BUSN 33946 & ECON 35101
International Macroeconomics and Trade

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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 2018 revision]:

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

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

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

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

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 in urban economics

Importing the gravity model into urban economics:

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

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 2020)

Gravity and goodness of fit

Naive gravity, the Newtonian analogy of force $\propto \frac{\text{mass}_i \times \text{mass}_j}{\text{distance}_{ij}}$, does quite well with GDP as mass:

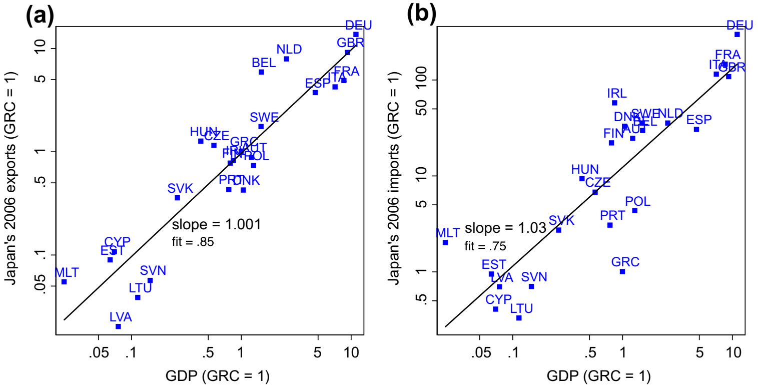


Figure 3.1 Trade is Proportional to Size; (a) Japan's Exports to EU, 2006; (b) Japan's Imports from EU, 2006. GRC: Greece

Gravity and goodness of fit

A broad notion of "distance" does well:

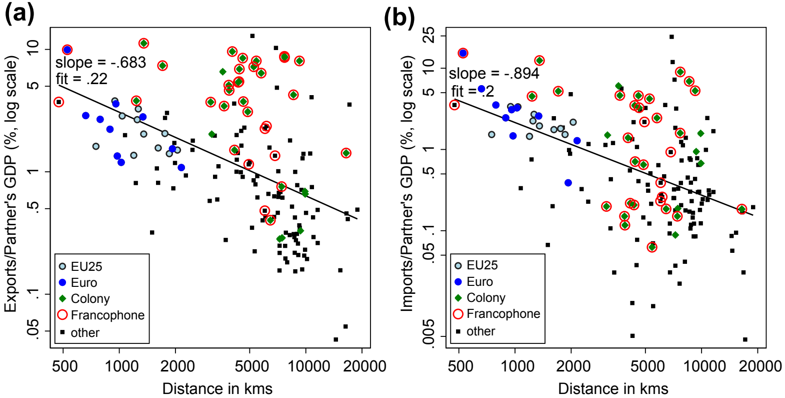


Figure 3.2 Trade is Inversely Proportional to Distance; (a) France's Exports (2006); (b) France's Imports (2006)

Gravity and goodness of fit

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

- 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)
- The meat of the structural models is in $\frac{\phi_{ij}}{\Omega_i \Phi_j}$
- 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."

Trade costs and preference shifters are isomorphic

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, 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."

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):

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

- Triple ratios (Caliendo & Parro 2015):

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

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

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

Logs vs levels: PPMLE and zeros

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 $\ln \eta_{ij}$?

How to handle zeros?

- I cannot put $\ln(0)$ on the LHS
- Can only generate $X_{ij} = 0$ in "structural gravity" by $\phi_{ij} = 0$, but this runs up against the triangle inequality for trade costs

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

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 weflare 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

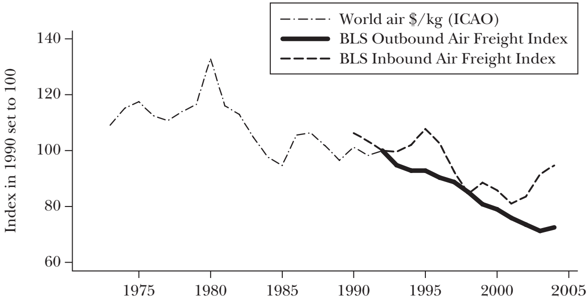
Three strategies:

- 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/.

