14.581: International Trade
— Lecture 14—
Trade Costs and Gravity (Empirics II)

1. Goodness of fit of gravity equations (when trade costs observed)

2. Using the gravity equation to estimate trade costs

Plan for Today's Lecture

1. **Goodness of fit of gravity equations (when trade costs observed)**

2. Using the gravity equation to estimate trade costs

Goodness of Fit of Gravity Equations

- Lai and Trefler (2002, unpublished) discuss (among other things) the fit of the gravity equation.

- Using the notation in Anderson and van Wincoop (2004, JEL), but study imports (M) into i from j rather than exports:

$$M_{ij}^k = \frac{E_i^k Y_j^k}{Y^k} \left(\frac{\tau_{ij}^k}{P_i^k \Pi_j^k} \right)^{1-\epsilon^k}$$

- Where P_i^k and Π_j^k are price indices (that of course depend on E, M and τ).
- Y^k is total world income/expenditure
- τ_{ij}^k here refers to tariffs

Goodness of Fit of Gravity Equations

$$M_{ij}^k = \frac{E_i^k Y_j^k}{Y^k} \left(\frac{\tau_{ij}^k}{P_i^k \Pi_j^k} \right)^{1-\epsilon^k}$$

- Lai and Trefler (2002) discuss the fit of this equation, and then divide up the fit into 3 parts (mapping to their notation):

  1. $Q_j^k \equiv Y_j^k$. Fit from this, they argue, is uninteresting due to the "data identity" that $\sum_i M_{ij}^k = Y_j^k$.

  2. $s_i^k \equiv E_i^k$. Fit from this, they argue, is somewhat interesting as it's due to homothetic preferences. But not *that* interesting.

  3. $\Phi_{ij}^k \equiv \left(\frac{\tau_{ij}^k}{P_i^k \Pi_j^k} \right)^{1-\epsilon^k}$. This, they argue, is the interesting bit of the gravity equation. It includes the partial-equilibrium effect of trade costs τ_{ij}^k, as well as the general equilibrium effects in P_i^k and Π_j^k.

Lai and Trefler (2002): Other Notes

- Other notes on their estimation procedure:
  - They use 3-digit manufacturing industries (28 industries), every 5 years from 1972-1992, 14 importers (OECD) and 36 exporters. (Big constraint is data on tariffs.)
  - They assume that trade costs τ_{ij}^k (which could, in principle, include transport costs, etc) is just equal to tariffs.
  - They estimate one parameter ϵ^k per industry k.
  - They also allow for unrestricted taste-shifters by country (fixed over time).
  - Note that the term Φ_{ij}^k is highly non-linear in parameters. So this is done via NLS. But that isn't strictly necessary because one could instead use the normal gravity method of regressing $\ln M_{ij}^k$ on $\ln \tau_{ij}^k$ using OLS with ik and jk fixed-effects
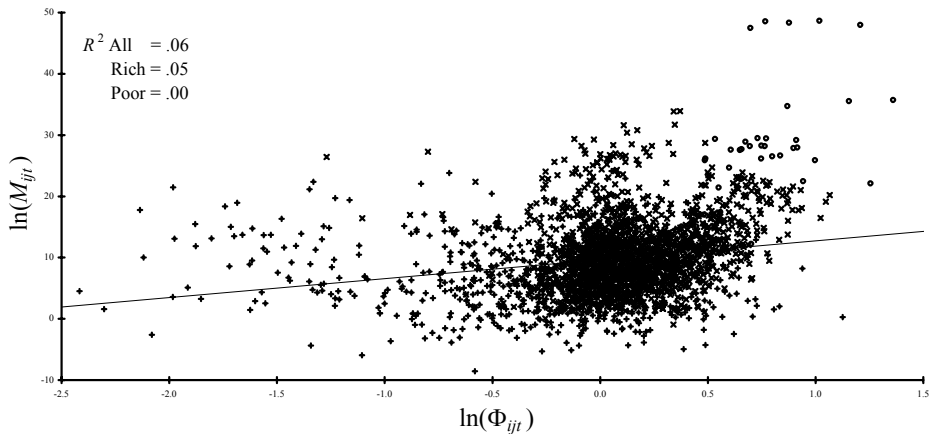
Lai and Trefler (2002): Results
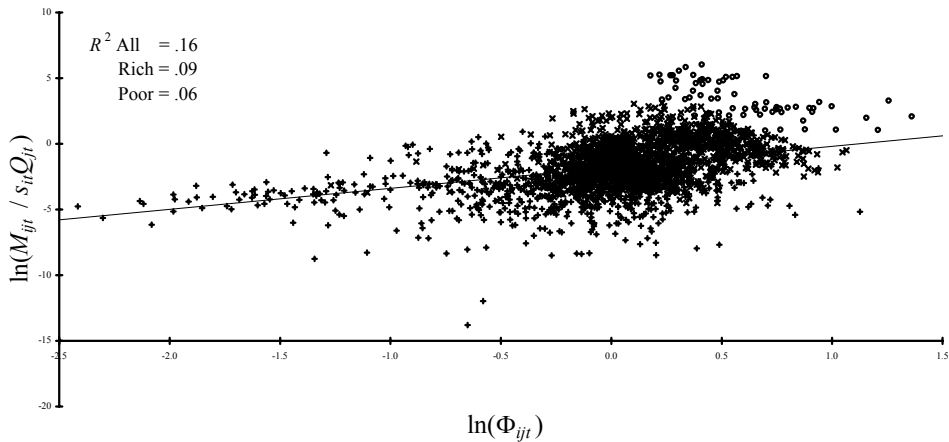
Overall fit, pooled cross-sections

