# Heterogeneity and the Distance Puzzle

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# Introduction

- Is the world getting smaller?
  - seems obvious to most observers of globalization
  - but conflicting evidence in gravity equations:
  - trade more sensitive to distance since 1960s
- 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,...): $Z_2$

$$\tau_{ij,t} = exp\left\{\rho_t \ln dist_{ij} + Z_1{}'\beta_{1,t} + Z_{2,t}{}'\beta_{2,t}\right\}$$

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

# 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:

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

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

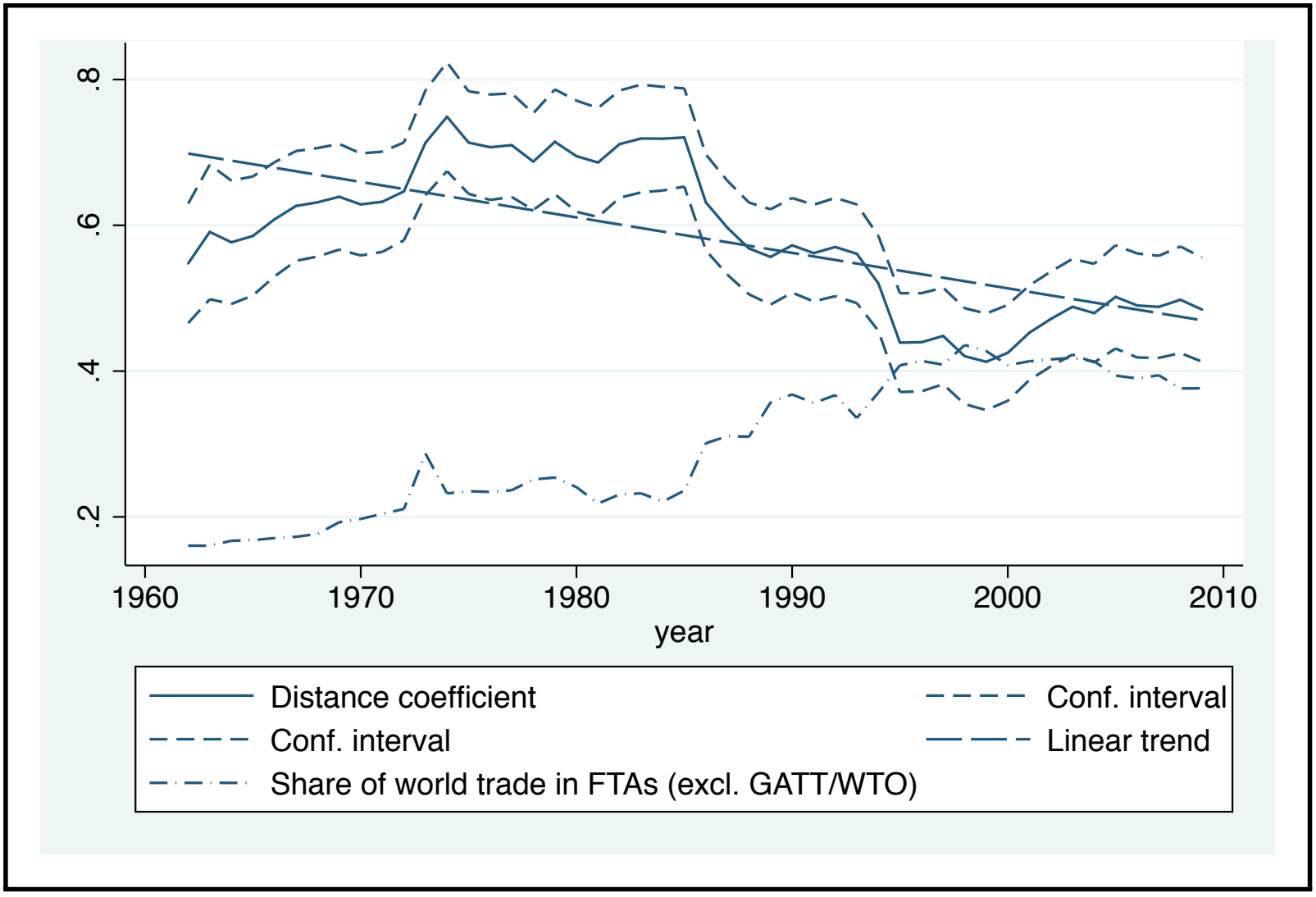
# Baseline regression (PPML)

