

EC3355: International Trade

Gravity model

Stijn van Weezel

Department of Economics
Royal Holloway, University of London

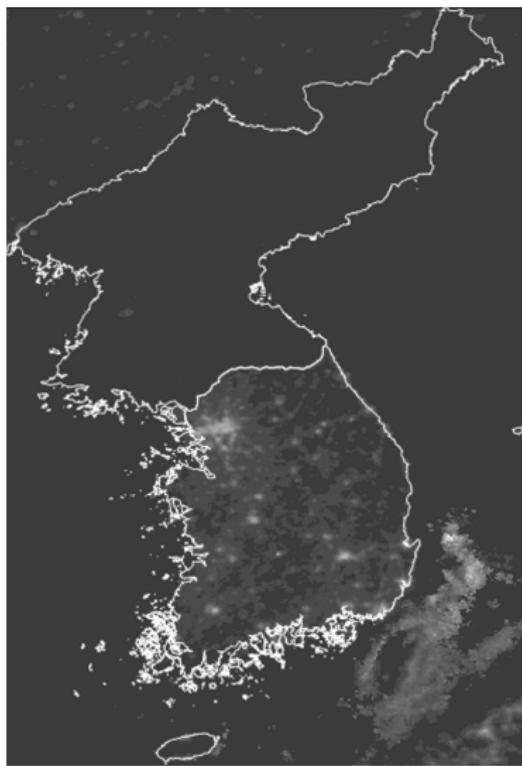
Last week

- ▶ Countries can gain from trade
 - ▶ Trading goods and services can create mutual benefits
 - ▶ Countries can use finite resources to produce what they are most productive at and trade for goods/services they want to consume
 - ▶ Endowments matter for what goods countries trade
- ▶ Change in trade composition over time
 - ▶ Decrease in share of primary commodities, and increase in manufactured goods
- ▶ Increase in trade volumes over time
 - ▶ Increase since the 1950s surpassed pre-WWI trade levels
 - ▶ Some countries trade more than others

Last week

Gains from trade: the Koreas

Source: NOAA



Today

- ▶ Trade flows
- ▶ Gravity model
- ▶ Estimating the gravity model
- ▶ Effect of distance
- ▶ Border effect
- ▶ Trade resistance

Food for thought

Q: Does the UK export more to China or Switzerland?

Trade flows

From last lecture: World trade shares per region for 2012

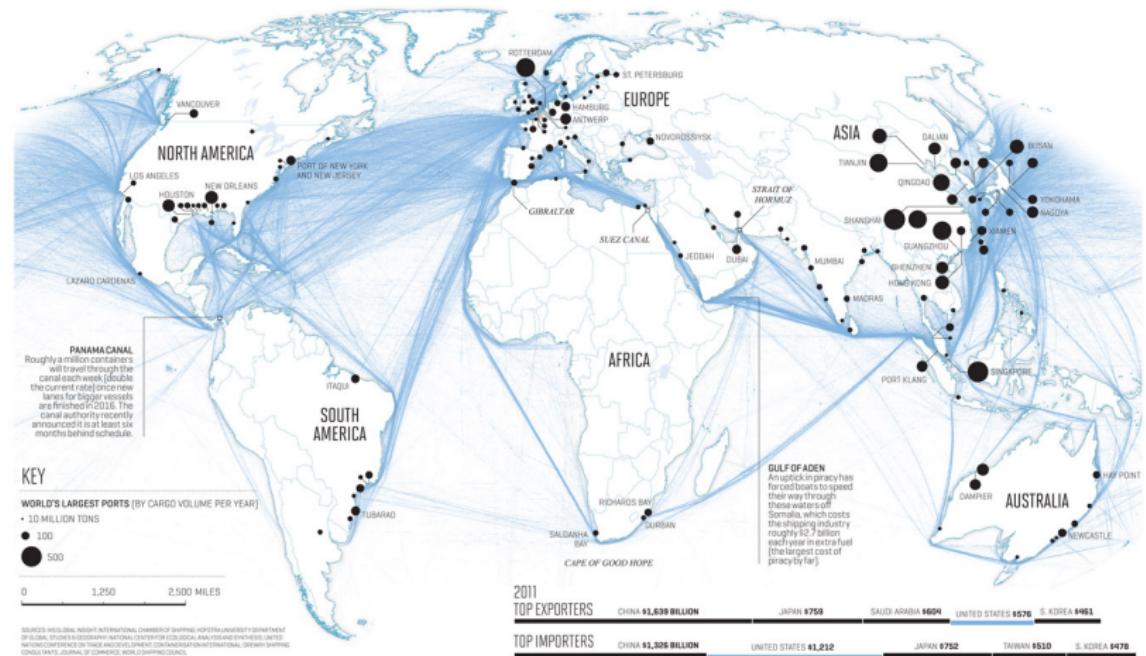
Source: WTO

Region	Exports	Imports
Africa	3.5	3.3
Asia	33.2	33.4
Commonwealth of Independent States	4.3	3.1
Europe	34.7	35.1
European Union internal trade	19.8	19.5
Middle East	7.3	3.9
North America	12.9	17.2
South and Central America	4.1	4.1

