Unpacking Sources of Comparative Advantage: A Quantitative Approach

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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

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   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

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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

  2. Simulated method of moments (Pakes and Pollard 1989)

     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%)

What this paper does: Counterfactuals

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    - 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:

  Eaton and Kortum (2002), Alvarez and Lucas (2007), Shikher (2007)
  Lai and Trefler (2002), Lai and Zhu (2004)
  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)
4. Welfare Counterfactuals on . . .
   - 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:

$$U_n = \left(Q_n^0\right)^{1-\eta} \left(\sum_{k \geq 1} \left(\int_0^1 (Q_n^k(j^k))^{\alpha} \; dj^k \right)^{\frac{\beta}{\alpha}} \right)^{\frac{\eta}{\beta}}, \quad \alpha, \beta, \eta \in (0,1) \qquad (1)$$

$\varepsilon = \frac{1}{1-\alpha} > 1$: 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:

$$p_{ni}^k(j) = \frac{c_i^k d_{ni}^k}{z_i^k(j)} \quad (2)$$

n: importer i: exporter j: varieties

- Unit production costs: $c_i^k = \prod_f (w_{if})^{s_f^k}, \quad s_f^k \in (0,1), \; \sum_f s_f^k = 1$

  Distance: $d_{ni}^k \geq 1, \; d_{ni}^k \leq d_{nm}^k d_{mi}^k$

  Productivity: $z_i^k(j)$

Modelling industry trade flows: Goods Prices

- Specify:

$$\ln z_i^k(j) = \lambda_i + \mu_k + \sum_{\{l,m\}} \beta_{lm} L_{il} M_{km} + \beta_0 \epsilon_i^k(j) \quad (3)$$

- 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:

$$\left(\frac{X_{ni}^k}{X_{nu}^k}\right) = \frac{(c_i^k d_{ni}^k)^{-\theta}\varphi_i^k}{(c_u^k d_{nu}^k)^{-\theta}\varphi_u^k} \tag{4}$$

where: (i) $\varphi_i^k = \exp\{\theta(\lambda_i + \mu_k + \sum_{\{l,m\}} \beta_{lm} L_{il} M_{km})\}$;
(ii) $\theta = \frac{1}{\beta_0}$ is an inverse spread parameter.

- Comparison with EK (2002): $K = 1$

$$\left(\frac{X_{ni}}{X_{nu}}\right) = \frac{(c_i d_{ni})^{-\theta} T_i}{(c_u d_{nu})^{-\theta} T_u} \tag{5}$$

- φ_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:

$$d_{ni}^{k} = \exp\{\beta_d D_{ni} + \delta_k + \zeta_{ni} + \nu_{ni}^{k}\} \quad (6)$$

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

Estimation: OLS Baseline

Estimating equation: (relative to u: US)

$$\ln\left(\frac{X_{ni}^k}{X_{nu}^k}\right) = \sum_{f=1}^{F} \theta\beta_f \left(\ln\frac{V_{if}}{V_{i0}} - \ln\frac{V_{uf}}{V_{u0}}\right) s_f^k + \sum_{\{l,m\}} \theta\beta_{lm}(L_{il} - L_{ul})M_{km}\dots$$
$$-\theta\beta_d(D_{ni} - D_{nu}) + I_i + I_{nk} - \theta\zeta_{ni} - \theta\nu_{ni}^k \qquad (7)$$

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

   (Haveman and Hummels 2004, Anderson and van Wincoop 2004, Silva-Santos and Tenreyro 2006, Helpman, Melitz and Rubinstein 2007)

2. Cannot identify θ, which we need to compute welfare counterfactuals

Modifying the theory to generate zeros

Let the $\epsilon_i^k(j)$'s now be independent draws from a *truncated* Gumbel distribution with bounded support $[\underline{x}, \bar{x}]$:

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

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:

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

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

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

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:

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

Moments matched, $b(\Theta)$:

