In Search of Trade Frictions

The Frank D. Graham Memorial Lecture

Princeton University
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Yale University
An exploration based on

‣ “Firm-to-Firm Trade …”
  ▪ joint with Jonathan Eaton and Francis Kramarz,
    ▪ they’re not responsible for any false claims here!

‣ Valuable comments
  ▪ Costas Arkolakis, Lorenzo Caliendo, Russell Cooper, Cecilia Fieler,
    Sharat Ganapati, Rod Ludema, …

‣ Invaluable research assistance
  ▪ Etienne Guigue and Bella Yao
Gravity for French Exports, 2017
Gravity for German Exports, 2017

- Imports From Germany Divided by GDP of Importer
- Distance, in hundreds of kilometers
Basic Questions

• Fraction of n’s spending imported from i (trade share)

\[
\frac{X_{ni}}{X_n} = \pi_{ni}
\]

• Why do trade shares vary so much?

• What type of friction drives that variation?

• Correlation with distance won’t answer this question
Typology of Trade Frictions

- **Type I**: Iceberg costs, Samuelson (1954)
  - freight costs, ad-valorem tariffs, etc.

- **Type II**: Fixed costs of exporting, Melitz (2003)
  - advertising investments, customizing products, etc.

- **Type III**: Search frictions, Chaney (2014)
  - customers (typically firms) ignorant of all that’s available
Bottom Line

- Models with only Type I and/or Type II frictions come up short

- **Type III** frictions square with new facts on the distribution of customers per French exporter

- Among EU countries, looks like **Type III** frictions could be dominant
Does it Matter?

- Need large Type I frictions to fit an order of magnitude variation in trade shares

- Take trade elasticity of 4, from Simonovska and Waugh (2014), and iceberg cost $d$

$$10^{-1} = d^{-4} \text{ implies } d = 1.78$$

- ... 80% cost increase, inconsistent with data on tariffs, freight rates, or cross-country price differentials for the same good

- Broader interpretation of trade frictions may resolve this tension
Outline of Talk

1. Describe evolution of firm-level trade models, driven by micro data

2. Introduce stripped-down version of firm-to-firm trade model, with search

3. Use it to reveal evidence of Type III frictions

4. Demonstrate the potential importance of such frictions for bilateral trade shares
Part I

- Micro data and evolution of models
  - Implications for trade frictions
Model Evolution

- Eaton, Kortum, and Kramarz (2011)
- Eaton, Kortum, and Kramarz (2019)

- All operate in general equilibrium, disciplined by macro trade shares …

\[ \pi_{ni} = \frac{X_{ni}}{X_n} \]
Type I, BEJK (2003)

- Add firms (imperfect competition) to Ricardian model of EK (2002)

\[ \pi_{ni} = \frac{d_{ni}^{-\theta}T_iw_i^{-\theta}}{\sum_{i'}d_{ni'}^{-\theta}T_{i'}w_{i'}^{-\theta}} \]

- Incorporating these trade shares, we can simulate a firm in country i producing some good j
  - will it export? what will it earn? how productive will it be?

- Successfully matched facts about US exporters
Coming up Short

- BEJK also makes a stark prediction for firms exporting to n from i, as a ratio to market share

\[ \frac{N_{ni}}{\pi_{ni}} = \alpha \]

- Several years later we could evaluate with 1986 data from Francis Kramarz on French exporters
  - ... now, using OECD data for 2012, we can examine other exporting countries too

- Plotting against market size, this ratio is not flat!
Lithuanian Exporters, 2012

Exporters Divided by Market Share (N/π)

Market Size ($ billions)
Type II, EKK (2011)

- Melitz (2003) model, with fixed costs (Type II frictions) explains why exporters flock to large markets

- Convenient Pareto parameterization of Chaney (2008)

\[ \mu_i^Z(z) = T_i z^{-\theta} \]

- … Type I frictions produce a parallel shift in measure of firms from i that can supply n at a cost below c

\[ \mu_{ni}(c) = d_{ni}^{-\theta} T_i \omega_i^{-\theta} c^\theta \]
Strengths

- If Type II frictions \( f \) vary only by destination, they drop out of the trade share equation

\[
\pi_{ni} = \frac{\mu_{ni}(c)}{\mu_n(c)} = \frac{d_{ni}^{-\theta}T_iw_i^{-\theta}}{\sum_{i'} d_{ni'}^{-\theta}T_{i'}w_{i'}^{-\theta}}
\]

- Number of exporters by destination

\[
\frac{N_{ni}}{\pi_{ni}} = \alpha \frac{X_n}{f_n}
\]

- ... increases in market size if \( X/f \) rises with market size
The OECD data show variation in sales per exporter, which the model attributes to Type II frictions.