Trade flows

Major shipping routes

Source: Nicolas Rapp



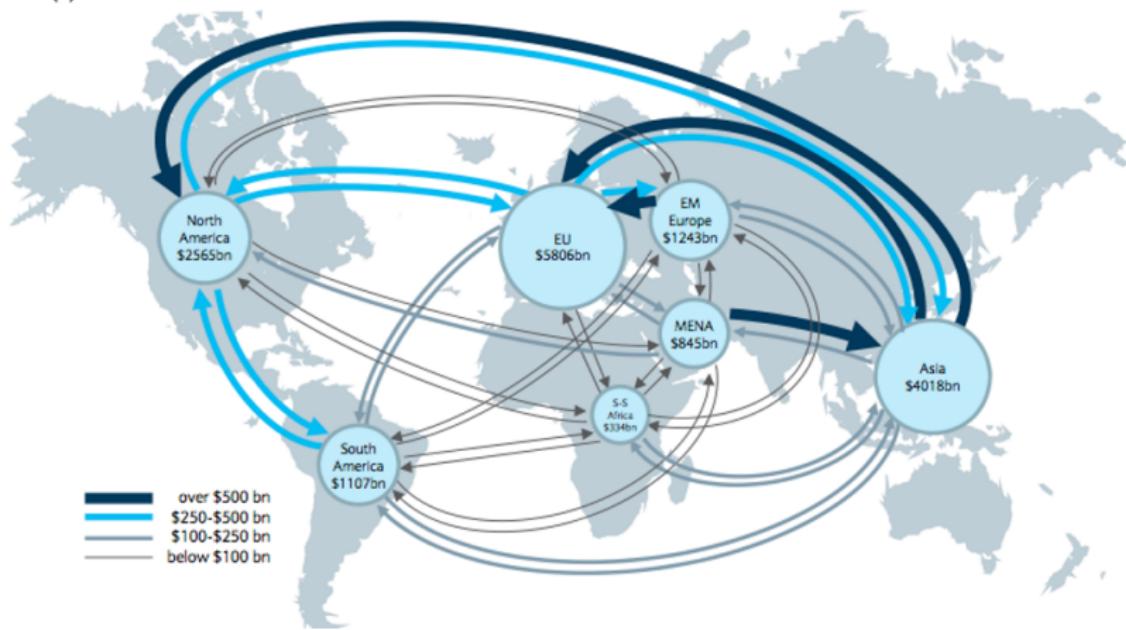
Trade flows

World merchandise trade flows for Nov-Dec 2012

Source: *Barclays Research*

Comparing global trade flows (merchandise trade values)

