Two-Sided Heterogeneity and Trade

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Introduction

- Trade networks are far from centralized and anonymous markets.
- A handful of global buyers and sellers typically account for the large majority of aggregate trade.
- Until very recently, little or no work on the formation of buyer-seller networks and their economic consequences.

Introduction

This paper

- Describes a new set of stylized facts about buyers & sellers in trade, and how they match.
  - Using Norwegian export and import data where foreign partners are identified in each transaction in every destination/source.
- Develops a simple multi-country model, broadly consistent with the facts.
- Explores implications of two-sided heterogeneity and test new predictions of the model.

Introduction

- Model ingredients:
  - Heterogeneity in efficiency among both buyers and sellers.
  - Sellers: Intermediate goods producers; buyers: final goods producers.
  - Meeting someone is costly, and not proportional to value of transaction ("relation-specific costs").
- Key takeaway I: Importer heterogeneity matters for trade flows:
  - Elasticity of firm trade flows with respect to trade barriers is higher in markets with less importer dispersion.

Introduction

- Key takeaway II: Downstream firm's marginal costs depend on foreign market access through the number of buyer-seller matches.
- Empirics
  - 2008-2009 trade collapse significantly raised costs for Norwegian manufacturing importers.
  - Model does well in matching the decline in buyer-seller connections.

Data - Norwegian Exporters

The universe of Norwegian exporters and all their foreign partners (buyers), 2005-2010.

- The unit of observation is an exporter-buyer-year-product-destination combination.
  - Exporter E exports machine parts (HS 847990) to buyer B located in Germany in 2005.
- No other information about B except what she buys from Norwegian exporters (value and quantity).
- 18,023 sellers, 68,052 buyers, 205 destinations, total trade USD 41 Billion (18% of non-oil GDP in 2005).

Data - Norwegian Importers

The universe of Norwegian importers and all their foreign partners (sellers), 2005-2010.

- The unit of observation is a importer-seller-year-product-source combination.
  - Importer *I* imports machine parts (HS 847990) from seller *S* located in S. Korea in 2005.

Five Facts: Fact 1- Buyer Margin

The buyer margin explains a large fraction of variation in aggregate trade.

Exports to country j:

