Globalization and the Gravity Model

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Aim of this talk:

- To show how the ambivalent perception of globalization is linked to the China shock
- To explain the China shock with the horse-model of international trade
- To give the intuition of the mechanisms of this model
- To derive this model and highlight its relevance for policy
- To measure the extent to which the “ world is not flat”
- To give an example of state of the art empirical modelling of international trade

Friedman T. (2005), The World Is Flat: A Brief History of the Twenty-first Century

Motivation

Perception of globalization

- Eurobarometer surveys
  - More "choice to the consumer", lower prices and higher purchasing power
  - Threat to employment and businesses
- Globalisation is two-faceted
- Why? This is all about *Gravity*!
- Combined with reduced trade cost and emergence of low-wage exporting countries


LA FEUILLE DE PAYE
ET LE CADDIE
Mondialisation, salaires
et emploi
Lionel Fontagné
Gain de pouvoir d'achat pour tous, perte de salaire pour certains : le commerce mondial redistribue les cartes sociales. Tout en profitant globalement à l'économie, il pénalise les citoyens français pour qui la baisse des prix à la consommation ne compense pas les effets négatifs sur la feuille de paye. Se profilent ainsi, d'un côté, les gagnants de la mondialisation, plutôt jeunes, éduqués, bien rémunérés et citadins, de l'autre ceux dont les compétences professionnelles sont difficilement reconvertibles et qui vivent loin des grands bassins d'emploi diversifiés. Lionel Fontagné décrypte ces mécanismes, qui ne mettent pas tant en cause la mondialisation que l'incapacité des politiques publiques à en faire bénéficier les laissés-pour-compte.
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China closer, Germany more distant

- China shock (entry WTO 2001)
- Containerization
- Internet and information technologies
- Source of variation used in several applied papers in international economics
- Trade patterns are driven by *relative* prices
- Change in trade patterns: more trade with a low-wage country
- Differently exposed local labor market will be affected differently (job displacement, wages, social unrest, political polarization, ...)

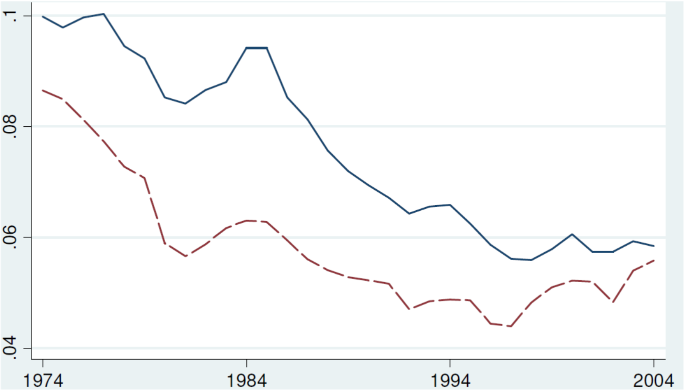


Figure: Transport cost as a fraction of the value shipped (1974-2004)

Source: Hummels (2007).
Notes: 0.1 = 10 percent. Dotted line: turnover of maritime transport over world trade value. Plain line: statistical estimation.

An increased supply of low-wage workers in the global market

- Ross Perot: The giant sucking sound of NAFTA (1992 US presidential campaign)
- Freeman (1995): Are your wages set in Beijing ?, Journal of Economic Perspectives
- Peter Navarro (2011): Death by China: Confronting the Dragon - A Global Call to Action
- Autor, Dorn & Hanson (2013), The China Syndrome : Local Labor Market Effects of Import Competition in the United States, American Economic Review
- Malgouyres (2017): The Impact of Chinese Import Competition on the Local Structure of Employment and Wages: Evidence from France. Journal of Regional Science