# 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 (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

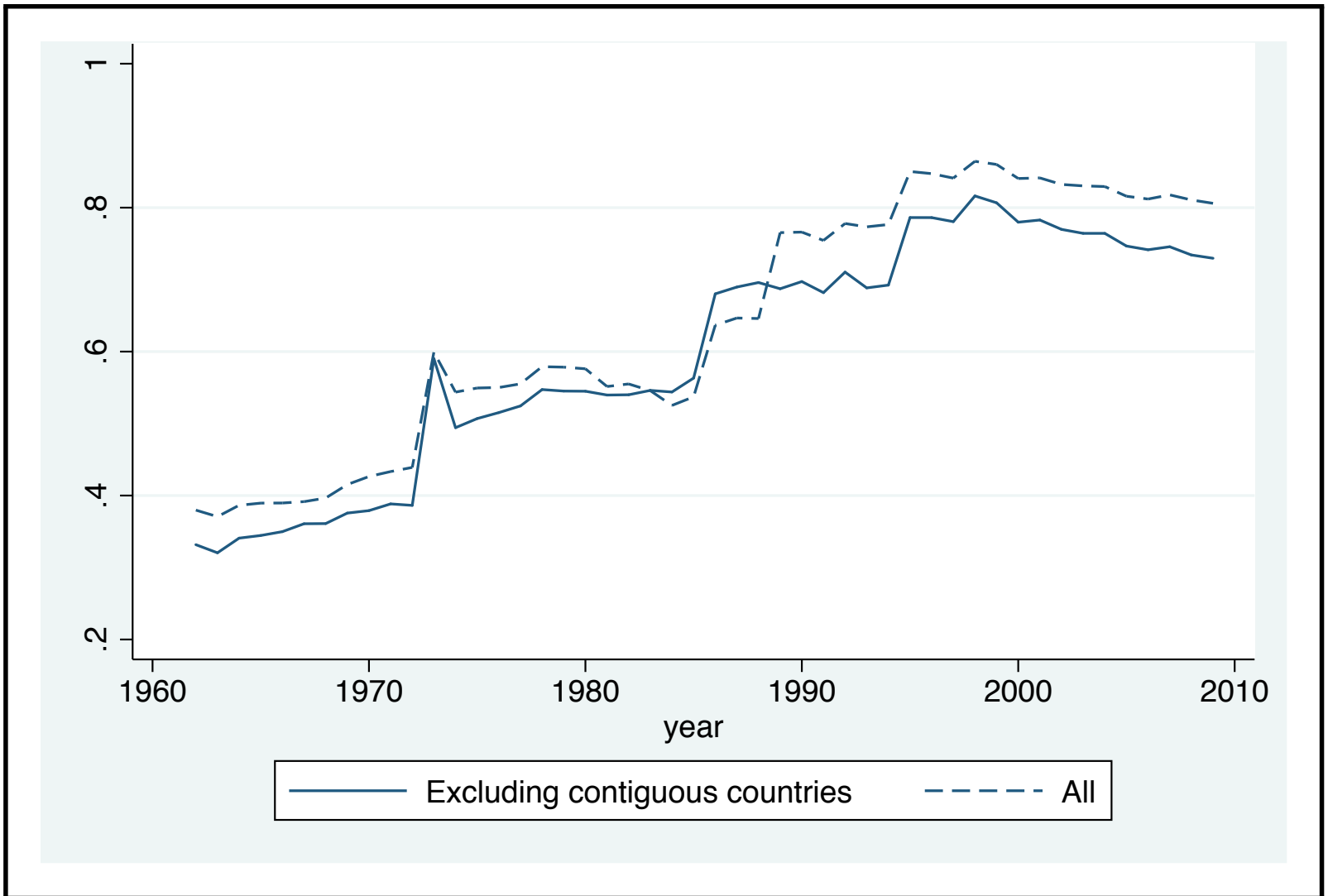
# Composition

# FTAs(1)


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

# FTAs(2)

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



# 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 $\zeta$
  - 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 $\zeta$

