Unpacking Sources of Comparative Advantage: A Quantitative Approach

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Motivation

- Comparative Advantage (CA) as the foundation of economists' understanding of patterns of trade.
- Recent ressurgence in empirical work on sources of CA:
  - **Productivity Levels:** Eaton & Kortum (2002).
  - **Factor Endowments:** Debeare (2003), Romalis (2004).
  - **Institutions:** Beck (2003), Manova (2006), Levchenko (2004), Nunn (2007), Costinot (2006), Cuñat & Melitz (2006).
- **Goal of Paper:** To develop a methodology for quantifying the importance of different sources of CA.
- **What Makes This Paper Different:**
  - Holistic view of the sources of CA (rather than testing for Ricardian and Heckscher-Ohlin forces in isolation).
  - Multi-sector analysis.
  - Estimation of model in a manner consistent with the prevalence of zero observations.

Roadmap

1. Extension of Eaton-Kortum (EK) model. ✓
2. OLS baseline results. ✓
3. Accounting for zero trade flows. ✓
4. SMM procedure.
5. Welfare counterfactuals.

Benchmark Model: An Extension of EK

- **Basic Set-up:**
  - N countries
  - K industries
    - k = 0, non-tradables (homogeneous good sector)
    - k ≥ 1, differentiated products industries, with the continuum of varieties within each industry indexed by $j^k \in [0,1]$
- **Utility:** $U_n = \left(Q_n^0\right)^{1-\eta}\left(\sum_{k\geq 1}\left(\int_0^1 \left(Q_n^k(j)\right)^{\alpha} dj\right)^{\frac{\beta}{\alpha}}\right)^{\frac{\eta}{\beta}}$

Nested CES function

Where:
- $Q_n^k(j)$ denotes quantity of variety j from industry k consumed in country n .
- $\varepsilon = 1/(1-\alpha) > 1$ is ES between varieties from same industry.
- $\phi = 1/(1-\beta) > 1$ is ES between varieties from different industries.
- $\varepsilon > \phi > 1.$

Benchmark Model

- **Representatative consumer solves:**

$$Max \left(Q_n^0\right)^{1-\eta}\left(\sum_{k\geq 1}\left(\int_0^1\left(Q_n^k(j)\right)^{\alpha} dj\right)^{\frac{\beta}{\alpha}}\right)^{\frac{\eta}{\beta}} \quad s.t.\ Y_n = Q_n^0 + \sum_{k\geq 1}\left(\int_0^1 p_n^k(j) Q_n^k(j) dj\right)$$

Which yields:

$$\begin{cases} Q_n^0(j) = \dfrac{(1-\eta)Y_n}{p_n^0(j)} = (1-\eta)Y_n & \text{for } k=0 \\ Q_n^k(j) = \dfrac{\eta Y_n}{p_n^k(j)^{\varepsilon}} \dfrac{(P_n^k)^{\varepsilon-\phi}}{\sum_{k\geq 1}\left(P_n^k\right)^{1-\phi}} & \text{for } k\geq 1 \end{cases}$$

Where: $\left(P_n^k\right)^{1-\varepsilon} = \int_0^1\left(p_n^k(j)\right)^{1-\varepsilon} dj$ is the ideal price index for industry *k*.

Benchmark Model

- **Price:**
  - Perfect competition.
  - CRS technology, no fixed costs (price = average cost).
  - $p_{ni}^k(j)$ denotes the price that country *i* charges for exporting variety *j* of industry *k* to country *n*, where:

$$p_{ni}^k(j) = \frac{c_i^k d_{ni}^k}{z_i^k(j)}$$

- c_i^k is **unit production cost**, $c_i^k = \prod_{f=0}^{F} (w_{if})^{s_f^k}$ with $\sum_{f=0}^{F} s_f^k = 1$ and $s_f^k \in (0,1)$
  - f indexes factors of production.
  - w_{if} denotes local unit price of factor f.
  - s_f^k share of total factor payments in industry *k* to factor f.

- d_{ni}^k is **price mark-up,** with $d_{ni}^k > 1$ and $d_{ni}^k \leq d_{nm}^k d_{mi}^k$.

