ECON G6905
Topics in Trade

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Columbia University
in the City of New York

Today

- The gravity equation
- Trade costs
- Gains from trade

The *Handbook* chapters on the gravity equation and gains from trade are excellent. Rely on them.

The gravity equation

General gravity (Allen Arkolakis Takahashi 2014) [not 2020 *JPE*]:

$$X_{ij} = G \times S_i \times M_j \times \phi_{ij}$$

Structural gravity (Head and Mayer 2014) [true by $Y_i = \sum_j X_{ij}$]:

$$X_{ij} = \underbrace{\frac{Y_i}{\Omega_i}}_{S_i} \times \underbrace{\frac{X_j}{\Phi_j}}_{M_j} \times \phi_{ij}$$

$$\Omega_i = \sum_\ell \frac{X_\ell}{\Phi_\ell}\phi_{i\ell} \quad \Phi_j = \sum_\ell \frac{Y_\ell}{\Omega_\ell}\phi_{\ell j}$$

Naive gravity ("gold medal error" of Baldwin and Taglioni):

$$X_{ij} = G \times Y_i^a \times Y_j^b \times \phi_{ij}$$

Recall last week's Armington model (this is general, is it structural?):

$$X_{ij} = \frac{Y_i^{1-\sigma}}{Q_i^{1-\sigma}} \frac{X_j}{P_j^{1-\sigma}} \tau_{ij}^{1-\sigma}$$

Gravity fits the cross section well

Naive gravity, akin to physics's force $\propto \frac{\text{mass}_i \times \text{mass}_j}{\text{distance}_{ij}^2}$, does very well with GDP as mass:

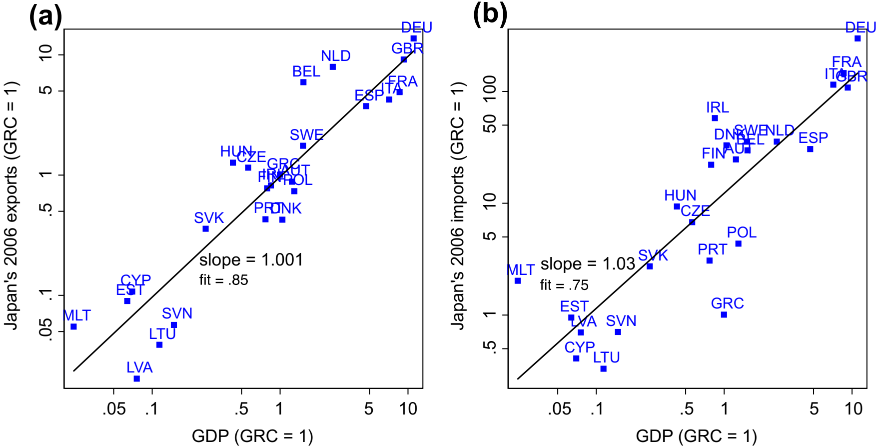

Figure 3.1 Trade is Proportional to Size; (a) Japan's Exports to EU, 2006; (b) Japan's Imports from EU, 2006. GRC: Greece

Gravity fits the cross section well

A broad notion of "distance" does well:

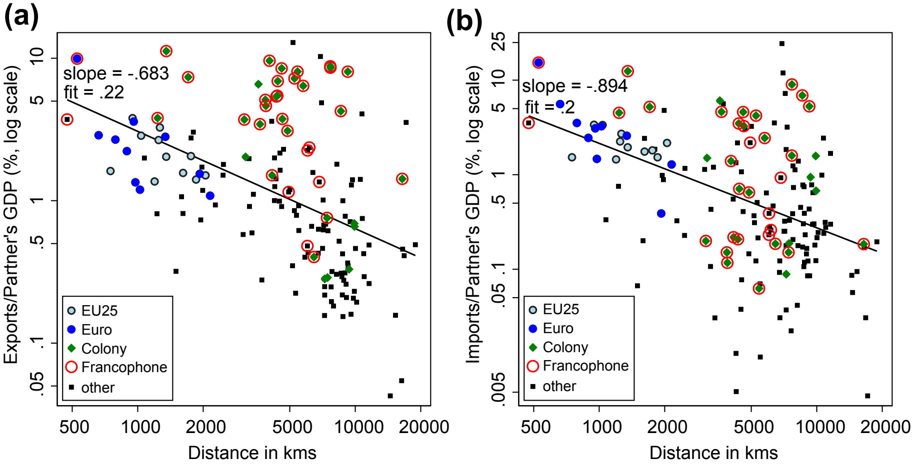

Figure 3.2 Trade is Inversely Proportional to Distance; (a) France's Exports (2006); (b) France's Imports (2006)