# 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
    $\rightarrow$ 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: $\rho\gamma$
  - $\gamma$ 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
    $\rightarrow$ 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: $\rho(\sigma - 1)$
  - $\sigma$ 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

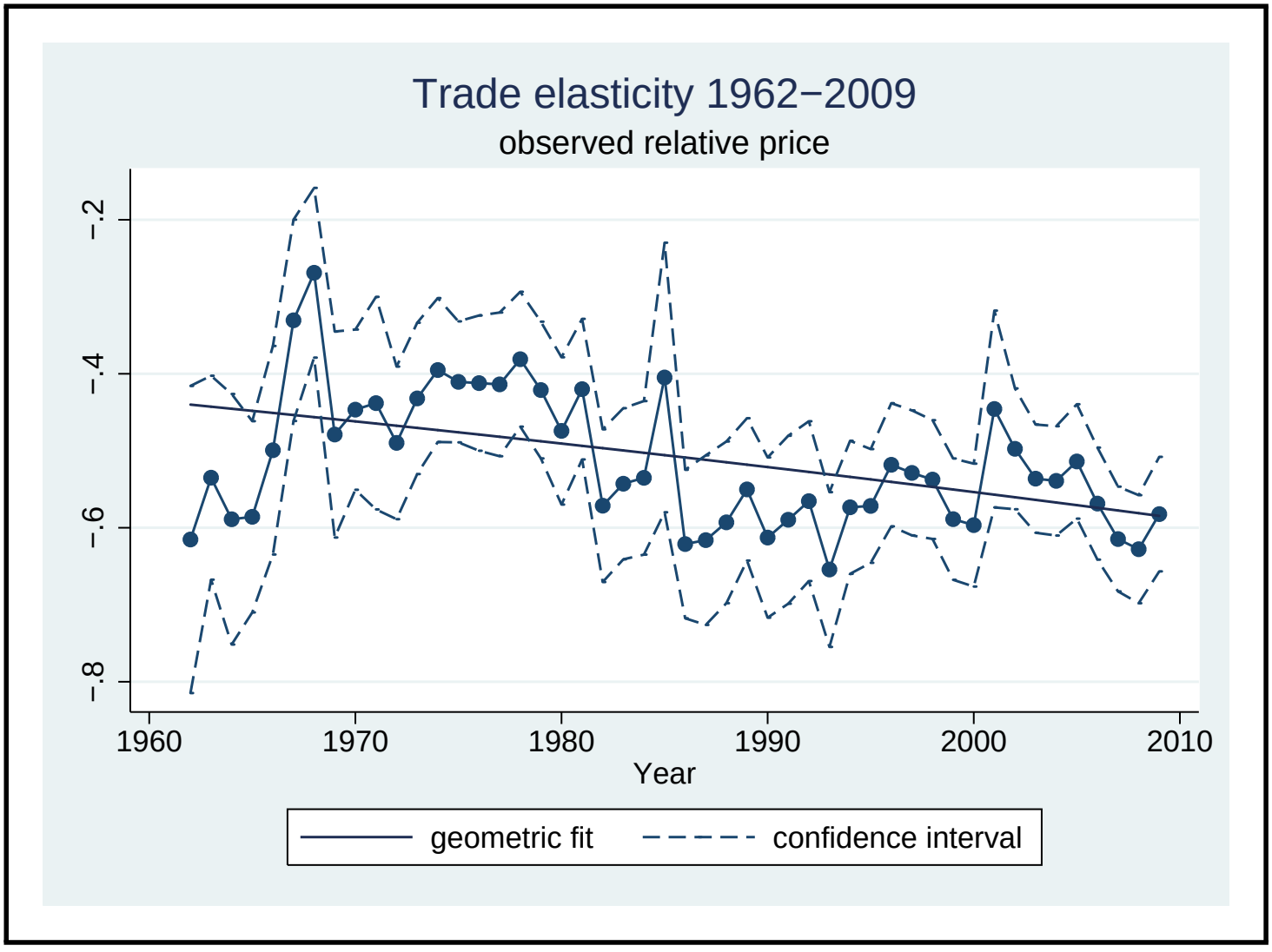
# Proportion of zero trade flows as a function of market share