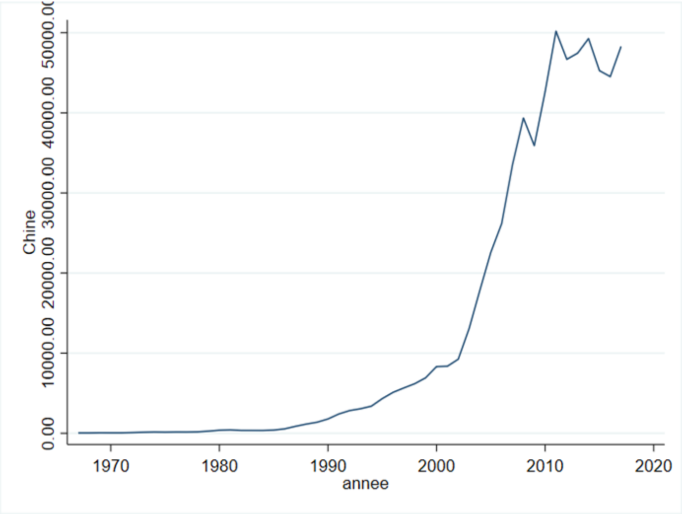


Figure: French imports from China(1967-2017), USD million

Source: CEPII-Chelem

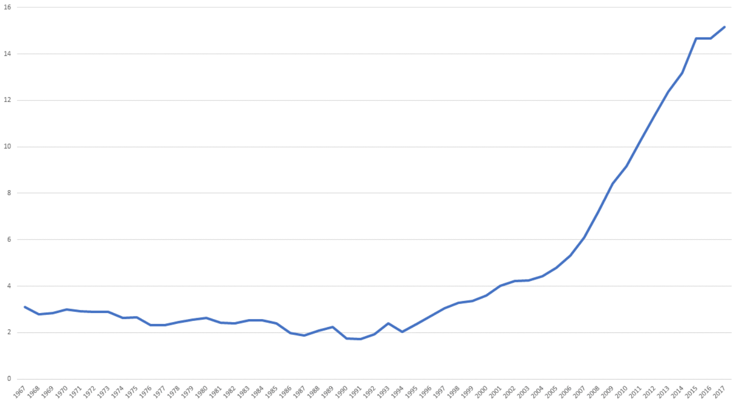


Figure: China share in World GDP (1967-2017), percent

Source: CEPII-Chelem.
Note: GDP in current USD

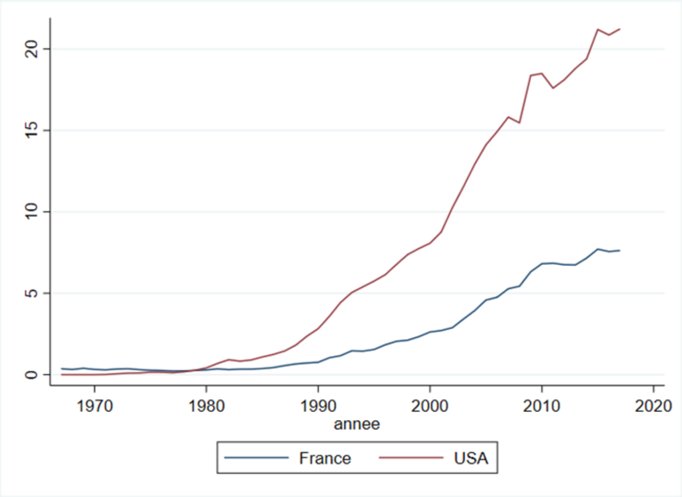
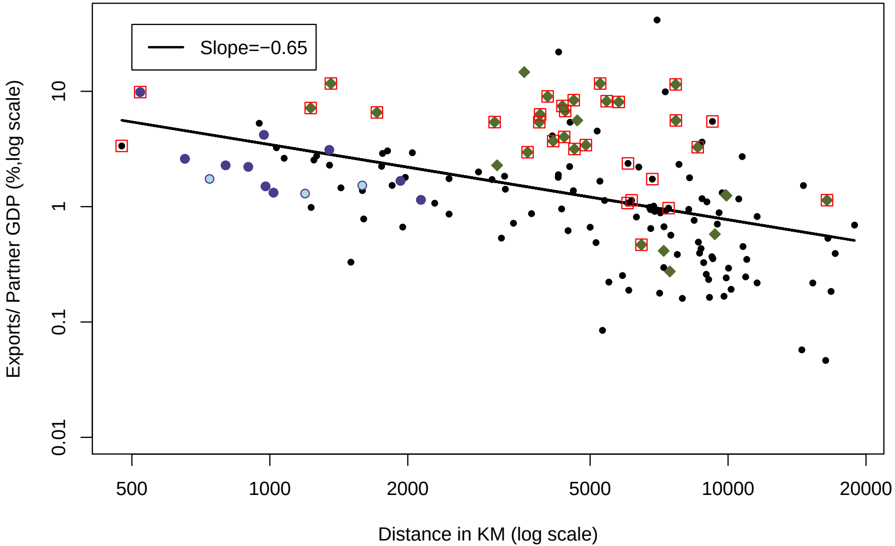


Figure: China share in French and US imports (1967-2017), percent

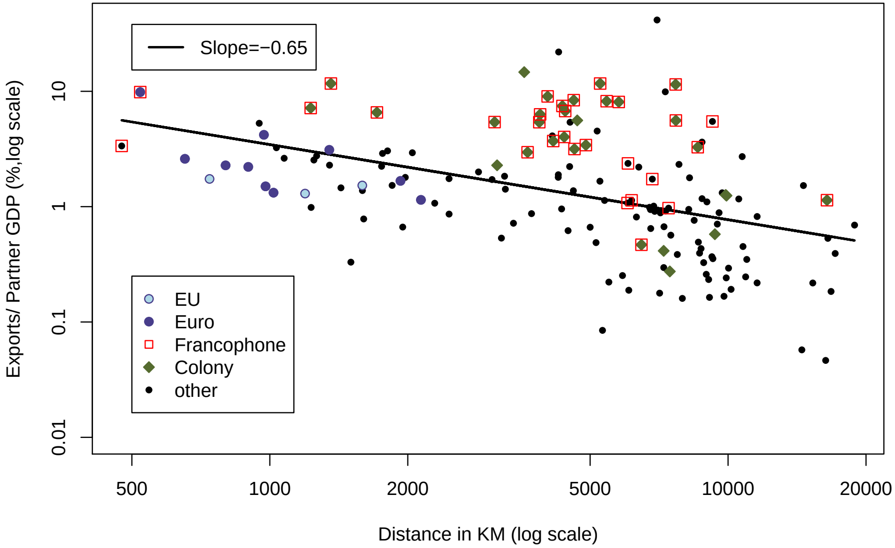
Source: CEPII-Chelem

Gravity in trade: a statistical regularity

- Gravity equation: one of the most stable relationship in economics.
- The bad news: develop a new proxy for trade costs and use a really big dataset; success is not guaranteed, but you're likely to find significance and likely to find a good "theory" for it.
- The good news: we know why it works – most trade models fit gravity.
- Let's give examples: France X, 2000 - France M, 2000 - Trade within the USA - 1997



