A Simple Model of Buyer-Seller Connections in International Trade

JGU International Economics Workshop

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Motivation

The Microeconomics of Globalization

Krugman (1979, 1980) marks the beginning of firms in international trade theory

Increasingly detailed and disaggregated datasets have made trade theory more and more micro-oriented

- new-exporters margin
- new-importers margin
- within-firm margins: quality, products, destinations, shipment size

Common simplification: scant modeling of trade-partner dimension

- exporters sell directly to consumers
- importers buy from anonymous markets

Emerging Networks Literature

Production Networks in Macroeconomics (Carvalho Tahbaz-Salehi, ARE 2019)

- fully specified networks / IO-linkages
- shock propagation (Carvalho et al. 2016), aggregate fluctuations (Acemoglu et al. 2012)

Cross-Border Firm-to-Firm Trade (Bernard Moxnes, ARE 2018)

- 'two-sided trade'
- partner-extensive margin, gravity of connections
    - Bernard Moxnes Ulltveit-Moe (2018)
    - Bernard Boler Dhingra (2019)
    - Blum Claro Horstmann (2012)
    - Carballo Ottaviano Martincus (2018)
    - Eaton Kortum Kramarz (2016)

Balls and Bins

Armenter and Koren (2014) ask:

Which stylized facts / moments in the data should be used to test theories of the extensive margin (firms, products, destinations)?

- statistical model of trade based on balls falling into bins
- reproduces important moments, such as the pattern of zeros or frequency of multiproduct exporters

Research Question and Results

Which moments in the data should be used to test theories of cross-border connections between firms?

A parsimonious re-interpretation of the Krugman (1980) model generates some of the seemingly surprising findings on the literature on cross-border connections, e.g.

- negative assortative matching
- stable normalized sales distribution

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- stable normalized sales distribution

The Model

Elements of Krugman (1980)

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- Utility is derived from consumption of differentiated varieties
- Demand in i for variety ω from j:

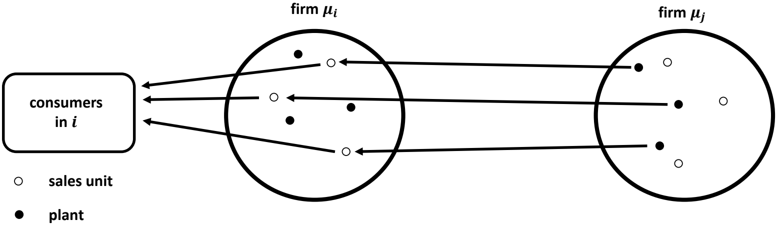
$$x_{ji}(\omega) = (p^*_{ji}(\omega)/P_i)^{-\sigma} Y_i/P_i \tag{1}$$

- $p^*_{ji}(\omega) = p^*_{ji} = \tau_{ji} p_j \ \forall \omega \in \Omega_j$
- Ω_j is the set of varieties produced in j. All varieties in Ω_j are sold in i

1 Plants and Firms

- one plant ⇔ one variety
- firm: arbitrary positive mass (number) of plants and sales units (see next slide)
- N_j *firms* active in country j
- firm size μ_j
    - firm size determines number of plants and sales units a firm can accommodate
    - exogenous firm size $\mu_j \sim F(\mu)$, pdf: $f(\mu)$
    - identical across countries
    - label firm in j with mass of varieties μ_j 'firm μ_j'
    - average firm has $E(\mu)$ plants and $E(\mu)$ varieties
    - total number of varieties in j is $E(\mu)N_j$

2 Importing Firms



- production *and* distribution takes place at the plant level
- export by producer in j, import and exclusive distribution by a sales unit in i
- random matching between exporting and importing *plants*
- with differing firm sizes, for an exporting plant the probability of being matched to an importing *firm* differs across firms
  - $\Pr[\mu_i \text{ imports } \omega] \propto \mu_i$
  - $\Pr[\mu_i \text{ imports } \omega \text{ from } \mu_j] \propto \mu_i \mu_j$

$\Rightarrow$ by LLN: interpret as fractions

3 Reporting Threshold

Value of firm-to-firm exports

$$X_{ji}(\mu_j, \mu_i) = \frac{\mu_i \mu_j}{L_i} \left(p^*_{ij}/P_i\right)^{1-\sigma} Y_i \qquad (2)$$

- no fixed costs of exporting (as in Krugman 1980) $\rightarrow$ all varieties are traded
- mass of varieties sold by firm μ_j to μ_i: $\mu_j \mu_i/(E(\mu)N_i) = \mu_j \mu_i/L_i$

Notice:

- each firm trades with every foreign firm
- as μ_i and/or μ_j become very small, trade values approach zero

3 Reporting Threshold

Trade flows between firms are only recorded if they are large enough

- reporting threshold at the *firm-level*
- trade between two firms is *recorded* if and only if

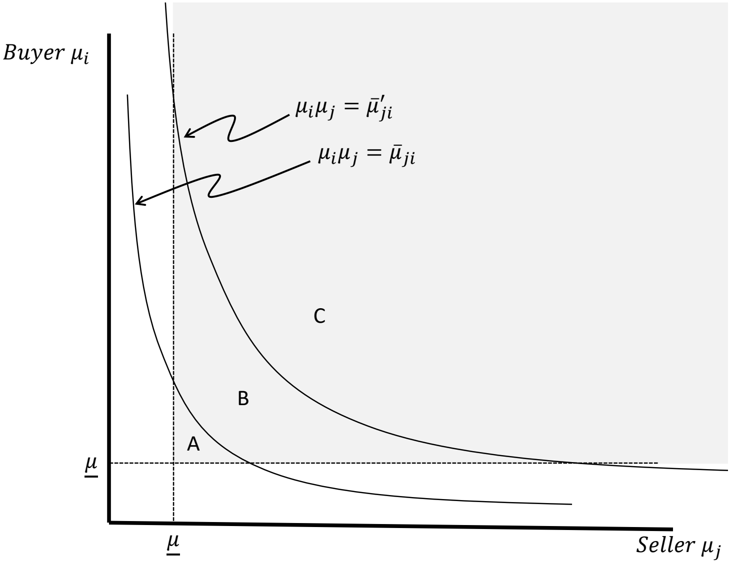
$$X_{ji}(\mu_j, \mu_i) > \bar{t} \tag{3}$$

$$\Leftrightarrow \qquad \mu_i \mu_j > \bar{\mu}_{ji} \tag{4}$$

where $\bar{\mu}_{ji} = \frac{\bar{t}}{\left(p^*_{ij}/P_i\right)^{1-\sigma} Y_i/(L_i)}$

- $\bar{\mu}_{ji}$ is
  - decreasing in importer p.c. income
  - increasing in iceberg trade costs and exporter marginal costs

Implications



Implications

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Fraction of firms in j *recorded* as selling to firm μ_i

$$S(j, \mu_i) = \int_{\bar{\mu}_{ji}/\mu_i}^{\infty} f(\mu) d\mu \tag{5}$$

Fraction of firms in i *recorded* as buying from μ_j

$$B(j, \mu_i) = \int_{\bar{\mu}_{ji}/\mu_j}^{\infty} f(\mu) d\mu \tag{6}$$

The Mass of Recorded Connections

Assumption: Pareto distribution of firm size

$$F(\mu) = 1 - \left(\mu/\underline{\mu}\right)^{-\theta}$$

- Note that the joint pdf of *all* connections is $f(\mu_i, \mu_j) = f(\mu_i)f(\mu_j)$

Main Results

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We confront our model with a set of stylized facts from the literature on firm-to-firm connections.

1. Positive link between firm exports and the number of partners
2. Distribution of the number of partners
3. Negative assortative matching
4. Conditional sales distribution

3 Negative Assortative Matching

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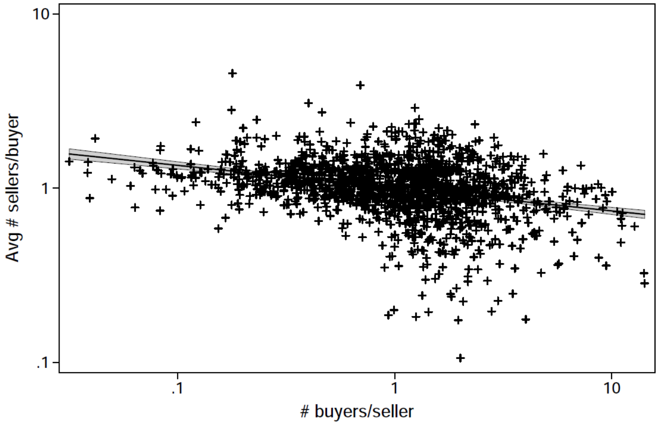

Note: 2006 data. The figure shows all possible values of the number of buyers per Norwegian firm in a given market j, a_j, on the x-axis, and the average number of Norwegian connections among these buyers, $b_j(a_j)$, on the y-axis. Axes scales are in logs. Both variables are demeaned, i.e. we show $b_j(a_j)/\bar{b}_j(\bar{a}_j)$, where $\bar{b}_j(\bar{a}_j)$ is the average number of Norwegian connections among all buyers in market j. The fitted regression line and 95% confidence intervals are denoted by the solid line and gray area. The slope coefficient is -0.13 (s.e. 0.01).