Is gravity's goodness of fitness impressive? (Lai and Trefler 2002)

$$X_{ij} = \frac{Y_i}{\Omega_i} \times \frac{X_j}{\Phi_j} \times \phi_{ij}$$

- Y_i is not terribly interesting because $Y_i = \sum_j X_{ij}$ is an identity
- $\frac{X_{ij}}{X_j} = \frac{S_i \phi_{ij}}{\Phi_j} = \frac{S_i \phi_{ij}}{\sum_\ell S_\ell \phi_{\ell j}}$ has substantive content, since it says that preferences are homothetic (budget shares don't depend on X_j), but see Deaton and Muellbauer quote
- The meat of the structural models is in $\frac{\phi_{ij}}{\Omega_i \Phi_j}$ (IIA and recursive multilateral resistance)
- Lai and Trefler (2002) estimate monopolistic-competition model via NLLS using panel data on manufacturing trade while assuming ϕ_{ij} depends only on tariffs
- Lai and Trefler (2002): "do changes in tariffs over time predict changes in bilateral trade flows? No. The data are completely at odds with the model's core behavioural and general equilibrium predictions about [tariff changes]."
- Head and Mayer (2014): "Nevertheless, the standard CES model is too entrenched — partly because it is so useful! — that it will not be abandoned based on one finding."

Evaluating gravity models based on predicting changes

Kehoe, Pujolas, Rossbach (2017) on applied general-equilibrium models:

- "AGE models do not have a good track record in predicting the impact of trade reforms on production and trade flows by industry"
- Typical AGE: "the model exactly matches the data in the base period" and "Cobb-Douglas or fixed-coefficient forms, which makes it easy to calibrate factor and demand intensities directly from IO tables" (cross-sectional fit is a given)

You need to get the shocks and the elasticities right.

- Key question: Which components of inferred/calibrated trade costs will respond to changes in trade policy?
- Kehoe's path forward: "need to incorporate product-level data on bilateral trade relations by industry and better model how trade reforms lower bilateral trade costs"
- Adao, Costinot, Donaldson (2023): "if the causal impact of policy changes in the researcher's model is correct, then the difference between observed and predicted changes should be equal to the causal impact of other shocks"

Kehoe, Pujolas, Rossbach (2017) on NAFTA

- "if AGE models cannot get one of the largest and most significant trade reforms in recent history correct, then there may be reasons to doubt the reliability of the AGE models currently being used for evaluating trade policy"
- "Although the focus of their study is on using their model to disentangle the welfare implications of NAFTA, we can also evaluate the accuracy of the model in matching actual changes in trade flows following the implementation of NAFTA."

Table 2 Comparisons of the CP model and LTP predictions for NAFTA with data

Exporter	Importer	CP correlation with data	CP correlation with data (only NAFTA tariffs)	CP correlation with data (no IO structure)	LTP correlation with data
Canada	Mexico	−0.46	−0.46	−0.50	0.27
Canada	United States	0.36	0.32	0.36	0.19
Mexico	Canada	−0.68	−0.66	−0.71	0.83
Mexico	United States	−0.17	−0.12	−0.21	0.33
United States	Canada	0.35	0.05	0.14	0.28
United States	Mexico	0.54	0.53	0.64	0.16
Simple average		−0.01	−0.06	−0.05	0.33

Abbreviations: CP, Caliendo-Parro; IO, input–output; LTP, least-traded products; NAFTA, North American Free Trade Agreement.

Allen, Arkolakis, Takahashi (2020): "Universal Gravity"

Setup

- Models with iceberg bilateral trade costs, CES aggregate demand, CES aggregate supply, exogenous trade deficits
- Aggregate supply elasticity is non-zero with roundabout production or labor mobility
- Not covered: models with variable elasticities, multiple factors of production, or intertemporal decisions

Results

- Sufficient conditions for existence, uniqueness, and interiority
- Counterfactual predictions of these gravity models depend on the elasticities of supply and demand (and observed data)
- *Local* responses of endogenous variables to trade shocks via matrix inversion (interpret as shock propagation) (vs EHA)
- Country-level supply elasticity of 68 is very high

Paper may seem abstract but you will find yourself re-reading it often

Gravity in urban economics

Importing the gravity model into urban economics:

- Gravity for commuting flows: Anas (1983), Ahlfeldt Redding Sturm Wolf (2015), Monte Redding Rossi-Hansberg (2018), Owens Rossi-Hansberg Sarte (2020), Severen (2019), Tsivanidis (2019), Dingel and Tintelnot (2023)
- Gravity for consumption in the city: Davis Dingel Monras Morales (2019), Allen Arkolakis Li (2015), Miyauchi Nakajima Redding (2021)

These settings differ slightly from canonical trade model:

- Model of discrete choice rather than CES demand (see Anderson, de Palma, Thisse book)
- Trade flows need not balance due to commuting (workplace income is residential expenditure)
- Zeros are far more pervasive (Dingel & Tintelnot 2023)
- Commonalities: estimation with two-way HDFE, recursive market-access terms