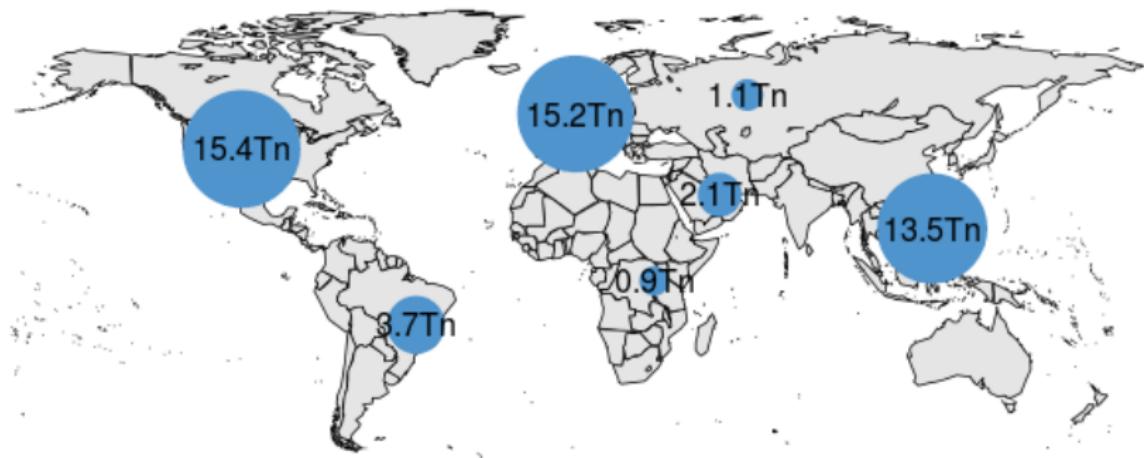
(a) 2012



Trade flows

World GDP 2012 per region

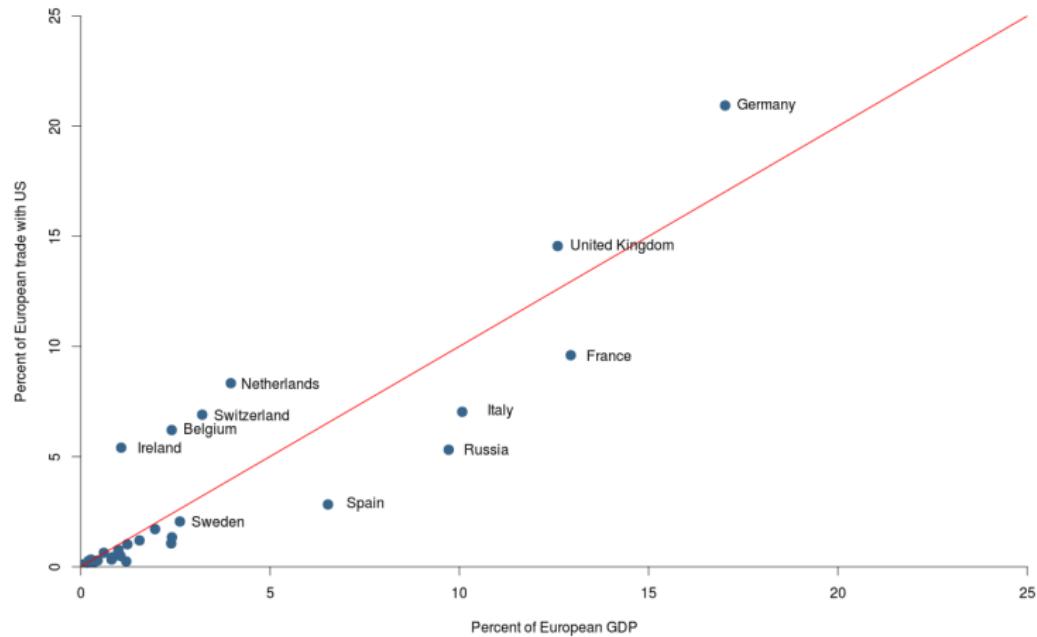
Source: WDI



Trade flows

U.S. trade with Europe for 2012

Source: U.S. Census Bureau, World Development Indicators



Trade flows

U.S. trade with Europe

- ▶ Top 3 of European trading partners are three largest European economies
- ▶ How come the U.S. trades more with these countries rather than other European economies?
- ▶ What explains the almost linear relationship between GDP and trade flows?

Trade flows

Size matters!

- ▶ Size of an economy is directly related to the trade volume
- 1. Larger economies produce more and thus have more to sell in the export market
- 2. Larger economies generate more income and are thus able to buy more imports
- ▶ Empirically established Jan Tinbergen in 1962

Gravity model

Some physics



Newton's law of universal gravitation:

$$F_{ij} = G \frac{M_1 M_2}{r^2}$$

M_i is the mass of the object

r is the distance between the object

G is a gravitational constant*

* 6.67×10^{-11} N*(m/kg)²

Gravity model

Applying physics to economics: gravity model of trade

- ▶ Trade between countries is similar to the force of gravitation between objects
- ▶ Objects with large mass, or those that are close together have greater gravitational pull between them
- ▶ There will be more trade between countries if:
 1. Countries have large economies
 2. Countries are close to each other

Gravity model

Economic gravity

$$T_{ij} = g \frac{M_i^\alpha M_j^\beta}{D_{ij}^\theta}$$

- ▶ T_{ij} : Trade flow from country i to j
- ▶ M_i and M_j : Relevant economic size of the two locations
- ▶ D_{ij} : Distance between the two locations

Gravity model

Numerator only

$$T_{ij} \propto M_i^\alpha M_j^\beta$$

- ▶ Exports rise proportionally with economic size of destination country
- ▶ Imports increase in proportion to origin's country economic size
- ▶ Model represents a short-hand for supply and demand forces
- ▶ For origin country i
 - ▶ M_i represents total supply of i
 - ▶ M_j represents total demand of j

Gravity model

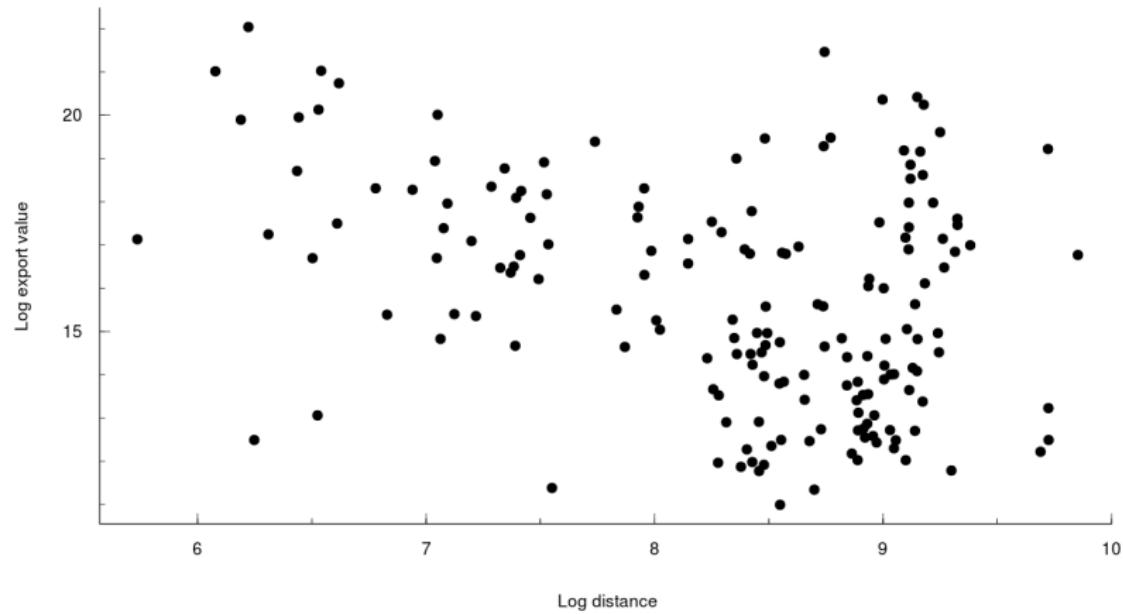
Denominator only

$$T_{ij} \propto \frac{1}{D_{ij}^\theta}$$

- ▶ T_{ij} is decreasing in distance
- ▶ Distance acts as a tax, imposes trade costs
- ▶ Results in lower equilibrium trade flows

