The Margins of Global Sourcing: Theory and Evidence from U.S. Firms

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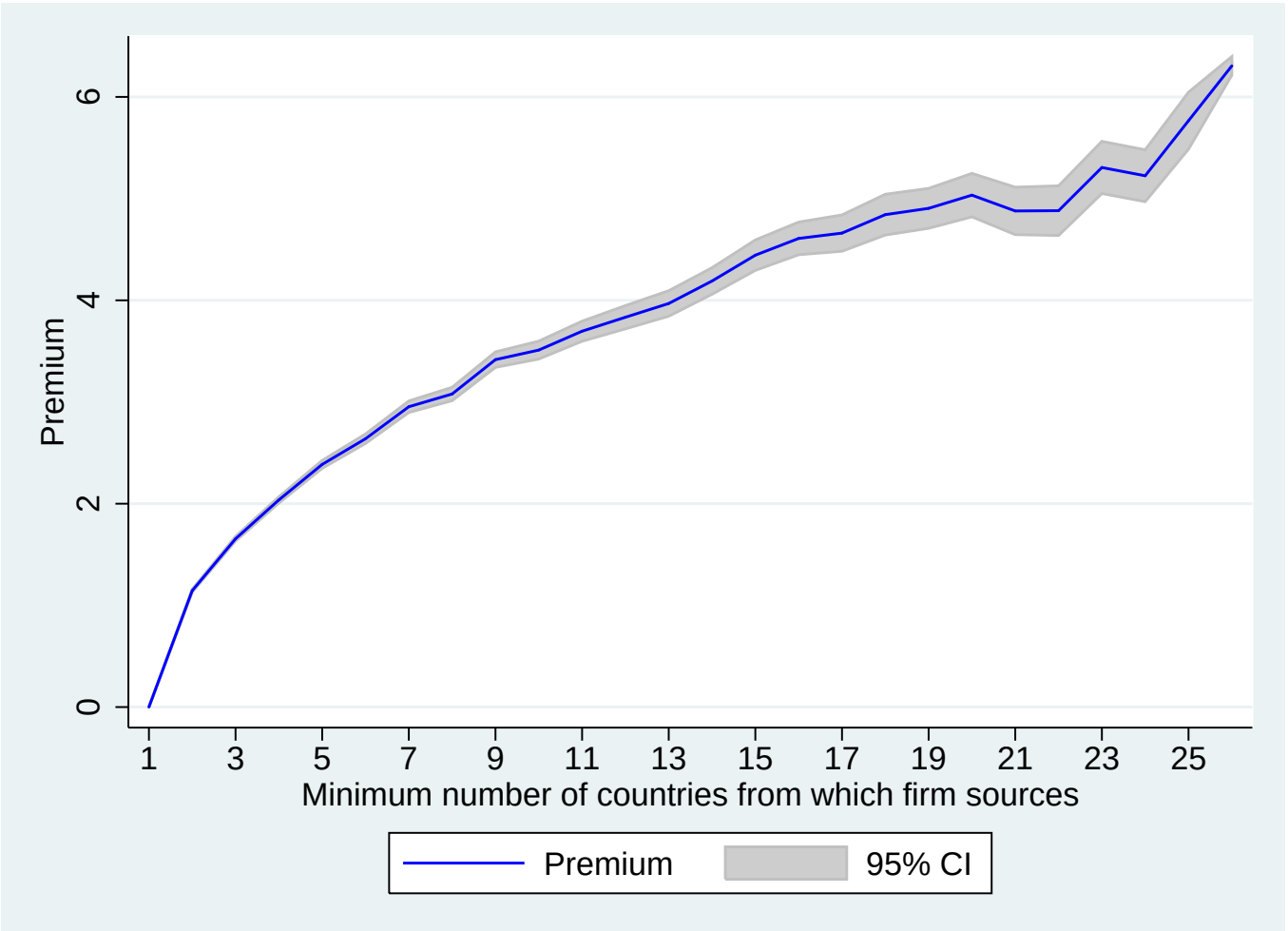
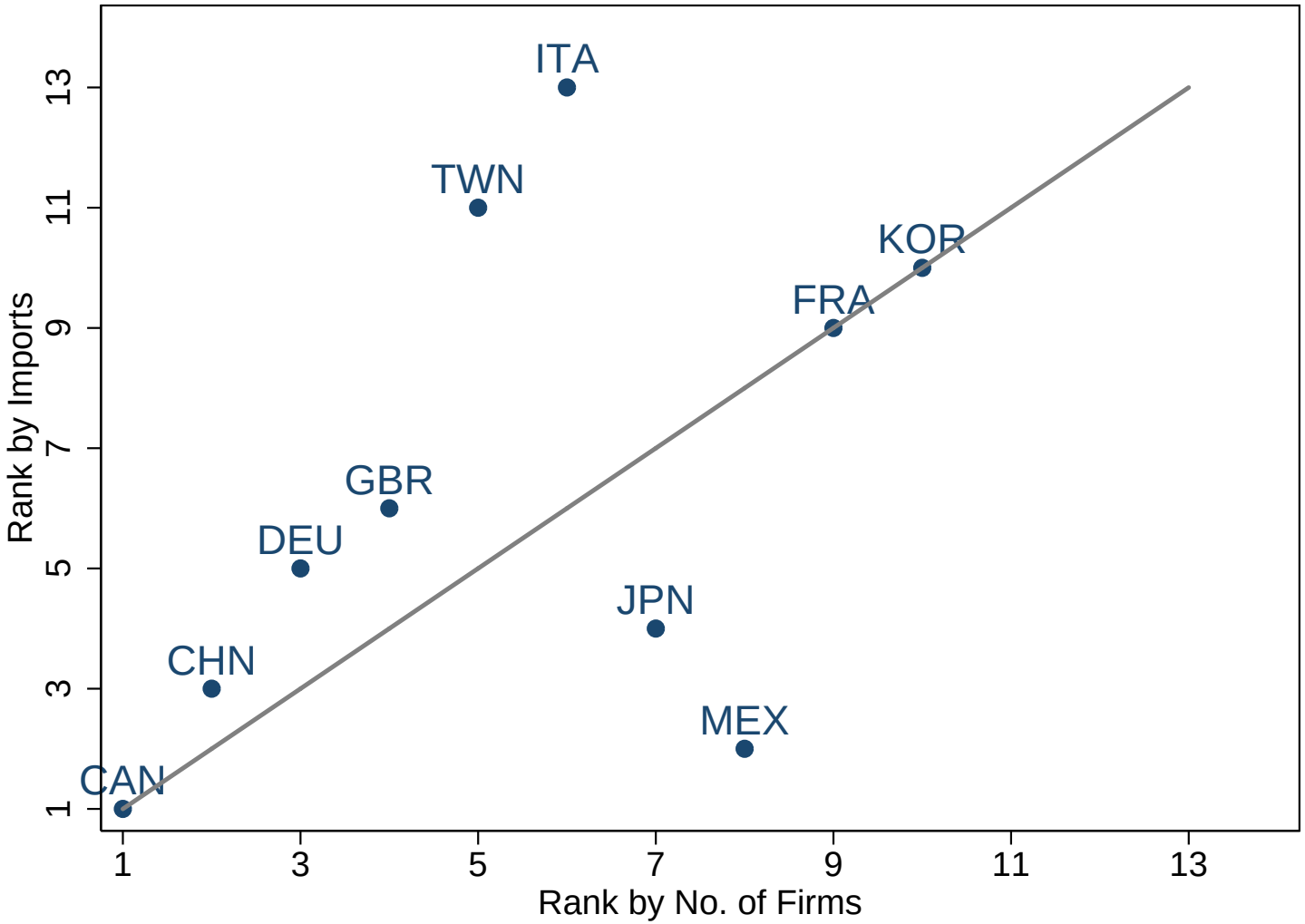
- Extensive margins (firms, products) account for most of the cross-country variation in U.S. imports and exports
- Extensive margins of exporting are much better understood than extensive margins of importing
- Yet two-thirds of world trade is intermediate inputs
  - Potential for importers' decisions to be key determinant of trade

2007 Importer Sales Premia by Number of Source Countries



▸ Premia2002 ▸ Premia with product controls

Country Rank by Importers vs. Total Imports



▸ Table

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- Import entry decisions are thus interdependent across markets
- Interdependencies across markets complicate the firm's decision
  - Which countries should a firm invest in importing from?
  - From which particular country should each input be bought?
  - How much of each input should be purchased?