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

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

Dataset

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 × Skill abundance
2. $s_k \times \log(K/L)$
   Capital intensity × Physical capital abundance
3. $s_m \times \log(Forest/L)$
   Materials intensity × Forest land

   $s_m \times \log(Arable/L)$
   Materials intensity × Arable land

Dataset

Institutional determinants: $L_{il} M_{km}$

1. *CAPDEP* × *FINDEV* (Beck 2003, Manova 2006)
   External capital dependence × Financial Development
2. *HI* × *LEGAL* (Levchenko 2007)
   Input concentration × Strength of legal institutions
3. *RS* × *LEGAL* (Nunn 2007)
   Input relationship-specificity × Strength of legal institutions
4. *COMPL* × *LEGAL* (Costinot 2006)
   Job complexity × Strength of legal institutions
   COMPL × $\log(H/L)$
   Job complexity × Skill abundance
5. *SVOL* × *FLEX* (Cuñat and Melitz 2007)
   Sales volatility × Labor market flexibility

Estimates (Table 3)

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

	(1) OLS	(3) Probit	(4) SMM
Distance and Geography:			
β_{d1}: Log (Distance)	−1.13***	−0.64***	−0.36***
	(0.03)	(0.03)	(0.13)
β_{d2}: Common Language	0.66***	0.50***	0.15
	(0.06)	(0.04)	(0.80)
β_{d3}: Colony	0.49***	−0.05	0.45
	(0.10)	(0.08)	(8.20)
β_{d4}: Common colonizer	0.24	0.00	−1.44
	(0.15)	(0.11)	(9.05)
β_{d5}: Border	0.09	−0.16	0.68
	(0.15)	(0.15)	(4.08)
β_{d6}: RTA	0.45***	−0.40***	0.78**
	(0.10)	(0.15)	(0.39)
β_{d7}: GATT	0.14	−0.30**	0.73**
	(0.25)	(0.15)	(0.35)

2. Factor endowments matter: Heckscher-Ohlin interactions for human capital and physical capital generally positive and significant

	(1) OLS	(3) Probit	(4) SMM
Heckscher-Ohlin determinants:			
β_{f1}: $s_h \times \log(H/L)$	15.37***	3.54***	10.13***
	(2.00)	(0.98)	(0.60)
β_{f2}: $s_k \times \log(K/L)$	0.28	−0.09	0.18**
	(0.20)	(0.08)	(0.08)
β_{f3}: $s_m \times \log(Forest/L)$	0.09	0.08**	0.04
	(0.10)	(0.04)	(0.68)
β_{f4}: $s_m \times \log(Arable/L)$	1.00***	0.26***	−0.29
	(0.15)	(0.06)	(0.70)

3. Institutions matter: Even when tested jointly

	(1) OLS	(3) Probit	(4) SMM
Institutional determinants:			
β_{Im1}: $CAPDEP \times FINDEV$	1.17***	0.25***	1.81***
	(0.09)	(0.06)	(0.59)
β_{Im2}: $HI \times LEGAL$	−0.55	8.57***	1.77
	(1.95)	(0.78)	(3.86)
β_{Im3}: $RS \times LEGAL$	4.70***	4.26***	1.43**
	(0.76)	(0.32)	(0.57)
β_{Im4}: $COMPL \times LEGAL$	4.87***	0.51**	0.36**
	(0.45)	(0.22)	(0.16)
β_{Im5}: $COMPL \times \log(H/L)$	2.16***	0.36**	1.81*
	(0.33)	(0.15)	(1.00)
β_{Im6}: $SVOL \times FLEX$	10.57***	1.26	−2.42
	(2.07)	(1.18)	(2.23)

SMM estimates (cont.)

