THE MARGINS OF GLOBAL SOURCING: THEORY AND EVIDENCE FROM U.S. FIRMS

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\textit{Disclaimer:} This work is \textit{unofficial} and thus has not undergone the review accorded to official Census Bureau publications. All results have been reviewed to ensure that no confidential information is disclosed. The views expressed in the paper are those of the authors and \textbf{not} necessarily those of the U.S. Census Bureau.
**Broad Motivation**

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- Firms source multiple inputs from multiple countries
- 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**

![Graph showing the relationship between the minimum number of countries from which a firm sources and the premium.](image)

- **Premia 2002**
- **Premia with product controls**
Country Rank by Importers vs. Total Imports
Challenges for a Multi-Input, Multi-Country Model of Global Sourcing

- Export models generally assume constant marginal costs
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- Importing inputs naturally affects the marginal cost of the firm
- 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
  - includes models by Eaton and Kortum (2002) and Chaney (2008) as special cases

- Provide estimates of country sourcing potential and fixed costs
  - new application of iterative algorithm from Jia (2008)
  - role of distance and language in fixed costs

- Study effects of shocks to global sourcing
  - changes to aggregate trade patterns
  - heterogeneous impact across firm size distribution
  - distinction between net and gross changes in sourcing / employment
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**RELATED LITERATURE**

- **Empirical evidence on firm sourcing**

- **Importing, firm efficiency, and markups**

- **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**
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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- Dixit-Stiglitz preferences over manufacturing varieties, elasticity of substitution $\sigma > 1$ (later introduce non-manufacturing sector)
- Final good sector producing these varieties:
  - Measure $N_j$ of heterogeneous firms (pinned down by free entry)
  - Non-tradable final output
  - Monopolistic competition
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- Intermediate good sector
  - Each firm uses a unit measure of (firm-specific) intermediate inputs
  - Trade cost $\tau_{ij}$ to import from country $j$ by country $i$
  - Perfect competition $\implies$ Marginal-cost pricing of inputs
Production Technology

- Final good requires the assembly of a bundle of intermediates
- Marginal cost of final good producer, $\varphi$:

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

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$$

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

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

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  \]

- Country-specific fixed cost of offshoring $w_i f_{ij}$
**Firm’s Problem**

- Firm chooses:
  - Sourcing strategy $\mathcal{J}_i(\varphi) \subseteq \{1, \ldots, J\}$
  - 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 $j$:

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

- Share of intermediate input purchases sourced from any country $j$:
  \[
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  \]

- Sourcing capability:
  \[
  \Theta_i(\varphi) \equiv \sum_{k \in J_i(\varphi)} T_k (\tau_{ik} w_k)^{-\theta}
  \]}
**Firm behavior conditional on sourcing strategy**

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$$

- Sourcing capability:

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

- Marginal cost:

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

- General profit function:

\[
\max_{I_{ij} \in \{0, 1\}^J} c_i(\varphi, \{I_{ij} \in \{0, 1\}^J\})^{1-\sigma} B_i - w_i \sum_{j=1}^J I_{ij} f_{ij}
\]
Optimal Sourcing Strategy

With cost function plugged in:

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

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

- Profits are supermodular in \( \varphi \) and \( \sum_{j=1}^{J} I_{ij} T_j (\tau_{ij} w_j)^{-\theta} \)

- **Proposition:** The solution \( I_{ij} (\varphi) \in \{0,1\}^J \) to the optimal sourcing problem is such that a firm’s sourcing capability
  \[ \Theta_i (\varphi) \equiv \sum_{j=1}^{J} I_{ij} (\varphi) T_j (\tau_{ij} w_j)^{-\theta} \]
  is nondecreasing in \( \varphi \)

- Implications for size distribution of firms
**Optimal Sourcing Strategy**

\[
\max_{I_{ij} \in \{0,1\}} \varphi^{\sigma-1} \left( \gamma \sum_{j=1}^{J} I_{ij} T_{j} (\tau_{ij} w_{j})^{-\theta} \right)^{(\sigma-1)/\theta} \quad B_{i} - w_{i} \sum_{j=1}^{J} I_{ij} f_{ij}
\]

- Complements case: \( \frac{\sigma-1}{\theta} > 1 \)
- Substitutes case: \( \frac{\sigma-1}{\theta} < 1 \)
Optimal Sourcing Strategy

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

- **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 \(J_i(\varphi_L) \subseteq J_i(\varphi_H)\) for \(\varphi_H \geq \varphi_L\), where \(J_i(\varphi) = \{j : I_{ij}(\varphi) = 1\}\).