Source: Head K., Mayer T. (2015), Gravity Equations: Workhorse,Toolkit, and Cookbook, Handbook of international economics, vol.4



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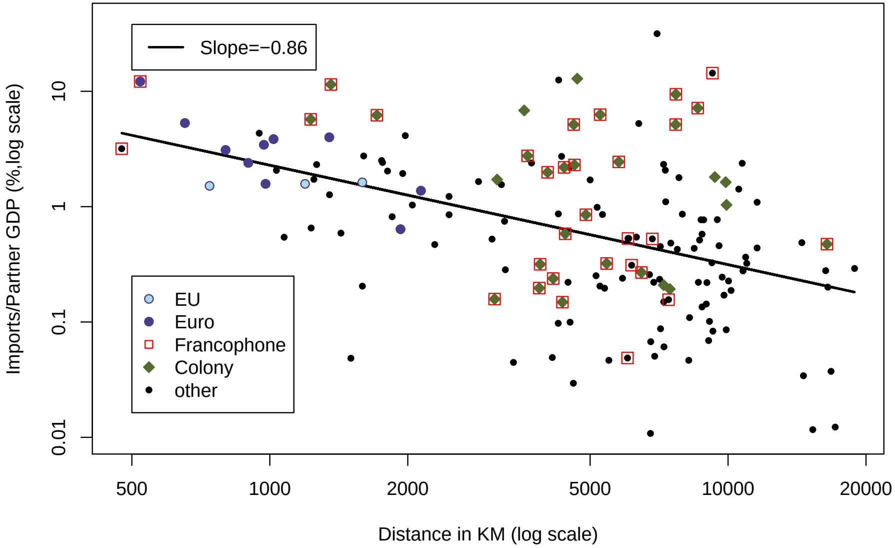

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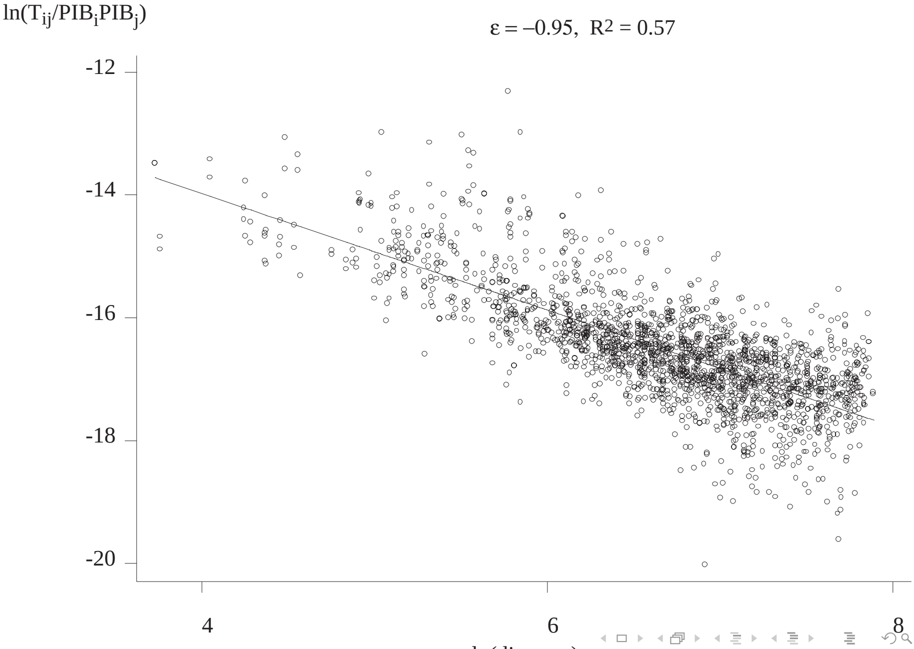
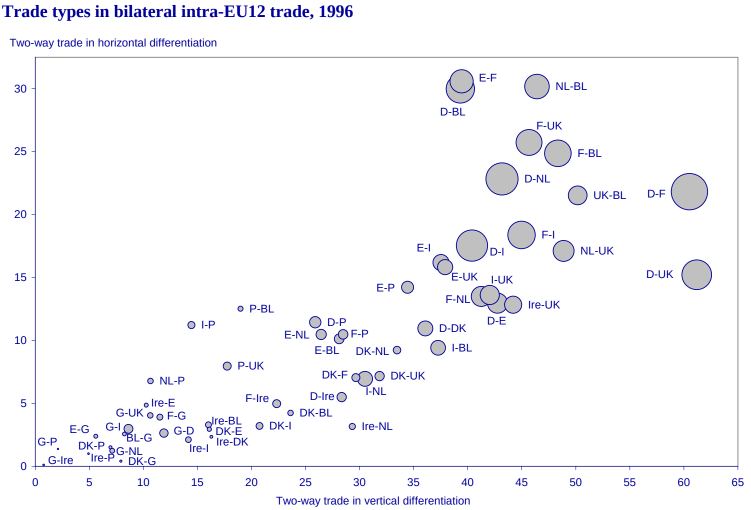

ln(Tij/PIBiPIBj)
ε = –0.95, R2 = 0.57
-12
-14
-16
-18
-20
4
6
8
ln(distance)