Gravity model

Swiss exports for 2012



Gravity model

Key feature gravity model

1. Everything enters multiplicatively - including distance
2. No 3rd country effects, except through GDP changes
 - ▶ In its simplest form only size and distance are important for trade
 - ▶ Gravity model has produced some of the most robust findings in economic research

Estimating the gravity model

$$\ln T_{ij} = \gamma + \alpha \ln M_i + \beta \ln M_j - \theta \ln D_{ij} + \epsilon_{ij}$$

- ▶ Log-linear model estimated using OLS
- ▶ Expect $\alpha = \beta = \theta = 1$

Estimating the gravity model

Economic mass

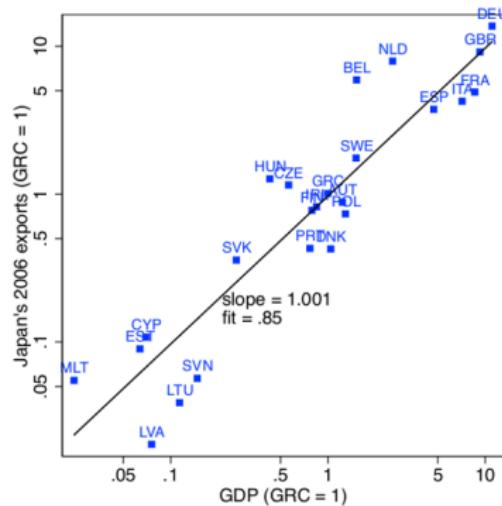
- ▶ Economic mass, M_i, M_j , often measured by GDP
- ▶ Estimated coefficients close to 1, range from 0.7 to 1.1
- ▶ Including M_i, M_j as regressors leads to inflated R^2 values
 - ▶ Unlikely that large economies don't trade more in absolute terms
 - ▶ Trade is part of GDP so simultaneity between T_{ij}, M_i , and M_j

Estimating the gravity model

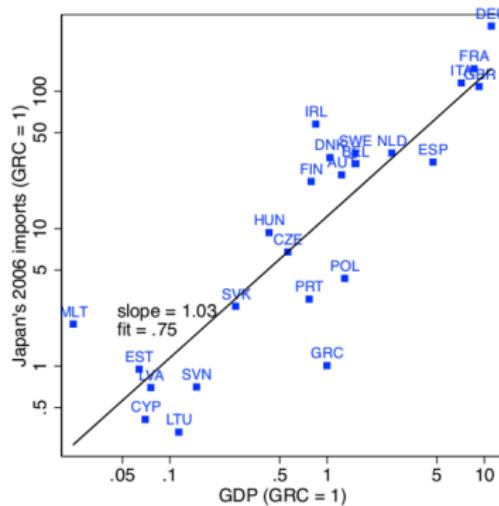
Head & Mayer, 2013

Figure 1: Trade is proportional to size

(a) Japan's exports to EU, 2006



(b) Japan's imports from EU, 2006



Estimating the gravity model

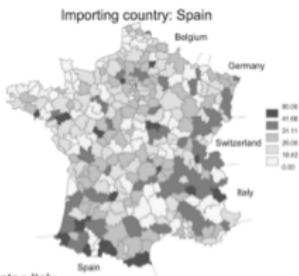
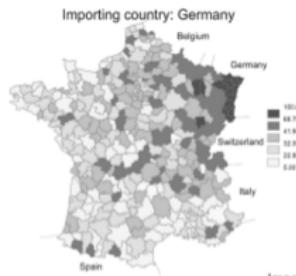
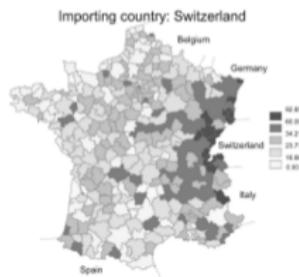
Distance

- ▶ Often based on great circle distance
 - ▶ Length of a straight line across the surface of a sphere
 - ▶ Underestimates the true distance
- ▶ 1% increase in distance associated with a 0.7-1% loss in trade volume
- ▶ Trade costs associated with distance seem very large

Estimating the gravity model

Percentage of firms that export

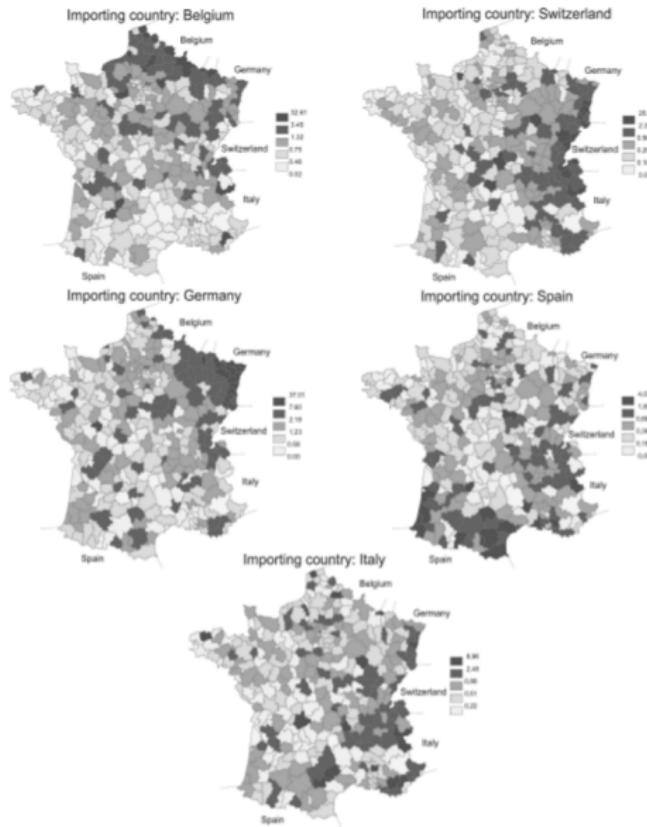
Source: Crozet and Koenig (2010)