- **Hierarchies in the complements case**
Industry and General Equilibrium

- Consumers spend constant share $\eta$ on manufacturing sector.
Industry and General Equilibrium

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- Workers are perfectly mobile across sectors (other sector pins down wage level)
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- Industry Equilibrium is characterized by:
  - Fixed point for the market potential, $B_i$
  - Free entry condition
Industry and General Equilibrium

- Consumers spend constant share $\eta$ 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 effect margin at the product level

- **General case**
  - Extensive margin effect at product and firm level
  - Third market effects

- **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
BRIEF DISCUSSION OF ASSUMPTIONS

- Model has many moving pieces
- Q1: Wouldn’t it be simpler to have a single-input model?
- Q2: Wouldn’t it be simpler to adopt an Armington model?
**Multiple countries and inputs**

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

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>25th Ptile</th>
<th>Median</th>
<th>95th Ptile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country Count</td>
<td>3.26</td>
<td>5.09</td>
<td>1</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>Product Count</td>
<td>11.91</td>
<td>48.89</td>
<td>1</td>
<td>3</td>
<td>41</td>
</tr>
</tbody>
</table>

- Although extreme, the continuum of inputs assumption helps a lot
## Countries Per Product

- Number of countries per HS10 products imported by a firm

<table>
<thead>
<tr>
<th>Firm Level</th>
<th>Mean</th>
<th>Median</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>1.11</td>
<td>1.00</td>
<td>1.61</td>
</tr>
<tr>
<td>Median</td>
<td>1.03</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>95%tile</td>
<td>1.78</td>
<td>1.00</td>
<td>4.00</td>
</tr>
</tbody>
</table>

- Not much evidence of differentiation by country of origin
Estimation
**DATA**

- 2007 data from the U.S. Census Bureau
  - Economic Censuses
  - Import transactions data

- Sample is all manufacturing firms (around 250,000 firms)
  - Include firms with non-manufacturing activity
  - 23% of employment and 38% of sales
  - 65% of (non-mining) imports
  - A quarter of these firms imports

- Structural Estimation
  - Limit analysis to countries with 200+ U.S. importers
  - 64 countries and the U.S.
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, \( \kappa \), and residual demand
  - Simulated method of moments + Jia’s (2008) algorithm

\[
\Pi(\mathcal{J}, \varphi, f^n_{ij}) = \varphi^{\sigma-1} \left( \sum_{j=1}^{\mathcal{J}} T_j (\tau_{ij} w_j)^{-\theta} \right) \]

\[
\hat{B} - \sum_{j \in \mathcal{J}} f^n_{ij} \]
Step 1: Estimate Country Sourcing Potential

- Define country potential $\xi_j = T_j (\tau_{ij} w_j)^{-\theta}$

- Normalize firm share from $j$: $\chi_{ij}^n / \chi_{ii}^n = \frac{T_j (\tau_{ij} w_j)^{-\theta}}{\Theta_i^n} / \frac{T_i (\tau_{ii} w_i)^{-\theta}}{\Theta_i^n}$

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

- Estimate via OLS
SOURCING POTENTIAL VERSUS NUMBER OF FIRMS

![Graph showing the relationship between log of number of importers and log of estimated sourcing potential. The graph includes data points for various countries represented by different markers. The countries are labeled on the plot, with a legend indicating their country codes. The axes are labeled as Log of Number of Importers on the y-axis and Log of Estimated Sourcing Potential on the x-axis. The countries labeled include PAN, SAU, LUX, ECU, SVK, BGR, VEN, ARE, EGY, UKR, HUN, COL, GRC, SLV, NZL, MAC, CRI, ROM, SVN, DNK, DOM, IRL, CZE, FIN, POL, BGD, NOR, PRT, HND, CHL, ARG, ZAF, AUT, AUS, SWE, BEL, SGP, ESP, TUR, NLD, CHE, PER, GTM, MYS, PHL, RUS, ISR, HKG, FRA, IDN, BRA, THA, GBR, VNM, ITA, PAK, KOR, IND, JPN, DEU, MEX, and TWN. Aggregate Imports is indicated by a marker near the bottom left of the graph.]}
**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 $\log \hat{\xi}_j = T_j (\tau_{ij} w_j)^{-\theta}$ on country variables
  - Wages (human capital adjusted)
  - Country controls for technology and controls for bilateral trade frictions
  - Instrument using population

$$\log \hat{\xi}_j = \beta_r \log R&D_j + \beta_k \log \text{capital}_j + \beta_C \text{control corruption}_j$$

$$+ \beta_n \log \text{no of firms} - \theta \log w_j$$

$$- \theta (\log \beta_c + \beta_d \log \text{distance}_{ij} + \text{language}_{ij} \log \beta_l) + \nu_j$$
## Step 2b: Estimate dispersion of productivities