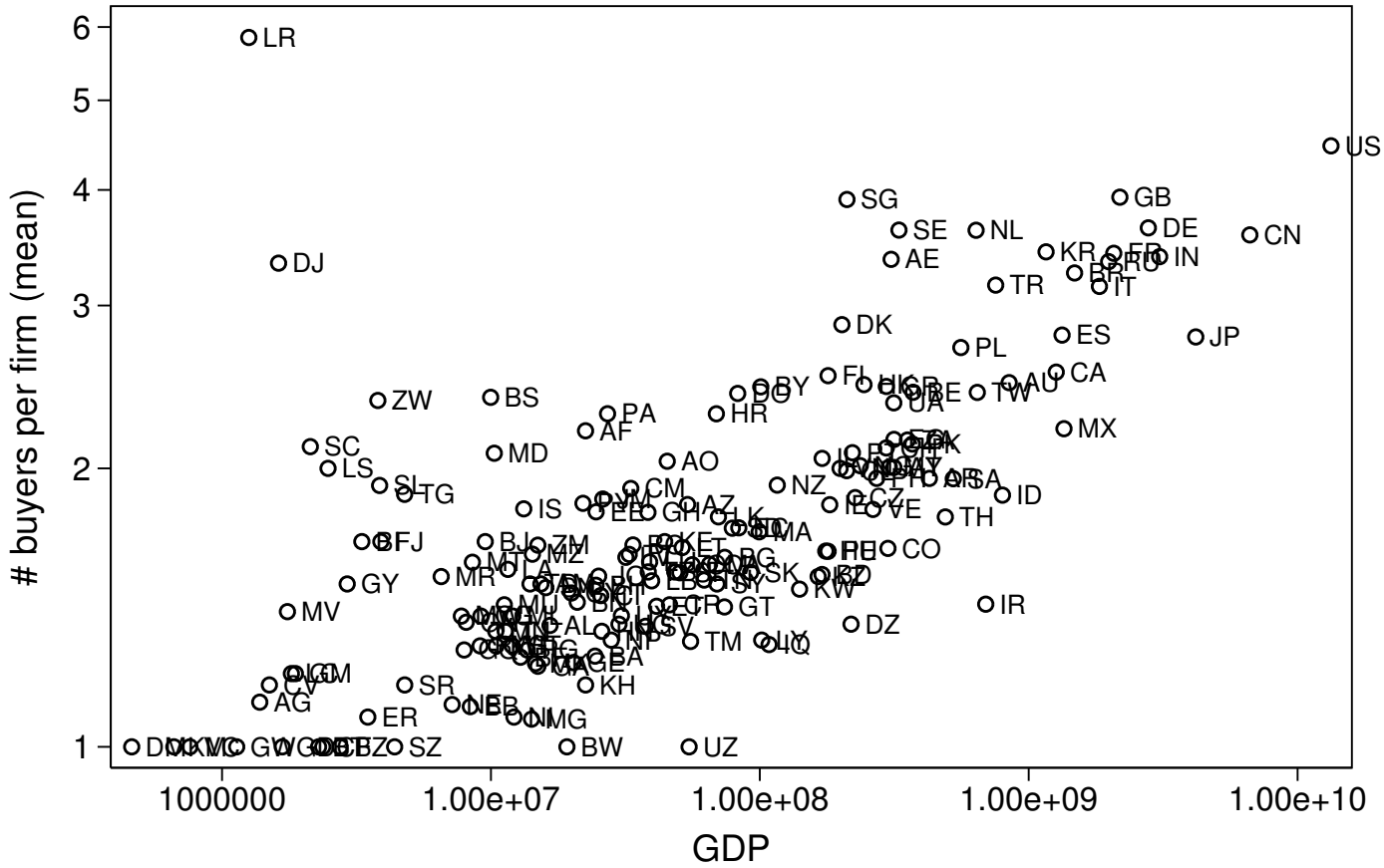
$$x_j = s_j p_j b_j d_j \bar{x}_j.$$

- s_j # sellers in country j, p_j # products, b_j # buyers, $\bar{x}_j$ average exports (per buyer-seller-product), and d_j density.
- Regress each of the margins on total exports (in logs), 2006.

VARIABLES	(1) Sellers	(2) Products	(3) Buyers	(4) Density	(5) Intensive
Exports (log)	0.57[a]	0.53[a]	0.61[a]	-1.05[a]	0.32[a]
	(0.02)	(0.02)	(0.02)	(0.04)	(0.02)
N	205	205	205	205	205
R^2	0.86	0.85	0.81	0.81	0.50

The buyer margin is as important as the product or exporter margins.

Fact 1 - Buyer Margin



The buyer margin is important in aggregate gravity.

Fact 1 - Buyer Margin

Regress each margin on a firm fixed effect, distance and GDP (in logs),

$$y_{fj} = \beta_f + \beta_1 \ln GDP_j + \beta_2 \ln Dist_j + \varepsilon_j$$

VARIABLES	(1) Exports	(3) # buyers	(5) Exports/buyer
Distance	-0.48^a	-0.31^a	-0.17^a
GDP	0.23^a	0.13^a	0.10^a
N	53,269	53,269	53,269
R^2	0.06	0.15	0.26

Note: 2006 data. Robust standard errors in parentheses clustered by firm. ^{a} p< 0.01, ^{b} p< 0.05, ^{c} p< 0.1.

The extensive buyer margin is an important component of gravity in trade.

Fact 2 - Concentrated Trade

The populations of sellers and buyers of Norwegian exports are both characterized by extreme concentration.

	Sweden	US	China
Trade share - top 10% sellers	.94	.96	.86
Trade share - top 10% buyers	.95	.97	.89
Number of exporters	8,614	2,088	725
Number of buyers	16,822	5,992	1,489
Share tot. exports (%)	11.3	8.8	2.1

Trade is dominated by the biggest exporters and importers.

Fact 2 - Concentrated Trade

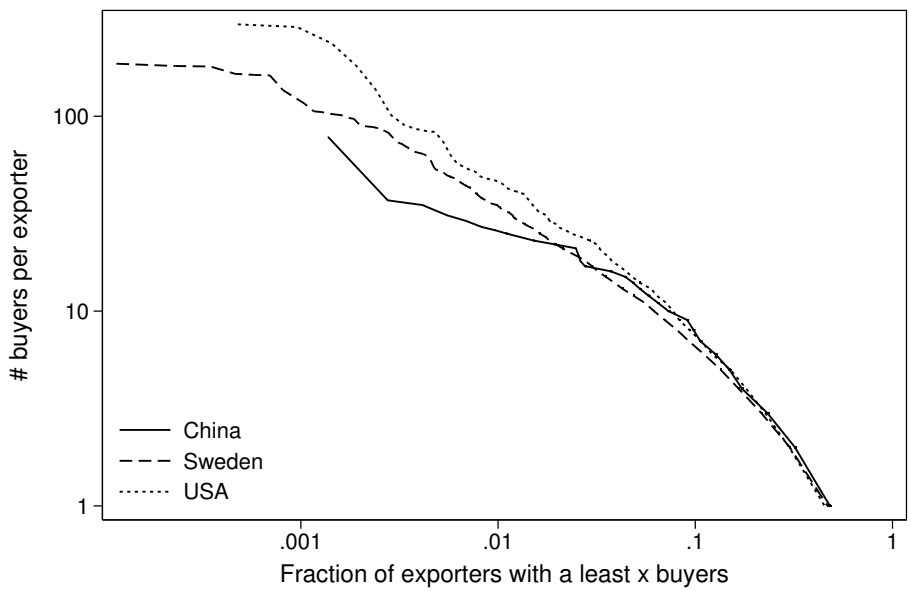
	(1) One-to-one	(2) Many-to-one	(3) One-to-many	(4) Many-to-many
Share of value, %	4.6	26.9	4.9	63.6
Share of counts, %	9.5	40.1	11.0	39.4