Estimating gravity regressions

- Approximating Ω_i and Φ_j: "remoteness" or "market potential"
- Estimating Ω_i and Φ_j: NLLS, SILS, or PPML for structural gravity
- Fixed effects: $\ln X_{ij} = \ln S_i + \ln M_j + \ln \phi_{ij}$
- Double ratios (tetrads) [relate to Head-Ries index]:

$$\frac{X_{ij}/X_{ik}}{X_{\ell j}/X_{\ell k}} = \frac{\phi_{ij}/\phi_{ik}}{\phi_{\ell j}/\phi_{\ell k}}$$

- Triple ratios (Caliendo & Parro 2015) [not quite right]:

$$\phi_{ij} = [(1+t_{ij})d_{ij}^{\delta}]^{\epsilon} \quad d_{ij} = d_{ji}\ \forall i,j$$

$$\frac{X_{ij}X_{hi}X_{jh}}{X_{hj}X_{ih}X_{ji}} = \left(\frac{(1+t_{ij})(1+t_{hi})(1+t_{jh})}{(1+t_{hj})(1+t_{ih})(1+t_{ji})}\right)^{\epsilon}$$

The keys to informative estimation are (1) not being naive, (2) distinguishing the trade elasticity from reduced-form coefficients, (3) handling zeros appropriately, and (4) recognizing the endogeneity of trade policy

Know your estimand: the trade elasticity or the distance elasticity?

- Consider the OLS regression with two-way high-dimensional fixed effects given by the CES Armington model ($\epsilon = \sigma - 1$):

$$\ln X_{ij} = \ln S_i + \ln M_j - \epsilon \ln \tau_{ij} + u_{ij}$$

- If you assume the trade costs are a function of, say, distance with $\ln \tau_{ij} = \beta \ln \text{distance}_{ij}$, then you would estimate

$$\ln X_{ij} = \ln S_i + \ln M_j - \epsilon\beta \ln \text{distance}_{ij} + u_{ij}$$

  You will recover $\epsilon\beta$. Do not mistake this for ϵ.

- You recover the trade elasticity with observed trade costs and pass-through assumptions. If $\ln \tau_{ij} = \beta_1 \ln \text{distance}_{ij} + \beta_2 \ln \text{tariff}_{ij}$ and you assume that $\beta_2 = 1$, then $\epsilon\beta_2 = \epsilon$. (Make sure you use trade flows inclusive of tariff payments or else you'll estimate $\epsilon - 1$)

Can you distinguish trade costs and preference shifters?

Consider an Armington model with asymmetric preferences:

$$U_j = \left(\sum_i \beta_{ij} q_{ij}^{(\sigma-1)/\sigma} \right)^{\sigma/(\sigma-1)}$$

$$\Rightarrow \frac{X_{ij}}{X_j} = \beta_{ij} \left(\frac{p_{ij}}{P_j} \right)^{1-\sigma} = \frac{w_i^{1-\sigma}}{P_j^{1-\sigma}} \beta_{ij} \tau_{ij}^{1-\sigma}$$

Now you have a structural gravity setting in which $\phi_{ij} = \beta_{ij} \tau_{ij}^{1-\sigma}$.

- Could bilateral preference shifters be correlated with common language, colonial status, import tariffs, or distance? Of course.
- Blum and Goldfarb (2006): "Americans are more likely to visit websites from nearby countries, even controlling for language, income, immigrant stock, etc. Furthermore, we show that this effect only holds for taste-dependent digital products, such as music, games, and pornography."

Logs vs levels and the Poisson PML estimator

Silva and Tenreyro (REStat 2006) raise logs vs levels issue:

$$X_{ij} = \alpha_0 Y_i^{\alpha_1} Y_j^{\alpha_2} D_{ij}^{\alpha_3} \eta_{ij}$$

$$\ln X_{ij} = \alpha_0 + \alpha_1 \ln Y_i + \alpha_2 \ln Y_j + \alpha_3 \ln D_{ij} + \ln \eta_{ij}$$

- The levels regression requires $\mathbb{E}\left(\eta_{ij} | Y_i, Y_j, D_{ij}\right) = 1$.
- What does the logs regression require of $\ln \eta_{ij}$?

Stack the fixed effects and log distance in a vector $\mathbf{Z}_{ij}$ and stack their associated coefficients in a vector β. Contrast OLS and PPML first-order conditions:

$$\text{Ordinary least squares:} \quad \sum_{i,j} \left[\ln X_{ij} - \beta \mathbf{Z}_{ij}\right] \mathbf{Z}_{ij} = 0$$

$$\text{Poisson pseudo maximum likelihood:} \quad \sum_{i,j} \left[X_{ij} - \exp\left(\beta \mathbf{Z}_{ij}\right)\right] \mathbf{Z}_{ij} = 0$$

The OLS FOC has a log difference; the PPML FOC has a level difference.