<table>
<thead>
<tr>
<th></th>
<th>log $\xi$</th>
<th>log aggregate import</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OLS</td>
<td>IV</td>
<td>IV</td>
</tr>
<tr>
<td>HC adjusted wage</td>
<td>-0.51***</td>
<td>-2.01***</td>
<td>-1.71**</td>
</tr>
<tr>
<td></td>
<td>(0.18)</td>
<td>(0.72)</td>
<td>(0.68)</td>
</tr>
<tr>
<td>log distance</td>
<td>-0.34*</td>
<td>-0.83**</td>
<td>-0.57**</td>
</tr>
<tr>
<td></td>
<td>(0.19)</td>
<td>(0.35)</td>
<td>(0.28)</td>
</tr>
<tr>
<td>common language</td>
<td>0.26</td>
<td>0.20</td>
<td>0.19</td>
</tr>
<tr>
<td></td>
<td>(0.21)</td>
<td>(0.31)</td>
<td>(0.28)</td>
</tr>
<tr>
<td>log R&amp;D</td>
<td>0.40***</td>
<td>0.52***</td>
<td>0.54***</td>
</tr>
<tr>
<td></td>
<td>(0.05)</td>
<td>(0.09)</td>
<td>(0.13)</td>
</tr>
<tr>
<td>log KL</td>
<td>-0.17</td>
<td>0.61</td>
<td>0.44</td>
</tr>
<tr>
<td></td>
<td>(0.17)</td>
<td>(0.43)</td>
<td>(0.38)</td>
</tr>
<tr>
<td>Control of corruption</td>
<td>0.11</td>
<td>0.70**</td>
<td>0.59*</td>
</tr>
<tr>
<td></td>
<td>(0.15)</td>
<td>(0.34)</td>
<td>(0.31)</td>
</tr>
<tr>
<td>log no. of firms</td>
<td>-0.01</td>
<td></td>
<td>-0.37</td>
</tr>
<tr>
<td></td>
<td>(0.14)</td>
<td></td>
<td>(0.39)</td>
</tr>
<tr>
<td>Constant</td>
<td>-3.60***</td>
<td>-6.60***</td>
<td>-5.97***</td>
</tr>
<tr>
<td></td>
<td>(0.89)</td>
<td>(1.87)</td>
<td>(1.55)</td>
</tr>
<tr>
<td>Observations</td>
<td>58</td>
<td>58</td>
<td>56</td>
</tr>
</tbody>
</table>
**Implications of First Two Steps**

- Sourcing from all countries, relative to only domestic sourcing
  - 7-10 percent lower input costs
  - 24-32 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 5 parameters via Simulated Method of Moments
  - Firm-country-specific fixed costs (distance, lang, cons, disp)
  - Residual demand
- Use 67 moments
  - Share of importing firms
  - Share of firms that sources from each country
  - Share of firms sourcing less than $50^{th}$ percentile from the U.S.
- Solve firm’s problem
  - $2^{65}$ or about $10^{19}$ possible choices
  - Exploit complementarities in profit function
  - Build on algorithm in Jia (2008)
Marginal benefit of country J

- Profits of a sourcing strategy $\mathcal{J}$ for a firm
  - given productivity $\varphi$ and fixed cost $f_{ij}^n$
    $$\Pi (\mathcal{J}, \varphi, f_{ij}^n) = \varphi^{\sigma-1} B \left( (\gamma \Theta_i (\mathcal{J}))^{(\sigma-1)/\theta} \right) - \sum_{j \in \mathcal{J}} f_{ij}^n,$$

- Marginal benefit of adding country $j$ given $\varphi$ and $\mathcal{J} \setminus j$
  $$\varphi^{\sigma-1} \gamma^{(\sigma-1)/\theta} B \left( \Theta_i (\mathcal{J})^{(\sigma-1)/\theta} - \Theta_i (\mathcal{J} \setminus j)^{(\sigma-1)/\theta} \right) - f_{ij}^n$$
SOLVE FIRM’S PROBLEM USING JIA (2008) ALGORITHM

