m_{ni} \middle| n_{ni}\right] = \sum_{j=1}^{J} \left(1 - \left(1 - s_j\right)^{n_{ni}}\right)$$

- s_j = share of variety j in world trade
- n_{ni} = number of shipments from country i to country n
- If one uses the observed value of the bilateral trade flow and divides it by e.g. $10'000$ (minimum value of reported flows) or $36'000$ (average shipment value in 2000) to get the number of balls n_{ni} one indeed can qualitatively replicate the income elasticities
- What does this say about our model?

Details

The Armenter and Koren (2008) Critique - II

- Standard gravity model does not have a separate role for per-capita income and population size $\longrightarrow$ using this model to predict the number of shipments on cannot get the observed pattern of the extensive margin
- However, there are models with separate roles for per-capita incomes and population size (Fieler (2008), Waugh (2008))
- Using these models to predict the number of shipments one can indeed explain the extensive margin using the simple purely statistical model of Armenter and Koren (2008)
- However, these models *make* (counterfactual) predictions w.r.t. extensive margin, i.e. we are not free to impose the Armenter and Koren (2008) mechanism
- We show that allowing for non-homothetic consumer behavior in the EK framework modifies the model in a way consistent with the data (but also with the Armenter and Koren (2008) model)

Details

The Armenter and Koren (2008) Critique - III

- To see that our model performs goes beyond the mechanical facts due to balls and bins we need to consider additional moments in the data
- Is there a systematic pattern of imports, i.e. do countries move along a given hierarchy when adjusting their extensive margins with rising income?
- Theory: Allow productivity draws to be correlated across countries

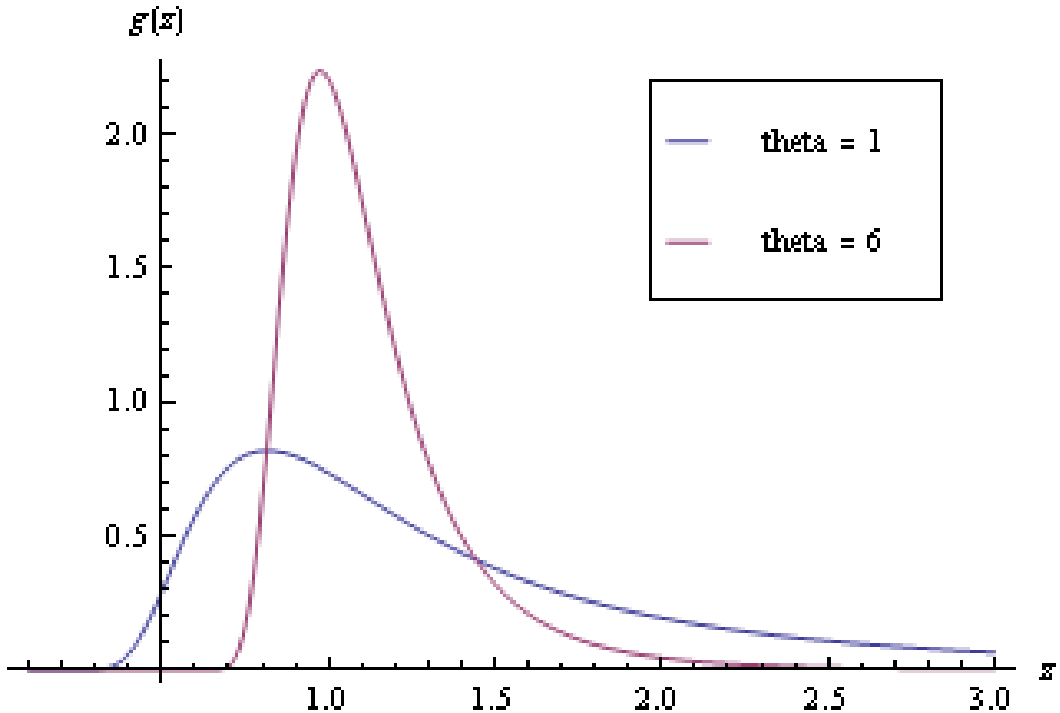
$$F(z_1, ..., z_N) = \exp\left\{-\left(\sum\left(T_i z_i^{-\theta}\right)^{1/\rho}\right)^{\rho}\right\}, \quad 1 \geq \rho > 0.$$