- $z_{ni}^k(j)$ is the **productivity term.**

Benchmark Model

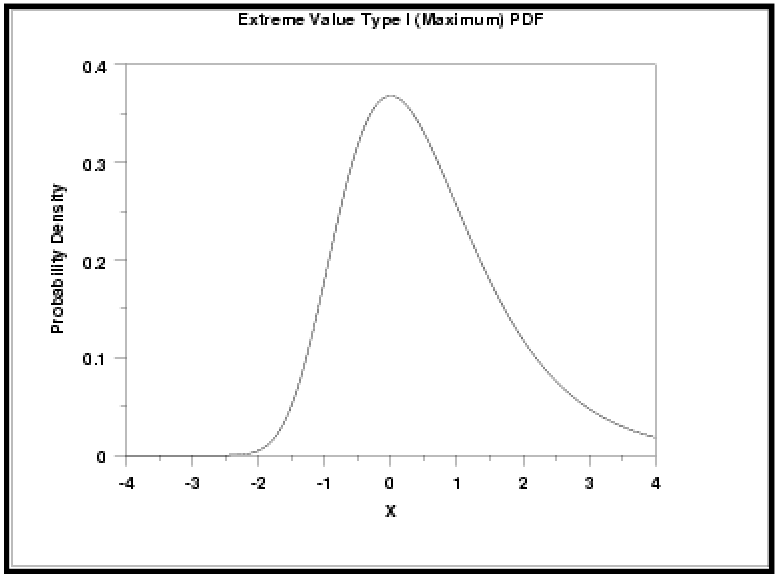
- **Productivity:**

$$\ln z_{ni}^{k}(j) = \underbrace{\lambda_i + \mu_k + \sum_{\{l,m\}} \beta_{lm} L_{il} M_{km}}_{\text{Systemic Component}} + \underbrace{\beta_0 \varepsilon_i^k(j)}_{\text{Stochastic Component}}$$

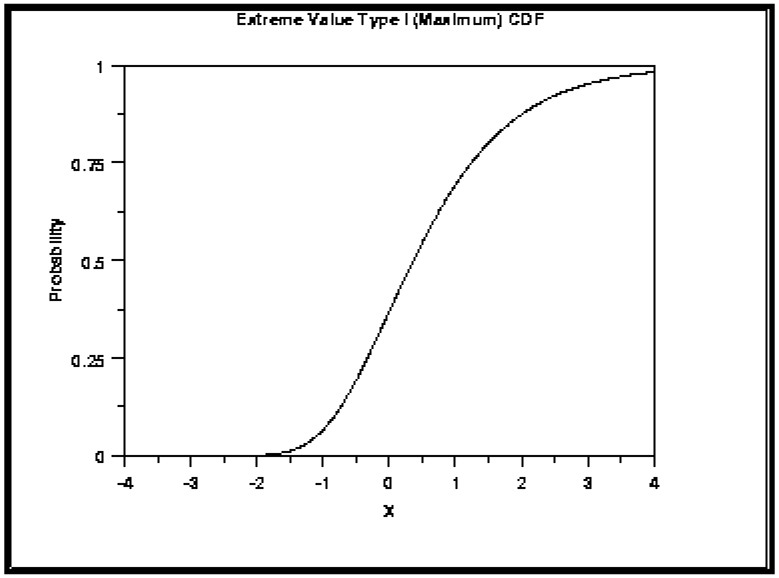
- Country Characteristics indexed by l: L_{il}
- Industry Characteristics indexed by m: M_{km}
- Exporter Fixed Effects: λ_i
- Industry Fixed Effects: μ_k
- Productivity Shocks: $\varepsilon_i^k(j)$
  - Independent draws from the Type I Extreme Value (Gumbel) distribution, with cdf $F(\varepsilon) = \exp(-\exp(-\varepsilon))$

