14.581: International Trade
— Lecture 24—
Trade Costs (Empirics)

Plan for Today's Lecture on Trade Costs

1. Introduction to trade costs

2. Estimating trade costs via direct measurement

3. Estimating trade costs via gravity equations

4. Using price dispersion and price gaps to infer trade costs.

Plan for Today's Lecture on Trade Costs

1 **Introduction to trade costs**

2 Estimating trade costs via direct measurement

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4 Using price dispersion and price gaps to infer trade costs.

Measuring Trade Costs: What do we mean by 'trade costs'?

- The sum total of all of the costs that impede trade from origin to destination.
- This includes:
    - Tariffs and non-tariff barriers (quotas etc).
    - Transportation costs.
    - Administrative hurdles.
    - Corruption.
    - Contractual frictions.
    - The need to secure trade finance (working capital while goods in transit).
- NB: There is no reason that these 'trade costs' occur only on international trade.

Introduction: Why care about trade costs?

- They enter many modern models of trade, so empirical implementations of these models need an empirical metric for trade costs.

- There are clear features of the international trade data that seem hard (but not impossible) to square with a frictionless world.

- As argued by Obstfeld and Rogoff (Brookings, 2000), trade costs may explain 'the six big puzzles' of international macro.

- Trade costs clearly matter for welfare calculations.

- Trade costs could be endogenous and driven by the market structure of the trading sector; this would affect the distribution of gains from trade. (E.g., a monopolist on transportation could extract some of the gains from trade.)

Are Trade Costs 'Large'?

- There is considerable debate (still unresolved) about this question.
- Arguments in favor:
    - Trade falls very dramatically with distance (see Figures). Need large trade costs to rationalize trade flows in standard (i.e. gravity) trade models.
    - Clearly haircuts are not very tradable but a song on iTunes is. Everything else is in between.
    - Contractual frictions of sale at a distance (Avner Greif's 'Fundamental Problem of Exchange') seem potentially severe.
    - One often hears the argument that a fundamental problem in developing countries is the poor quality of their transportation infrastructure (i.e. ports, roads, etc). E.g., see colorful anecdotes in *Economist* article on traveling with a truck driver in Cameroon.

Are Trade Costs 'Large'?

- Arguments against:
  - Inter- and intra-national shipping rates aren't that high: in March 2010 (even at relatively high gas prices) a California-Boston refrigerated truck journey cost around $5,000. Fill this with grapes and they will sell at retail for around $100,000.
  - Tariffs are not that big (nowadays).
  - Repeated games and reputations/brand names are likely to circumvent any high stakes contractual issues.

- Surprisingly little hard evidence has been brought to bear on these issues.

- One area where there has been a lot of work, as we shall see, involves estimating gravity equations, where a robust finding is that trade costs are large and trade appears to fall very rapidly with distance.

Trade Falls with Distance: Leamer (JEL 2007)
From Germany. Visual evidence for the gravity equation

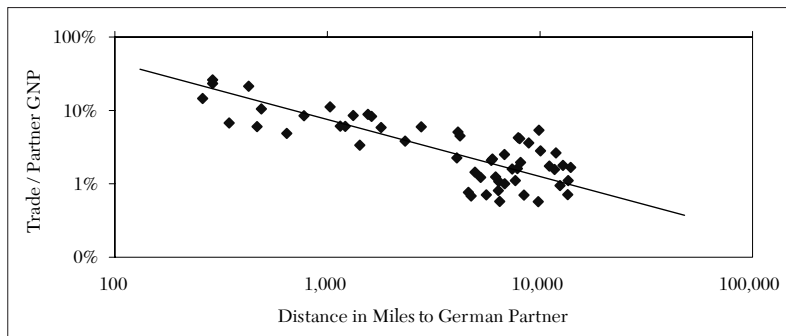*Leamer: A Review of Thomas L Friedman's* The World is Flat   111

Figure 8. West German Trading Partners, 1985
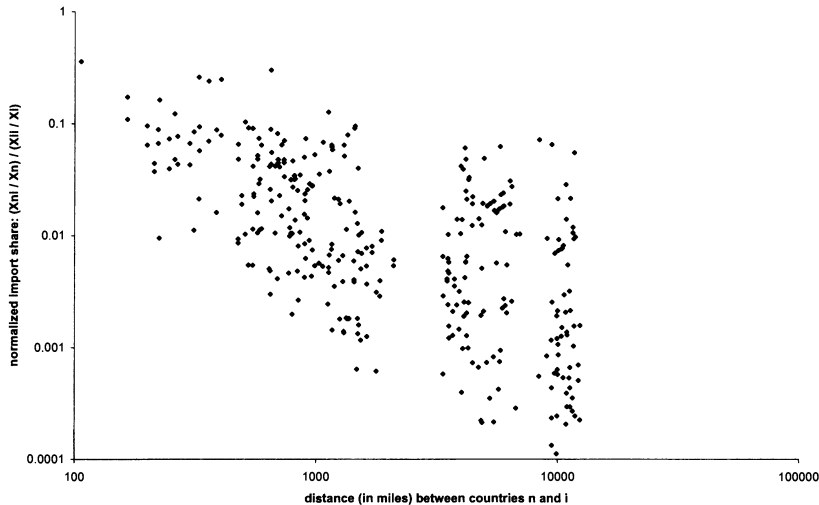
FIGURE 1.—Trade and geography.

Figure 1: Mean value of individual-firm exports (single-region firms, 1992)

Figure 2: Percentage of firms which export (single-region firms, 1992)
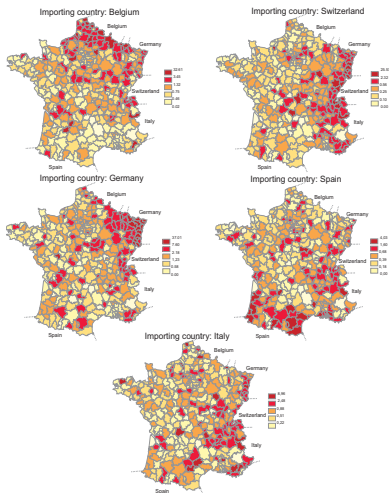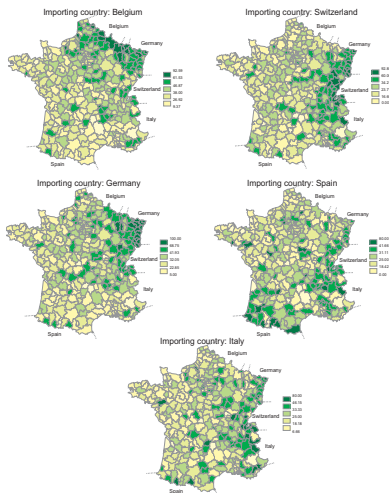
Trade Falls with Distance: Inside the US

Hilberry and Hummels (EER 2008) using zipcode-to-zipcode data
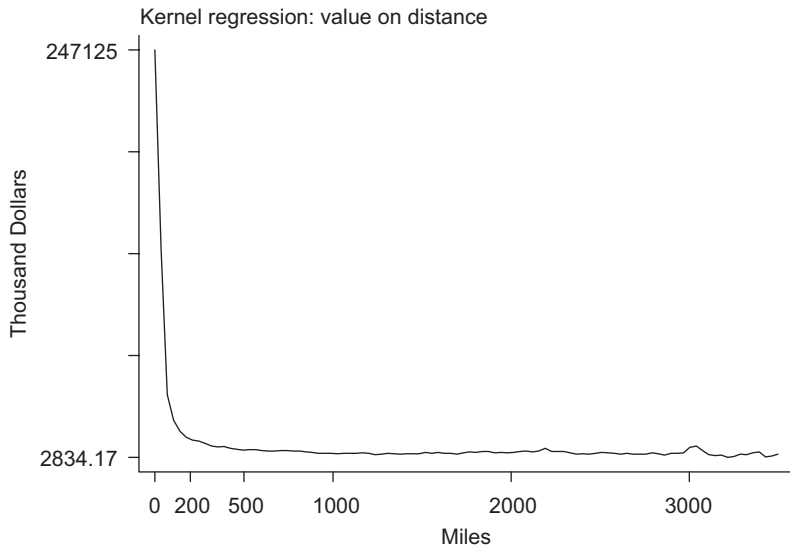
Kernel regression: value on distance

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Direct Measurement of Trade Costs

- The simplest way to measure TCs is to just go out there and measure them directly.

