Trade, Size, and Frictions: the Gravity Model

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1 International Trade

Map of World Trade

FIGURE 1-1

World Trade in Goods, 2006 ($ billions) Trade in merchandise goods between selected countries and regions of the world.

Figure 1: Trade is proportional to size

(a) Japan's exports to EU, 2006 (b) Japan's imports from EU, 2006

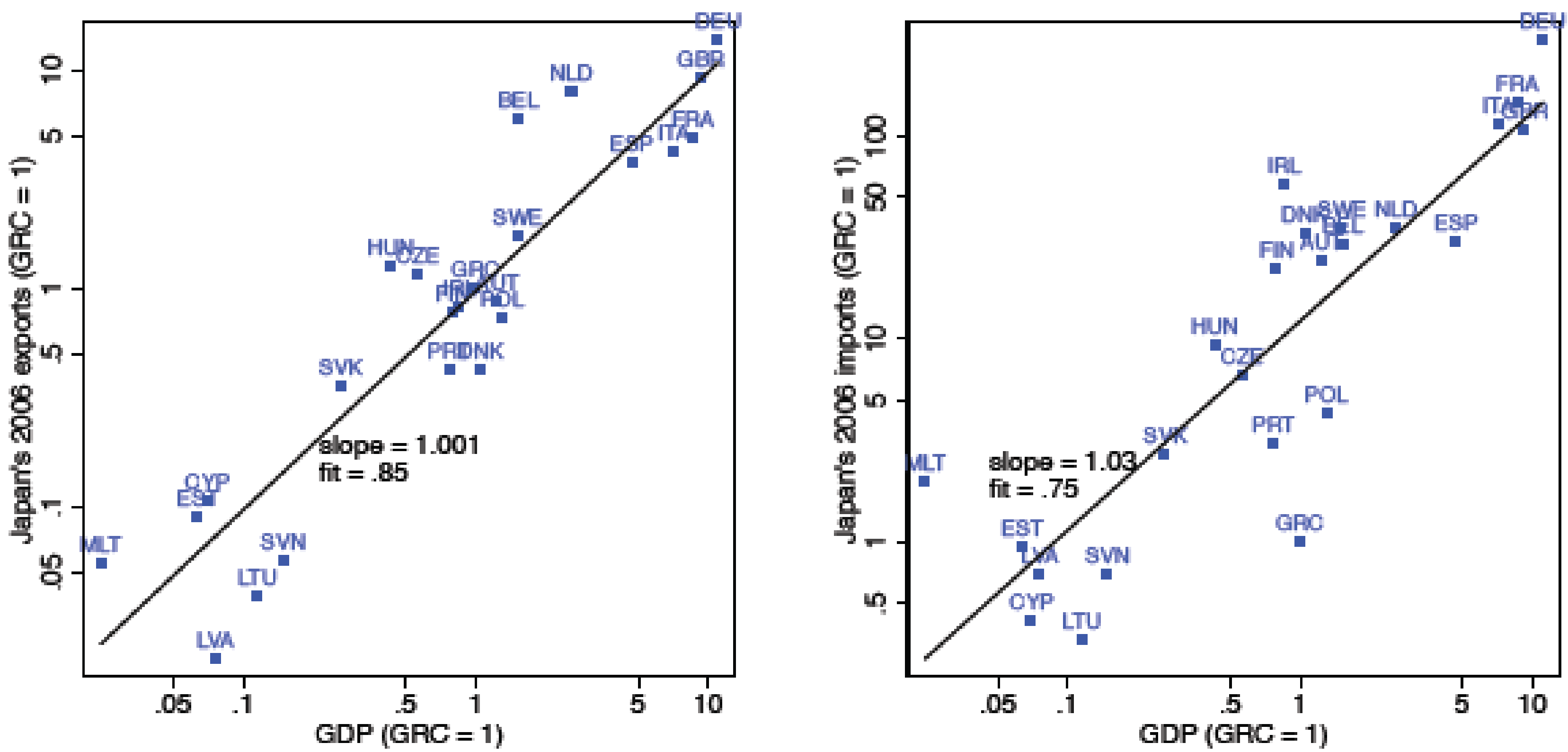
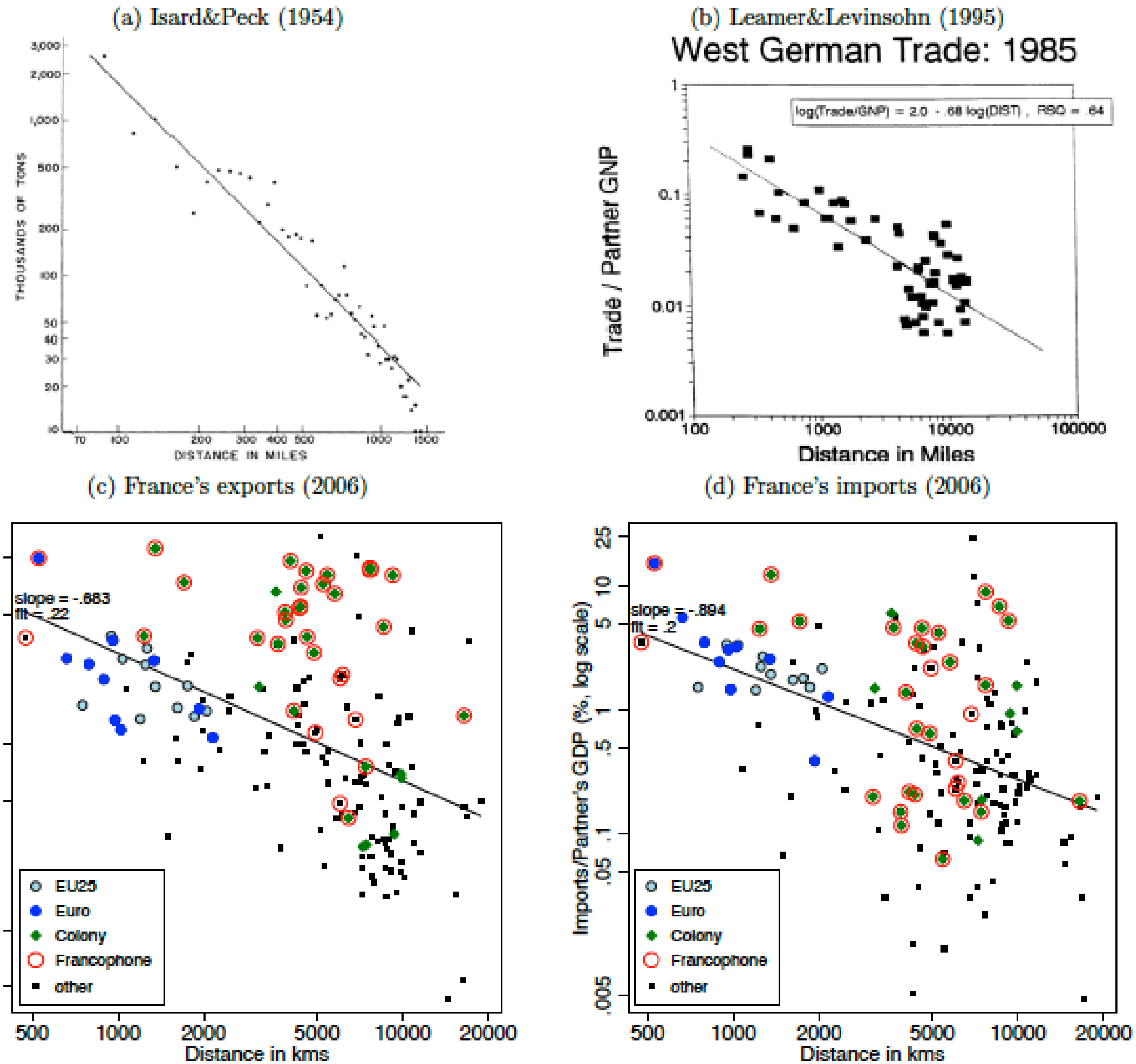


