Firm Export Dynamics in Interdependent Markets

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In(ter)dependent Decisions Within and Across Countries

- Large literature on *within-country* path dependence in firm exports:

  causal impact of y_{ijt-1} on y_{ijt}.

- This literature assumes firm export choices are independent across countries.

- Recent empirical evidence on *cross-country* complementarities in firm exports:

  causal impact of y_{ijt} on $y_{ij't}$.

- Are cross-country complementarities quantitatively important?

Cross-Country Complementarities & Trade Policy

- Bilateral preferential trade agreements (PTAs) as gateways to wider markets.

  "By consolidating our relationship with Singapore, [this agreement] gives us the possibility to increase our trade flows with other Asian countries."

  Minister of Economy of Costa Rica
  (during legislative approval of the 2013 PTA between Costa Rica and Singapore)

- Deep PTAs create complementarities between members and, thus, generate positive third-market effects (counteracting the trade diversion effect).

  "Third-country effect could be [affected] by regulatory divergence. If the UK's regulations divert over time from the EU's, trade costs would rise for third countries due to production process adjustment costs and potential duplication of proofs of compliance."

  UNCTAD ("Brexit Beyond Tariffs")

DATA

Data Sources

- Sample period: 2005-2015.
- Sample: all non-foreign-owned manufacturing firms located in Costa Rica.
- Data sources:
  - Customs: revenue at the country-firm-year level.
  - Corporate income tax returns: sector (four-digit ISIC) and domestic sales.
- Other sources of data
  - CEPII: trade flows (by sector) and geographical distance between countries.
  - Barari and Kim (2020): tariffs (by sector) on imports from Costa Rica.
  - Ethnologue: linguistic distance between countries.
  - Hoffman, Osnago and Ruta (2017): depth of preferential trade agreements.

Summary Statistics

REDUCED-FORM EVIDENCE

Correlation in Firm Export Participation Decisions

Outcome Variable:	Dummy for Positive Exports in a Destination and Year			
	(1)	(2)	(3)	(4)
Y^{g}_{ijt}	0.2043^{a}			0.1809^{a}
	(0.0086)			(0.0078)
Y^{l}_{ijt}		0.1160^{a}		0.0720^{a}
		(0.0066)		(0.0054)
Y^{a}_{ijt}			0.0473^{a}	0.0207^{a}
			(0.0026)	(0.0018)
Observations		3,859,618		

Note: ^{a} denotes 1% significance. Standard errors clustered by firm. All specifications control for firm-year and sector-country-year fixed effects.

- Slightly larger estimates with no firm-year or sector-country-year fixed effects.
- Smaller estimates when using a laxer definition of cross-country closeness.
- Likely OVB due to cross-country correlation in firm-specific export shifters.

Specification Closeness Additional Estimates

EMPIRICAL MODEL

Potential Export Profits

- Potential (static) export profits of firm i in country j at period t:

$$\pi_{ijt} = \Pi_{ijt} - f_{ijt} - (1 - y_{ijt-1})s_{jt},$$

with

$$\begin{aligned} \Pi_{ijt} &= \text{ potential export gross profits,} \\ f_{ijt} &= \text{ fixed export costs,} \\ s_{jt} &= \text{ sunk export costs.} \end{aligned}$$

Potential Export Gross Profits and Export Revenues

$$\pi_{ijt} = \Pi_{ijt} - f_{ijt} - (1 - y_{ijt-1})s_{jt}.$$

- Microfounded potential export gross profits:

$$\Pi_{ijt} = \eta^{-1} r_{ijt} \qquad \text{and} \qquad r_{ijt} = \left[\frac{\eta}{\eta - 1}\frac{\tau_{ijt} w_{it}}{P_{jt}}\right]^{1-\eta} Y_{jt}.$$

- Revenue impact of "iceberg" trade costs:

$$(\tau_{ijt})^{1-\eta} = \exp(\xi_y y_{ijt-1} + \xi_s + \xi_{jt} + \xi_a \ln(a_{sjt}) + \xi_w \ln(w_{it})), \quad \xi_y \geq 0.$$

- Thus, with

$$r_{ijt} = \exp(\alpha_y y_{ijt-1} + \alpha_s + \alpha_{jt} + \alpha_a \ln(a_{sjt}) + \alpha_r \ln(r_{iht})).$$

- Parametric restrictions on the time-series process of $\{\alpha_{jt}, a_{sjt}, r_{iht}\}$.

Details

Fixed Export Costs

$$\pi_{ijt} = \Pi_{ijt} - f_{ijt} - (1 - y_{ijt-1})s_{jt}.$$

- Fixed exports costs are the sum of four terms:

$$f_{ijt} = g_{jt} - eg_{ijt} + \nu_{ijt} + \omega_{ijt}.$$

Fixed Export Costs - Gravity Term

$$\pi_{ijt} = \Pi_{ijt} - f_{ijt} - (1 - y_{ijt-1})s_{jt},$$
$$f_{ijt} = g_{jt} - eg_{ijt} + \nu_{ijt} + \omega_{ijt}.$$

- First term depends on distance between h and j:

$$g_{jt} = \gamma_0^F + \gamma_g^F n_{hj}^g + \gamma_l^F n_{hj}^l + \gamma_a^F n_{hjt}^a,$$

with

$$n_{hj}^g = \textit{geographical} \text{ distance between } h \text{ and } j,$$
$$n_{hj}^l = \textit{linguistic} \text{ distance between } h \text{ and } j,$$
$$n_{hjt}^a = \textit{regulatory} \text{ distance between } h \text{ and } j.$$

Fixed Export Costs - Extended Gravity Term

$$\pi_{ijt} = \Pi_{ijt} - f_{ijt} - (1 - y_{ijt-1})s_{jt},$$
$$f_{ijt} = g_{jt} - eg_{ijt} + \nu_{ijt} + \omega_{ijt}.$$

- Second term accounts for complementarities across destinations:

$$eg_{ijt} = \sum_{j' \neq j} y_{ij't} \underbrace{(c^g_{jj'} + c^l_{jj'} + c^a_{jj't})}_{c_{jj't}},$$

with, e.g.,

$$c^g_{jj'} = \gamma^E_g \exp(-\kappa^E_g n^g_{jj'})$$

and

$$n^g_{jj'} = \text{geographical distance between } j \text{ and } j'.$$

Fixed Export Costs - Normal Shock

$$\pi_{ijt} = \Pi_{ijt} - f_{ijt} - (1 - y_{ijt-1})s_{jt},$$
$$f_{ijt} = g_{jt} - eg_{ijt} + \nu_{ijt} + \omega_{ijt}$$

- Third term is unobserved and *iid* across firms and years, with distribution

$$\nu_{ijt} \sim \mathbb{N}(0, \sigma_\nu^2),$$

and cross-country correlation coefficient

$$corr(\nu_{ijt}, \nu_{ij't}) = \rho^g_{jj'} + \rho^l_{jj'} + \rho^a_{jj't},$$

with, e.g.,

$$\rho^g_{jj'} = \gamma^N_g \exp(-\kappa^N_g n^g_{jj'}).$$

Fixed Export Costs - Exit Shock

$$\pi_{ijt} = \Pi_{ijt} - f_{ijt} - (1 - y_{ijt-1})s_{jt},$$
$$f_{ijt} = g_{jt} - eg_{ijt} + \nu_{ijt} + \omega_{ijt}.$$

- Fourth term is unobserved and *iid* across firms, countries and years, with

$$P(\omega_{ijt} = \omega) = \begin{cases} p & \text{if } \omega = \underline{\omega}, \\ 1 - p & \text{if } \omega = \overline{\omega}. \end{cases}$$

In our implementation,

$$\underline{\omega} = 0 \qquad \text{and} \qquad \overline{\omega} = \infty.$$

Sunk Export Costs

$$\pi_{ijt} = \Pi_{ijt} - f_{ijt} - (1 - y_{ijt-1})s_{jt}$$

- Sunk costs only depend on distance between h and j:

$$s_{jt} = \gamma_0^S + \gamma_g^S n_{hj}^g + \gamma_l^S n_{hj}^l + \gamma_a^S n_{hjt}^a.$$

Optimal Export Destinations, Information Set, and Beliefs

- Among all possible bundles of J destinations, firms choose in every period the bundle maximizing the expected discounted infinite sum of profits.
- Firm i has perfect information at t on all current and future payoff-relevant variables expect for

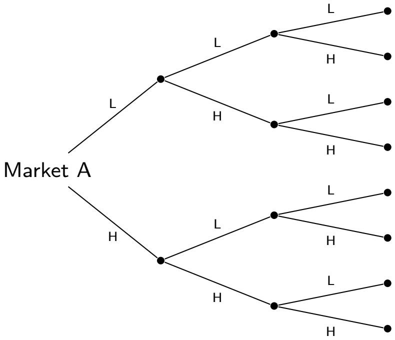
$$\{(\omega_{i1t'}, \ldots, \omega_{iJt'})\}_{t'>t}.$$

- Firms' expectations are rational.
- For reasonable J, common solution algorithms computationally infeasible:
  1. *Discrete Choice Set of Cardinality* 2^J
  2. *Integration Over Discrete Random Vector with* 2^J *Points of Support*
  3. *State Space With* 2^{2J} *Points*

VISUAL REPRESENTATION OF SOLUTION ALGORITHM

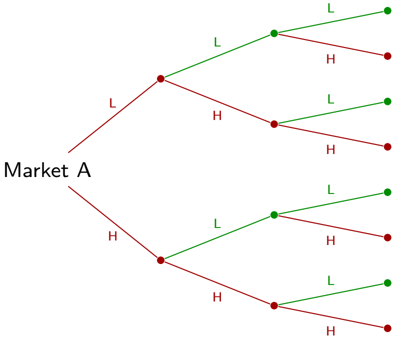
Example - Setting

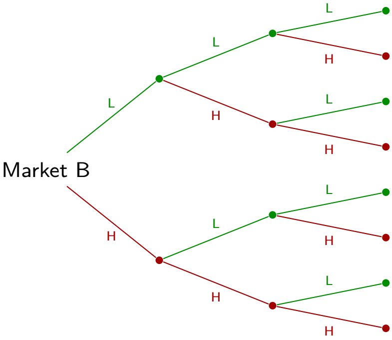
Two Countries (A and B) and Three Periods



Example - Step 1 of Algorithm - Upper Bound

Compute Upper-Bound Policy Function



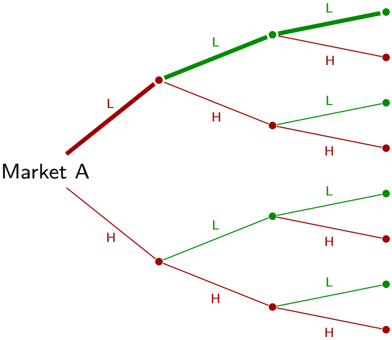


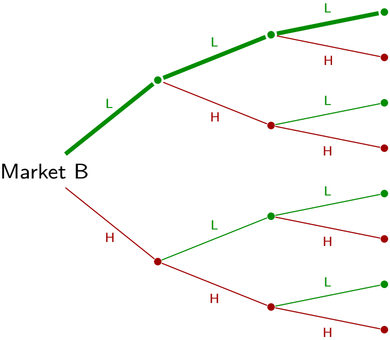
Assuming that in market B...

Assuming that in market A...

Example - Step 1 of Algorithm - Upper Bound

Update Constant Upper Bounds





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Update

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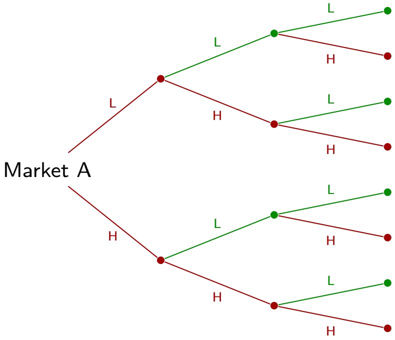

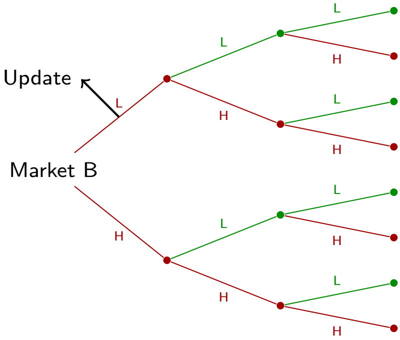

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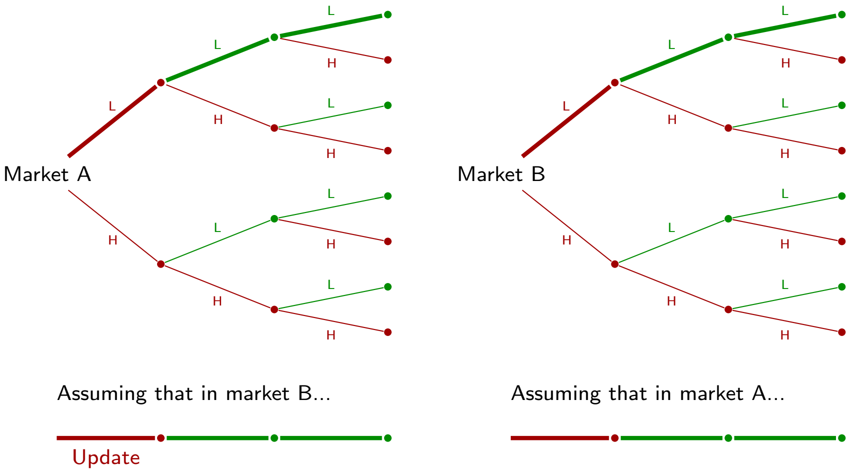
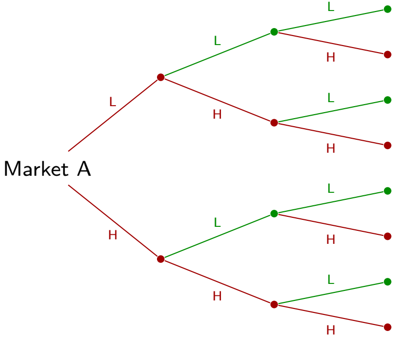
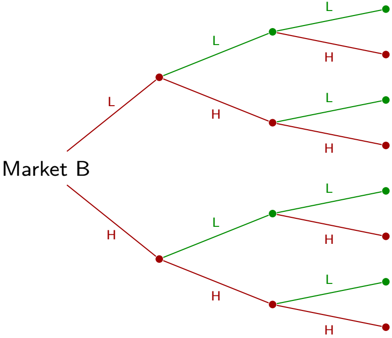


Example - Step 1 of Algorithm - Upper Bound

(Try to) Update Upper-Bound Policy Function:



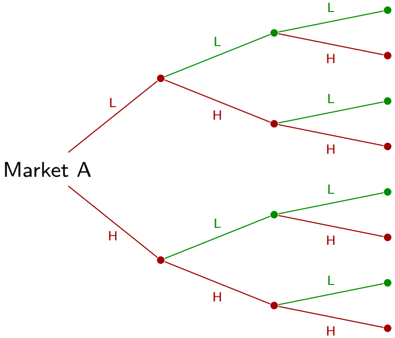


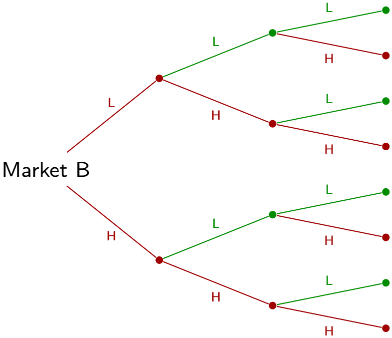
Assuming that in market B...

Assuming that in market A...

Example - Step 1 of Algorithm - Upper Bound

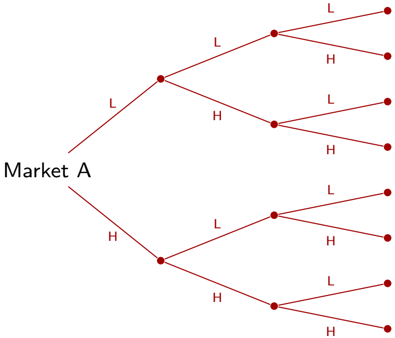
Upper-Bound Policy Function After Convergence:

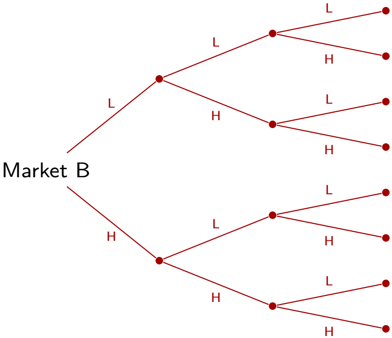




Example - Step 1 of Algorithm - Lower Bound

Compute Lower-Bound Policy Function



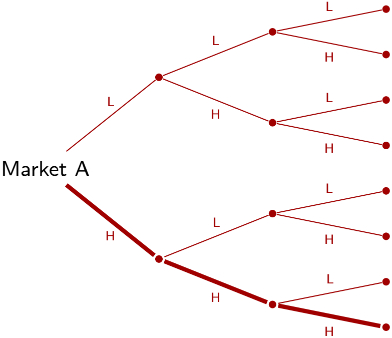


Assuming that in market B...

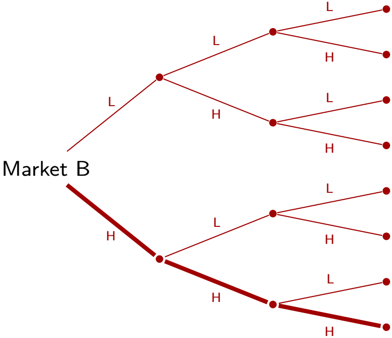
Assuming that in market A...

