Understanding Bilateral Trade

- bilateral trade rises with the size of either trading partner
- countries further apart trade less
- borders appear to impede trade a lot

The gravity model explains these patterns

Frictionless Gravity Setup

size alone has a lot of explanatory power, isolated here.
Assume

- demand at each destination for goods from all origins
- market clearance
- perfect arbitrage with, for now, no trade costs

Notation: Expenditure by j is E_j; GDP of i is Y_i; world GDP is Y.

Exports flow from i to j, X_{ij} is given by:

$$X_{ij} = \frac{Y_i E_j}{Y}$$

Frictionless Gravity Derivation

Expenditure on *i*'s goods by *j*

$$X_{ij} = \alpha_i E_j \tag{1}$$

The market clearance requirement implies that

$$\sum_j X_{ij} = Y_i.$$

Replace X_{ij} with $\alpha_i E_j$ in the market clearance equation above.
Solve the equation for the expenditure share parameter:

$$\alpha_i = Y_i / \sum_j E_j.$$

World budget constraint $\Rightarrow \sum_j E_j = \sum_i Y_i = Y$.
Substitute Y_i / Y for α_i in (1) for the frictionless gravity equation:

$$X_{ij} = Y_i E_j / Y. \tag{2}$$

Implications of Frictionless Gravity

Define $s_i = Y_i/Y$, country i's share of world GDP. Balanced trade $\Rightarrow E_j = Y_j$.

The frictionless gravity equation can be written

$$X_{ij} = s_i s_j Y.$$

Implications

1. Any country trades more with bigger partners.
2. smaller countries are more naturally open.

$$\sum_{i \neq j} X_{ij}/Y_j = 1 - s_j$$

   which is decreasing in s_j.
3. Country pairs that are growing faster than the world average have an increasing share of the world's trade

$$\frac{X_{ij}}{\sum_{i \neq j} X_{ij}} = \frac{s_i}{1 - s_j}.$$

   This expression is increasing in both s_i and s_j.

Evidence of Frictions

Trade is much smaller than indicated by (2). US has 25 percent of world GDP, exports should be 75 percent of GDP vs. 10 percent actual.

- Trade falls sharply with distance:

$$X_{ij} = \frac{Y_i E_j}{Y} \frac{1}{D_{ij}}$$

  gives a pretty good fit with actual trade data.
- Crossing borders reduces trade a lot.
- McCallum: Canadian provinces trade 22 times as much with other Canadian provinces as with US states, all else equal! The border puzzle.

Economic Theory of Gravity

Arbitrage: $p_{ij} = p_i t_{ij}$, where $t_{ij} > 1$ is a trade cost markup factor and p_i is the factory gate price of GDP of country i.

expenditure share assumption

$$\alpha_{ij} = \frac{(p_i t_{ij})^{1-\sigma}}{P_j^{1-\sigma}}, \tag{3}$$

where $\sigma > 1$ is the elasticity of substitution parameter and P_j is the cost of living (consumer price) index, an index of all the p_{ij}'s.

Derivation of Gravity

$X_{ij} = \alpha_{ij} E_j$ becomes

$$X_{ij} = \left\{ \frac{t_{ij}}{\Pi_i P_j} \right\}^{1-\sigma} \frac{Y_i E_j}{Y}.$$

Π_i: index of trade costs (t_{ij}'s) that origin i faces on its shipments (outward multilateral resistance).

P_j: consumer price index, also an index of the trade costs (t_{ij}'s) that destination j faces on its shipments (inward multilateral resistance).

Statistical Inference of Gravity

Inference of trade costs from trade flows: assume t_{ij} is loglinearly related to distance D_{ij}, border related variables (e.g. language, currencies...), directly observed trade costs such as tariffs, transport charges.

Gravity in logs (lower case denotes the log of a variable, e.g., $x = log(X)$):

$$x_{ij} = y_i + e_j - y + (1 - \sigma)(ad_{ij} + b_{ij} + \cdots) - (1 - \sigma)(\pi_i + p_j) + \epsilon_{ij},$$

where ϵ_{ij} is a random error term.