- Many components of TCs are probably measurable. But many aren't (that would be a bit like measuring firms' marginal costs—notoriously hard to do via simple direct measurement).

- Still, this sort of descriptive evidence is extremely valuable for getting a sense of things.

- Examples of creative sources of this sort of evidence:
  - Hummels (JEP, 2007) survey on transportation.
  - Anderson and van Wincoop (JEL, 2004) survey on trade costs.
  - Limao and Venables (2008) on shipping.
  - Barron and Olken (JPE 2008) on bribes and trucking in Indonesia.
  - Fafchamps (2004 book) on traders and markets in Africa.
  - Startz (2017) on traders in Nigeria

Figure 1
Worldwide Air Revenue per Ton-Kilometer
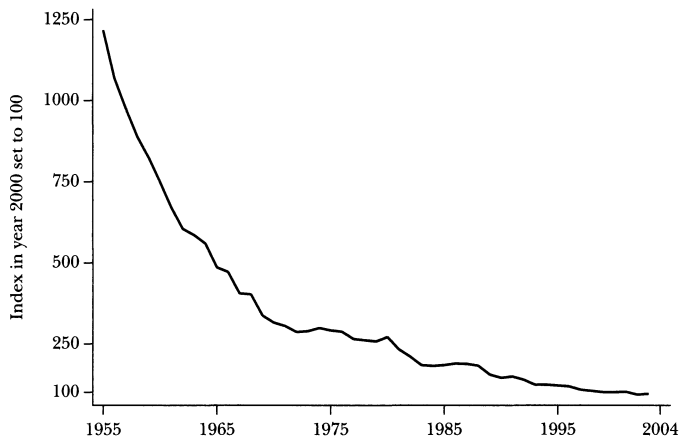
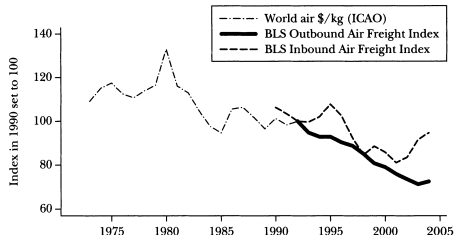*Source:* International Air Transport Association, *World Air Transport Statistics,* various years.

Direct Measures: Hummels (2007)

Air shipping prices falling.

Figure 2
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/.

Notes: ICAO Data on Route Groups:

Annualized growth rates for 1973–80 of shipping price per kg (in year 2000 dollars): All routes 2.87; North Atlantic 1.03; Mid Atlantic 3.45; South Atlantic 3.98; North and Mid Pacific −3.43; South Pacific −2.49; North to Central America 3.63; North and Central America to South America 2.34; Europe to Middle East 4.80; Europe and Middle East to Africa 1.84; Europe/Middle East/Africa to Asia/Pacific 3.32; Local Asia/Pacific 0.97; Local North America 1.63; Local Europe 4.51; Local South America 2.53; Local Middle East 1.92; Local Africa 4.94.

Annualized growth rates for 1980–93 of shipping price per kg (in year 2000 dollars): All routes −2.52; North Atlantic −3.59; Mid Atlantic −3.36; South Atlantic −3.92; North and Mid Pacific −1.48; South Pacific −0.98; North to Central America −0.72; North and Central America to South America −1.34; Europe to Middle East −3.02; Europe and Middle East to Africa −2.34; Europe/Middle East/Africa to Asia/Pacific −2.78; Local Asia/Pacific −1.52; Local North America −1.73; Local Europe −2.63; Local Central America 0.97; Local South America −2.25; Local Middle East −1.46; Local Africa −2.43.

Figure 3
Tramp Price Index
(with U.S. GDP deflator and with commodity price deflator)
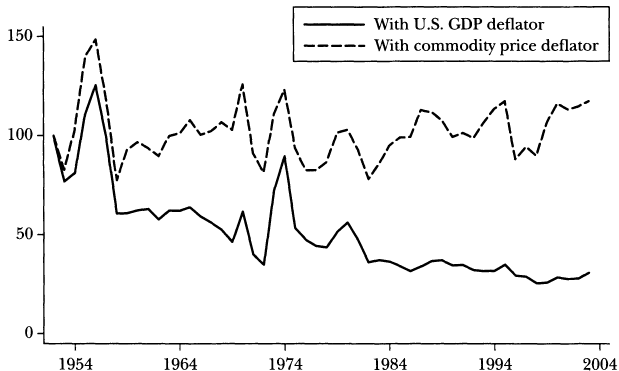
Source: United Nations Conference on Trade and Development, *Review of Maritime Transport,* various years.
Note: Tramp prices deflated by a U.S. GDP deflator and tramp prices deflated by commodity price deflator.

Sea shipping has (surprisingly, given containerization) not moved much.

Figure 4
Liner Price Index
(with German GDP deflator and with German traded goods price deflator)
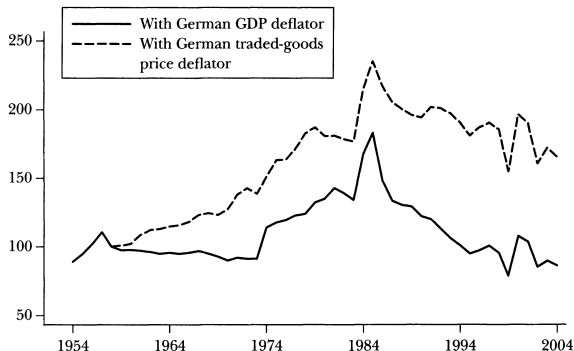
Source: United Nations Conference on Trade and Development *Review of Maritime Transport,* various years.
Note: Liner prices deflated by a German GDP deflator and liner prices deflated by a German traded-goods price deflator.

Figure 5
Ad Valorem Air Freight
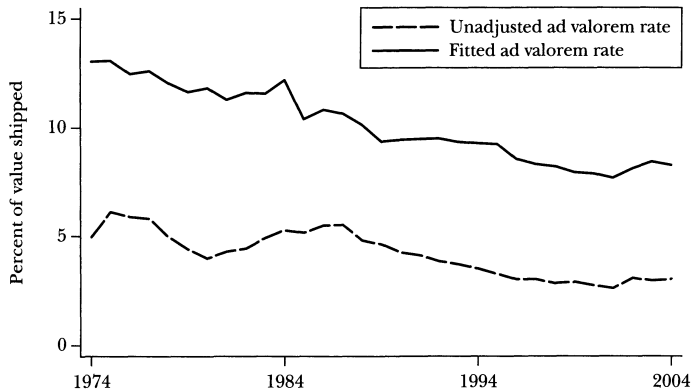
Source: Author's calculation based on U.S. Census Bureau *U.S. Imports of Merchandise.*
Note: The unadjusted ad valorem rate is simply expenditure/import value. The fitted ad valorem rate is derived from a regression and controls for changes in the mix of trade partners and products traded.

These effects are moderated by compositional changes.

