International Trade
Introduction: Trade Facts and the Gravity Equation

Stefania Garetto
The field of International Trade tries to answer the following questions:

- What explains the pattern of trade across countries?
- What explains the changes in trade patterns over time?
- Which goods do countries trade?
- Which kind of firms trade?
- What can explain the growth in trade? Does trade affect GDP growth?
- What are the effects of trade on the labor markets? Does trade affect income inequality?
- What is the role of outsourcing, foreign direct investment (FDI) and multinational production (MP)? What are the causes and the effects of the geographic fragmentation of production?
World Trade

- After WWII, unprecedented growth of trade volumes, both in absolute terms and as % of GDP.

Figure 1: Volumes of World Trade
In the last 50 years, volumes of trade in the U.S. increased ten-fold.

Since the 70s, negative trade balance.

Figure 2: Volumes of US Trade
Trading Countries

- Major exporters (in absolute value): China, United States, Germany.
- Trade within U.S. + Europe accounts for about 1/3 of world total trade.
- Exports from U.S. + Europe account for almost 60% of world total export.

<table>
<thead>
<tr>
<th>Area</th>
<th>Share</th>
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<tbody>
<tr>
<td>Europe and the Americas</td>
<td>59%</td>
</tr>
<tr>
<td>Asia</td>
<td>30.5%</td>
</tr>
<tr>
<td>Middle East and Russia</td>
<td>7.5%</td>
</tr>
<tr>
<td>Africa</td>
<td>1.5%</td>
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<tr>
<td>Australia and New Zealand</td>
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Table 1: Share of world export, by area (2016). Source: WDI.

- About 42% of total trade flows happen between developed countries, about 37% between developing countries, about 21% between developed and developing countries.
- Rising importance of China: Chinese exports increased 40-fold in the last 30 years (they now account for 30% of Chinese GDP).
Figure 3: Trade as a % of GDP, selected countries.
U.S. Trading Partners

**Introduction**

- **Facts**
- **Theory**

**Gravity**

Large volumes of trade with **neighboring countries** and **large countries**.

**Top Ten U.S. Trading Partners, 2016**

- China: $578.588
- Canada: $544.894
- Mexico: $525.11
- Japan: $195.466
- Germany: $163.589
- South Korea: $112.198
- United Kingdom: $109.722
- France: $77.706
- India: $67.687
- Taiwan: $65.358

Total Trade ($ Billion)
Well, even before that...

- **1817: Ricardo’s *Principles of Political Economy and Taxation***

  THEORY OF COMPARATIVE ADVANTAGE: a country exports products in which its labor productivity is high relative to its labor productivity in other products, compared to the same magnitude for its trading partner(s).

- **1920s: Heckscher-Ohlin (HO)**

  FACTOR ENDOWMENTS DETERMINE THE PATTERN OF TRADE: a country should export the product that is relatively intensive in using the factor with which the country is relatively well-endowed.

The intuitive content of the HO Theory made it the dominant framework in the early stages of the field...
Testing the Heckscher-Ohlin prediction

... attracting the attention of empirical research too:

- 1954: LEONTIEF PARADOX:

  Leontief found that the $K/L$ ratio embodied in US imports exceeded the one in US exports (opposite to HO if we believe the US are more capital intensive than their trading partners).
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- **1960s-1980s: other attempts to test the theory obtained mixed results.**
  Attempts based on pure accounting relationships and unrealistic assumptions: factor price equalization (FPE), common technologies and production structures across countries.
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- **Trefler (1995):** reconciles the HO model with the data by taking into account productivity differences.
The empirical failure of the HO model motivated a “return” of the field to Ricardian frameworks: the data suggest the need to MODEL CROSS-COUNTRY DIFFERENCES IN TECHNOLOGY AND PRODUCTION STRUCTURE.

Only in the early 2000s the Ricardian model comes back as the “textbook” framework that provides a good fit with the (aggregate) trade data (Eaton and Kortum, 2002).

As of today, the EK model (with its extensions) remains the dominant framework to model bilateral trade flows across countries.

In the meantime...
The “New Trade Theory”

- Krugman (1979): new, complementary theory based on ECONOMIES OF SCALE and PRODUCT DIFFERENTIATION.

