Heterogeneity and the Distance Puzzle

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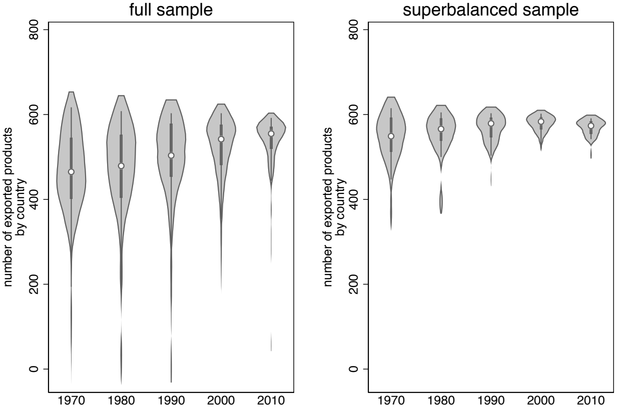
Introduction: the paradox of distance

- The distance effect is increasing or stable through time in gravity models: Disdier & Head, (2008), Head & Mayer (2013)...
  - This seems counter-intuitive ("Death of distance")
- Various answers in the literature (see Head & Mayer (2013)):
  - Problem with the log-linear estimation strategy?
    - Not taking zeros into account + heteroskedasticity
    - $\Rightarrow$ PPML estimates (Santo Silva & Tenreyro (2006), , Bosquet & Boulhol (2015))
  - Composition effect (Larch et al. (2016))
  - Relative evolution of short-distance trade costs compared to long-distance trade costs (Buch & al. (2004), Krautheim (2012))
  - Input-output linkage (Daudin et al. (2011))
  - Network : the distance coefficient does not depend on trade costs (Chaney (2018))

How do we contribute?

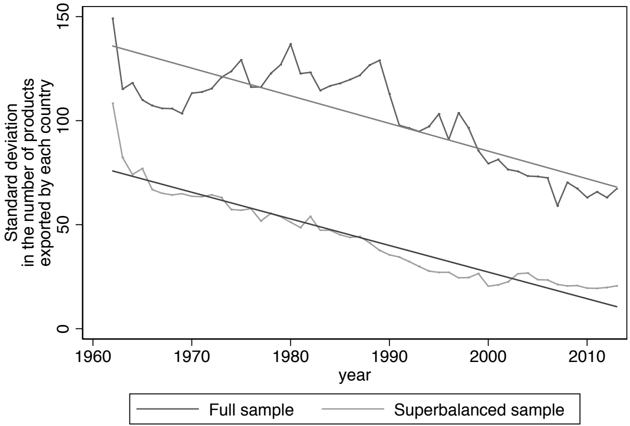
- Every theoretical fundation of the gravity equation delivers a relationship betwee the distance elasticity and a degree of structural heterogeneity in some model-specific structural dimension
  - "Trade elasticity" (Arkolakis et al. (2012))
- The distance coefficient is the product of:
  1. The elasticity of distance to trade costs
  2. The elasticity of trade to trade costs
- Empirical evidence on the historical evolution of structural heterogeneity is notoriously scarce
  - The only other try we know of is Berthelon & Freund (2008) from the late 1980s to early 2000s
- We document over 1962-2013 how the increasing substituability of the bundles shipped out by each country (Armington framework) contributes to the paradox

Dispersion of the number of products exported by each country



At SITC 4-digit, COMTRADE data, samples defined in the text

Standard deviation in the number of products exported by each country



At SITC 4-digit, COMTRADE data, samples defined in the text

Overview

The distance puzzle in our data

- Benchmark estimation
- Composition, sample, FTA effects

Interpreting properly the distance coefficient

- The heterogeneity dimension in each model
- The heterogeneity dimension captured in our data

Estimation strategy and results

- Benchmark estimation
- Robustness checks

Conclusion

Summary of results

- Robustness of distance puzzle in 1962-2013: increase in distance coefficient
  - +5% controlling for estimation strategy
  - +31% controlling for composition and sample effects
- Evolution of heterogeneity parameter:
  - ??% increase in 1963-2013 (??% in 1970-2013)
  - this estimate is likely to be a lower bound
- Elasticity of trade costs to distance has not increased
  - ???% decrease in 1963-2013
  - ??% decrease in 1970-2013
- Which dimension of increased country similarity?
  - Result obtained within the Armington framework
  - Increased substitutability of traded product bundles