Main Contributions

- Develop a quantifiable multi-country sourcing model
  - Closed-form solution for intensive margin of sourcing
  - Characterization of firms' extensive margin sourcing decisions
  - Countries differ along two dimensions
  - Eaton and Kortum (2002) and Chaney (2008) are special cases

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- New methodology to solve firm's problem with interdependencies
  - Apply theoretical insights and IO algorithm to estimate model
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- Study effects of shocks to global sourcing
  - Heterogeneous impact across firm size distribution
  - Distinguish net vs. gross changes in sourcing / employment
  - Reduced form evidence consistent with these predictions

Related literature

- Empirical evidence on firm sourcing

  Bernard, Jensen, Redding, and Schott (2007, 2009); Bernard, Blanchard, Van Beveren, Vandebussche (2012); Fort (2014)

- Importing, firm efficiency, and markups

  Amiti and Konings (2007), Halpern, Koren, and Szeidl (2011), De Loecker, Goldberg, Khandelwal, and Pavcnik (2012), Gopinath and Neiman (2013), Amiti, Itskhoki, and Konings (2013), Garetto (2013)

- Multi-country sourcing

  Head, Ries, Jing (2010); Blaum, Lelarge, and Peters (2013, 2014); Bernard, Moxnes, Ulltveit-Moe (2014)

- Firm-level interdependencies in MP and/or exporting

  Tintelnot (2016), Morales, Sheu, and Zahler (2014), Yeaple (2003)

Model

Environment

- J countries
- Measure of L_j consumers / workers
- Dixit-Stiglitz preferences over manufacturing varieties, elasticity of substitution $\sigma > 1$ (later introduce non-manufacturing sector)

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  - Non-tradable final output
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- Final good sector producing these varieties:
  - Measure N_j of heterogeneous firms (pinned down by free entry)
  - Non-tradable final output
  - Monopolistic competition
- Intermediate good sector
  - Each firm uses a unit measure of (firm-specific) intermediate inputs
  - Trade cost τ_{ij} to import from country j by country i
  - Perfect competition $\Longrightarrow$ Marginal-cost pricing of inputs

Production Technology

- Final good requires assembly of a bundle of intermediates
- Marginal cost of final good producer, φ:

$$c_i\left(\{j(v)\}_{v=0}^{1}, \varphi\right) = \frac{1}{\varphi}\left(\int_0^1 \left(p_i\left(v, j(v), \varphi\right)\right)^{1-\rho} dv\right)^{1/(1-\rho)}$$

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- Productivity $1/a_j\left(v,\varphi\right)$ for a given location j drawn from Fréchet distribution:

$$\Pr(a_j\left(v,\varphi\right)\geq a)=e^{-T_j a^{\theta}},\quad \text{with } T_j>0.$$

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- Country-specific fixed cost of offshoring $w_i f_{ij}$

Firm's problem

- Firm chooses:
  - Sourcing strategy $\mathcal{J}_i(\varphi) \subseteq \{1, ..., J\}$
  - Source country $j(v) \in \mathcal{J}_i(\varphi)$ for each intermediate v
  - Price of final good
- Sourcing strategy thus determines set of countries from which firm can buy inputs
- For all other countries $j \notin \mathcal{J}_i(\varphi)$, it is as if $a_j(v, \varphi) = +\infty$

Firm behavior conditional on sourcing strategy

- Share of intermediate input purchases sourced from any country j:

$$\chi_{ij}(\varphi) = \frac{T_j (\tau_{ij} w_j)^{-\theta}}{\Theta_i(\varphi)} \quad \text{if } j \in \mathcal{J}_i(\varphi)$$

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- Sourcing capability:

$$\Theta_i(\varphi) \equiv \sum_{k \in \mathcal{J}_i(\varphi)} T_k (\tau_{ik} w_k)^{-\theta}$$

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- Marginal cost:

$$c_i(\varphi) = \frac{1}{\varphi} (\gamma \Theta_i(\varphi))^{-1/\theta}$$

Optimal Sourcing Strategy

- General profit function:

$$\max_{I_{ij} \in \{0,1\}_{j=1}^{J}} c_i(\varphi, \{I_{ij} \in \{0,1\}_{j=1}^{J}\})^{1-\sigma} B_i - w_i \sum_{j=1}^{J} I_{ij} f_{ij}$$

Optimal Sourcing Strategy

- With cost function plugged in:

$$\max_{I_{ij}\in\{0,1\}_{j=1}^{J}} \varphi^{\sigma-1}\left(\gamma\sum_{j=1}^{J} I_{ij}T_j\left(\tau_{ij}w_j\right)^{-\theta}\right)^{(\sigma-1)/\theta} B_i - w_i\sum_{j=1}^{J} I_{ij}f_{ij}$$

Optimal Sourcing Strategy

$$\max_{I_{ij}\in\{0,1\}_{j=1}^{J}} \varphi^{\sigma-1}\left(\gamma\sum_{j=1}^{J} I_{ij}T_j\left(\tau_{ij}w_j\right)^{-\theta}\right)^{(\sigma-1)/\theta} B_i - w_i\sum_{j=1}^{J} I_{ij}f_{ij}$$

- Profits are supermodular in φ and $\sum_{j=1}^{J} I_{ij}T_j\left(\tau_{ij}w_j\right)^{-\theta}$
- Proposition: The solution $I_{ij}\left(\varphi\right)\in\{0,1\}_{j=1}^{J}$ to the optimal sourcing problem is such that a firm's sourcing capability $\Theta_i\left(\varphi\right)\equiv\sum_{j=1}^{J} I_{ij}\left(\varphi\right)T_j\left(\tau_{ij}w_j\right)^{-\theta}$ is nondecreasing in φ
- Implications for size distribution of firms

Optimal Sourcing Strategy

$$\max_{I_{ij}\in\{0,1\}_{j=1}^{J}} \varphi^{\sigma-1}\left(\gamma\sum_{j=1}^{J} I_{ij}T_j\left(\tau_{ij}w_j\right)^{-\theta}\right)^{(\sigma-1)/\theta} B_i - w_i\sum_{j=1}^{J} I_{ij}f_{ij}$$

- Complements case: $\frac{\sigma-1}{\theta} > 1$
- Substitutes case: $\frac{\sigma-1}{\theta} < 1$

Optimal Sourcing Strategy

$$\max_{I_{ij}\in\{0,1\}_{j=1}^{J}} \varphi^{\sigma-1}\left(\gamma\sum_{j=1}^{J} I_{ij}T_j\left(\tau_{ij}w_j\right)^{-\theta}\right)^{(\sigma-1)/\theta} B_i - w_i\sum_{j=1}^{J} I_{ij}f_{ij}$$

- Complements case: $\frac{\sigma-1}{\theta} > 1$

- Proposition: Whenever $(\sigma-1)/\theta > 1$, the solution $I_{ij}(\varphi) \in \{0,1\}_{j=1}^{J}$ to the optimal sourcing problem satisfies $\mathcal{J}_i(\varphi_L) \subseteq \mathcal{J}_i(\varphi_H)$ for $\varphi_H \geq \varphi_L$, where $\mathcal{J}_i(\varphi) = \{j : I_{ij}(\varphi) = 1\}$.

- Hierarchies in extensive margin decisions
- Increasing differences in the profit function

Firm sourcing from country j holding B_i fixed

- Firm sourcing from country j

$$M_{ij}(\varphi) = (\sigma - 1) B_i \varphi^{\sigma-1} \left(\gamma \Theta_i(\varphi)\right)^{\left(\frac{\sigma-1}{\theta}\right)} \frac{T_j \left(\tau_{ij} w_j\right)^{-\theta}}{\Theta_i(\varphi)}$$

Firm sourcing from country j holding B_i fixed

- Firm sourcing from country j

$$M_{ij}(\varphi) = C\varphi^{\sigma-1}\left(\Theta_i(\varphi)\right)^{\left(\frac{\sigma-1}{\theta}\right)}\frac{T_j\left(\tau_{ij}w_j\right)^{-\theta}}{\Theta_i(\varphi)}$$

Firm sourcing from country j holding B_i fixed

- Firm sourcing from country j and a shock to country k

$$M_{ij}(\varphi) = C\varphi^{\sigma-1} T_j (\tau_{ij} w_j)^{-\theta} \underbrace{(\Theta_i(\varphi))^{\left(\frac{\sigma-1}{\theta}\right)}}_{\text{Scale effect}} \underbrace{\frac{1}{\Theta_i(\varphi)}}_{\text{Substitution effect}}$$

Firm sourcing from country j holding B_i fixed

- Firm sourcing from country j and a shock to country k

$$M_{ij}(\varphi) = \tilde{C}_j \varphi^{\sigma-1} \left(\Theta_i(\varphi)\right)^{\left(\frac{\sigma-1}{\theta}-1\right)}$$