Figure 6

Ad Valorem Ocean Freight
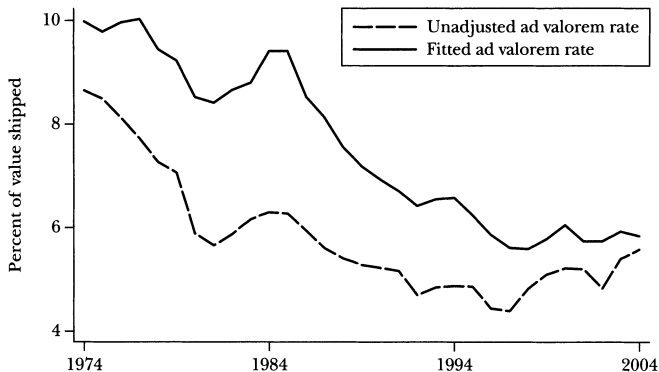
Source: Author's calculations based on the U.S. Census Bureau's *U.S. Imports of Merchandise*.
Note: The unadjusted ad valorem rate is simply expenditure/import value. The fitted ad valorem rate is derived from a regression and controls for changes in the mix of trade partners and products traded.

Direct Measures: AvW (2004) Survey

- Anderson and van Wincoop (2004) survey the literature on estimating trade costs in great detail.

- They begin with descriptive, 'direct' evidence on:
  - Tariffs—but this is surprisingly hard. (It is very surprising how hard it is to get good data on the state of the world's tariffs.)
  - NTBs—much harder to find data. And then there are theoretical issues such as whether quotas are binding.
  - Transportation costs (mostly now summarized in Hummels (2007)).
  - Wholesale and retail distribution costs (which clearly affect both international and intranational trade).

Direct Measures: AvW (2004)

Tariffs

TABLE 2
SIMPLE AND TRADE-WEIGHTED TARIFF AVERAGES—1999

Country	Simple Average	TW Average
Argentina	14.8	11.3
Australia	4.5	4.1
Bahamas	0.7	0.8
Bahrain	7.8	–
Bangladesh	22.7	21.8
Barbados	19.2	20.3
Belize	19.7	14.9
Bhutan	15.3	–
Bolivia	9.7	9.1
Brazil	15.5	12.3
Canada	4.5	1.3
Chile	10.0	10.0
Colombia	12.2	10.7
Costa Rica	6.5	4.0
Czech Republic	5.5	–
Dominica	18.5	15.8
Ecuador	13.8	11.1
European Union	3.4	2.7
Georgia	10.6	–
Grenada	18.9	15.7
Guyana	20.7	–
Honduras	7.5	7.8
Hong Kong	0.0	0.0
India	30.1	–
Indonesia	11.2	–
Jamaica	18.8	16.7
Japan	2.4	2.9
Korea	9.1	5.9
Mexico	17.5	6.6
Montserrat	18.0	–
New Zealand	2.4	3.0
Nicaragua	10.5	11.0
Paraguay	13.0	6.1
Peru	13.4	12.6
Philippines	9.7	–
Romania	15.9	8.3
Saudi Arabia	12.2	–
Singapore	0.0	0.0
Slovenia	9.8	11.4
South Africa	6.0	4.4
St. Kitts	18.7	–
St. Lucia	18.7	–
St. Vincent	18.3	–
Suriname	18.7	–
Switzerland	0.0	0.0
Taiwan	10.1	6.7
Trinidad	19.1	17.0
Uruguay	4.9	4.5
USA	2.9	1.9
Venezuela	12.4	13.0

Notes: The data are from UNCTAD's TRAINS database (Haveman repackaging).
A "–" indicates that trade data for 1999 are unavailable in TRAINS.

Direct Measures: AvW (2004)

NTB 'coverage ratios' (% of product lines that are subject to an NTB).

TABLE 3
Non-Tariff Barriers—1999

Country	NTB ratio (narrow)	TW NTB ratio (narrow)	NTB ratio (broad)	TW NTB ratio (broad)
Algeria	.001	.000	.183	.388
Argentina	.260	.441	.718	.756
Australia	.014	.006	.225	.351
Bahrain	.009	–	.045	–
Bhutan	.041	–	.045	–
Bolivia	.014	.049	.179	.206
Brazil	.108	.299	.440	.603
Canada	.151	.039	.307	.198
Chile	.029	.098	.331	.375
Colombia	.049	.144	.544	.627
Czech Republic	.001	–	.117	–
Ecuador	.065	.201	.278	.476
European Union	.008	.041	.095	.106
Guatemala	.000	.000	.348	.393
Hungary	.013	.034	.231	.161
Indonesia	.001	–	.118	–
Lebanon	.000	–	.000	–
Lithuania	.000	.000	.191	.196
Mexico	.002	.000	.580	.533
Morocco	.001	–	.066	–
New Zealand	.000	.004	.391	.479
Oman	.006	.035	.134	.162
Paraguay	.018	.108	.256	.385
Peru	.021	.094	.377	.424
Poland	.001	.050	.133	.235
Romania	.001	.000	.207	.185
Saudi Arabia	.014	–	.156	–
Slovenia	.030	.019	.393	.408
South Africa	.000	.002	.113	.161
Taiwan	.057	.074	.138	.207
Tunisia	.000	.000	.317	.598
Uruguay	.052	.098	.354	.470
USA	.015	.055	.272	.389
Venezuela	.131	.196	.382	.333

Notes: The data are from UNCTAD's TRAINS database (Haveman repackaging). The "narrow" category includes, quantity, price, quality and advance payment NTBs, but does not include threat measures such as antidumping investigations and duties. The "broad" category includes quantity, price, quality, advance payment and threat measures. The ratios are calculated based on six-digit HS categories.
A "–" indicates that trade data for 1999 are not available.

Direct Measures: AvW (2004)

Multi-Fibre Agreement (MFA): An example of a case/industry where good quota data exists. Deardorff and Stern (1998) converted to tariff equivalents.

TABLE 5
Tariff Equivalents of U.S. MFA Quotas, 1991 and 1993 (Percent)

Sector	1991		1993			
	Rent Tar Eq.	Rent Tar Eq.	S Tariff	TW Tariff	Rent + TW Tariff	%US Imports
Textiles:						
Broadwoven fabric mills	8.5	9.5	14.4	13.3	22.8	0.48
Narrow fabric mills	3.4	3.3	6.9	6.7	10.0	0.22
Yarn mills and textile finishing	5.1	3.1	10.0	8.5	11.6	0.06
Thread mills	4.6	2.2	9.5	11.8	14.0	0.01
Floor coverings	2.8	9.3	7.8	5.7	15.0	0.12
Felt and textile goods, n.e.c.	1.0	0.1	4.7	6.2	6.3	0.06
Lace and knit fabric goods	3.8	5.9	13.5	11.8	17.7	0.04
Coated fabrics, not rubberized	2.0	1.0	9.8	6.6	7.6	0.03
Tire cord and fabric	2.3	2.4	5.1	4.4	6.8	0.08
Cordage and twine	3.1	1.2	6.2	3.6	4.8	0.03
Nonwoven fabric	0.1	0.2	10.6	9.5	9.7	0.04
Apparel and fab. textile products:						
Women's hosiery, except socks	5.4	2.3				
Hosiery, n.e.c.	3.5	2.4	14.9	15.3	17.7	0.04
App'l made from purchased mat'l	16.8	19.9	13.2	12.6	32.5	5.71
Curtains and draperies	5.9	12.1	11.9	12.1	24.2	0.01
House furnishings, n.e.c.	8.3	13.9	9.3	8.2	22.1	0.27
Textile bags	5.9	9.0	6.4	6.6	15.6	0.01
Canvas and related products	6.3	5.2	6.9	6.4	11.6	0.03
Pleating, stitching, ... embroidery	5.2	7.6	8.0	8.1	15.7	0.02
Fabricated textile products, n.e.c.	9.2	0.6	5.2	4.8	5.4	0.37
Luggage	2.6	10.4	12.1	10.8	21.2	0.28
Women's handbags and purses	1.0	3.1	10.5	6.7	9.8	0.44

Notes: "S" indicates "simple" and "TW" indicates "trade-weighted." Rent equivalents for U.S. imports from Hong Kong were estimated on the basis of average weekly Hong Kong quota prices paid by brokers, using information from International Business and Economic Research Corporation. For countries that do not allocate quota rights in public auctions, export prices were estimated from Hong Kong export prices, with adjustments for differences in labor costs and productivity. Sectors and their corresponding SIC classifications are detailed in USITC (1995) Table D-1. Quota tariff equivalents are reproduced from Deardorff and Stern (1998), Table 3.6 (Source USITC 1993,1995). Tariff averages, trade-weighted tariff averages and U.S. import percentages are calculated using data from the UNCTAD TRAINS dataset. SIC to HS concordances from the U.S. Census Bureau are used.