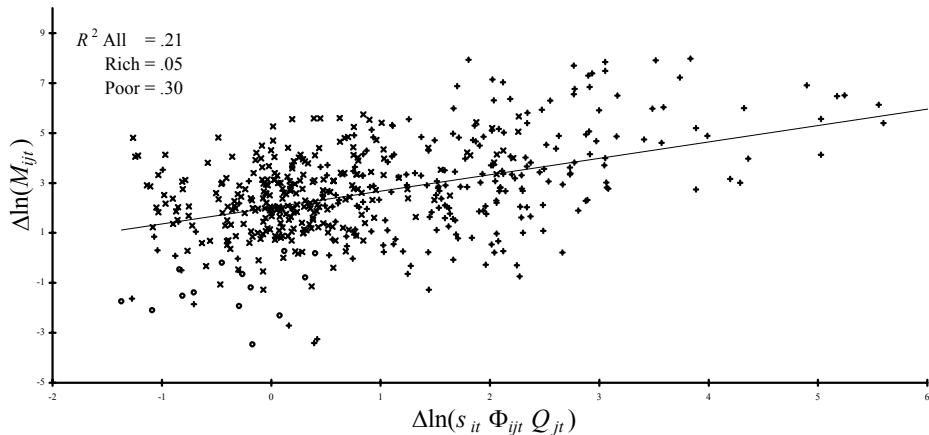Fit from just Φ_{ijt}^k, pooled cross-sections
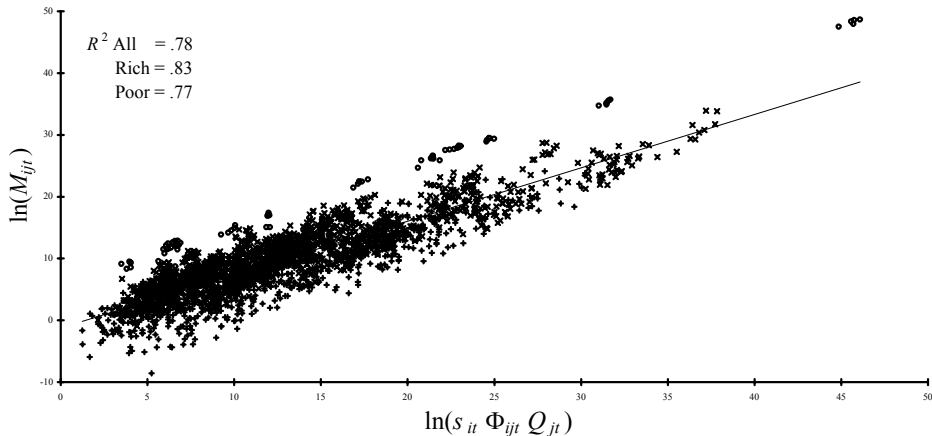
Lai and Trefler (2002): Results