Firm sourcing from country j holding B_i fixed

- Firm sourcing from country j and a shock to country k

$$M_{ij}(\varphi) = \tilde{C}_j \varphi^{\sigma-1} \left(\Theta_i(\varphi)\right)^{\left(\frac{\sigma-1}{\theta}-1\right)}$$

- Complements case: $\frac{\sigma-1}{\theta} > 1$

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- Complements case: $\frac{\sigma-1}{\theta} > 1$
- Holding B_i constant, increase in sourcing capability (Θ_i) weakly increases:
  - foreign sourcing
  - domestic sourcing

Industry and General Equilibrium

- Consumers spend constant share η on manufacturing sector.
- Workers are perfectly mobile across sectors (other sector pins down wage level)
- Industry Equilibrium is characterized by:
  - Fixed point for the market potential, B_i
  - Free entry condition

- Proposition: Given a positive wage vector, solution for B_i and N_i is unique

Gravity

- Special case 1: Universal importing
  - Aggregate trade flows as in Eaton and Kortum (2002)
  - Extensive margin effect at the product level
- Special case 2: Independent entry decisions ($(\sigma - 1)/\theta = 1$ and core efficiency Pareto)
  - Aggregate trade flows as in Chaney (2008)
  - Extensive margin effect at product and firm level
- General case
  - Extensive margin effect at product and firm level
  - Third market effects

▸ Universal Importing ▸ General Case ▸ Independent Entry Decisions

Estimation

Data

- 1997 and 2007 firm sourcing from U.S. Census Bureau
  - Economic Censuses
  - Import transactions data
  - All firms with positive manufacturing activity

- Structural Estimation
  - Limit analysis to countries with 200+ U.S. importers
  - 66 countries and the U.S.
  - Country data from World Bank, CEPII, and Penn World Tables

- Counterfactual comparisons to actual data
  - Panel of manufacturing firms in 1997 and 2007
  - UN Comtrade data
  - 1997 BEA Input-Output tables

▸ Import stats ▸ Firm-product stats

Road Map for Estimation

- Step 1: Back out sourcing potential from firm-level input shares
  - Recovered from country fixed effects in normalized share regressions
- Step 2: Estimate demand elasticity and productivity dispersion
  - Project fixed effect on human-capital adjusted labor cost
- Step 3: Estimate fixed costs of sourcing and residual demand
  - Simulated method of moments + Jia's (2008) algorithm

$$\Pi(\mathcal{J},\varphi,f_{ij}^n) = \varphi^{\sigma-1}\left(\sum_{j=1}^{j\in\mathcal{J}} T_j(\tau_{ij}w_j)^{-\theta}\right)^{(\sigma-1)/\theta} \widetilde{B} - \sum_{j\in\mathcal{J}} f_{ij}^n$$

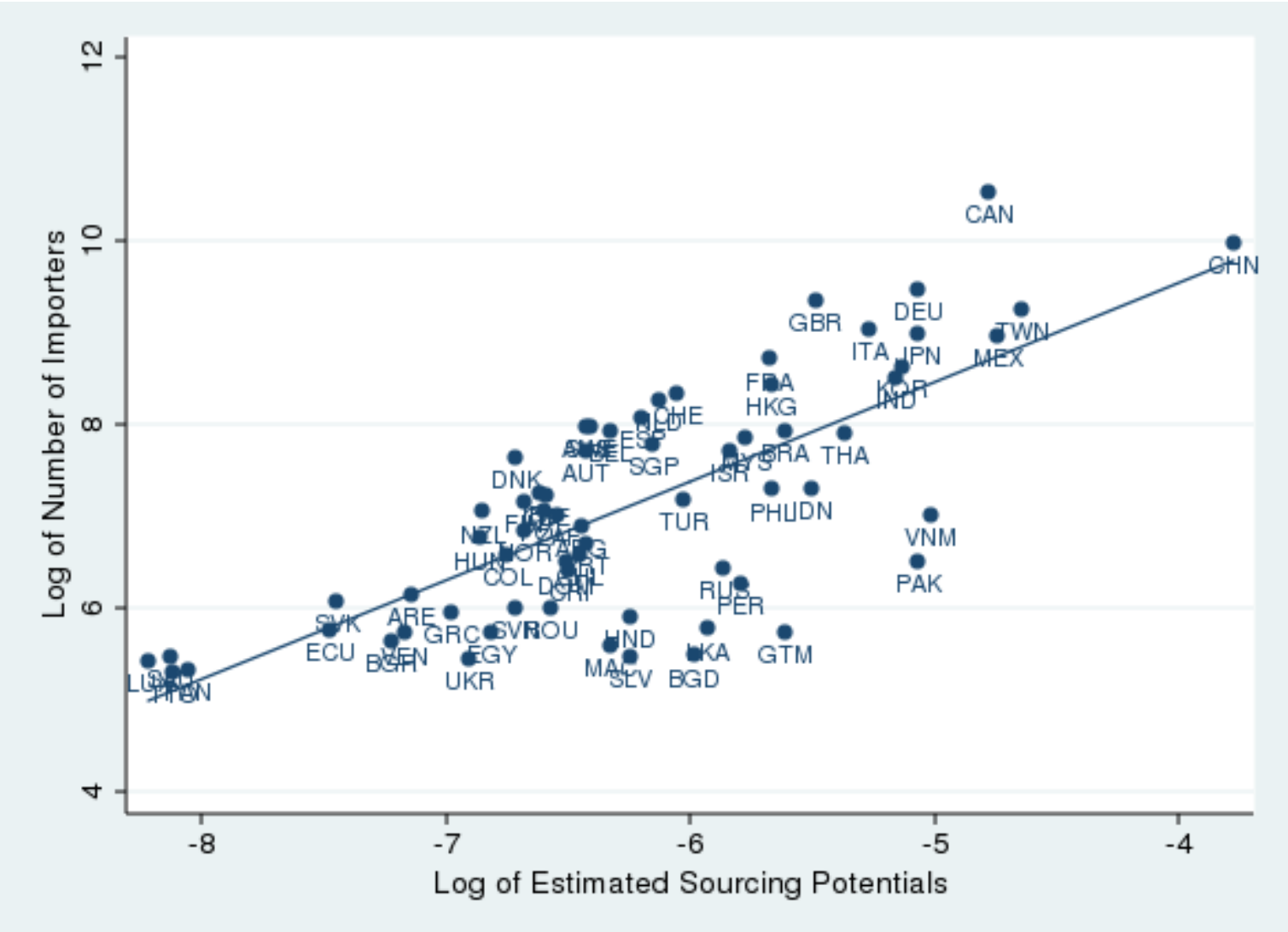
Step 1 Step 2 Step 3

Step 1: Estimate country sourcing potential

- Define country potential $\xi_j = T_j \left(\tau_{ij} w_j\right)^{-\theta}$
- Normalize firm share from j: $\chi^n_{ij} / \chi^n_{ii} = \frac{T_j (\tau_{ij} w_j)^{-\theta}}{\Theta^n_i} / \frac{T_i (\tau_{ii} w_i)^{-\theta}}{\Theta^n_i}$
- Log-Linearize: $\log \chi^n_{ij} - \log \chi^n_{ii} = \log \xi_j + \epsilon^n_j$
- Estimate via OLS

▸ Measuring input shares

Sourcing potential versus number of firms



▸ Aggregate Imports

Step 2: Estimate elasticity of demand and dispersion of productivities

- Estimate elasticity of demand using model's predicted mark-up
  - Median manufacturing firm's mark-up is 1.35
  - Implies $\sigma = 3.85$

- Project $\hat{\xi}_j = T_j \widehat{(\tau_{ij} w_j)^{-\theta}}$ on country variables
  - Wages (human capital adjusted)
  - Country controls for technology and bilateral trade frictions
  - Instrument using population

$$\begin{aligned}\log \hat{\xi}_j =& \beta_r \log \text{R\&D}_j + \beta_k \log \text{capital}_j + \beta_C \text{control corruption}_j \\ &+ \beta_n \log \text{no of firms} - \theta \log w_j \\ &- \theta \left(\log \beta_c + \beta_d \log \text{distance}_{ij} + \text{language}_{ij} \log \beta_l \right) + \iota_j\end{aligned}$$