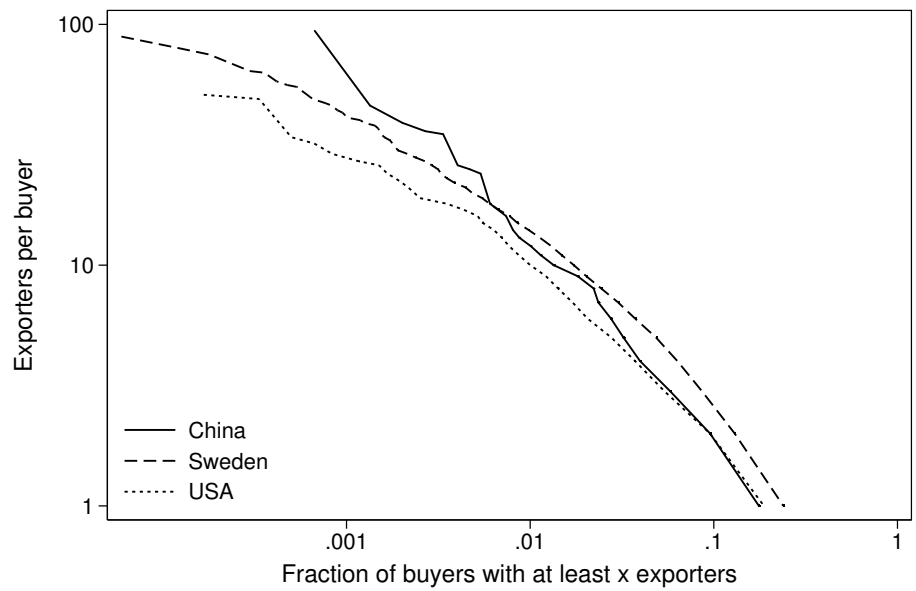
Note: 2006 data. (1) exporters (E) and importers (I) each have one connection in a market, (2) E has many connections and I has one, (3) E has one connection and I has many, (4) both E and I have many connections. The unit of observation is firm-destination.

Most trade involves at least one well-connected firm. One-to-one matches are rare and small in terms of value.

Fact 3 - Few to Many

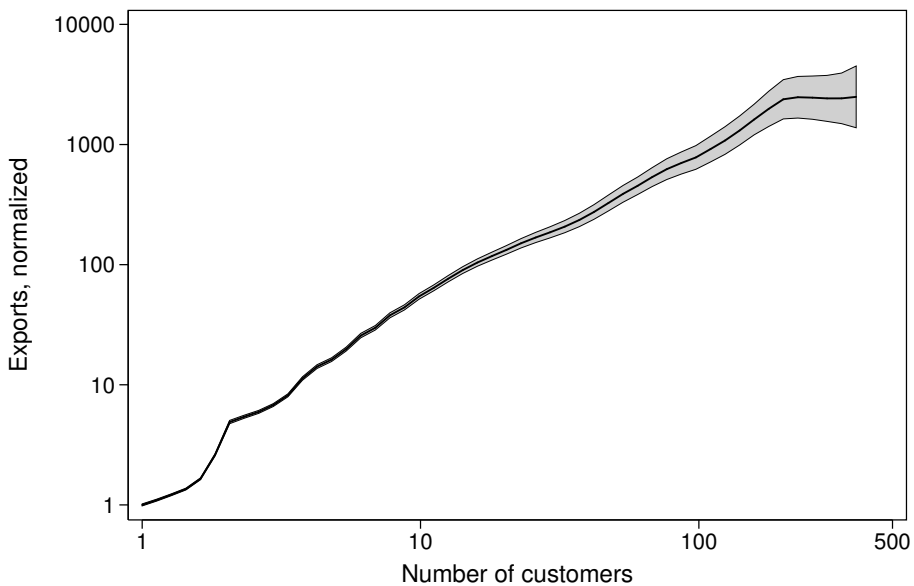
The distributions of buyers per firm and exporters per buyer are characterized by many firms with few connections and few firms with many connections.