Roadmap

The distance puzzle in our data

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- Composition, sample, FTA effects

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Estimation procedure (1)

- run gravity equations (obviously)
  - COMTRADE data, 1962-2009 STIC 4 digits (1962-2009)
  - cross section, no panel
  - focus on evolution of distance elasticity overtime
  - using the PPML estimator (consistency & efficiency)
- Microfounded gravity equation (Anderson & Wincoop (2003)):

$$X_{ij,t} = \left(\frac{Y_{i,t}Y_{j,t}}{Y_t}\right)\left(\frac{\tau_{ij,t}}{\Pi_{i,t}P_{j,t}}\right)^{\epsilon_t}$$

- heterogeneity parameter: ϵ_t: $1-\sigma_t$ in Armington (sector or firm productivity heterogeneity in Metlitz and Eaton & Kortum framworks)

Estimation procedure (2)

- Trade costs:
  - distance parameter: $\eth_{ij}$
  - time-invariant cost vector of controls (adjacency,...): Z
  - time-varying cost vector of controls (policy: FTAs,...): S_t
  - unobserved bilateral trade cost component assumed to have mean zero conditional on the observables:ν_{ijt}

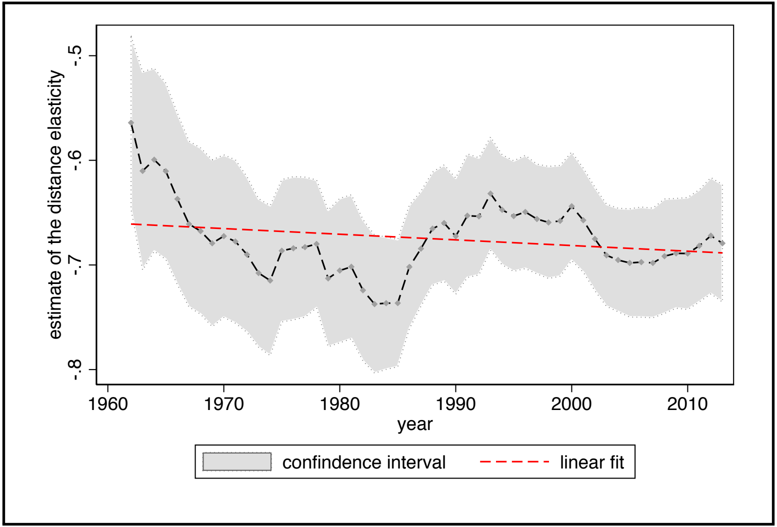
$$\tau_{ijt} = \exp\left\{\rho_t \ln \eth_{ij} + Z_{ij}\zeta_t + S_{ijt}\varsigma_t + \nu_{ijt}\right\}$$

  - ρ_t is the 'world shrinkage' parameter
    i.e. elasticity of trade costs to distance
- Estimated equation:

$$X_{ij,t} = \exp\left(\xi_t - \delta_t \ln \eth_{ij} + Z_{ij}\tilde{\zeta}_t + S_{ijt}\tilde{\varsigma}_t + f_{it} + f_{jt}\right)\eta_{ijt}$$

  - f_{it} and $f_{jt}$are fixed effects to control for price levels
  - ξ_{ijt} is a multiplicative error term which includes the exponentiated unobserved bilateral trade cost
  - distance elasticity: $-\delta_t = \epsilon_t \rho_t$

Baseline regression (PPML)