Fit from just Φ_{ijt}^k, but controlling for s_{it}^k and Q_{jt}^k, pooled cross-sections

Lai and Trefler (2002): Results

Overall fit, long differences

R^2 All = .01
Rich = .00
Poor = .06
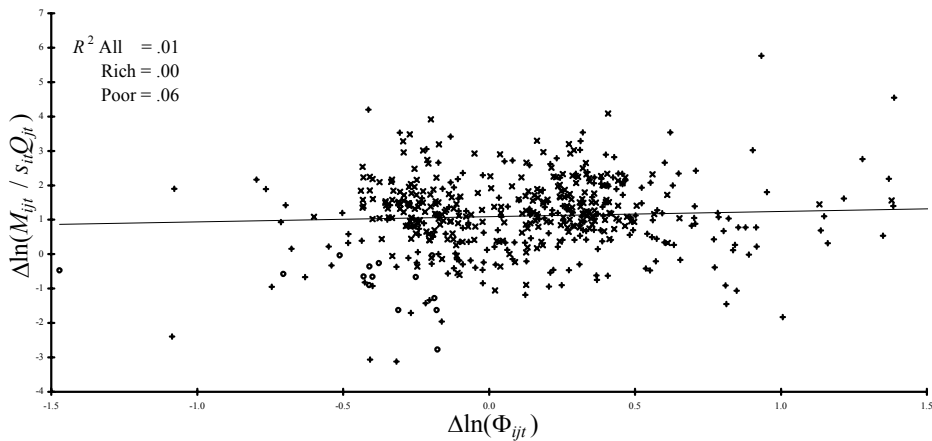
Lai and Trefler (2002): Results

Is fit over long diffs driven by s_{it}^k or Q_{jt}^k?
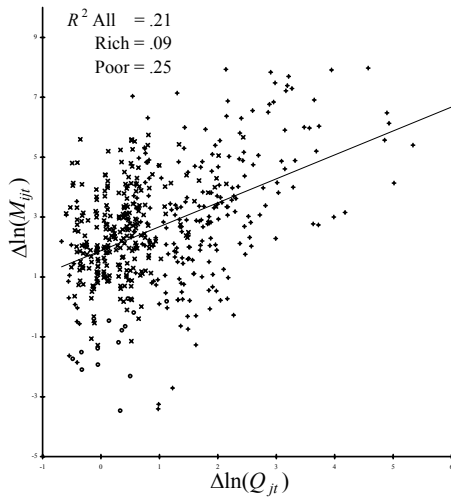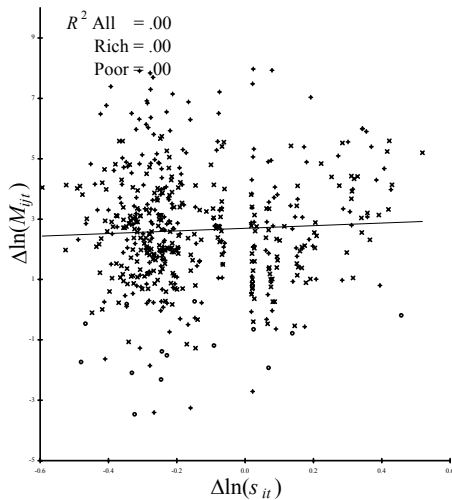
Plan for Today's Lecture

1. Goodness of fit of gravity equations (when trade costs observed)

2. **Using the gravity equation to estimate 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.

  - 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. (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.)

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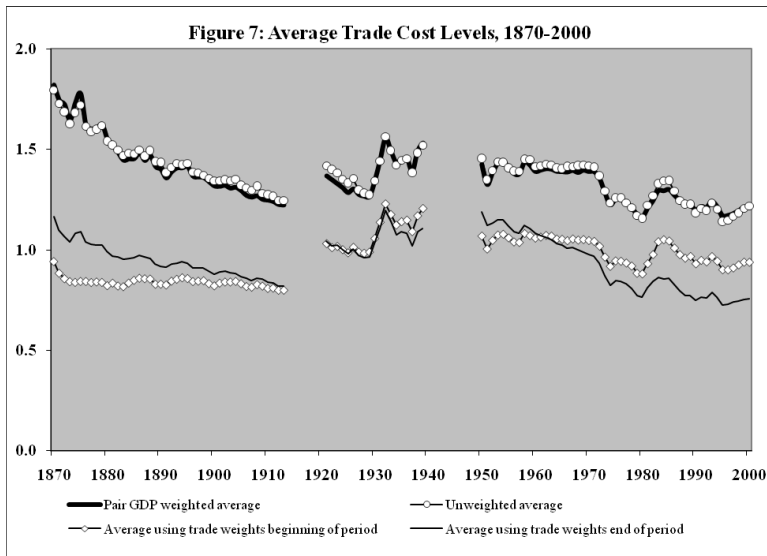
Estimating τ_{ij}^k from the Gravity Equation: 'Determinants Approach'