Example - Step 1 of Algorithm - Lower Bound

(Try to) Update Constant Lower Bounds:



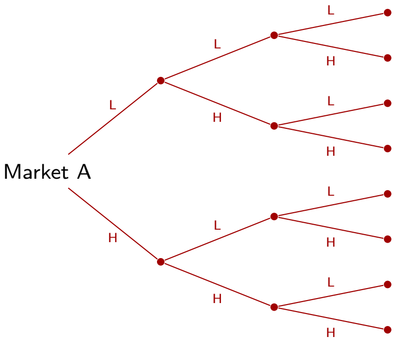
Assuming that in market B...



Assuming that in market A...

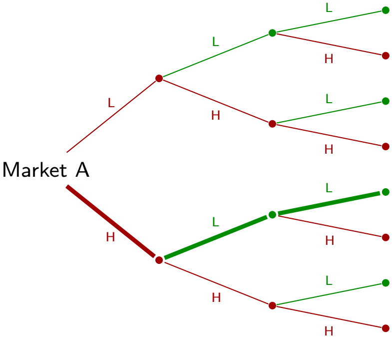
Example - Step 1 of Algorithm - Lower Bound

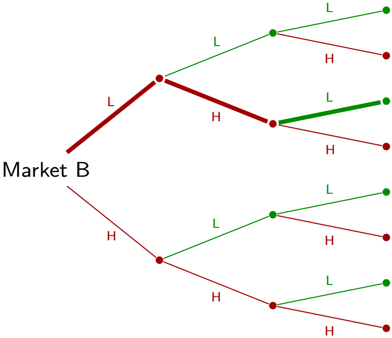
Lower-Bound Policy Function After Convergence:



Example - Step 1 of Algorithm - Evaluate Bounds

Evaluate Upper-Bound Policy Function at Path of Interest

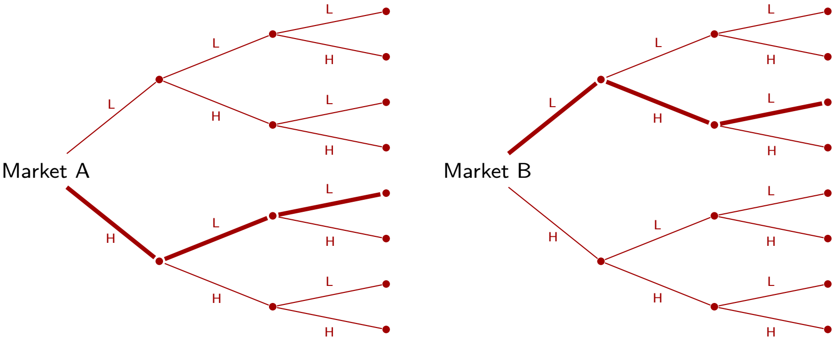




$(\bar{y}_{A1}, \bar{y}_{A2}, \bar{y}_{A3}) = (0, 1, 1)$ $(\bar{y}_{B1}, \bar{y}_{B2}, \bar{y}_{B3}) = (0, 0, 1)$

Example - Step 1 of Algorithm - Evaluate Bounds

Evaluate Lower-Bound Policy Function at Path of Interest



$(\underline{y}_{A1}, \underline{y}_{A2}, \underline{y}_{A3}) = (0, 0, 0)$ $(\underline{y}_{B1}, \underline{y}_{B2}, \underline{y}_{B3}) = (0, 0, 0)$

Example - Step 1 of Algorithm - Combine Bounds

- Compare upper and lower bounds at path of interest in market A:

$$(\bar{y}_{A1}, \bar{y}_{A2}, \bar{y}_{A3}) = (0, 1, 1),$$
$$(\underline{y}_{A1}, \underline{y}_{A2}, \underline{y}_{A3}) = (0, 0, 0).$$

- Compare upper and lower bounds at path of interest in market B:

$$(\bar{y}_{B1}, \bar{y}_{B2}, \bar{y}_{B3}) = (0, 0, 1),$$
$$(\underline{y}_{B1}, \underline{y}_{B2}, \underline{y}_{B3}) = (0, 0, 0).$$

- Bounds coincide at $t = 1$; we found the solution at $t = 1$:

$$(y_{A1}, y_{B1}) = (0, 0).$$

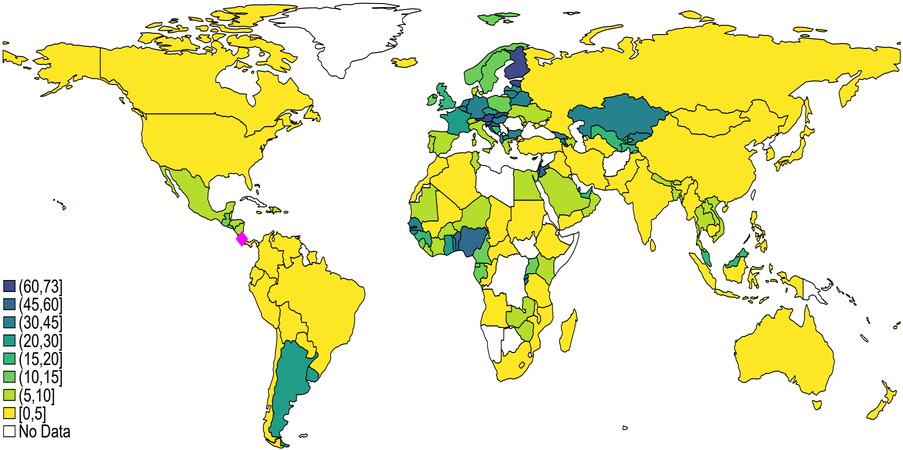
- Bounds (in A) do not coincide at $t = 2$; in Step 2, refine bounds for $t \geq 2$.

Step 2

ESTIMATION RESULTS

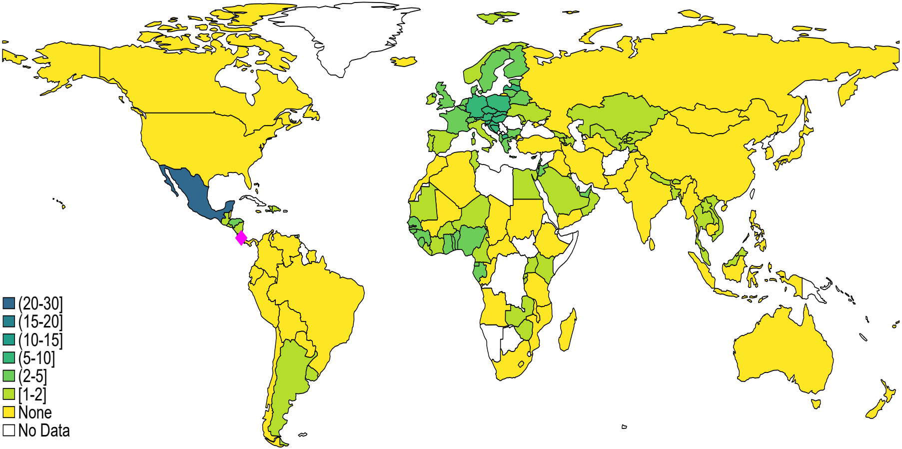
% Reduction in Fixed Costs From to Closest Neighbor

$$(\max_{j' \neq j}\{c^{g}_{jj'} + c^{l}_{jj'} + c^{a}_{jj't}\}/g_{jt}) \times 100\%$$

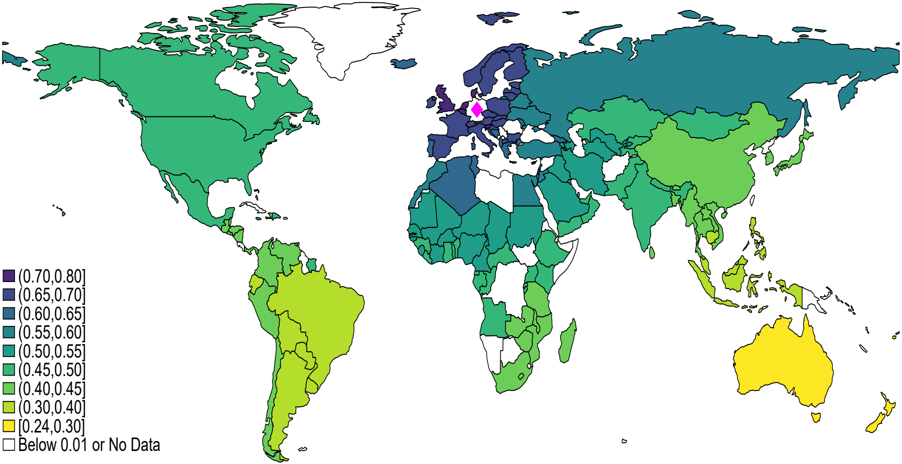


Num. Neighbors Reduce Fixed Costs in More Than 5%

$$\sum_{j' \neq j} \mathbb{1}\{(c^{g}_{jj'} + c^{l}_{jj'} + c^{a}_{jj't})/g_{jt} \geq 5\%\}$$



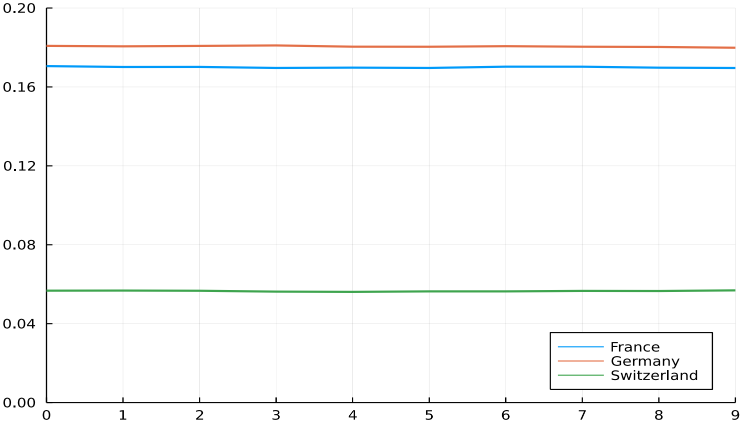
Correlation in Unobserved Fixed Costs: Germany



MODEL PROPERTIES

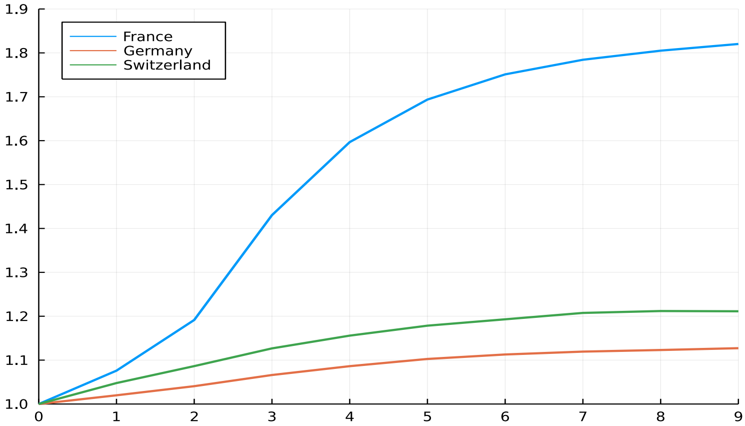
Steady-State Export Probabilities

- Export probabilities before shocks of interest.



Effect of Increase in Export Potential in France

- Relative change in export probabilities due to announcement at $t = 1$ of a 10% permanent increase in potential export revenues in France at $t = 3$.

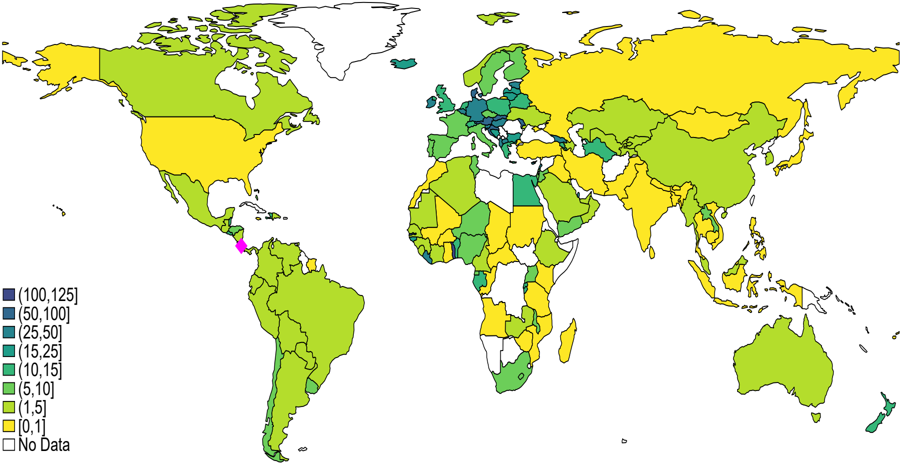


QUANTIFICATION

Impact of Eliminating Cross-country Complementarities

	Sources of Complementarities Maintained:			
Percentage Reduction in:	None	Geographic Proximity	Linguistic Proximity	Common Deep PTA
Number of Export Events:	11.78%	6.57%	2.35%	2.57%
Export Revenues:	5.14%	2.74%	0.86%	1.58%

Percentage Increase in Export Revenues



Impact of Regulatory Differences Due to Brexit

Countries:	Percentage Reduction in: Export Events	Export Revenues
	Panel (a): *2017-2020*	
United Kingdom	-1.38%	-0.52%
European Union	-0.19%	-0.07%
In particular:		
Belgium	-0.58%	-0.23%
Ireland	-0.19%	-0.09%
	Panel (b): *2021-2030*	
United Kingdom	-4.13%	-3.81%
European Union	-0.46%	-0.45%
In particular:		
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Impact of Costa Rica Becoming a CPTPP Member

Countries:	Model With Cross-Country Complementarities				Model Without Cross-Country Complementarities			
	With Tariff Changes		Without Tariff Changes		With Tariff Changes		Without Tariff Changes	
	Export Events (1)	Export Revenues (2)	Export Events (3)	Export Revenues (4)	Export Events (5)	Export Revenues (6)	Export Events (7)	Export Revenues (8)
	Panel (a): *If Costa Rica Joins the CPTPP*							
Members	18.30%	28.01%	5.67%	2.33%	15.56%	25.73%	4.80%	1.92%
Others	0.24%	0.30%	0.20%	0.28%	0%	0%	0%	0%
United States	0.17%	0.08%	0.13%	0.06%	0%	0%	0%	0%
	Panel (b): *If Costa Rica Joins the CPTPP (with the US as member)*							
Members	22.88%	40.10%	6.49%	3.13%	15.56%	25.73%	4.80%	1.92%
Others	0.24%	0.32%	0.21%	0.30%	0%	0%	0%	0%
United States	10.03%	15.67%	6.02%	2.82%	5.63%	8.43%	4.42%	1.46%

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CONCLUSION

Conclusion

- Partial-equilibrium dynamic model with cross-country complementarities.
- Quantify importance of cross-country complementarities.
- Novel algorithm to solve single-agent dynamic discrete-choice problems with cross-choice complementarities.
- A step in a research agenda with many open questions:
  - Additional departures of perfect-foresight assumption?
  - Alternative forms of cross-country interdependencies? Due to information? In variable trade costs? Cross-country substitutabilities in the short-run?
  - General-equilibrium effects in the presence of cross-country complementarities?

THANK YOU!

EXTRA SLIDES

EXTRA SLIDES:
I. SUMMARY STATISTICS

Summary Statistics

- The dataset contains 7203 manufacturing firms.
- Approximately 13.4% of all sample firms export at least once during sample period, reaching to a total of 129 destinations.
- On an average year, ...
  - ...8.6% of firms are exporters;
  - ...60% of exporters export to more than one destination;
  - ...32% of exporters export to more than two destinations;
  - ...18% of exporters export to more than five destinations.
- Average and median export sales by firm, market, and year are USD 288,000 and USD 33,000, respectively.
- Sectors with most exporting events are:
  - Manufacturing of Other Food Products;
  - Manufacturing of Plastic Products; and,
  - Processing and Preserving Of Fruit and Vegetables.

