Unpacking Sources of Comparative Advantage:  
A Quantitative Approach

Davin Chor  
(Singapore Management University)

5 Jan 2008  
NAWM of the Econometric Society (New Orleans)
Recent empirical work on sources of comparative advantage:

1. **Productivity levels** (Ricardian framework):
   - Eaton and Kortum (2002): Multi-country Ricardian model that yields closed-form trade flows
   - Good fit to bilateral manufacturing trade data in the OECD

   Structural approach facilitates counterfactual exercises:
   eg computing welfare gains from the reduction of distance barriers
Background

Recent empirical work on sources of comparative advantage:

1. **Productivity levels** (Ricardian framework):
   - Eaton and Kortum (2002): Multi-country Ricardian model that yields closed-form trade flows
   - Good fit to bilateral manufacturing trade data in the OECD

   Structural approach facilitates counterfactual exercises:
   eg computing welfare gains from the reduction of distance barriers

2. **Factor endowments** (Heckscher-Ohlin framework):
   - Romalis (2004): Countries export more from industries that use their abundant factors more intensively
Background (cont.)

3. **Institutional determinants:**
   - Financial development (Beck 2003, Manova 2006)
   - Legal/Contracting institutions (Levchenko 2007, Nunn 2007, Costinot 2006)
   - Labor market institutions (Cuñat and Melitz 2007)

Empirical strategy: Countries with particular institutional strengths export more in industries that are dependent on these institutional conditions.

Focus on identifying effects, rather than welfare implications
Background (cont.)

3. Institutional determinants:

- Financial development (Beck 2003, Manova 2006)
- Legal/Contracting institutions (Levchenko 2007, Nunn 2007, Costinot 2006)
- Labor market institutions (Cuñat and Melitz 2007)

Empirical strategy: Countries with particular institutional strengths export more in industries that are dependent on these institutional conditions.

Focus on identifying effects, rather than welfare implications

How much do different sources of comparative advantage matter for patterns of specialization and country welfare?
What this paper does: Model

- Develops a structural framework for quantifying the importance of different sources of comparative advantage:

  Eaton-Kortum model extended to *industry trade flows*

- Comparative advantage driven by the interaction of country and industry characteristics

  **Intuition:** Countries specialize in industries whose production needs they can best satisfy with their factor endowment mix, institutional environment, and technological strengths.

- In general equilibrium, specialization patterns and welfare are functions of underlying country and industry characteristics, and distance barriers
What this paper does: Empirics

- Estimation on a dataset of bilateral industry trade flows
  (82 countries and 20 manufacturing industries)

1. **OLS baseline**
   Corroborates literature on the significance of distance barriers, factor endowments, and institutional conditions in explaining bilateral trade patterns

   To account for the bias from omitting zero trade flows
   (about two-thirds of the data)
What this paper does: Counterfactuals

1. **Effect of Distance:** Large welfare gains from reduction of physical distance barriers (25.6%)
   - Comparable to what EK find for the OECD (16.1%-24.1%)
   - Developing countries benefit more than the OECD (29.8% vs 7.0%)
1. **Effect of Distance:** Large welfare gains from reduction of physical distance barriers (25.6%)
   - Comparable to what EK find for the OECD (16.1%-24.1%)
   - Developing countries benefit more than the OECD (29.8% vs 7.0%)

2. **Policy experiments:** Raising all countries’ factor endowments or institutional characteristics to the world frontier level ... 
   
   Also ... illustrate welfare gains and the shift in industry composition for a single country (Indonesia) when raising its country attributes
Related literature

- Estimation of model of bilateral trade flows / MNC activity:
  Ramondo (2006)
  Costinot and Komunjer (2006)

- This paper:
  - Ties pattern of industry trade flows to country characteristics
  - Estimation in a manner consistent with the zero trade flows
Plan of Talk

1. Introduction and Motivation

2. **Theory: Extending Eaton-Kortum to the industry level**

3. Estimation
   - OLS baseline
   - Simulated method of moments (SMM)

   - Distance barriers
   - Country characteristics

5. Conclusions
**Modelling industry trade flows: Utility**

$k = 0, 1, \ldots, K$ industries:

- Industry 0: non-tradable, domestic numeraire
- Industry $k \geq 1$: tradables

**Utility:**

\[
U_n = \left( Q_n^0 \right)^{1-\eta} \left( \sum_{k \geq 1} \left( \int_0^1 (Q_n^k(j^k))^\alpha \ dj^k \right)^{\beta/\alpha} \right)^{\eta/\beta}, \quad \alpha, \beta, \eta \in (0, 1) \tag{1}
\]

$\varepsilon = \frac{1}{1-\alpha} > 1$: elasticity of substitution between varieties from the same industry

$\phi = \frac{1}{1-\beta} > 1$: elasticity of substitution between varieties across industries

Assume: $\varepsilon > \phi > 1$. 
Modelling industry trade flows: Goods Prices

- Market structure: perfect competition
- Production: constant returns to scale
- Firms price at average cost:

\[ p^k_{ni}(j) = \frac{c^k_i d^k_{ni}}{z^k_i(j)} \]  \hspace{1cm} (2)

\( n \): importer \hspace{0.5cm} i: exporter \hspace{0.5cm} j: varieties

- Unit production costs: \( c^k_i = \prod_f (w_{if})^{s^k_f}, \quad s^k_f \in (0,1), \quad \sum_f s^k_f = 1 \)

Distance: \( d^k_{ni} \geq 1, \quad d^k_{ni} \leq d^k_{nm}d^k_{mi} \)

Productivity: \( z^k_i(j) \)
Modelling industry trade flows: Goods Prices

- Specify:
  \[ \ln z_i^k(j) = \lambda_i + \mu_k + \sum_{\{l,m\}} \beta_{lm} L_{il} M_{km} + \beta_0 \epsilon_i^k(j) \] (3)

- **Systematic component:** \( \lambda_i + \mu_k + \sum_{\{l,m\}} \beta_{lm} L_{il} M_{km} \)
  - \( L_{il} \): country characteristics
  - \( M_{km} \): industry characteristics

- **Stochastic component:** \( \epsilon_i^k(j) \) is a draw from the Type I extreme-value (Gumbel) distribution, \( F(x) = \exp(-\exp(-x)) \)

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

- **Head-to-head competition:** Each variety is procured from the lowest-price exporter
Modelling industry trade flows

- **Normalized trade flows:**

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

where:

(i) \( \varphi_i^k = \exp \left\{ \theta (\lambda_i + \mu_k + \sum_{l,m} \beta_{lm} L_{il} M_{km}) \right\} \);

(ii) \( \theta = \frac{1}{\beta_0} \) is an inverse spread parameter.

- **Comparison with EK (2002):** \( K = 1 \)

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

- \( \varphi_i^k \) unpacks productivity as a function of country and industry characteristics
Plan of Talk

1. Introduction and Motivation

2. Theory: Extending Eaton-Kortum to the industry level

3. Estimation
   ▶ OLS baseline
   ▶ Simulated method of moments (SMM)

4. Welfare Counterfactuals on ...
   ▶ Distance barriers
   ▶ Country characteristics

5. Conclusions
Estimation: OLS Baseline

Specify:

\[ d_{ni}^k = \exp\{\beta_d D_{ni} + \delta_k + \zeta_{ni} + \nu_{ni}^k\} \]  

\( D_{ni} \): distance measures from gravity literature
\( \zeta_{ni} \sim N(0, \sigma_{\zeta}^2) \), and \( \nu_{ni}^k \sim N(0, \sigma_{\nu}^2) \)

From CEPII and Rose (2004):

(i) Log distance; (ii) Common language dummy; (iii) Colonial dummy;
(iv) Common colonizer dummy; (v) Common border dummy;
(vi) GATT dummy; (vii) Regional Trade Agreement dummy
Motivation and Introduction

Theory: Extending Eaton-Kortum

Estimation: OLS and SMM

Welfare Counterfactuals

Estimation: OLS Baseline

**Estimating equation:** (relative to \( u: \) US)

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

(7)

**Natural decomposition:** Normalized trade flows as a function of:

1. Distance
2. Heckscher-Ohlin determinants
3. Institutional determinants
4. Exporter and importer-industry fixed effects
5. Idiosyncratic noise
OLS estimates: Caveats

OLS provides a baseline for comparison with existing empirical work.