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

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

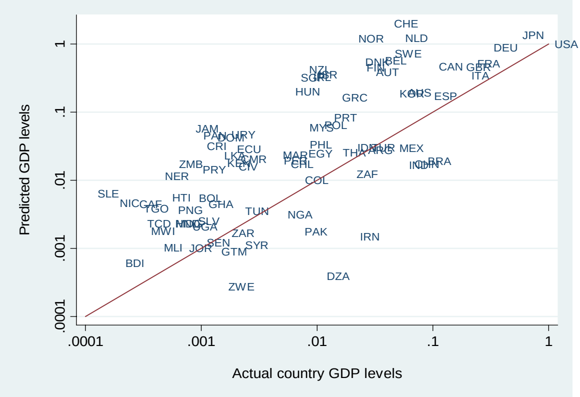
3. $\{\eta, c_1, \gamma_1, c_2, \gamma_2\} = \{0.24, -0.0045, 2.34, -0.06, 2.52\}$

Assessing the fit

1. Generated income levels vs actual GDP (WDI)

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

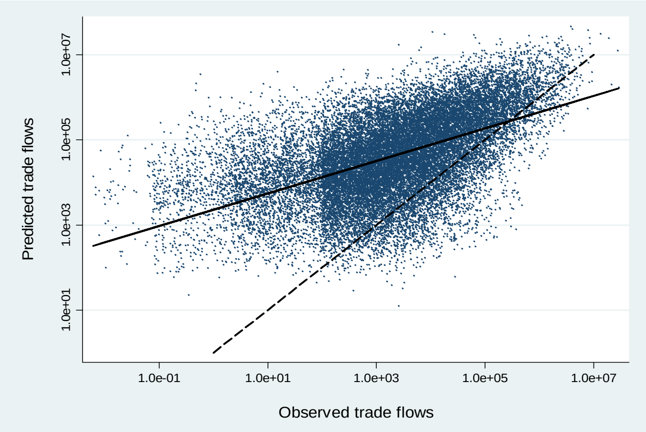
   - Spearman rank correlation: 0.69
   - Pearson correlation (log incomes): 0.71



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)



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   - Distance barriers
   - Country characteristics
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Computing welfare counterfactuals

Indirect utility:

$$W_n = \frac{(1-\eta)^{1-\eta}\eta^{\eta}\ Y_n}{(p_n^0)^{1-\eta}\left(\sum_{k\geq 1}(P_n^k)^{1-\phi}\right)^{\frac{\eta}{1-\phi}}} \tag{9}$$

Welfare change:

$$\frac{\Delta W_n}{W_n} = \frac{\Delta Y_n}{Y_n} - (1-\eta)\frac{\Delta(p_n^0)}{p_n^0} - \eta\frac{\Delta\left(\sum_{k\geq 1}(P_n^k)^{1-\phi}\right)^{1/(1-\phi)}}{\left(\sum_{k\geq 1}(P_n^k)^{1-\phi}\right)^{1/(1-\phi)}}$$

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

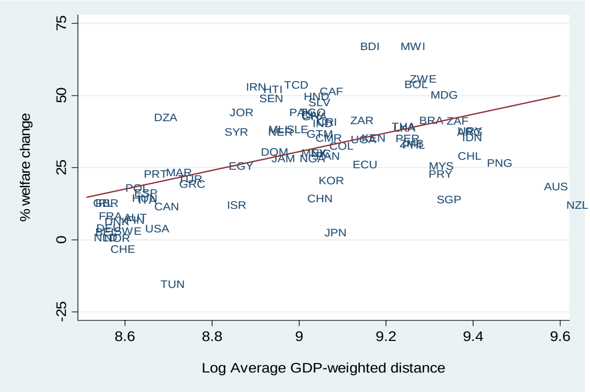
Distance counterfactuals

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

	% Welfare Change				Decomposition Due to change in:		
	Min.	Max.	Std. Dev.	Wtd. Avg.	GDP	Prices ($k \geq 1$)	Prices ($k = 0$)
Reducing Distance Barriers:							
Log (Distance)	−15.3	67.1	17.2	**25.6**	87.3	5.1	−66.8
			OECD:	7.0	12.7	4.0	−9.7
			ROW:	29.8	104.3	5.3	−79.8
Halving distance mark-up	−0.9	37.2	6.3	8.5	32.3	1.0	−24.7
			OECD:	3.5	11.9	0.7	−9.1
			ROW:	9.6	36.9	1.0	−28.3