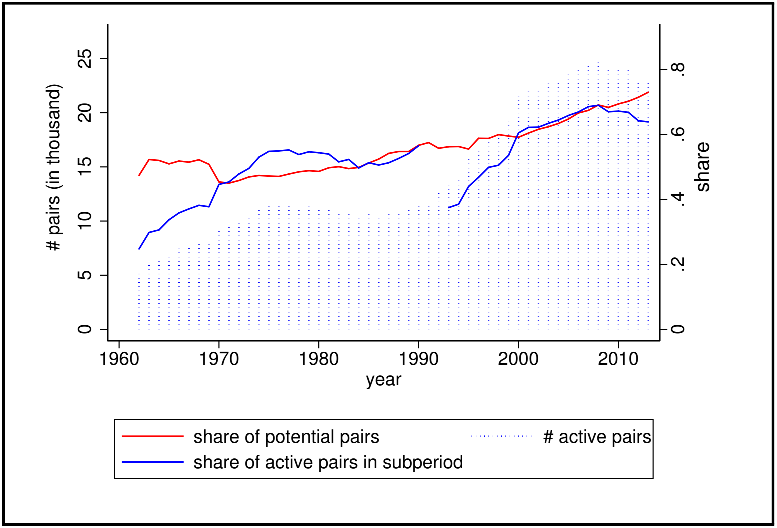


Decline of 4.5% : basically stable

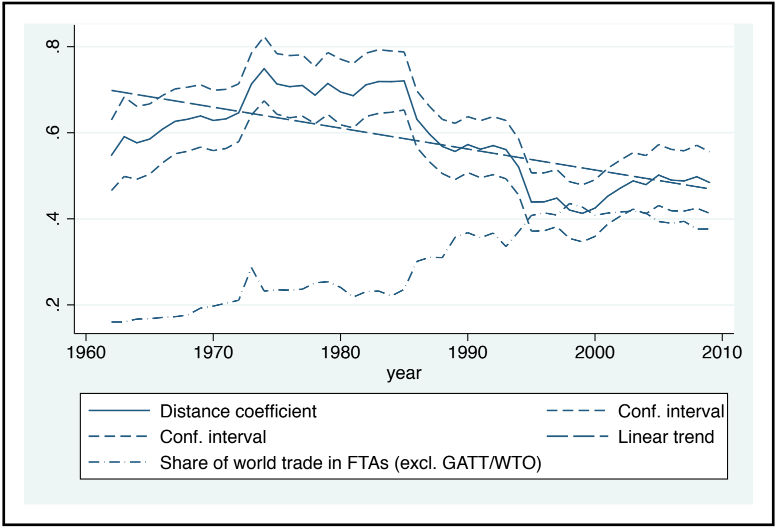
Sample composition effect

- We know the country sample potentially matters
  - Increasing number of new low volume long-distance relationship
  - Potentially increases the distance elasticity of trade (Mayer et al. (2019), Head & Mayer (2013))
  - Though it should be less of an issue with PPML
- There are big sample issues in the data
- Test: keep only trading pairs that have reciprocal non-zero trade every year from 1962 to 2009
  - It deepens the puzzle

Share of active pairs



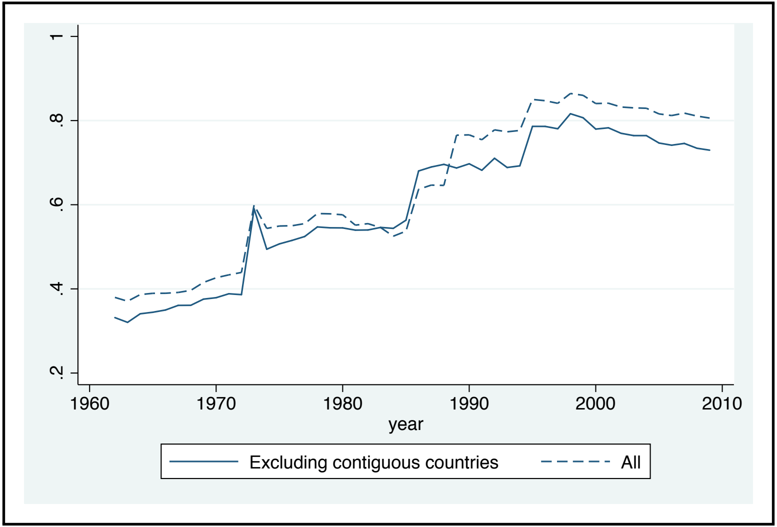
FTAs(1)



.2
.4
.6
.8
1960
1970
1980
1990
2000
2010
year
Distance coefficient
Conf. interval
Conf. interval
Linear trend
Share of world trade in FTAs (excl. GATT/WTO)

FTAs(2)

Figure: Share of intra-FTA trade among nearby countries (2000km or less)