Sotelo (2019): "when using PML methods to estimate gravity models, specifying the dependent variable as shares or as levels amounts to assigning different weights to each importer country."

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Zeros and PPML

How to handle zeros (on the left side)?

- I cannot put ln(0) on the LHS
- We use the PPML estimator to handle zeros

By the way, one can only generate $X_{ij} = 0$ in "structural gravity" by $\phi_{ij} = 0$, but this runs up against the triangle inequality for trade costs

$$X_{ij} = \frac{Y_i}{\Omega_i} \times \frac{X_j}{\Phi_j} \times \phi_{ij}$$

It is very natural to use the PPML estimator for commuting flows, since they are literally count data and the PPML estimator's FOC coincides with the logit MLE's FOC (see Dingel and Tintelnot 2023 for more comments).

PPML estimator and structural gravity

Fally (2015): The Poisson pseudo-maximum-likelihood estimator automatically satisfies adding-up constraints of structural gravity

- NLLS imposes (using observed Y_ℓ and X_ℓ)

$$\hat{\Phi}_j = \sum_\ell \frac{Y_\ell}{\hat{\Omega}_\ell} \hat{\phi}_{\ell j} \quad \hat{\Omega}_i = \sum_\ell \frac{X_\ell}{\hat{\Phi}_\ell} \hat{\phi}_{i\ell}$$

- Generally, fixed-effect estimation is consistent with the structural-gravity framework if we use fitted output ($\hat{Y}_i = \sum_\ell \hat{X}_{i\ell}$) and fitted expenditures ($\hat{X}_\ell = \sum_i \hat{X}_{i\ell}$) instead of observed output and expenditures
- PPMLE's estimated FE deliver model-consistent $\hat{\Phi}$ and $\hat{\Omega}$ because fitted output equals observed output and fitted expenditures equal observed expenditures
- Poisson is the only PML estimator with this property

Example: Redding and Venables (2004) estimate bilateral gravity regression to recover $\hat{\Phi}$ and $\hat{\Omega}$ and relate them to GDP per capita

Gravity in a panel setting

- The simplest data-generating process is repeated cross sections (no state variables, no intertemporal links):

$$X_{ijt} = \frac{Y_{it}}{\Omega_{it}} \times \frac{X_{jt}}{\Phi_{jt}} \times \phi_{ijt}$$
$$= S_{it} M_{jt} \phi_{ijt}$$

- Let bilateral trade costs have permanent and time-varying components:

$$\phi_{ijt} = \bar{\phi}_{ij} \tilde{\phi}_{ijt}$$

- Given this panel setting, you should use it, jt, and ij fixed effects
- Typical example: a dummy for WTO membership or preferential trade agreements is an observed covariate in $\tilde{\phi}_{ijt}$
- Ruzicska et al (2024): "By most metrics, machine learning models only marginally outperform the gravity equation. The high explanatory power achieved by all models is primarily due to their ability to explain cross-sectional variation rather than time-series changes."

Gravity and trade imbalances

Relevant for "Liberation Day" is Cunat & Zymek - "Bilateral Trade Imbalances" (*REStud* 2024)
If sectoral trade flows obey structural gravity, countries' bilateral trade imbalances are the result of macro trade imbalances, "triangular trade", or pairwise asymmetric trade barriers. Using data for 40 major economies and the Rest of the World, we show that large and pervasive asymmetries in trade barriers are required to account for most of the observed variation in bilateral imbalances. A dynamic quantitative trade model suggests that eliminating these asymmetries would significantly reduce bilateral (but not macro) imbalances and have sizeable impacts on welfare. We provide evidence that the asymmetries we measure are in part related to the policy environment: trade inside the European Single Market appears to be subject to more bilaterally symmetric frictions. Extending the same symmetry to all parts of the global economy would give a large boost to the real incomes of several non-E.U. countries.

Estimation in practice

The homework assignment explores practical issues:

- Speed consequences of how you handle the high-dimensional fixed effects
- Selection-bias consequences of how you handle the zeros
- Speed consequences of choice of software (Stata vs R vs Julia)

Trade costs

Trade costs ϕ_{ij} are the frictions that make international and intranational trade distinct (from integrated GE) and interesting, yet we struggle to measure them

- Tariffs (easy to define, but go download TRAINS data)
- Transportation costs (money + time + trade finance)
- Communication costs
- Contractual frictions

Trade costs are important:

- Almost essential to rationalizing observed prices and quantities
- Obstfeld and Rogoff (2001) propose that trade frictions key to six puzzles in international macro (Eaton, Kortum, Neiman 2016)
- Key to evaluating welfare and government investment in transportation infrastructure, from roads to ports

Are trade costs large or is the world integrated?

Arguments for large trade costs:

- Exchange declines dramatically with geographic distance (Head and Disdier 2008 for countries, Dingel 2017 table C.1 for US cities)
- Large price gaps (from within cities to across countries) aren't arbitraged away

Arguments for trade costs not being a big deal:

- MFN tariffs are in the single digits for most of world economy
- The cost of moving manufactured goods fell 90% over the twentieth century (Glaeser and Kohlhase 2004)

Is ϕ_{ij} a good description of international business frictions?