Modelling trade with gravity: the trick

- Monopolistic competition and HO with continuum of goods models:
  - Both have many more goods than factors.
  - $\rightarrow$ *complete specialisation in different product varieties across countries*.
  - In this case,*trade patterns can be described by a gravity equation*.
  - ACR(2012): (almost) all trade models subsume in a simple gravity equation but interpretation of trade elasticity differs.
- Gravity equation:
  - Bilateral trade between two countries proportional to the product of their GDP's.
  - Larger countries trade more with each other.
  - More similar countries also trade more.
  - Empirical regularity observed e.g. for Intra-Industry Trade.

Arkolakis C., Costinot A. & Rodriguez-Clare A. (2012), New Trade Models, Same Old Gains?, American Economic Review



The area of the bubbles represents the relative importance of total bilateral trade in total intra-EU trade, ranging from some 10% (France-Germany) to about 0.02% (Greece-Portugal, Greece-Ireland and Portugal-Ireland).

Seminal contributions:

- Lancaster (1980) and Helpman (1981): consumers differ in their ideal variety of a differentiated good.
- Spence (1976) and Dixit & Stiglitz (1977): single representative consumer & love of variety.
- Krugman (1979,1980,1981) based on Dixit & Stiglitz.
- Anderson & van Wincoop (2001): proper derivation of gravity equation and solution to border effect puzzle.
- Chaney (2008): heterogeneous firms. *Variable* trade costs enter the gravity equation with an exponent which is the shape of the Pareto, not the elasticity of substitution.
- Anderson & Yotov (2016): CGEM of an endowment economy based on structural gravity.

Anderson, J. E., & Van Wincoop, E. (2003). Gravity with gravitas: A solution to the border puzzle. American economic review
Chaney, T. (2008). Distorted gravity: the intensive and extensive margins of international trade. American Economic Review
Anderson, J. E., & Yotov, Y. V. (2016). Terms of trade and global efficiency effects of free trade agreements, 1990-2002. Journal of International Economics

Gravity:
size, market potential, competition & accessability

From intuition to testable relationship

- Notations:
- Country i is the exporter
- Country j is the importer
- Product is noted k

Head K., Mayer T. (2015), Gravity Equations: Workhorse,Toolkit, and Cookbook, Handbook of international economics, vol.4

- Two important constraints in gravity equations.
  1. Budget allocation for the importer.
  2. Market-clearing for the exporter.
- How these two constraints have been addressed depend of the trade model.

Budget allocation

- Let i be the exporter and j be the importer (or destination).
- Let X^j represent the total "pie" to be allocated to competitors in market j.
- Let Π^{ij} be the share of the pie allocated to country i.
- Then as an accounting identity we have:

$$X^{ij} = \Pi^{ij} X^j, \tag{1}$$

where $\sum_i \Pi^{ij} = 1$ and $\sum_i X^{ij} = X^j$.
- In trade models X^j is *total expenditure* by the importing country.

Budget allocation (cont.)

- Critical step: show that Π^{ij} can be expressed in the following *multiplicatively separable form:*

$$\Pi^{ij} = \frac{A^i \phi^{ij}}{\Phi^j}. \tag{2}$$

- A^i represents "capabilities" of exporter i.
- $0 \leq \phi^{ij} \leq 1$ represents the accessability of the destination market to that particular exporter.
- Φ^j measures the set of opportunities of consumers in j or, equivalently, the degree of competition in that market.
- Most specific trade models yield such form.

- Consequently, bilateral trade has a multiplicative form:

$$X^{ij} = GS^i M^j \phi^{ij}. \tag{3}$$

- G is just a constant:
    - "Gravitational constant" in analogies with physics.
    - Does not depend on i or j.
    - But varies over time $\rightarrow$ extent of "globalization".
- S^i comprises everything that is exporter-specific.
- M^j encompasses all importer-specific factors,
- At this point $G = 1$, $M^j = X^j/\Phi^j$ and $S^i = A^i$.
- With market-clearing, S^i will depend on A^i and also on all the ϕ^{ij} and M^j.