Sector composition

- Test: suppose the composition of trade constant i.e. at 1962 shares for 4 digit goods
- It deepens the puzzle (increse in manuf share)

- FTAs
- Test: introduce FTA variables
- It ‘solves’ the puzzle
- But what does it mean ?
- Increasing number of proximity controls overtime
- Mechanically reduces the effect of distance

Summary (PPML)

	% change relatively to baseline	Total change 1962-2009
Baseline		1.07
Sample effect	7%	1.14
Composition effect	7%	1.14
FTA effect	-54%	0.49
Composition + sample	7%	1.14
Composition + FTA	-29%	0.75
Sample + FTA	-59%	0.44
Sample + Composition + FTA	-54%	0.49

Ingredients of the puzzle

- The distance coefficient is the elasticity of trade to distance
  - Trivial: the whole point of log-linear equations
  - Still the case in the Poisson specification
- It is a product of two coefficients:
  - Elasticity of trade flows to trade costs ζ
  - Elasticity of trade costs to distance ρ
- The 'death of distance' intuition is really about the elasticity of trade costs to distance
- Which should be going down
- But it does not tell much about the heterogeneity dimension, i.e. the trade elasticity ζ

Short incursion in microfoundations (1)

- The gravity equation can be justified by three families of theories:
- Ricardian framework
  Homogeneous goods
  Shop around the world for lowest cost supplier (intersectoral productivity heterogeneity)
- Heterogeneous firms framework:
  Trade because all firms produce different varieties
  A subset of firms enters export markets (intrasectoral productivity heterogeneity)
- Armington framework
  Trade because consumers value variety
  Country-specific goods (heterogeneity: degree of substitutability between bundles)

Short incursion in microfoundations (2)

- Ricardian framework:
  - Distance coefficient: $\rho\theta$
  - θ captures intersectoral productivity dispersion
  - if sectors have similar productivity
    $\rightarrow$ small differences in variable costs have a large effect on trade flows
    $\rightarrow$ high elasticity of trade to trade costs

- Monopolistic competition between heterogeneous firms:
  - Distance coefficient: $\rho\gamma$
  - γ captures productivity dispersion across firms (parameter of Pareto)
  - if distribution decays swiftly, higher probability that productivity cut-off for exporting is close to the mass of firms
    $\rightarrow$ small differences in variable costs have large effect on entry
    $\rightarrow$ high elasticity of trade to trade costs

Short incursion in microfoundations (3)

- Armington framework
  - Distance coefficent: $\rho(\sigma-1)$
  - σ captures degree of similarity between country-specific product bundles
  - if the set of goods produced by different countries is similar
    $\rightarrow$ high Armington elasticity
    $\rightarrow$ high elasticity of trade to trade costs

- In all cases: elasticity of trade flows to trade costs is inversely related to heterogeneity

Measuring the trade elasticity

- Features of our data: information on bilateral trade flows and unit values
- To measure efficiency heterogeneity: need information on domestic prices
  - intuition: country-specific cut-off for entry common to all exporters
  - price distribution in destination across all sources needed to estimate shape parameter of productivity distribution
- However we can measure substitutability across frameworks
  - use variation of market shares of country-level composite goods across export markets
  - construct relative prices of product bundles
  - estimate the aggregate Armington elasticity in cross section
- The estimated parameter is the trade elasticity in the Armington framework

Relative prices of product bundles

- Consistent aggregation procedure to get relative prices
  - CES preferences at inter- and intrasectoral level
  - Intra- and intersectoral elasticities assumed equal
  - Write sector-specific demand equation
  - Sum across all sectors
- Gives market share equation for aggregate bilateral trade as a function of the weighted average of sectoral relative prices of exporter in destination

$$\ln\left[\frac{X_{ij}}{Y_j}\right] \approx -(\sigma-1)\ln\left[\sum_{k=1}^{K}\omega_j(k)\frac{P_{ij}(k)}{P_j(k)}\right]$$

- Exponentiating gives equation estimated in Poisson:

$$X_{ij}/Y_j = \exp\left[\lambda_0-(\sigma-1)\ln\left(\sum_k \omega_k\frac{P_{ij}(k)}{P_j(k)}\right)+fe_i+fe_j\right]\eta_{ij}$$