- Contrast ad valorem tariffs with specific tariffs
- Contrast border barriers with income differences or regulatory differences

Inferring trade costs

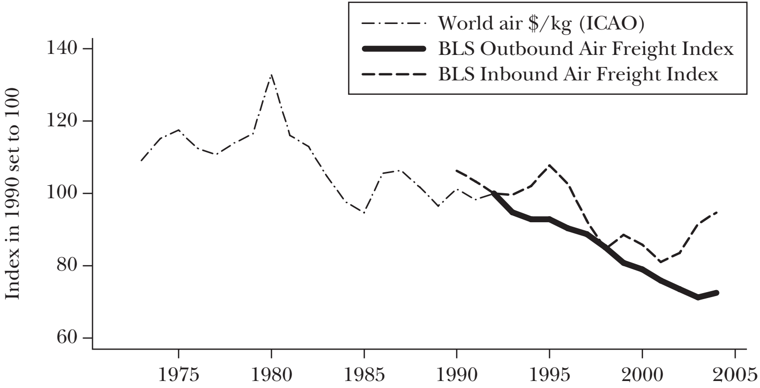
Three strategies:

- Measure trade costs directly
- Infer trade costs from observed exchange volumes
- Infer trade costs from observed price gaps

Direct measurement: Transport prices

Hummels (JEP 2007) has lots of direct measures:

Air Transport Price Indices



Source: International Civil Aviation Organization (ICAO), "Survey of Air Fares and Rates," various years; U.S. Department of Labor Bureau of Labor Statistics (BLS) import/export price indices, http://www.bls.gov/mxp/.

Container shipping

- First used for a Newark-Houston shipment in 1956
- In 1964, 10 US ports and 3 Australian ports are containerized
- By 1977, 68 countries had adopted the technology

Direct measures of trade costs

See Anderson and van Wincoop (JEL 2004) for survey

- Endogenous price quotes for freight and insurance (above plus the US and Australian import data)
- UNCTAD TRAINS for tariffs (convert specific to ad-valorem equivalent?) (coverage concerns) (ask about preference utilization)
- UNCTAD TRAINS for non-tariff barriers (do quotas bind?) (coverage concerns)
- World Bank's Doing Business measures for port/border costs

In addition to the limitations of these individual measures, the overriding concern is that these observables cannot capture all trade costs related to coordination, contracts, intermediaries' market power, uncertainty and just-in-time production, etc

Inferring from observed exchanges: Gravity residuals

Head and Ries (2001) suggest backing out the freeness of trade by assuming $\phi_{ii} = 1\ \forall i$ (normalization) and $\phi_{ij} = \phi_{ji}\ \forall i, j$ (symmetry)

$$X_{ij} = \frac{Y_i}{\Omega_i} \times \frac{X_j}{\Phi_j} \times \phi_{ij} \quad \Rightarrow \quad \hat{\phi}_{ij}^k = \sqrt{\frac{X_{ij}^k X_{ji}^k}{X_{jj}^k X_{ii}^k}}$$

- Requires data on internal trade X_{ii}^k, which does not appear in customs records
- Requires assumption on tastes and trade elasticity to turn ϕ_{ij} into trade costs
- See Jacks, Meissner, Novy 2010 and Novy 2013 for related applications

TABLE 1

The Trade Cost Measure for the United States

Partner Country	Tariff Equivalent τ_{ij} in % 1970	Tariff Equivalent τ_{ij} in % 2000	Percentage Change
Canada	50	25	−50
Germany	95	70	−26
Japan	85	65	−24
Korea	107	70	−35
Mexico	96	33	−66
UK	95	63	−34
Simple average	88	54	−38
Trade-weighted average	74	42	−44

Notes: All numbers are in percent and rounded off to integers. Countries listed are the six biggest U.S. export markets as of 2000. Computations based on Equation (5).

Inferring from observed exchanges: Feyrer (2009)

Table 1: Trade Versus Sea Distance with the Closure of Suez 67-75

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				Pairwise ln(trade)				
ln(sea dist)	-0.149+	-0.266**	-0.312**	-0.458**				
	(0.084)	(0.091)	(0.074)	(0.083)				
ln(sea dist) (67)					-0.330**	-0.402**	-0.473**	-0.558**
					(0.111)	(0.123)	(0.106)	(0.116)
ln(sea dist) (74)					-0.024	-0.147	-0.155	-0.329**
					(0.114)	(0.119)	(0.104)	(0.108)
Test 67 == 74 (p-value)					0.04	0.11	0.03	0.13
Pairs	2,605	2,605	1,294	1,294	2,605	2,605	1,294	1,294
Observations	60,920	46,726	34,938	27,174	60,920	46,726	34,938	27,174
R-squared	0.871	0.866	0.906	0.902	0.871	0.866	0.906	0.902
Balanced Panel	No	No	Yes	Yes	No	No	Yes	Yes
Omit Transition	No	Yes	No	Yes	No	Yes	No	Yes

** p<0.01, * p<0.05, + p<0.1
Regressions include country pair and year dummies.
Standard errors clustered by country pair
Years 1967-1969 and 1975-1977 are the transition periods.