3 Negative Assortative Matching

In our model, the number of connections per firm increases with firm size μ_j

- along the x-axis, exporters become larger
- along the y-axis, importers become larger

For our model, the graph implies:

Larger exporters (who have more importers) should connect to smaller importers (who connect with fewer exporters)

3 Negative Assortative Matching

Our model:

- distribution of importer sizes for exporter of size μ_j:

$$F(\mu|\mu \geq \bar{\mu}_{ji}/\mu_j) = 1 - (\mu/\max\{\bar{\mu}_{ji}/\mu_j, \underline{\mu}\})^{-\theta}$$

- the χ^{th} percentile, defined through $F(\mu|\mu_\chi \geq \bar{\mu}_{ji}/\mu_j) = \chi$, is

$$\mu_\chi(\mu_j) = (1-\chi)^{-1/\theta} \max\{\bar{\mu}_{ji}/\mu_j, \underline{\mu}\} \tag{7}$$

Implication:

$$\frac{\partial \mu_\chi(\mu_j)}{\partial \mu_j} < 0 \; \forall \chi \text{ if } \bar{\mu}_{ji}/\mu_j > \underline{\mu} \tag{8}$$

$\Rightarrow$ This implies Negative Assortative Matching

Intuition: Larger firms reach much deeper into the pool of potential trade partners than smaller firms, lowering the partner size at *any* percentile.

4 Conditional Sales Distribution

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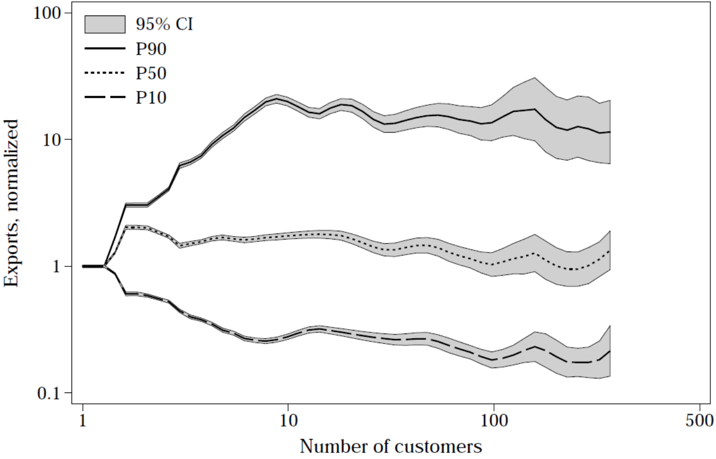

Note: 2006 data. The figure shows the fitted lines from kernel-weighted local polynomial regressions of the x'th percentile of within-firm-destination log exports on firm-destination log number of customers. Axes scales in logs. Exports are normalized, see footnote 4.

4 Conditional Sales Distribution

Our model:

Firm-to-firm sales from exporter μ_j to the importer at the χ^{th} percentile are given by

$$X(\mu_j, \mu_\chi(\mu_j)) = (1-\chi)^{-1/\theta}\overline{t} \quad (9)$$

whenever $\bar{\mu}_{ji}/\mu_j > \underline{\mu}$ holds.

Observation: The absolute trade volume of an exporter to its χ^{th} percentile buyer is independent of the exporter's size.

Normalizing by the median sales of *any* exporting firm μ_{j_0} (e.g., the 'smallest' exporter) yields

$$\frac{X(\mu_j, \mu_\chi(\mu_j))}{X(\mu_{j_0}, \mu_{1/2}(\mu_j))} = (2(1-\chi))^{-1/\theta} \quad (10)$$

Result: For a given exporting firm μ_j, the distribution of firm-to-firm sales, normalized by the median sales of an arbitrary exporting firm μ_{j_0}, is independent of μ_j

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Conclusion

We show that a parsimonious re-interpretation of the Krugman (1980) model can reproduce some of the prominent stylized facts from the firm-to-firm trade literature.