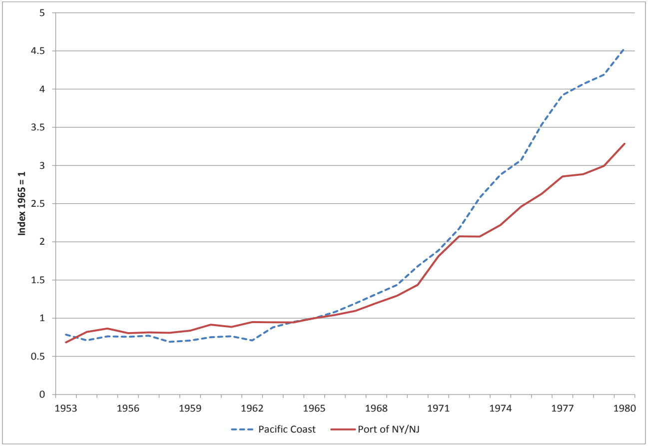
Classic example is Limao and Venables (2001), who got price quotes from World Bank's freight forwarder for sending a 40-foot container from Baltimore to 64 destination cities. Land costs more than sea.

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


Ocean transport costs

Port Productivity, 1953-1980

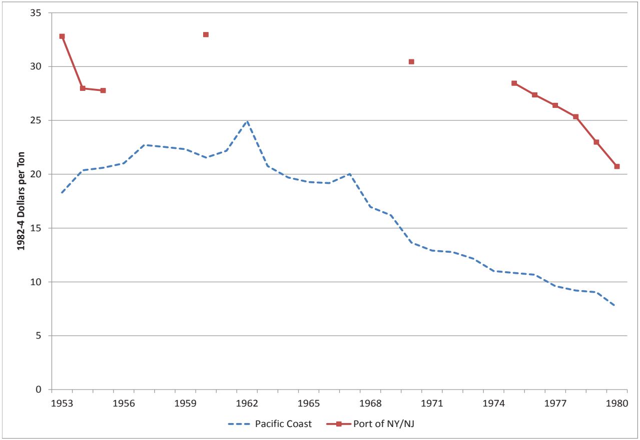


Tons handled per hour worked

Bridgman, "Why Containerization Did Not Reduce Ocean Trade Shipping Costs", 2014

Ocean transport costs

Real Port Labor Cost per ton, 1953-1980

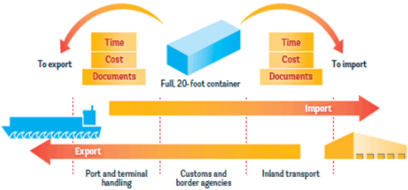


Payments to labor per ton deflated by CPI

Bridgman, "Why Containerization Did Not Reduce Ocean Trade Shipping Costs", 2014

Doing Business: Trading across borders

How much time, how many documents and what cost to import or export a 10-ton 20-foot container worth $20,000 by sea?



Documents required to export and import (number)
Bank documents
Customs clearance documents
Port and terminal handling documents
Transport documents
Time required to export and import (days)
Obtaining, filling out and submitting all the documents
Inland transport and handling
Customs clearance and inspections
Port and terminal handling
Does not include sea transport time
Cost required to export and import (US$ per container)
All documentation
Inland transport and handling
Customs clearance and inspections
Port and terminal handling
Official costs only, no bribes

methodology

Doing Business: Trading across borders

TABLE 9.3

Who makes exporting easy—and who does not?