Table 2: Trade Versus Distance 1967-1975

	(1)	(2)	(3)	(4)	(5)	(6)
			Pairwise ln(trade)			
ln(air distance)	-1.084**		-0.791**	-1.006**		-0.740**
	(0.031)		(0.072)	(0.033)		(0.079)
ln(sea distance)		-1.022**	-0.309**		-0.922**	-0.280**
		(0.032)	(0.072)		(0.035)	(0.078)
Pairs	2,605	2,605	2,605	1,294	1,294	1,294
Observations	60,920	60,920	60,920	34,938	34,938	34,938
R-squared	0.720	0.714	0.721	0.775	0.767	0.777
Balanced Panel	No	No	No	Yes	Yes	Yes

*** p<0.01, ** p<0.05, * p<0.1
All regressions include a set of country and year dummies.
Standard errors clustered by country pair

- The Suez Canal offer shortest Asia-Europe sea route and today handles $\sim 8\%$ of world trade
- Egypt closed the Suez Canal 1967-1975

Inferring from observed exchanges across products

- Djankov, Freund, Pham (REStat 2010) on "Trading on Time"
  - Each day of delay at port reduces trade by $\sim 1\%$
  - Delays have a relatively greater impact on exports of time-sensitive goods, such as perishable crops
- Bernhofen, El-Sahlid, Kneller (JIE 2016) "Estimating the effects of the container revolution on world trade"
  - Diff-in-diffs design using staggered intro of container facilities across countries and product variation in container usage
  - North-North trade shows cumulative ATE of 17% after five years
- Hortaçsu, Martínez-Jerez, Douglas (2009) "The Geography of Trade in Online Transactions: Evidence from eBay and MercadoLibre"
  - Sample of a quarter million eBay listings scraped Feb-May 2004
  - Gravity regressions show larger same-city effect for product categories with more buyer dissatisfaction

Mis-specified gravity and trade elasticities

Yi (JPE 2003) motivates his paper with two puzzles:

- Observed trade elasticity (wrt tariffs) of ~ 20 much higher than prediction of standard models
- This elasticity became much higher, non-linearly, around the 1980s. Why?

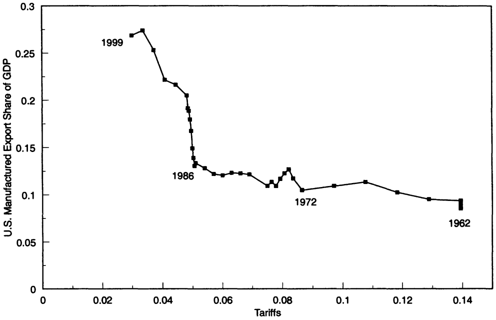


FIG. 1.—Manufacturing export share of GDP and manufacturing tariff rates. Source: World Trade Organization (2002) and author's calculations (see App. A and Sec. V).

Answer is "vertical specialization" (tradable intermediate inputs)

- Yi (JPE 2003): The possibility of international fragmentation of production raises the trade-to-tariff elasticity.
- Yi (AER 2010): Similarly for "border effect" estimates

Yi (2003): Vertical specialization story

Yi (2003) introduces a two-country DFS-style model with vertical specialization. Model lacking without VS misses two puzzle.

- Puzzle 1: if goods cross border N times, tariff costs is $(1+\tau)^N$ rather than $1+\tau$
- Puzzle 2: high tariffs $\rightarrow$ intermediates are not traded. Elasticity will be initially low (as if $N=1$) and then suddenly higher (as if $N>1$).

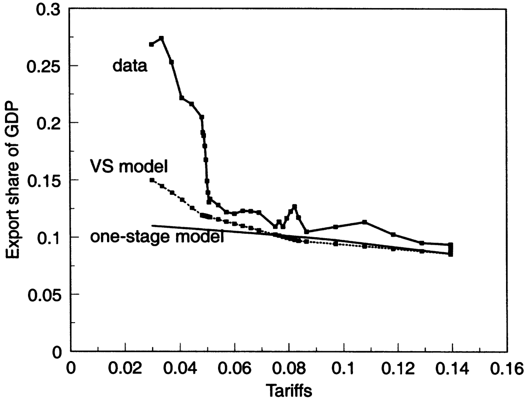


FIG. 10.—Narrow case: vertical model vs. one-stage model

Also see Adao, Costinot, and Donaldson (AER 2017) on relaxing CES/IIA part of gravity