Market clearing

- Sum of i's exports to all destinations—including i—equals the total value of i's production, Q^i.

$$Q^i = \sum_j X^{ij} = A^i \sum_j \frac{\phi^{ij} X^j}{\Phi^j}. \tag{4}$$

- Market-clearing tells us something about A^i: Define $s^j = X^j/X = X^j/Q$ as country j's share of world expenditure (and production).
- Define the following *market potential (or access)* term:

$$\Phi^{*i} = \sum_h \frac{\phi^{ih} s^h}{\Phi^h}. \tag{5}$$

- Market clearing, can be re-expressed as $Q^i = A^i Q \Phi^{*i}$, and implies:

$$A^i = \frac{Q_i}{Q\Phi^{*i}}. \tag{6}$$

- For a country to produce a lot (high Q^i), if remote from world markets (low Φ^{*i}), it must have good capabilities (high A^i).
- A country's share of world output is a function of good capabilities and good geography: $s^i = A^i \Phi^{*i}$
- At the aggregate level, $B^i = 0$ and $Q^i = X^i = Y^i$
- Substituting $s^i = X^i/X = Y^i/Y$ into $A^i = s^i/\Phi^{*i}$,

- For a country to produce a lot (high Q^i), if remote from world markets (low Φ^{*i}), it must have good capabilities (high A^i).
- A country's share of world output is a function of good capabilities and good geography: $s^i = A^i \Phi^{*i}$
- At the aggregate level, $B^i = 0$ and $Q^i = X^i = Y^i$
- Substituting $s^i = X^i/X = Y^i/Y$ into $A^i = s^i/\Phi^{*i}$, and then A^i into equation (2) and then Π^i into equation (1) we get:

$$X^{ij} = \underbrace{\frac{1}{Y}}_{G} \underbrace{\frac{Y^i}{\Phi^{*i}}}_{S^i} \underbrace{\frac{Y^j}{\Phi^j}}_{M^j} \phi^{ij}. \tag{7}$$

- Which is the proper formulation of our initial gravity equation.

- Literature reached this final formulation only step by step.

$$X_{ij} = \underbrace{\frac{1}{Y}}_{Gravitational constant} \times \underbrace{\frac{Y_i}{\Phi_i^*}}_{Size of exporter / market access} \times \underbrace{\frac{Y_j}{\Phi_j}}_{Size of market / degree competition} \times \underbrace{\phi_{ij}}_{accessability of market}$$

Gravity without frictions

- Helpman (1987) is the first step.
- Monopolistic competition model: countries completely specialised in different product varieties.
- Trade in these product varieties is referred to as IIT.
- Notice that complete specialisation and IIT does not occur in the HO model *as long as* EPF is verified.

Helpman E. (1987), Imperfect Competition and International Trade: Evidence from Fourteen Industrial Countries, Journal of the Japanese and International Economies.

- Gravity equation originally used as an empirical regularity.
- Took long before precise role of frictions and prices are fully understood.
- Helpman (1987) derives a prediction about trade flows in a frictionless world
- Key assumptions:
  - Free trade and zero transport cost, so that all countries have identical prices: $\rightarrow$ "the world is flat".
  - Demand is identical and homothetic across countries.
  - Countries are completely specialised in different varieties.
- $\rightarrow$ a good produced in any country is sent to all other countries in proportion to the purchasing country's GDPs.

- Consider a multicountry framework where $i, j = 1, \ldots, C$ denotes countries, and $k = 1, \ldots, N$ denotes products.
- Consider any variety of a good counts as a distinct product.
- Let y_k^i denote country i's production of good k.
- In a flat world prices are the same across all countries: normalise them to unity, so y_k^i actually measures the value of production of good k by country i.
- GDP in country i is:

$$Y^i = \sum_{k=1}^{N} y_k^i$$

- World GDP is:

$$Y = \sum_{i=1}^{C} Y^i$$

- s^j is share of destination market j in world expenditure and since trade in balanced also in world GDP
- Identical and homothetic preferences lead to the following bilateral exports:

$$X_k^{ij} = s^j y_k^i \tag{8}$$

- Total bilateral exports are:

$$X^{ij} = \sum_k X_k^{ij} = s^j \sum_k y_k^i = s^j Y^i = \frac{Y^j Y^i}{Y} = X^{ji} \tag{9}$$

- To be compared with:

$$X^{ij} = \frac{1}{Y} \frac{Y^i}{\Phi^{*i}} \frac{Y^j}{\Phi^j} \phi^{ij}$$

- Finally, bilateral trade between i and j sums to:

$$X^{ij} + X^{ji} = \frac{2}{Y} Y^i Y^j \tag{10}$$

- Equation (10) can be transformed in:

$$X^{ij} + X^{ji} = 2 s^i s^j Y \tag{11}$$

- Re-express this by considering size of the two countries relative to each other (define a region A of the world economy comprising these two countries).
- The share of country i in A's GDP is s^{iA}.
- The share of region A in world GDP is s^A.
- (11) can be re-written as:

$$\frac{X^{ij} + X^{ji}}{Y^A} = 2 s^{iA} s^{jA} s^A$$

- We can square the sum of the shares $s^{i(j)A}$ (that sum to unity) and obtain:

$$\frac{X^{ij} + X^{ji}}{Y^A} = [1 - (s^{iA})^2 - (s^{jA})^2] s^A$$

Helpman (1987)

If countries are completely specialised in their outputs, tastes are identical and homothetic, and there is free trade worldwide, then the volume of trade among countries in region A relative to their GDP is:

$$s^A[1 - \sum_{i \in A}(s^{iA})^2] \tag{12}$$

The dispersion index is maximised for countries of the same size $(1/N)$.
Conversely, as any country has a share approaching unity, the index approaches zero.
The volume of trade relative to GDP is proportional to the similarity index.