TABLE 6
DISTRIBUTION MARGINS FOR HOUSEHOLD CONSUMPTION AND CAPITAL GOODS

Select Product Categories	Aus. 95	Bel. 90	Can. 90	Ger. 93	Ita. 92	Jap. 95	Net. 90	UK 90	US 92
Rice	1.239	1.237	1.867	1.423	1.549	1.335	1.434	1.511	1.435
Fresh, frozen beef	1.485	1.626	1.544	1.423	1.605	1.681	1.640	1.390	1.534
Beer	1.185	1.435	1.213	1.423	1.240	1.710	1.373	2.210	1.863
Cigarettes	1.191	1.133	1.505	1.423	1.240	1.398	1.230	1.129	1.582
Ladies' clothing	1.858	1.845	1.826	2.039	1.562	2.295	1.855	2.005	2.159
Refrigerators, freezers	1.236	1.586	1.744	1.826	1.783	1.638	1.661	2.080	1.682
Passenger vehicles	1.585	1.198	1.227	1.374	1.457	1.760	1.247	1.216	1.203
Books	1.882	1.452	1.294	2.039	1.778	1.665	1.680	1.625	1.751
Office, data proc. mach.	1.715	1.072	1.035	1.153	1.603	1.389	1.217*	1.040	1.228
Electronic equip., etc.	1.715	1.080	1.198	1.160	1.576	1.432	1.224*	1.080	1.139
Simple Average (125 categories)	1.574	1.420	1.571	1.535	1.577	1.703	1.502	1.562	1.681

Notes: The table is reproduced from Bradford and Lawrence, "Paying the Price: The Cost of Fragmented International Markets", Institute of International Economics, forthcoming (2003). Margins represent the ratio of purchaser price to producer price. Margins data on capital goods are not available for the Netherlands, so an average of the four European countries' margins is used.

Direct Measures: Djankov, Freund and Pham ReStat 2010

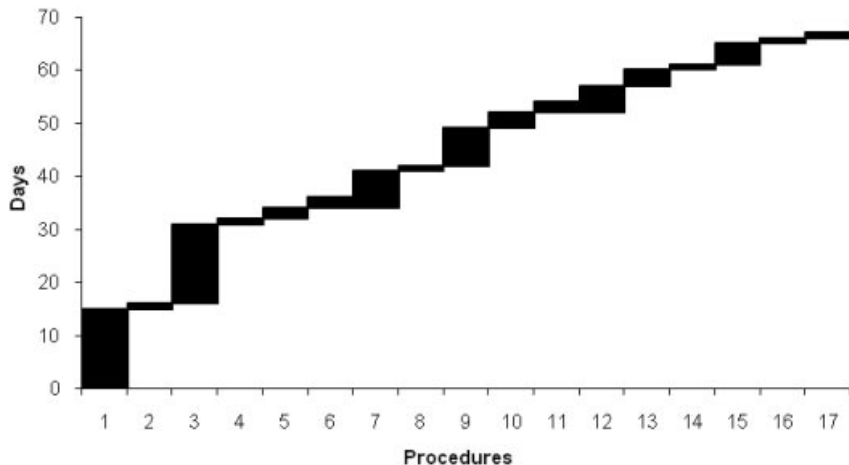'Doing business' style survey on freight forwarding firms around the world.

List of Procedures to Export from Burundi

1. Secure letter of credit
2. Obtain and load containers
3. Assemble and process export documents
4. Pre-shipment inspection and clearance
5. Prepare transit clearance
6. Inland transportation to port of departure
7. Arrange transport; waiting for pickup and loading on local carriage
8. Wait at border crossing
9. Transportation from border to port
10. Terminal handling activities
11. Pay of export duties, taxes or tariffs
12. Waiting for loading container on vessel
13. Customs inspection and clearance
14. Technical control, health, quarantine
15. Pass customs inspection and clearance
16. Pass technical control, health, quarantine
17. Pass terminal clearance

Direct Measures: Djankov, Freund and Pham (ReStat, 2010)

'Doing business' style survey on freight forwarding firms around the world.

FIGURE 1.—EXPORT PROCEDURES IN BURUNDI

Direct Measures: Djankov, Freund and Pham (ReStat, 2010)

'Doing business' style survey on freight forwarding firms around the world.

TABLE 1.—DESCRIPTIVE STATISTICS BY GEOGRAPHIC REGION
REQUIRED TIME FOR EXPORTS

	Mean	Standard Deviation	Minimum	Maximum	Number of Observations
Africa and Middle East	41.83	20.41	10	116	35
COMESA	50.10	16.89	16	69	10
CEMAC	77.50	54.45	39	116	2
EAC	44.33	14.01	30	58	3
ECOWAS	41.90	16.43	21	71	10
Euro-Med	26.78	10.44	10	49	9
SADC	36.00	12.56	16	60	8
Asia	25.21	11.94	6	44	14
ASEAN 4	22.67	11.98	6	43	6
CER	10.00	2.83	8	12	2
SAFTA	32.83	7.47	24	44	6
Europe	22.29	17.95	5	93	34
CEFTA	22.14	3.24	19	27	7
CIS	46.43	24.67	29	93	7
EFTA	14.33	7.02	7	21	3
ELL FTA	14.33	9.71	6	25	3
European Union	13.00	8.35	5	29	14
Western Hemisphere	26.93	10.33	9	43	15
Andean Community	28.00	7.12	20	34	4
CACM	33.75	9.88	20	43	4
MERCOSUR	29.50	8.35	22	39	4
NAFTA	13.00	4.58	9	18	3
Total sample	30.40	19.13	5	116	98

Note: Seven countries belong to more than one regional agreement.
Source: Data on time delays were collected by the Doing Business team of the World Bank/IFC. They are available at www.doingbusiness.org.

Direct Measures: Barron and Olken (JPE 2009)

Survey of truckers in Aceh, Indonesia.

TABLE 1
SUMMARY STATISTICS

	Both Roads (1)	Meulaboh Road (2)	Banda Aceh Road (3)
Total expenditures during trip (rupiah)	2,901,345	2,932,687	2,863,637
	(725,003)	(561,736)	(883,308)
Bribes, extortion, and protection payments	361,323	415,263	296,427
	(182,563)	(180,928)	(162,896)
Payments at checkpoints	131,876	201,671	47,905
	(106,386)	(85,203)	(57,293)
Payments at weigh stations	79,195	61,461	100,531
	(79,405)	(43,090)	(104,277)
Convoy fees	131,404	152,131	106,468
	(176,689)	(147,927)	(203,875)
Coupons/protection fees	18,848	. . .	41,524
	(57,593)		(79,937)
Fuel	1,553,712	1,434,608	1,697,010
	(477,207)	(222,493)	(637,442)
Salary for truck driver and assistant	275,058	325,514	214,353
	(124,685)	(139,233)	(65,132)
Loading and unloading of cargo	421,408	471,182	361,523
	(336,904)	(298,246)	(370,621)
Food, lodging, etc.	148,872	124,649	178,016
	(70,807)	(59,067)	(72,956)
Other	140,971	161,471	116,308
	(194,728)	(236,202)	(124,755)
Number of checkpoints	20	27	11
	(13)	(12)	(6)
Average payment at checkpoint	6,262	7,769	4,421
	(3,809)	(1,780)	(4,722)
Number of trips	282	154	128

NOTE.—Standard deviations are in parentheses. Summary statistics include only those trips for which salary information was available. All figures are in October 2006 rupiah (US$1.00 = Rp. 9,200).