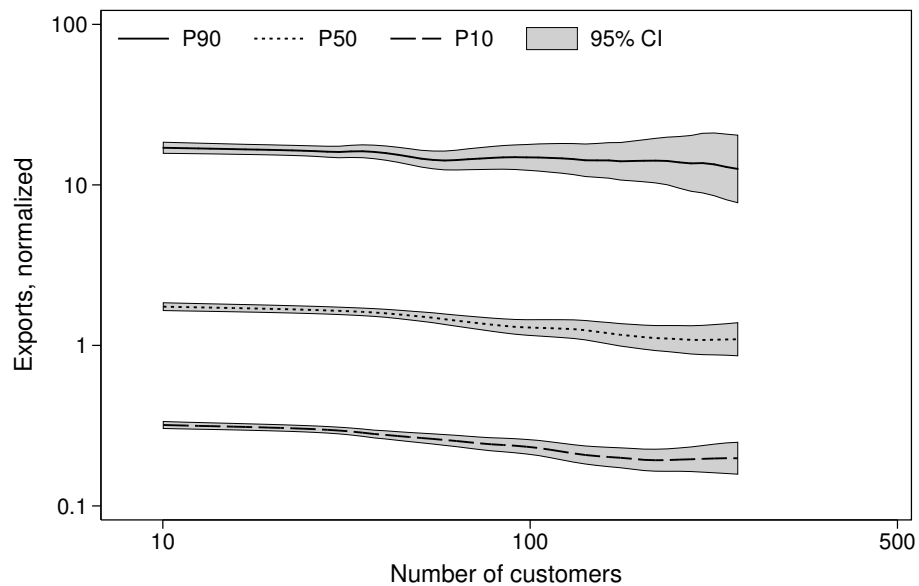




Fact 4 - More Customers = Big Exporters

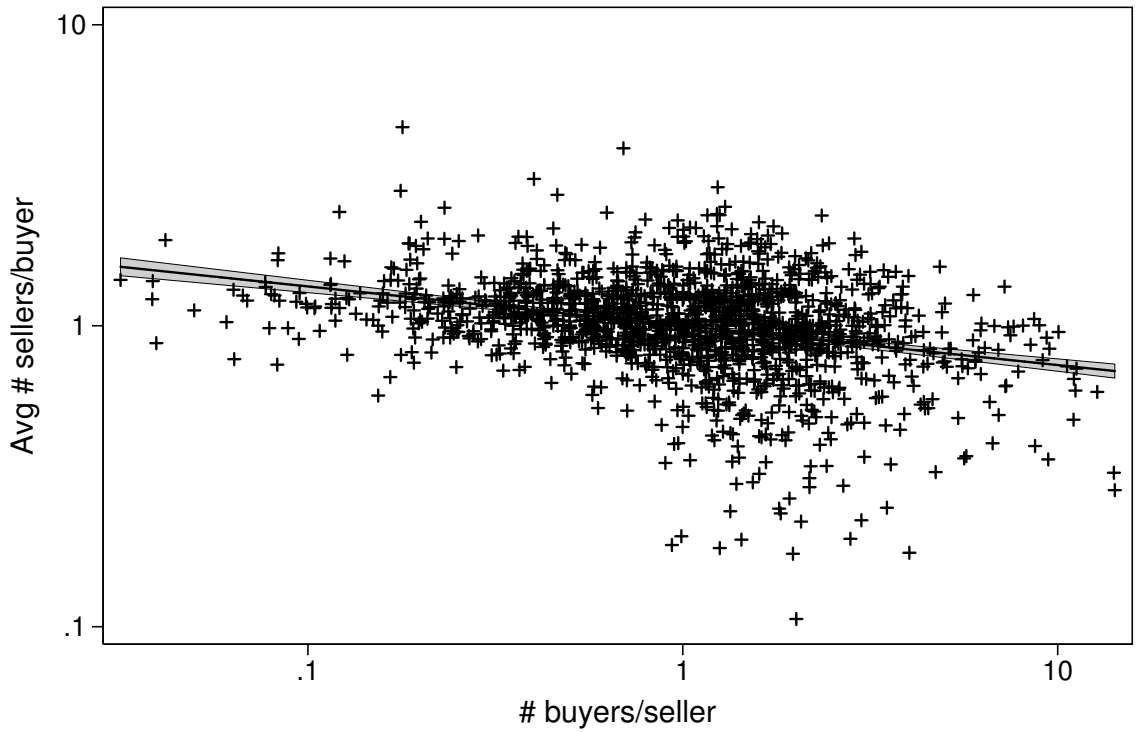
Within a market, exporters with more customers have higher total sales. However, the distribution of sales across buyers does not vary with the number of buyers.





