

# Heterogeneity and the Distance Puzzle

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# Introduction

- ▶ Is the world getting smaller?
  - ▶ seems obvious to many observers of globalization ("Death of distance")
  - ▶ but conflicting evidence in gravity equations: trade has become more sensitive to distance since 1960s: Disdier & Head, (2008), Head & Mayer (2013)...
- ▶ What explains this 'distance puzzle'?
  - ▶ estimation strategy
  - ▶ composition effect
- ▶ Not a puzzle, but a finding?
  - ▶ relative growth in short vs. long-distance trade
  - ▶ evolution of distance-related trade costs
    1. transport costs relatively to price of traded goods
    2. growing importance of certain trade cost components

# Motivation

- ▶ The contribution:
  - ▶ take microfoundations of the gravity equation seriously
  - ▶ to provide a direct explanation of the increasing distance elasticity of trade over long time period
- ▶ The trick?
  - ▶ distance coefficient is a product of two elasticities:
    1. elasticity of trade to trade costs ('heterogeneity')
    2. elasticity of trade costs to distance ('pop debate')
  - ▶ focus on the parameter capturing heterogeneity
  - ▶ to refine understanding of how the world is shrinking
- ▶ The message?
  - ▶ Not only... reduction in trade cost elasticity to distance
  - ▶ But also... increasing similarity of countries in a model-specific dimension

# Summary of results

- ▶ Robustness of distance puzzle in 1962-2009: increase in distance coefficient
  - ▶ 7% controlling for estimation strategy
  - ▶ 14% controlling for composition and sample effects
- ▶ Evolution of heterogeneity parameter:
  - ▶ 13% increase in 1963-2009 (19% in 1970-2009)
  - ▶ this estimate is likely to be a lower bound
- ▶ Elasticity of trade costs to distance has not increased
  - ▶ 5-7% decrease in 1963-2009
  - ▶ 17% decrease in 1970-2009
- ▶ 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

- 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

# Estimation procedure (1)

- ▶ Microfounded gravity equation:

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

- ▶ heterogeneity parameter:  $\zeta_t$ :  $\sigma_t - 1$  in Armington
- ▶ Trade costs:
  - ▶ time-invariant cost controls (adjacency,...):  $Z_1$
  - ▶ time-varying cost controls (policy: FTAs,...):  $Z_2$

$$\tau_{ij,t} = \exp \{ \rho_t \ln \text{dist}_{ij} + Z_1' \beta_{1,t} + Z_2' \beta_{2,t} \}$$

- ▶  $\rho_t$  is the 'world shrinkage' parameter  
i.e. elasticity of trade costs to distance

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## Estimation procedure (2)

- ▶ COMTRADE data, 4-digit level (SITC), 1962-2009
- ▶ run gravity equations (obviously)
- ▶ cross section, no panel
- ▶ focus on evolution of distance elasticity overtime
- ▶ using the PPML estimator (consistency & efficiency)
- ▶ Estimated equation:

$$X_{ij,t} = \exp \left( cons_t - \alpha_t \ln dist_{ij} + Z_1' \beta_{1,t} + Z_2' \beta_{2,t} + fe_{i,t} + fe_{j,t} \right) \epsilon_{ij,t}$$

- ▶ distance elasticity:  $\alpha_t = \zeta_t \rho_t$
- ▶ Baseline: trade policy controls excluded (FTAs)

## Baseline regression (PPML)





# Robustness of puzzle

- ▶ Sample
  - ▶ Test: keep only trading pairs that have reciprocal non-zero trade every year from 1962 to 2009
  - ▶ It deepens the puzzle
- ▶ Composition
  - ▶ Test: suppose the composition of trade constant i.e. at 1962 shares for 4 digit goods
  - ▶ It deepens the puzzle (increase 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