Inferring trade costs from price gaps

If place i exports homogeneous good u to destination j, the no-arbitrage condition for prices is

$$\ln p_{jt}(u) - \ln p_{it}(u) = \ln \tau_{ijt}(u)$$

- Need homogeneous products (so there is arbitrage opportunity)
- Need to know that i is selling to j (otherwise: only an inequality)
- Need competitive market (otherwise: need pass-through rate)

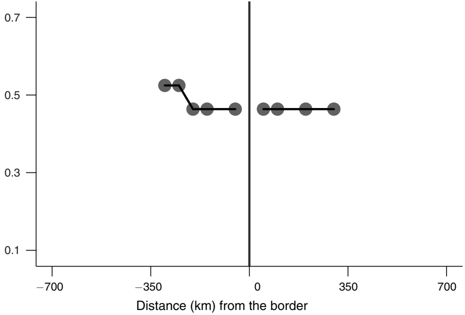
Donaldson (2018) on salt in India differentiated by geographic origin tackles 1 and 2 explicitly

Atkin and Donaldson (2015) work on 1-3

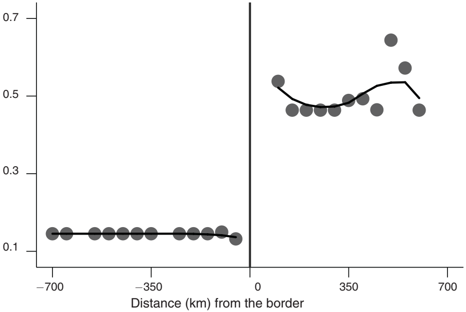
- CPI micro-data from Ethiopia and Nigeria (and US)
- Neglecting 1-3 would underestimate cost of distance
- Distance effect 4-5 times larger than in US
- Intermediate captures the majority of the surplus

Border effects in prices

- Law of one price (LOP): Identical goods sell at same price
- Gopinath Gourinchas Hsieh Li (2011) use price data from a multinational retail chain



Oregon-Washington



Canada-USA

Perrier Sparkling Natural Mineral Water, 25-ounce bottles, log average price. Store distance to the border is positive for Oregon/US, negative for Washington/CA.

Markups or costs? Authors say variation in retail prices related to exchange rate changes due to change in wholesale costs

Price gaps over time (1/3)

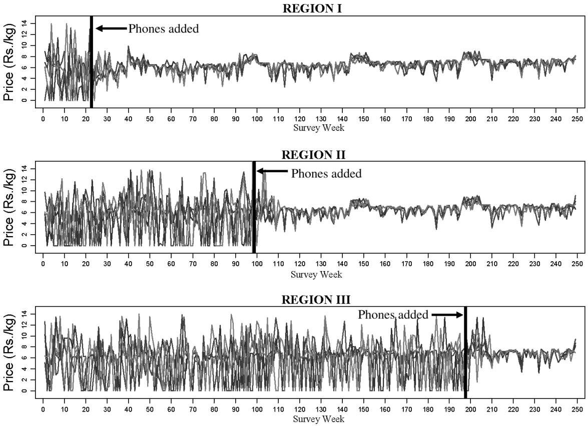


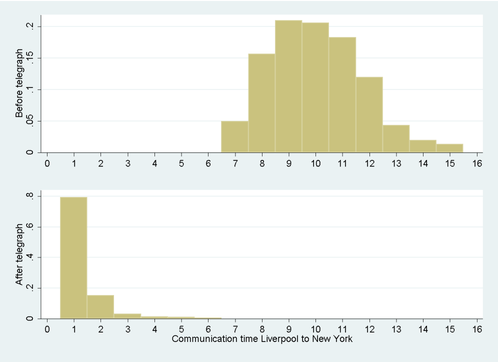
FIGURE IV

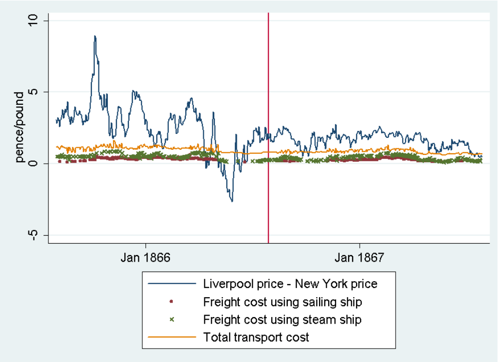
Prices and Mobile Phone Service in Kerala

Data from the Kerala Fisherman Survey conducted by the author. The price series represent the average 7:30–8:00 A.M. beach price for average sardines. All prices in 2001 Rs.