Direct Measures: Barron and Olken (JPE 2009)

Survey of truckers in Aceh, Indonesia.

Fig. 1.—Routes

Direct Measures: Barron and Olken (JPE 2009)

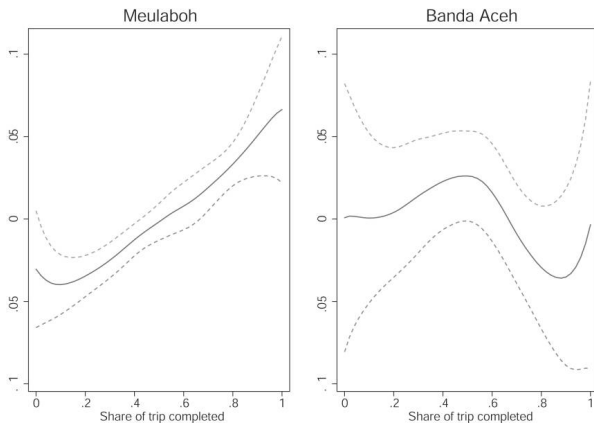Survey of truckers in Aceh, Indonesia.

Fig. 4.—Payments by percentile of trip. Each graph shows the results of a nonparametric Fan (1992) locally weighted regression, where the dependent variable is log payment at checkpoint, after removing checkpoint × month fixed effects and trip fixed effects, and the independent variable is the average percentile of the trip at which the checkpoint is encountered. The bandwidth is equal to one-third of the range of the independent variable. Dependent variable is log bribe paid at checkpoint. Bootstrapped 95 percent confidence intervals are shown in dashes, where bootstrapping is clustered by trip.

Table 6: **Summary Statistics: Bribe Payments**

	Pre Tariff Change	Post Tariff Change	
	2007	2008	2011-2012
Probability of Paying a Bribe (%)	80	26	16
Avg Bribe Amount per Ton (Metical 2007, CPI Adjusted)	2,164	280	494
	(7,800)	(963)	(2,746)
Primary Bribe Recipient	Customs (97%)	Customs (84%)	Customs (72%)
Primary Reason for Bribe Payment	Tariff Evasion (61%)	Congestion (59%)	Congestion (38%)
Ratio of Bribe Amount to Tariff Duties Saved [0-1]*	0.07	0.028	0.008
	(0.13)	(0.09)	(0.02)
Avg clearing time for all shipments (days)	2.4	2.6	2.6
	(1.4)	(1.4)	(3.6)
Avg clearing time with the payment of a bribe (days)	2.5	2.3	2.5
	(1.5)	(1.2)	(3.1)
Avg clearing time without the payment of a bribe (days)	1.9	2.7	2.6
	(0.74)	(1.38)	(3.7)
Avg clearing time with bribe payment for tariff evasion (days)	2.2	2.6	2.4
	(1.7)	(1.4)	(1.8)

[a] *Conditional on the bribe being paid for tariff evasion.
[b] Source: Audit study conducted by the author.
[c] NOTES: Average clearing times moved in tandem with increases in the overall volume of cargo handled at the port between 2007 and 2011. Total volumes increased by 13% in 2008 and 18% in 2011. Note that in 2009, the port of Maputo was still functioning at 30% of capacity so it was capable of handling the observed increase in volumes without substantially increasing congestion.

Figure 2: Likelihood of traveling and travel cost
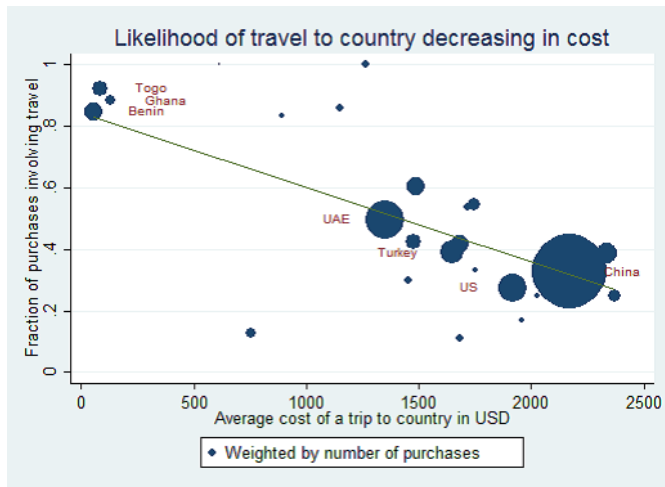
Figure 3: Travel, transport, and tariff expenditures relative to goods value
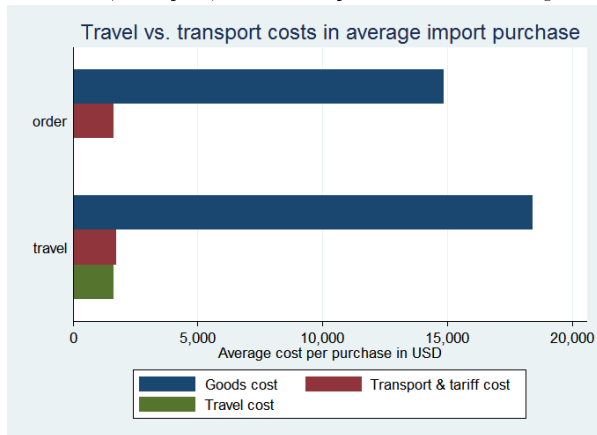
Direct Measures: Startz (2016)

Nigerian Traders: Keep on traveling even after many years trading with country/supplier

Table 4: Probability of traveling for a purchase

	(1) Traveled	(2) Traveled	(3) Traveled
Business age	0.006		
	(0.005)		
Years buying from country	0.010	-0.016**	
	(0.007)	(0.007)	
Years buying from supplier	-0.004	0.005	0.004
	(0.006)	(0.004)	(0.004)
Observations	3035	3037	3213
Sector x country FEs	yes		
Trader and country FEs		yes	
Trader x country FEs			yes
Mean levels of independent variables			
Business age	10.64		
Years buying from country	5.37		
Years buying from supplier	3.88		

Notes: All columns are linear probability models. Robust
standard errors clustered at the trader level are shown in
parentheses.

Direct Measures: Startz (2016)

Nigerian Traders: When travel pay lower prices, charge higher markups, buy newer styles, change suppliers

Table 5: Travel and transaction outcomes

	(1) Log unit cost	(2) Markup (price/cost)	(3) New style	(4) New supplier	(5) Log unit cost	(6) Markup (price/cost)	(7) New style	(8) New supplier
Traveled	-0.30**	0.34***	0.07**	0.05*	-0.13**	0.09*	0.02	0.12***
	(0.119)	(0.109)	(0.032)	(0.028)	(0.054)	(0.048)	(0.044)	(0.046)
Observations	2741	2614	3536	3354	2647	2513	3431	3259
Mean of outcome	1.90	2.07	0.51	0.20	1.90	2.07	0.51	0.20
Sector x country FEs	yes	yes	yes	yes				
Trader x country FEs					yes	yes	yes	yes

Notes: Columns 3/4/7/8 are LPMs. Robust standard errors clustered at the trader level are shown in parentheses.
* significant at 10% ** significant at 5% *** significant at 1%.

Plan for Today's Lecture on Trade Costs

1. Introduction to trade costs

2. Estimating trade costs via direct measurement

3. **Estimating trade costs via gravity equations**

4. Using price dispersion and price gaps to infer trade costs.

Measuring Trade Costs from Trade Flows

- Descriptive statistics can only get us so far. No one ever writes down the full extent of costs of trading and doing business afar.
  - For example, in the realm of transportation-related trade costs: the full transportation-related cost is not just the freight rate (which Hummels (2007) presents evidence on) but also the time cost of goods in transit, etc.

- The most commonly-employed method (by far) for measuring the full extent of trade costs is the gravity equation that we have seen throughout this course.
  - This is a particular way of inferring trade costs from trade flows.
  - Implicitly, we are comparing the amount of trade we see in the real world to the amount we'd expect to see in a frictionless world; the 'difference'—under this logic—is trade costs.
  - Gravity models put a lot of structure on the model in order to (very transparently and easily) back out trade costs as a residual.