We can simply back out these frictions as

\[ f_{ni} = \alpha \frac{X_{ni}}{N_{ni}} \]

Striking correlation with bilateral trade shares …
Type II Frictions

![Graph showing bilateral fixed costs vs. bilateral trade shares with source and destination effects removed.]
Coming up Short

- In this setting, bilateral trade shares become
  - … with CES demand elasticity $\sigma$

$$\tilde{\theta} = \theta / (\sigma - 1) > 1$$

Type I and Type II friction

$$\pi_{ni} = \frac{d_{ni} - \theta f_{ni}^{-(\tilde{\theta}-1)} T_i w_i^{-\theta}}{\sum_{i'} d_{ni'} - \theta f_{ni'}^{-(\tilde{\theta}-1)} T_i' w_i'^{-\theta}}$$

- Now require even more variation in Type I frictions
Type III, EKK (2019)

- Granular theory of trade with search frictions, developed throughout the remainder of today’s talk
- Incorporates Type I and Type III trade frictions
  - eschewing Type II
- Shares the strengths and accounts for the shortcomings of earlier models
  - … as we’ll see
Part II

- Firm-to-Firm Trade, with Eaton and Kramarz
  - stripped down
Provenance

- Close cousin to recent theories of individuals or firms interacting to exchange goods or technologies
  - Lucas (2009), Lucas and Moll (2014), and Oberfield (2018)

- In the spirit of Arkolakis (2011), with firms reaching individual consumers in foreign markets
  - but here integers are key

- Most like Chaney (2018) and Lim (2018)
  - but no dynamics

- EK and Melitz work together in this model
Motivation via Customer Data

- French exports to 24 other EU countries in 2005
  - and purchases by individual customers (from VAT)

- From Kramarz, Martin, and Mejean (2015)
  - Bernard, Moxnes, and Ulltveit-Moe (2017) have something similar for Norway
  - Lenoir, Martin, and Mejean (2019) consider the product level as well, interpreted using our firm-to-firm model

- New concept (for us) relationships

\[ R_{nF} = \bar{b}_{nF} N_{nF} \]
Exporters and Relationships

France

exporter 1

exporter 2

exporter 3

buyers

Germany

Lithuania

$N_{GF} = 3$

$R_{GF} = 6$

$\bar{b}_{GF} = 2$

$N_{LF} = R_{LF} = 1$
Basic Regressions

\[
\ln N_{nF} = -1.27 + 0.47 \ln X_n + 0.65 \ln \pi_{nF}
\]

\[
(0.63) \quad (0.04) \quad (0.11)
\]

\[
\ln R_{nF} = -2.71 + 0.81 \ln X_n + 1.02 \ln \pi_{nF}
\]

\[
(1.06) \quad (0.06) \quad (0.19)
\]

\[
N = 24, \quad R^2 = 0.92
\]
Overview

• Buyers and sellers meet randomly as in Mortensen and Pissarides (1994)

• **As buyers:** firms seek suppliers to carry out intermediate tasks for production
  - … or to serve final customers
  - Buy from the lowest cost seller they encounter, and they will always find one

• **As sellers:** firms seek customers, but may fail to find one in any given market
Search Frictions

- Potential exporter in $i$ (cost $c$) meets buyer in $n$ with intensity

$$\lambda_{ni}(c) = \lambda_{ni} B_n^{-\varphi} S_n(c)^{-\gamma}$$

- $B$ is measure of buyers

- $S(c)$ is the measure of suppliers with cost below $c$, from anywhere, weighted by inverse Type III frictions
  - Supplier congestion favors low-cost exporters

- Increasing returns in matching if $\varphi + \gamma < 1$
Production

- Potential producers in $i$ with efficiency $> z$
  \[ \mu_i^Z(z) = T_i z^{-\theta} \]

- ... who are able to sell in $n$ at cost $< c$
  \[ \mu_{ni}(c) = d_{ni}^{-\theta} T_i \Xi_i c^{\theta} \]

- Fixed point of firm-to-firm trade
  \[ \Xi_i = \bar{g} w_i^{-\theta \beta} \left( \frac{B_i^{1-\varphi}}{1 - \gamma} \sum_{i'} \lambda_{ii'} d_{ii'}^{-\theta} T_i \Xi_{i'} \right)^{1-\beta} \]
Buyer Choosing a Supplier