Fact 5 - Negative Degree Assortivity

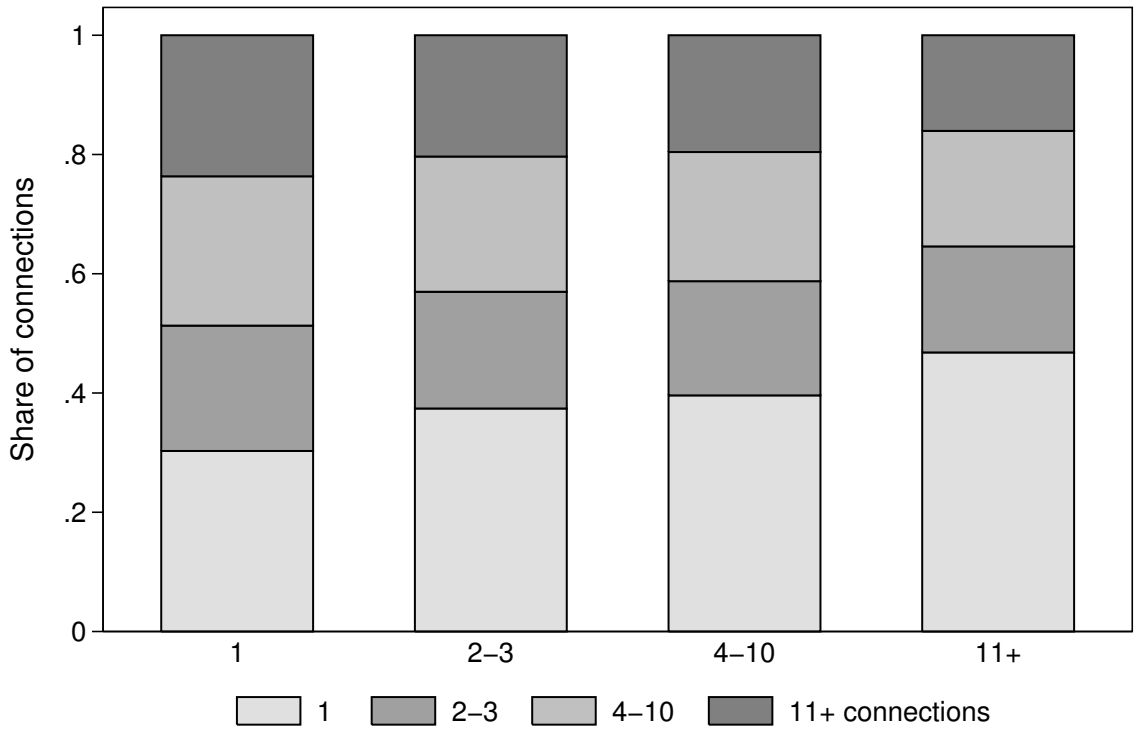
There is negative degree (extensive margin) assortativity among sellers and buyers.



Note: All possible values of the number of buyers per Norwegian firm in a given market, a_j, on the x-axis, and the average number of Norwegian connections among these buyers, $b_j(a_j)$, on the y-axis (in logs and demeaned). Regression slope is -0.13.

Fact 5 - Negative Degree Assortivity

Well-connected sellers sell to both well-connected and poorly-connected buyers. Less-connected sellers typically sell only to well-connected buyers.



Note: 2006 data. Destination market is Sweden. Each bar represents a group of exporters. The groups are (i) Firms with 1 connection, (ii) 2-3, (iii) 4-10 and (iv) 11+ connections.

The Model : Setup

Firms:

- 1 homogeneous good sector, freely traded and numeraire.
- 2 differentiated goods sectors, intermediate and final goods.
  - Market structure monopolistic competition.
- Intermediate goods ("sellers"):
  - Traded.
  - Labor only input, supplied inelastically.
  - Productivity z; Pareto with shape $\gamma > \sigma - 1$, lower bound z_L.
- Final goods ("buyers"):
  - Non-traded.
  - Intermediates only input, bundled with CES technology.
  - Elasticity of substitution over intermediates σ.
  - Productivity Z; Pareto with shape $\Gamma > \gamma$, lower bound normalized to 1.

The Model : Setup

Consumers:

- L_i workers, CES preferences over final goods.
- Elasticity of substitution over final goods σ.
- Wage w_i pinned down by outside sector.

Trade costs:

- Iceberg trade costs τ_{ij} from source i to destination j.
- Relation-specific cost f_{ij} for each match, incurred by seller.

Entry fixed:

- Exogenous measure n_i sellers and N_i buyers.
- Profits collected in Chaney (2008) global fund.
- Total worker income $w_i(1+\psi)L_i$, ψ the dividend per share of fund.

The Model : Solution

- Problem of the buyer:
  - Maximize profits by finding price $P(Z)$, given demand curve & set of available intermediates. Gives

$$P_j(Z) = \bar{m}\frac{q_j(Z)}{Z},$$

    where $q_i(Z)$ is the price index for inputs.
- Problem of the seller:
  - Maximize profits by finding price $p(z)$ and measure of buyers to sell to.
  - Define the lowest Z buyer that z will sell to $\underline{Z}_{ij}(z)$ so $\pi_{ij}\left(z, \underline{Z}_{ij}(z)\right) = 0$.

