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 resurgence in empirical work on sources of CA:
  ● **Productivity Levels**: Eaton & Kortum (2002).
  ● **Factor Endowments**: Debeare (2003), Romalis (2004).

● **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:**
  \[
  U_n = \left( Q_n^0 \right)^{-\eta} \left( \sum_{k \geq 1} \left( \int_0^1 \left( Q_n^k(j) \right)^{\alpha} \, dj \right)^{\frac{\beta}{\alpha}} \right)^{\frac{\eta}{\beta}}
  \]

  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

- **Representative consumer solves:**

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

Which yields:

\[
\begin{align*}
Q_n^0(j) &= \frac{(1 - \eta)Y_n}{p_n^0(j)} = (1 - \eta)Y_n \quad \text{for} \quad k = 0 \\
Q_n^k(j) &= \frac{\eta Y_n}{p_n^k(j)\epsilon} \left( \frac{P_n^k}{\sum_{k \geq 1} (P_n^k)^{\frac{\epsilon}{1 - \phi}}} \right)^{\frac{\epsilon}{1 - \phi}} \quad \text{for} \quad k \geq 1
\end{align*}
\]

Where: \( (P_n^k)^{1 - \epsilon} = \int_0^1 (p_n^k(j))^{1 - \epsilon} dj \) 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:

\[
p_{ni}^k(j) = \frac{c_i^k d_{ni}^k}{z_{ni}^k(j)}
\]

- \( c_i^k \) 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:**
  \[
  \ln z_{ni}^k(j) = \lambda_i + \mu_k + \sum_{l,m} \beta_{lm} L_{il} M_{km} + \beta_0 \varepsilon_i^k(j)
  \]

- Country Characteristics indexed by \( l: L_{il} \)
- Industry Characteristics indexed by \( m: M_{km} \)
- Exporter Fixed Effects: \( \lambda_i \)
- Industry Fixed Effects: \( \mu_k \)
- 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:
  \[ \ln p^k_{ni}(j) = \ln(c^k d^k_{ni}) - \lambda_i - \mu_k - \sum_{\{l,m\}} \beta_{lm} L_{li} M_{km} - \beta_0 \varepsilon^k_i(j) \]

- Distribution of prices:
  \[ G^k_{ni}(p) = \Pr\{ p^k_{ni}(j) < p \} = 1 - \exp\left\{ -\left( c^k d^k_{ni} \right)^{-\theta} p^\theta \varphi^k_i \right\} \]
  Where:
  - \( \theta = \frac{1}{\beta_0} \) (inverse productivity spread parameter)
  - \( \varphi^k_i = \exp\{ \theta \lambda_i + \theta \mu_k + \theta \sum_{\{l,m\}} \beta_{lm} L_{li} M_{km} \} \) (increasing in systematic comp.)

- Price actually paid by country \( n \) for variety \( j \) from industry \( k \):
  \[ p^k_n(j) = \min\{ p^k_{ni}(j) : i = 1,...,N \} \]

- Industry \( k \) price distribution facing country \( n \):
  \[ G^k_n(p) = 1 - \prod_{i=1}^{N} [1 - G^k_{ni}(p)] = 1 - \exp\left\{ -\left( \sum_{i=1}^{N} (c^k d^k_{ni})^{-\theta} \varphi^k_i \right) p^\theta \right\} \]
Benchmark Model

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

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

- 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:

\[
\frac{X_{ni}^k}{X_n^k} = \frac{\pi_{ni}^k \int_0^\infty \int_0^1 p_n^k(j)Q_n^k(j) dj dG_n^k(p_n^k)}{\sum_{i=1}^N \pi_{ni}^k \int_0^\infty \int_0^1 p_n^k(j)Q_n^k(j) dj dG_n^k(p_n^k)} = \frac{\pi_{ni}^k}{\sum_{s=1}^N (c_s^k d_{ns}^k)^{-\theta} \phi_s^k} = \frac{(c_i^k d_{ni}^k)^{-\theta} \phi_i^k}{\sum_{s=1}^N (c_s^k d_{ns}^k)^{-\theta} \phi_s^k}
\]

- Useful to normalize by country \(n\)’s expenditure share from a fixed reference country, \(u\):

\[
\frac{X_{ni}^k}{X_{nu}^k} = \frac{(c_i^k d_{ni}^k)^{-\theta} \phi_i^k}{(c_u^k d_{nu}^k)^{-\theta} \phi_u^k} \tag{1}
\]

Basis for OLS estimation
Chor vs. EK

- **Chor:**
  \[
  \frac{X_{ni}^k}{X_{nu}^k} = \left(\frac{c_i^k d_{ni}^k}{c_u^k d_{nu}^k}\right)^{-\theta} \Phi_i^k
  \]

- **EK:**
  \[
  \frac{X_{ni}}{X_{nu}} = \left(\frac{c_i d_{ni}}{c_u d_{nu}}\right)^{-\theta} T_i
  \]

**Differences:**
- Chor replaces each term with its industry-specific counterpart
- Chor replaces \( T_i \) with \( \Phi_i^k = e_i^{\{\theta\lambda_i + \theta\mu_k + \theta \sum_{\{l,m\}} \beta_{lm} L_{il} M_{km}\}}\)
OLS Estimation

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

- Take log of (1):

\[
\ln\left(\frac{X_{ni}^k}{X_{nu}^k}\right) = -\theta \sum_{f=0}^{F} (\ln w_{if} - \ln w_{uf}) s_f^k + \theta \sum_{\{l,m\}} \beta_{lm} (L_{il} - L_{ul}) M_{km} - \ldots - \theta \beta_d (D_{ni} - D_{nu}) + \theta (\lambda_i - \lambda_u) - \theta (\zeta_{ni} - \zeta_{nu}) - \theta (\nu_{ni} - \nu_{nu}) \quad (2)
\]

- 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:

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

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

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

- 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:

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

$$\ldots - \theta \beta_d (D_{ni} - D_{nu}) + I_i + I_{nk} - \theta \zeta_{ni} - \theta \nu_{ni}^k$$
OLS Estimation: Summary

Heckscher-Ohlin Determinants

Interaction between relative factor endowments and industry factor intensities

\[
\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} - ... \\

- \theta \beta_d (D_{ni} - D_{nu}) - I_i + I_{nk} - \theta \zeta_{ni} - \theta \nu_{ni}

Bilateral Distance Variables

Export Fixed Effects

Institutional Determinants

Interaction between institutional characteristics and industry measures of dependence

Idiosyncratic Shocks

Importer-Industry 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.