- Define mapping $V : \{0, 1\}^N \rightarrow \{0, 1\}^N$
  - $V_j(\mathcal{J}) = 1$ 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
**Parameter Estimates**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$B$</td>
<td>0.123</td>
</tr>
<tr>
<td>$\beta_f^c$</td>
<td>0.011</td>
</tr>
<tr>
<td>$\beta_d^f$</td>
<td>0.340</td>
</tr>
<tr>
<td>$\beta_l^f$</td>
<td>0.611</td>
</tr>
<tr>
<td>$\beta_{disp}^f$</td>
<td>0.859</td>
</tr>
</tbody>
</table>

- Fixed costs 40 percent lower if common language
- Fixed costs increasing in distance with elasticity of .34 percent
- Median fixed cost estimates range from 9,000 to 28,000 USD
**Counterfactual**

- 100% shock to China’s sourcing potential
- Resolve for the equilibrium price index and the mass of entering firms

**Compare**
- Baseline
- Alternative parameter values that imply universal importing or independent entry decisions

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

<table>
<thead>
<tr>
<th>Chinese import status</th>
<th>Change sourcing from US</th>
<th>Change Sourcing from other countries</th>
<th>Share of firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entrants</td>
<td>1.010</td>
<td>1.023</td>
<td>0.143</td>
</tr>
<tr>
<td>Exiters</td>
<td>NaN</td>
<td>NaN</td>
<td>0.000</td>
</tr>
<tr>
<td>Continuers</td>
<td>0.999</td>
<td>0.998</td>
<td>0.098</td>
</tr>
<tr>
<td>Others</td>
<td>0.989</td>
<td>0.970</td>
<td>0.759</td>
</tr>
</tbody>
</table>

- Aggregate sourcing from the U.S. is reduced by 1.06 percent
- For every 10 domestic manufacturing jobs destroyed, 1 new job is created.
Baseline - Size distribution and price index

- Price index falls by .4%.
ALTERNATIVE PARAMETERS: UNIVERSAL IMPORTING

- No fixed costs of foreign sourcing

<table>
<thead>
<tr>
<th>Chinese import status</th>
<th>Change sourcing from US</th>
<th>Change Sourcing from other countries</th>
<th>Share of firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entrants</td>
<td>NaN</td>
<td>NaN</td>
<td>0.000</td>
</tr>
<tr>
<td>Exiters</td>
<td>NaN</td>
<td>NaN</td>
<td>0.000</td>
</tr>
<tr>
<td>Continuers</td>
<td>0.991</td>
<td>0.991</td>
<td>1.000</td>
</tr>
<tr>
<td>Others</td>
<td>NaN</td>
<td>NaN</td>
<td>0.000</td>
</tr>
</tbody>
</table>

- All type of firms decrease sourcing from the U.S. and from third markets by the same amount
**ALTERNATIVE PARAMETERS: INDEPENDENT ENTRY DECISIONS**

- Set $\theta = \sigma - 1$

<table>
<thead>
<tr>
<th>Chinese import status</th>
<th>Change sourcing from US</th>
<th>Change Sourcing from other countries</th>
<th>Share of firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entrants</td>
<td>0.996</td>
<td>0.990</td>
<td>0.150</td>
</tr>
<tr>
<td>Exiters</td>
<td>NaN</td>
<td>NaN</td>
<td>0.000</td>
</tr>
<tr>
<td>Continuers</td>
<td>0.996</td>
<td>0.995</td>
<td>0.092</td>
</tr>
<tr>
<td>Others</td>
<td>0.996</td>
<td>0.989</td>
<td>0.758</td>
</tr>
</tbody>
</table>

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

\[ M_{ij} = \tau_{ij} \theta \frac{E_i}{\Theta_i} \sum_k \frac{Q_j}{\Theta_k} \tau_{kj} \theta \frac{E_k}{\Theta_k} \]

- Familiar from Eaton and Kortum (2002)
- Trade elasticity is given by \( \theta \)
- Extensive margin effect at the product-level
**Gravity - General Case**

- General case

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

where

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

- \(\Lambda_{ij}\) yields
  - Extensive margin effect at the *firm-level* in addition to the *product-level*
  - Third market effects
Gravity - Independent Entry Decisions

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

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

- Trade elasticity as in Chaney (2008)
- Extensive margin effect
- No third market effects
2002 Sales Premia for 2002 Non-Importers
2007 Sales Premia with product controls

(a) Controlling for number of imported goods
(b) Controlling for number of exported goods
**Measuring Input Shares**