Summary Statistics

Table: Aggregate Statistics

Years	Total Exports	Number of Exporters	Number of Destinations
2005	262,549.6	400	95
2006	303,344.6	415	96
2007	332,929.1	422	91
2008	371,202.9	419	91
2009	328,435.2	438	87
2010	347,235.1	432	96
2011	431,820.7	456	91
2012	479,806.0	459	90
2013	450,472.3	437	84
2014	494,083.5	436	84
2015	479,485.1	395	90

Notes: *Total Exports* are reported in thousands of 2013 dollars

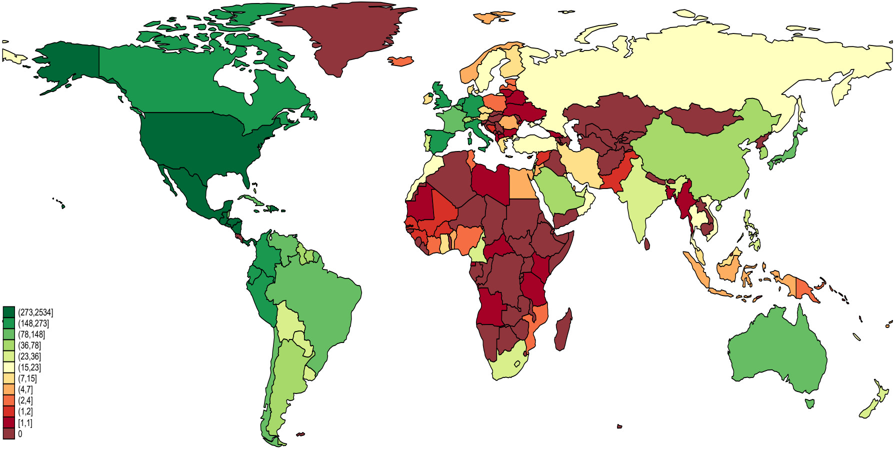
Summary Statistics

Table: Firm-level Statistics

Years	Domestic Sales (All Firms)		Domestic Sales (Exporters)		Exports		Number of Destinations (Exporters)		
	Average	Median	Average	Median	Average	Median	Average	Median	95th/99th
2005	684.4	119.4	3,312.0	822.9	656.4	63.4	3.38	2	10/17
2006	695.4	118.4	3,553.2	772.6	731.0	63.1	3.28	2	10/18
2007	782.4	131.7	3,864.6	904.3	788.9	63.7	3.35	2	10/16
2008	889.6	147.0	4,693.6	1,160.0	885.9	66.4	3.30	2	9/18
2009	839.1	126.4	4,682.5	1,033.4	749.9	43.4	3.19	2	10/18
2010	937.2	139.2	5,256.7	1,161.1	803.8	56.7	3.28	2	9/18
2011	1,031.9	147.4	5,601.4	1,201.7	947.0	56.3	3.25	2	9/19
2012	1,067.5	154.1	5,663.2	1,091.7	1,045.3	65.9	3.22	2	9/19
2013	1,098.9	158.1	5,922.9	1,178.6	1,030.8	78.2	3.35	2	10/17
2014	1,043.8	147.4	5,793.3	1,208.3	1,133.2	59.7	3.28	2	10/18
2015	1,166.0	155.8	6,809.5	1,566.5	1,213.9	80.5	3.62	2	11/20

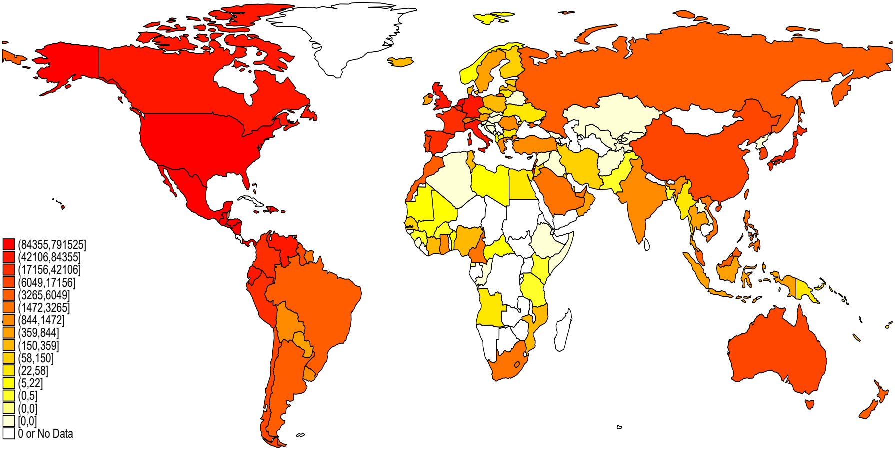
Notes: *Domestic sales* and *Exports* are reported in thousands of 2013 dollars.

Export Activity by Destination



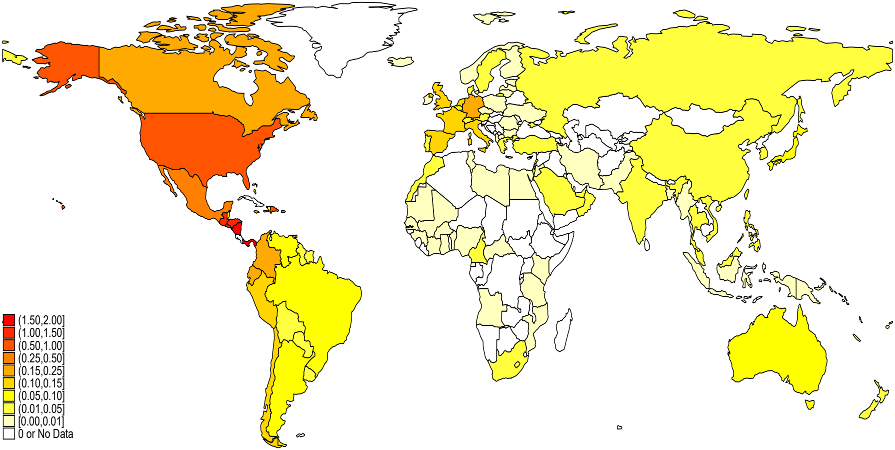
Number of firm-year observations with positive exports in 2005-2015

Export Activity by Destination



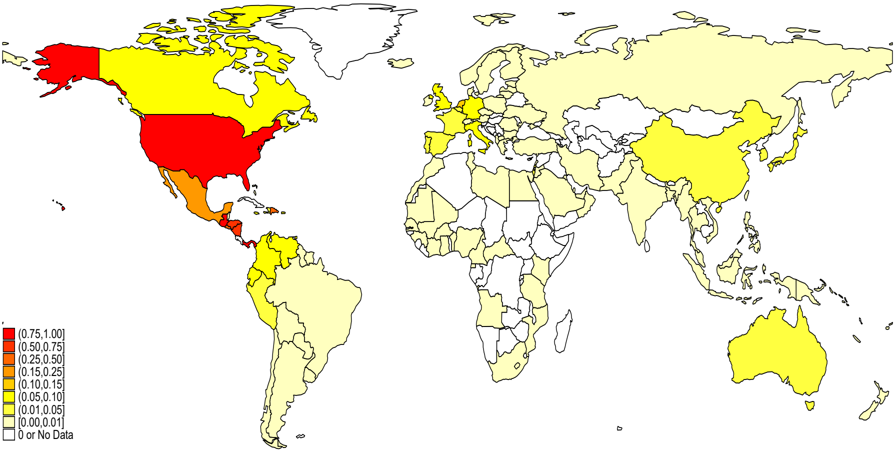
Volume of exports in 2005-2015 (in thousands of 2013 dollars)

Export Activity by Destination - Relative to the US



Number of firm-year obs. with positive exports (relative to the US) in 2005-2015

Export Activity by Destination - Relative to the US



Volume of exports (relative to the US) in 2005-2015.

Within-Market Distribution of Export Sales

Table: Distribution of Export Sales in Several Markets

Country	Average	Percentiles					
		5	25	50	75	95	99
United States	597.6	0.4	5.0	28.1	227.4	3,477.9	9,615.9
Panama	271.4	1.2	7.4	32.5	138.6	1,013.6	5,022.9
Germany	350.8	0.3	6.3	54.0	419.5	1,844.9	3,015.5
Nicaragua	209.8	1.2	8.7	37.6	134.5	879.5	3,013.9
Mexico	295.4	0.4	9.0	51.0	284.2	1,224.8	2,637.1
China	128.8	0.2	3.9	21.8	68.9	713.7	1,584.0

Notes: all numbers in this table are reported in thousands of 2013 dollars.

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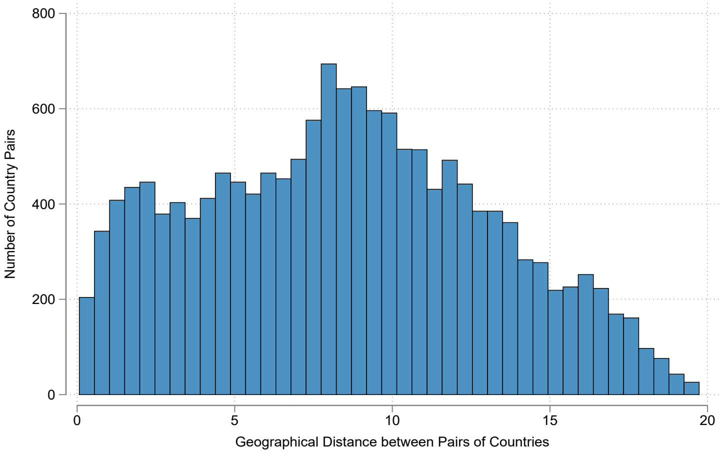
EXTRA SLIDES:

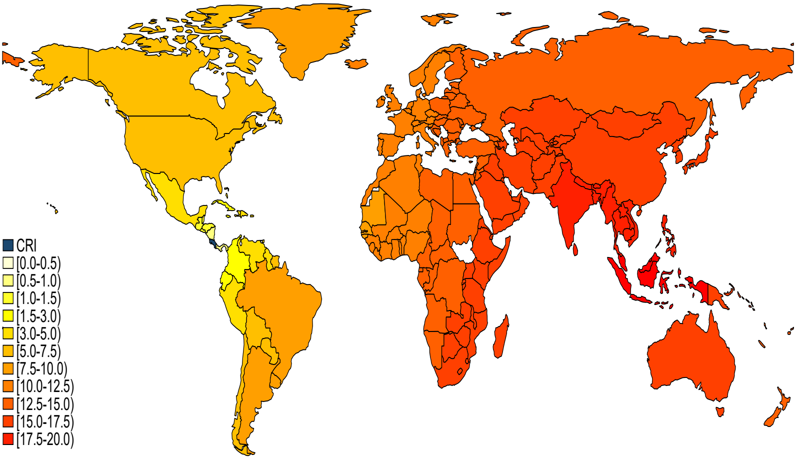
II. ADDITIONAL DETAILS ON GEOGRAPHICAL DISTANCES

Histogram of Bilateral Geographical Distances



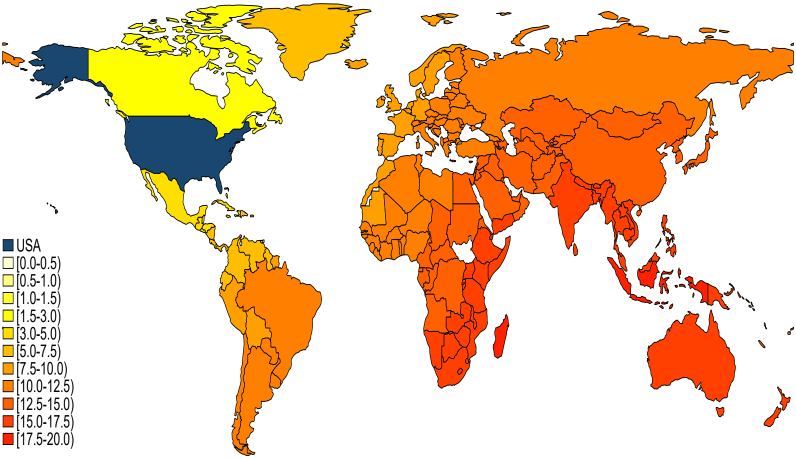
All distances are in thousands of kilometers.

Bilateral Geographical Distances - From Costa Rica



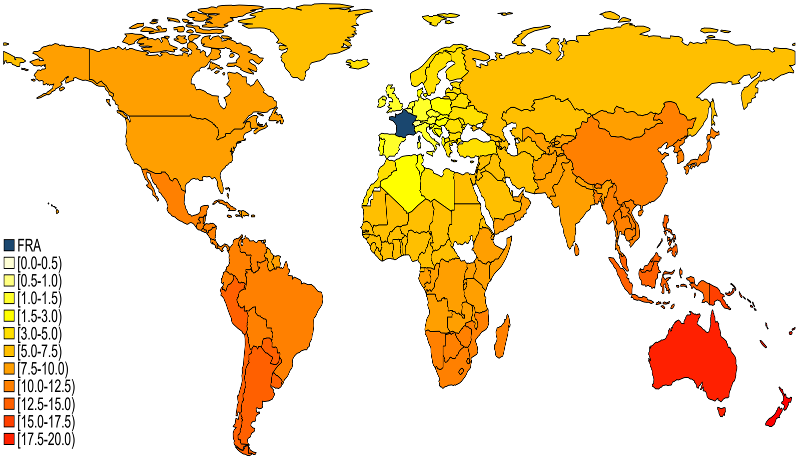
All distances are in thousands of kilometers.

Bilateral Geographical Distances - From the US



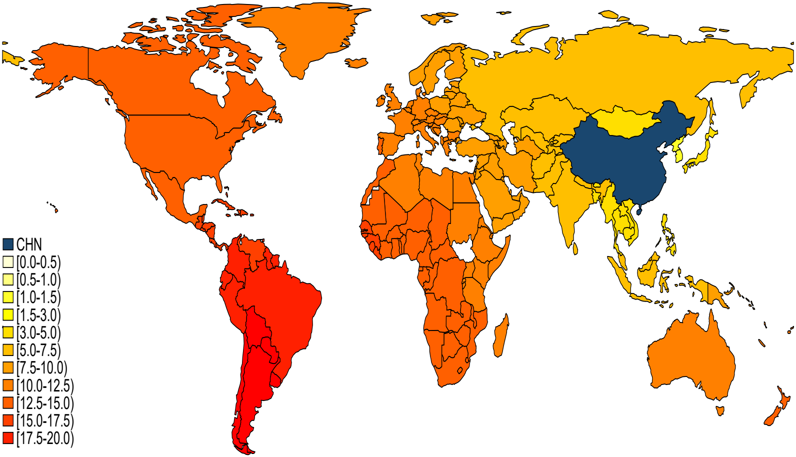
All distances are in thousands of kilometers.

Bilateral Geographical Distances - From France



All distances are in thousands of kilometers.

Bilateral Geographical Distances - From China



All distances are in thousands of kilometers.

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EXTRA SLIDES:

III. ADDITIONAL DETAILS ON LINGUISTIC DISTANCES

Measure of Linguistic Distance

- Assume there are only two languages in the world, k_1 and k_2.
- Probability two individuals i and i' randomly selected from countries j and j', respectively, speak a common language is:

$$P((\{i \text{ speaks } k_1\} \cap \{i' \text{ speaks } k_1\}) \cup (\{i \text{ speaks } k_2\} \cap \{i' \text{ speaks } k_2\}))$$
$$=$$
$$P(\{i \text{ speaks } k_1\} \cap \{i' \text{ speaks } k_1\}) + P(\{i \text{ speaks } k_2\} \cap \{i' \text{ speaks } k_2\}) -$$
$$P((\{i \text{ speaks } k_1\} \cap \{i' \text{ speaks } k_1\}) \cap (\{i \text{ speaks } k_2\} \cap \{i' \text{ speaks } k_2\})).$$

- As i and i' were chosen randomly in their countries, for $k = \{k_1, k_2\}$, it holds

$$\begin{aligned} P(\{i \text{ speaks } k\} \cap \{i' \text{ speaks } k\}) &= P(\{i \text{ speaks } k\})\mathrm{P}(\{i' \text{ speaks } k\}) \\ &= s_{jk}s_{j'k}. \end{aligned}$$

Measure of Linguistic Distance

- Thus, we can write linguistic distance between j and j' as

$$1 - P((\{i \text{ speaks } k_1\} \cap \{i' \text{ speaks } k_1\}) \cup (\{i \text{ speaks } k_2\} \cap \{i' \text{ speaks } k_2\}))$$
$$=$$
$$1 - s_{jk_1} s_{j'k_1} - s_{jk_2} s_{j'k_2} +$$
$$P((\{i \text{ speaks } k_1\} \cap \{i' \text{ speaks } k_1\}) \cap (\{i \text{ speaks } k_2\} \cap \{i' \text{ speaks } k_2\})).$$

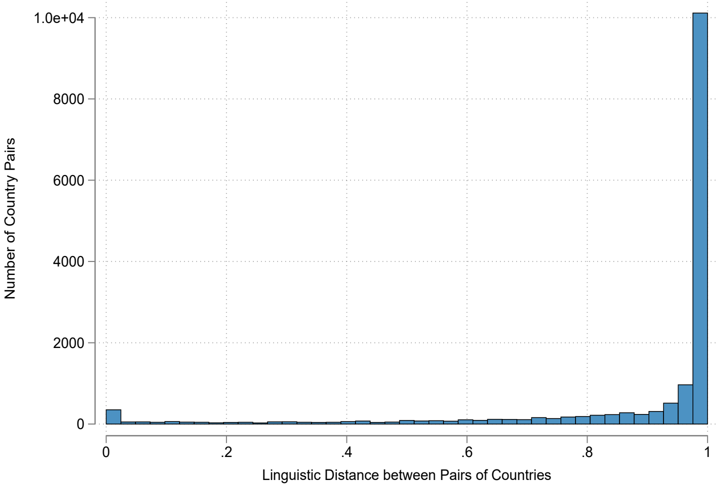
- As the last term is the probability of the intersection of two events, we can compute a lower bound on it as

$$\max\{0, s_{jk_1} s_{j'k_1} + s_{jk_2} s_{j'k_2} - 1\}.$$

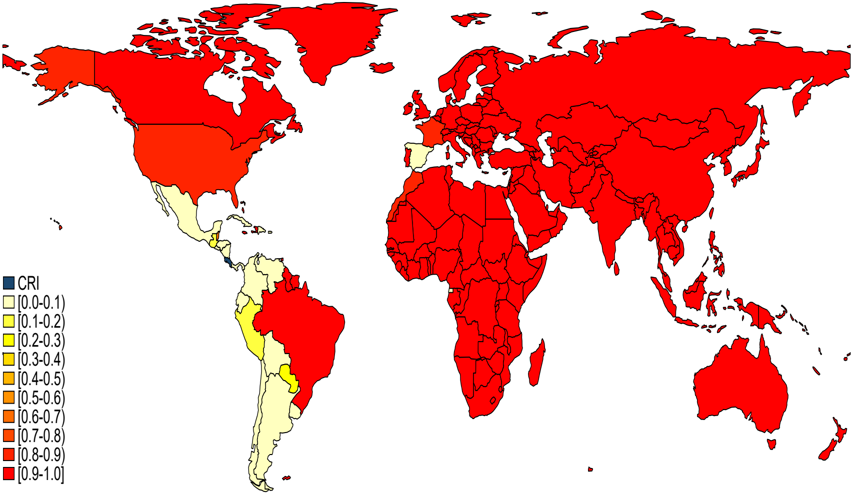
- Therefore, a lower bound on the probability two individuals randomly selected from j and j', respectively, do not speak a common language is

$$\max\{0, 1 - s_{jk_1} s_{j'k_1} - s_{jk_2} s_{j'k_2}\}.$$

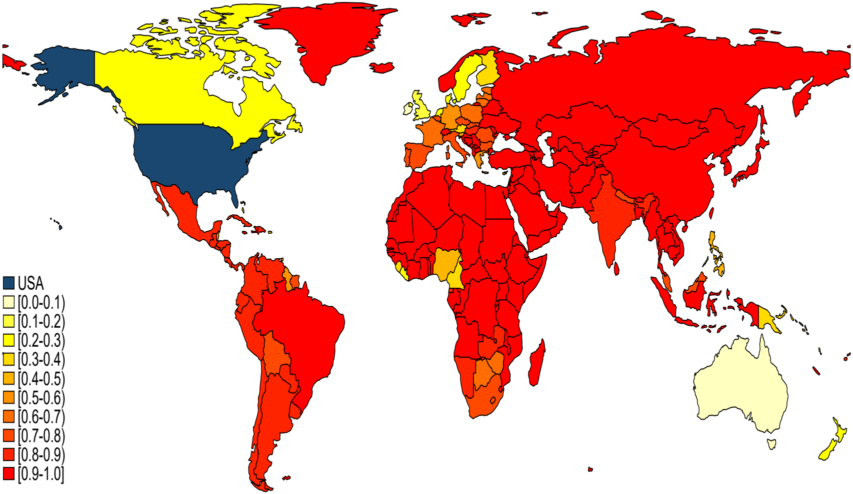
Histogram of Bilateral Linguistic Distances