- 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.

Anderson and van Wincoop (AER, 2003)

- An important message about how one actually estimates the gravity equation was made by AvW (2003).

- Suppose you are estimating the general gravity model:

$$\ln X_{ij}^k(\boldsymbol{\tau}, \mathbf{E}) = A_i^k(\boldsymbol{\tau}, \mathbf{E}) + B_j^k(\boldsymbol{\tau}, \mathbf{E}) + \varepsilon^k \ln \tau_{ij}^k + \nu_{ij}^k. \qquad (2)$$

- Suppose you assume $\tau_{ij}^k = \beta D_{ij}^\rho$ and try to estimate ρ^k.
  - Aside: Note that you can't actually estimate ρ^k here! All you can estimate is $\delta^k \equiv \varepsilon^k \rho^k$. But with outside information on ε^k (in some models it is the CES parameter, which maybe we can estimate from another study) you can back out ε^k.
  - Another aside: what happens to β?

Anderson and van Wincoop (AER, 2003)

- Suppose you are estimating the general gravity model:

$$\ln X_{ij}^k(\boldsymbol{\tau}, \mathbf{E}) = A_i^k(\boldsymbol{\tau}, \mathbf{E}) + B_j^k(\boldsymbol{\tau}, \mathbf{E}) + \varepsilon^k \ln \tau_{ij}^k + \nu_{ij}^k. \qquad (3)$$

- Note how A_i^k and B_j^k (which are equal to $Y_i^k(\Pi_i^k)^{\varepsilon^k-1}$ and $E_j^k(P_j^k)^{\varepsilon^k-1}$ respectively in the AvW (2004) system) depend on τ_{ij}^k too.

- Obviously the Y_i^k and E_j^k terms, as well as the P_j^k and Π_i^k terms, are all endogenous.

- In addition, the price index terms P_j^k and Π_i^k are very hard to get data on.

- So a naive regression of X_{ij}^k on E_j^k, Y_i^k and τ_{ij}^k is usually performed (this is AvW's 'traditional gravity') instead.

- AvW (2003) pointed out that this is wrong. The estimate of ρ will be biased by OVB (we've omitted the P_j^k and Π_i^k terms and they are correlated with τ_{ij}^k).

Anderson and van Wincoop (AER, 2003)

- How to solve this problem?
  - AvW (2003) propose non-linear least squares:
    - The functions $(\Pi_i^k)^{1-\varepsilon^k} \equiv \sum_j \left(\frac{\tau^k}{P_j^k}\right)^{1-\varepsilon^k} \frac{E_j^k}{Y^k}$ and
      $(P_j^k)^{1-\varepsilon^k} \equiv \sum_i \left(\frac{\tau^k}{\Pi_i^k}\right)^{1-\varepsilon^k} \frac{Y_i^k}{Y^k}$ are known.
      - These are non-linear functions of the parameter of interest (ρ), but NLS can solve that.
  - A simpler approach (first in Harrigan, 1996) is usually pursued instead though:
    - The terms $A_i^k(\tau, \mathbf{E})$ and $B_j^k(\tau, \mathbf{E})$ can be partialled out using α_i^k and α_j^k fixed effects.
    - Note that (i.e. avoid what Baldwin and Taglioni call the 'gold medal mistake') if you're doing this regression on panel data, you need separate fixed effects α_{it}^k and α_{jt}^k in each year t.

Anderson and van Wincoop (AER, 2003)

- This was an important general point about estimating gravity equations
  - And it is a nice example of general equilibrium empirical thinking.