Documents *(number)*			
Fewest		**Most**	
France	2	Cambodia	11
Estonia	3	Namibia	11
Korea, Rep.	3	Mauritania	11
Panama	3	Angola	11
Canada	3	Malawi	11
Micronesia, Fed. Sts.	3	Burkina Faso	11
Singapore	4	Congo, Rep.	11
Hong Kong, China	4	Kazakhstan	11
Finland	4	Afghanistan	12
United Arab Emirates	4	Fiji	13
Time *(days)*			
Fastest		**Slowest**	
Singapore	5	Central African Republic	54
Estonia	5	Niger	59
Denmark	5	Kyrgyz Republic	63
Hong Kong, China	6	Angola	65
Netherlands	6	Uzbekistan	71
United States	6	Afghanistan	74
Luxembourg	6	Chad	75
Norway	7	Tajikistan	82
Germany	7	Kazakhstan	89
Cyprus	7	Iraq	102
Cost *(US$ per container)*			
Least		**Most**	
Malaysia	450	Uzbekistan	3,100
Singapore	456	Tajikistan	3,150
China	500	Uganda	3,190
Finland	540	Rwanda	3,275
United Arab Emirates	593	Zimbabwe	3,280
Latvia	600	Afghanistan	3,350
Pakistan	611	Niger	3,545
Hong Kong, China	625	Iraq	3,900
Thailand	625	Central African Republic	5,491
Brunei Darussalam	630	Chad	5,497

Who makes importing easy—and who does not?

Documents *(number)*			
Fewest		**Most**	
France	2	Uzbekistan	11
Denmark	3	Burkina Faso	11
Sweden	3	Afghanistan	11
Korea, Rep.	3	Congo, Rep.	12
Thailand	3	Fiji	13
Singapore	4	Russian Federation	13
Hong Kong, China	4	Eritrea	13
Estonia	4	Kazakhstan	13
Norway	4	Azerbaijan	14
Panama	4	Central African Republic	17
Time *(days)*			
Fastest		**Slowest**	
Singapore	3	Venezuela, R.B.	71
Hong Kong, China	5	Burundi	71
Estonia	5	Kyrgyz Republic	72
Denmark	5	Zimbabwe	73
Cyprus	5	Kazakhstan	76
United States	5	Afghanistan	77
Sweden	6	Tajikistan	83
Netherlands	6	Uzbekistan	92
Luxembourg	6	Chad	100
Norway	7	Iraq	101
Cost *(US$ per container)*			
Least		**Most**	
Singapore	439	Niger	3,545
Malaysia	450	Burkina Faso	3,830
China	545	Iraq	3,900
São Tomé and Principe	577	Burundi	4,285
United Arab Emirates	579	Tajikistan	4,550
Hong Kong, China	583	Uzbekistan	4,600
Israel	605	Rwanda	5,070
Finland	620	Zimbabwe	5,101
Fiji	630	Central African Republic	5,554
Qatar	657	Chad	6,150

Source: Doing Business database.

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)
- 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 2012 for related applications

TABLE 1

The Trade Cost Measure for the United States

Partner Country	Tariff Equivalent τ_{ij} in % 1970	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.

- The Suez Canal offer shortest Asia-Europe sea route and today handles $\sim 8\%$ of world trade
- Egypt closed the Suez Canal 1967-1975
- Comments on the specification? LHS? Fixed effects? Sample of observations?

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

Inferring from observed exchanges across products

- Djankov, Freund, Pham (REStat 2010) on "Trading on Time"
- Bernhofen, El-Sahlid, Kneller (JIE 2016) "Estimating the effects of the container revolution on world trade"
- Hortaçsu, Martínez-Jerez, Douglas - "The Geography of Trade in Online Transactions: Evidence from eBay and MercadoLibre" (2009)
  - Sample of a quarter million eBay listings scraped Feb-May 2004
  - Description of item, seller's location, shipping and handling fee
  - Buyer's location inferred from previous transactions as seller

  Why is this an interesting empirical setting?