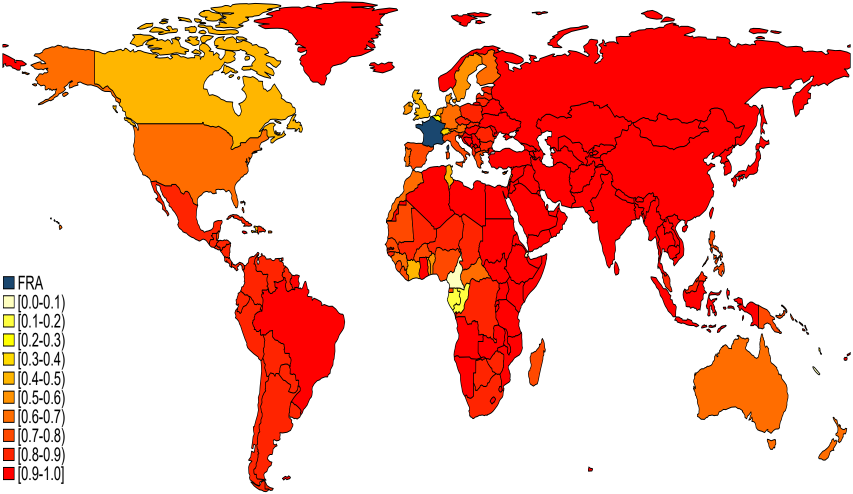
Bilateral Linguistic Distances - From Costa Rica



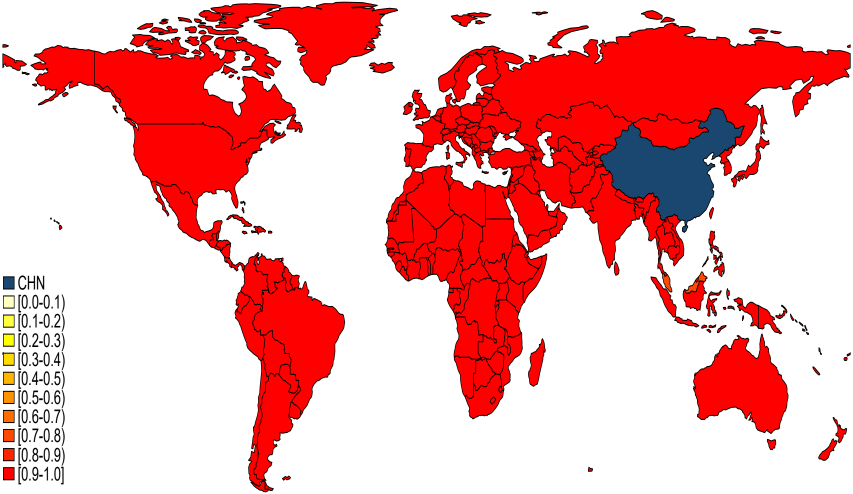
Bilateral Linguistic Distances - From the US



Bilateral Linguistic Distances - From France



Bilateral Linguistic Distances - From China



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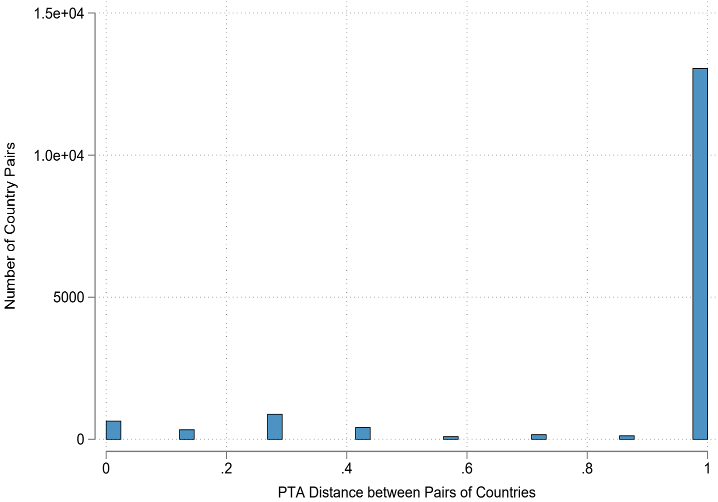
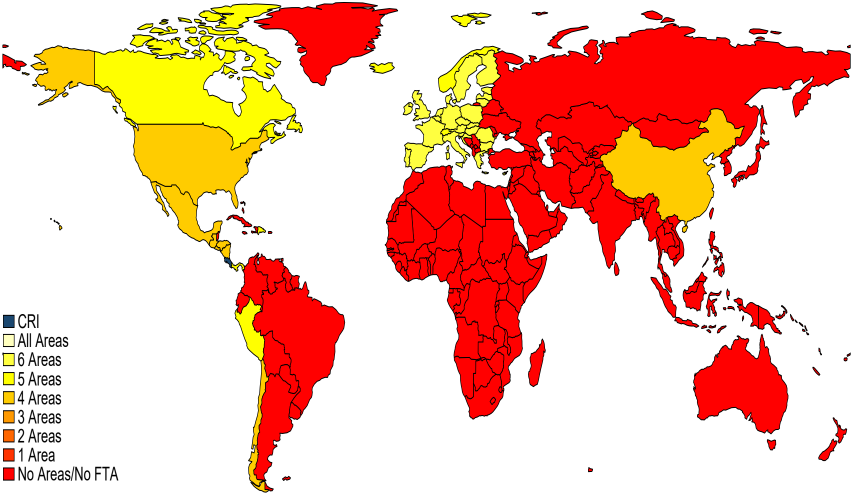
EXTRA SLIDES:

IV. ADDITIONAL DETAILS ON REGULATORY DISTANCES

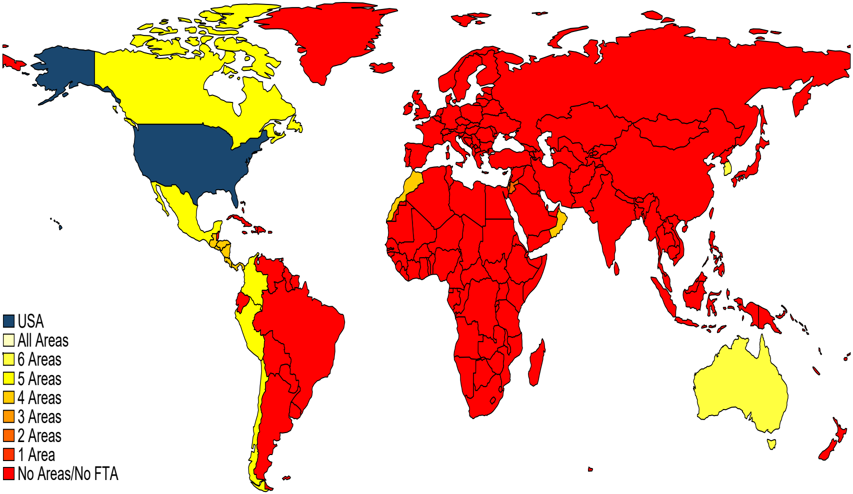
Histogram of Bilateral Regulatory Distances



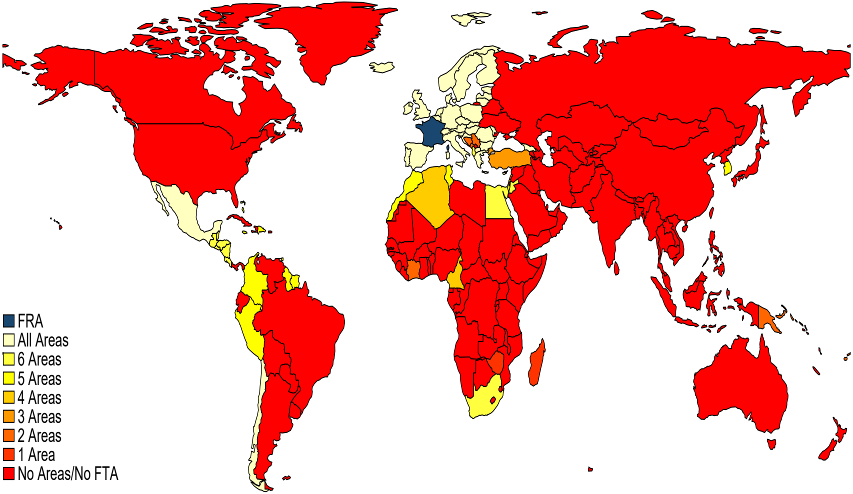
Bilateral Regulatory Distances - From Costa Rica



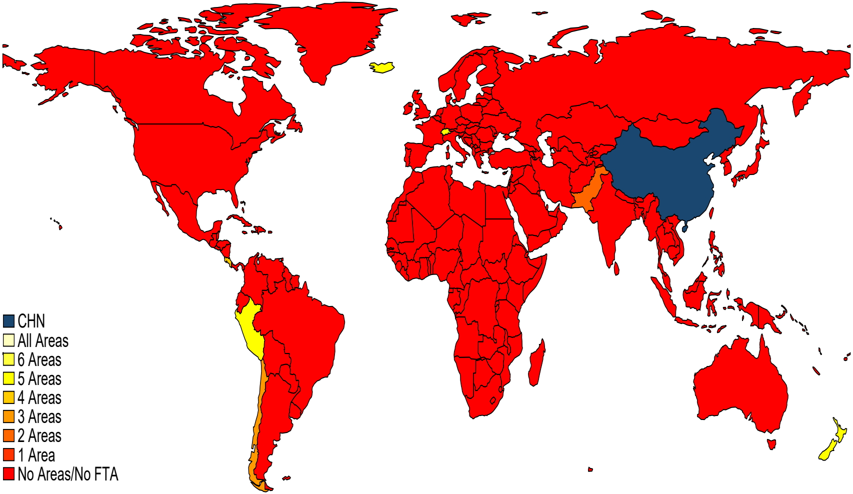
Bilateral Regulatory Distances - From the US



Bilateral Regulatory Distances - From France



Bilateral Regulatory Distances - From China



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EXTRA SLIDES:

V. DEFINITION OF CLOSENESS

Definitions of Closeness Between Countries - Baseline

$$\bar{n}_g = 790 \text{ km} = \text{percentile 2.5 of distribution of } n^g_{jj'}.$$

- Spain and Portugal are close, but Switzerland and the UK are not.

$$\bar{n}_l = 0.11 = \text{percentile 2.5 of distribution of } n^l_{jj'}.$$

- Spain and Argentina are close, but France and the UK are not.

$$\bar{n}_a = 0.43 = \frac{3}{7}.$$

- All members of EU, NAFTA, CAFTA or MERCOSUR are close. The EU has PTAs with Bosnia, Serbia or Turkey, but is not close to them.

Definitions of Closeness Between Countries - Alternative

$$\bar{n}_g = 1153 \text{ km} = \text{percentile 5 of distribution of } n^g_{jj'}.$$

- Switzerland and the UK are close, but Switzerland and Ireland are not.

$$\bar{n}_l = 0.5 = \text{percentile 5 of distribution of } n^l_{jj'}.$$

- France and the UK are close, but France and Portugal are not.

$$\bar{n}_a = 0.72 = \frac{5}{7}.$$

- All members of EU, NAFTA, CAFTA or MERCOSUR are close.

Back to Main Back to Export Potential

EXTRA SLIDES:
VI. EXPORT POTENTIAL MEASURES

Measure of a Destination's Export Potential

- Use PPML to estimate parameters of gravity equation:

$$X^s_{odt} = \exp(\Psi^s_{ot} + \Xi^s_{dt} + \lambda^s_g n^g_{od} + \lambda^s_l n^l_{od} + \lambda^s_a n^a_{odt}) + u^s_{odt}.$$

- Costa Rica's export potential in sector s, destination j, and year t as

$$E^s_{jt} = \exp(\hat{\Xi}^s_{jt} + \hat{\lambda}^s_g n^g_{hj} + \hat{\lambda}^s_l n^l_{hj} + \hat{\lambda}^s_a n^a_{hjt}).$$

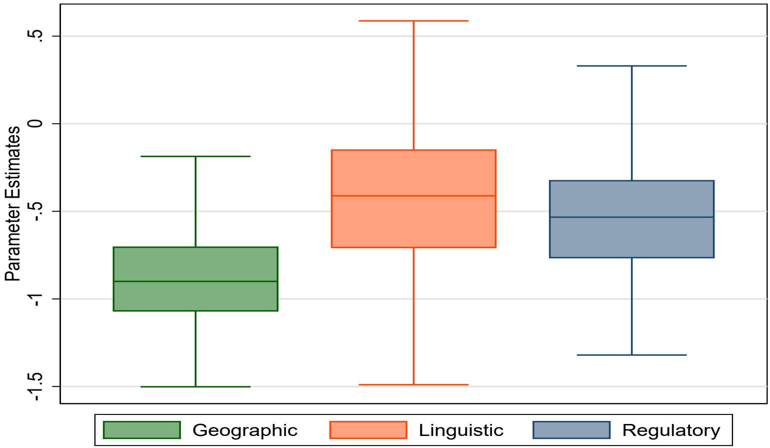
- Costa Rica's export potential in s, markets geographically close to j, and t as

$$AE^s_{jt,g} = \sum_{j' \neq j} \mathbb{1}\{n^g_{jj'} \leq \bar{n}_g\} E^s_{j't}.$$

- Analogous measures for markets linguistically close to each destination j, or cosignatories of a deep PTA with j.

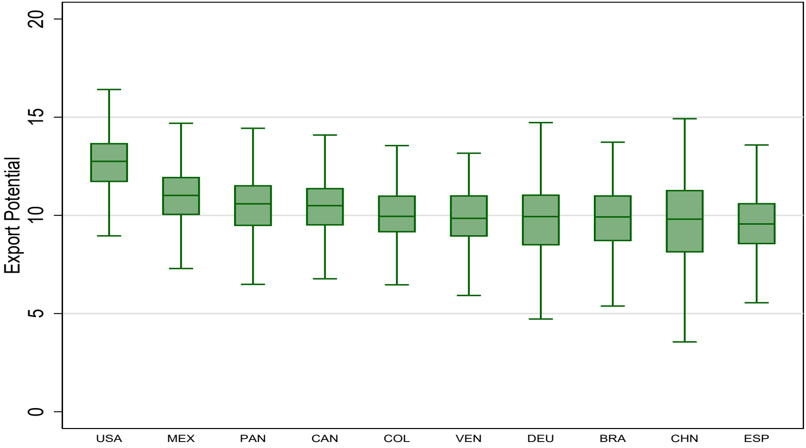
Definition of Closeness

PPML Estimates of Parameters on Distance Measures



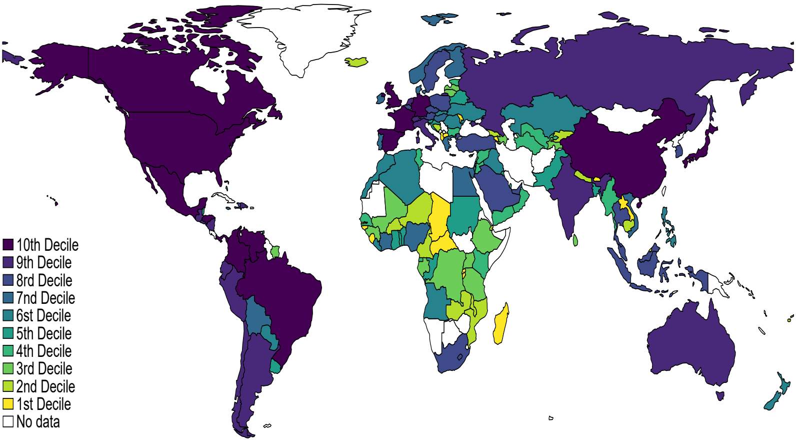
Distribution of $\{\hat{\lambda}_g^s\}_s$, $\{\hat{\lambda}_l^s\}_s$, and $\{\hat{\lambda}_a^s\}_s$.