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% ↑

	% Welfare Change				Decomposition Due to change in:		
	Min.	Max.	Std. Dev.	Wtd. Avg.	GDP	Prices ($k \geq 1$)	Prices ($k = 0$)
Raising Factor endowments:							
$s_h \times \max(\log(H/L))$	−0.7	45.8	11.1	18.5	64.4	0.5	−46.5
$s_k \times \max(\log(K/L))$	−0.4	105.2	27.9	**42.0**	16.7	0.1	25.2
Total effect:							
$\max(\log(H/L))$	0.5	97.0	22.1	**37.6**	157.2	1.2	−120.8

Country policy experiments (cont.)

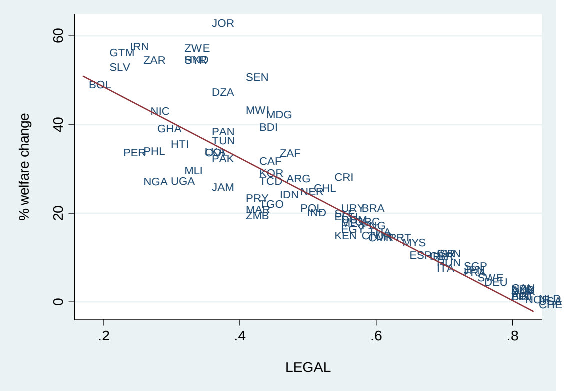
3. Combined effect of improving legal institutions: 17.7% ↑

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

	% Welfare Change				Decomposition Due to change in:		
	Min.	Max.	Std. Dev.	Wtd. Avg.	GDP	Prices ($k \geq 1$)	Prices ($k = 0$)
Raising Institutional attributes:							
HI × max(*LEGAL*)	−0.1	17.1	3.2	2.3	9.7	0.1	−7.5
RS × max(*LEGAL*)	−0.3	47.5	12.9	13.2	55.5	0.4	−42.7
COMPL × max(*LEGAL*)	−0.0	8.0	1.8	1.7	7.2	0.1	−5.5
Total effect:							
max(*LEGAL*)	−0.1	62.9	16.7	**17.7**	74.4	0.1	−57.3

Country policy experiments (cont.)

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



Country policy experiments: Raising one country

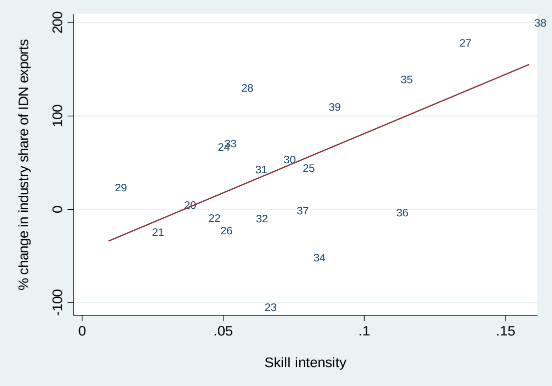
Raise attributes of one large developing country, Indonesia

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 *LEGAL*: 20.2% ↑

	% Welfare Change for IDN Due to change in:				% Welfare Change for sample			
	Total	GDP	Prices ($k \geq 1$)	Prices ($k = 0$)	Min.	Max.	Std. Dev.	Wtd. Avg.
Raising:								
max(log(H/L))	**38.7**	147.9	0.7	−109.8	−0.1	38.7	4.3	1.9
max(log(K/L))	**43.8**	17.7	0.1	26.1	−0.0	43.8	0.5	1.9
max(*FINDEV*)	8.8	40.0	0.1	−31.4	−0.2	8.8	1.0	0.4
max(*LEGAL*)	**20.2**	85.8	0.0	−65.9	−0.3	20.2	2.2	1.0

Country policy experiments (cont.)