Dealing with missing unit values

- Trade flow observed, but information on quantities missing
- On average, this is the case for 14% of total trade
- Use stepwise price imputation procedure
  - construct relative prices at highest disaggregation level
  - construct next level relative price as weighted average of observed relative prices
  - destination-specific weights at each step
  - repeat at each aggregation level
- assumption: missing unit values can be best approximated by observed prices for similar goods

Dealing with zero trade flows

- Under model assumptions some trade would be observed in every sector between each pair
- Zero trade flows prevalent: from 86-90% of possible observations at 4-digit level
- Assumption: statistical, not structural zeros linked to data collection thresholds
- Same stepwise procedure used for price imputation
- Corresponds to assumption that unobserved relative price equal to observed
- Problem: unobserved prices much higher than imputed prices

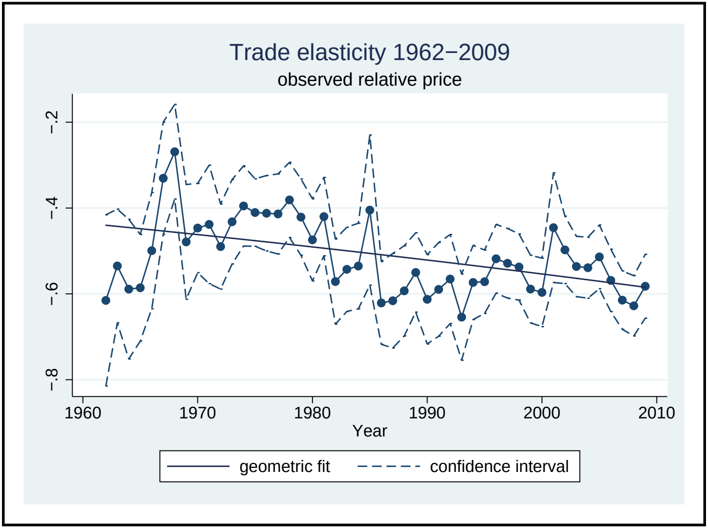
Proportion of zero trade flows as a function of market share

Share of ZTF		
ms	-0.0427***	-0.2573***
	(0.0001)	(0.013)
year	-0.0033***	-0.0024***
	(0.0000)	(0.000)
$ms * year$		0.0001***
		(0.000)
constant	6.0976***	4.2515***
	(0.0366)	(0.134)
Observations	657001	657001

Overestimation bias

- Underestimation factor not constant across exporters
  - share of ztf decreasing in market share
  - reduction in share of ztf proceeds at quicker pace for small exporters
- Relative price underestimated by more for small exporters
- For given distribution of market shares, true underlying distribution of prices is greater than observed distribution
- Estimated parameter overestimates the true substitutability parameter
- But less so overtime
- If estimated elasticity increases, this is a lower bound on true parameter evolution

Results



- 33% increase in parameter 1962-2009
- corresponds to annual increase of .6% per year