Figure 2: Trade is inversely proportional to distance



Size and Distance Affect Trade

Some patterns:

- Big countries trade more (e.g. US and China) but small ones appear more open (e.g. Belgium).
- Distance and borders apparently kill off a lot of trade, given relative country size.

The gravity model organizes these striking regularities.

Key idea:
Compare actual trade relative to a frictionless benchmark for bilateral trade flows featuring relative size of countries.

Implications

T. Friedman's "the world is flat" is hugely wrong — world trade is $<$ 10% of frictionless trade.

Interdependence is highly skewed in two dimensions. All else equal:

1. proximity *greatly* increases interdependence. Inverse proportion to distance approximation implies that country A interacts 2 times as much with country B than with country C 2 times further away than B.
2. Size increases interdependence. Country A is twice as dependent on trade with country D that is twice as large as country E.

The "natural" skewness of interdependence affects policies and institutions that mediate interdependence.

More Features of Gravity

Gravity explains multi-country interactions. (Intuitively, the more country A trades with country B, the less is left over for trade with country C. Frictions between B and C thus affect A's trade with either B or C.)

Gravity used for inference of barriers to trade.

Gravity applies within countries, regions (and even within institutions such as BC). Remarkably, seems to apply at any scale.

- Applies to migration (first use in fact, in 1880s UK) and foreign direct investment patterns.
- Seems to apply to ideas, culture, ...

Modeling Trade with Size and Distance

Empirical explorations say

- bilateral trade rises with the size of either trading partner
- countries further apart trade less
- less obviously, borders appear to impede trade (EU 25 points are closer to regression line)

The gravity *model* explains these patterns within a structure that is consistent with economic theory.

Frictionless World Benchmark

Size has a lot of explanatory power. Bigger incomes buy more from everywhere; bigger sales sell more to everywhere.

Developing a model where size *alone* determines trade patterns is thus useful in abstracting from complex frictions.

A particularly important use for such a model is to provide a *benchmark* for what a frictionless world would look like.

Frictionless Gravity Model

Assume:

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

Expenditure by j is E_j; sales of i is Y_i; world sales is Y.

In a completely smooth homogenized world, the exports flow from i to j, X_{ij} is given by:

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

Equation (1) $\Rightarrow$ j's expenditure share on i $=$ world's expenditure share ($=$ i's sales share). Natural frictionless benchmark.

Figure 1 $\Rightarrow$ (1) fits fairly well: given Y_i, X_{ij} proportional to E_j.