Estimating the gravity model

Mean value of individual-firm exports

Source: Crozet and Koenig (2010)



Effect of distance

- ▶ Distance has large effect on trade flows
- ▶ Doubling of distance reduces trade by half
- ▶ Theoretically the effect can be attributed to
 - ▶ Elasticity of substitution between goods from different countries
 - ▶ Transportation costs

Effect of distance

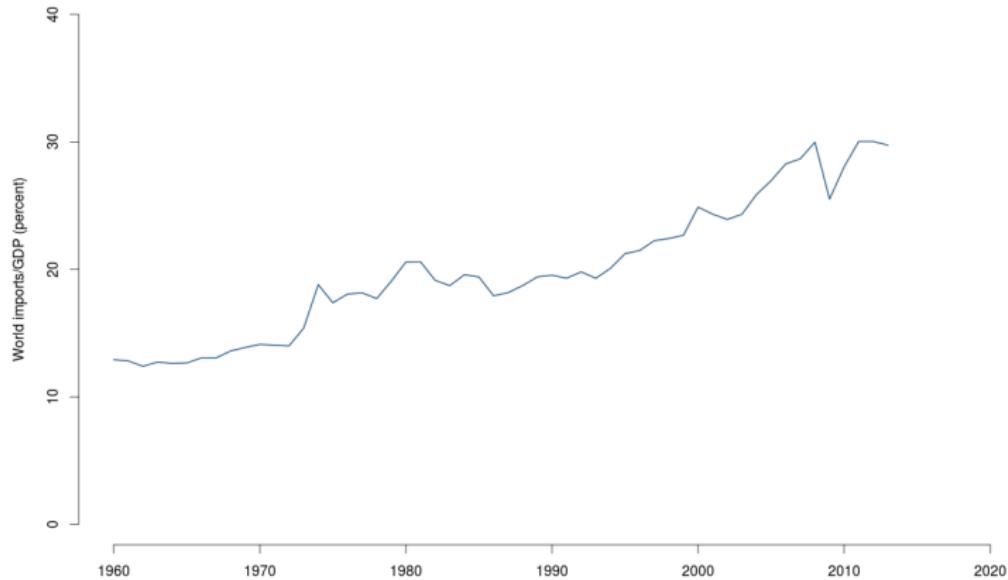
Causes for drop in trade resistance

1. Containerisation, lowered cost and shipping time of manufactured goods
2. Commercial jet air transport costs fell by 90% between 1955-2004
3. International telephone costs per minute fell by 95% between 1980-2010
4. Internet-based communication increased bandwidth of long-distance information flows

Effect of distance

World imports relative to GDP over time

(Source: WDI)



Effects of distance

Other factors that could influence trade

- ▶ Geography
 - ▶ Availability of ports and lack of mountain barriers make transportation and trade easier
- ▶ Multinational corporations
 - ▶ Imports/exports between company division increases trade flows
 - ▶ Also associated with synchronisation costs
- ▶ Cultural distance
 - ▶ Cultural ties are often correlated with economic ties
 - ▶ Different cultures could inhibit communication, generate misunderstandings, clashes in negotiation style etc.
- ▶ Borders
 - ▶ Crossing border involves formalities and possibly tariffs

Effect of distance

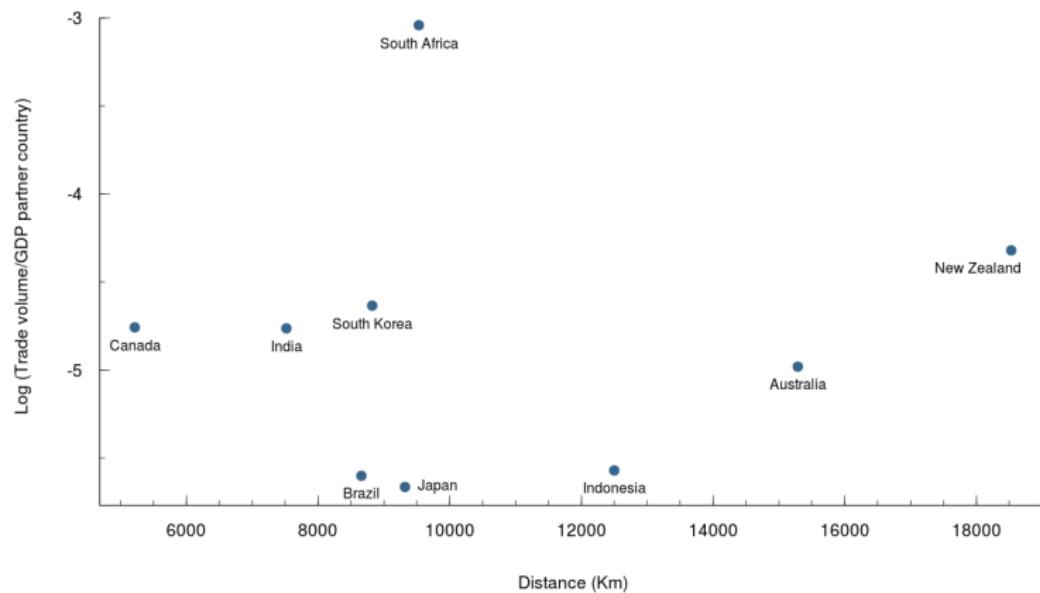
Distance can be a proxy for:

1. Similar language
2. Cultural affinity
3. Contiguity

Effect of distance

UK trade with distant trade partners for 2012

Source: *The Atlas of Economic Complexity, World Development Indicators, Wolfram Alpha*



Border effect

- ▶ Only 15% of French firms export (Eaton, Kortum, & Kramarz (2011))
- ▶ Region-pairs within countries are 10 to 20 times more likely to trade than identical region-pairs across countries
- ▶ Trade between countries is harder than trade within countries
- ▶ Difficulty of trade across country is called the Border Effect

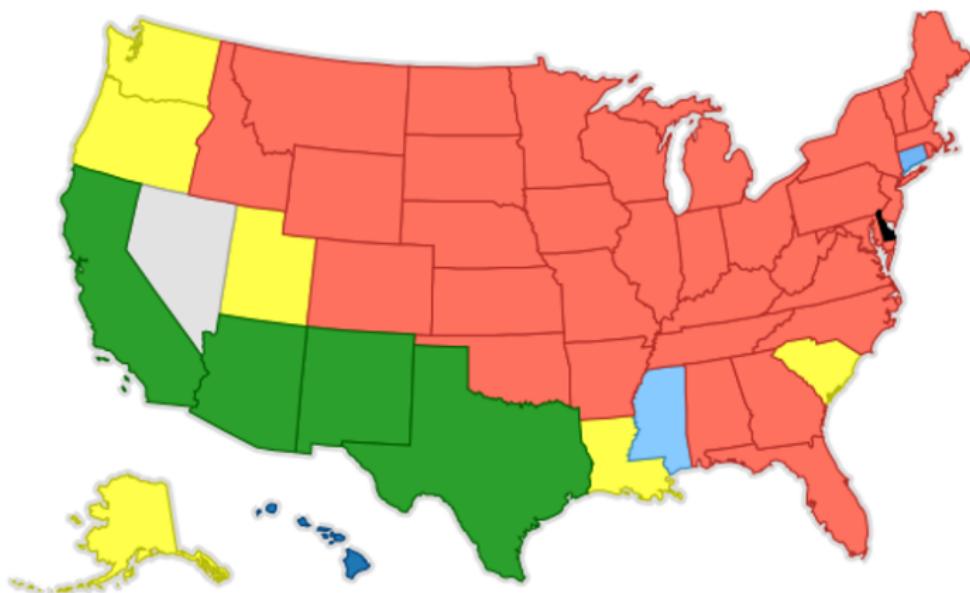
Border effect

Main foreign export partner by US state for 2013

Source: *Washington Post*

Legend:

- Canada (Red)
- China (Yellow)
- Mexico (Green)
- Australia (Dark Blue)
- Switzerland (Light Gray)
- Panama (Light Blue)
- Belgium (Black)
- France (Dark Blue)