Robert Jensen, "The Digital Provide," *QJE*, 2007

Price gaps over time (2/3)





Steinwender, "Real Effects of Information Frictions: When the States and the Kingdom Became United", *AER* 2018

Price gaps over time (3/3)

Adler, “Raging Bulls”, *Wired*, 2012 Budish *et al* “HFT Arms Race”, *QJE*, 2015

"The" trade elasticity and gains from trade in the Armington model

$$X_{ij} = \frac{w_i^{1-\sigma}}{A_i^{1-\sigma}} \frac{X_j}{P_j^{1-\sigma}} \tau_{ij}^{1-\sigma} \qquad \tau_{ii} = 1$$

$$\Rightarrow \left(\frac{w_i/A_i}{P_i}\right)^{\sigma-1} = \frac{X_i}{X_{ii}} \quad \Rightarrow \frac{w_i}{P_i} = A_i \left(\frac{X_{ii}}{X_i}\right)^{\frac{-1}{\sigma-1}}$$

- The partial elasticity $\frac{\partial X_{ij}/X_{jj}}{\partial \tau_{i'j}}$ is a constant $1-\sigma$ for $i'=i$ and zero otherwise
- In the "ACR" class of models, "the" trade elasticity is a common constant $\epsilon = -\frac{\partial X_{ij}/X_{jj}}{\partial \tau_{i'j}}$ for $i'=i$ and zero otherwise
- This is θ in Eaton & Kortum (2002) and $\sigma-1$ in Armington. Microfoundations differ.
- Compare welfare w_i/P_i in trade equilibrium to autarky welfare

$$\frac{(w_i/P_i)_{\text{trade}}}{(w_i/P_i)_{\text{autarky}}} = \left(\frac{\pi_{ii}}{1}\right)^{-1/\epsilon}$$

- This formula says US gains from trade are about 1% when $\epsilon \approx 5$

Arkolakis, Costinot, and Rodriguez-Clare (AER 2012)

"New Trade Models, Same Old Gains?" is a very influential and insightful paper.

- Within a class of gravity models, $\widehat{\lambda}_{ii}$ and ϵ are sufficient statistics for welfare analyses of changes in trade costs $\hat{\tau}$ or market size $\hat{L}$

$$\widehat{W_i} = \widehat{\lambda}_{ii}^{\frac{-1}{\epsilon}}$$

  where W_i denotes welfare, λ_{ii} denotes the domestic share of expenditure, and $\widehat{x} = \frac{x'}{x}$ denotes proportional changes
- Notice that the gains-from-trade result is just a corollary of this since $\widehat{\lambda}_{ii} = \lambda_{ii}$ when moving from autarky to trade
- The paper provides sufficient conditions for this result and shows the class contains many models
- Optimistic view: welfare predictions of Armington model are more robust than you might have thought
- Pessimistic view: within that class of models, micro-level data do not matter

Are these gains too small?

Ossa (JIE 2015) extends ACR (2012) environment to multiple sectors

- While imports in the average industry do not matter too much, imports in some industries are critical to the functioning of the economy
- The aggregate formula $G_j = \lambda_j^{-\frac{1}{\epsilon}}$ extends to $G_j = \lambda_j^{-\frac{1}{\tilde{\epsilon}_j}}$ with multiple industries, where $1/\tilde{\epsilon}_j$ is a weighted average of the industry-level $1/\epsilon_s$
- Only a few low-elasticity industries are needed to generate large gains from trade which is missed when using the aggregate formula
- The industry-level formula predicts about three times larger gains from trade than the aggregate formula amounting to an average 55.9%

Estimates of income gains from panel variation in trade costs

Feyrer (2009, 2018) revisits the Frankel and Romer (1999) idea using panel settings with changes in trade costs due to the Suez Canal and rise of air transport

- Zero stage: Predicted trade is sum of predicted changes in bilateral trade flows due to Suez shock or rise of air transport
- First stage: Total trade on predicted trade
- 2SLS regression of GDP per capita on total trade

Two papers differ in terms of gradual vs sudden shocks and roles of sea vs air transport

- Elasticity of GDP per capita wrt trade for Suez is about 0.2
- Elasticity of GDP per capita wrt trade for air transport is in 0.5-0.7 range

Whither "trade theory with numbers"?

Costinot and Rodriguez-Clare (2014):

new quantitative trade models put more emphasis on transparency and less emphasis on realism. The idea is to construct middle-sized models that are rich enough to speak to first-order features of the data, like the role of country size and geography, yet parsimonious enough so that one can credibly identify its key parameters and understand how their magnitude affects counterfactual analysis.

Donaldson (2018) on Indian railroads:

a little over one-half of the total impact of the railroads estimated in column 1 can be explained by the mechanism of enhanced opportunities to trade according to comparative advantage, represented in the model

Donaldson (2015) on Feyrer (2009, 2018):

How can we explain the magnitude of the effects in these papers... [LATE, SUTVA, residual OVB] ...or simply the possibility that the stylized and parametric quantitative gravity models—especially those with just one sector and no IO linkages—against which the empirical results here are being compared are too pessimistic about the size of the gains from trade.

Next week: Multiple factors of production