- At any cost $< c$, the number of suppliers from $i$ that a buyer meets is Poisson, with mean

$$\rho_{ni}(c) = \int_0^c \lambda_{ni}(c')d\mu_{ni}(c')$$

- Summing over source-countries $i$, Poisson mean

$$\rho_n(c) = \frac{1}{1 - \gamma} B_n^{-\phi} S_n(c)^{1-\gamma}$$

- Fraction of suppliers from $i$ is the trade share

$$\pi_{ni} = \frac{\rho_{ni}(c)}{\rho_n(c)} = \frac{\lambda_{ni}d_{ni}^{-\theta}T_i\Xi_i}{\sum_{i'} \lambda_{ni'}d_{ni'}^{-\theta}T_{i'}\Xi_{i'}}$$

Type III and Type I friction

In Search of Trade Frictions
Seller Finding Customers

- Number of customers, for seller with cost $c$ from country $i$, is Poisson with mean

$$\eta_{ni}(c) = \lambda_{ni}(c)B_n e^{-\rho_n(c)}$$

Poisson parameter for number of potential buyers encountered

Probability that potential buyer hasn’t met a lower cost supplier

- Empirical implications flow from this expression
Aggregate

• Measure of exporters

\[ N_{ni} = \int_{0}^{\infty} \left( 1 - e^{-\eta_{ni}(c)} \right) d\mu_{ni}(c) \]

• Measure of relationships

\[ R_{ni} = \int_{0}^{\infty} \eta_{ni}(c) d\mu_{ni}(c) \]
Relationships

‣ They integrate!

\[ R_{ni} = \pi_{ni}B_n \]

‣ Theory reproduces a feature of basic relationships regression, with coefficient of 1 on market share
  - Coefficient on market size likely reflects increasing returns in matching, but just beginning to formalize that

‣ Exporters are more subtle …
Exporters

- Simplify with a change of variable

\[ N_{ni} = \pi_{ni} B_n \frac{1}{\tilde{\lambda}_{ni}} \int_{0}^{\infty} \left( 1 - e^{-\tilde{\lambda}_{ni} \eta(x)} \right) dx = R_{ni} f(\tilde{\lambda}_{ni}) \]

\[ \eta(x) = x^{-\gamma} e^{-\frac{1}{1-\gamma} x^{1-\gamma}} \]

- Scale-adjusted search parameter

\[ \tilde{\lambda}_{ni} = \lambda_{ni} B_n^{1-\phi/(1-\gamma)} \]

- Given R, exporters decline in search parameter

  - Globalization and concentration go hand in hand
Customers of an Exporter

• Measure of exporters with exactly k customers in n

\[ N_{ni}^{(k)} = R_{ni} \frac{1}{\lambda_{ni}} \int_0^\infty \frac{1}{k!} \left( \tilde{\lambda}_{ni} \eta(x) \right)^k e^{-\tilde{\lambda}_{ni} \eta(x)} dx \]

• Fraction of exporters with exactly exactly k

\[ P_{ni}^{(k)} = \frac{\int_0^\infty \frac{1}{k!} \left( \tilde{\lambda}_{ni} \eta(x) \right)^k e^{-\tilde{\lambda}_{ni} \eta(x)} dx}{\int_0^\infty \left( 1 - e^{-\tilde{\lambda}_{ni} \eta(x)} \right) dx} \]
Part III

- Evidence of **Type III** Frictions
  - From 2005 data on customers of French exporters
Backing out Search Frictions

\[ f(\tilde{\lambda}) = \frac{1}{\tilde{\lambda}} \int_0^\infty \left( 1 - e^{-\tilde{\lambda} \eta(x)} \right) dx \]
Evaluation on French Data

- Step 1: Take supplier congestion, common to all destinations, from our earlier estimates $\gamma = 0.4$
- Step 2: Back out scale-adjusted search parameter, to match mean customers per exporter, for each of the 24 EU destinations $\tilde{\lambda}_{nF}$
- Step 3: Compute the distribution of customers per exporter in each of the 24 EU destinations $P_{nF}^{(k)}$
- Plot the Type III frictions, then evaluate fit for distributions of customers per exporter …
Implied inverse Type III Frictions
Customers of French Exporters