Border effects

What about Canadian exports to Canada?

- The Helpman's theorem applies to a flat world.
- Fails miserably in the best illustrative example of two integrated economies: Canada and USA.
- Launched research on "border effects".
- Starting point: right benchmark for bilateral trade flows between two countries is not average bilateral trade within a sample but internal trade.
- Has stimulated research on the proper derivation of the gravity equation.
- Take-home:
  - International differences in prices must be explicitly taken into account in trade equations.
  - In an *endowment economy*, impact of openness subsumes in variation on prices in the exporting and importing country.
  - Estimated gravity equations must control for... "domestic trade"

- McCallum (1995) compares trade between Canadian provinces and between these provinces and US states.
- McCallum used 1988 data. Replicated by Feenstra with 1993 data.
- Anderson and van Wincoop (2001) fixed the problem and proposed a solution systematically used since then.
- McCallum estimates the following equation:

$$\ln(X^{ij} + X^{ji}) = \alpha + \beta_1 \ln Y^i + \beta_2 \ln Y^j + \gamma\delta^{ij} + \rho \ln d^{ij} + \epsilon^{ij} \quad (13)$$

  $\delta = 1$ if i and j are two Canadian provinces.
- McCallum's dataset did not comprise trade between US states: addition by Feenstra.

McCallum, J. (1995). National borders matter: Canada-US regional trade patterns. The American Economic Review
Feenstra, R. C. (2015). Advanced international trade: theory and evidence.

Dep. var.: Value of exports for Province/State Pairs

	(1)	(2)	(3)
data	1988	1993	1993
$\ln Y^i$	1.21	1.22	1.13
	(0.03)	(0.04)	(0.02)
$\ln Y^j$	1.06	0.98	0.97
	(0.03)	(0.03)	(0.02)
$\ln d^{ij}$	-1.42	-1.35	-1.11
	(0.06)	(0.07)	(0.03)
Canada	3.09	2.80	2.75
	(0.13)	(0.12)	(0.11)
US			0.40
			(0.05)
Border effect Canada	22	16.4	15.7
Border effect US			1.5
Border effect average			4.8
R^2	0.81	0.76	0.85
N	683	679	1511

Note: Border effect average $= (e^{2.75} e^{0.40})^{(1/2)}$

- Comparison with border effects estimated for US states trading with Canadian provinces suggests that there is a misspecification.
- Prices missing.
- Three solutions:
  - Prices indexes
  - Estimated border effects
  - Fixed effects (FE_i, FE_j in cross section, must be time-varying in panel)
- Need to derive again our monopolistic equation of trade, by taking into account frictions

A CES world

Monopolistic competition *cum* frictions

- Introduce transport costs, tariffs and other frictions (language, culture, regulations, ...).
- Homogeneous firms.
- Prices are no longer equalised across countries.
- Monop. compet.: each variety is produced by one firm only (hence one country): export of a variety to a destination equals expenditure on this variety in this destination.
- Total expenditure in destination country j of variety exported by i : c_k^{ij}
- There are C countries indexed by i producing each N^i varieties.
- Using CES formulation, utility of country j is:

$$U^j = \sum_{i=1}^{C} \sum_{k=1}^{N^i} (c_k^{ij})^{(\sigma-1)/\sigma} \tag{14}$$

- We now introduce prices.
- All firms of i sell at same price in j: homogeneous firms.
- Prices charged in j are CIF.
- Products k are exported FOB from i.
- Hence we must write:

$$p_k^{ij} = p^{ij} = T^{ij} p^i$$

- Since all varieties k shipped by i to j are sold the same price $c_k^{ij} = c^{ij}$
- $T^{ii} = 1$ and $T^{ij} \geq 1$: iceberg cost, Samuelson (1952).
- Utility is accordingly:

$$U^j = \sum_{i=1}^{C} N^i (c^{ij})^{(\sigma-1)/\sigma} \tag{15}$$

- The *aggregate* budget constraint in destination country j is:

$$Y^j = \sum_{i=1}^{C} N^i p^{ij} c^{ij} \tag{16}$$

- Maximising (15) s.t. (16) we get:

$$c^{ij} = \frac{Y^j}{P^j} (\frac{p^{ij}}{P^j})^{-\sigma} \tag{17}$$

Where P^j refers to country j's overall price index

- This is the demand in j, c^{ij}, for each product k exported by i
- P^j is defined as:

$$P^j = [\sum_{i=1}^{C} N^i (p^{ij})^{1-\sigma}]^{1/(1-\sigma)} \tag{18}$$

- To obtain a gravity equation we must now sum over all individual exporters:

$$X^{ij} \equiv N^i p^{ij} c^{ij}$$

- And from (17):

$$X^{ij} = N^i Y^j \left(\frac{p^{ij}}{P^j}\right)^{1-\sigma} \tag{19}$$

- N^i is not observable but directly related to Y^i with homogenous firms:

$$Y^i = N^i p^i y^i$$

- Hence the gravity equation (19) can also be written as:

$$X^{ij} = Y^i Y^j (\frac{p^{ij}}{P^j})^{1-\sigma} (y^i p^i)^{-1} \quad (20)$$

- We can now make use of $p^{ij} = p^i T^{ij}$ to obtain:

$$X^{ij} = Y^i Y^j (T^{ij})^{1-\sigma} (P^j)^{\sigma-1} (p^i)^{-\sigma} (y^i)^{-1} \quad (21)$$