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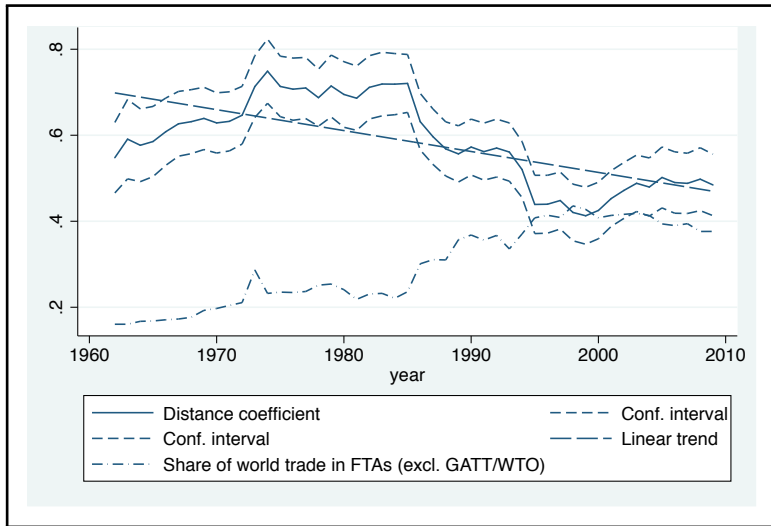
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# Composition

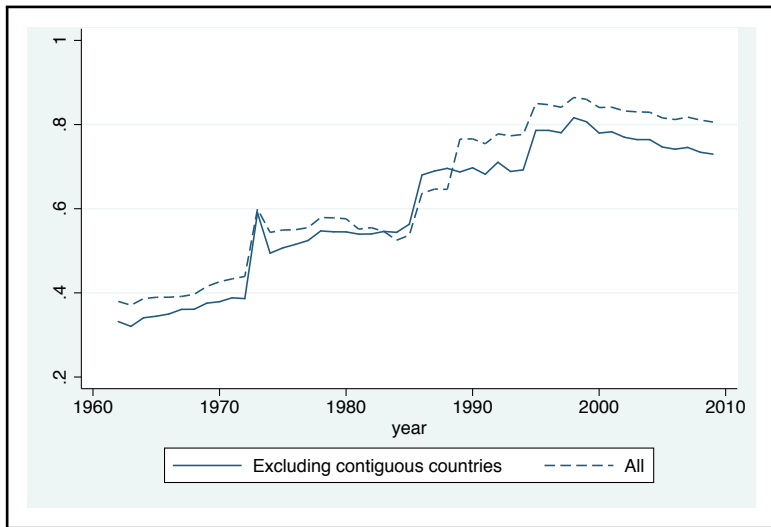


# FTAs(1)



## FTAs(2)

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



## Summary (PPML)

	<b>% change relatively to baseline</b>	<b>Total change 1962-2009</b>
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  $\zeta$
  - ▶ Elasticity of trade costs to distance  $\rho$
- ▶ 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  $\zeta$

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## 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:  $\rho\theta$
- ▶  $\theta$  captures intersectoral productivity dispersion
- ▶ if sectors have similar productivity
  - small differences in variable costs have a large effect on trade flows
  - high elasticity of trade to trade costs

- ▶ Monopolistic competition between heterogeneous firms:

- ▶ Distance coefficient:  $\rho\gamma$
- ▶  $\gamma$  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
  - small differences in variable costs have large effect on entry
  - high elasticity of trade to trade costs



## Short incursion in microfoundations (3)

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

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## 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

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## 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

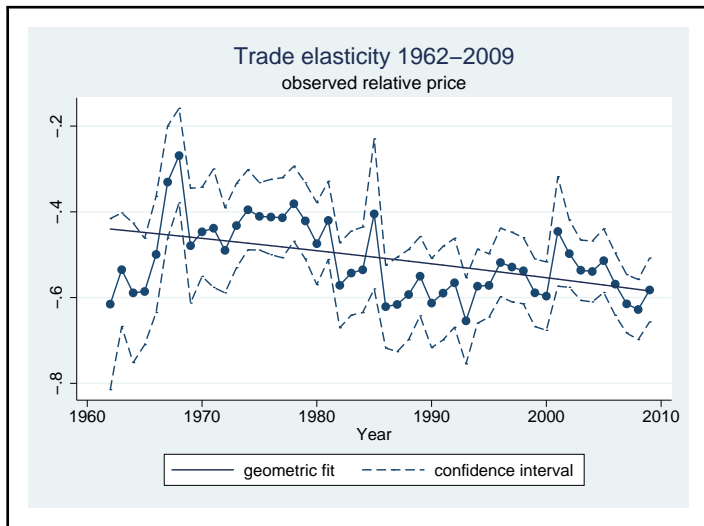
## Proportion of zero trade flows as a function of market share