Geography of eBay transactions

Category	SAME-CITY coefficient	Standard error
Tickets	1.80***	0.10
Sports memorabilia, cards & fan shop	0.78***	0.09
Travel/luggage	0.53***	0.11
Cameras & photo	0.52***	0.11
Clothing, shoes & accessories	0.48***	0.09
Jewelry & watches	0.48***	0.11
Video games	0.46***	0.09
Pottery & glass	0.44***	0.11
Home & garden	0.42***	0.09
Toys & hobbies	0.41***	0.10
Business & industrial	0.39***	0.12
Consumer electronics	0.38***	0.12
Sporting goods	0.38***	0.09
DVDs & movies	0.37***	0.10
Music	0.36***	0.11
Computers & networking	0.30***	0.09
Health & beauty	0.27***	0.09
Musical instruments	0.25***	0.09
Antiques	0.24*	0.14
Coins	0.23**	0.12
Crafts	0.23**	0.11
Everything else	0.19*	0.11
Stamps	0.18	0.20
Dolls & bears	0.16	0.12
Books	0.15*	0.09
Collectibles	0.14	0.10
Art	0.09	0.15
Gift certificates	−0.01	0.22
Entertainment memorabilia	−0.01	0.15

Geography of eBay transactions

TABLE 9—IMPACT OF DISTANCE ON TRADE PATTERNS OF DIFFERENT TYPES OF GOODS

	Dependent variable: coefficient on SAME-CITY
Average weight in category	−0.001
	(0.007)
Average (%) shipping cost in category	−0.001
	(0.001)
Percent negatives in average seller's record	0.170**
	(0.073)
Average price in category	0.001
	(0.001)
Observations	27
Adjusted R^2	0.17

Notes: In this table, we regress the impact of distance on trade on characteristics of the goods traded and the reputation of their sellers. The dependent variable is the coefficient of the *SAME-CITY* dummy variables from regressions of measures of intercity trade on distance and economy size by category of good traded. We exclude from this regression the Tickets and Sports memorabilia categories. Average weight is the average weight of the goods sold in the category, based on our estimation of item weights from 50 randomly sampled listings from each category. Seller's reputation is measured by the average percentage of negative feedback received by sellers in the category. Standard errors are in parentheses.

*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

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?

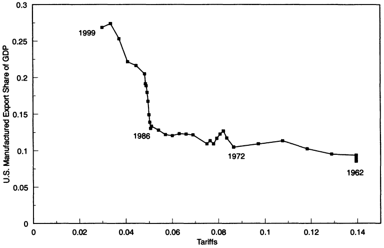


Fig. 1.—Manufacturing export share of GDP and manufacturing tariff rates. Source: World Trade Organization (2002) and author's calculations (see App. A and Sec. V).

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 $N>1$).

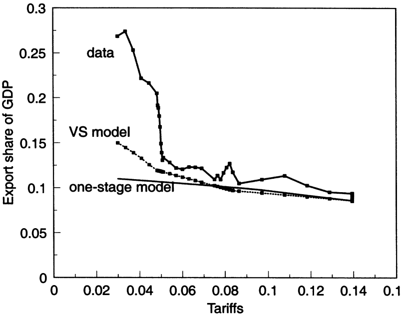


Fig. 10.—Narrow case: vertical model vs. one-stage model

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

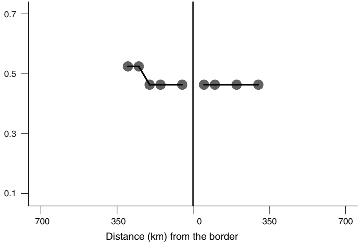
$$\ln p_{jt}(u) - \ln p_{it}(u) = \ln \tau_{ijt}(u)$$

- Need homogeneous products (otherwise there isn't an arbitrage opportunity)
- Need to know that i is selling to j
- Need competitive market (arbitrage opportunities are exploited)

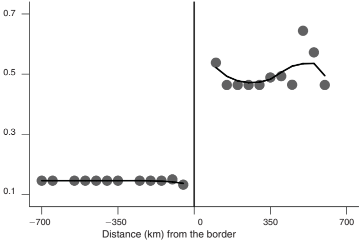
Donaldson (2018) on salt in India differentiated by geographic origin tackles 1 and 2 explicitly; Atkin and Donaldson (Ecma R&R) work on 1-3