| 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

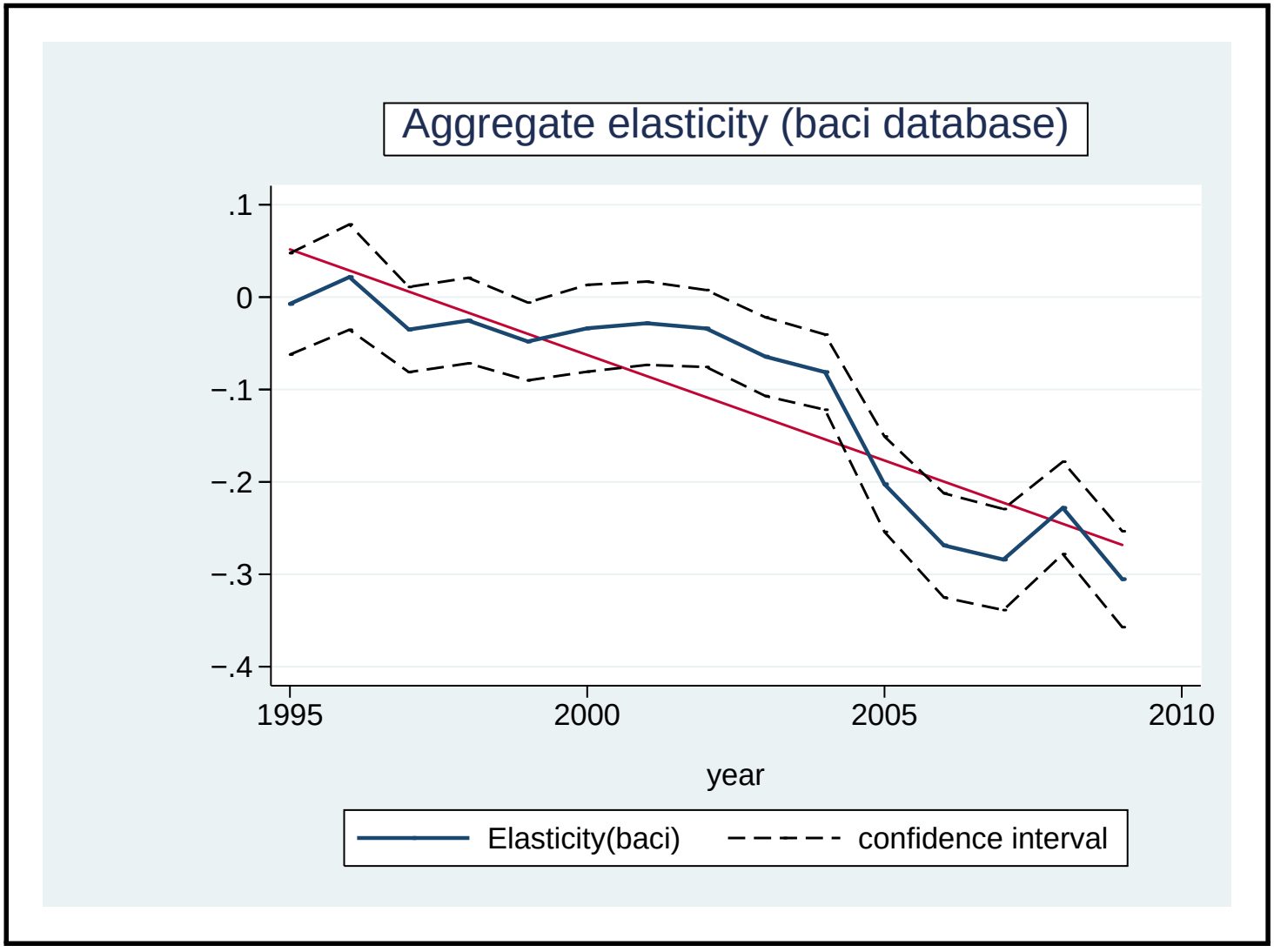



Figure: Estimated $(1 - \widetilde{\sigma})$, BACI database