Gumbel Distribution

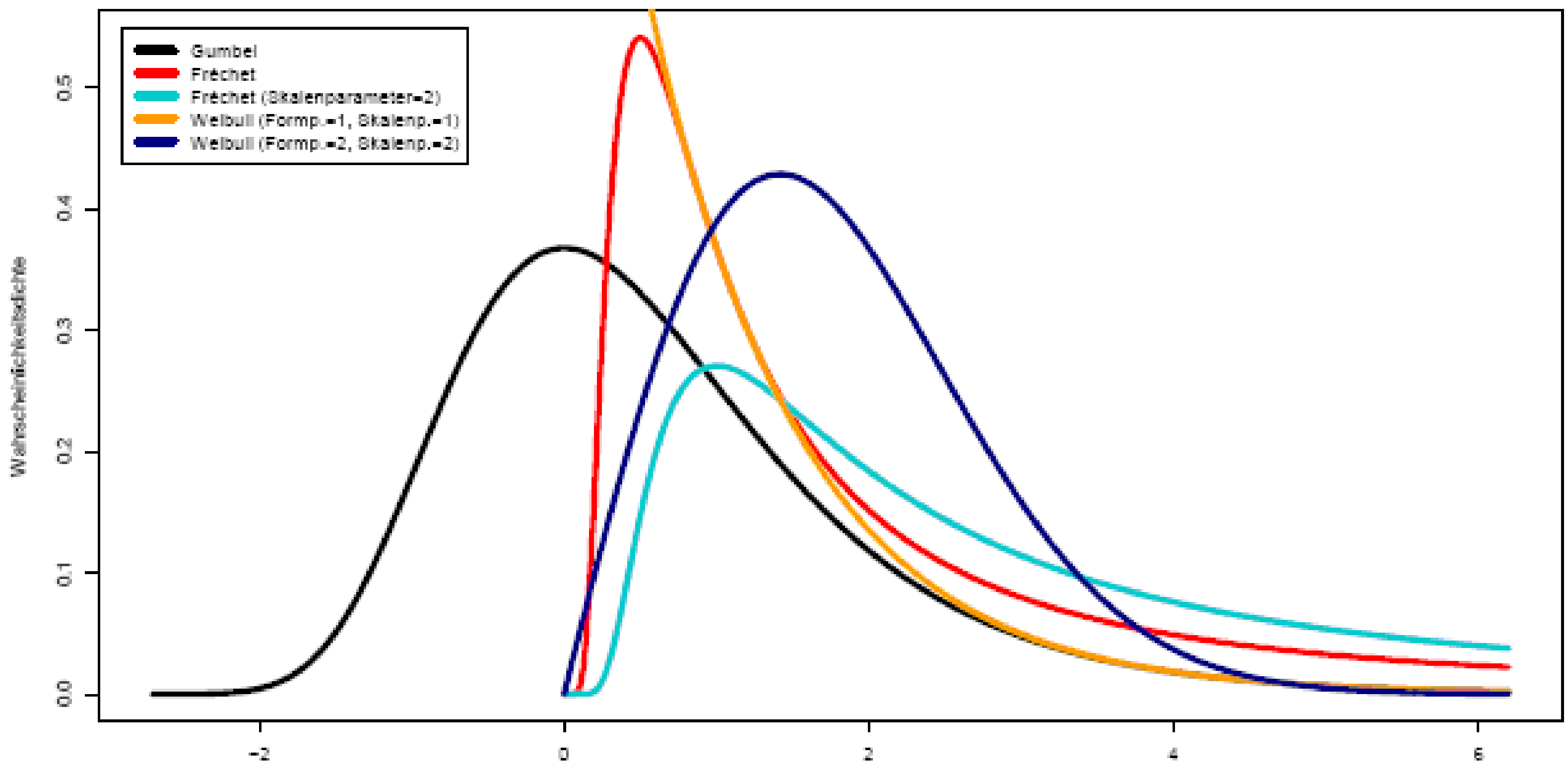
PDF



CDF



Gumbel and Fréchet



GUMBEL DISTRIBUTION IN BLACK

FRÉCHET DISTRIBUTION IN RED & LIGHT BLUE

Benchmark Model

- **Rewrite price as:**

$$\ln p_{ni}^{k}(j) = \ln(c_i^k d_{ni}^k) - \lambda_i - \mu_k - \sum_{\{l,m\}} \beta_{lm} L_{il} M_{km} - \beta_0 \varepsilon_i^k(j)$$

- **Distribution of prices:**

$$G_{ni}^{k}(p) = \Pr\{p_{ni}^k(j) < p\} = 1 - \exp\{-(c_i^k d_{ni}^k)^{-\theta} p^{\theta} \varphi_i^k\}$$

Where:

- $\theta = \frac{1}{\beta_0}$ *(inverese productivity spread parameter)*
- $\varphi_i^k = \exp\{\theta\lambda_i + \theta\mu_k + \theta\sum_{\{l,m\}} \beta_{lm} L_{il} M_{km}\}$ *(increasing in systematic comp.)*

- **Price actually paid by country *n* for variety *j* from industry *k*:**

$$p_n^k(j) = \min\{p_{ni}^k(j) : i = 1, \ldots, N\}$$

- **Industry *k* price distribution facing country *n*:**

$$G_n^k(p) = 1 - \prod_{i=1}^{N}[1 - G_{ni}^k(p)] = 1 - \exp\{-(\sum_{i=1}^{N}(c_i^k d_{ni}^k)^{-\theta} \varphi_i^k p^{\theta}\}$$

Benchmark Model

- Probability of country *i* being the lowest-price provider of an industry-*k* variety to country *n*:

$$\pi_{ni}^{k} = \int_0^\infty [1 - G_{ns}^{k}(p)] dG_{ns}^{k}(p) = \frac{(c_i^k d_{ni}^k)^{-\theta} \varphi_i^k}{\sum_{s=1}^{N} (c_s^k d_{ns}^k)^{-\theta} \varphi_s^k}$$

Contribution of country *i*

- Let X_{ni}^{k} denote the value of industry-*k* exports from country *i* to *n.*

- Then $\sum_{i=1}^{N} X_{ni}^{k}$ is country *n*'s total consumption in industry *k.*

- An expression for trade flows can be derived as:

$$\frac{X_{ni}^{k}}{X_{n}^{k}} = \frac{\pi_{ni}^{k} \int_0^\infty \int_0^1 p_n^k(j) Q_n^k(j) dj dG_n^k(p_n^k)}{\sum_{i=1}^{N} \pi_{ni}^{k} \int_0^\infty \int_0^1 p_n^k(j) Q_n^k(j) dj dG_n^k(p_n^k)} = \pi_{ni}^{k} = \frac{(c_i^k d_{ni}^k)^{-\theta} \varphi_i^k}{\sum_{s=1}^{N} (c_s^k d_{ns}^k)^{-\theta} \varphi_s^k}$$

- Useful to normalize by country *n*'s expenditure share from a fixed reference country, *u*:

$$\frac{X_{ni}^{k}}{X_{nu}^{k}} = \frac{(c_i^k d_{ni}^k)^{-\theta} \varphi_i^k}{(c_u^k d_{nu}^k)^{-\theta} \varphi_u^k} \qquad (1)$$

Basis for OLS estimation

Chor vs. EK

- Chor: $$\frac{X_{ni}^{k}}{X_{nu}^{k}} = \frac{(c_i^k d_{ni}^k)^{-\theta} \varphi_i^k}{(c_u^k d_{nu}^k)^{-\theta} \varphi_u^k}$$ ← More General Productivity Term

- EK: $$\frac{X_{ni}}{X_{nu}} = \frac{(c_i d_{ni})^{-\theta} T_i}{(c_u d_{nu})^{-\theta} T_u}$$ ← Tecnological parameter

- Differences:
  - Chor replaces each term with its industry-specific counerpart
  - Chor replaces T_i with $\varphi_i^k = e_i^{\{\theta\lambda_i + \theta\mu_k + \theta\sum_{\{l,m\}}\beta_{lm}L_{il}M_{km}\}}$

OLS Estimation

- Deriving the Estimating Equation
  - Specify $d_{ni}^{k} = \exp\{\beta_d D_{ni} + \delta_k + \zeta_{ni} + \upsilon_{ni}^{k}\}$
  - Where $\beta_d D_{ni}$ is a liner combination of distance variables:
    - physical distance,
    - shared linguistic ties,
    - colonial links,
    - border relationships,
    - indicator for trade regional trade agreements,
    - Indicator for GATT membership.
  - δ_k is industry fixed effect
  - $\zeta_{ni} + \upsilon_{ni}^{k}$ are idiosyncratic shocks, iid, with $\begin{cases} \zeta_{ni} \sim N(0, \sigma_{\zeta}^{2}) \\ \upsilon_{ni}^{k} \sim N(0, \sigma_{\upsilon}^{2}) \end{cases}$