Estimating τ_{ij}^k from the Gravity Equation: 'Residual Approach'

- One natural approach would be to use the above structure to back out what trade costs τ_{ij}^k must be. Let's call this the 'residual approach'.

- Head and Ries (2001) propose a way to do this:
  - Suppose that intra-national trade is free: $\tau_{ii}^k = 1$. This can be thought of as a normalization of all trade costs (e.g. assume that AvW (2004)'s 'distributional retail/wholesale costs' apply equally to domestic goods and international goods, after the latter arrive at the port).

  - And suppose that inter-national trade is symmetric: $\tau_{ij}^k = \tau_{ji}^k$.

    - Then we have the 'phi-ness' of trade:

$$\phi_{ij}^k \equiv (\tau_{ij}^k)^{1-\varepsilon^k} = \sqrt{\frac{X_{ij}^k X_{ji}^k}{X_{ii}^k X_{jj}^k}} \tag{1}$$

Estimating τ_{ij}^k from the Gravity Equation: 'Residual Approach'

- There are some drawbacks of this approach:

    - We have to be able to measure internal trade, X_{ii}^k. (You can do this if you observe gross output or final expenditure in each i and k, and re-exporting doesn't get misclassified into the wrong sector.)

    - We have to know ε^k. (But of course this should come as no surprise. We are inferring prices from quantities so clearly it would be impossible to proceed without an estimate of supply/demand elasticities, i.e. the trade elasticity ε^k.)

Figure 7: Average Trade Cost Levels, 1870-2000
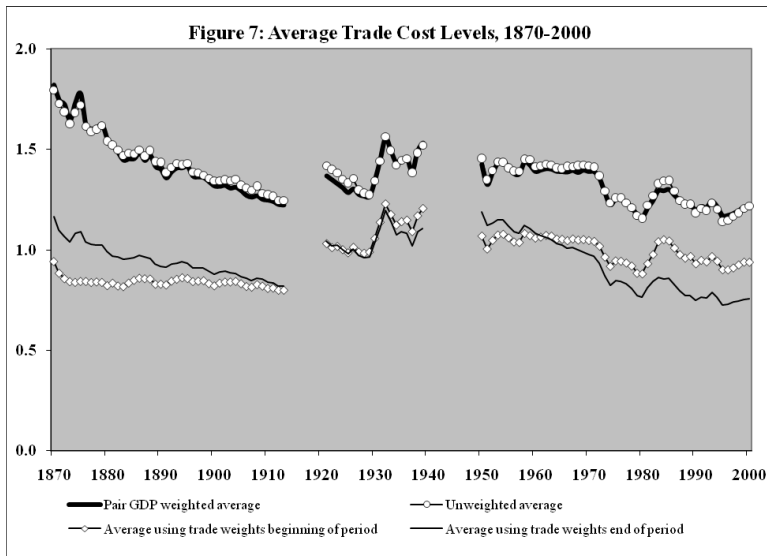
Estimating τ_{ij}^k from the Gravity Equation: 'Determinants Approach'

- A more common approach to measuring τ_{ij}^k is to give up on measuring the full τ, and instead parameterize τ as a function of observables.
- The most famous implementation of this is to model TCs as a function of distance (D_{ij}):
  - $\tau_{ij}^k = \beta D_{ij}^\rho$.
  - So we give up on measuring the full set of τ_{ij}^k's, and instead estimate just the elasticity of TCs with respect to distance, ρ.
    - How do we know that trade costs fall like this in distance? Eaton and Kortum (2002) use a spline estimator.
- But equally, one can imagine including a whole host of m 'determinants' $z(m)$ of trade costs:
  - $\tau_{ij}^k = \prod_m (z(m)_{ij}^k)^{\rho_m}$.
- This functional form doesn't really have any microfoundations (that I know of).
  - But this functional form certainly makes the estimation of ρ_m in a gravity equation very straightforward.

Other elements of Trade Costs

- Many determinants of TCs have been investigated in the literature.
- AvW (2004) summarize these:
    - Tariffs, NTBs, etc.
    - Transportation costs (directly measured). Roads, ports. (Feyrer (2009) on Suez Canal had this feature).
    - Currency policies.
    - Being a member of the WTO.
    - Language barriers, colonial ties.
    - Information barriers. (Rauch and Trindade (2002).)
    - Contracting costs and insecurity (Evans (2001), Anderson and Marcoulier (2002)).
    - US CIA-sponsored coups. (Easterly, Nunn and Sayananth (2010).)

- Aggregating these trade costs together into one representative number is not trivial (assuming the costs differ across goods).
    - Anderson and Neary (2005) have outlined how to solve this problem (conditional on a given theory of trade).

TABLE 7
Tariff Equivalent of Trade Costs

|	method	data	reported by authors	$\sigma=5$	$\sigma=8$	$\sigma=10$
all trade barriers						
Head and Ries (2001) U.S.-Canada, 1990-1995	new	disaggr.	48 ($\sigma=7.9$)	97	47	35
Anderson and van Wincoop (2003) U.S.-Canada, 1993	new	aggr.		91	46	35
Eaton and Kortum (2002) 19 OECD countries, 1990 750-1500 miles apart	new	aggr.	48–63 ($\sigma=9.28$)	123–174	58–78	43–57
national border barriers						
Wei (1996) 19 OECD countries, 1982-1994	trad.	aggr.	5 ($\sigma=20$)	26–76	14–38	11–29
Evans (2003a) 8 OECD countries, 1990	trad.	disaggr.	45 ($\sigma=5$)	45	30	23
Anderson and van Wincoop (2003) U.S.-Canada, 1993	new	aggr.	48 ($\sigma=5$)	48	26	19
Eaton and Kortum (2002) 19 OECD countries, 1990	new	aggr.	32–45 ($\sigma=9.28$)	77–116	39–55	29–41
language barrier						
Eaton and Kortum (2002) 19 OECD countries, 1990	new	aggr.	6 ($\sigma=9.28$)	12	7	5
Hummels (1999) 160 countries, 1994	new	disaggr.	11 ($\sigma=6.3$)	12	8	6
currency barrier						
Rose and van Wincoop (2001) 143 countries, 1980 and 1990	new	aggr.	26 ($\sigma=5$)	26	14	11

A Concern About Identification

- The above methodology identified τ_{ij}^k (or its determinants) only by assuming trade separability. This seems potentially worrying.

- In particular, there is a set of taste or technology shocks that can rationalize any trade cost vector you want.
  - E.g. if we allowed each country i to have its own taste for varieties of k that come from country j (this would be a bilateral shifter that hits each good in the utility function for i, a_{ij}^k) then this would mean everywhere we see τ_{ij}^k in the gravity equation there should really be $\tau_{ij}^k a_{ij}^k$
  - In general a_{ij}^k might just be noise with respect to determining τ_{ij}^k. But if a_{ij}^k is spatially correlated, as τ_{ij}^k is (when, for example, we are projecting τ on distance), then the estimation of τ would be biased.

A Concern About Identification

- To take an example from the Crozet and Koenigs (2009) maps, do Alsaciens trade more with Germany (relative to how the rest of France trades with Germany) because:
    - They have low trade costs (proximity) for getting to Germany?
    - They have tastes for similar goods?
    - There is no barrier to factor mobility here. Self-employed French barbers might even cut hair in Germany and register their sales as exports.
    - Integrated supply chains choose to locate near each other.
        - Ellison, Glaeser and Kerr (AER, 2009) look at this 'co-agglomeration' in the US.
        - Hummels and Hilberry (EER, 2008) look at this on US trade data by checking whether imports of a zipcode's goods are correlated with the upstream input demands of that zipcode's industry-mix.
        - Rossi-Hansberg (AER, 2005) models this on a spatial continuum where a border is just a line in space.
        - Yi (JPE, 2003) looks at this. And Yi (AER, 2010) argues that this explains much of the 'border effect' that remains even in AvW (2003).