Changing the dataset: BACI

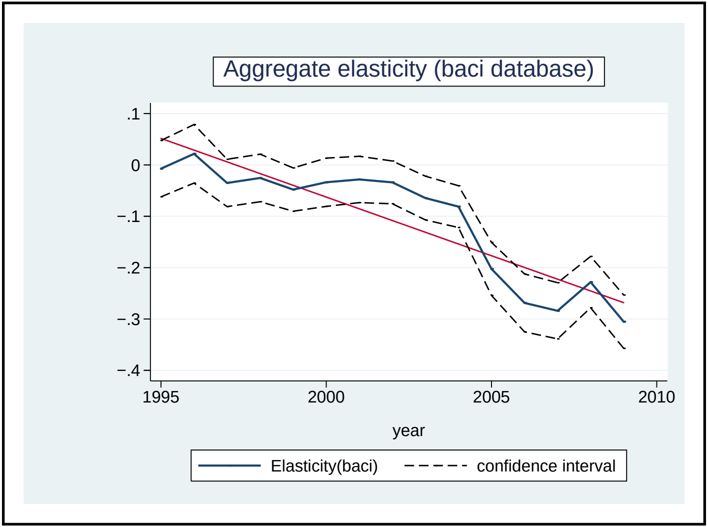


Figure: Estimated $(1-\widetilde{\sigma})$, BACI database

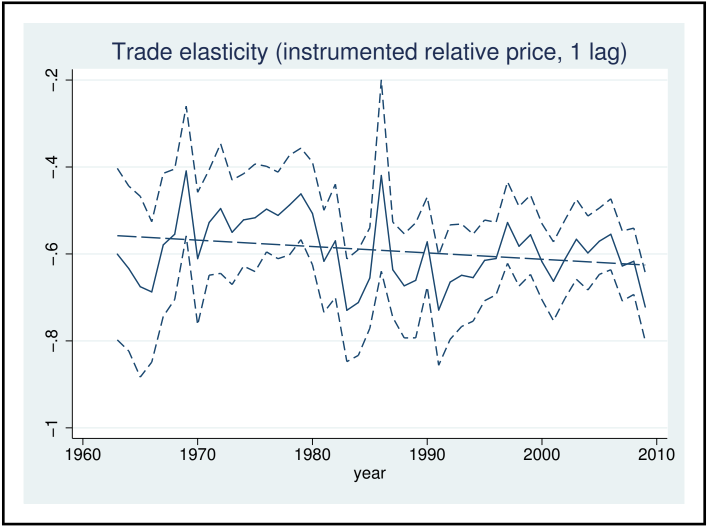
Instrumenting: motivation

- Results subject to caution?
  - attenuation bias (if supply schedules not horizontal)
  - matters not only for level, but for evolution (Feenstra(1994))
- Objective: capture exporter-specific shocks to the price of the composite good which are not demand-driven
- Indicator: GDP price level (Penn World Tables: 189 countries, 1950-2009)

Instrumenting: procedure

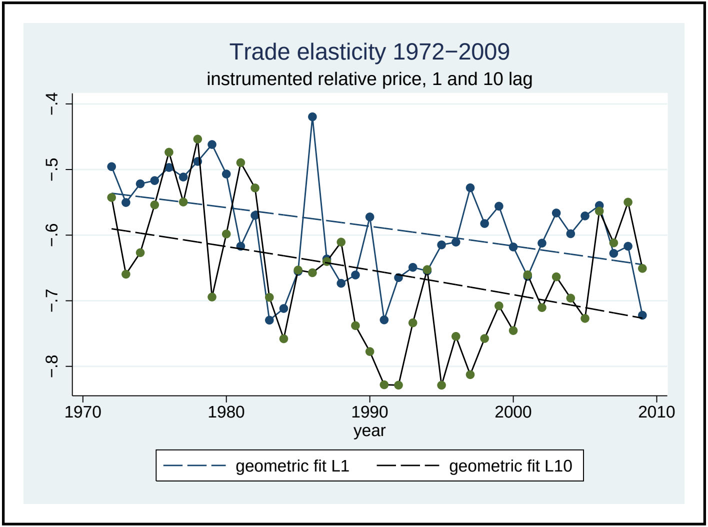
- compute relative prices for exporter-specific composite goods
- compute evolution of GDP price levels of trading partners, weighted by market shares (common currency)
- compute hypothetical relative price in t for each exporter as:
  - product of its relative price in $(t - s)$
  - evolution of its GDP price level between t and $(t - s)$ relatively to all other partners
- predict relative price of each exporter in t: regress observed relative price on hypothetical relative price.
- Idea: get an instrumented relative price which depends on past relative price and relative evolution of GDP price level.
- Estimate market share equation using instrumented relative prices

Instrumenting: one lag



- reassuring: level of parameter increases by 9%
- results on evolution hold: 13% increase

Increasing the number of lags



- level increases with number of lags: 22% for 10 lags
- results on evolution hold: 23% increase in 1972-2009

Is there a distance puzzle left?

- empirical evidence on 13% increase in substitutability parameter
- this is aggregate trade elasticity in Armington framework
- combining with 7% increase in distance elasticity
- provides a direct explanation of the distance puzzle
- economic interpretation of increased perceived substitutability of product bundles?
  - increasing similarity in set of traded goods across countries
  - composition effects (changes in range or shares of traded goods)
- Not done: separate out net effect of increased perceived similarity
- Not feasible? parameter estimated on aggregate data is not a weighted average of sectoral parameters