Frictionless Gravity Equilibrium

Market clearance (material balance) implies that

$$\sum_j X_{ij} = Y_i. \tag{2}$$

World budget constraint $\Rightarrow \sum_j E_j = \sum_i Y_i = Y$. Thus (1) is consistent with market clearance: check by summing right hand side of (1) over j and using the world budget constraint to set $\sum_j E_j / Y = 1$.

If we impose a balanced trade budget constraint for each country

$$E_i = Y_i \Rightarrow X_{ij} = Y_i Y_j / Y,$$

but general specification (1) is more realistic.

Implications of Frictionless Gravity

Define $s_i = Y_i/Y$, country i's share of world sales. Assume balanced trade for simplicity, $E_i = Y_i$. Then (1) becomes:

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

Implications

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

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

   which is decreasing in s_j.
3. Faster growing country pairs have increasing share of world trade: $X_{ij}/Y = s_i s_j$ is increasing in s_i, s_j.

Aside on Growth Rate Accounting

Point 3 on the previous slide is based on a property of growth accounting.

Let $\widehat{x}$ denote the growth rate of x. Then (the Hat Rule)

$$x = yz \Rightarrow \widehat{x} = \widehat{y} + \widehat{z}.$$

and

$$x = y/z \Rightarrow \widehat{x} = \widehat{y} - \widehat{z}$$

Thus the rate of growth of X_{ij}/Y is equal to $\widehat{s}_i + \widehat{s}_j$. And $\widehat{s}_i = \widehat{Y}_i - \widehat{Y}$.

The Hat Rule follows from log differentiation:

$$d \ln \frac{y}{z} = d \ln y - d \ln z = \widehat{y} - \widehat{z}.$$

Evidence of Frictions

Trade is much smaller than indicated by (1). Example: divide (1) by Y_{US}. $\Rightarrow X_{US,ROW}/Y_{US} = E_{ROW}/Y = Y_{ROW}/Y$ with balanced trade. US has 25 percent of world GDP, exports should be 75 % of GDP. Actual US export/GDP ratio10-15 %.

- Trade falls sharply with distance (with effect D_{ij} reflecting distance between i and j). Use for example

$$X_{ij} = \frac{Y_i E_j}{Y} \frac{1}{D_{ij}}. \tag{3}$$

  (3) gives a pretty good fit with actual trade data (viz. Figure 2). Implication: doubled distance $\Rightarrow$ halved trade.
- Crossing borders further reduces trade. For example $D_{ij} = d_{ij} B_{ij}$ where $B_{ij} > 1 = B_{ii}$ for $i \neq j$ in equation (3) is the effect of a border between i and j and d_{ij} is distance.

Distance and Border Effects

Distance effects (such as elasticity = -1) are much too big in fitted gravity equations to be the effect of transport costs rising with distance.

Border effects are much to big to reflect tariffs and other measurable costs at the border.

Evidently, distance and borders are geographic proxies for other costs that are not directly observable.

Analogy to dark matter in cosmology: observable stars do not move as they should if what is observed matter is the only matter.

An inspiration to observe more closely, but as with cosmology, some costs are impossible for economists to observe.

Theory of Gravity

Equation (3) was inspired by Newton's Law of Gravity (where $D_{ij} = d_{ij}^2$, the square of bilateral distance between i and j, Y_i is mass at i and $1/Y$ is the gravitational constant).

To improve equation fit, the distance and size elasticities are allowed to take best fit values. This form has no economic theory foundation.

Moreover, gravity models in this crude form do not satisfy elementary economic requirements (market clearance):

$$\sum_j \frac{Y_i E_j}{Y} \frac{1}{d_{ij}^{\delta}} \neq Y_i$$

unless $\delta = 0$, frictionless trade.

Economic Theory of Gravity

Economic theory leads to an expenditure share called structural gravity. [For the derivation see Anderson (2011).]

$$\frac{X_{ij}}{E_j} = \frac{Y_i}{Y}\left(\frac{D_{ij}}{\Pi_i P_j}\right)^{1-\sigma}, \tag{4}$$

where $\sigma > 1$, hence trade elasticity with respect to D_{ij} is $1 - \sigma < 0$.
Π_i, Pj are indexes of bilateral trade costs outward from i to all destinations and inward to j from all origins, called outward and inward multilateral resistance respectively. Π_i, P_j take equilibrium values ensuring market clearance $\sum_j X_{ij} = Y_i$ and budget constraints $\sum_i X_{ij} = E_j$.

'Economic distance' in (4) is bilateral *relative to multilateral* 'distance'.

Application: the Border Puzzle

McCallum in 1995 posed the Border Puzzle using atheoretic (3). Example, BC's trade with ON compared to BC's trade with OH:

$$\frac{X_{BC,ON}/E_{ON}}{X_{BC,OH}/E_{OH}} = \left(\frac{D_{BC,ON}}{D_{BC,OH}}\right)^{1-\sigma} \approx 22. \tag{5}$$

Distance BC-ON $=$ distance BC-OH $\Rightarrow$ huge border barrier.