But ... 

1. Can only interpret these as effects conditional on observing positive trade flows, even though majority (67.6%) of the data is zeros

   Coefficients are biased when omitting zeros

2. Cannot identify $\theta$, which we need to compute welfare counterfactuals
Modifying the theory to generate zeros

Let the $\epsilon^k_j$'s now be independent draws from a truncated Gumbel distribution with bounded support $[\underline{x}, \bar{x}]$:

$$\tilde{F}(\epsilon) = \frac{F(\epsilon) - F(x)}{F(\bar{x}) - F(x)}, \quad \text{where } F(\epsilon) = \exp(-\exp(-\epsilon))$$

Zero trade flows arise when there are large cross-country productivity gaps

- Lose closed-forms for trade flows, but can simulate them
- Motivates a simulated method of moments (SMM) estimator; akin to Ramondo (2006)
Procedure for simulating trade flows

1. For each variety $j$, compute the prices presented by all $N$ countries to each importing country $n$:

$$\ln(p_{ni}^k)^{(j)} = \frac{1}{\theta} \left( \theta \beta_d \cdot D_{ni} - \sum_{f=1}^{F} \theta \beta_f \cdot s_i^k \ln \frac{V_{if}}{V_{i0}} - \sum_{\{l,m\}} \theta \beta_{lm} \cdot L_{il} M_{km} + \tilde{l}_i + \tilde{l}_k - (\epsilon_i^k)^{(j)} \right)$$

Proxy for exporter fixed effects: $\tilde{l}_i = c_1 (\ln(l_i)^{\gamma_1}; \ c_1 < 0, \ \gamma_1 > 0$

Proxy for industry fixed effects: $\tilde{l}_k = c_2 (\ln(T_k))^{\gamma_2}; \ c_2 < 0, \ \gamma_2 > 0$

2. Identify the exporting country that presents the lowest price, and compute the corresponding quantity.

3. Sum over varieties for the value of bilateral industry trade flows.
SMM Estimator

- $\varepsilon = 3.8$ (from Bernard et al. 2003); $\phi = 2$
- $J = 100$

$$\hat{\Theta} = \arg \min \ (b(\hat{\Theta}) - b(\Theta))' \Psi (b(\hat{\Theta}) - b(\Theta)) \tag{8}$$

where:

$$\Theta = \{x, \bar{x}, \theta, \eta, c_1, \gamma_1, c_2, \gamma_2, \beta_{d1}, \ldots, \beta_{d7}, \beta_{f1}, \ldots, \beta_{f4}, \beta_{lm1}, \ldots, \beta_{lm6}\}$$

Moments matched, $b(\Theta)$:

- Covariances: $\text{Cov}(X^k_{ni}, \text{Log}(<\text{Distance}))$, $\ldots$, $\text{Cov}(X^k_{ni}, \text{SVOL} \times \text{FLEX})$
- Mean trade flows by industry

Davin Chor (Singapore Management University)
Dataset

- 82 countries
- 20 US SIC-87 industries (2-digit manufacturing)
- $82 \times 81 \times 20 = 132,840$ observations
- Year: 1990 (same as EK)

- $X_{ni}^k$: Feenstra et al. (2005), concorded from SITC Rev 2 to SIC-87
Heckscher-Ohlin determinants: \[ \left( \ln \frac{V_{if}}{V_{i0}} - \ln \frac{V_{uf}}{V_{u0}} \right) s_{f}^{k} \]

- Follows Romalis (2004)

1. \( s_{h} \times \log(H/L) \)
   Skill intensity \( \times \) Skill abundance

2. \( s_{k} \times \log(K/L) \)
   Capital intensity \( \times \) Physical capital abundance

3. \( s_{m} \times \log(Forest/L) \)
   Materials intensity \( \times \) Forest land

   \( s_{m} \times \log(Arable/L) \)
   Materials intensity \( \times \) Arable land
Dataset

Institutional determinants:  \( L_{il} M_{km} \)