PPML Estimates of Export Potentials - Top 10 Countries



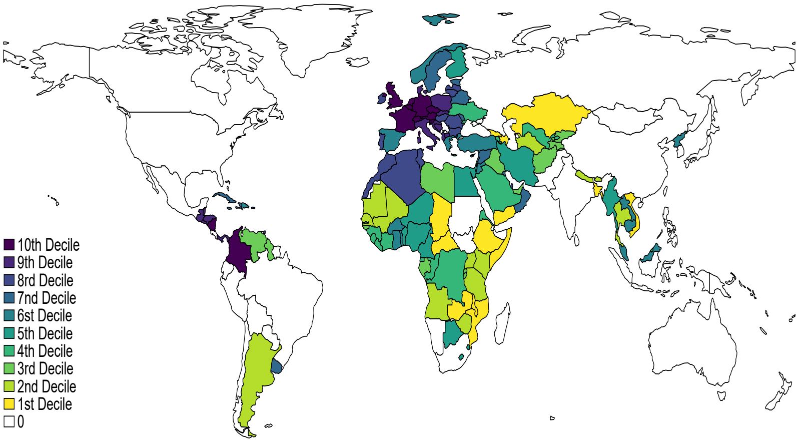
Distribution of $\{E_{jt}^{s}\}_{s,t}$ for Top 10 Destinations by Mean Export Potentials.

PPML Estimates of Export Potentials



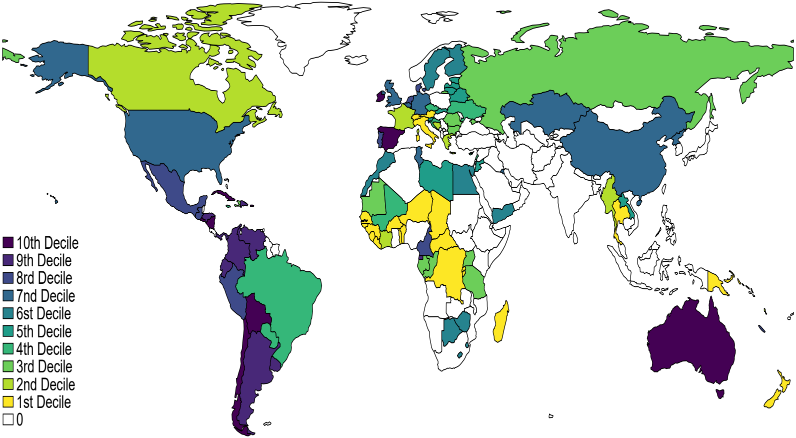
Distribution of Mean Values of E^s_{jt} by Destination.

Aggregate Export Potentials - Geographic Neighbors



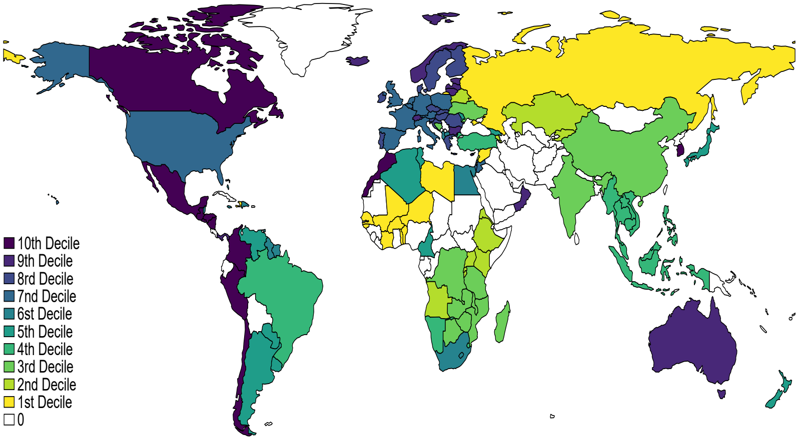
Distribution of Mean Values of $AE^{s}_{jt,g}$ by Destination.

Aggregate Export Potentials - Linguistic Neighbors



Distribution of Mean Values of $AE^{s}_{jt,l}$ by Destination.

Aggregate Export Potentials - Deep PTA Neighbors



Distribution of Mean Values of $AE^{s}_{jt,a}$ by Destination.

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EXTRA SLIDES:

VII. CORRELATION IN FIRM EXPORT PARTICIPATION DECISIONS

- ADDITIONAL ESTIMATES -

Correlation in Firm Export Participation Decisions

- Within-firm correlation in export participation across markets sharing sources of cross-country complementarities:

$$y_{ijt} = \sum_{x=\{g,l,a\}} \beta_x Y_{ijt}^x + \beta_{it} + \beta_{jt}^s + u_{ijt},$$

with, e.g.,

$$Y_{ijt}^g = \mathbb{1}\Big\{ \sum_{j' \neq j} \mathbb{1}\{n_{jj'}^g \leq \bar{n}_g\} y_{ij't} > 0 \Big\}.$$

- The parameter β_x for $x = \{g, l, a\}$ may capture cross-country correlation in firm-specific export profit shifters $\Rightarrow$ importance of controlling for correlation in unobservables in structural model.

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Correlation in Firm Export Participation Decisions

Outcome Variable:	Dummy for Positive Exports in a Destination and Year			
	(1)	(2)	(3)	(4)
Y^{g}_{ijt}	0.2622[a]			0.2082[a]
	(0.0092)			(0.0079)
Y^{l}_{ijt}		0.1617[a]		0.0752[a]
		(0.0076)		(0.0054)
Y^{a}_{ijt}			0.0857[a]	0.0386[a]
			(0.0037)	(0.0021)
Observations	3,859,618			

Note: [a] denotes 1% significance. Standard errors clustered by firm.

Controlling neither for firm-year nor for sector-country-year fixed effects.

Correlation in Firm Export Participation Decisions

Outcome Variable:	Dummy for Positive Exports in a Destination and Year			
	(1)	(2)	(3)	(4)
Y^g_{ijt}	0.2226^a			0.1957^a
	(0.0089)			(0.0081)
Y^l_{ijt}		0.1220^a		0.0718^a
		(0.0067)		(0.0055)
Y^a_{ijt}			0.0517^a	0.0259^a
			(0.0026)	(0.0018)
Observations	3,902,316			

Note: ^{a} denotes 1% significance. Standard errors clustered by firm.

Controlling only for firm-year fixed effects.

Correlation in Firm Export Participation Decisions

Outcome Variable:	Dummy for Positive Exports in a Destination and Year			
	(1)	(2)	(3)	(4)
Y_{ijt}^{g}	0.2462[a]			0.1955[a]
	(0.0089)			(0.0076)
Y_{ijt}^{l}		0.1572[a]		0.0764[a]
		(0.0074)		(0.0052)
Y_{ijt}^{a}			0.0809[a]	0.0363[a]
			(0.0035)	(0.0019)
Observations	3,859,618			

Note: [a] denotes 1% significance. Standard errors clustered by firm.

Controlling only for sector-country-year fixed effects.

Correlation in Firm Export Participation Decisions

Outcome Variable:	Dummy for Positive Exports in a Destination and Year			
	(1)	(2)	(3)	(4)
Y_{ijt}^{g}	0.1384^{a}			0.1116^{a}
	(0.0065)			(0.0057)
Y_{ijt}^{l}		0.1013^{a}		0.0721^{a}
		(0.0048)		(0.0039)
Y_{ijt}^{a}			0.0431^{a}	0.0169^{a}
			(0.0025)	(0.0017)
Observations	3,859,618			

Note: ^{a} denotes 1% significance. Standard errors clustered by firm. All specifications control for firm-year and sector-country-year fixed effects.

Using a laxer definition of closeness between countries

Back

EXTRA SLIDES:

IX. MODEL DETAILS

Time-Varying Exogenous Determinants of Export Revenues

- Country-year shifter:

$$\alpha_{jt} = (X^{\alpha}_{jt})'\beta_{\alpha} + \rho_{\alpha}\alpha_{jt-1} + e^{\alpha}_{jt}, \qquad e^{\alpha}_{jt} \sim \mathbb{N}(0, \sigma^2_{\alpha}), \qquad |\rho_{\alpha}| < 1,$$

with $X_{jt} = (n^g_{hj}, n^l_{hj}, n^a_{hjt}, \ln(gdp_{jt}))$, and X_{jt} constant in non-sample years.

- Firm-year shifter:

$$\ln(r_{iht}) = (X^r_i)'\beta_r + \rho_r \ln(r_{iht-1}) + e^r_{iht}, \qquad e^r_{iht} \sim \mathbb{N}(0, \sigma^2_r), \qquad |\rho_r| < 1,$$

with X^r_i including dummies for firm i's sector and province of location.

- Tariffs: constant in non-sample years.

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EXTRA SLIDES:

X. SOLUTION ALGORITHM

Update Constant Upper Bound Given Upper-Bound Policy

- To compute $\bar{b}_{it}^{[1]}$, implement the following iteration algorithm

$$
\begin{aligned}
\bar{b}_{i\underline{t}_i} &= \bar{o}_{i\underline{t}_i}^{[0]}(0_J, \underline{\omega}_J) \\
\bar{b}_{i\underline{t}_i+1} &= \bar{o}_{i\underline{t}_i+1}^{[0]}(\bar{b}_{i\underline{t}_i}, \underline{\omega}_J) \\
&\vdots \\
\bar{b}_{it-1} &= \bar{o}_{it-1}^{[0]}(\bar{b}_{it-2}, \underline{\omega}_J) \\
\bar{b}_{it} &= o_{it-1}^{[0]}(\bar{b}_{it-1}, \underline{\omega}_J)
\end{aligned}
$$

where

$$0_J = \text{export bundle at } \underline{t}_i - 1.$$

Back

Compute Bound on Optimal Exports At Path of Interest

- To compute $\check{\bar{y}}_{it'}$, implement the following iteration algorithm

$$
\begin{aligned}
\check{\bar{y}}_{i\underline{t}_i} &= \bar{o}^*_{i\underline{t}_i}(\mathbf{0}_J, \check{\omega}_{i\underline{t}_i}) \\
\check{\bar{y}}_{i\underline{t}_i+1} &= \bar{o}^*_{i\underline{t}_i+1}(\check{\bar{y}}_{i\underline{t}_i}, \check{\omega}_{i\underline{t}_i+1}) \\
&\vdots \\
\check{\bar{y}}_{it-2} &= \bar{o}^*_{it-2}(\check{\bar{y}}_{it-3}, \check{\omega}_{it-2}) \\
\check{\bar{y}}_{it-1} &= \bar{o}^*_{it-1}(\check{\bar{y}}_{it-2}, \check{\omega}_{it-1})
\end{aligned}
$$

where

$$\mathbf{0}_J = \text{export bundle at } \underline{t}_i - 1.$$

Back

General Description - Step 2 of the Algorithm

- Denote as τ the smallest t with $\check{\bar{y}}_{it} > \check{\underline{y}}_{it}$.
- Compute new constant upper bounds for all $t \geq \tau$ as

$$\begin{aligned} \bar{b}^{[0]}_{i\tau|\tau} &= \bar{o}^{*}_{i\tau}(\check{y}_{i\tau-1}, \check{\omega}_{i\tau}), \\ \bar{b}^{[0]}_{it'|\tau} &= \bar{o}^{*}_{it'}(\bar{b}^{[0]}_{it'-1|\tau}, \underline{\omega}_{J}), \qquad \text{for } t' = \tau+1, \ldots, t, \end{aligned}$$

  using them to obtain new policies $\bar{o}^{[0]}_{it|\tau}(y_{it-1}, \omega_{it})$ for all $t \geq \tau$ and (y_{it-1}, ω_{it}).
- Update constant upper bounds for all $t \geq \tau$ as

$$\begin{aligned} \bar{b}^{[1]}_{i\tau} &= \bar{o}^{[0]}_{i\tau|\tau}(\check{y}_{i\tau-1}, \check{\omega}_{i\tau}), \\ \bar{b}^{[1]}_{it'} &= \bar{o}^{[0]}_{it'|\tau}(\bar{b}^{[1]}_{it'-1}, \underline{\omega}_{J}), \qquad \text{for } t' = \tau+1, \ldots, t, \end{aligned}$$

  using them to obtain new policies $\bar{o}^{[1]}_{it|\tau}(y_{it-1}, \omega_{it})$ for all $t \geq \tau$ and (y_{it-1}, ω_{it}).
- Iterate until convergence; denote resulting upper-bound policies

$$\bar{o}^{*}_{it|\tau}(y_{it-1}, \omega_{it}) \qquad \text{for all } t \geq \tau \text{ and all } (y_{it-1}, \omega_{it}).$$

General Description - Step 2 of the Algorithm

- Lower-bound process is analogous.
- Evaluate converged bound policies along path of interest at τ:

$$\bar{\check{y}}_{i\tau|\tau} = \bar{o}^{*}_{i\tau|\tau}(\check{y}_{i\tau-1}, \breve{\omega}_{i\tau}) \qquad \text{and} \qquad \underline{\check{y}}_{i\tau|\tau} = \underline{o}^{*}_{i\tau|\tau}(\check{y}_{i\tau-1}, \breve{\omega}_{i\tau}).$$

- If

$$\bar{\check{y}}_{i\tau|\tau} = \underline{\check{y}}_{i\tau|\tau},$$

  we found the solution to the firm's optimal choice along path of interest at τ.
- Otherwise, proceed to step 3 and solve multiple countries jointly at τ.

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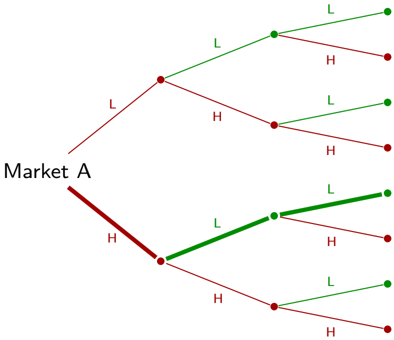
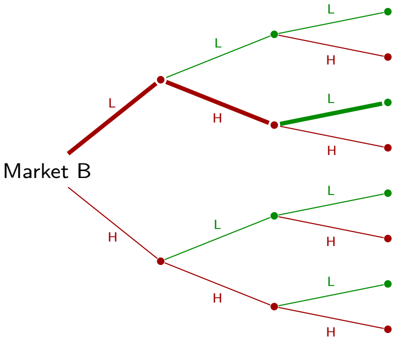
Example - Step 2 of Algorithm - Upper Bound

Compute Constant Upper Bounds Conditional on Path at $t = 2$



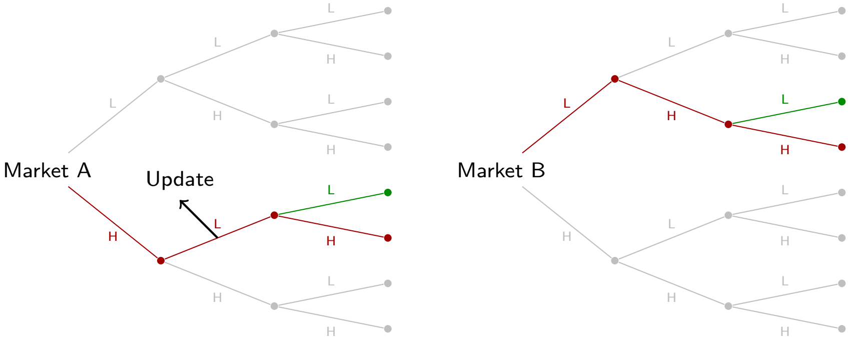


Assuming that in market B...

Assuming that in market A...

Example - Step 2 of Algorithm - Upper Bound

Update Upper-Bound Policy Function Conditional on Path at $t = 2$

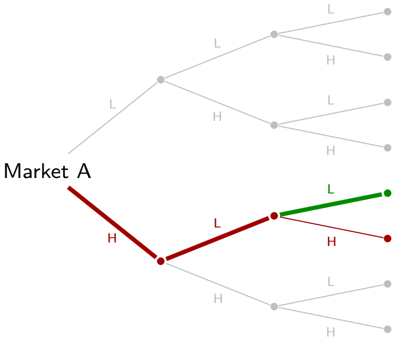


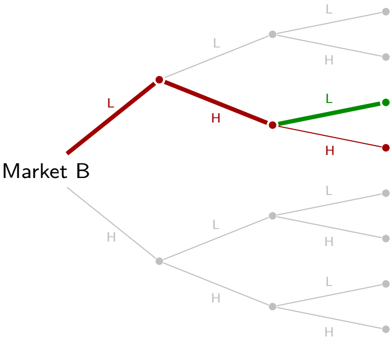
Assuming that in market B...

Assuming that in market A...

Example - Step 2 of Algorithm - Upper Bound

Update Constant Upper Bounds Conditional on Path at $t = 2$



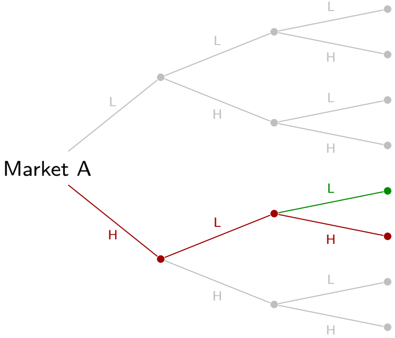


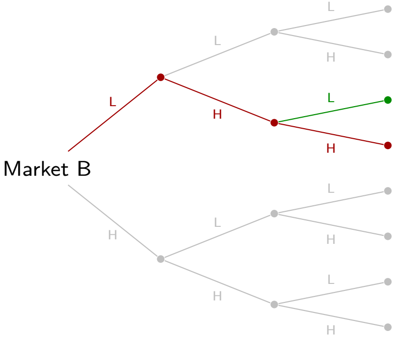
Assuming that in market B...