Resolution (Anderson and van Wincoop, 2003):
Use theoretical (4) instead of (3)

$$\frac{X_{BC,ON}/E_{ON}}{X_{BC,OH}/E_{OH}} = \left(\frac{D_{BC,ON}}{D_{BC,OH}}\frac{P_{OH}}{P_{ON}}\right)^{1-\sigma}$$

Border Puzzle Resolved

$$\frac{X_{BC,ON}/E_{ON}}{X_{BC,OH}/E_{OH}} = \left(\frac{D_{BC,ON}}{D_{BC,OH}}\frac{P_{OH}}{P_{ON}}\right)^{1-\sigma} \tag{6}$$

P_{ON} is inward multilateral resistance, an index of all bilateral trade costs $D_{i,ON}$ into ON, and similarly for P_{OH}.

If $P_{ON}/P_{OH} > 1$ it reduces the border effect in $D_{BC,ON}/D_{BC,OH}$ inferred from (6). $P_{ON}/P_{OH} > 1$ in fact, because (by Implication 2 above) *small countries naturally trade more across borders* so their average trade costs must be higher. US is 10 times bigger than Canada $\Rightarrow P_{ON}/P_{OH} >> 1$.

Anderson-van Wincoop infer that the tax equivalent of the US-Canada border is around 40%. Big, but not crazy.

Application 2: Gains from Trade in Gravity Model

Countries gain from trade by being able to consume goods not produced at home. Lowering trade frictions increases the gains.

Gravity model gains are inversely related to home goods share X_{ii}/Y_i. In autarky $X_{ii}^A/Y_i^A = 1$.

The % gain from observed trade relative to autarky is (Arkolakis, Costinot and Rodriguez-Clare, AER, 2012):

$$G = \left(\frac{X_{ii}}{Y_i}\right)^{1/(1-\sigma)} - 1. \tag{7}$$

US Example: $X_{ii}/Y_i = 0.85$. Suppose $\sigma = 6$. $G^{US} = 0.033$ or 3.3%. German $X_{ii}/Y_i = 0.60 \Rightarrow G^{DE} = 0.108$ or 10.8%.

G is lower if σ rises. $\sigma \to \infty \Rightarrow G \to 0$. σ represents substitutability of home for foreign goods. Intuitively right.

Application 3: Gains from Frictionless Trade

Frictionless world $\Rightarrow$ different GDPs, but to get a ballpark number, pretend frictions vanish with GDPs = observed data. Back of envelope calculations with gravity $\Rightarrow$ trade changes are big, $\Rightarrow$ big gains from trade. How big?

Gain for US relative to autarky is computed from (7) using $X^*_{ii}/Y^*_i = Y_i/Y = 0.25$ (US earns 25% of world GDP). Then $G^* = 0.32$, 32% with $\sigma = 6$. Relative to observed gain, frictionless trade increase $\approx 32 - 3.3 = 28.7\%$.

Lessons

1. gains from trade are big.
2. smaller countries gain more from trade
3. potential gains from globalization are very big
4. gains are less as home & foreign goods more substitutable.

Economic Theory of Gravity

Repeat the theoretical share equation (4)

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

The right hand side of share equation is in two parts. Y_i/Y is the frictionless expenditure share prediction. $\left(D_{ij}/\Pi_i P_j\right)^{1-\sigma}$ is the effect of trade frictions.

Π_i is the appropriate 'average' portion of trade costs borne by seller i to *all* destinations, outward multilateral resistance. P_j is the appropriate average portion of trade costs borne by buyer j from all sources, inward multilateral resistance.

Π_i and P_j are not observable but can be inferred along with D_{ij}.

Behind the Share Equation, 2

While share equation (4) is certainly quite special, it represents the force of relative price in three distinct models:

1. consumers (producers) gain from variety of goods consumed (used in production). Example: wine.
2. consumers (producers) differ in their ideal varieties, and equation (4) gives the proportion of buyers who prefer the variety of region *i*. Examples: smartphones, cars. Proportions characterized by a probability distribution.
3. Consumers demand a set of goods, none differentiated by origin. Producers in each region and good differ in productivities, characterized by a probability distribution. Origin-destination pairs are selected by least cost. Equation (4) is share of goods produced by *i*, sold to *j*.

Behind the Share Equation, 3

In the gains from variety case the paramter $\sigma > 1$ is the elasticity of substitution between varieties. Large values of σ imply close substitutes (wine varieties); low values imply less close substitutes (rice and wine).

In cases 2 and 3 the parameter $1 - \sigma$ fixes dispersion of the probability distribution (like the variance parameter of the normal distribution). A large value of σ implies large variance in the probability distribution: i.e. large heterogeneity in consumer tastes (case 2) or productivity (case 3).

For relatively homogeneous types of products, variant 3 is the natural interpretation while for differentiated products variants 1 or 2 are the natural interpretation.

Gravity, Migration and Investment

The gravity model is also applied to migration of labor and to foreign direct investment. The same structure yields similarly good fit with data.