Trade Pattern Implications

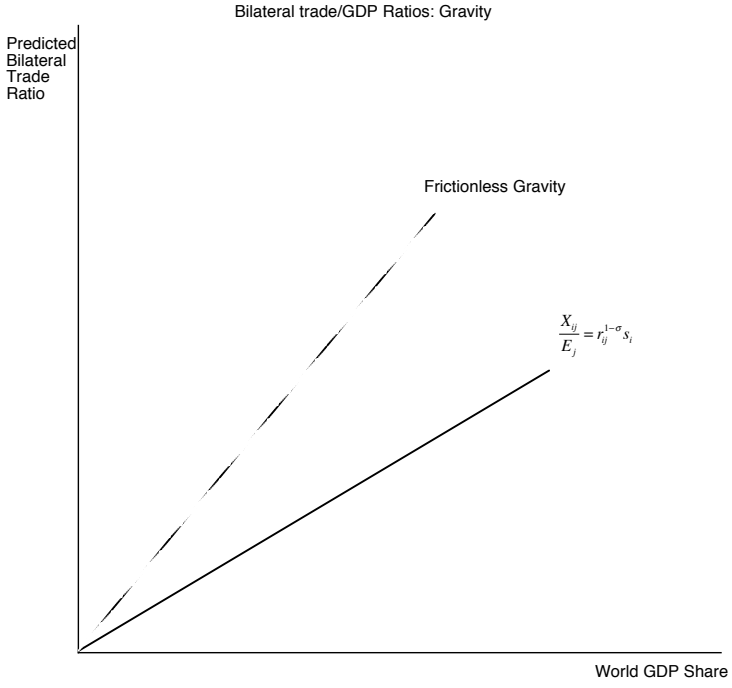
Define relative resistance

$$r_{ij} = \frac{t_{ij}}{\Pi_i P_j}.$$

Gravity implies the bilateral trade to GDP ratio (assuming balanced trade):

$$\frac{X_{ij}}{E_j} = r_{ij}^{1-\sigma} s_i.$$

A diagram shows the predicted relationship referenced by the frictionless relationship where $r_{ij} = 1$ and for a constant friction $r_{ij} > 1$, associated with an average distance and average border effects.



Country *j*'s trade flows lie on the solid line for partners with average distance, border effects. Below for longer distance and higher border barriers; above for lower.

Relative Trade Implications

Exports of EU country i to the US:

$$X_{i,US} = \frac{Y_i E_{US}}{Y} r_{i,US}^{1-\sigma}.$$

The total exports of the EU to the US:

$$X_{EU,US} = \frac{Y_{EU} E_{US}}{Y} \bar{r}_{EU,US}^{1-\sigma},$$

obtained by summing the preceding equation across EU countries and defining an average EU to US relative resistance. Taking the ratio of the second equation to the first yields:

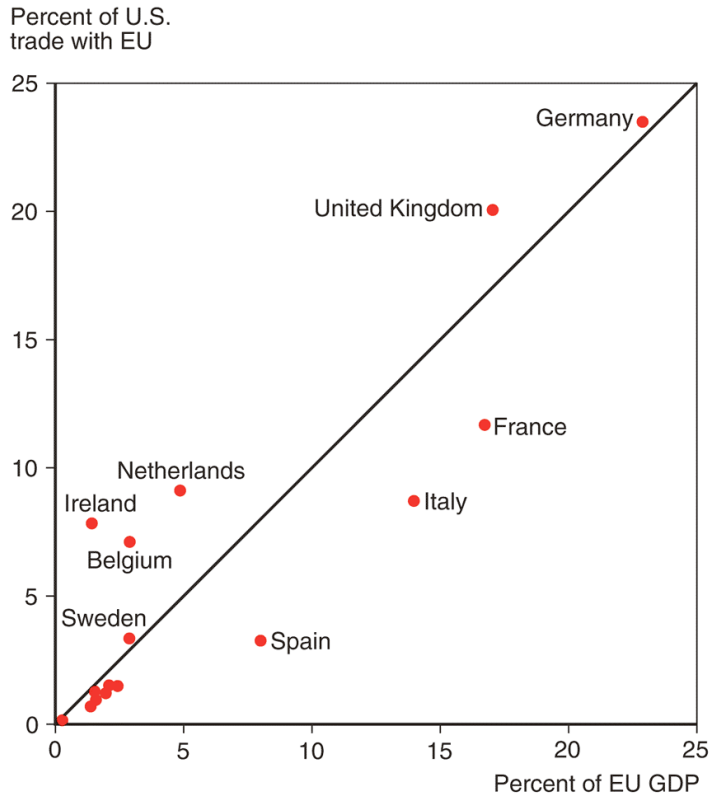
$$\frac{X_{i,US}}{X_{EU,US}} = \frac{Y_i}{Y_{EU}} \frac{r_{i,US}^{1-\sigma}}{\bar{r}_{EU,US}^{1-\sigma}}.$$

Size Matters: The Gravity Model (cont.)