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



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:
  (i) OLS baseline
  (ii) 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?

Estimation: SMM (extra slide)

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, $(p_{n,i(j)}^k)^{(j)}$.

Estimation: SMM (extra slide)

Simulating trade flows: [cont.]

3. Calculate quantities:

$$(Q^k_{n,i(j)})^{(j)} = \frac{\eta Y_n \, (P^k_n)^{\varepsilon-\phi}}{\sum_{k\geq 1}(P^k_n)^{1-\phi}} \, ((p^k_{n,i(j)})^{(j)})^{-\varepsilon}, \quad (P^k_n)^{1-\varepsilon} \approx \frac{1}{J}\sum_{j=1}^{J}((p^k_{n,i(j)})^{(j)})^{1-\varepsilon}$$

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

$$(X^k_{ni})^{sim} = \frac{1}{J} \sum_{\{j:\ i(j)=i\}} (p^k_{n,i(j)})^{(j)} (Q^k_{n,i(j)})^{(j)}$$

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:

$$
\begin{aligned}
EXP_i &\approx \frac{1}{J} \sum_{n=1}^{N} \sum_{k=1}^{K} \sum_{\{j:\ i(j)=i\}} (p^k_{n,i(j)})^{(j)} (Q^k_{n,i(j)})^{(j)} \\
&= \frac{1}{J} \sum_{k=1}^{K} \sum_{n=1}^{N} \sum_{\{j:\ i(j)=i\}} \frac{\eta Y_n \ (P^k_n)^{\varepsilon-\phi}}{\sum_{k\geq 1} (P^k_n)^{1-\phi}} \ ((p^k_{n,i(j)})^{(j)})^{1-\varepsilon} \\
&= IMP_i = \eta Y_i
\end{aligned}
$$

   $\Rightarrow$ 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:

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

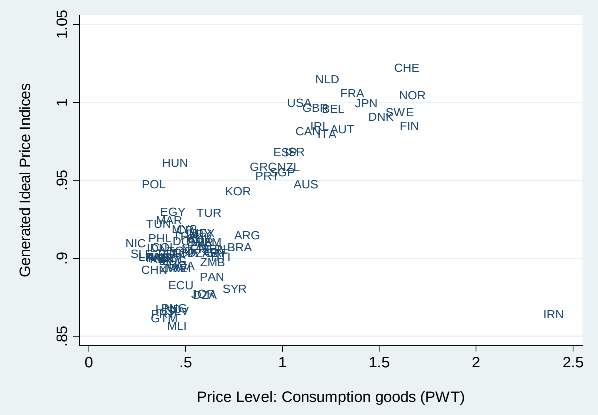
Change in w_{nf} computed as the change in total payments to that factor minus any change in endowments:

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

Assumed factor shares: $s_h^0 = 0.07$, $s_l^0 = 0.13$, $s_m^0 = 0.6$, $s_k^0 = 0.2$.
(Calibrated with shares in US agriculture)

Extra slide: Assessing the fit

3. Generated ideal price index vs PPP consumption price index (PWT)
    - Spearman rank correlation: 0.60
    - Pearson correlation: 0.68



Distance counterfactuals (cont.)

2. Gains from a global GATT (6.9% ↑)

   Main beneficiaries are:

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

	% Welfare Change				Decomposition Due to change in:			Correlation
	Min.	Max.	Std. Dev.	Wtd. Avg.	GDP	Prices ($k \geq 1$)	Prices ($k = 0$)	
Global GATT	−2.5	54.6	12.6	**6.9**	27.7	0.3	−21.1	−0.89***
			OECD:	**−0.1**	−0.4	0.0	0.3	
			ROW:	**8.5**	34.1	0.3	−25.9	