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

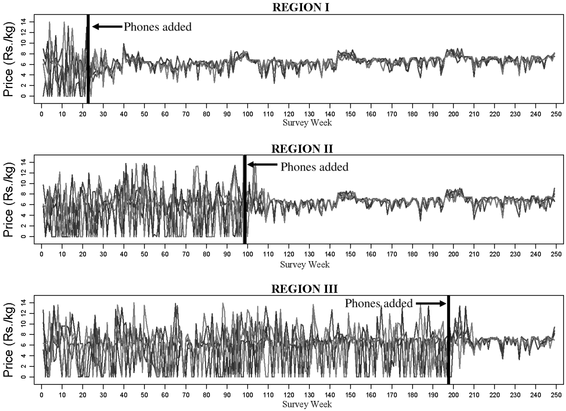


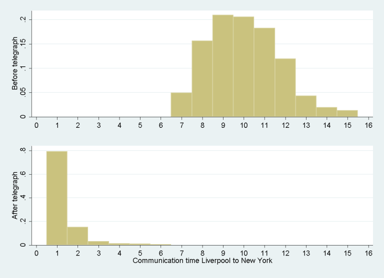
FIGURE IV

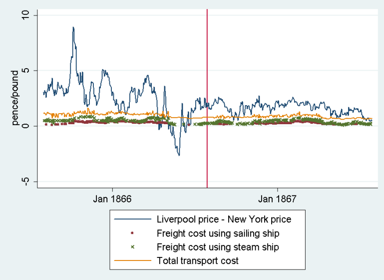
Prices and Mobile Phone Service in Kerala

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





Steinwender, "Information Frictions and the Law of One Price", 2015

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

Gains from trade in Armington and EK models

Armington:

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

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

Eaton & Kortum (2002):

$$\pi_{ni} = \frac{T_i \left(d_{ni} c_i\right)^{-\theta}}{\Phi_n} \quad d_{ii} = 1 \quad P_n = \Phi_n^{-\frac{1}{\theta}} \Gamma\left(\left(\theta + 1 - \sigma\right)/\theta\right)$$

$$\Rightarrow \pi_{ii} = \left(\frac{w_i}{P_i}\right)^{-\theta} \frac{T_i}{\Gamma(\cdot)} \quad \Rightarrow \frac{w_i}{P_i} = \pi_{ii}^{-1/\theta} \left(\frac{\Gamma(\cdot)}{T_i}\right)^{-1/\theta}$$

In autarky, $\pi_{ii} = \frac{X_{ii}}{X_i} = 1$, so to compute gains from trade, we only need observed π_{ii} and knowledge of θ or σ.

“The” trade elasticity and gains from trade

- In the Armington model, the partial elasticity $\frac{\partial X_{ij}/X_{jj}}{\partial \tau_{i'j}}$ is a constant $1-\sigma$ for $i'=i$ and zero otherwise

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

- 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 EK and $\sigma - 1$ in Armington. Microfoundations differ.

Gains from trade

- Compare welfare in trade equilibrium w_i/P_i 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 $\epsilon \approx 5$

This result generalizes to more models.

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

"New Trade Models, Same Old Gains?" is one of the most influential trade papers in the last decade.

- 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

ACR (2012): Environment

Consumers have CES utility with ideal price index

$$P_i = \left(\int_{\omega \in \Omega} p_i\left(\omega\right)^{1-\sigma} d\omega \right)^{\frac{1}{1-\sigma}}$$

Labor is the only factor of production and the cost function is

$$C_{ij}\left(\omega, t, q\right) = \underbrace{q w_i \tau_{ij} \alpha_{ij}\left(\omega\right) t^{\frac{1}{1-\sigma}}}_{\text{variable cost}} + \underbrace{w_i^{1-\beta} w_j^{\beta} \xi_{ij} \phi_{ij}\left(\omega\right) m_{ij}\left(t\right)}_{\text{fixed cost}},$$