1. \( CAPDEP \times FINDEV \) (Beck 2003, Manova 2006)
   External capital dependence \( \times \) Financial Development

2. \( HI \times LEGAL \) (Levchenko 2007)
   Input concentration \( \times \) Strength of legal institutions

3. \( RS \times LEGAL \) (Nunn 2007)
   Input relationship-specificity \( \times \) Strength of legal institutions

4. \( COMPL \times LEGAL \) (Costinot 2006)
   Job complexity \( \times \) Strength of legal institutions
   \( COMPL \times \log(H/L) \)
   Job complexity \( \times \) Skill abundance

5. \( SVOL \times FLEX \) (Cuñat and Melitz 2007)
   Sales volatility \( \times \) Labor market flexibility
Estimates (Table 3)

1. **Gravity matters:** Distance variables have expected sign, though not all significant

<table>
<thead>
<tr>
<th></th>
<th>(1) OLS</th>
<th>(3) Probit</th>
<th>(4) SMM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Distance and Geography:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\beta_{d1}$: Log (Distance)</td>
<td>$-1.13^{***}$</td>
<td>$-0.64^{***}$</td>
<td>$-0.36^{***}$</td>
</tr>
<tr>
<td></td>
<td>(0.03)</td>
<td>(0.03)</td>
<td>(0.13)</td>
</tr>
<tr>
<td>$\beta_{d2}$: Common Language</td>
<td>$0.66^{***}$</td>
<td>$0.50^{***}$</td>
<td>0.15</td>
</tr>
<tr>
<td></td>
<td>(0.06)</td>
<td>(0.04)</td>
<td>(0.80)</td>
</tr>
<tr>
<td>$\beta_{d3}$: Colony</td>
<td>$0.49^{***}$</td>
<td>$-0.05$</td>
<td>0.45</td>
</tr>
<tr>
<td></td>
<td>(0.10)</td>
<td>(0.08)</td>
<td>(8.20)</td>
</tr>
<tr>
<td>$\beta_{d4}$: Common colonizer</td>
<td>0.24</td>
<td>0.00</td>
<td>$-1.44$</td>
</tr>
<tr>
<td></td>
<td>(0.15)</td>
<td>(0.11)</td>
<td>(9.05)</td>
</tr>
<tr>
<td>$\beta_{d5}$: Border</td>
<td>0.09</td>
<td>$-0.16$</td>
<td>0.68</td>
</tr>
<tr>
<td></td>
<td>(0.15)</td>
<td>(0.15)</td>
<td>(4.08)</td>
</tr>
<tr>
<td>$\beta_{d6}$: RTA</td>
<td>$0.45^{***}$</td>
<td>$-0.40^{***}$</td>
<td>0.78**</td>
</tr>
<tr>
<td></td>
<td>(0.10)</td>
<td>(0.15)</td>
<td>(0.39)</td>
</tr>
<tr>
<td>$\beta_{d7}$: GATT</td>
<td>0.14</td>
<td>$-0.30^{**}$</td>
<td>0.73**</td>
</tr>
<tr>
<td></td>
<td>(0.25)</td>
<td>(0.15)</td>
<td>(0.35)</td>
</tr>
</tbody>
</table>
2. **Factor endowments matter:** Heckscher-Ohlin interactions for human capital and physical capital generally positive and significant

<table>
<thead>
<tr>
<th>Heckscher-Ohlin determinants:</th>
<th>(1) OLS</th>
<th>(3) Probit</th>
<th>(4) SMM</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta_{f1}: s_h \times \log(H/L)$</td>
<td>15.37***</td>
<td>3.54***</td>
<td>10.13***</td>
</tr>
<tr>
<td></td>
<td>(2.00)</td>
<td>(0.98)</td>
<td>(0.60)</td>
</tr>
<tr>
<td>$\beta_{f2}: s_k \times \log(K/L)$</td>
<td>0.28</td>
<td>−0.09</td>
<td>0.18**</td>
</tr>
<tr>
<td></td>
<td>(0.20)</td>
<td>(0.08)</td>
<td>(0.08)</td>
</tr>
<tr>
<td>$\beta_{f3}: s_m \times \log(Forest/L)$</td>
<td>0.09</td>
<td>0.08**</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>(0.10)</td>
<td>(0.04)</td>
<td>(0.68)</td>
</tr>
<tr>
<td>$\beta_{f4}: s_m \times \log(Arable/L)$</td>
<td>1.00***</td>
<td>0.26***</td>
<td>−0.29</td>
</tr>
<tr>
<td></td>
<td>(0.15)</td>
<td>(0.06)</td>
<td>(0.70)</td>
</tr>
</tbody>
</table>
3. **Institutions matter**: Even when tested jointly