- Empirics: Hepenstrick (2009) uses Feenstra and Rose (2000) methodology to show that there is indeed a systematic pattern in how the extensive margin adjusts with rising incomes

Details

The Fréchet Distribution - I

- $G_i(z) = e^{-T_i z^{-\theta}}, \quad E[z] = T^{\frac{1}{\theta}} \Gamma\left[1 - \frac{1}{\theta}\right]$



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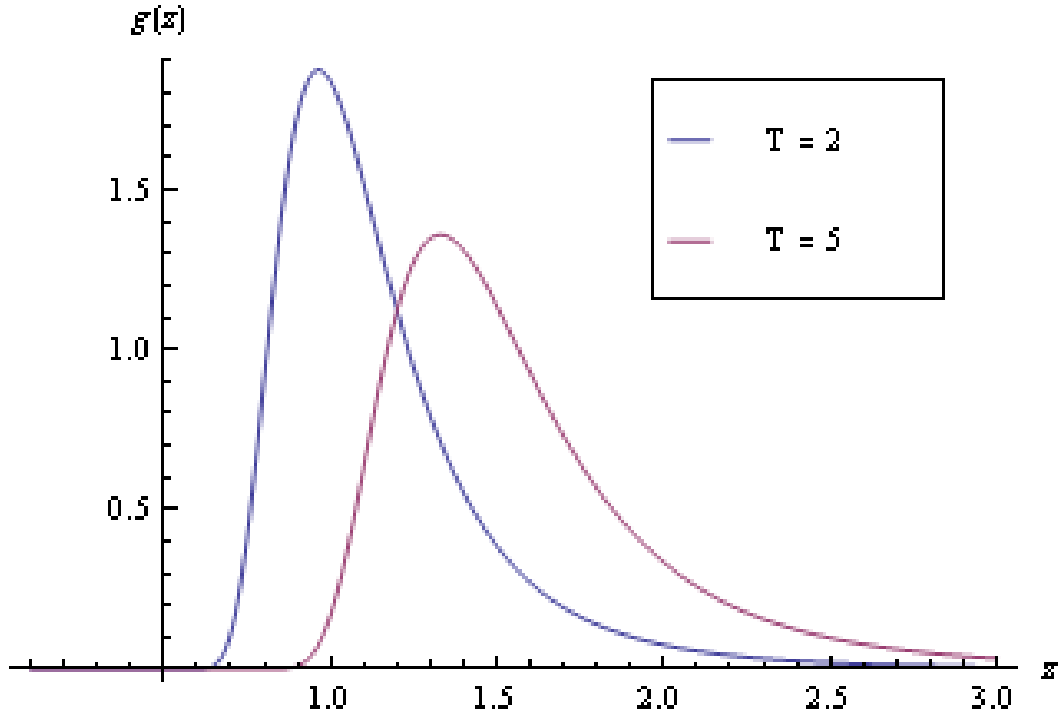
Details

The Fréchet Distribution - II



- Important property: order statistics of Fréchet variables are Fréchet distributed!