Hilberry and Hummels (EER 2008) using zipcode-to-zipcode US data

Is it really plausible that trade costs fall this fast with distance?

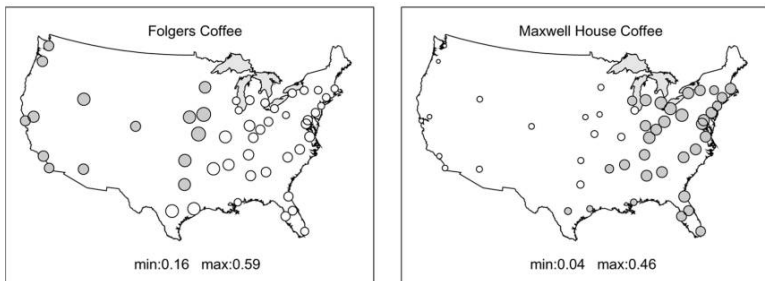Kernel regression: value on distance
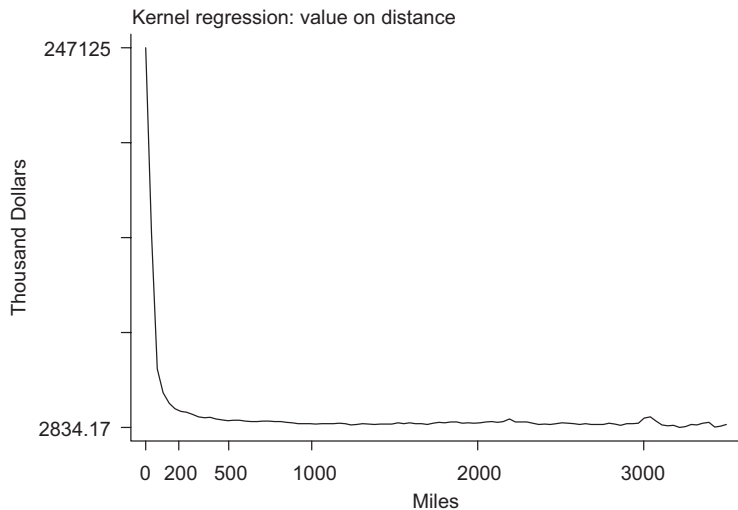
Fig. 2.—The joint geographic distribution of share levels and early entry across U.S. markets in ground coffee. The areas of the circles are proportional to share levels. Shaded circles indicate that a brand locally moved first.
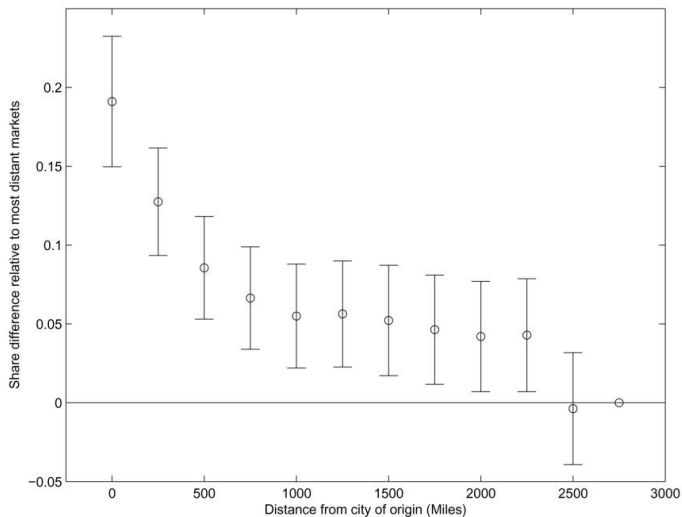
Fɪɢ. 3.—Effect of distance from city of origin on market share (net of brand-specific fixed effects). Whiskers indicate 95 percent confidence intervals.

Atkin (AER 2012): Endogenous Tastes?

Western Rajasthan

Item	Food Share	Price (1000 Cal)
Rice	0.4	1.4
Wheat	31.0	0.7
Jowar	2.7	0.6
Bajra	7.9	0.8
Milk	25.4	4.0
Fish	0.0	19.0

Western Plains West Bengal

Item	Food Share	Price (1000 Cal)
Rice	57.0	1.1
Wheat	2.1	0.9
Jowar	0.2	0.7
Bajra	0.0	-
Milk	4.1	4.0
Fish	4.6	14.3

Southern Kerala

Item	Food Share	Price (1000 Cal)
Rice	34.0	1.1
Wheat	1.9	1.0
Jowar	0.0	0.9
Bajra	0.0	1.4
Milk	8.0	4.3
Fish	10.6	8.1

Inland Eastern Maharashtra

| Item	Food Share	Price (1000 Cal)
Rice	5.3	1.1
Wheat	9.2	0.8
Jowar	18.9	0.4
Bajra	0.2	0.8
Milk	8.7	4.0
Fish	0.4	14.8
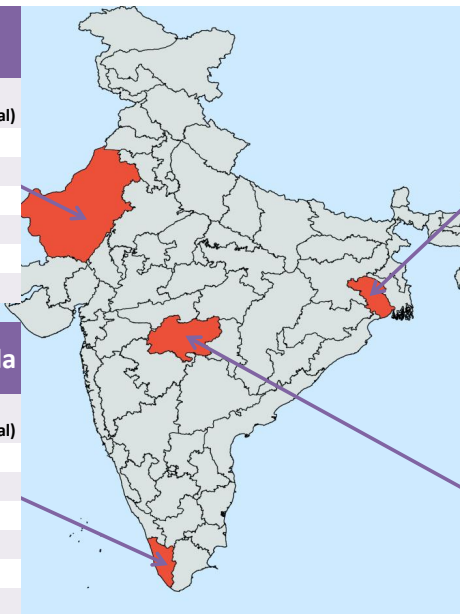
Puzzling Findings from Gravity Equations

- Trade costs seem very large.

- The decay with respect to distance seems particularly dramatic.

- The distance coefficient has not been dying over time

- One sees a distance and a 'border' effect on eBay too:
  - Hortascu, Martinez-Jerez and Douglas (AEJ 2009).
  - Blum and Goldfarb (JIE, 2006) on digital products. But only for 'taste-dependent digital goods': music, games, pornography.

- Hortascu, Martinez-Jerez and Douglas (AEJ 2009) also show how you see big distance effects for "local tastes" goods like sports team memorabilia.

FIGURE 3.—THE VARIATION OF $\hat{\theta}$ GRAPHED RELATIVE TO THE MIDPERIOD OF THE DATA SAMPLE
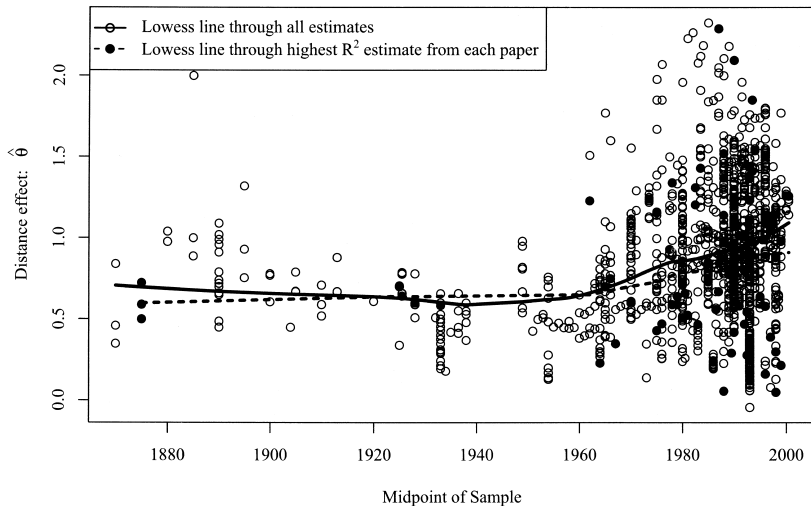
Consequences of Supply Chains for Estimating Trade Costs via Gravity

- We now discuss some of the consequences of international fragmentation for the study of trade flows.
    1. Yi (JPE 2003): The possibility of international fragmentation raises the trade-to-tariff elasticity.
    2. Yi (AER, 2010): Similar consequences for estimation of the 'border effect'.