- \( \text{Inputs}^n = \text{Sales}^n - \text{Value Added}^n + \text{Production Worker Wages}^n \)
  - Manufacturing and wholesale coverage
  - Highly correlated with traditional input measures for manufacturing

- \( \chi_{ij}^n = \frac{M^*_j}{\text{Inputs}^n} \)
  - 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
# Top 10 Countries Source Countries

<table>
<thead>
<tr>
<th>Rank by:</th>
<th>Number of Firms</th>
<th>Value of Imports</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firms</td>
<td>Value</td>
<td></td>
</tr>
<tr>
<td>Canada</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>China</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Germany</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Taiwan</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>Italy</td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td>Japan</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Mexico</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>France</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Korea, South</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>
Firm-level Instrument

- Ideally, want the importance of each product in firm production
  - Use HS-IO tables and firm industry to get product weights?
  - Firm-specific if firms span multiple industries or switch over time
  - Works for all firms

- Alternative strategy for importers
  - Use import product share in pre-sample
  - Firm-specific, time invariant share
  - Time variation comes from China product-level shocks

- Similar product-level test
  - Effect of shock to product $k$ on sourcing strategy
  - Sample is all firms already importing a product (not from China)
  - $Pr(y_{ijkt}|X_{ijt} = 1) = M_{i,China,t-1} + Sales_{it} + Controls$
  - Where $y_{ijkt} = 1$ if firm switches its import of product $k$ to China
  - Also assess how this change affects other sourcing decisions
**Why depart from Armington?**

- Number of countries per HS10 products traded by a firm

<table>
<thead>
<tr>
<th></th>
<th>Firm Level Imports</th>
<th></th>
<th>Firm Level Exports</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Median</td>
<td>Max</td>
<td>Mean</td>
</tr>
<tr>
<td>Mean</td>
<td>1.11</td>
<td>1.00</td>
<td>1.61</td>
<td>1.66</td>
</tr>
<tr>
<td>Median</td>
<td>1.03</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>95%tile</td>
<td>1.78</td>
<td>1.00</td>
<td>4.00</td>
<td>4.00</td>
</tr>
</tbody>
</table>

- Generally higher counts for exports
**WHY DEPART FROM ARMINGTON?**

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

<table>
<thead>
<tr>
<th></th>
<th>Firm Level Imports</th>
<th>Firm Level Exports</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Median</td>
</tr>
<tr>
<td>Mean</td>
<td>1.28</td>
<td>1.05</td>
</tr>
<tr>
<td>Median</td>
<td>1.19</td>
<td>1.00</td>
</tr>
<tr>
<td>95%tile</td>
<td>1.96</td>
<td>1.00</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of observations</td>
<td>200,000</td>
</tr>
<tr>
<td>Number of importing firms</td>
<td>64,600</td>
</tr>
<tr>
<td>Mean Squared Error</td>
<td>2.64</td>
</tr>
<tr>
<td>Range of foreign log $\xi_j$</td>
<td>-4.12 to -8.42</td>
</tr>
<tr>
<td>Sum of foreign $\xi_j$</td>
<td>0.137</td>
</tr>
</tbody>
</table>
Sourcing potential versus aggregate imports

![Graph showing the relationship between log of aggregate imports and log of estimated sourcing potential. The graph plots various countries on a scatter plot, with a trend line indicating a positive correlation.](image-url)
**PARAMETERS**

- $f_{ij}^n$ distributed log-normal
  - Scale parameter: $\log \beta^f_c + \beta^f_d \log \text{distance}_{ij} + \log \beta^f_l \text{language}_{ij}$
  - Dispersion parameter $\beta^f_{\text{disp}}$

- No domestic fixed cost of sourcing

- $\delta = [B, \beta^f_c, \beta^f_d, \beta^f_l, \beta^f_{\text{disp}}]$

- Simulate more than 2 million firms
Moments

1. The share of importing firms

2. The share of firms that sources from each country

3. The share of firms in each input quantile for each country
   - Quantiles defined by the qth percentile of inputs in data
   - Where $q = (25, 50, 90)$
**Import Percentiles by Country**

(a) 25th and 50th

(b) 90th
## Statistics on Jia Algorithm Performance

<table>
<thead>
<tr>
<th>Cardinality of difference in bounds</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9-25</th>
<th>≥ 26</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of occasions</td>
<td>9959361735</td>
<td>0</td>
<td>374149</td>
<td>22523</td>
<td>1514</td>
<td>72</td>
<td>6</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
SHARE OF IMPORTERS BY COUNTRY