Figure 2-2

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

Source: U.S. Department of Commerce, European Commission.



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Interpretation

P_{US} is a constant, so it cancels out. Relative resistance varies because

1. bilateral resistance varies over EU to US pairs. Countries with good infrastructure oriented toward the western coast of Europe are likely to have lower trade costs.
2. outward multilateral resistance varies over the EU countries. Smaller countries have higher multilateral resistance, lowering their relative resistance.

In Figure 2-2,

- both (1) and (2) operate to increase the EU to US trade share of Ireland, Netherlands and Belgium; and to decrease the EU to US trade share of Spain, Italy and France.
- The two factors tend to offset for the EU to US trade share of the UK and Germany, with (1) apparently dominating (2).
- For Sweden, trade decreasing (1) is offset by the trade increasing effect (2).

Resolving the Border Puzzle: Theory

Theoretical gravity model implies

$$\frac{X_{ij}}{X_{ik}} = \frac{t_{ij}^{1-\sigma}}{t_{ik}^{1-\sigma}} \frac{\Pi_i^{1-\sigma} P_k^{1-\sigma}}{\Pi_i^{1-\sigma} P_j^{1-\sigma}} \frac{Y_i E_j}{Y_i E_k}$$

for a pair of regions i and j within Canada relative to Canadian province i and US state k. For pairs the same distance apart and with the same total expenditure levels:

$$\frac{1}{\tau^{1-\sigma}} \frac{P_k^{1-\sigma}}{P_j^{1-\sigma}} = \tau^{\sigma-1} \frac{P_j^{\sigma-1}}{P_k^{\sigma-1}}.$$

Here $\tau > 1$ is the implicit cost factor due to crossing the border. McCallum's border effect combines the effect of a 'pure' border cost with the effect of borders on relative multilateral resistance.

Country Size and Multilateral Resistance

The US is about 10 times the size of Canada.

- Multilateral resistance (P and Π) is generally decreasing in country size.
- The intuition is that small countries or regions have more of their purchases or sales crossing international borders, raising their average trade costs.

Thus Canadian provinces have higher P's than US states.

Resolving the Border Puzzle: Results

Anderson and van Wincoop (2003).
τ is around 1.4; equivalent to a 40 per cent 'tax' imposed by crossing the border.

If $\sigma = 6$, a reasonable estimate in the context of the gravity model, then the effect of the border is to multiply within border trade relative to cross border trade by a factor 5.4. The effect of higher average multilateral resistance in Canada acts to roughly double this 'pure' effect of the border.

McCallum's larger estimate reflects omitted variable bias (multilateral resistance) and different data.

Trade Cost Evidence: AvW, 2004

Representative OECD total cost equivalent = 170%

- 21% transportation costs, (direct plus 9% time value of transport)
- 44% border related trade barriers
- 55% retail and wholesale margins
- total 1.7=1.21*1.44*1.55-1

Border Barriers

- 8% direct policy barrier
- 7% language barrier
- 14% currency barrier (from the use of different currencies)
- 6% information cost barrier
- 3% security barrier
- 44% total $=1.08 * 1.07 * 1.14 * 1.06 * 1.03 - 1$
- Overall range of g-model border barriers comparison (Table 7): 25-50%

Heterogeneity of Trade Costs

- Bigger for non-OECD countries: Latin Am policy 16%, security 16%; Argentina domestic margin 80%
- Commodity line variation is big
- costs of trading firms?

Empirical Puzzles

- why does distance matter so much?
- why do borders matter so much?
- currency barrier puzzle

Likely to be wide heterogeneity of trade cost across goods. Likely to have big implications for resource allocation. Likely to be aggregation bias in preceding estimates.