Next steps:

- use Colombian firm-level data to replicate the stylized facts from the literature
- develop further testable implications of our model
- test new implications in the data

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1 Firm Exports and the Number of Partners

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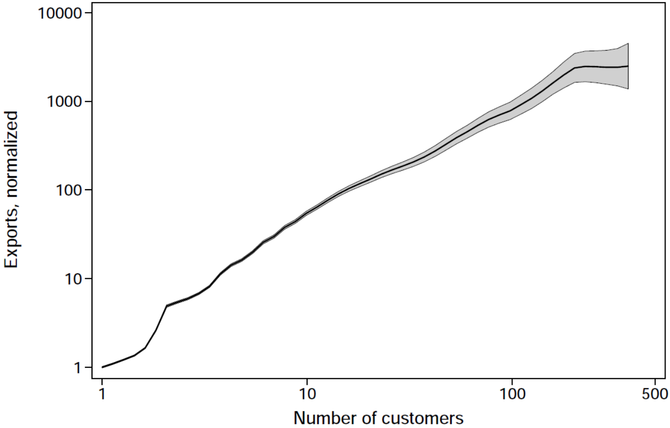

Note: 2006 data. The figure shows the fitted line from a kernel-weighted local polynomial regression of firm-destination log exports on firm-destination log number of customers. Axes scales are in logs. Exports are normalized, see footnote 4.

Source:

1 Firm exports and the number of partners

Exports by firm μ_j

$$X_{ji}(\mu_j) = \int_{\bar{\mu}_{ji}/\mu_j}^{\infty} X_{ji}\left(\mu_j, \mu_i\right) f(\mu_i) d\mu_i$$
$$= \frac{\theta}{\theta - 1} \left(\frac{p_{ji}}{P_i}\right)^{1-\sigma} Y_i \frac{\mu_j}{L_i} \underline{\mu}^{\theta} \left[\bar{\mu}_{ji}/\mu_j\right]^{1-\theta} \tag{11}$$

Number of importers for a firm μ_j

$$N_i B(\mu_j, i) = N_i \int_{\bar{\mu}_{ji}/\mu_j}^{\infty} f(\mu_i) d\mu_i = N_i \underline{\mu}^{\theta} \left[\bar{\mu}_{ji}/\mu_j\right]^{-\theta} \tag{12}$$

Relationship between firm exports and the number of partners

$$X_{ji}(\mu_j) = \frac{\theta}{\theta - 1} \bar{t} B(\mu_j, i) \tag{13}$$

Firm μ_j's exports to i increase in the *share* of firms connected to in i with *unit elasticity*.

Main Results

2 Distribution of the Number of Partners

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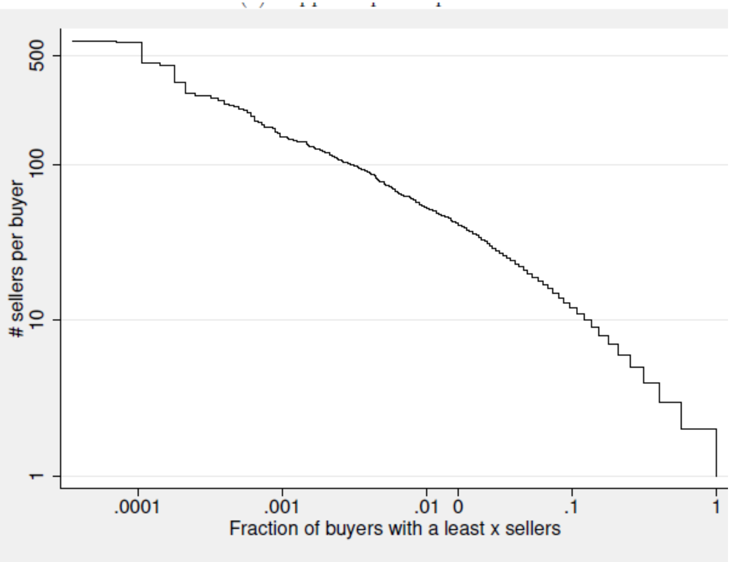

2 Distribution of the number of partners

Importer of size μ_i has $S(j,\mu_i)N_j$ suppliers

$$S(j,\mu_i)N_j = N_j \underline{\mu}^{\theta} \bar{\mu}_{ji}^{-\theta} \mu_i^{\theta}. \tag{14}$$

The share of firms with at least as many connections as μ_i is equal to the fraction of firms that is larger than μ_i

$$\Pr\left[\mu \geq \mu_i\right] = 1 - F(\mu_i) = \mu_i^{-\theta} \underline{\mu}^{\theta} \tag{15}$$

Combining the two gives

$$N_j S(j,\mu_i) = N_j \underline{\mu}^{2\theta} \bar{\mu}_{ji}^{-\theta} \Pr\left[\mu \geq \mu_i\right]^{-1} \tag{16}$$

The relationship between number of connections and fraction of firms with more connections

- is negatively sloped
- has unit elasticity

Main Results