<table>
<thead>
<tr>
<th>Institutional determinants</th>
<th>(1) OLS</th>
<th>(3) Probit</th>
<th>(4) SMM</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta_{lm1}$: $CAPDEP \times FINDEV$</td>
<td>$1.17^{***}$</td>
<td>$0.25^{***}$</td>
<td>$1.81^{***}$</td>
</tr>
<tr>
<td></td>
<td>$(0.09)$</td>
<td>$(0.06)$</td>
<td>$(0.59)$</td>
</tr>
<tr>
<td>$\beta_{lm2}$: $HI \times LEGAL$</td>
<td>$-0.55^{***}$</td>
<td>$8.57^{***}$</td>
<td>$1.77$</td>
</tr>
<tr>
<td></td>
<td>$(1.95)$</td>
<td>$(0.78)$</td>
<td>$(3.86)$</td>
</tr>
<tr>
<td>$\beta_{lm3}$: $RS \times LEGAL$</td>
<td>$4.70^{***}$</td>
<td>$4.26^{***}$</td>
<td>$1.43^{**}$</td>
</tr>
<tr>
<td></td>
<td>$(0.76)$</td>
<td>$(0.32)$</td>
<td>$(0.57)$</td>
</tr>
<tr>
<td>$\beta_{lm4}$: $COMPL \times LEGAL$</td>
<td>$4.87^{***}$</td>
<td>$0.51^{**}$</td>
<td>$0.36^{**}$</td>
</tr>
<tr>
<td></td>
<td>$(0.45)$</td>
<td>$(0.22)$</td>
<td>$(0.16)$</td>
</tr>
<tr>
<td>$\beta_{lm5}$: $COMPL \times \log(H/L)$</td>
<td>$2.16^{***}$</td>
<td>$0.36^{**}$</td>
<td>$1.81^{*}$</td>
</tr>
<tr>
<td></td>
<td>$(0.33)$</td>
<td>$(0.15)$</td>
<td>$(1.00)$</td>
</tr>
<tr>
<td>$\beta_{lm6}$: $SVOL \times FLEX$</td>
<td>$10.57^{***}$</td>
<td>$1.26$</td>
<td>$-2.42$</td>
</tr>
<tr>
<td></td>
<td>$(2.07)$</td>
<td>$(1.18)$</td>
<td>$(2.23)$</td>
</tr>
</tbody>
</table>
SMM estimates (cont.)

1. $\theta = 12.41^{***}$
   On the high end of EK’s range of estimates (2.44 to 12.86)

2. $\{x, \bar{x}\} = \{-1.61, 7.07^{***}\}$

3. $\{\eta, c_1, \gamma_1, c_2, \gamma_2\} = \{0.24, -0.0045, 2.34, -0.06, 2.52\}$
Assessing the fit

1. Generated income levels vs actual GDP (WDI)

Pin down \((Y_1, \ldots, Y_n)\) via trade balance: \(EXP_i = IMP_i = \eta Y_i\)

- Spearman rank correlation: 0.69
- Pearson correlation (log incomes): 0.71
Assessing the fit

2. Simulated vs actual trade flows

- Slope coefficient: 0.77
- Number of zeros: 81,990 vs 89,806 (64,506 of these shared)
Plan of Talk

1. Introduction and Motivation

2. Theory: Extending Eaton-Kortum to the industry level

3. Estimation
   - OLS baseline
   - Simulated method of moments (SMM)

   - Distance barriers
   - Country characteristics

5. Conclusions
Computing welfare counterfactuals

Indirect utility:

\[ W_n = \frac{(1 - \eta)^{1-\eta} \eta^n Y_n}{(p_0^n)^{1-\eta} \left( \sum_{k \geq 1} (P_k^n)^{1-\phi} \right)^{1/\phi}} \] (9)