- This is the gravity equation to be estimated, to be compared with:

$$X^{ij} = \frac{1}{Y} \frac{Y^i}{\Phi^{*i}} \frac{Y^j}{\Phi^j} \phi^{ij}$$

- Y^i and Y^j are the GDPs (aggregate exports), or production and expenditure at sectoral level.
- (T^{ij}) is the transport cost (can also include tariffs) and other determinants of the difference between CIF and FOB prices.
- P^j is the overall price index in j, p^i the price of the exporter.
- $y^i = (\sigma - 1)\alpha\beta^{-1}$ is a constant that cannot be observed.
- What prices should be used?

Unobservable Prices and Fixed Effects

- There are many disadvantages in using the actual aggregate prices:
  - GDP prices comprise the prices of non traded goods and services.
  - Sectoral price indexes are not systematically available.
  - Price indexes are dependent on the base year.
  - Price indexes have no "dimension" and do not inform us on price levels
- One may better consider that prices are not observable.
- In this case, two approaches are possible:
  - Solve the system of equations for the prices
  - Replace the price effects with bilateral fixed effects

- We start by modeling the cif prices p^{ij} as differing from the fob prices p^i due to distance d^{ij} and other frictions τ^{ij}:

$$lnT^{ij} = \tau^{ij} + \rho lnd^{ij} + \epsilon^{ij} \tag{22}$$

- d^{ij} and τ^{ij} are either observed (in this case for instance τ will include bilateral applied tariffs), or *estimated*.
- Estimating τ^{ij} provides an indirect evidence on protection. Here, estimating the two factors will help sorting out the issue of prices.
- Remind that our gravity equation is:

$$X^{ij} = N^i Y^j (\frac{p^i T^{ij}}{P^j})^{1-\sigma}$$

- Substituting the value of T^{ij} in this expression leads to a complex expression for estimation. This is where the market clearing conditions will help.

- Market clearing condition: in presence of transport costs we have fob sales = cif expenditures ($p^i y^i = \sum_{j=1}^{C} p^{ij} c^{ij}$):

$$y^i = \sum_{j=1}^{C} c^{ij} T^{ij} \tag{23}$$

- Instead of using this market clearing condition to solve for the unknown prices, Anderson and van Wincoop (2001) use an implicit solution.
- The implicit solution to (23) for individual prices is:

$$\widetilde{p}^i \equiv (s^i/N^i)^{1/(1-\sigma)}/\widetilde{P}^i \tag{24}$$

- One can introduce the implicit price $\widetilde{p}^i$ in the gravity equation (19)
- And get a gravity equ. whereby the unobservable N are no longer present:

$$X^{ij} = \frac{1}{Y} \frac{Y^i}{(\widetilde{P}^i)^{1-\sigma}} \frac{Y^j}{(\widetilde{P}^j)^{1-\sigma}} (T^{ij})^{1-\sigma} \tag{25}$$

- This is precisely our initial gravity equation, in the CES case:

$$X^{ij} = \frac{1}{Y} \frac{Y^i}{\Phi^{*i}} \frac{Y^j}{\Phi^j} \phi^{ij}$$

- The terms $\widetilde{P}$ are two (unobservable) *indexes of multilateral resistance*.
- These *Outward* and *inward* MRTs are the core of any computable general equilibrium model of an endowment economy.

- The term in Y is just a constant that can be dropped in cross-section.
- The coefficients on the terms Y^i and Y^j can be constrained so that the dependent variable is X^{ij}/Y^iY^j.
- Then we can factor in the expression for the difference between cif and fob prices $\ln T^{ij} = \tau^{ij} + \rho \ln d^{ij} + \epsilon^{ij}$ and take the logs:

$$\begin{aligned} \ln(X^{ij}/Y^iY^j) &= \rho(1-\sigma)\ln d^{ij} + (1-\sigma)\tau^{ij} \\ &+ \ln(\widetilde{P}^i)^{\sigma-1} + \ln(\widetilde{P}^j)^{\sigma-1} \\ &+ (1-\sigma)\epsilon^{ij} \end{aligned} \tag{26}$$

- τ is a variable trade cost, i.e. a price shifter: taking tariffs, and assuming full pass through, one can estimate σ.
- And recover ρ. See our database of product level trade elasticities.
- Shows that distance cannot be used to estimate trade elasticities: impact of distance is the combined effect of elasticity of transport cost to distance and elasticity of export to price (inclusive of transport).