- q : quantity,
- w_i : wage,
- τ_{ij} : iceberg transport cost
- $\alpha_{ij}\left(\omega\right)$: good-specific heterogeneity
- ξ_{ij} : fixed-cost parameter,
- $\phi_{ij}\left(\omega\right)$: good-specific heterogeneity in fixed costs
- $m_{ij}\left(t\right)$: cost for endogenous destination-specific technology choice, t,

$$t \in \left[\underline{t}, \bar{t}\right], m_{ij}' > 0, m_{ij}'' \geq 0$$

ACR (2012): Environment (continued)

- There is either perfect competition in which case
  - Firms can produce any good
  - There are no fixed exporting costs
- Or there is monopolistic competition in which case
  - Either firms in i can pay $w_i F_i$ for monopoly power over a random good
  - Or an exogenous measure of firms, $\bar{N}_i < \bar{N}$, receive monopoly power
- Let N_i be the measure of goods that can be produced in i
  - Under perfect competition: $N_i = \bar{N}$
  - Under monopolistic competition: $N_i < \bar{N}$

ACR (2012): Macro-level restrictions

- **R1** For any country j, trade is balanced

$$\sum_{i \neq j} X_{ij} = \sum_{i \neq j} X_{ji}$$

- **R2** For any country j, variable profits are a constant share of sales

$$\frac{\Pi_i}{\sum_{j=1}^{n} X_{ij}} \text{ is constant}$$

- **R3** The import demand system satisfies,

$$\epsilon_j^{ii'} \equiv \partial \ln \left(X_{ij} / X_{jj} \right) / \partial \ln \tau_{i'j} = \begin{cases} \epsilon < 0 & i = i' \neq j \\ 0 & otherwise \end{cases}$$

- **R3′** The import demand system satisfies,

$$X_{ij} = \frac{\chi_{ij} \cdot M_i \cdot \left(w_i \tau_{ij} \right)^{\epsilon} \cdot Y_j}{\sum_{i'=1}^{n} \chi_{i'j} \cdot M_{i'} \cdot \left(w_{i'} \tau_{i'j} \right)^{\epsilon}}$$

ACR (2012): Ex-post results

Theorem

If **R1**-**R3** *hold, then a sufficient statistic for the welfare effects of foreign shocks is*

$$\widehat{W}_j = \widehat{\lambda}_{jj}^{1/\epsilon}$$

Corollary

The welfare gains of moving from autarky to current levels of trade are given by

$$\widehat{W}_j = \lambda_{jj}^{1/\epsilon}$$

These are ex-post results in the sense that $\widehat{\lambda}_{jj}$ needs to be observed.

ACR (2012): Ex-ante result

Theorem

If $\mathbf{R1}$-$\mathbf{R3'}$ *hold, then the welfare effects of trade cost changes can be predicted from*

$$\widehat{W}_j = \widehat{\lambda}_{jj}^{1/\epsilon}$$

where $\widehat{\lambda}_{jj}$ *can be calculated from*

$$\widehat{\lambda}_{jj} = \left(\sum_{i=1}^{n} \lambda_{ij} \left(\hat{w}_i \hat{\tau}_{ij}\right)^{\epsilon}\right)^{-1},$$

after solving for $\widehat{w}_i$ *given* $\hat{\tau}_{ij}$ *from*

$$\widehat{w}_i = \sum_{j=1}^{n} \frac{\lambda_{ij} \hat{w}_j Y_j \left(\hat{w}_i \hat{\tau}_{ij}\right)^{\epsilon}}{Y_i \sum_{i'=1}^{n} \lambda_{i'j} \left(\hat{w}_{i'} \hat{\tau}_{i'j}\right)^{\epsilon}}.$$

This is an ex-ante result which requires the stronger assumption $\mathbf{R3'}$.
Also see Adao, Costinot, and Donaldson (AER 2017) on relaxing CES/IIA part of gravity

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%

Reduced-form estimates of income gains

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

What do you think?

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