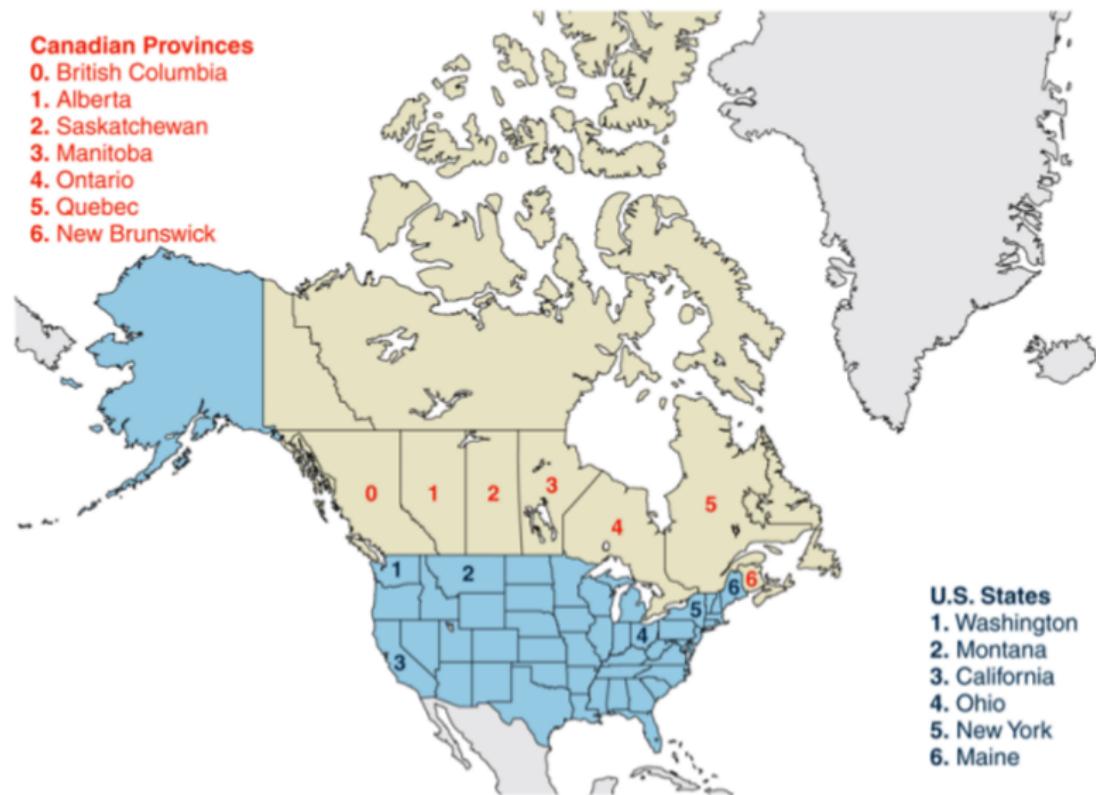
Border effect

Trade between USA and Canada

- ▶ Canada is the USA's main trade partner (16.4% of total trade in 2014)
- ▶ Canada is similar to USA in terms of language, culture, and history
- ▶ Relatively small distance between the two countries (contiguous)
- ▶ Border is associated with a reduction in trade

Border effect

Canadian provinces and US states that trade with British Columbia



Border effect

Canadian provinces and US states that trade with British Columbia

Canadian Province	Trade as Percent of GDP	Trade as Percent of GDP	U.S. State at Similar Distance from British Columbia
Alberta	6.9	2.6	Washington
Saskatchewan	2.4	1.0	Montana
Manitoba	2.0	0.3	California
Ontario	1.9	0.2	Ohio
Quebec	1.4	0.1	New York
New Brunswick	2.3	0.2	Maine

Source: Howard J. Wall, "Gravity Model Specification and the Effects of the U.S.-Canadian Border," Federal Reserve Bank of St. Louis Working Paper 2000-024A, 2000.

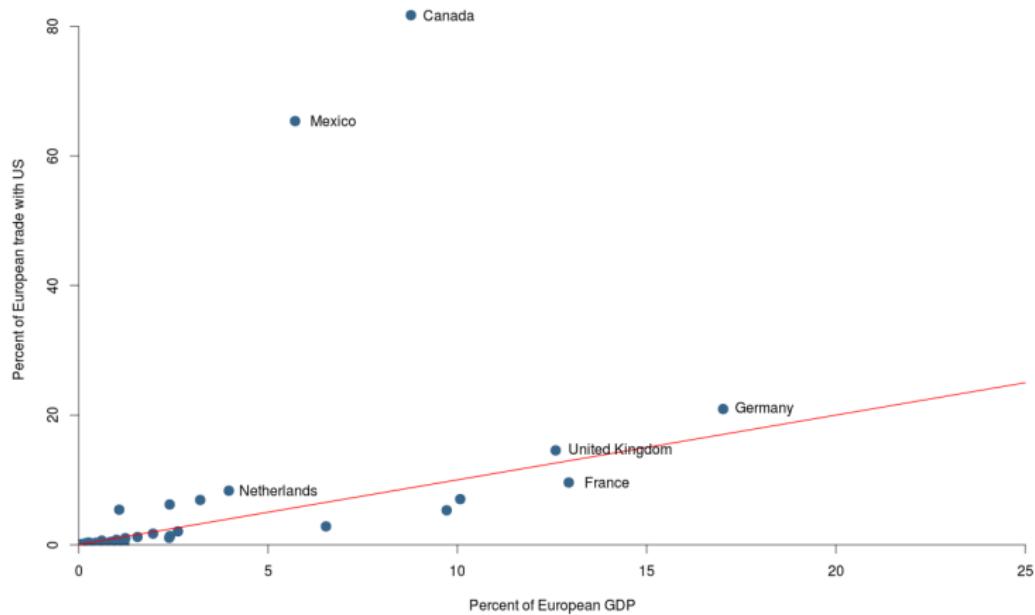
Border effect

- ▶ Border increase cost and time needed to trade
- ▶ Trade agreement between countries aim to reduce these costs and increase trade
- ▶ Gravity model can assess the effect of the trade agreement

Border effect

U.S. trade with Europe and NAFTA for 2012

(Source: U.S. Census Bureau, World Development Indicators)



Food for thought

- ▶ Chinese GDP 9.24 Trillion USD (2013)
- ▶ Swiss GDP 640.5 Billion USD (2013)
- ▶ Distance UK-China 8500Km (pop. weighted)
- ▶ Distance UK- Switzerland 900Km (pop. weighted)