The Model : Solution

- Profits independent across buyers $\longrightarrow$ can solve $p(z)$ and $\underline{Z}_{ij}(z)$ separately.
- The marginal buyer is characterized by

$$\frac{r_{ij}\left(z, \underline{Z}_{ij}\right)}{\sigma} = \left(\frac{p_{ij}(z)}{q_j\left(\underline{Z}_{ij}\right)}\right)^{1-\sigma} \frac{E_j\left(\underline{Z}_{ij}\right)}{\sigma} = f_{ij}, \tag{1}$$

  where $E_j(Z)$ total spending on intermediates for firm Z.
- Problem: Both $q_j(Z)$ and $E_j(Z)$ are unknown functions.

Equilibrium Sorting

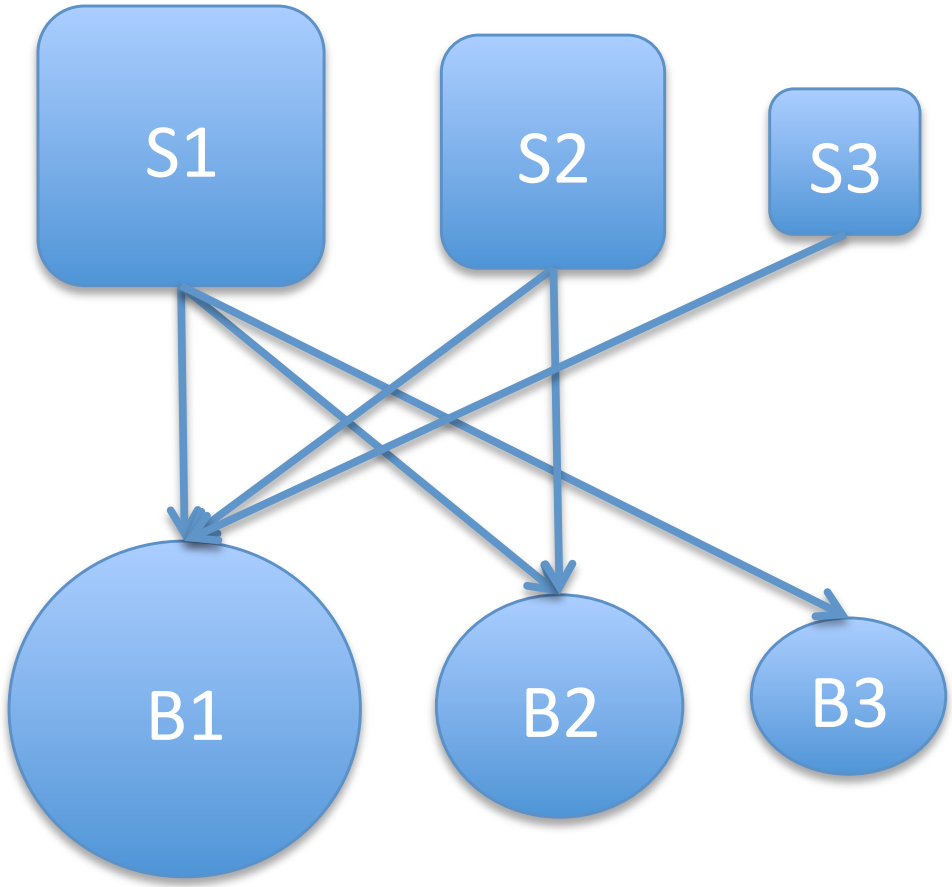
Sorting function:

$$\begin{aligned} \underline{Z}_{ij}(z) &= \frac{\tau_{ij} w_i \Omega_j}{z} f_{ij}^{1/(\sigma-1)} \left(\frac{Y_j}{N_j} \right)^{-1/\gamma} \\ \Omega_j &\equiv \left(\frac{\sigma}{\kappa_3} \frac{\gamma}{\gamma_2} \sum_k n'_k \left(\tau_{kj} w_k \right)^{-\gamma} f_{kj}^{-\gamma_2/(\sigma-1)} \right)^{1/\gamma}, \end{aligned}$$

where $\gamma_2 = \gamma - (\sigma - 1)$.
Intermediates spending:

$$E_j(Z) = \kappa_3 \frac{Y_j}{N_j} Z^{\gamma}.$$

Equilibrium Sorting



Trade Elasticities

Firm-level exports and number of buyers for $z < z_H$ firms:

$$r_{ij}^{TOT}(z) = \kappa_1 N_j f_{ij}^{1-\Gamma/(\sigma-1)} \left(\frac{z}{\tau_{ij} w_i \Omega_j}\right)^{\Gamma} \left(\frac{Y_j}{N_j}\right)^{\Gamma/\gamma},$$

$$b_{ij}(z) = N_j f_{ij}^{-\Gamma/(\sigma-1)} \left(\frac{z}{\tau_{ij} w_i \Omega_j}\right)^{\Gamma} \left(\frac{Y_j}{N_j}\right)^{\Gamma/\gamma}.$$

Proposition

For $z < z_H$, the elasticity of firm-level exports with respect to variable trade costs equals Γ, the Pareto shape coefficient for buyer productivity.