Welfare change:

\[ \frac{\Delta W_n}{W_n} = \frac{\Delta Y_n}{Y_n} - (1 - \eta) \frac{\Delta (p_0^n)}{p_0^n} - \eta \frac{\Delta \left( \sum_{k \geq 1} (P_k^n)^{1-\phi} \right)^{1/(1-\phi)}}{\left( \sum_{k \geq 1} (P_k^n)^{1-\phi} \right)^{1/(1-\phi)}} \]

(Assumption: Factors are mobile domestically, but not across borders)
Distance counterfactuals

1. Large average gains from removing physical distance (25.6% ↑)
   ▶ Comparable to what Eaton-Kortum find for the OECD (16.1%-24.1%)
   ▶ Decomposition of welfare change: Most of the increase stems from change in country GDP as market access is opened

<table>
<thead>
<tr>
<th>% Welfare Change</th>
<th>GDP (k ≥ 1)</th>
<th>Prices (k = 0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reducing Distance Barriers:</td>
<td>87.3</td>
<td>5.1</td>
</tr>
<tr>
<td>Log (Distance)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min.</td>
<td>−15.3</td>
<td></td>
</tr>
<tr>
<td>Max.</td>
<td>67.1</td>
<td></td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>17.2</td>
<td></td>
</tr>
<tr>
<td>Wtd. Avg.</td>
<td>25.6</td>
<td></td>
</tr>
<tr>
<td>OECD:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROW:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Halving distance mark-up</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min.</td>
<td>−0.9</td>
<td></td>
</tr>
<tr>
<td>Max.</td>
<td>37.2</td>
<td></td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>6.3</td>
<td></td>
</tr>
<tr>
<td>Wtd. Avg.</td>
<td>8.5</td>
<td></td>
</tr>
<tr>
<td>OECD:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROW:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Davin Chor (Singapore Management University)

Unpacking Sources of Comparative Advantage: A Quantitative Approach
Distance counterfactuals (cont.)

- Countries that are more isolated see greater gains
- Developing countries gain more than the OECD (29.8% vs 7.0%); similar to Lai and Zhu (2004)
Country policy experiments: Raising all countries

**Caveat:** Welfare changes are due to the underlying shift in industrial composition from introducing the shock to the interaction term.

1. Gains from physical capital accumulation through $s_k \times \log(K/L)$ term: 42.0% ↑
2. Combined effect from human capital accumulation through $s_h \times \log(H/L)$ and $COMPL \times \log(H/L)$ terms: 37.6% ↑

<table>
<thead>
<tr>
<th></th>
<th>% Welfare Change</th>
<th>Decomposition Due to change in:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min.</td>
<td>Max.</td>
</tr>
<tr>
<td>Raising Factor endowments:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$s_h \times \max(\log(H/L))$</td>
<td>$-0.7$</td>
<td>45.8</td>
</tr>
<tr>
<td>$s_k \times \max(\log(K/L))$</td>
<td>$-0.4$</td>
<td>105.2</td>
</tr>
<tr>
<td>Total effect:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\max(\log(H/L))$</td>
<td>0.5</td>
<td>97.0</td>
</tr>
</tbody>
</table>
3. Combined effect of improving legal institutions: 17.7% ↑

About two-thirds of this from increased specialization in industries that use a large share of relationship-specific inputs

<table>
<thead>
<tr>
<th></th>
<th>% Welfare Change</th>
<th>Decomposition Due to change in:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min.</td>
<td>Max.</td>
</tr>
<tr>
<td>Raising Institutional attributes:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$HI \times \max(LEGAL)$</td>
<td>−0.1</td>
<td>17.1</td>
</tr>
<tr>
<td>$RS \times \max(LEGAL)$</td>
<td>−0.3</td>
<td>47.5</td>
</tr>
<tr>
<td>$COMPL \times \max(LEGAL)$</td>
<td>−0.0</td>
<td>8.0</td>
</tr>
<tr>
<td>Total effect: $\max(LEGAL)$</td>
<td>−0.1</td>
<td>62.9</td>
</tr>
</tbody>
</table>
Country policy experiments (cont.)