Step 2b: Estimate dispersion of productivities

	$\log \xi$		log aggregate imports	
	OLS	IV	OLS	IV
log HC adjusted wage	-0.537***	-1.789**	-0.643	-4.544**
	(0.184)	(0.696)	(0.390)	(1.844)
log distance	-0.341*	-0.621**	-0.859**	-1.733**
	(0.197)	(0.294)	(0.418)	(0.779)
log R&D	0.352***	0.524***	0.763***	1.298***
	(0.068)	(0.125)	(0.144)	(0.332)
log capital/worker	-0.184	0.425	-0.264	1.633
	(0.175)	(0.390)	(0.370)	(1.033)
common language	0.105	0.146	0.354	0.479
	(0.223)	(0.289)	(0.471)	(0.764)
control corrupt	0.156	0.621**	0.365	1.816**
	(0.151)	(0.312)	(0.319)	(0.826)
log no. of firms	0.108	-0.020	0.031	-0.369
	(0.086)	(0.130)	(0.183)	(0.345)
Constant	-7.250***	-11.068***	14.499***	2.600
	(0.922)	(2.323)	(1.952)	(6.156)
Observations	57	57	57	57

Implications of first two steps

- Sourcing from all countries, relative to only domestic sourcing
  - 9 percent lower input costs
  - 33 percent larger sales

- Robust result: $\frac{\sigma-1}{\theta} > 1$
  - Complements case from model
  - Increasing differences of the profit function in the sourcing set

Step 3: Estimate fixed costs and residual demand

- Fix the shape parameter of Pareto distribution $\kappa = 4.5$
- Estimate 6 parameters via Simulated Method of Moments
  - Firm-country-specific fixed costs (cons, distance, lang, corrupt, disp)
  - Residual demand

- Use 68 moments
  - Share of importing firms
  - Share of firms that sources from each foreign country
  - Share of firms sourcing less than 50^{th} percentile from the U.S.

- Solve firm's problem
  - 2^{67} or about 10^{20} possible choices
  - Exploit complementarities in profit function
  - Build on algorithm in Jia (2008)

▸ Parameters ▸ Hierarchies

Solve firm's problem using Jia (2008) algorithm

- Define mapping $V : \{0,1\}^N \to \{0,1\}^N$
  - $V_j(\mathcal{J}) = 1$ if marginal benefit of j given $\mathcal{J}$ is positive
- Increasing differences in profit function imply $V()$ is an increasing function
- Start from set $\mathcal{J}^0$ and use iterative application of V-operator to obtain lower bound for sourcing strategy
- Start from set $\mathcal{J}^1$ and use iterative application of V-operator to obtain upper bound for sourcing strategy
- If bounds do not overlap, evaluate all combinations between them

▸ Statistics on Performance

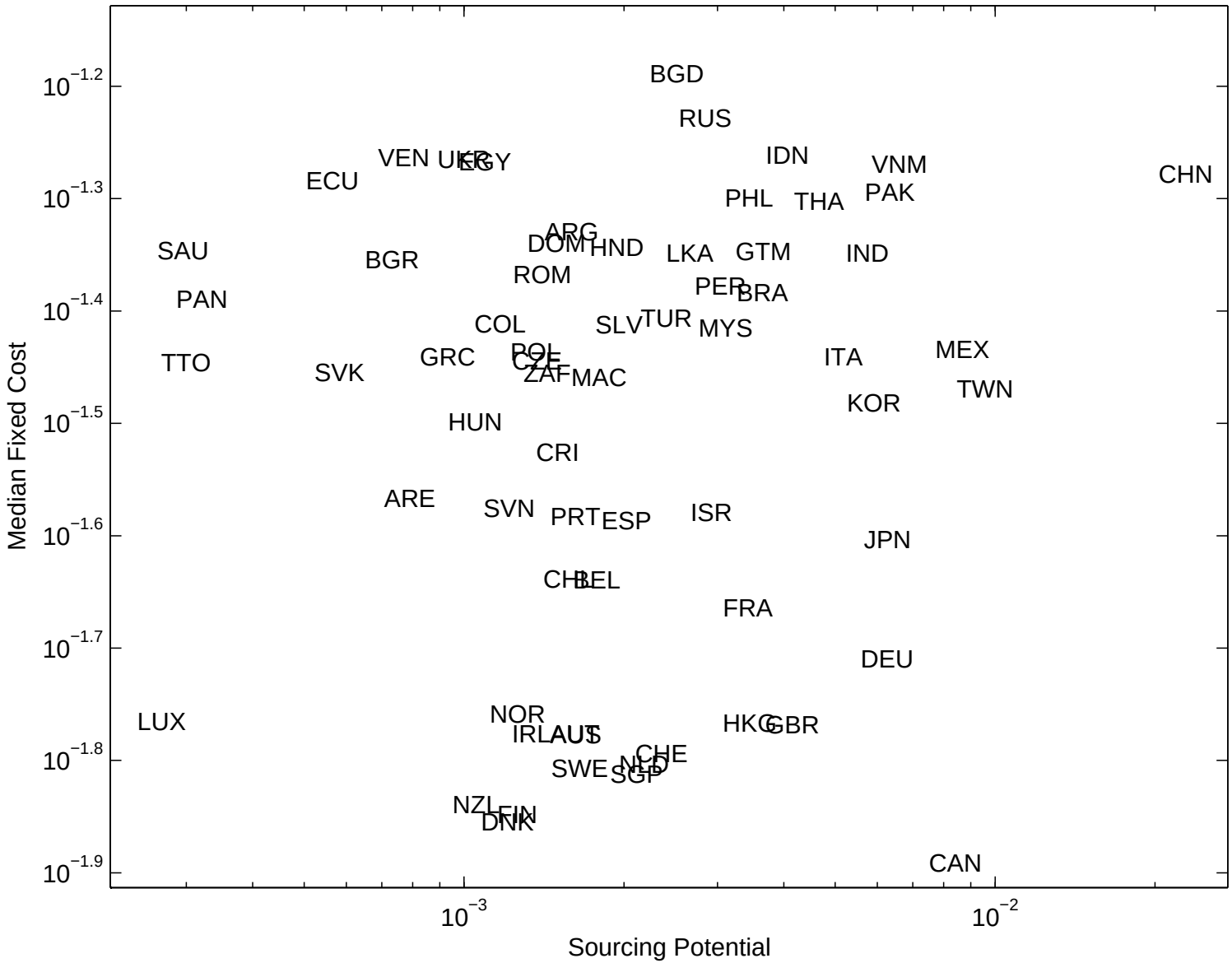
Parameter Estimates

B	0.127
β_c^f	0.021
β_d^f	0.146
β_l^f	0.893
β_C^f	-0.408
β_{disp}^f	0.829

- Fixed costs 11 percent lower if common language
- Fixed costs increase in distance with elasticity of .15
- Fixed costs decrease with control of corruption
- Median fixed cost estimates range from 9,000 to 46,000 USD