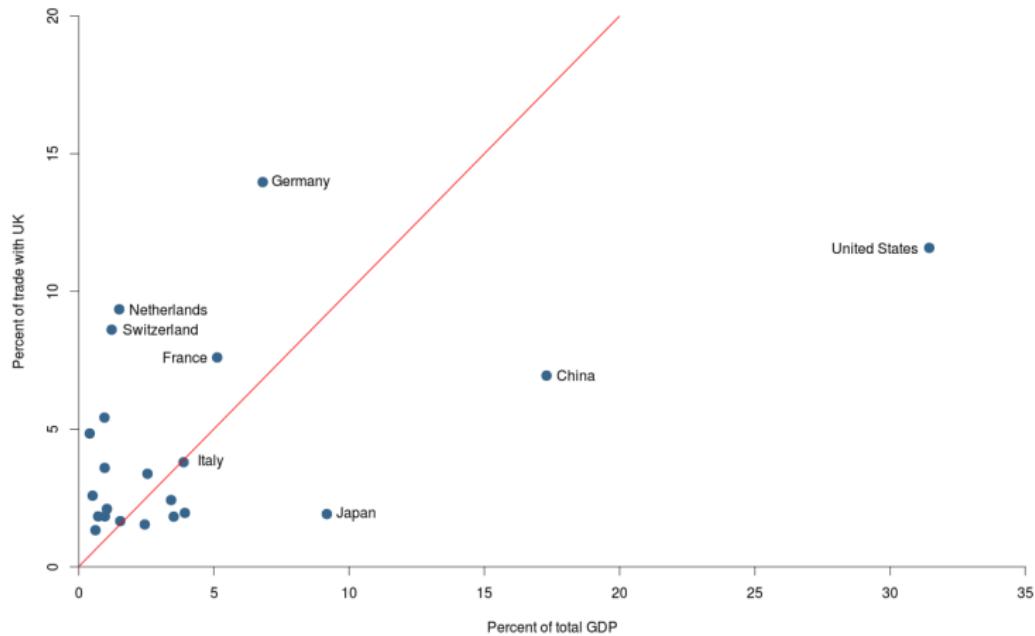
Food for thought

- ▶ UK exports to China: 2.0 Billion USD (October 2014)
- ▶ UK exports to Switzerland: 2.3 Billion USD (October 2014)

Food for thought

UK trade with major trade partners for 2012

Source: HM Revenue & Customs and World Development Indicators



Trade resistance

Explaining distance and border effects

From Grossman (1998)

1. Imperfect information where familiarity declines rapidly with distance
2. Very localised tastes which are historically determined and change only slowly with experience (home bias)
3. Distribution networks play a more central role

Trade resistance

Information as barrier to trade

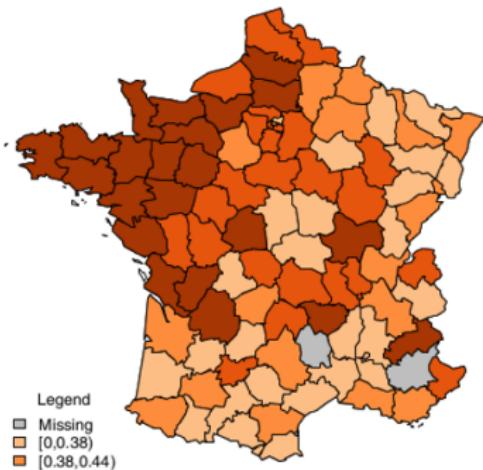
- ▶ Distance has a similarly large effect on flows and transactions other than trade
 - ▶ Foreign Direct Investment
 - ▶ Portfolio investment
 - ▶ Web browsing
 - ▶ Patent citations
- ▶ Distance is a proxy for lack of information, which leads to uncertainty

Trade resistance

Localised historical tastes

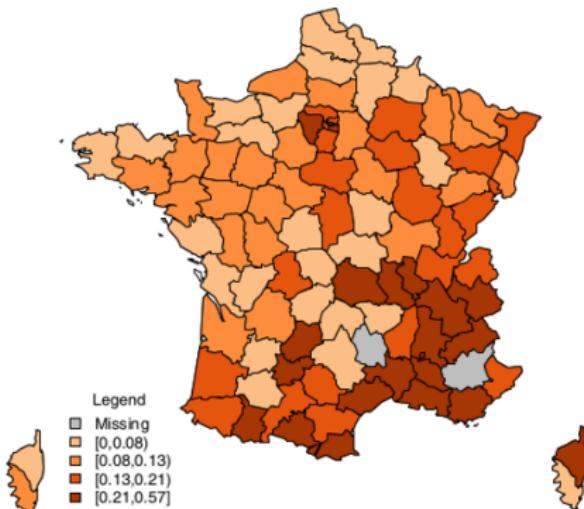
(Source: Head and Mayes, 2013)

(a) Butter



Note: 10 240 households – 2005–06

(b) Olive oil



Note: 10 240 households – 2005–06

FIGURE 8 Expenditure shares (out of all fats and oils) of 10,240 French households, 2005–2006

Trade resistance

Persistent colonial legacies and history of violence

- ▶ Colonial legacies

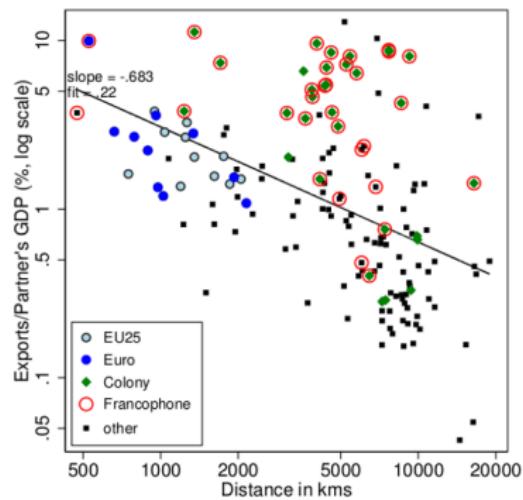
- ▶ Some examples of strong trade links (Quebec and France, UK and Canada)
- ▶ In general there is a steady decline
- ▶ Both between colonial power and colony and between colonies of same colonial power
- ▶ Trade lost of permanent basis, despite same language, common institutions, very low trade barriers, and substantial bilateral migration
- ▶ Trade levels higher than predicted by gravity model

Trade resistance

Head & Mayer, 2013

Figure 2: Trade is inversely proportional to distance

(a) France's exports (2006)



(b) France's imports (2006)