- But AvW (2003) applied their method to revisit McCallum (AER, 1995)'s famous argument that there was a huge 'border' effect within North America:
  - This is an additional premium on crossing the border, controlling for distance.
  - Ontario appears to want to trade far more with Alberta (miles away) than New York (close, but over a border).

- The problem is that, as AvW (2003) showed, McCallum (1995) didn't control for the endogenous terms $A_i^k(\boldsymbol{\tau}, \mathbf{E})$ and $B_j^k(\boldsymbol{\tau}, \mathbf{E})$.

Anderson and van Wincoop (AER, 2003): Results

Re-running McCallum (1995)'s specification. Canadian border effect much larger than US border effect. It is also enormous.

TABLE 1—McCallum Regressions

Data	McCallum regressions			Unitary income elasticities		
	(i) CA–CA CA–US	(ii) US–US CA–US	(iii) US–US CA–CA CA–US	(iv) CA–CA CA–US	(v) US–US CA–CA	(vi) US–US CA–CA CA–US
Independent variable						
$\ln y_i$	1.22	1.13	1.13	1	1	1
	(0.04)	(0.03)	(0.03)			
$\ln y_j$	0.98	0.98	0.97	1	1	1
	(0.03)	(0.02)	(0.02)			
$\ln d_{ij}$	−1.35	−1.08	−1.11	−1.35	−1.09	−1.12
	(0.07)	(0.04)	(0.04)	(0.07)	(0.04)	(0.03)
Dummy–Canada	2.80		2.75	2.63		2.66
	(0.12)		(0.12)	(0.11)		(0.12)
Dummy–U.S.		0.41	0.40		0.49	0.48
		(0.05)	(0.05)		(0.06)	(0.06)
Border–Canada	16.4		15.7	13.8		14.2
	(2.0)		(1.9)	(1.6)		(1.6)
Border–U.S.		1.50	1.49		1.63	1.62
		(0.08)	(0.08)		(0.09)	(0.09)
$\bar{R}^2$	0.76	0.85	0.85	0.53	0.47	0.55
Remoteness variables added						
Border–Canada	16.3		15.6	14.7		15.0
	(2.0)		(1.9)	(1.7)		(1.8)
Border–U.S.		1.38	1.38		1.42	1.42
		(0.07)	(0.07)		(0.08)	(0.08)
$\bar{R}^2$	0.77	0.86	0.86	0.55	0.50	0.57

Notes: The table reports the results of estimating a McCallum gravity equation for the year 1993 for 30 U.S. states and 10 Canadian provinces. In all regressions the dependent variable is the log of exports from region i to region j. The independent variables are defined as follows: y_i and y_j are gross domestic production in regions i and j; d_{ij} is the distance between regions i and j; *Dummy–Canada* and *Dummy–U.S.* are dummy variables that are one when both regions are located in respectively Canada and the United States, and zero otherwise. The first three columns report results based on nonunitary income elasticities (as in the original McCallum regressions), while the last three columns assume unitary income elasticities. Results are reported for three different sets of data: (i) state–province and interprovincial trade, (ii) state–province and interstate trade, (iii) state–province, interprovincial, and interstate trade. The border coefficients *Border–U.S.* and *Border–Canada* are the exponentials of the coefficients on the respective dummy variables. The final three rows report the border coefficients and $\bar{R}^2$ when the remoteness indices (3) are added. Robust standard errors are in parentheses.

Anderson and van Wincoop (AER, 2003): Results

Using theory-consistent (NLS) specification. All countries now have similar (and reasonable) border effects.

TABLE 2—ESTIMATION RESULTS

		Two-country model	Multicountry model
Parameters	$(1 - \sigma)\rho$	-0.79	-0.82
		(0.03)	(0.03)
	$(1 - \sigma)\ln b_{US,CA}$	-1.65	-1.59
		(0.08)	(0.08)
	$(1 - \sigma)\ln b_{US,ROW}$		-1.68
			(0.07)
	$(1 - \sigma)\ln b_{CA,ROW}$		-2.31
			(0.08)
	$(1 - \sigma)\ln b_{ROW,ROW}$		-1.66
			(0.06)
Average error terms:	US–US	0.06	0.06
	CA–CA	-0.17	-0.02
	US–CA	-0.05	-0.04

Notes: The table reports parameter estimates from the two-country model and the multicountry model. Robust standard errors are in parentheses. The table also reports average error terms for interstate, interprovincial, and state–province trade.