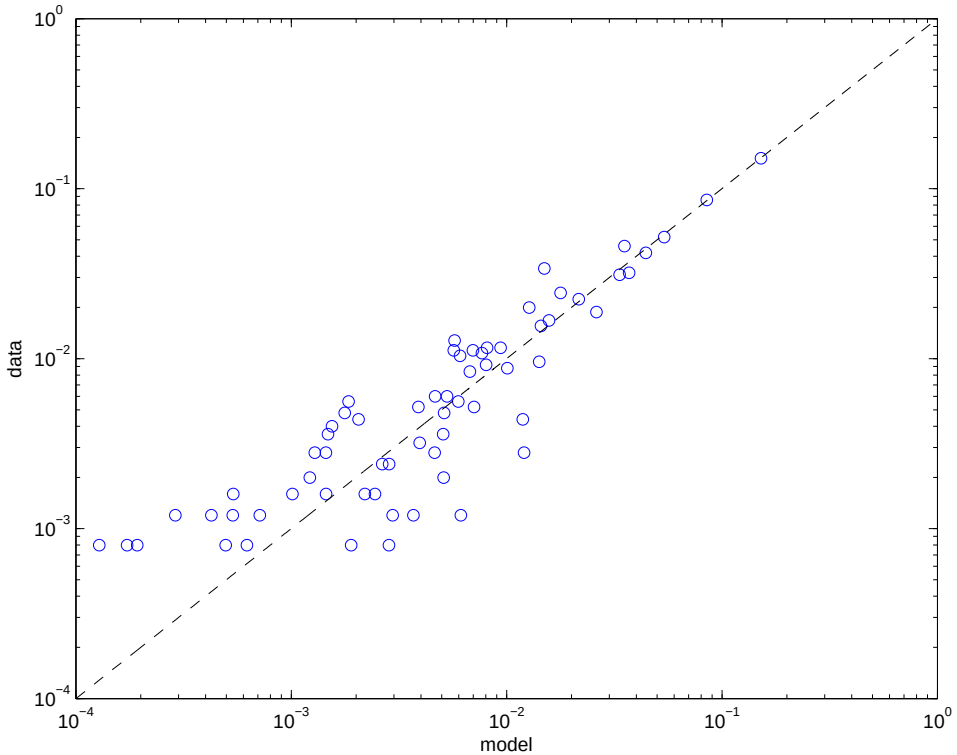
▸ Share of Importers

Sourcing potential vs. fixed cost estimates

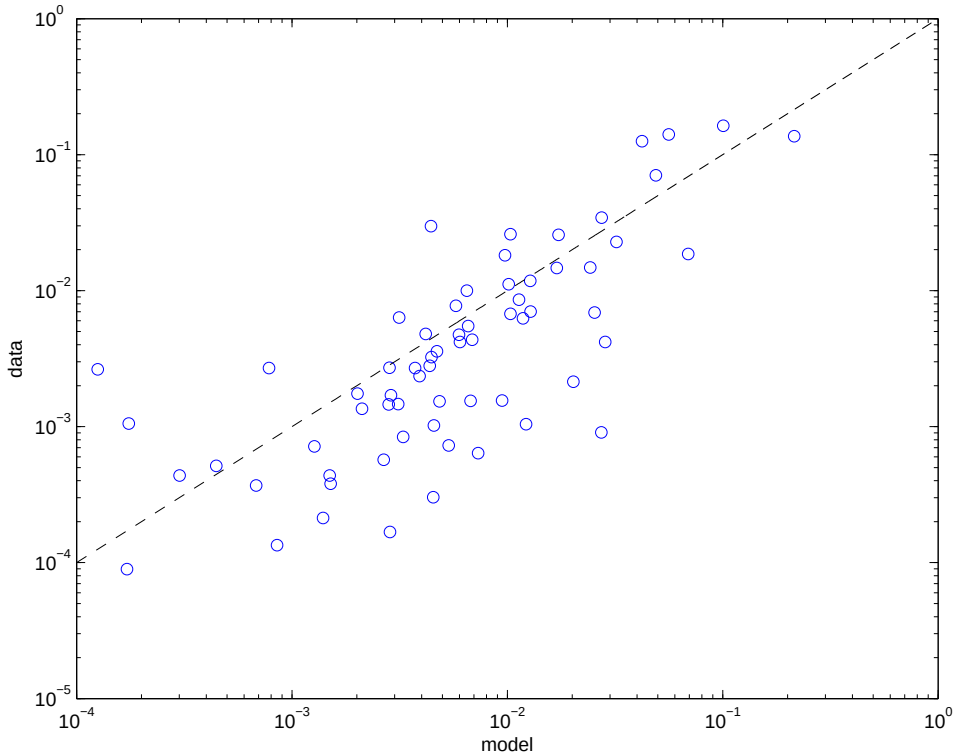


Model fit (I)

: Share of importers by country (targeted moment)



: Share of aggregate foreign sourcing by country (non-targeted moment)



Model fit (II)

String	Data	Baseline Model
CA	29.82	29.62
CA-CH	3.67	3.97
CA-CH-DE	0.56	0.74
CA-CH-DE-GB	0.25	0.17
CA-CH-DE-GB-TW	0.13	0.11
CA-CH-DE-GB-TW-IT	0.05	0.03
CA-CH-DE-GB-TW-IT-JP	0.05	0.04
CA-CH-DE-GB-TW-IT-JP-MX	0.08	0.09
CA-CH-DE-GB-TW-IT-JP-MX-FR	0.27	0.15
CA-CH-DE-GB-TW-IT-JP-MX-FR-KR	1.08	0.84

Notes: This Table depicts the percentage of importers following a particular sourcing pattern. The first row shows the percentage of firms only importing from Canada, the second row shows the percentage of firms only importing from Canada and China, and so forth (irrespective of firm sourcing outside these top 10 countries).

Counterfactual

- Negative shock to China's sourcing potential to match 1997 share of China importers (38% of its 2007 level)
- Resolve for equilibrium price index and mass of new firms
- Calculate impact from going back to 2007 sourcing potential values

- Compare baseline model predictions to models with alternative parameter values that imply:
  - Universal importing
  - Independent entry decisions
  - Common fixed costs

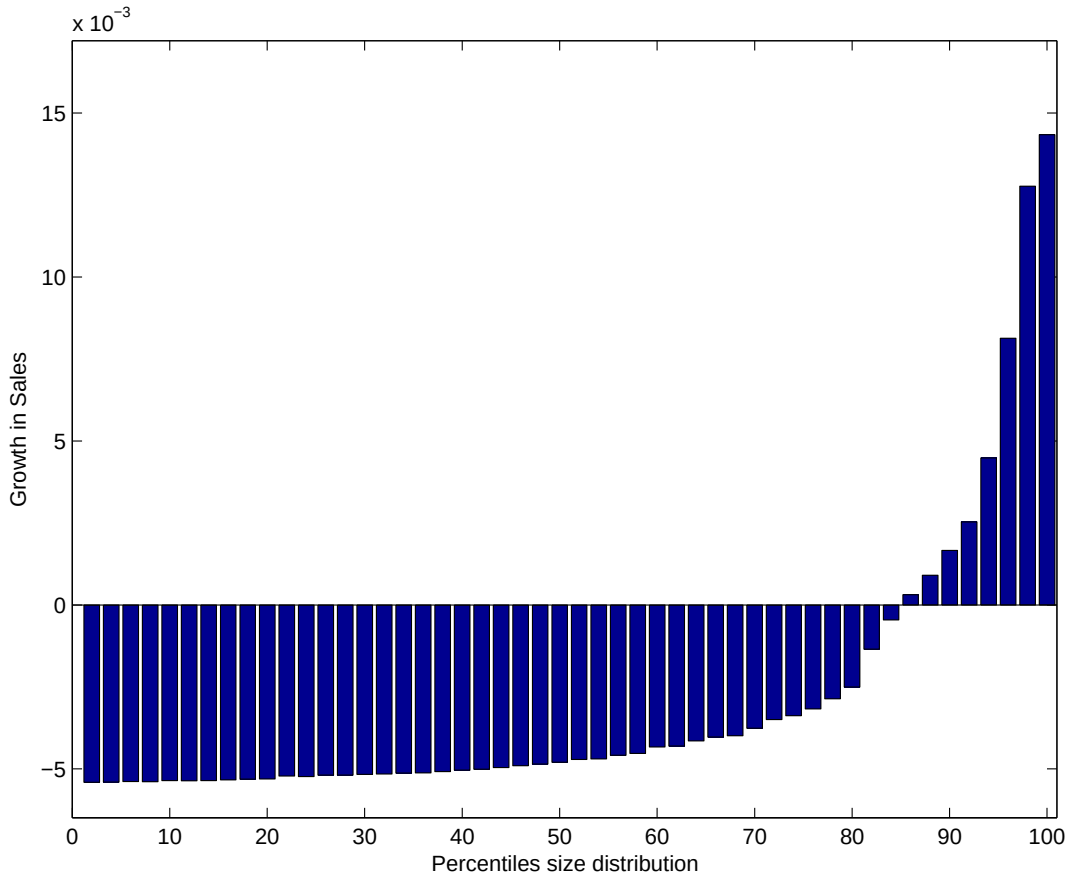
- Focus on
  - Third market effects and sourcing from the U.S.
  - Gross versus net changes in sourcing
  - Size distribution

Baseline

Chinese import status	Change sourcing from US	Change Sourcing from other countries	Share of firms
Entrants	1.008	1.015	0.066
Continuers	1.002	1.002	0.019
Others	0.994	0.986	0.915

- Aggregate sourcing from the U.S. is reduced by 0.60 percent
- For every 10 domestic manufacturing jobs destroyed, 2 new jobs are created

Baseline - Size distribution and price index



- Price index falls by .2 %.