Motivated by:

1. Large volumes of trade between countries with similar factor proportions.

2. Large volumes of intra-industry trade.

(None of this can be driven by differences in factor endowments).
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In the first half of this semester we will study the H-O model, Ricardian Trade Theory, and New Trade Theory.
Back to the Data: Trade and Size

Gravity
- Evidence
- Setup
- Border Effect
- Trade Costs
- Distance

Figure 2-2
The Size of European Economies, and the Value of Their Trade with the United States

**Trade and Distance**

**Figure 2-3**

**Economic Size and Trade with the United States**

The United States does markedly more trade with its neighbors than it does with European economies of the same size.

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This pattern can be tested empirically with the Gravity Equation:

$$T_{ij} = \alpha + \beta(GDP_i \times GDP_j) + \gamma D_{ij} + \varepsilon_{ij}$$

where:

- $T_{ij}$ denotes bilateral trade flows between countries $i$ and $j$
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There is “gravity” when:

- $\hat{\beta} > 0$
- $\hat{\gamma} < 0.$
Consider a world where:
- every country is specialized in a distinct set of products;
- each country’s population has the same homothetic preferences;
- trade is balanced;
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- expenditures in imported goods are also proportional to GDP levels.
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**GRAVITY**: VOLUMES OF TRADE are positively related to the GDP LEVELS of the trading countries and negatively related to the DISTANCE between the trading countries.

[Notice: gravity needs a minimal set of assumptions to hold. It could be generated by a Ricardian model, by HO, or by the new trade theory models.]
The Gravity Equation under Free Trade

- $y^i_k$: country $i$'s output of good $k$;

- $Y^i := \sum_{k=1}^{N} y^i_k$: country $i$'s GDP;

- $Y := \sum_{i=1}^{I} Y^i$: world GDP;

- $s^i := Y^i / Y$: country $i$'s share of world expenditure (GDP).

Exports from $i$ to $j$ of good $k$: $X_{k}^{ij} = s^j y^i_k$.

Total exports from $i$ to $j$:

$$X^{ij} = \sum_{k=1}^{N} X_{k}^{ij} = s^j \sum_{k=1}^{N} y^i_k = s^j Y^i = \frac{Y^j Y^i}{Y} = s^j s^i Y (= X^{ji}).$$

Bilateral trade between $i$ and $j$:

$$X^{ij} + X^{ji} = \frac{2Y^j Y^i}{Y} = 2s^j s^i Y. \quad (1)$$
The Role of Trade Barriers: The Border Effect


\[
\ln X_{ij} = \alpha + \beta_1 \ln(Y_i) + \beta_2 \ln(Y_j) + \rho \ln(d_{ij}) + \gamma \delta_{ij} + \varepsilon_{ij}
\]

where \(d_{ij}\) = distance and \(\delta_{ij} = 1\) if within-Canada trade, zero otherwise.

Results:

\[
\hat{\beta}_1, \hat{\beta}_2 \approx 1 \\
\hat{\rho} < 0 \Rightarrow \text{negative effect of distance} \\
\hat{\gamma} \approx 3 \Rightarrow \text{BORDER EFFECT: intranational trade is about 22 times larger than international trade!!!}
\]

\(\Rightarrow\) Need of introducing TRADE BARRIERS into the analysis!

BUT: This implies that prices may differ across countries: need for more microfoundation, including prices in the Gravity Equation.
A Simple Model

- $X_{ij}^k$: exports from $i$ to $j$ of good $k$;
- $c_{ij}^k$: consumption in $j$ of good $k$ (produced in $i$), $X_{ik}^k = p_{ik}^j c_{ij}^k$;
- $N_i$: number of products produced in country $i$;
- $p_i$: F.O.B. price of goods produced in country $i$;
- $p_{ij}^i = T_{ij}^i p_i$: C.I.F. price of goods prod. in $i$ and sold in $j$, $T_{ij}^i \geq 1$, $T_{ii}^i = 1$.

Assume each good is produced with the same technology:
$p_{ij}^i = p_{ij}^j$, $\forall k \Rightarrow c_{ij}^k = c_{ij}^j$, $\forall k$.

$$
\max_{c_{ij}^j} U_j = \left[ \sum_{i=1}^I N_i (c_{ij}^j)^{\frac{\sigma-1}{\sigma}} \right]^\frac{\sigma}{\sigma-1}
$$

Consumers’ problem:
$$
s.t. \sum_{i=1}^I N_i p_{ij}^i c_{ij}^j = Y_j
$$
(where $\sigma > 1$). The solution takes the form:

$$
X_{ij} = N_i \left( \frac{p_{ij}^i}{P_j} \right)^{1-\sigma} \quad Y_j = \frac{Y_i Y_j}{(p_i)^{\sigma} \bar{y}} \left( \frac{T_{ij}^i}{P_j} \right)^{1-\sigma}
$$

(2)

where $P_j = \left[ \sum_{i=1}^I N_i (p_{ij}^i)^{1-\sigma} \right]^{\frac{1}{1-\sigma}}$ and $\bar{y} = Y_i / (N_i p_i)$. 