4. Welfare gain negatively correlated with initial level of the country characteristic

![Figure 9: Welfare Effect of a Counterfactual Improvement in Legal Institutions](image)

Notes:
The vertical axis plots the percent welfare change from improving all countries' legal institutions to the world frontier (the highest index value observed in the sample), as described in Section 5.2. This is plotted against the initial index value of LEGAL for each country. The linear best fit line is illustrated; the Pearson linear correlation is -0.90, significant at the 1% level.
## Country policy experiments: Raising one country

Raise attributes of one large developing country, Indonesia

1. Largest gains from physical capital accumulation: 43.8% ↑
   Any beggar-thy-neighbor effects are small
2. Similar gains from human capital accumulation: 38.7% ↑
3. Slightly more modest, but still strong gains from improving \( \text{LEGAL} \): 20.2% ↑

<table>
<thead>
<tr>
<th>% Welfare Change for IDN Due to change in:</th>
<th>% Welfare Change for sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
</tr>
<tr>
<td>Raising:</td>
<td></td>
</tr>
<tr>
<td>max((\log(H/L)))</td>
<td>38.7</td>
</tr>
<tr>
<td>max((\log(K/L)))</td>
<td>43.8</td>
</tr>
<tr>
<td>max((\text{FINDEV}))</td>
<td>8.8</td>
</tr>
<tr>
<td>max((\text{LEGAL}))</td>
<td>20.2</td>
</tr>
</tbody>
</table>
Country policy experiments (cont.)

4. **Shift in industry composition**: Raising a country characteristic promotes expansion in industries that are intensive/dependent on that characteristic.

![Graph showing the effect of raising Indonesia's human capital endowment on domestic industrial composition. The graph plots the percent change in each industry's share of Indonesia's total exports against skill intensity. The linear best fit line is illustrated; the Pearson linear correlation is 0.59, significant at the 1% level.](image-url)
Conclusion

- Developed a methodology that facilitates quantification of the welfare impact of different sources of comparative advantage

- Model: EK model with comparative advantage determined by the interaction of country and industry characteristics

- Estimation:
  1. OLS baseline
  2. SMM procedure: To account for the zeroes

- Welfare counterfactuals:
  Reasonable magnitudes for the welfare gains from reducing physical distance, factor accumulation, or improvements in institutions.
Ongoing work

- SMM Estimation with a full set of fixed effects
- Further counterfactual applications: How much can be gained from regional trade integration?
- Thinking about dynamics: What does this framework imply about trade and growth?
Simulating trade flows:

1. For each variety, compute the prices presented by all $N$ countries to each importing country $n$:

$$\ln(p_{ni}^k(j)) = \frac{1}{\theta} \left( \theta \beta_d \cdot D_{ni} - \sum_{f=1}^{F} \theta \beta_f \cdot s_f^k \ln \frac{V_{if}}{V_{i0}} - \sum_{\{l,m\}} \theta \beta_{lm} \cdot L_{il} M_{km} + \tilde{I}_i + \tilde{I}_k - (\epsilon_i^k(j)) \right)$$

Requires $N \times K \times J$ independent draws from the truncated Gumbel distribution with support $[\underline{x}, \bar{x}]$ for the $(\epsilon_i^k(j))$'s.

2. For each variety $j$ and each importing country, $n$, identify the exporting country, $i(j)$, that presents the lowest price, $(p_{ni, i(j)}^k)^{(j)}$. 
Estimation: SMM (extra slide)

**Simulating trade flows:** [cont.]

3. Calculate quantities:

\[
(Q_{n,i(j)}^k)_{(j)} = \frac{\eta Y_n (P_n^k)^{\epsilon - \phi}}{\sum_{k \geq 1} (P_n^k)^{1 - \phi}} ((P_n^k)_{(j)})^{-\epsilon}, \quad (P_n^k)^{1 - \epsilon} \approx \frac{1}{J} \sum_{j=1}^{J} (((p_n^k,{i(j)})(j))^{1 - \epsilon}
\]