Alternative parameters: Universal importing

- No fixed costs of foreign sourcing

Chinese import status	Change sourcing from US	Change Sourcing from other countries	Share of firms
Entrants	-	-	0.000
Continuers	0.988	0.988	1.000
Others	-	-	0.000

- All type of firms descrease sourcing from the U.S. and from third markets by the same amount

Alternative parameters: Independent entry decisions

- Set $\theta = \sigma - 1$

Chinese import status	Change sourcing from US	Change Sourcing from other countries	Share of firms
Entrants	0.997	0.993	0.067
Continuers	0.997	0.995	0.019
Others	0.997	0.991	0.914

- All firms decrease sourcing from the U.S. by the same amount
- No gross increases of sourcing

Alternative parameters: Common fixed costs

Chinese import status	Change sourcing from US	Change Sourcing from other countries	Share of firms
Entrants	1.004	1.060	0.143
Continuers	0.998	0.997	0.041
Others	0.990	-	0.817

- Perfect pecking order restricts extensive margin responses

Reduced-form comparison to the data

- Model predicts increased domestic and third market sourcing by China importers

$$\Delta y_n = \beta_0 + \beta_{Ch} \Delta China_n + \varepsilon_n$$

- $\Delta China_n = \frac{Imports^{Ch}_{n2007} - Imports^{Ch}_{n1997}}{(Imports^{Ch}_{n2007} + Imports^{Ch}_{i1997})/2}$
- Δy_n is 1997 to 2007 change in firm n's:
  - log domestic inputs
  - DHS growth rate of non-China imports
  - log number of non-China source countries

IV Estimation of China sourcing decision

- Identify changes in firm-level sourcing from China using shock to Chinese comparative advantage in inputs of industry h

$$China_{ht}^{input} = \sum_{m \in h} s_m \frac{EUimports_{mt}^{China}}{EUimports_{mt}^{World/US}}$$

  - s_m is expenditure share of inputs from industry m in industry h
- Firm-level shock based on firm's industries

$$shock_n^{input} = \Delta \sum_{h \in n} s_{nh} China_{ht}^{input}$$

  - Change from 1997 to 2007
  - s_{nh} is industry h's share of firm n's manufacturing sales in 1997

Estimates of the China shock on firm sourcing

Dependent variable is change from 1997 to 2007 in firm n:

	Domestic inputs	No. of countries	Foreign inputs	Domestic inputs	No. of countries	Foreign inputs
	OLS			IV		
China, DHS	0.084***	0.255***	0.360***	0.934***	0.553***	0.654***
	(0.012)	(0.007)	(0.013)	(0.258)	(0.080)	(0.197)
Constant	0.069***	0.144***	0.315***	-0.064	0.097***	0.269***
	(0.023)	(0.013)	(0.026)	(0.047)	(0.017)	(0.044)
Adj. R^2	0.00	0.11	0.05			
N	127,400	127,400	127,400	127,400	127,400	127,400
First Stage Statistics		Coeff (se) 2.691*** (0.504)			KP Fstat 28.51	

Notes: All variables are changes or growth rates from 1997 to 2007. Standard errors are in parentheses and clustered by 439 NAICS industries. N rounded for disclosure avoidance.

▸ Import Penetration ▸ Import Penetration IV ▸ New Importers ▸ First stage stats

Conclusion

- New framework for firm sourcing in a multi-country world
  - Interdependencies in firms' extensive margin decisions
  - Distinguish between country potential and fixed costs
- Counterfactual implications
  - Third market effects
  - Heterogeneous effects across firms
  - Gross changes versus net changes
- Framework and methodology can be applied to other problems

Back-up

Gravity - universal importing

- Special case 1: Very low fixed cost of offshoring

$$M_{ij} = \tau_{ij}^{-\theta} \frac{Ei}{\Theta_i} \frac{Q_j}{\sum_k \tau_{kj}^{-\theta} \frac{E_k}{\Theta_k}}$$

- Familiar from Eaton and Kortum (2002)
- Trade elasticity is given by θ
- Extensive margin effect at the *product-level*

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Gravity - general case

- General case

$$M_{ij} = \tau_{ij}^{-\theta} \Lambda_{ij} \frac{E_i}{P_i^{1-\sigma}/N_i} \frac{Q_j}{\sum_k \tau_{kj}^{-\theta} \Lambda_{kj} \frac{E_k}{P_j^{1-\sigma}/N_j}}$$

  where

$$\Lambda_{ij} = \int_{\tilde{\varphi}_{ij}}^{\infty} I_{ij}(\varphi) \left(\Theta_i(\varphi)\right)^{(\sigma-1-\theta)/\theta} \varphi^{\sigma-1} dG_i(\varphi),$$

- Λ_{ij} yields
  - Extensive margin effect at the *firm-level* in addition to the *product-level*
  - Third market effects

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Gravity - independent entry decisions

- Special case 2: $(\sigma - 1)/\theta = 1$ and core efficiency Pareto

$$M_{ij} = \tau_{ij}^{-\kappa} f_{ij}^{1-\kappa/(\sigma-1)} \Psi_i \frac{E_i}{P_i^{-\kappa}} \frac{Q_j}{\sum_k \tau_{kj}^{-\kappa} f_{kj}^{1-\kappa/(\sigma-1)} \Psi_k \frac{E_k}{P_k^{-\kappa}}},$$

- Trade elasticity as in Chaney (2008)
- Extensive margin effect
- No third market effects

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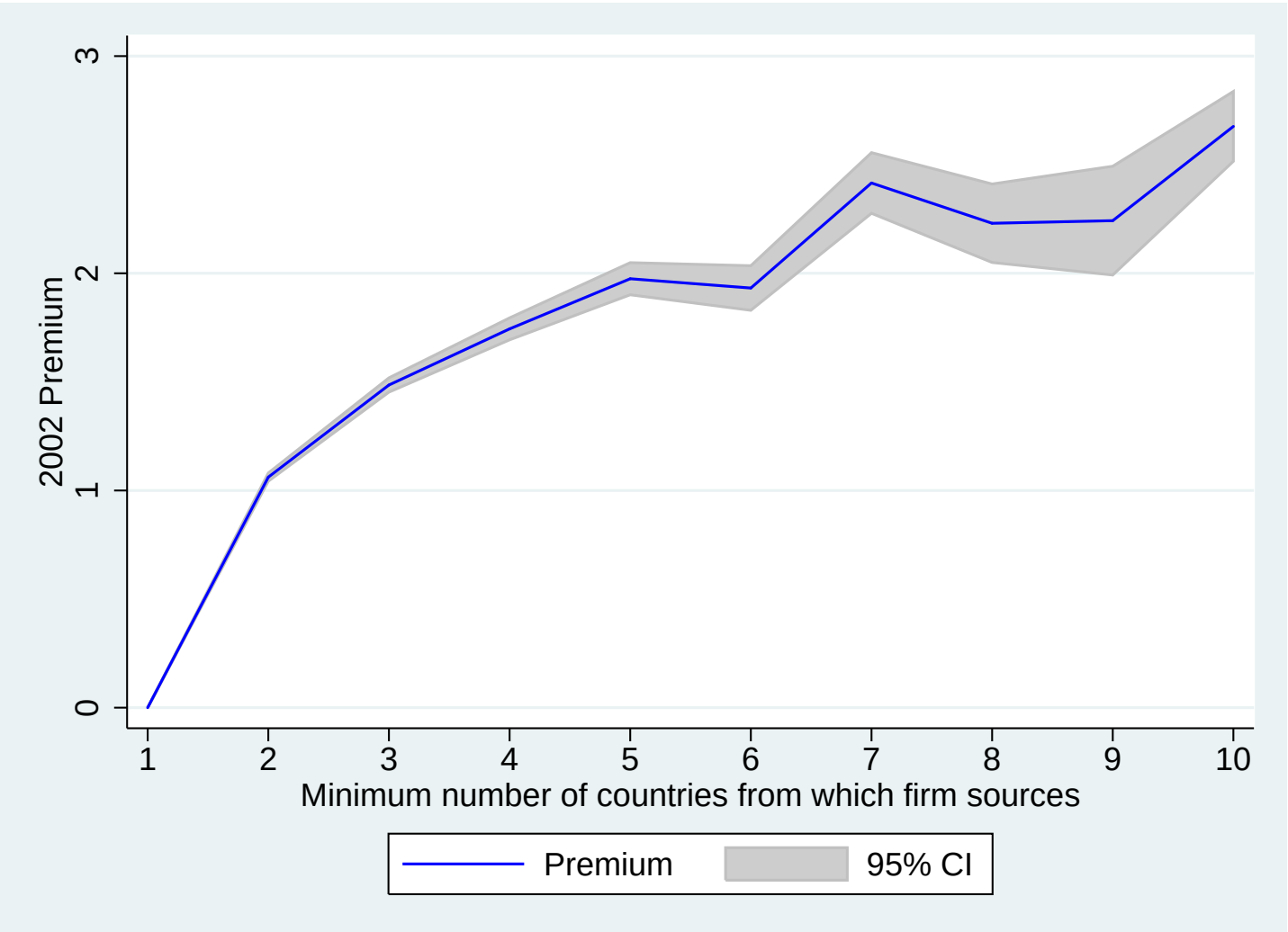
2002 Sales Premia for 2002 non-importers