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Details

The Fieler (2008) methodology - I

- We observe population sizes L_i and take per-capita incomes as a proxy for the wage rates w_i
- For given $\Upsilon = (\gamma_0, \gamma_1, \gamma_2, \gamma_S, \gamma_B, \gamma_F)$ I can solve for the $\{T_i\}_{i=1}^{NN}$ consistent with global labor market clearing

$$L_i = \sum_{n=1}^{N} \frac{T_i \left(w_i d_{ni}\right)^{-\theta}}{\sum_{j=1}^{N} T_j \left(w_j d_{nj}\right)^{-\theta}} \frac{w_n}{w_i} L_n$$

- I then compute the corresponding bilateral trade flows

$$X_{ni} = \frac{T_i \left(w_i d_{ni}\right)^{-\theta}}{\sum_{j=1}^{N} T_j \left(w_j d_{nj}\right)^{-\theta}} w_n L_n$$

↪ back

Details

The Fieler (2008) methodology - II

- Find $\hat{\mathrm{Y}}$ that minimizes quadratic distance

$$L(\mathrm{Y}) = \frac{\sum_{i=1}^{N} \sum_{n \neq i} \omega_{ni} \left(X_{ni} - X_{ni}(\mathrm{Y}) \right)^2}{\sum_{i=1}^{N} \sum_{n \neq i} \omega_{ni} \left(X_{ni} \right)^2}$$

- As weight I choose $\omega_{ni} = \left(w_n L_n w_i L_i \right)^{-2}$
  - $\omega_{ni} = 1$ would imply that we mostly use information from big countries
  - Need to normalize trade flow by some measure for country size
  - Gravity literature (e.g. Anderson and van Wincoop (2003)) suggests that trade is proportional to product of the gdps.
- Nummerical mimimization using the simplex method with bounds as implemented in the IMSL-routines for FORTRAN

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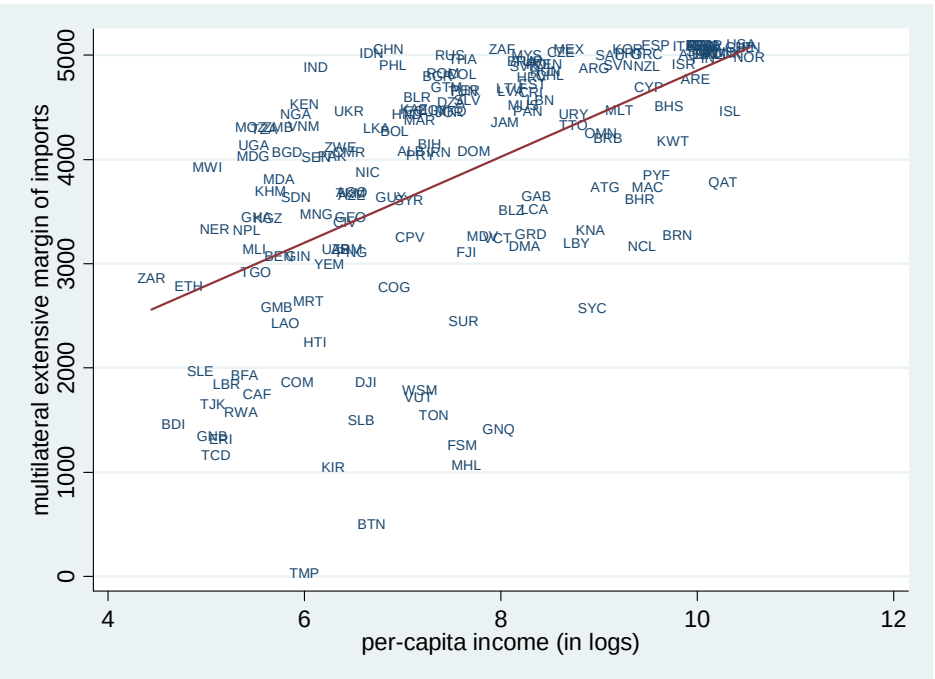
Details

Alternative Method for Calibrating the Preference Parameter

- Ideal: All countries' extensive margins of consumption
- Do not observe this (potentially in WB ICP)
- We do observe multilateral import margin $m_n = M_n (1 - \pi_{nn})$



- Choose $\bar{x}$ to match $\partial m_n / \partial \log(w_n)$ $\quad \rightarrow \quad$ $\bar{x} = 1.95$

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