4. Sum over the relevant exporter subscripts to obtain bilateral trade flows:

\[
(X_{ni}^k)_{sim} = \frac{1}{J} \sum_{\{j: \text{i}(j) = i\}} (p_n^k,{i(j)})(j)(Q_n^k,{i(j)})(j)
\]
SMM estimates: Assessing the fit (Extra slide)

1. Generated income levels vs actual GDP (WDI)

   Close the model to pin down \((Y_1, \ldots, Y_n)\) via trade balance:

   \[
   EXP_i \approx \frac{1}{J} \sum_{n=1}^{N} \sum_{k=1}^{K} \sum_{\{j: i(j)=i\}} (p_{n,i(j)}^k)^{(j)}(Q_{n,i(j)}^k)^{(j)}
   \]

   \[
   = \frac{1}{J} \sum_{k=1}^{K} \sum_{n=1}^{N} \sum_{\{j: i(j)=i\}} \frac{\eta Y_n (P_n^k)^{\epsilon-\phi}}{\sum_{k \geq 1} (P_n^k)^{1-\phi}} \left( (p_{n,i(j)}^k)^{(j)} \right)^{1-\epsilon}
   \]

   \[
   = IMP_i = \eta Y_i
   \]

   ⇒ A linear homogenous system in \(Y_1, \ldots, Y_N\).

   Solve up to a constant of proportionality (set \(Y_{US} = 1\)).
Welfare Counterfactuals (Extra slide)

- $\frac{\Delta Y_n}{Y_n}$ and $\frac{\Delta \left( \sum_{k \geq 1} (P_n^k)^{1-\phi} \right)^{1/(1-\phi)}}{\left( \sum_{k \geq 1} (P_n^k)^{1-\phi} \right)^{1/(1-\phi)}}$ are straightforward to compute.

- $\frac{\Delta (p_n^0)}{p_n^0}$ is more tricky:

$$\frac{\Delta (p_n^0)}{p_n^0} = \sum_{f=0}^{F} s_f^0 \frac{\Delta (w_{nf})}{w_{nf}}$$

Change in $w_{nf}$ computed as the change in total payments to that factor minus any change in endowments:

$$\frac{\Delta (w_{nf})}{w_{nf}} = \frac{\Delta (s_f^0 (1-\eta) Y_n + \sum_{k \geq 1} s_f^k \sum_{j=1}^{J} \sum_{s=1}^{N} (p_{sn}^k)^{(j)} (Q_{sn}^k)^{(j)})}{(s_f^0 (1-\eta) Y_n + \sum_{k \geq 1} s_f^k \sum_{j=1}^{J} \sum_{s=1}^{N} (p_{sn}^k)^{(j)} (Q_{sn}^k)^{(j)})} - \frac{\Delta (V_{nf})}{V_{nf}}$$

Assumed factor shares: $s_h^0 = 0.07$, $s_i^0 = 0.13$, $s_m^0 = 0.6$, $s_k^0 = 0.2$.

(Calibrated with shares in US agriculture)
3. Generated ideal price index vs PPP consumption price index (PWT)

- Spearman rank correlation: 0.60
- Pearson correlation: 0.68

Notes:
The horizontal axis plots country price indices for consumption goods from the Penn World Tables (PWT), adjusted for purchasing power parity. The vertical axis plots the country ideal price indices for manufactures generated by the model, using the SMM estimates from the full sample. Both axes are normalized with the US value equal to 1. The Pearson correlation between the two variables is 0.68, while the Spearman rank correlation is 0.60, both significant at the 1% level.
2. Gains from a global GATT (6.9% ↑)

Main beneficiaries are:

(i) Non-GATT members
(ii) Developing countries

<table>
<thead>
<tr>
<th></th>
<th>% Welfare Change</th>
<th>Decomposition Due to change in:</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min.</td>
<td>Max.</td>
<td>Std. Dev.</td>
</tr>
<tr>
<td>Global GATT</td>
<td>−2.5</td>
<td>54.6</td>
<td>12.6</td>
</tr>
<tr>
<td>OECD:</td>
<td>−0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROW:</td>
<td>8.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>