Assuming that in market A...

Example - Step 2 of Algorithm - Upper Bound

(Try to) Update Upper-Bound Policy Function Conditional on Path at $t = 2$



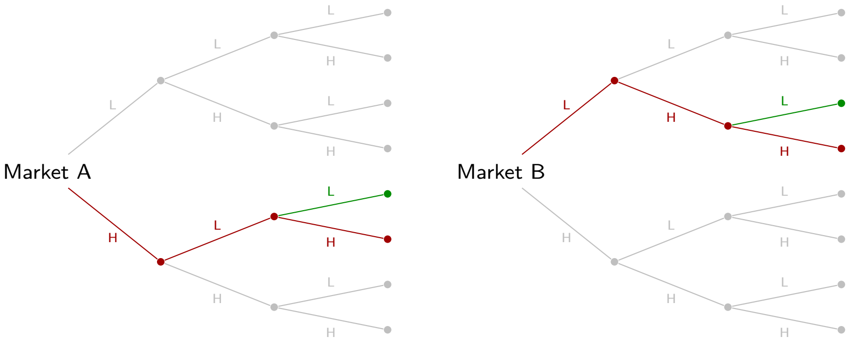


Assuming that in market B...

Assuming that in market A...

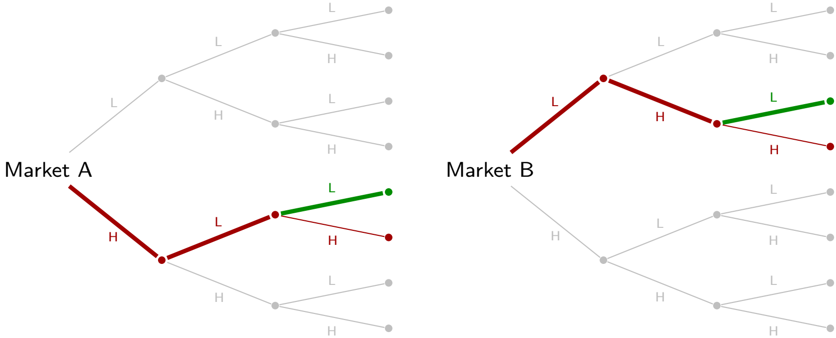
Example - Step 2 of Algorithm - Upper Bound

Upper-Bound Policy Function Conditional on Path at $t = 2$ After Convergence:



Example - Step 2 of Algorithm - Evaluate Bounds

Evaluate Upper-Bound Policy Function at Path of Interest for $t \geq 2$



$(\check{\bar{y}}_{A2|2}, \check{\bar{y}}_{A3|2}) = (0, 1)$

$(\check{\bar{y}}_{B2|2}, \check{\bar{y}}_{B3|2}) = (0, 1)$

Example - Step 2 of Algorithm - Combine Bounds

- Compare upper and lower bounds at path of interest for $t \geq 2$ in market A:

$$(\bar{\check{y}}_{A2|2}, \bar{\check{y}}_{A3|2}) = (0, 1),$$
$$(\underline{\check{y}}_{A2|2}, \underline{\check{y}}_{A3|2}) = (0, 0).$$

- Compare upper and lower bounds at path of interest for $t \geq 2$ in market A:

$$(\bar{\check{y}}_{B2|2}, \bar{\check{y}}_{B3|2}) = (0, 1),$$
$$(\underline{\check{y}}_{B2|2}, \underline{\check{y}}_{B3|2}) = (0, 0).$$

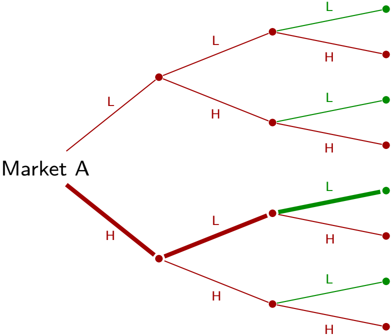
- Bounds coincide at $t = 2$; we found the solution at $t = 2$:

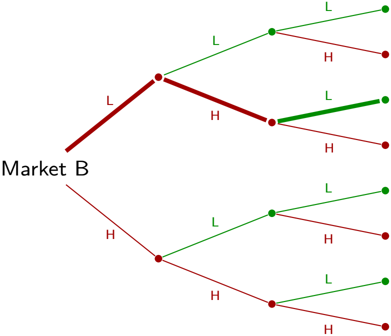
$$(\check{y}^*_{A2}, \check{y}^*_{B2}) = (0, 0).$$

- Bounds do not coincide at $t = 3$; go back to Step 2 to refine bounds at $t = 3$.

Example - Step 2 of Algorithm - Upper Bound

(Try to) Update Constant Upper Bounds Conditional on Path at $t = 3$:





Assuming that in market B...

Assuming that in market A...

Example - Step 2 of Algorithm - Combine Bounds

- Compare upper and lower bounds at path of interest at $t = 3$ in A and B:

$$\check{\bar{y}}_{A3|3} > \underline{\check{y}}_{A3|3}, \qquad \text{and} \qquad \check{\bar{y}}_{B3|3} > \underline{\check{y}}_{B3|3}.$$

- In each of the two markets, the firm exports to it at path of interest at $t = 3$ conditional on exporting to the other market; and it does not export to it at the path of interest at $t = 3$ conditional on not exporting to the other market.
- Thus, upper and lower bound policies diverge at the path of interest at $t = 3$.
- In Step 3, solve optimal choices in A and B jointly given history at $t = 3$.

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EXTRA SLIDES:
X. ESTIMATION DETAILS

Estimation Procedure: Step 1

- GMM estimator of export revenue parameters:

$$((\alpha_y, \alpha_a, \alpha_r), \{\alpha_{jt}\}_{jt}, \{\alpha_s\}_s).$$

- Estimating equation:

$$r_{ijt}^{obs} = \exp(\alpha_y y_{ijt-1} + \alpha_s + \alpha_{jt} + \alpha_a \ln(a_{sjt}) + \alpha_r \ln(r_{iht})) + \epsilon_{ijt},$$

  where ϵ_{ijt} captures measurement error (i.e., $r_{ijt}^{obs} = (r_{ijt} + \epsilon_{ijt})(1 - y_{ijt})$) and

$$\mathbb{E}[\epsilon_{ijt} | d_s, d_{jt}, y_{ijt-1}, a_{sjt}, r_{iht}, y_{ijt} = 1] = 0,$$

  where d_s and d_{jt} are vectors of sector and country-year dummies, respectively.
- PPML estimates computed using data on firm-country-years with $y_{ijt} = 1$.

Estimation Procedure: Step 1

- Estimator of demand elasticity:

$$\eta.$$

- Estimating equation:

$$\underbrace{(r_{iht} + \sum_{j=1}^{J} y_{ijt} r_{ijt})}_{r_{it}} = \tilde{\eta} vc_{it} + e^r_{it}$$

where e^r_{it} captures measurement error (i.e., $r^{obs}_{it} = r_{it} + \epsilon^r_{it}$) and

$$\mathbb{E}[e^r_{it} | vc_{it}] = 0.$$

- Given OLS estimate $\hat{\tilde{\eta}}$ and robust standard error, compute the point estimate

$$\hat{\eta} = \hat{\tilde{\eta}} / (\hat{\tilde{\eta}} - 1),$$

and compute its standard error using the Delta method.

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Step 1: Estimates

- Estimates of export revenue parameters:

Parameters	
α_y	0.285[a] (0.041)
α_a	-3.832[a] (0.066)
α_r	0.285[a] (0.041)
Observations	13,293

Note: Robust standard errors in parenthesis. Specification includes country-year and sector fixed effects.

- Demand elasticity estimate: $\hat{\eta} = 5.713$ with std. err. 0.489, computed using data on 44,785 firm-year observations.

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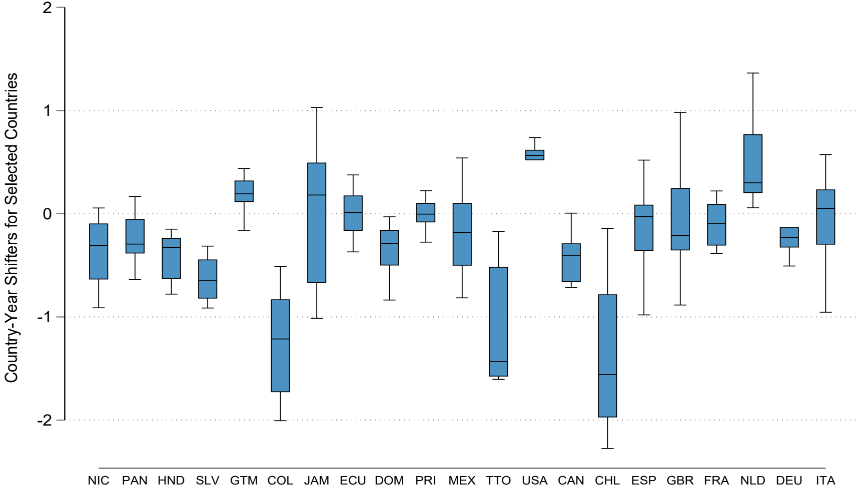
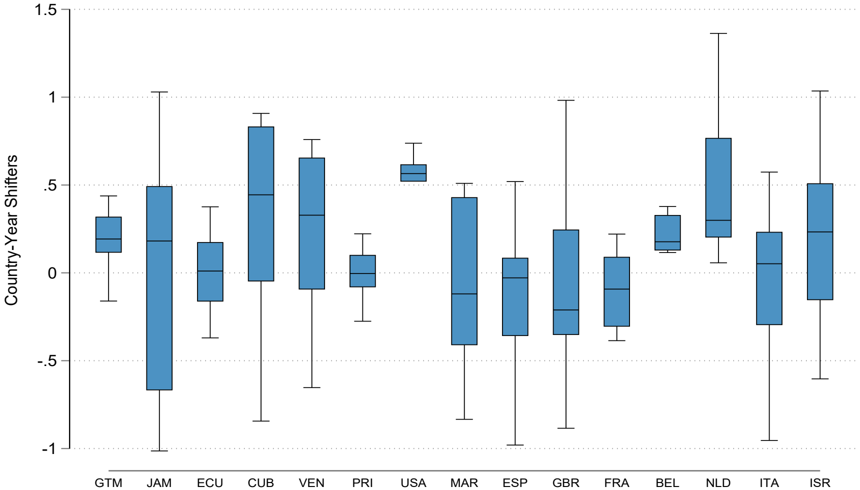
Step 1: Estimates of α_{jt}



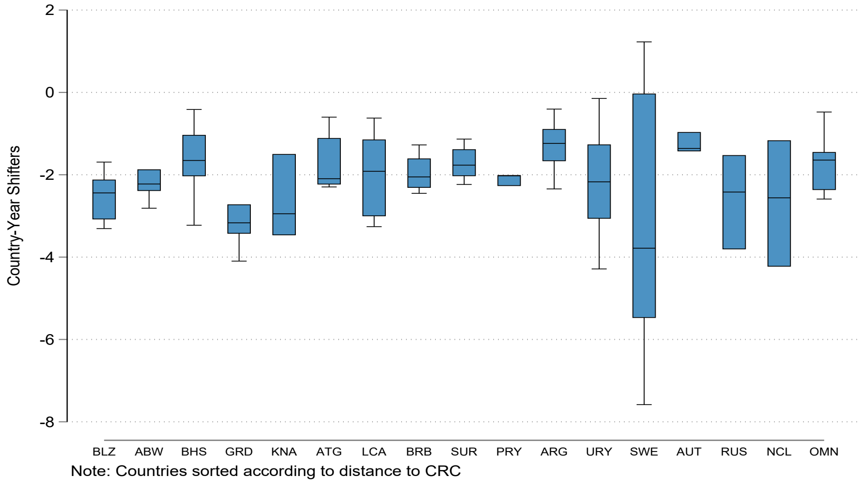
Note: Countries sorted according to distance to CRC

Step 1: Estimates of α_{jt} for Top 15 Countries



Note: Countries sorted according to distance to CRC

Step 1: Estimates of α_{jt} for Bottom 15 Countries



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Estimation Procedure: Step 2

- Given $\{\hat{\alpha}_{jt}\}_j$ for all sample years, compute OLS estimator of

$$(\beta_{\alpha,g}, \beta_{\alpha,l}, \beta_{\alpha,a}, \beta_{\alpha,gdp}, \rho_\alpha, \sigma_\alpha).$$

  where $(\beta_{\alpha,g}, \beta_{\alpha,l}, \beta_{\alpha,a}, \beta_{\alpha,gdp})$ are the coefficients on $(n^g_{hj}, n^l_{hj}, n^a_{hjt}, \ln(gdp_{jt}))$.
- Estimating equation:

$$\hat{\alpha}_{jt} = (X^\alpha_{jt})' \beta_\alpha + \rho_\alpha \hat{\alpha}_{jt-1} + e^\alpha_{jt},$$

  with

$$\begin{aligned} (X^\alpha_{jt}) &= (n^g_{hj}, n^l_{hj}, n^a_{hjt}, \ln(gdp_{jt})), \\ \beta_\alpha &= (\beta_{\alpha,g}, \beta_{\alpha,l}, \beta_{\alpha,a}, \beta_{\alpha,gdp}), \end{aligned}$$

  and

$$\mathbb{E}[e^\alpha_{jt} | X^\alpha_{jt}, \hat{\alpha}_{jt-1}] = 0, \qquad \mathbb{V}[e^\alpha_{jt}] = \sigma^2_\alpha.$$

Estimation Procedure: Step 2

- OLS estimator of:

$$(\beta_r, \rho_r, \sigma_r),$$

where β_r is a vector of sector and province fixed effects.

- Estimating equation:

$$\ln(r_{iht}) = (X_i^r)'\beta_r + \rho_r \ln(r_{iht-1}) + e_{iht}^r,$$

with X_i^r a vector of sector and province dummies, and

$$\mathbb{E}[e_{jt}^r | X_i^r, r_{iht-1}] = 0, \qquad \mathbb{V}[e_{jt}^r] = \sigma_r^2.$$

Back

Estimates of Parameters of Stochastic Process for α_{jt}

Parameters	
$\beta_{\alpha,g}$	-0.117[b] (0.037)
$\beta_{\alpha,l}$	-0.047 (0.071)
$\beta_{\alpha,a}$	-0.109 (0.079)
$\beta_{\alpha,gdp}$	0.079[a] (0.019)
ρ_{α}	0.686[a] (0.059)
σ_{α}	0.630
Observations	467

Note: [a] denotes significance at 1%, [b] denotes significance at 5%. Standard errors clustered by destination in parenthesis.

Estimates of Parameters of Stochastic Process for $\ln(r_{iht})$

Parameters	
ρ_r	0.857^a
	(0.012)
σ_r	0.865
Observations	43,300

Note: [a] denotes significance at 1%, [b] denotes significance at 5%. Standard errors clustered by firm in parenthesis. Specification includes sector and province fixed effects.

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Estimation Procedure: Step 3

- Given Steps 1 and 2 estimates, optimal two-step SMM estimates of fixed and sunk costs parameters, with diagonal weighting matrix in first step. Present standard error estimates according to formula in Gourieroux et al. (1993).
- We use 89 moments to jointly estimate 25 parameters.
- Define the following vector of unknown parameters:

$$\theta \equiv (\gamma_0^F, \gamma_0^S, \sigma_\nu, p, \{(\gamma_x^F, \gamma_x^E, \psi_x^E, \kappa_x^E, \gamma_x^N, \kappa_x^N, \gamma_x^S)\}_{x=\{g,l,a\}}).$$

- Define a vector capturing all observed payoff-relevant variables and estimated parameters:

$$z_i \equiv (\hat{\alpha}_y, \hat{\alpha}_a, \hat{\alpha}_r, \hat{\beta}_\alpha, \hat{\rho}_\alpha, \hat{\sigma}_\alpha, \hat{\beta}_r, \hat{\rho}_r, \hat{\sigma}_r, \{\hat{\alpha}_{jt}\}_{j=1,t=t_l}^{J,t_F}, \hat{\alpha}_s, \{r_{iht}\}_{t=t_l}^{t_F}, \{a_{st}\}_{t=t_l}^{t_F},$$
$$\{(n_{jj'}^g, n_{jj'}^l)\}_{j=1,j'=1}^{J,J}, \{n_{jj't}^a\}_{j=1,j'=1,t=t_l}^{J,J,t_F}, \{(n_{hj}^g, n_{hj}^l)\}_{j=1}^{J}, \{n_{hjt}^a\}_{j=1,t=t_l}^{J,t_F}),$$

where s denotes firm i's sector.