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

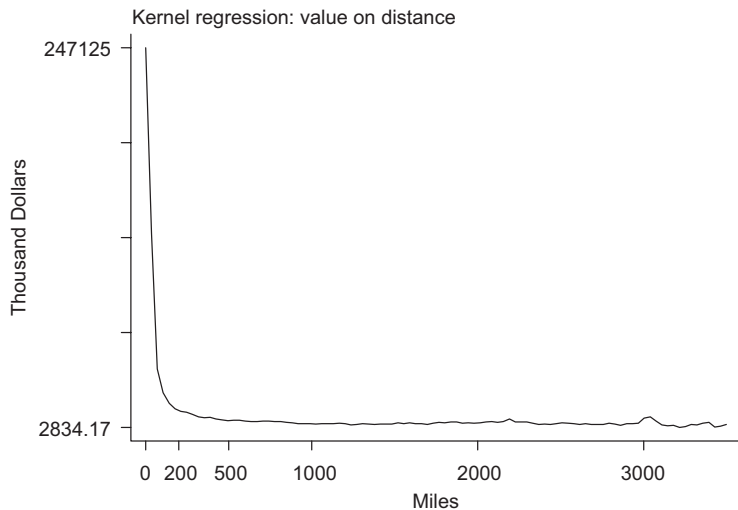# A Concern About Identification

- The above methodology identified tau (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 above 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?
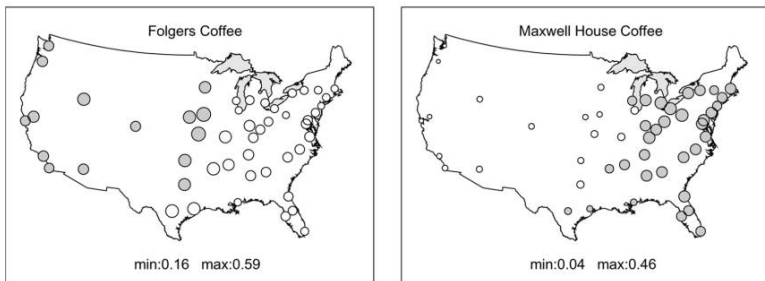

Kernel regression: value on distance

Fɪɢ. 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.

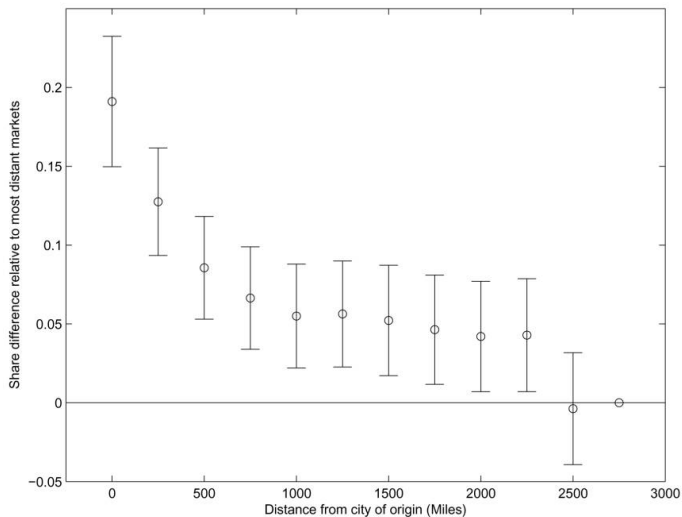# Bronnenberg, Dube (JPE 2009): Endogenous Tastes?

Fig. 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
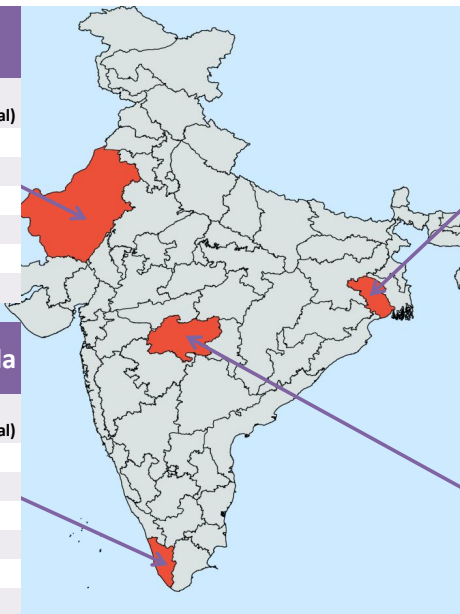
Puzzling Findings from Gravity Equations

- Trade costs seem very large.