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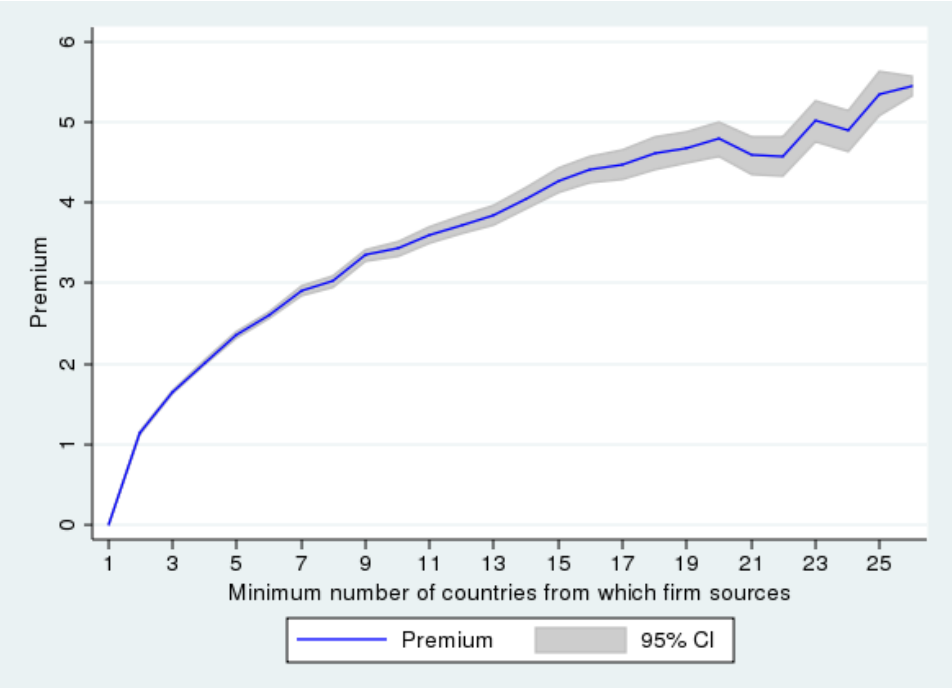
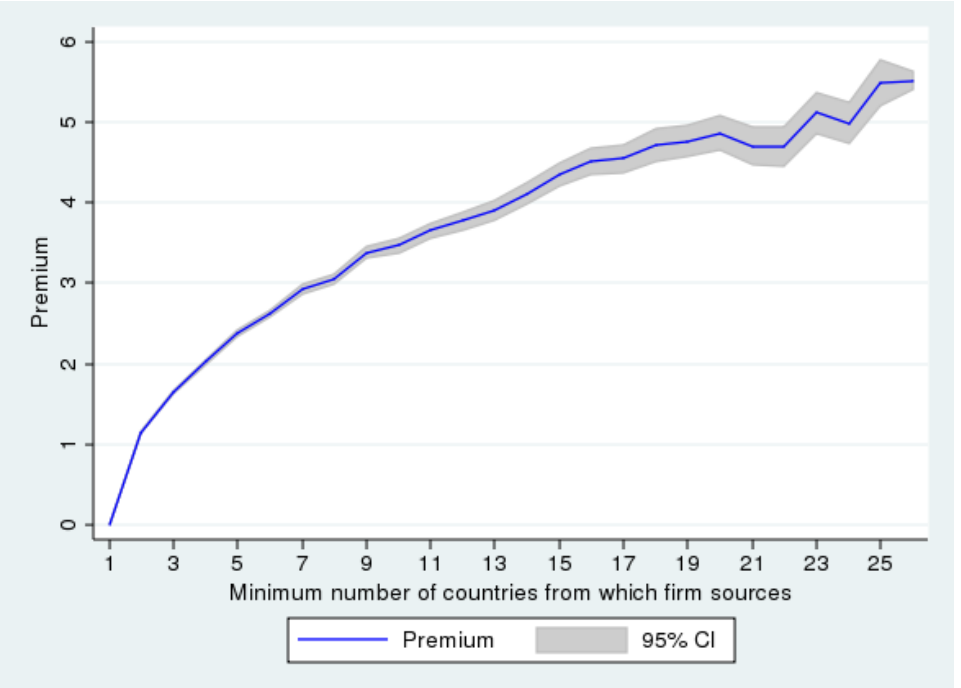
2007 Sales Premia with product controls



(a) Controlling for number of imported goods



(b) Controlling for number of exported goods

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Measuring Input Shares

- $Inputs^n = Sales^n - ValueAdded^n + ProductionWorkerWages^n$
  - Manufacturing and wholesale coverage
  - Highly correlated with traditional input measures for manufacturing

- $\chi_{ij}^n = M_j^n / Inputs^n$
  - Use imports from j to measure inputs sourced from j
  - Domestic sourcing is the residual
  - Imports are zero if country is not in the firm's sourcing strategy

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Top 10 Countries Source Countries

	Rank by: Firms	Rank by: Value	Number of Firms	Value of Imports
Canada	1	1	37,800	145,700
China	2	3	21,400	121,980
Germany	3	5	13,000	62,930
United Kingdom	4	6	11,500	30,750
Taiwan	5	11	10,500	16,630
Italy	6	13	8,500	13,230
Japan	7	4	8,000	112,250
Mexico	8	2	7,800	125,960
France	9	9	6,100	22,980
Korea, South	10	10	5,600	20,390

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Estimates of the China shock on firm sourcing controlling for import penetration

Dependent variable is percent change from 1997 to 2007 in firm:

	Domestic inputs	No. of countries	Foreign inputs	Domestic inputs	No. of countries	Foreign inputs
	OLS			IV		
China, DHS	0.085***	0.255***	0.360***	1.368***	0.660***	0.788***
	(0.012)	(0.007)	(0.012)	(0.424)	(0.098)	(0.243)
Import penetration	-0.103	0.039	-0.010	-1.019**	-0.250***	-0.316*
	(0.196)	(0.079)	(0.144)	(0.511)	(0.090)	(0.190)
constant	0.074***	0.142***	0.315***	-0.084	0.093***	0.263***
	(0.027)	(0.015)	(0.031)	(0.055)	(0.017)	(0.044)
Adj.R2	0.00	0.11	0.05			
N	127,400	127,400	127,400	127,400	127,400	127,400
First Stage Statistics			Coeff (se) 2.089*** (0.520)		KP Fstat 16.13	

Notes: Standard errors are in parentheses and clustered by 439 NAICS industries. N rounded for disclosure avoidance.

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Estimates of the china shock on firm sourcing instrumenting for import penetration

Dependent variable is percent change from 1997 to 2007 in firm:

	Domestic inputs	No. of countries	Foreign inputs	Domestic inputs	No. of countries	Foreign inputs
	OLS			IV		
China, DHS	0.085***	0.255***	0.360***	1.010***	0.867***	1.245***
	(0.012)	(0.007)	(0.012)	(0.318)	(0.112)	(0.261)
Import Penetration	-0.103	0.039	-0.010	-0.179	-0.736***	-1.388***
	(0.196)	(0.079)	(0.144)	(0.558)	(0.182)	(0.393)
constant	0.074***	0.142***	0.315***	-0.068	0.083***	0.242***
	(0.027)	(0.015)	(0.031)	(0.050)	(0.017)	(0.042)
Adj.R2	0.00	0.11	0.05			
N	127,400	127,400	127,400	127,400	127,400	127,400
First Stage Statistics		Coeff (se) 2.810*** (0.670)			KP Fstat 7.72	

Notes: Standard errors are in parentheses and clustered by 439 NAICS industries. N rounded for disclosure avoidance.

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Estimates of the China shock on firm sourcing, for new China importers

Dependent variable is percent change from 1997 to 2007 in firm:

	Domestic inputs	No. of countries	Foreign inputs	Domestic inputs	No. of countries	Foreign inputs
	OLS			IV		
New China importer	0.173***	0.553***	0.774***	2.261***	1.208***	1.426***
	(0.027)	(0.015)	(0.027)	(0.557)	(0.170)	(0.425)
constant	0.069***	0.143***	0.313***	-0.062	0.094***	0.265***
	(0.023)	(0.012)	(0.026)	(0.048)	(0.017)	(0.045)
Adj.R2	0.00	0.11	0.05	-0.30	-0.04	0.01
N	127,400	127,400	127,400	127,400	127,400	127,400
First Stage Statistics			Coeff (se) 1.233*** (0.237)		KP Fstat 27.11	

Notes: Standard errors are in parentheses and clustered by 439 NAICS industries. N rounded for disclosure avoidance.