Yi (2003)

- Yi (2003) motivates his paper with 2 puzzles:

  1. The trade flow-to-tariff elasticity in the data is way higher than what standard models predict.

  2. The trade flow-to-tariff elasticity in the data appears to have become much higher, non-linearly, around the 1980s. Why?

- Yi (2003) formulates and calibrates a 2-country DFS (1977)-style model with and without 'vertical specialization' (ie intermediate inputs are required for production, and these are tradable).

  - The model without VS fails to match puzzles 1 or 2.

  - The calibrated model with VS gets much closer.

  - Intuition for puzzle 1: if goods are crossing borders N times then it is not the tariff $(1 + \tau)$ that matters, but of course $(1 + \tau)^N$ instead.

  - Intuition for puzzle 2: if tariffs are very high then countries won't trade inputs at all. So the elasticity will be initially low (as if $N = 1$) and then suddenly higher (as if $N > 1$).
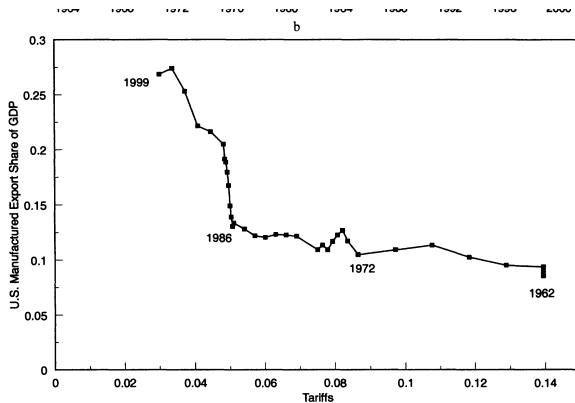
Fig. 1.—Manufacturing export share of GDP and manufacturing tariff rates. Source: World Trade Organization (2002) and author's calculations (see App. A and Sec. V).

- Production takes 3 stages:

    1. $y_1^i(z) = A_1^i(z) l_1^i(z)$ with $i = H, F$. Sector 1 produces inputs (using labor).

    2. $y_2^i(z) = x_1^i(z)^\theta \left[A_2^i(x) l_2^i(z) \right]^{1-\theta}$ with $i = H, F$. Sector 2 uses inputs x_1 to produce final goods. Inputs x_1 are the output of sector 1.

    3. $Y = exp \left[\int_0^1 \ln \left[x_2(z) \right] dz \right]$. Final (non-tradable) consumption good is Cobb-Douglas aggregate of Stage 2 goods.

Yi (2003): Simplified Version of Model

- If VS is occurring (ie τ is sufficiently low) then let z_l be the cut-off that makes a Stage 3 firm indifferent between using a "HH" and a "HF" upstream organization of production.
  - This requires that: $\frac{w^H}{w^F} = (1+\tau)^{(1+\theta)/(1-\theta)} A_2^H(z_l)/A_2^F(z_l)$.
  - Differentiating (and ignoring the change in the wage):
  $$\widehat{1-z_l} = \left(\frac{1+\theta}{1-\theta}\right)\left[\frac{z_l}{(1-z_l)\eta_{A_2}}\right]\widehat{1+\tau}$$

- However, if VS is not occurring (ie τ is high) then:
  - This requires $\frac{w^H}{w^F} = (1+\tau) A_2^H(z_l)/A_2^F(z_l)$.
  - So the equivalent derivative is:
  $$\widehat{1-z_l} = \left[\frac{z_l}{(1-z_l)\eta_{A_2}}\right]\widehat{1+\tau}$$

- For $\theta < 1$ (eg $\theta = \frac{2}{3}$) the multiplier in the VS can be quite big (eg 5).
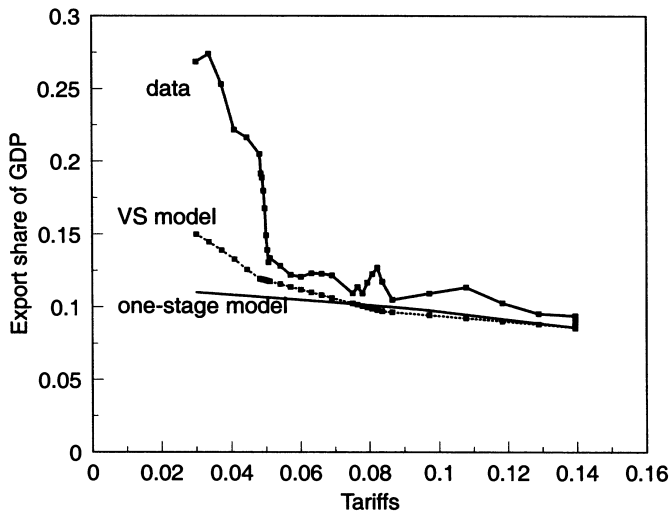
Fig. 10.—Narrow case: vertical model vs. one-stage model

Yi (AER, 2010)

- Yi (2010) points out that the Yi (2003) VS argument also has implications for <u>cross-sectional</u> variation in the trade elasticities

  - Recall that estimates of the gravity equation (eg Anderson and van Wincoop, 2003) within the US and Canada find that there appears to be a significant additional trade cost involved in crossing the US-Canada border. The tariff equivalent of this border effect is much bigger than US-Canada tariffs.

  - This is called the 'border effect' or the 'home bias of trade' puzzle.

- Yi (2010) argues that if production can be fragmented internationally then the (gravity equation-) estimated border-crossing trade cost will be higher than the true border-crossing trade cost.

  - This is because (in such a model) the true trade flow-to-border cost elasticity will be larger than that in a standard model (without multi-stage production).

Yi (2010): Results

- Yi (2010) uses data on tariffs, NTBs, freight rates and wholesale distribution costs to claim that the 'true' Canada-US border trade costs are 14.8%.

- He then simulates (a calibrated version of) his model based on this 'true' border cost.

- He then compares the border dummy coefficient in 2 regressions:
  - A gravity regression based on his model's predicted trade data.
  - And the gravity regression based on actual trade data.

- The coefficient on the model regression is about 2/3 of the data regression. A trade cost of 26.1% would be needed for the coefficients to match.
  - By contrast, a standard Eaton and Kortum (2002) model equivalent (without multi-stage production) would give much smaller coherence between model and data.

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Using price dispersion to estimate trade costs

- A large literature does this instead of using quantities/expenditure as in the gravity appraoch.
  - See, e.g., Fackler and Goodwin (2001 Handbook survey) or Anderson and van Wincoop (2004, JEL)

- The attraction is that it is less parametric. Purely rests on the arbitrage idea that if i is currently exporting homogeneous product k to location j at time t (ie $X_{ijt}^k > 0$ is true) then we must have, if we believe in arbitrage:

$$\ln p_{jt}^k - \ln p_{it}^k = \ln \tau_{ijt}^k \tag{2}$$

Challenges in doing this

1. Have to observe homogeneous products. (Otherwise price gaps will reflect quality differences.)

2. Have to know whether two locations are trading that product
   - This is challenging in practice since at the level of 'products' for which you can plausibly overcome problem 1, it is often impossible to see trade flow data that narrowly

3. Have to believe in perfect arbitrage (and hence also perfect competition) or else have a convincing way of correcting for this

Some recent progress has been made on this. Examples include:
- Donaldson (2018) on solving 1 and 2 in certain settings.
- Cosar, Greico and Tintelnot (2015) and Atkin and Donaldson (2015) on attempts to solve 1-2 and also make progress on 3. Recitation will cover the latter paper.