Firm-level Imports

$$R_{ij}^{TOT}(Z) = \kappa_4 Y_i (w_i f_{ij})^{1-\gamma/(\sigma-1)} \left(\frac{Z}{\tau_{ij} w_i \Omega_j} \right)^{\gamma},$$

while the measure of suppliers is

$$L_{ij}(Z) = Y_i (w_i f_{ij})^{-\gamma/(\sigma-1)} \left(\frac{Z}{\tau_{ij} w_i \Omega_j} \right)^{\gamma}.$$

Proposition

A downstream firm's marginal costs are inversely proportional to the market access term Ω_j.

Empirics: Proposition 1

Firm-level trade elasticity with respect to variable trade barriers is higher when importer productivity is less dispersed.

- Firm-level exports:

$$r_{ij}^{TOT}(z) = \kappa_1 N_j f_{ij}^{1-\Gamma/(\sigma-1)} \left(\frac{z}{\tau_{ij} w_i \Omega_j}\right)^{\Gamma} \left(\frac{Y_j}{N_j}\right)^{\Gamma/\gamma}$$

- The aggregate trade share is

$$\pi_{ij} = Y_i \left(w_i f_{ij}\right)^{1-\gamma/(\sigma-1)} \left(\tau_{ij} w_i \Omega_j\right)^{-\gamma}.$$

- Solving for $\tau_{ij} w_i \Omega_j$ gives us

$$r_{ij}^{TOT}(z) = \kappa_1 Y_j Y_i^{-\Gamma/\gamma} \left(w_i f_{ij}\right)^{1-\Gamma/\gamma} \pi_{ij}^{\Gamma/\gamma} z^{\Gamma}.$$

where the observable trade share is π_{ij}.

Empirics: Proposition 1

Empirical specification: (Taking logs), we estimate

$$\ln x_{mjkt} = \alpha_{mj} + \delta_{jt} + \beta_1 \ln Y_{jkt} + \beta_2 \ln \pi_{jkt} + \beta_3 \ln \pi_{jkt} \times \Gamma_j + \varepsilon_{mjkt}$$

- α_{mj} is a firm-country fixed effect
- We exploit industry-level variation (k) to include country-year fixed effects, δ_{jt}.
- $\partial \ln x_{mjkt} / \partial \ln \pi_{jkt} = \beta_2 + \Gamma_j \beta_3$,

$H_0 : \beta_3 > 0$, the elasticity is higher in markets with less importer dispersion.

Data Issues

Trade share, π_{jkt}, is potentially endogenous

- A Norwegian productivity increase drives exports and the trade share.
  - Instrument using the industry-destination trade shares of other Nordic countries.
  - Exclusion restriction: Nordic market shares do not directly impact Norwegian exports.
  - Possible violations bias down the estimated coefficients.

Dispersion of buyer productivity for each destination

- Calculate Pareto coefficient, Γ_j, from firm employment distributions
  - Orbis Database, $>$ 100 mill. firms worldwide.
  - Sampling may vary across countries $\longrightarrow$ Restrict sample to firms with $>$ 50 employees.
  - All countries with 1000 or more Orbis firms $\longrightarrow$ Pareto coeff for 48 countries (89% of exports).

Market Access and Heterogeneity - 2SLS

	(1) Exports	(2) # Buyers	(3) Exports	(4) # Buyers
Y_{jkt}	$.18^a$	$.05^a$	$.18^a$	$.05^a$
	(.01)	(.00)	(.01)	(.00)
π_{jkt}	$.30^a$	$.07^a$	$.33^a$	$.08^a$
	(.01)	(.00)	(.01)	(.00)
$\pi_{jkt} \times \Gamma_j^1$ (Pareto)	$.07^a$	$.01^b$		
	(.01)	(.00)		
$\pi_{jkt} \times \Gamma_j^2$ (Std. Dev.)			$-.10^a$	$-.01^a$
			(.01)	(.00)
Firm-country FE	Yes	Yes	Yes	Yes
Country-year FE	Yes	Yes	Yes	Yes
N	264,544	264,544	264,544	264,544

Note: Y_{jkt} is absorption in country-industry jk. π_{jkt} and $\pi_{jkt} \times \Gamma_j^1$ are instrumented with $\pi_{Nordic,jkt}$ and $\pi_{Nordic,jkt} \times$ respectively, where $\pi_{Nordic,jkt}$ is the Nordic (excluding Norway) market share in country-industry jk.

Lower buyer dispersion raises the elasticity with respect to variable trade costs.

Empirics: Proposition 2

A downstream firm's marginal costs are inversely proportional to the market access term, Ω_j.