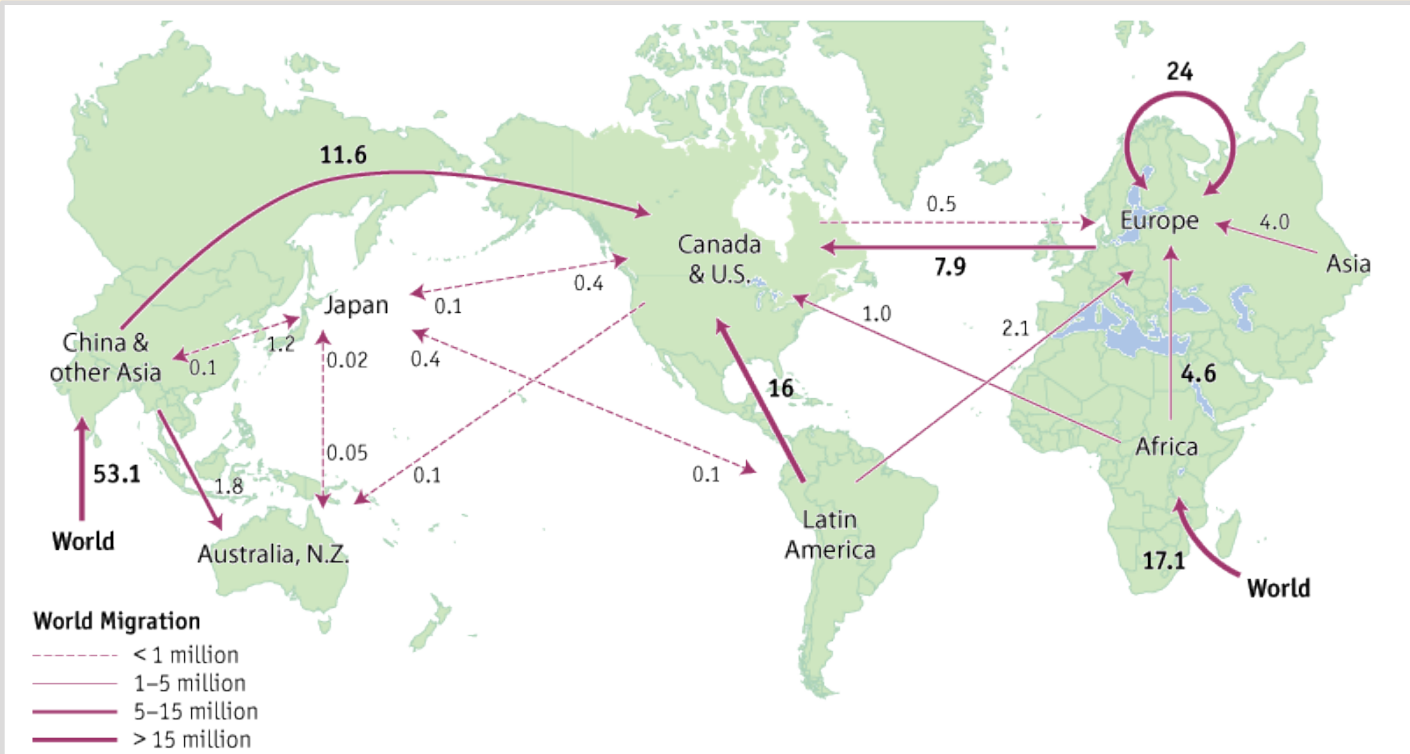
The theoretical share equations are based on heterogenous migrants and heterogeneous multinational firms, like the heterogeneous consumers of goods trade. One change in detail is important: the theory applies to *stocks* of migrants and of FDI (in contrast to goods flows). The dynamics of migration and FDI are less worked out.

Gravity also tends to explain portfolio investment (cross country ownership of stocks and bonds) but here the theory base is lacking.

2 Migration and Foreign Direct Investment

Map of Migration

FIGURE 1-3



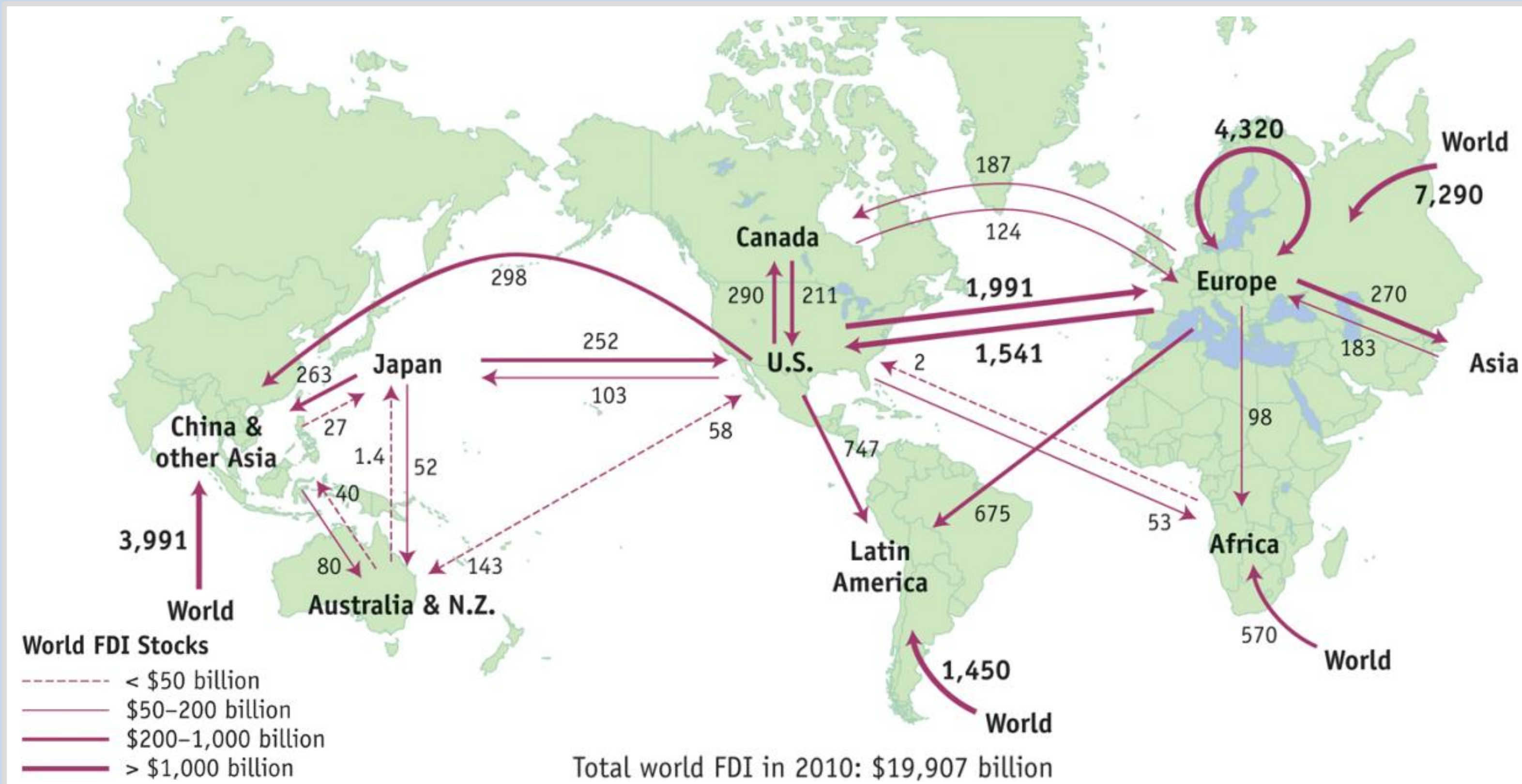
Foreign-Born Migrants, 2005 (millions)