Share of ZTF		
ms	-0.0427*** (0.0001)	-0.2573*** (0.013)
year	-0.0033*** (0.0000)	-0.0024*** (0.000)
<i>ms * year</i>		0.0001*** (0.000)
constant	6.0976*** (0.0366)	4.2515*** (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

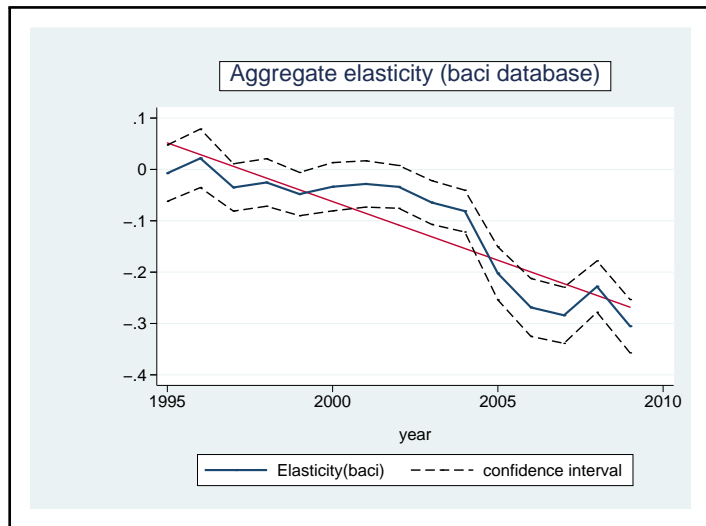


Figure: Estimated  $(1 - \tilde{\sigma})$ , BACI database

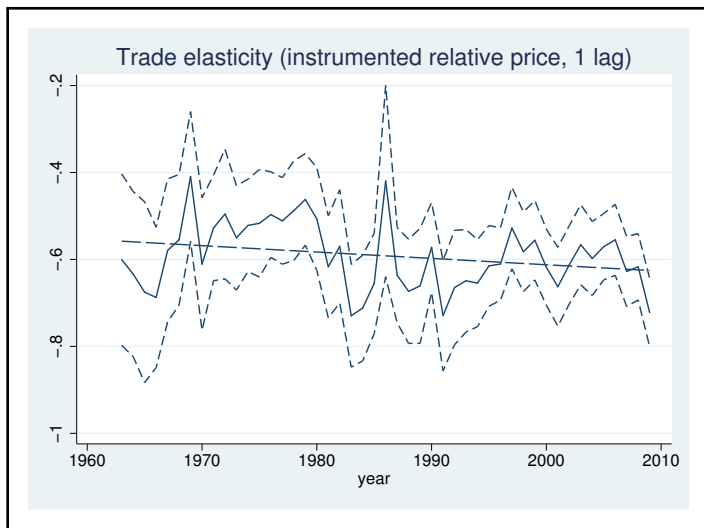
# Instrumenting: motivation

- ▶ 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

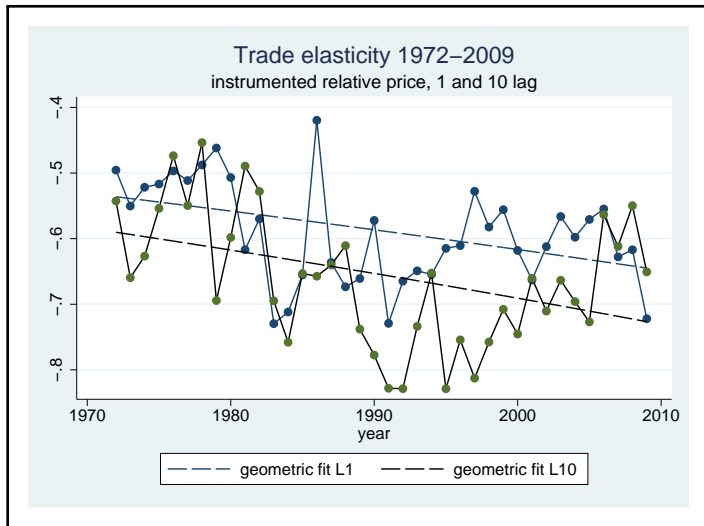
- ▶ compute relative prices for exporter-specific composite goods
- ▶ compute evolution of GDP price levels of trading partners, weighted by market shares (common currency)
- ▶ compute hypothetical relative price in  $t$  for each exporter as:
  - ▶ product of its relative price in  $(t - s)$
  - ▶ evolution 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

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