- The decay with respect to distance seems particularly dramatic.

- The distance coefficient has not been dying.

- 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
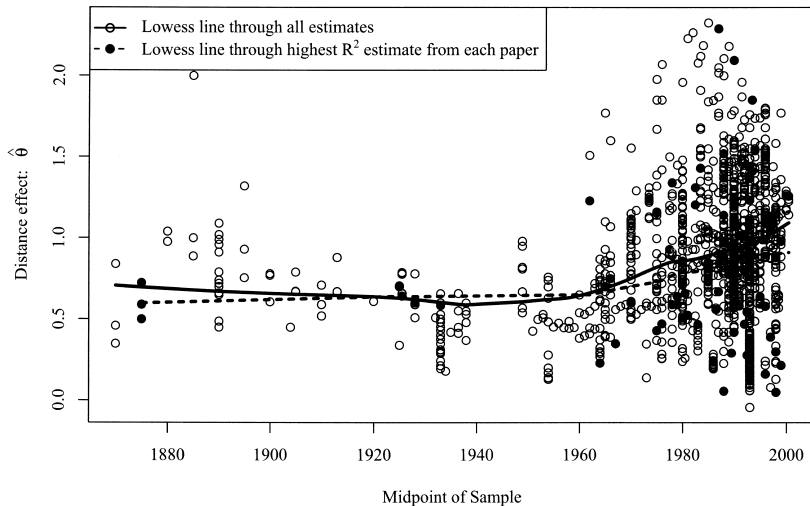
Consequences of Supply Chains for Estimating Trade Costs via Gravity

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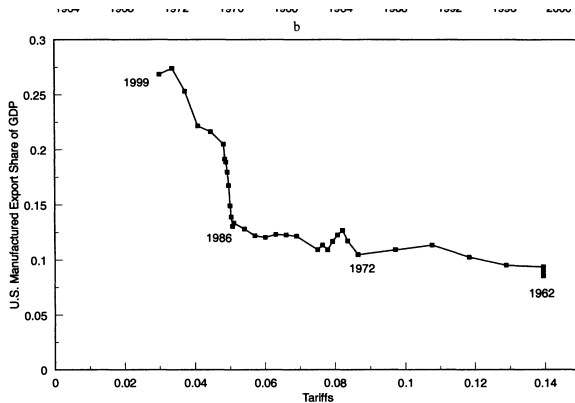
Fig. 1.—Manufacturing export share of GDP and manufacturing tariff rates. Source: World Trade Organization (2002) and author's calculations (see App. A and Sec. V).

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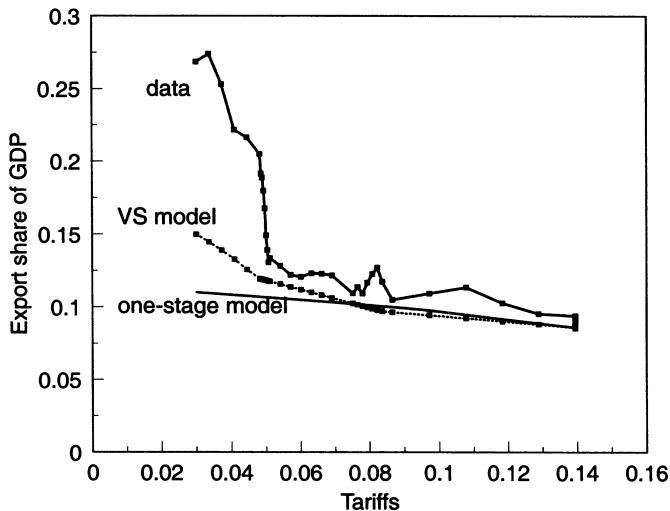
Fig. 10.—Narrow case: vertical model vs. one-stage model

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.