This figure shows the number of foreign-born migrants living in selected countries and regions of the world for 2005 in millions of people.

2 Migration and Foreign Direct Investment

Map of Foreign Direct Investment

FIGURE 1-6



Stock of Foreign Direct Investment, 2010 ($ billions) This figure shows the stock of **foreign direct investment (FDI)** between selected countries and regions of the world for 2010 in billions of dollars. The largest stocks have the heaviest lines.

Empirical Application of the Share Equation

Equation (4) is linear in logarithms — suggestion for empirical practice: fit a straight line on data points relating log trade shares to log economic distance. The slope is $1 - \sigma$, to be inferred.

Essentially this line fitting is the empirical procedure used.

- Complicated by multivariate inference. Π_i and P_j act on X_{ij} as common exporter and importer country shifters (fixed effects) to be inferred.
- Π_i, P_j capture all 3rd party effects on bilateral trade.

Need to specify bilateral economic distance related to proxies such as bilateral distance.

Empirical Gravity

Example: econometric inference of coefficients δ, b in assumed economic distance function:

$$D_{ij} = d_{ij}^{\delta} b^{b_{ij}} \tag{8}$$

where d_{ij} is the distance between i and j, $b_{ij} = 1$ if there is a border between i and j and $b_{ij} = 0$ if there is no border (inter- or intra-regional trade). $b > 1$ is the border resistance, identified when both internal and cross-border shipments data (e.g. US-CA case).

(8) $\Rightarrow$ border resistance common to all countries; can be relaxed to allow variation by country and by direction of trade.

Can elaborate border effect in (8); allow for language differences, contiguity, former colonial ties, etc.

From Theory to Data

Economic theory of gravity indicates application at disaggregated level (e.g., wine).

Thus Y_i is country i's shipments of wine, E_j is country j's expenditure on wine and X_{ij} is the bilateral wine trade from i to j. Note that GDP does not appear in this version of equation (4); gross shipment Y_i, (e.g. wine shipments from i) is the relevant variable.

Aggregation (e.g. national bilateral trade flows) can be legitimized by noting that a wide range of goods have trade patterns explained by share equation (4).

But disaggregation needed to understand trade frictions that vary by product and product mix that varies by country.

Inference

Infer best fitting coefficients $\delta(1-\sigma), b(1-\sigma)$ along with $\Pi_i^{1-\sigma}$ and $P_j^{1-\sigma}$ from

$$\frac{X_{ij}}{Y_i E_j / Y} = \left(\frac{d_{ij}^{\delta} b^{bij}}{\Pi_i P_j} \right)^{1-\sigma} \epsilon_{ij} \tag{9}$$

where ϵ_{ij} is the random error term representing the forces not explained by the model.

Estimated equations like (9) usually "explain" 90% of the variation in trade. Coefficients are precisely estimated.

Coefficient $1-\sigma$ can be inferred if some trade cost is directly observed (e.g. tariffs). [σ not needed for many purposes.]

Inference, 2

$\delta(1-\sigma)$ *et al.* coefficients are inferred. Distance elasticities $\delta(1-\sigma) \approx -1$ typically in aggregate data, more dispersion with disaggregation. Too large (in absolute value) to be explained by transport costs, given reasonable values of σ. $1-\sigma$ can be inferred if some trade cost element of D_{ij} is directly observed (e.g. tariffs). Typically $10 > \sigma > 6$.