Estimating Price Indexes

Gravity Equation:

\[ X_{ij} = \frac{Y_i Y_j}{(p_i)^\sigma \bar{y}} \left( \frac{T_{ij}}{P_j} \right)^{1-\sigma} \]

Estimating equation:

\[ \Delta \ln X_{ij} = \Delta \ln (Y_i Y_j) + (1-\sigma) \Delta \ln T_{ij} - \sigma \Delta \ln p^i + (\sigma - 1) \Delta \ln (P_j) + \varepsilon_{ij} \]
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But ideal price indexes are not observable! 3 approaches:

1. directly measure them as **GDP deflators**;
2. estimate them using the **market clearing conditions** of the model: Anderson and van Wincoop (2003);
3. proxy for them using **country fixed effects**.
Market clearing: \( p^i y^i = \sum_{j=1}^{I} T^{ij} p^i c^{ij} \).

**Theorem 1** Assume trade costs are symmetric: \( T^{ij} = T^{ji} \). Then an implicit solution to the market clearing condition is:

\[
p^i = \frac{1}{P^i} \left( \frac{s^i}{N^i} \right)^{\frac{1}{1-\sigma}}
\]  

(3)

which implies:

\[
(P^j)^{1-\sigma} = \sum_{i=1}^{I} s^i \left( \frac{T^{ij}}{P^i} \right)^{1-\sigma}.
\]  

(4)

Why this is progress? Substituting (3) into the gravity equation, we obtain:

\[
X^{ij} = \frac{Y^i Y^j}{Y} \left( \frac{T^{ij}}{P^i P^j} \right)^{1-\sigma}.
\]
Assume the following form for $T^{i,j}$:

$$T^{i,j} = \tau^{i,j} + \rho \ln(d^{i,j}) + \varepsilon^{i,j}. \quad (5)$$

The gravity equation

$$X^{i,j} = \frac{Y_i Y_j}{Y} \left( \frac{T^{i,j}}{P_i P_j} \right)^{1-\sigma}$$

leads to the following estimation equation:

$$\ln\left(\frac{X^{i,j}}{(Y_i Y_j)}\right) = \rho(1 - \sigma) \ln(d^{i,j}) + (1 - \sigma) \tau^{i,j} + ...$$

$$+ \ln(P_i)^{\sigma-1} + \ln(P_j)^{\sigma-1} + (1 - \sigma) \varepsilon^{i,j}. \quad (6)$$

Estimation of system (4)-(6):

1. Run the estimation equation (6).
2. Use (5) to obtain predicted values for $T^{i,j}$.
3. Use (4) to compute the “multilateral resistance terms” $(P_i)^{\sigma-1}$, $(P_j)^{\sigma-1}$.
4. Iterate until convergence.
Results:

1. **Size** (+) and **trade barriers** (-) matter in determining volumes of trade.
Anderson and van Wincoop (2003) (cont.)

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Anderson and van Wincoop (2003) (cont.)

- Introduction
  - Gravity
    - Evidence
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5. **Asymmetry of the border effect**: intranational trade is about 2.5 times higher than international trade for the US, suggesting a larger border effect for smaller countries.

Exhaustive survey of the literature on measurement of trade costs.
Look at different types of trade costs:

1. Transportation costs
2. Policy barriers (tariff and non-tariff barriers)
3. Wholesale and distribution costs

and at sources of data on trade costs:

- direct measures
- indirect measures
  - from evidence on quantities
  - from evidence on prices.

Use gravity theory to infer trade costs from trade volumes and other observable variables.
Meta-analysis of the relation between distance and bilateral trade flows (look at 1,467 gravity estimates in 103 papers).

Main results:

- Persistence of the distance effect:
  1. Significant effect in all studies (with different samples and methodologies);
  2. NOT declining over time: the negative impact of distance on trade flows increased around 1950 and remained persistently high since then.

- Mean estimated distance effect: $-0.9$ (a 10% increase in distance lowers bilateral trade by about 9%). This is a large effect, cannot arise only because of transportation costs!