OLS Estimation

- Take log of (1):

$$\ln\left(\frac{X_{ni}^{k}}{X_{nu}^{k}}\right) = -\theta\sum_{f=0}^{F}(\ln w_{if} - \ln w_{uf})s_{f}^{k} + \theta\sum_{\{l,m\}}\beta_{lm}(L_{il} - L_{ul})M_{km} - \ldots$$
$$\ldots - \theta\beta_{d}(D_{ni} - D_{nu}) + \theta(\lambda_{i} - \lambda_{u}) - \theta(\zeta_{ni} - \zeta_{nu}) - \theta(\upsilon_{ni}^{k} - \upsilon_{nu}^{k}) \quad (2)$$

- Both $\theta\sum_{f=0}^{F}(\ln w_{if} - \ln w_{uf})s_{f}^{k}$ and $\theta\sum_{\{l,m\}}\beta_{lm}(L_{il} - L_{ul})M_{km}$ capture how well conditions in country *i* provide for the production needs of industry *k*.

- The first term picks up the role of Heckscher-Ohlin forces (endowment-based cost advantage)

- The second term identifies sources of CA stemming from a country's ability to provide right institutional and technological conditions for the industry.

OLS Estimation

- Since $s_0^k = 1 - \sum_{f=1}^{F} s_f^k$, we can rewrite (2) as:

$$\ln\left(\frac{X_{ni}^k}{X_{nu}^k}\right) = -\theta \sum_{f=1}^{F} (\ln \frac{w_{if}}{w_{i0}} - \ln \frac{w_{uf}}{w_{u0}}) s_f^k + \theta \sum_{\{l,m\}} \beta_{lm} (L_{il} - L_{ul}) M_{km} - \ldots$$

$$\ldots - \theta \beta_d (D_{ni} - D_{nu}) + I_i + I_{nk} - \theta \zeta_{ni} - \theta \upsilon_{ni}^k \qquad (3)$$

- Where constants have been rearranged as $I_i = \theta \lambda_i$ and $I_{nk} = \theta \zeta_{nu} + \theta \upsilon_{nu}^k$.

- However, since good data on factor prices is not readily available, use proxy for relative prices: inverse relative factor endowments, $\ln \frac{V_{if}}{V_{uf}}$

- Finally, we obtain the estimating equation:

$$\ln\left(\frac{X_{ni}^k}{X_{nu}^k}\right) = \sum_{f=1}^{F} \theta \beta_f (\ln \frac{V_{if}}{V_{i0}} - \ln \frac{V_{uf}}{V_{u0}}) s_f^k + \sum_{\{l,m\}} \theta \beta_{lm} (L_{il} - L_{ul}) M_{km} - \ldots$$

$$\ldots - \theta \beta_d (D_{ni} - D_{nu}) + I_i + I_{nk} - \theta \zeta_{ni} - \theta \upsilon_{ni}^k \qquad (4)$$

OLS Estimation: Summary

Heckscher-Ohlin Determinants

Interaction between relative factor endowments and industry factor intensities

Institutional Determinants

Interaction between institutional characteristics and industry measures of dependence

$$\ln\left(\frac{X_{ni}^{k}}{X_{nu}^{k}}\right) = \sum_{f=1}^{F} \theta\beta_f \left(\ln\frac{V_{if}}{V_{i0}} - \ln\frac{V_{uf}}{V_{u0}}\right) s_f^{k} + \sum_{\{l,m\}} \theta\beta_{lm}(L_{il} - L_{ul}) M_{km} - \dots$$

$$\dots - \theta\beta_d (D_{ni} - D_{nu}) + I_i + I_{nk} - \theta\zeta_{ni} - \theta\upsilon_{ni}^{k}$$

Idiosyncratic Shocks

Bilateral Distance Variables

Importer-Industry Fixed Effects

Exporter Fixed Effects

OLS Estimation

- 82 countries.
- 20 sectors, 2-digit US SIC-87 Classification.
- United States as fixed reference country "*u*"

- 80% of all recorded manufacturing trade in 1990.
- 82 x 81 x 20 = 132,840 observations.
- Only 32.4% record positive amount of trade.
- OLS estimates have to be interpreted as effects conditional on observing positive trade flows into a country from both exporter *i* and the United States.

- OLS regression results: See handout.