Distance elasticity varies depending on distance range: results show mostly higher for shorter distance ranges.

Border effects: typically cross-border trade is reduced to 1/20th to 1/3 of potential value: $0.05 \leq b^{1-\sigma} \leq 0.37$.

Inferred Border Tax Equivalents

Typical inferred border effects on trade $B = b^{1-\sigma}$. Convert to ad valorem tax equivalent $t = B^{1/(1-\sigma)} - 1$.

US-Canada example (Anderson & van Wincoop, AER 2003): Inferred t using $\sigma = 8$ is $\approx 40\%$ (estimated B=0.095).

Much larger than insurance (transport costs are very similar & NAFTA $\Rightarrow$ tariffs $= 0$ between US and CA).

Implication: “Dark" trade costs, to be explained...

One idea is home bias in preferences: consumers like local goods. But globalization is homogenizing tastes. Information differences suggested, home goods are more familiar, but ignorance and prejudice can be overcome...

Trade Frictions and Network Formation

Most trade requires search by buyers and sellers for appropriate partners. Trust is part of a willingness to deal. Successful links persist and new links are easier to form with partners of partners. This story suggests that networks are more dense at shorter distances, implying more trade all else equal.

Borders $\Rightarrow$ search frictions due to cultural and legal differences, language differences, etc. Formal enforcement probably discriminates against foreigners. Informal enforcement probably discriminates against foreigners too, and against those further away ‘in the network’.

Models of firm behavior based on the network story are having success (Chaney, AER, 2014). Part of the darkness is lifting.

Gravity and Openness Measures

Use estimated coefficients to form ratio of predicted (indicated by tildes, $\widetilde{X}$ for any variable X) to predicted frictionless trade:

$$\frac{\widetilde{X}_{ij}}{Y_i E_j / Y} = \left(\frac{\widetilde{D}_{ij}}{\widetilde{\Pi}_i \widetilde{P}_j} \right)^{1-\sigma} \tag{10}$$

A particularly useful instance of (10) is for internal trade, $i = j$. This case is Constructed Home Bias, the predicted excess (relative to frictionless) amount of local trade.

$$CHB_i = \left(\frac{\widetilde{D}_{ii}}{\widetilde{\Pi}_i \widetilde{P}_i} \right)^{1-\sigma} \tag{11}$$

Estimated CHBs are an inverse measure of openness.

Constructed Home Bias and Welfare

CHB is related to the measure of foregone potential gains of Arkolakis, Costinot & Rodriguez-Clare (AER, 2012).

Their measure of gains foregone from not having frictionless trade of the given supplies in the observed equilibrium is

$$G_i = CHB_i^{1/(1-\sigma)} s_i^{1/(1-\sigma)}.$$

The higher is CHB, the larger the foregone gains. The second term is the familiar size effect, smaller world sales shares increase the gains foregone from not having frictionless trade.

CHB in Manufacturing

Using manufacturing trade and production data for 76 countries from 1990-2002, Anderson and Yotov (2011) estimate CHBs.

The results below add another major implication about the relationship of size and trade: *While bigger producers trade less in the frictionless benchmark, they tend to trade more (a lot more) relative to the frictionless benchmark*.

- CHB is very large. Average $> 10 \Rightarrow$ international trade < 1/10 of potential.
- CHB is (much) lower for bigger producers
- the lower CHB is due almost entirely to lower Π, interpretable as sellers' incidence of trade costs.
- falling (rising) CHB over time is due to falling (rising) Π, associated with increasing (decreasing) sales shares Y_i/Y.
- lower Π is equivalent to productivity improvement

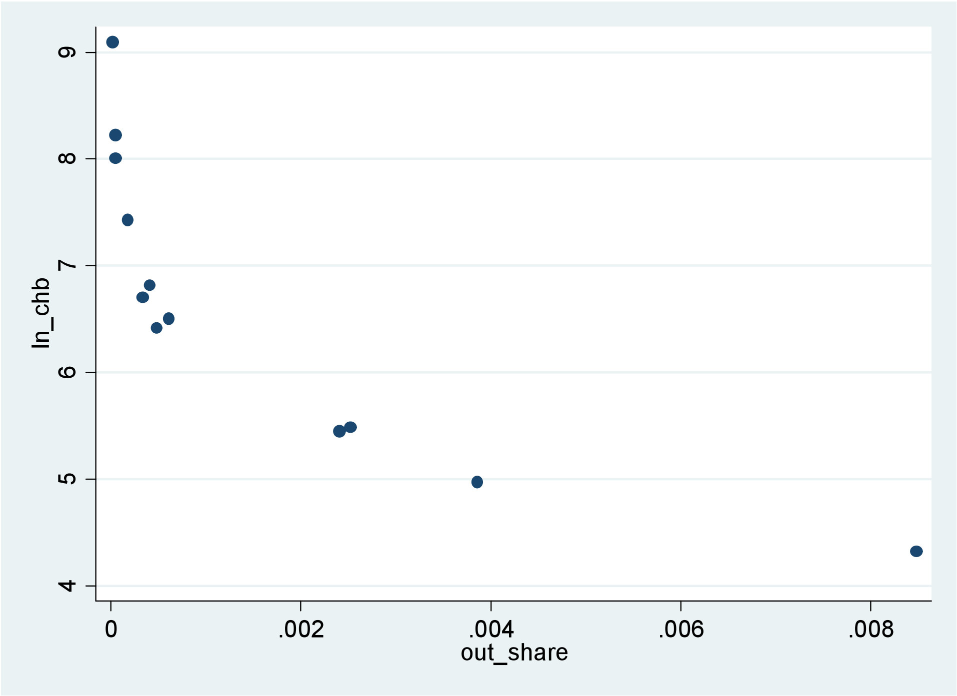
Table: Constructed Home Bias Indexes by Country