Estimation Procedure: Step 3

- Define a vector capturing all unobserved payoff-relevant variables:

$$\chi_i \equiv (\{\alpha_{jt}\}_{j=1,t=\underline{t}_i}^{J,t=t_I-1}, \{\alpha_{jt}\}_{j=1,t=t_F+1}^{J,t=T}, \{r_{iht}\}_{t=\underline{t}_i}^{t=t_I-1}, \{r_{iht}\}_{t=t_F+1}^{t=T},$$
$$\{\nu_{ijt}\}_{j=1,t=\underline{t}_i}^{J,T}, \{\omega_{ijt}\}_{j=1,t=\underline{t}_i}^{J,t_F}).$$

- Given z_i, a draw χ_i^s from the distribution of χ_i conditional on z_i, and a value of θ, solution algorithm yields vector $y_i^s(\theta)$ of model-implied export decisions for every country and period t in $t_I \leq t \leq t_F$.
- Given $x = \{E_{jt}^s\}_{s=1,j=1,t=t_I}^{S,J,t_F}$, write each moment k as

$$\frac{1}{M}\sum_{i=1}^{M}\left\{\frac{1}{J(t_F - t_i)}\sum_{j=1}^{J}\sum_{t=t_i}^{t_F}\left\{m_k(y_i^{obs}, z_i, x) - \frac{1}{S}\sum_{i=1}^{S} m_k(y_i^s(\theta), z_i, x)\right\}\right\} = 0,$$

where $t_i = \max\{t_I, \underline{t}_i\}$ is the first year firm i is observed, and M and S are number of sample firms and simulation draws, respectively.

Back

Estimation Procedure: Step 3

- Moments targeting the parameters

$$(\gamma_0^F, \gamma_0^S, \{(\gamma_x^F, \gamma_x^S)\}_{x=\{g,l,a\}})$$

rely on moment functions of the kind

$$m_k(\cdot) = y_{ijt}\mathbb{1}\{n_{hj}^{x_1} < n_{x_1}^*\}\mathbb{1}\{n_{hj}^{x_2} < n_{x_2}^*\}n_{hj}^{x_1}n_{hj}^{x_2}$$
$$m_k(\cdot) = y_{ijt}\mathbb{1}\{n_{hj}^{x_1} \geq n_{x_1}^*\}\mathbb{1}\{n_{hj}^{x_2} < n_{x_2}^*\}n_{hj}^{x_1}n_{hj}^{x_2}$$
$$m_k(\cdot) = y_{ijt}\mathbb{1}\{n_{hj}^{x_1} < n_{x_1}^*\}\mathbb{1}\{n_{hj}^{x_2} \geq n_{x_2}^*\}n_{hj}^{x_1}n_{hj}^{x_2}$$
$$m_k(\cdot) = y_{ijt}\mathbb{1}\{n_{hj}^{x_1} \geq n_{x_1}^*\}\mathbb{1}\{n_{hj}^{x_2} \geq n_{x_2}^*\}n_{hj}^{x_1}n_{hj}^{x_2}$$

for $(x_1, x_2) = \{(g, l), (g, a), (l, a)\}$ and

$$n_g^* = 6000, \qquad n_l^* = 0.5, \qquad n_a^* = 1.$$

Estimation Procedure: Step 3

- Moments targeting the parameters

$$(\gamma_0^F, \gamma_0^S, \{(\gamma_x^F, \gamma_x^S)\}_{x=\{g,l,a\}})$$

and on moment functions of the kind

$$m_k(\cdot) = y_{ijt} y_{ijt-1} \mathbb{1}\{n_{hj}^{x_1} < n_{x_1}^*\} \mathbb{1}\{n_{hj}^{x_2} < n_{x_2}^*\} n_{hj}^{x_1} n_{hj}^{x_2}$$
$$m_k(\cdot) = y_{ijt} y_{ijt-1} \mathbb{1}\{n_{hj}^{x_1} \geq n_{x_1}^*\} \mathbb{1}\{n_{hj}^{x_2} < n_{x_2}^*\} n_{hj}^{x_1} n_{hj}^{x_2}$$
$$m_k(\cdot) = y_{ijt} y_{ijt-1} \mathbb{1}\{n_{hj}^{x_1} < n_{x_1}^*\} \mathbb{1}\{n_{hj}^{x_2} \geq n_{x_2}^*\} n_{hj}^{x_1} n_{hj}^{x_2}$$
$$m_k(\cdot) = y_{ijt} y_{ijt-1} \mathbb{1}\{n_{hj}^{x_1} \geq n_{x_1}^*\} \mathbb{1}\{n_{hj}^{x_2} \geq n_{x_2}^*\} n_{hj}^{x_1} n_{hj}^{x_2}$$

for $(x_1, x_2) = \{(g, l), (g, a), (l, a)\}$ and

$$n_g^* = 6000, \qquad n_l^* = 0.5, \qquad n_a^* = 1.$$

Back

Estimates

Parameters	Estimates
γ_0^F	62.92^a (1.11)(1.34)(2.77)
γ_g^F	13.11^a (0.38)(1.17)(3.43)
γ_l^F	4.14^a (0.99)(1.71)(4.71)
γ_a^F	29.28^a (0.78)(0.62)(1.09)
γ_0^S	114.76^a (3.18)(3.09)(6.03)
γ_g^S	19.95^a (0.92)(1.10)(2.80)
γ_l^S	0.23 (3.56)(4.43)(8.36)
γ_a^S	21.83^a (1.04)(0.83)(1.46)

Note: ^{a} denotes significance at 1%. In parenthesis, robust standard errors, standard errors clustered by firm-year, and standard errors clustered by firm, respectively.

Back

Estimation Procedure: Step 3

- Define the following aggregate export potential measures for each destination j, period t and sector s:

$$AE^{s,d}_{jt,x} = \sum_{j' \neq j} \mathbb{1}\{\underline{n}_{x,d} \leq n^{x}_{jj'} < \bar{n}_{x,d}\} E^{s}_{j't},$$

for $x = \{g, l, a\}$ and for $d = \{1, 2, 3\}$.

- We use the following values of the thresholds $(\underline{n}_{g,d}, \bar{n}_{g,d})$:

$$(\underline{n}_{g,d}, \bar{n}_{g,d}) = \begin{cases} (0, 426) & \text{if } d = 1, \\ (426, 791) & \text{if } d = 2, \\ (791, 1153) & \text{if } d = 3. \end{cases}$$

Export Potential

Estimation Procedure: Step 3

- Define the following aggregate export potential measures for each destination j, period t and sector s:

$$AE^{s,d}_{jt,x} = \sum_{j' \neq j} \mathbb{1}\{\underline{n}_{x,d} \leq n^{x}_{jj'} < \bar{n}_{x,d}\} E^{s}_{j't},$$

for $x = \{g, l, a\}$ and for $d = \{1, 2, 3\}$.

- We use the following values of the thresholds $(\underline{n}_{l,d}, \bar{n}_{l,d})$:

$$(\underline{n}_{l,d}, \bar{n}_{l,d}) = \begin{cases} (0, 0.01) & \text{if } d = 1, \\ (0.01, 0.11) & \text{if } d = 2, \\ (0.11, 0.50) & \text{if } d = 3. \end{cases}$$

Export Potential

Estimation Procedure: Step 3

- Define the following aggregate export potential measures for each destination j, period t and sector s:

$$AE^{s,d}_{jt,x} = \sum_{j' \neq j} \mathbb{1}\{\underline{n}_{x,d} \leq n^{x}_{jj'} < \bar{n}_{x,d}\} E^{s}_{j't},$$

for $x = \{g, l, a\}$ and for $d = \{1, 2, 3\}$.

- We use the following values of the thresholds $(\underline{n}_{a,d}, \bar{n}_{a,d})$:

$$(\underline{n}_{a,d}, \bar{n}_{a,d}) = \begin{cases} (0, \frac{1}{7}) & \text{if } d = 1, \\ (\frac{1}{7}, \frac{3}{7}) & \text{if } d = 2, \\ (\frac{3}{7}, \frac{6}{7}) & \text{if } d = 3. \end{cases}$$

Export Potential

Estimation Procedure: Step 3

- Moments targeting the parameters

$$\{(\gamma_x^E, \psi_x^E, \kappa_x^E)\}_{x=\{g,l,a\}}$$

rely on moment functions of the kind

$$\begin{aligned}
m_k(\cdot) &= y_{ijt}\mathbb{1}\{n_{hj}^x < n_x^*\}\mathbb{1}\{AE_{jt,x}^{s,d} = 0\} \\
m_k(\cdot) &= y_{ijt}\mathbb{1}\{n_{hj}^x < n_x^*\}\mathbb{1}\{0 < AE_{jt,x}^{s,d} \le p_{66}(AE_{jt,x}^{s,d})\} \\
m_k(\cdot) &= y_{ijt}\mathbb{1}\{n_{hj}^x < n_x^*\}\mathbb{1}\{p_{66}(AE_{jt,x}^{s,d}) < AE_{jt,x}^{s,d}\} \\
m_k(\cdot) &= y_{ijt}\mathbb{1}\{n_{hj}^x \ge n_x^*\}\mathbb{1}\{AE_{jt,x}^{s,d} = 0\} \\
m_k(\cdot) &= y_{ijt}\mathbb{1}\{n_{hj}^x \ge n_x^*\}\mathbb{1}\{0 < AE_{jt,x}^{s,d} \le p_{66}(AE_{jt,x}^{s,d})\} \\
m_k(\cdot) &= y_{ijt}\mathbb{1}\{n_{hj}^x \ge n_x^*\}\mathbb{1}\{p_{66}(AE_{jt,x}^{s,d}) < AE_{jt,x}^{s,d}\}
\end{aligned}$$

for $x = \{g, l, a\}$ and for $d = \{1, 2, 3\}$, where $p_{66}(X)$ denotes percentile 66 of the distribution of X.

Back

Estimates

Parameters	Estimates
γ_g^E	9.83^a (2.33)(2.85)(6.42)
φ_g^E	1.96^a (0.50)(0.66)(1.55)
κ_g^E	6.02^a (0.28)(0.49)(0.66)
γ_l^E	0.98^a (0.08)(0.07)(0.11)
φ_l^E	2.74 (2.88)(3.79)(7.16)
κ_l^E	5.40 (6.05)(7.84)(19.56)
γ_a^E	3.32^a (0.04)(0.04)(0.06)
φ_a^E	1.21 (0.52)(0.73)(1.51)
κ_a^E	6.85^a (1.02)(1.48)(3.18)

Note: ^{a} denotes significance at 1%. In parenthesis, robust standard errors, standard errors clustered by firm-year, and standard errors clustered by firm, respectively.

Back

Estimation Procedure: Step 3

- Moments targeting the parameters

$$(\sigma_\nu, p, \{(\gamma_x^N, \kappa_x^N)\}_{x=\{g,l,a\}})$$

rely on moment functions of the kind

$$m_k(\cdot) = y_{ijt} \sum_{i' \neq i} y_{i'jt} \mathbb{1}\{r_{iht} \approx r_{i'ht}\},$$

$$m_k(\cdot) = y_{ijt} \sum_{j' \neq j} y_{ij't} \mathbb{1}\{y_{ijt-1} = y_{ij't-1}\} \mathbb{1}\{E^s_{jt} \approx E^s_{j't}\} \mathbb{1}\{\underline{n}_{x,d} \leq n^x_{jj'} < \bar{n}_{x,d}\},$$

for $x = \{g, l, a\}$ and for $d = \{1, 2, 3\}$, and on the moment functions

$$m_k(\cdot) = y_{ijt}(1 - y_{ijt-1})y_{ijt-2} + y_{ijt}(1 - y_{ijt-1})(1 - y_{ijt-2})y_{ijt-3},$$

$$m_k(\cdot) = (1 - y_{ijt})y_{ijt-1}(1 - y_{ijt-2}) + (1 - y_{ijt})y_{ijt-1}y_{ijt-2}(1 - y_{ijt-3}).$$

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Estimates

Parameters	Estimates
γ_g^N	0.64[a] (0.00)(0.00)(0.01)
κ_g^N	0.05[a] (0.00)(0.00)(0.01)
γ_l^N	0.15[a] (0.00)(0.00)(0.01)
κ_l^N	4.54[a] (0.29)(0.31)(0.50)
γ_a^N	0.06[a] (0.01)(0.01)(0.01)
κ_a^N	2.61[a] (0.00)(0.00)(0.00)
σ_ν	80.04[a] (0.51)(0.79)(2.05)
p	0.72[a] (0.00)(0.00)(0.00)

Note: [a] denotes significance at 1%. In parenthesis, robust standard errors, standard errors clustered by firm-year, and standard errors clustered by firm, respectively.

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EXTRA SLIDES:
XI. GOODNESS-OF-FIT MEASURES OF MODEL WITH COMPLEMENTARITIES

Export Probabilities by Type of Destination

Type of Country j	Data	Model
All	0.44%	0.47%
$\mathbb{1}\{E^s_{jt} \geq E^*\}$	0.89%	0.93%
$\mathbb{1}\{E^s_{jt} < E^*\}$	0.08%	0.10%
$\mathbb{1}\{n^g_{hj} < n^*_g\}$	0.86%	0.89%
$\mathbb{1}\{n^g_{hj} \geq n^*_g\}$	0.10%	0.14%
$\mathbb{1}\{n^l_{hj} < n^*_l\}$	1.29%	1.37%
$\mathbb{1}\{n^l_{hj} \geq n^*_l\}$	0.16%	0.18%
$\mathbb{1}\{n^a_{hjt} < n^*_a\}$	0.90%	0.98%
$\mathbb{1}\{n^a_{hjt} \geq n^*_a\}$	0.13%	0.13%

Note: Cutoffs are $E^* = median(E^s_{jt})$, $n^*_g = 6000$, $n^*_l = 0.5$, and $n^*_a = 1$. Model probabilities are computed as the average probability over 100 simulations of χ^s_i for each i.

Correlation in Firm Export Participation Decisions

- Predicted correlations with baseline estimates.

Outcome Variable:	Dummy for Positive Exports in a Destination and Year			
	(1)	(2)	(3)	(4)
Y^g_{ijt}	0.1420^a			0.1212^a
	(0.0025)			(0.0027)
Y^l_{ijt}		0.0710^a		0.0402^a
		(0.0014)		(0.0016)
Y^a_{ijt}			0.0250^a	0.0044^a
			(0.0008)	(0.0007)
Observations	3,902,316			

Note: ^{a} denotes 1% significance. Standard errors clustered by firm. All specifications control for firm-year and sector-country-year fixed effects.

- Qualitatively similar but quantitatively smaller estimates than in the data.

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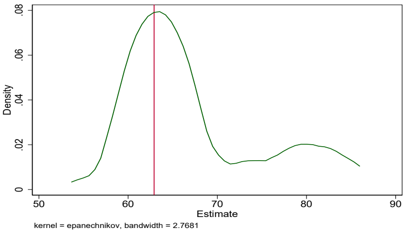
EXTRA SLIDES:
XII. ROBUSTNESS OF ESTIMATES TO ALTERNATIVE SIMULATION DRAWS

Robustness to Alternative Simulation Draws

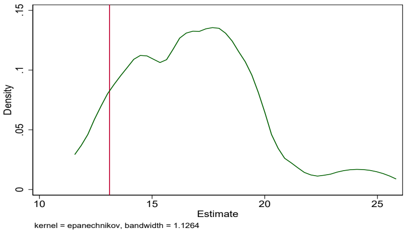
- We re-compute our SMM parameter estimates using 50 alternative sets of 5 simulation draws of χ_i^s.
- Report non-parametric estimates of the density functions for the 50 estimates of each parameter obtained in our SMM estimation procedure.
- In each figure, we indicate the baseline estimate through a vertical red line.

Robustness to Alt. Simulation Draws - Fixed Cost Param.

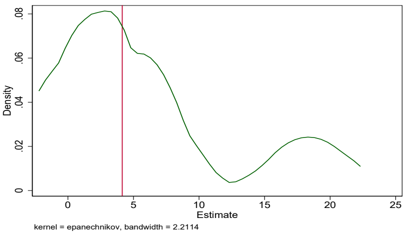
(a) γ_0^F



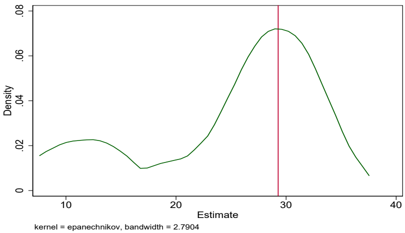
(b) γ_g^F



(c) γ_l^F

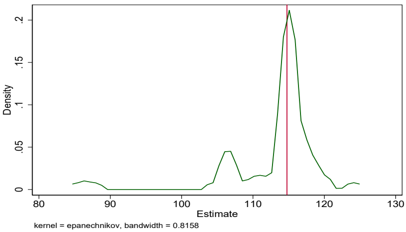


(d) γ_a^F

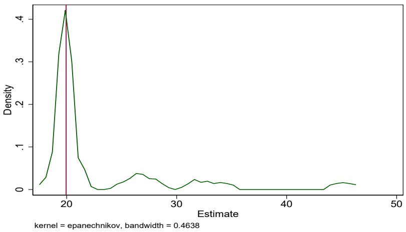


Robustness to Alt. Simulation Draws - Sunk Cost Param.

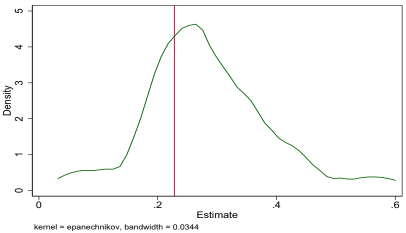
(a) γ_0^S



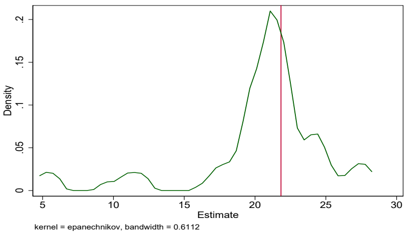
(b) γ_g^S



(c) γ_l^S

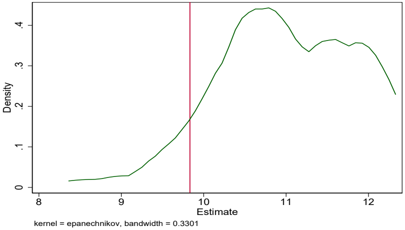


(d) γ_a^S

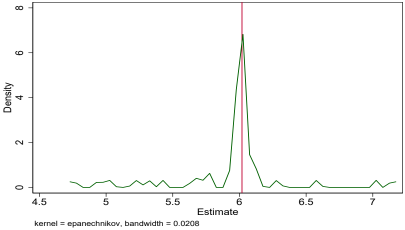


Robustness to Alt. Draws - Static Complementarities.