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First stage statistics

Dependent variable is change from 1997 to 2007 in firm

	Domestic inputs	No. of countries	Foreign inputs	Domestic inputs	No. of countries	Foreign inputs
	OLS			IV		
China, DHS	0.084***	0.255***	0.360***	0.934***	0.553***	0.654***
	(0.012)	(0.007)	(0.013)	(0.258)	(0.080)	(0.197)
Constant	0.069***	0.144***	0.315***	-0.064	0.097***	0.269***
	(0.023)	(0.013)	(0.026)	(0.047)	(0.017)	(0.044)
Adj. R^2	0.00	0.11	0.05			
N	127,400	127,400	127,400	127,400	127,400	127,400
AR F stat				12.98	12.05	5.17
AR pval				0.000	0.001	0.023
AR χ^2 stat				13.01	12.07	5.18
AR pval				0.000	0.001	0.023
First Stage Statistics		Coeff (se) 2.691*** (0.504)			KP Fstat 28.51	

Notes: Standard errors are in parentheses and clustered by 439 NAICS industries. N rounded for disclosure avoidance.

Back

Multiple countries and inputs

- Count of distinct source locations and products imported by a firm

	Mean	Std. Dev.	25th Ptile	Median	95th Ptile
Country Count	3.26	5.09	1	2	11
Product Count	11.91	48.89	1	3	41

- Although extreme, the continuum of inputs assumption helps a lot

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Firm-level import statistics

- Number of imported HS10 products per country
- Number of countries per imported HS10 product

	Products Per Country			Countries Per Product		
	Firm-level			Firm-level		
	Mean	Median	Max	Mean	Median	Max
Mean	2.78	2.18	7.21	1.11	1.00	1.61
Median	2.00	2.00	2.00	1.03	1.00	1.00
95%tile	8.23	5.00	25.00	1.78	1.00	4.00

- Not much evidence of differentiation by country of origin

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Firm-level import and export statistics

- Number of countries per HS6 products traded by a firm

	Firm Level Imports			Firm Level Exports		
	Mean	Median	Max	Mean	Median	Max
Mean	1.15	1.05	1.92	1.76	1.33	4.87
Median	1.00	1.00	1.00	1.11	1.00	2.00
95%tile	1.93	1.00	5.00	4.26	3.00	21.00

Notes: Table reports statistics on the firm-level mean, median, and maximum of the number of countries from which a firm imports or exports the same HS6 product.

- Generally higher counts for exports

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Why depart from Armington?

- Number of countries per HS10 products traded by a firm, for firms that trade with at least 3 countries

	Firm Level Imports			Firm Level Exports		
	Mean	Median	Max	Mean	Median	Max
Mean	1.28	1.05	3.18	2.26	1.48	8.25
Median	1.19	1.00	2.00	1.73	1.00	4.00
95%tile	1.96	1.00	9.00	5.17	3.00	30.00

- Same basic pattern for firms that trade with at least 3 countries

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Hierarchies in Firm Sourcing Patterns

Table: U.S. firms importing from strings of top 10 countries

	Data		Under Independence	
String	Firms	% of Importers	Firms	% of Importers
CA	17,980	29.82	6,760	11.21
CA-CH	2,210	3.67	3,730	6.19
CA-CH-DE	340	0.56	1,030	1.71
CA-CH-DE-GB	150	0.25	240	0.40
CA-CH-DE-GB-TW	80	0.13	50	0.08
CA-CH-DE-GB-TW-IT	30	0.05	10	0.02
CA-CH-DE-GB-TW-IT-JP	30	0.05	0	0.00
CA-CH-DE-GB-TW-IT-JP-MX	50	0.08	0	0.00
CA-CH-DE-GB-TW-IT-JP-MX-FR	160	0.27	0	0.00
CA-CH-DE-GB-TW-IT-JP-MX-FR-KR	650	1.08	0	0.00
TOTAL Following Pecking Order	21,680	36.0	11,820	19.6

Notes: The string CA means importing from Canada but no other among the top 10; CA-CH means importing from Canada and China but no other, and so forth. % of Importers shows percent of each category relative to all firms that import from top 10 countries.

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Estimation of countries' sourcing potential

- Estimate via OLS

$$\log \chi_{ij}^n - \log \chi_{ii}^n = \log \xi_j + \log \epsilon_j^n$$

- Summary statistics for sourcing appeal estimation

Number of observations	200,000
Number of importing firms	64,600
Mean Squared Error	2.64
Range of foreign $\log \xi_j$	- 4.12 to -8.42
Sum of foreign ξ_j	0.137

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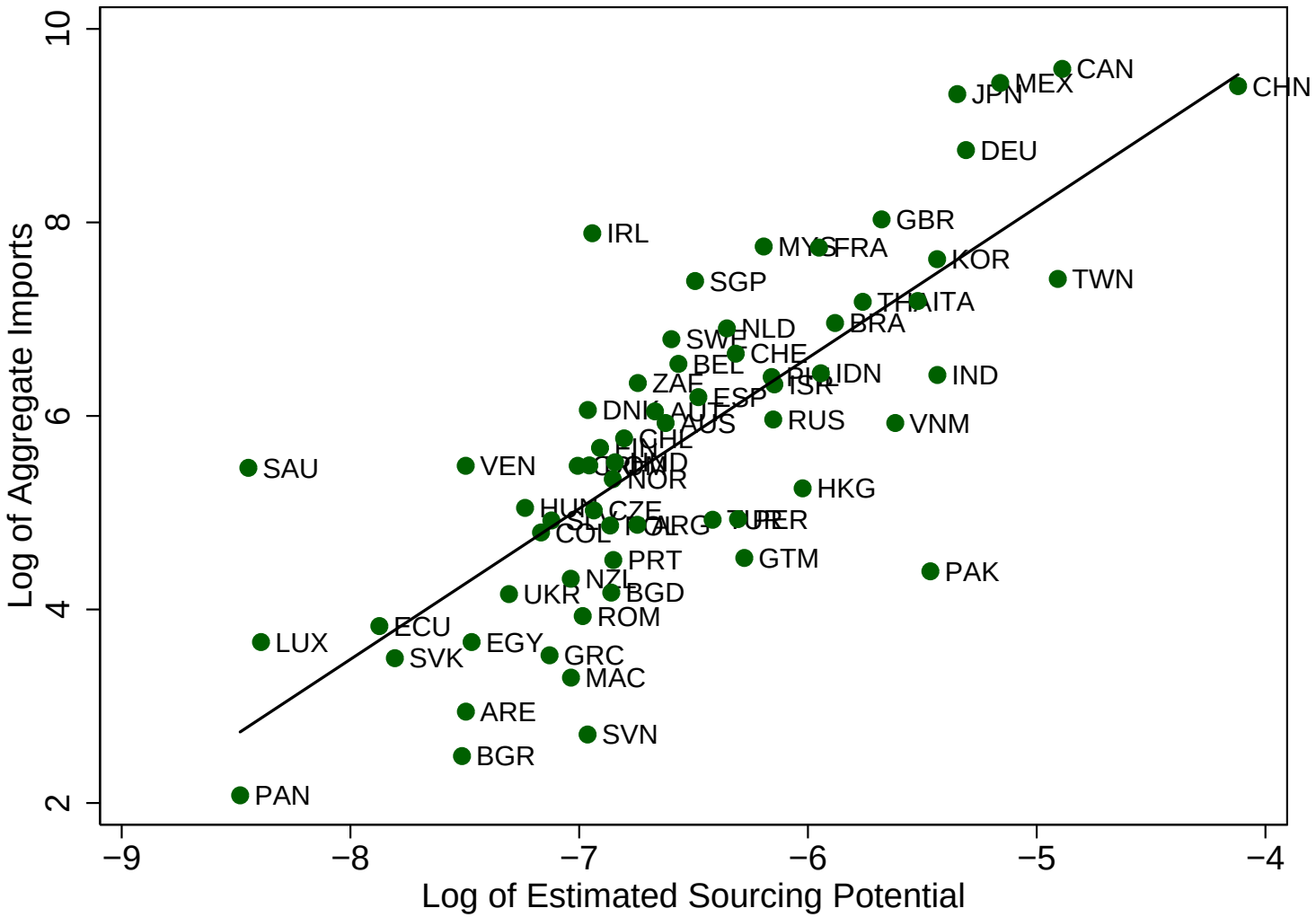
Sourcing potential versus aggregate imports



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Parameters

- f_{ij}^n distributed log-normal
  - Scale parameter: $\log \beta_c^f + \beta_d^f \log \text{distance}_{ij} + \log \beta_l^f \text{language}_{ij}$
  - Dispersion parameter β_{disp}^f
- No domestic fixed cost of sourcing
- $\delta = \left[B, \beta_c^f, \beta_d^f, \beta_l^f, \beta_{\text{disp}}^f\right]$
- Simulate more than 2 million firms

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Statistics on Jia Algorithm Performance

Cardinality of difference in bounds	0	1	2	3	4	5	6	7	8	9-25	≥ 26
Number of occasions	9959361735	0	374149	22523	1514	72	6	1	0	0	0

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