Countries with Lowest CHB		
ISO	1996	$\%\Delta CHB$
USA	3	-11
JPN	5	41
DEU	8	0
FRA	11	2
CHN	12	-51
ITA	13	-14
GBR	14	15
CAN	19	0
HKG	20	-22
KOR	20	-28
ESP	25	-2
BRA	32	56
MYS	36	-52
BLX	37	30
NLD	39	24
RUS	39	33
AUT	41	13
IND	44	-13

Countries with Highest CHB		
ISO	1996	$\%\Delta CHB$
MUS	658	-37
LVA	679	-43
CRI	694	-33
EST	704	-54
AZE	737	154
BOL	778	-5
JOR	866	-28
PAN	872	-15
OMN	948	-49
SLV	1186	-54
MDA	1224	24
TZA	1254	-28
MNG	1328	139
SEN	1336	-5
TTO	1577	-58
ARM	2423	-39
KGZ	2554	276
MOZ	2630	-44

Size and CHB in Services Trade

Plot ln CHB_i vs. Y_i/Y, Canada's provinces (Anderson, Milot and Yotov, IER, 2014).



Size and Sellers' Incidence

Multilateral resistance is interpreted as average incidence: outward for sellers Π_i, and inward for buyers P_j for each i and j.

Why does Π get smaller as size gets larger?

- A big country has less of its total shipments forced into crossing borders (as in the frictionless model), so it incurs less trade cost on average on its shipments $\Rightarrow$ lower sellers' incidence of trade costs.
- This is a tendency only, not a one-to-one relationship. Statistically close relationship in the sense of high negative correlation.

An important force acting as if economies of scale, even though no economies of scale in model.

Size and Trade Again

Summarizing the key insights from the gravity literature:

1. Any country naturally trades more with bigger partners.
2. Smaller countries are more naturally open.
3. Faster growing country pairs have increasing share of world trade
4. Given natural openness, bigger countries tend to trade much more because they tend to have much lower Constructed Home Bias.
5. Bigger countries lower CHB due mostly to lower outward multilateral resistance $=$ sellers' incidence.

Projections

A valuable use of the empirical gravity model is to project missing data.

- Use estimated gravity coefficients (estimated using other data and (10)) to calculate

$$\frac{Y_i E_j}{Y} \left(\frac{d_{ij}^{\delta} b^{b_{ij}}}{\Pi_i P_j} \right)^{1-\sigma} = \widetilde{X}_{ij}.$$

- Can be used to check or replace bad or suspicious data (e.g. smuggling)
- Used to forecast effects of big changes — e.g., fall of Iron Curtain on E. European countries.
- Forecast effects of building a canal, bridge, etc.
- Forecast effects of Free Trade Agreements (or estimate effects of past FTAs)

What Are “Trade Costs"?

Frictions implied by gravity are way bigger than can be explained by measured trade costs. (See Anderson & van Wincoop JEL survey, 2004.)

A number of possible explanations for ‘dark’ trade costs:

- information costs
- non-monetary barriers — regulation, licensing,...
- taste differences
- extortion, insecure contracts

Need to drill deeper to understand these forces.

Mystery of Missing Globalization

Estimation of gravity coefficients on various datasets yields no recent evidence of decreasing coefficients on distance (or other frictions such as borders).

One answer to the puzzle is that if all trade costs (distance) shrink(s) uniformly, all relative trade costs (distances) t_{ij}/t_{kl} (d_{ij}/d_{kl}) remain the same $\Rightarrow$ constant relative trade X_{ij}/X_{kl}. Thus no decrease in the distance coefficient would be found in estimated gravity equations across time, even though the world was 'getting smaller'.

Uniformity hypothesis is roughly plausible: better shipping and communications stimulate trade within as well as between countries.

Direct Measures of Trade Cost Changes

Recent data on changes over time in trade costs:

- sea freight rates have risen (container rates) but quality is much better (containerization). See M. Levinson *The Box*.
- Some freight has shifted from surface to air.
- Observed willingness-to-pay difference is lower bound estimate of quality improvement. Further effects of quality change may be large.
- Tariffs fell most among big countries in the 50s through 70s, so not much recent action there.
- end of Multi-Fibre Arrangement is much more significant for textiles and apparel.
- some regulatory agreements have fostered trade, especially in services.
- Free Trade Agreements seem to foster trade much more than implied by the tariff cuts.

Globalization and Specialization

World trade T is rising (except for the 2008 sharp recession) relative to value of world shipments Y, good by good and overall. What is the explanation, if gravity coefficients are constant?

- measurement of constant gravity coefficients may be wrong.
- production/expenditure patterns shifting may induce trade-increasing changes. *Specialization* may explain the changing location of production.

Work is proceeding on both points.