Lithuania: $\gamma = 0.4$

Fraction of exporters with that number of customers vs. Number of customers
Customers of French Exporters
Fraction of French Exporters with Corresponding Relationships
Part IV

- Contribution of Type III frictions
  - Using 2012 OECD data
Back to the OECD Data

- French data are, of course, limited to $i = F$
- To assess the contribution of Type III frictions, need a matrix across source $i$ and destination $n$
- EU countries in 2012, industry less construction
- Bilateral exporters $N$ and intra-EU exporters $E$ (and matching trade volumes)
Identification Strategy

- No relationships data, so need to estimate

\[ R_{ni} = \pi_{ni}B_n = \pi_{ni}\alpha_0X_n^{\alpha_1} \]

Stick with \( \gamma = 0.4 \)

- Back out Type III frictions, just identified given conjectured relationships
  - Model implies Type I frictions act only via trade shares

- Identify two remaining parameters by minimizing deviations from intra-EU exporters
Model Equations

- Bilateral exporters

\[ \frac{N_{ni}}{R_{ni}} = \frac{1}{\tilde{\lambda}_{ni}} \int_{0}^{\infty} \left( 1 - e^{-\tilde{\lambda}_{ni}\eta(x)} \right) dx \]

- Intra-EU exporters

\[ E_i = \int_{0}^{\infty} \left( 1 - e^{-\tilde{\eta}_i(y)} \right) dy \]

\[ \tilde{\eta}_i(y) = \sum_{n \neq i} \tilde{\lambda}_{ni} \left( \frac{\tilde{\lambda}_{ni}}{R_{ni} y} \right)^{-\gamma} e^{-\frac{1}{1-\gamma} \left( \frac{\tilde{\lambda}_{ni}}{R_{ni} y} \right)^{1-\gamma}} \]
Preliminary Findings

• Implied measure of buyers (estimate of alpha’s)

\[ B_n = 601.4 \times X_n^{0.639} \]

• How well do we fit bilateral and intra-EU exporters?
Decomposition of Trade Frictions

- Recall bilateral trade shares depend on both types of trade frictions

\[
\pi_{ni} = \frac{\tilde{\lambda}_{ni} d_{ni}^{-\theta} T_i \Xi_i}{\sum_{i'} \tilde{\lambda}_{ni} d_{ni'}^{-\theta} T_{i'} \Xi_{i'}}
\]

- Want to distinguish the role of Type III vs. Type I

- Inverse Type III frictions are highly correlated with trade shares, reducing the role of Type I

- Projecting each on source and destination fixed effects …
Type III Frictions (Inverse)
Type III Frictions are Dominant?

- Regress $\ln \tilde{\lambda}_{ni}$ on $\ln \pi_{ni}$
  - including a full set of source and destination-country effects
- Amounts to regressing $\ln \lambda_{ni}$ on $\ln \lambda_{ni}d_{ni}^{-\theta}$
- OLS slope coefficient:

$$\hat{\beta} = \frac{Var(\ln \lambda_{ni}) + Cov(\ln \lambda_{ni}, \ln d_{ni}^{-\theta})}{Var(\ln \lambda_{ni}) + Var(\ln d_{ni}^{-\theta}) + 2Cov(\ln \lambda_{ni}, \ln d_{ni}^{-\theta})}$$

- Ignoring the covariance, a slope close to 0 means Type I frictions dominate; a slope close to 1 means Type III frictions dominate

- Regression Table 1 …
## Regression Table 1

<table>
<thead>
<tr>
<th></th>
<th>Log($\hat{\lambda}_{ni}$)</th>
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<td></td>
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<td>(0.04)</td>
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<td>(0.82)</td>
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<td>90</td>
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<td>Dest. and source F.E.</td>
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<td>Yes</td>
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<td>Selected markets</td>
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<td>$R^2$</td>
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<td>0.93</td>
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$^1$ We drop 25 observations where we do not fit bilateral exporters $N_{ni}$.

OECD data 2012; Standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. 
A More Nuanced Picture

- If Type III frictions are dominant
  - our estimates of them are noisy!

- We haven’t killed distance, yet, but progress
  - when we limit the sample to the 10 largest economies

- Regression Table 2 …
Regression Table 2

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Conclusion

• **Type III** search frictions account for new facts
  - and appear to play a critical role in aggregate patterns of bilateral trade

• The stripped-down model of search frictions can be extended in many directions to ask new questions

• Jonathan Eaton, Francis Kramarz, and I are doing that in