- A sufficient statistic for a firm's change in marginal costs comes from
  - (i) the level of, and the change in, intermediate import shares and (ii) the trade elasticity γ.
- We evaluate the impact of the 2008-2009 trade collapse on Norwegian importers' production costs.
  - Rise in sourcing costs due to increased trade costs and a reduced pool of potential of suppliers reduces buyer-seller links and and increases downstream firms' marginal production costs.
  - Norwegian import data on 8000+ manufacturing firms, matched to foreign suppliers
  - Assess the fit of the model and evaluate the quantitative importance of the buyer margin.
  - Solve the model in changes (Dekle et al (2007)).

Empirics: Proposition 2

- The change in the market access term Ω_j is

$$\hat{\Omega}_{mj} \equiv \left(\sum_i \pi_{mij} \hat{\rho}_{ij} \right)^{1/\gamma}$$

  - ρ_{ij} is a composite index of *sourcing costs* for location i, $\hat{\rho}_{ij} \equiv \hat{Y}_i \left(\hat{\tau}_{ij} \hat{w}_i \right)^{-\gamma} \left(\hat{w}_i \hat{f}_{ij} \right)^{1-\gamma/(\sigma-1)}$.
  - π_{mij} is firm m's trade share in $t-1$.
  - Ω_{jm} is firm-specific as ex-ante trade shares π_{ijm} vary across firms.

Empirics: Proposition 2

The change in a downstream firm's import share from i is

$$\hat{\pi}_{mij} \equiv \frac{\hat{R}_{ij}^{TOT}(Z)}{\hat{E}_j(Z)} = \hat{\rho}_{ij}\hat{\Omega}_{mj}^{-\gamma}.$$

- Using the import share π_{mij} eliminates a firm's productivity Z thus isolating sourcing costs ρ_{ij}.
- This allows us to calculate the change in market access, $\hat{\Omega}_{mj}$, which is a weighted average of sourcing costs, using ex-ante trade shares π_{mij} as weights.

Estimating Sourcing Costs

Fixed point procedure

- No closed form solution for $\hat{\Omega}_{mj}$ because $\hat{\Omega}_{mj}$ and $\hat{\rho}_{ij}$ are non-linear functions of each other.
- Solve numerically for $\hat{\Omega}_{mj}$ using the following fixed point procedure.
  - Step 1: choose initial values for $\hat{\rho}_{ij}$.
  - Step 2: solve for $\hat{\Omega}^{\gamma}_{mj}$ for firm m
  - Step 3: calculate $\hat{\rho}_{ij} = \hat{\Omega}^{\gamma}_{mj}\hat{\pi}_{mij}$.
    - ★ The resulting sourcing cost $\hat{\rho}_{ij}$ will vary across firms because of measurement error and firm-country specific shocks.
    - ★ We take the median of $\hat{\rho}_{ij}$ across firms.

Normalization.

- $\hat{\rho}_{ij}$ is identified up to a constant
- The change in domestic sourcing cost is normalized to one, $\hat{\rho}_{1j} = 1$ where $i = 1$ is the domestic market.

Great Trade Collapse, 2008-2009 - Results

	Median	Mean	Weighted mean	Stdev
Data:				
$\ln \hat{\pi}_{mij}$	-0.099	-0.208	-0.212	1.099
$\ln \hat{L}_{mij}$	0	-0.079	-0.080	0.546
$\ln \hat{L}_{mij}$, ≥ 2 suppliers	-0.154	-0.216	-0.164	0.524
Model:				
$\ln \hat{\Omega}^{\gamma}_{mj}$	-0.014	-0.027	-0.035	0.036
$\ln \hat{\pi}_{mij}$	-0.112	-0.106	-0.106	0.109
$\ln \hat{L}_{mij}$	-0.112	-0.106	-0.106	0.109
$\ln \hat{L}_{mij}$, ≥ 2 suppliers	-0.105	-0.105	-0.117	0.086
Firms	3,331			
Countries	110			

Notes: 2008 to 2009 changes. Firm revenue is used as weights in weighted mean calculations. $\hat{\Omega}^{\gamma}_{mj}$ is change in market access for firm m, $\hat{\pi}_{mij}$ is change in the import share from i for firm m, and $\hat{L}_{mij}$ is change in the measure of suppliers from i for firm m .

Fall in weighted mean market access translates into a 1 percent cost increase.

Great Trade Collapse, 2008-2009 - Model Fit

	Median	Mean	Weighted mean	Stdev
Data:				
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The model captures the decline in supplier connections well.

Conclusions

- New stylized facts about importers and exporters in trade.
- Introduction of buyer-side heterogeneity into a standard trade model
  - Matching most of the new facts.
  - Empirical results consistent with testable implications of the model.
- Important new role for the *demand side* in understanding trade flows and trade margins.
- Extensive margin (suppliers) is important for marginal costs and measured productivity of downstream firms.