- Anderson and van Wincoop use this equation to estimate the border effects between Canada and the US.
- They do not use the term $(1-\sigma)\tau^{ij}$n but a dummy δ^{ij} equal to 0 for Canada-US trade and 1 otherwise.
- The estimated equation is now:

$$\begin{aligned} \ln(X^{ij}/Y^{i}Y^{j}) &= \alpha \ln d^{ij} + \gamma(1-\delta^{ij}) \\ &+ \ln(\widetilde{P}^{i})^{\sigma-1} + \ln(\widetilde{P}^{j})^{\sigma-1} \\ &+ (1-\sigma)\epsilon^{ij} \end{aligned} \quad (27)$$

- The coefficient on the indicator of cross border trade $(1-\delta^{ij})$ is -1.55 in column 4 of next Table, using the FE strategy (column 3 reproduces previous results).
- $e^{1.55} = 4.7 \approx$ border effect average previously calculated.

Dep. var.: Value of exports for Province/State Pairs

	(3)	(4)
data	1993	1993
$\ln Y^i$	1.13	1
	(0.02)	
$\ln Y^j$	0.97	1
	(0.02)	
$\ln d^{ij}$	-1.11	-1.25
	(0.03)	(0.04)
Canada	2.75	
	0.11	
US	0.40	
	0.05	
Border		-1.55
		(0.06)
Border effect Canada	15.7	
Border effect US	1.5	
Border effect average	4.8	4.7
R^2	0.85	0.66
N	1511	1511

- We have the following transformation:

$$\begin{aligned} (1-\sigma)\tau^{ij} &= \gamma(1-\delta^{ij}) \\ \Rightarrow \tau^{ij} &= \frac{\gamma(1-\delta^{ij})}{(1-\sigma)} \\ \Rightarrow e^{\tau^{ij}} &= e^{[\gamma(1-\delta^{ij})/(1-\sigma)]} \end{aligned}$$

  with $\delta^{ij} = 0$ for cross-border trade.

- Hence a σ equal to 5.3 (our estimate) would lead to a *tariff equivalent* of the US-Canada border of 43% ($e^{\tau} = 1.43$)

Structural gravity in practice

- Economic impacts of preferential trade agreements.
- Conditional on their level of ambition.
- Cluster 278 agreements, encompassing 910 provisions over 18 policy areas.
- Estimate the trade elasticity for the different clusters.

Fontagné L., Rocha N., Ruta M., Santoni G. (2022) The Economic Impact of Deepening Trade Agreements. Working paper

- Structural gravity equation
- Estimated, using PPML with panel data
- In panel
- In shares of absorption at destination – namely $\frac{X_{ij,t}}{\sum_i X_{ij,t}}$
- $X_{ij,t}$ includes both intra-national and international manufacturing trade flows
- 5-year intervals from 1978 to 2018

$$X_{ij,t} = exp\left(\sum_{z=1}^{3} \beta_z PTA^z_{ij,t} + \sum_{T=1978}^{2000} \beta_T INTL\ BRDR_{ij} * T + \pi_{i,t} + \chi_{j,t} + \mu_{ij}\right) + \epsilon_{ij,t} \quad (28)$$

Table: PPML: Gravity Estimations of the elasticity of trade to PTAs by Cluster

Dep Var:			X_{ijt}			X_{ijt}/X_{jt}	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$PTA_{ij,t}$	0.629	0.663	0.294				
	(0.051)	(0.059)	(0.043)				
$PTA_{ij,t}^{K\#1}$				0.595	0.535	0.512	0.529
				(0.045)	(0.043)	(0.069)	(0.087)
$PTA_{ij,t}^{K\#2}$				0.256	0.235	0.277	0.325
				(0.054)	(0.033)	(0.035)	(0.045)
$PTA_{ij,t}^{K\#3}$				0.109	0.153	0.164	0.184
				(0.045)	(0.048)	(0.044)	(0.053)
Transit. $PTAs_{ij,t}$		0.160	0.136	0.228	0.229	0.163	0.183
		(0.055)	(0.047)	(0.052)	(0.045)	(0.046)	(0.055)
BRDR∗1980			-0.944	-0.933	-1.194	-1.135	-1.117
			(0.043)	(0.043)	(0.050)	(0.065)	(0.098)
BRDR∗1990			-0.574	-0.576	-0.819	-0.859	-0.844
			(0.035)	(0.034)	(0.040)	(0.048)	(0.068)
BRDR∗2000			-0.223	-0.223	-0.294	-0.361	-0.345
			(0.027)	(0.027)	(0.031)	(0.037)	(0.053)
Intra-Nat. flows	Raw	Raw	Raw	Raw	Raw	Extrapolated	Extrapolated
Period	1978-2018	1978-2018	1978-2018	1978-2018	1978-2018	1978-2018	1978-2018
N. Ctry	133	133	133	133	133	142	142
N. Ctry (year 2018)	61	61	61	61	61	112	112
Obs.	68,225	68,225	68,225	68,225	68,225	122,633	122,633
FEs	it, jt, ij	it, jt, ij	it, jt, ij	it, jt, ij	it, jt, ij	it, jt, ij	it, jt, ij three-way correction

Merci

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