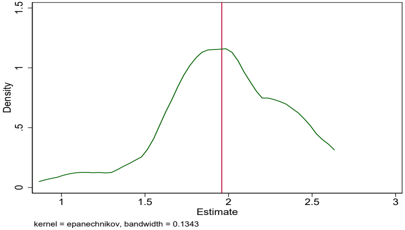
(a) γ_g^E



(b) κ_g^E

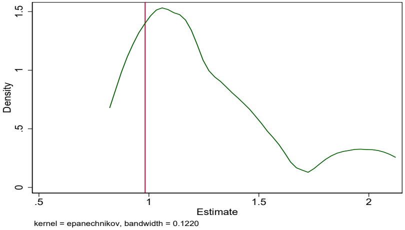


(c) φ_g^E

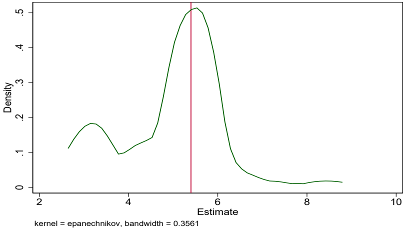


Robustness to Alt. Draws - Static Complementarities.

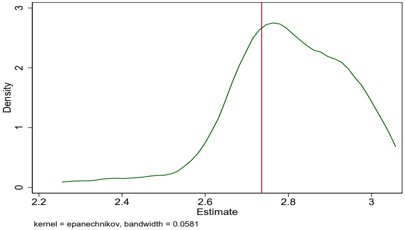
(a) γ_I^E



(b) κ_I^E

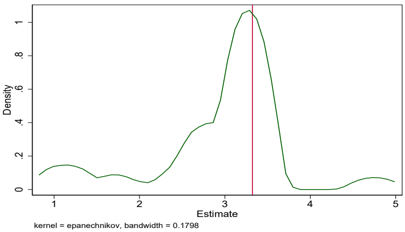


(c) φ_I^E

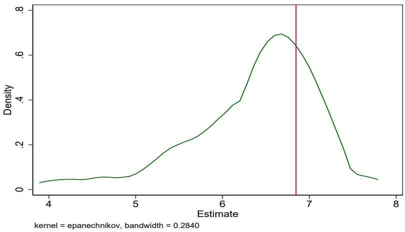


Robustness to Alt. Draws - Static Complementarities.

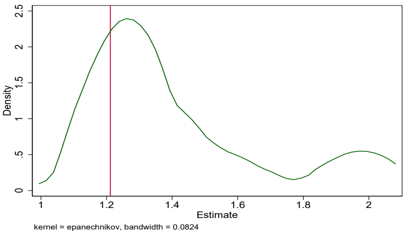
(a) γ_a^E



(b) κ_a^E

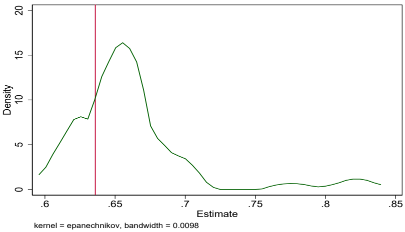


(c) φ_a^E

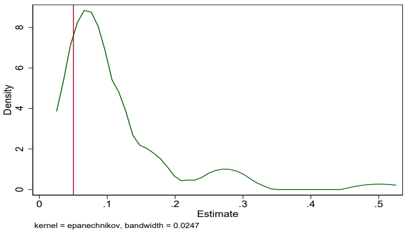


Robustness to Alt. Simulation Draws - Variance Param.

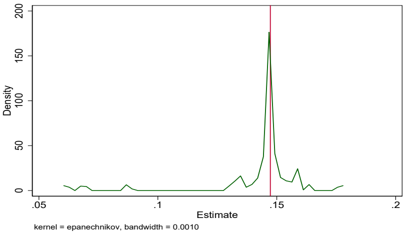
(a) γ_g^N



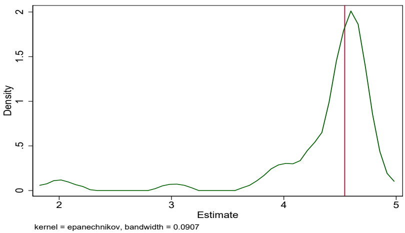
(b) κ_g^N



(c) γ_l^N

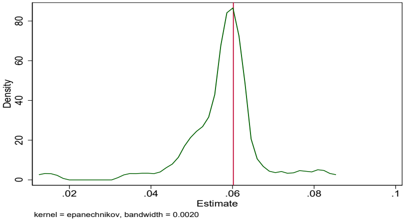


(d) κ_l^N

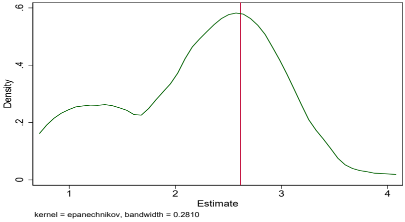


Robustness to Alt. Simulation Draws - Variance Param.

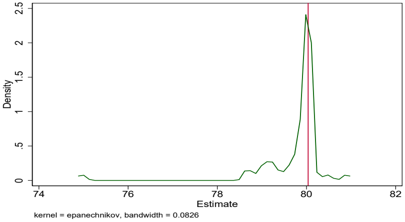
(a) γ_a^N



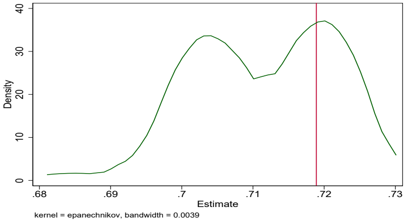
(b) κ_a^N



(c) σ_ν



(d) p



Robustness to Alt. Simulation Draws - Compare Estimates

Parameters	Baseline Estimates	Alternative Estimates	Parameters	Baseline Estimates	Alternative Estimates
γ_0^F	62.92	63.53	κ_l^E	5.40	5.53
γ_g^F	13.11	17.68	γ_a^E	3.32	3.29
γ_l^F	4.14	2.79	φ_a^E	1.21	1.26
γ_a^F	29.28	28.99	κ_a^E	6.85	6.68
γ_0^S	114.76	115.09	γ_g^N	0.64	0.66
γ_g^S	19.95	19.88	κ_g^N	0.05	0.10
γ_l^S	0.23	0.26	γ_l^N	0.15	0.15
γ_a^S	21.83	21.07	κ_l^N	4.54	4.60
γ_g^E	9.83	10.79	γ_a^N	0.06	0.06
φ_g^E	1.96	1.98	κ_a^N	2.61	2.57
κ_g^E	6.02	6.03	σ_ν	80.04	79.98
γ_l^E	0.98	1.06	p	0.72	0.72
φ_l^E	2.74	2.76			

Note: For each parameter, the number in the "Alternative Estimates" column is the mode of the corresponding nonparametric distribution of the estimates obtained when reestimating our model using 50 alternative sets of 5 simulation draws of χ_i^s.

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EXTRA SLIDES:

XIII. PERFORMANCE OF ALGORITHM

Performance of Algorithm at Estimated Parameters

- The number of optimal export decisions y_{ijt} we must compute is

$$\text{num. firms} \times \text{num. countries} \times \text{num. periods} \times \text{num. simulations} =$$
$$4,709 \times 74 \times 13 \times 5 = 22,650,290$$

- Algorithm's performance when parameters are set to our baseline estimates:

	Percentage of Firms Solved	Percentage of Choices Solved	Time (in seconds)
Step 1	78.51%	99.72%	131
Step 2	82.74%	99.75%	163
Step 3	95.80%	99.89%	741

- Times at PU's Della cluster using 44 processors of 20 GB of memory each.

Performance of Algorithm at Estimated Parameters

- Large percentage of choices solved in Step 1 may be due to there being many firm-market-years with $\check{y}_{ijt} = 0$ regardless of what i does in other markets.
- Share of firm-market-years for which our algorithm determines that $\check{y}_{ijt} = 1$ solved at each intermediate step of the algorithm:

	Percentage of Choices With $\check{y}_{ijt} = 1$ Solved
Step 1	96.23%
Step 2	96.23%
Step 3	100%

- $\Rightarrow$ a large share of firm-market-years with $\check{y}_{ijt} = 1$ are also solved in Step 1.

Performance of Algorithm at Estimated Parameters

- The destinations with more unsolved values of $\{\check{y}_{ijt}\}_{ijt}$ are the following:

	Share of Unsolved Choices	
	Step 1	Step 3
Mexico	3.23%	6.81%
Belgium	5.77%	6.61%
Netherlands	5.79%	5.97%
Germany	3.98%	5.53%
Sweden	2.61%	4.85%
France	2.44%	4.60%
⋮		
Saint Vincent and the Grenadines	6.38%	1.44%
Saint Lucia	5.79%	1.57%
Jordan	5.15%	1.22%
Israel	5.28%	0.83%
Grenada	4.51%	1.22%

Performance of Algorithm at Alternative Parameter Values

- Performance when each parameter is 20% larger than our baseline estimate.

Parameter	Percentage of Firms Solved	Time (in seconds)	Parameter	Percentage of Firms Solved	Time (in seconds)
γ_0^F	97.18%	606	κ_l^E	96.03%	703
γ_g^F	97.25%	479	γ_a^E	91.28%	1256
γ_l^F	95.89%	710	φ_a^E	94.70%	935
γ_a^F	96.21%	628	κ_a^E	96.35%	647
γ_0^S	96.77%	582	γ_g^N	95.67%	795
γ_g^S	96.59%	569	κ_g^N	95.86%	742
γ_l^S	95.80%	719	γ_l^N	95.67%	687
γ_a^S	95.96%	692	κ_l^N	95.83%	689
γ_g^E	93.27%	1119	γ_a^N	95.77%	702
φ_g^E	93.59%	1070	κ_a^N	95.81%	686
κ_g^E	97.33%	479	σ_ν	93.88%	841
γ_l^E	95.52%	790	p	82.29%	2841
φ_l^E	95.65%	749			

Note: *Percentage of Firms Solved* and *Time* measured after Step 3 of the algorithm has concluded.

Performance of Algorithm at Alternative Parameter Values

- Performance when each parameter is 20% smaller than our baseline estimate.

Parameter	Percentage of Firms Solved	Time (in seconds)	Parameter	Percentage of Firms Solved	Time (in seconds)
γ_0^F	93.12%	1038	κ_l^E	95.46%	796
γ_g^F	92.40%	1198	γ_a^E	96.98%	504
γ_l^F	95.67%	749	φ_a^E	96.31%	590
γ_a^F	95.29%	798	κ_a^E	94.79%	856
γ_0^S	94.41%	889	γ_g^N	95.83%	695
γ_g^S	94.45%	939	κ_g^N	95.64%	708
γ_l^S	95.79%	724	γ_l^N	95.81%	680
γ_a^S	95.67%	771	κ_l^N	95.73%	701
γ_g^E	97.06%	524	γ_a^N	95.81%	692
φ_g^E	96.96%	534	κ_a^N	95.83%	691
κ_g^E	84.40%	1594	σ_ν	96.81%	592
γ_l^E	96.10%	675	p	98.93%	250
φ_l^E	95.99%	704			

Note: *Percentage of Firms Solved* and *Time* measured after Step 3 of the algorithm has concluded.

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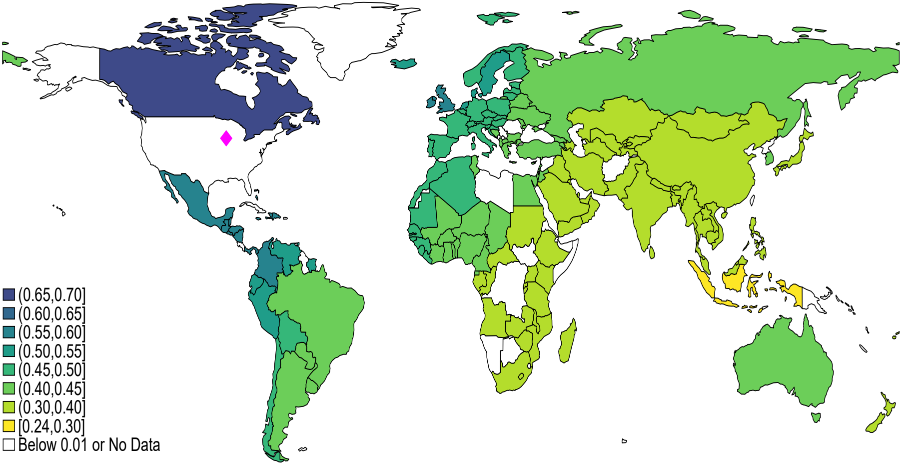
EXTRA SLIDES:

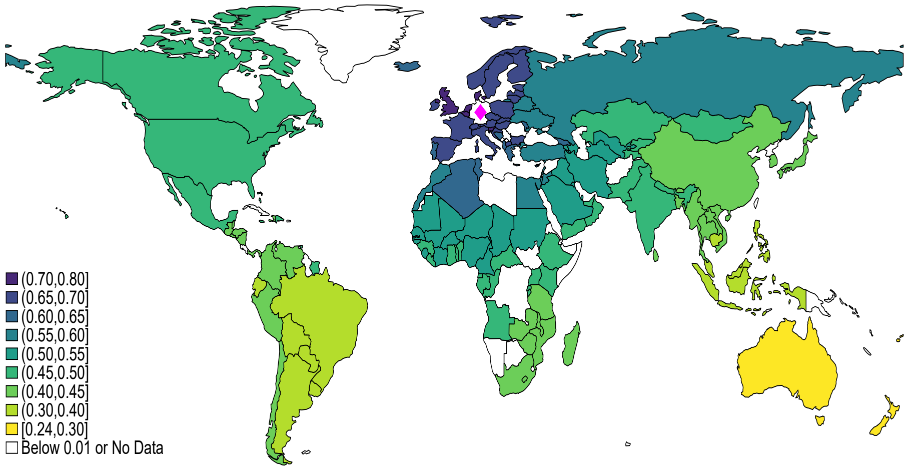
XVI. ADDITIONAL RESULTS ON STRUCTURAL ESTIMATES

- CORRELATION COEFFICIENTS -

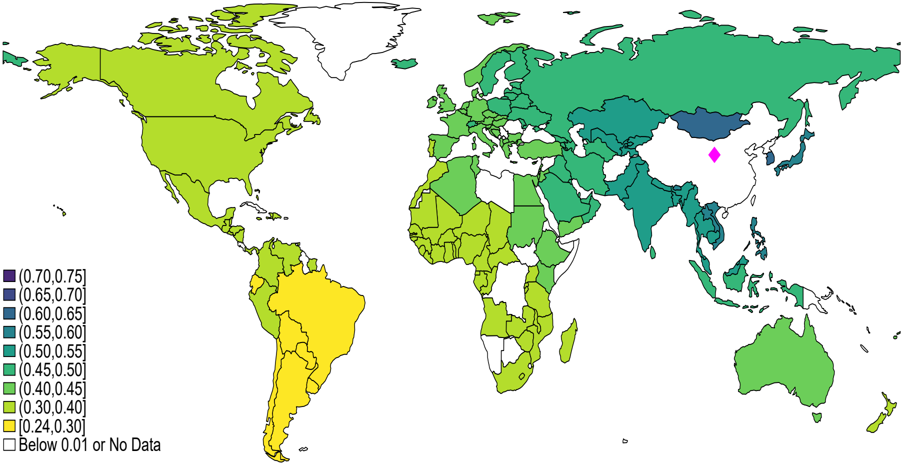
Correlation in Fixed Costs Unobs. Term: United States



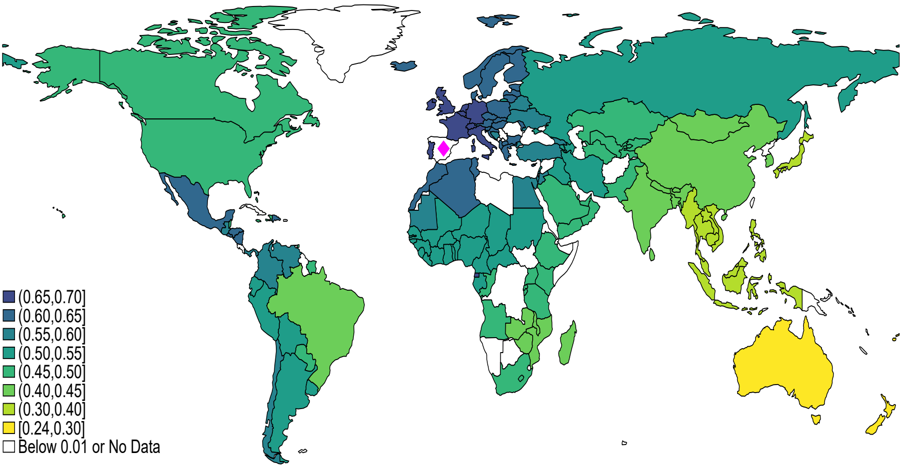
Correlation in Fixed Costs Unobs. Term: Germany



Correlation in Fixed Costs Unobs. Term: China



Correlation in Fixed Costs Unobs. Term: Spain



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