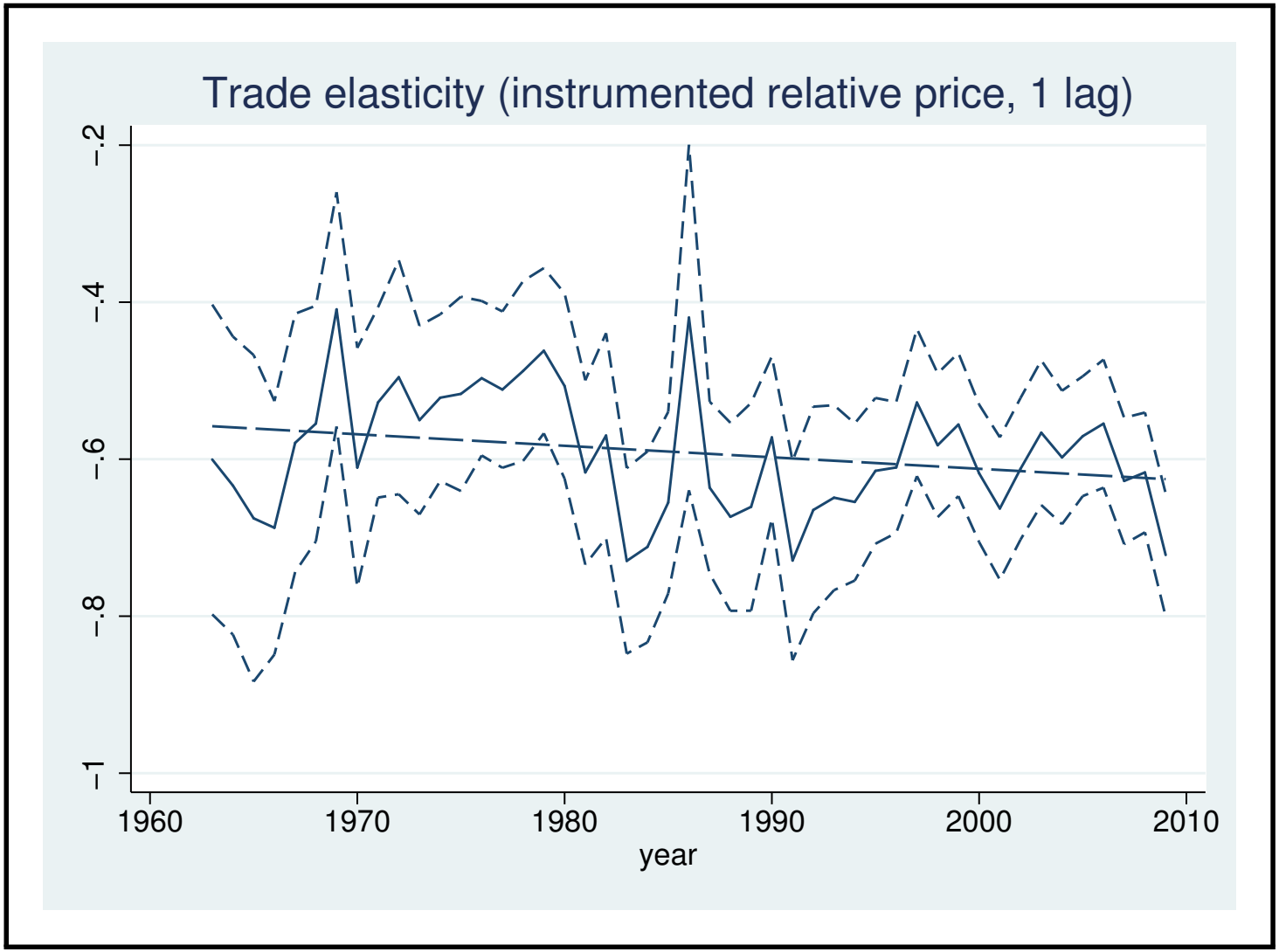
# Instrumenting: motivation

- 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

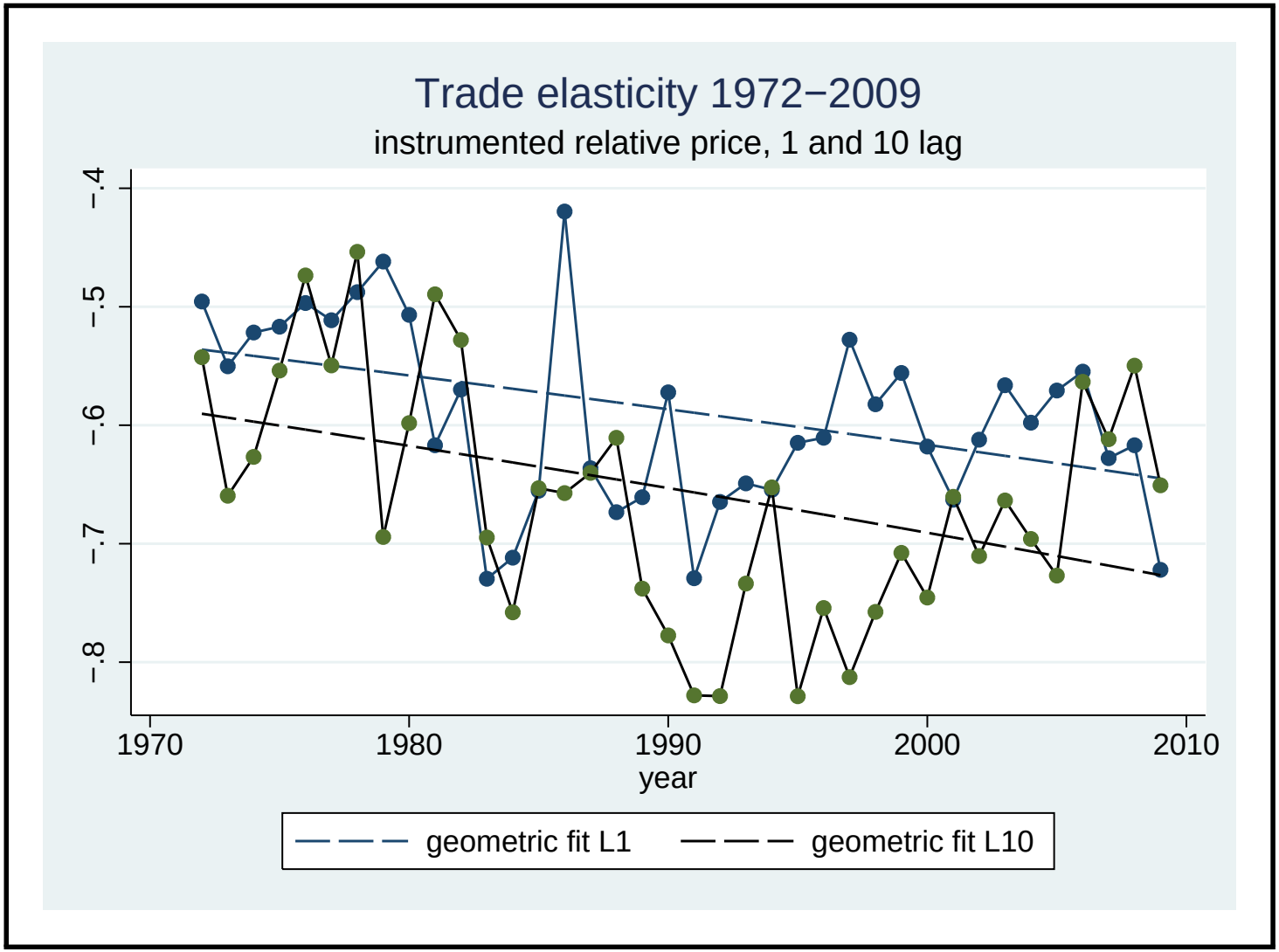
- compute relative prices for exporter-specific composite goods
- compute evolution of GDP price levels of trading partners, weighted by market shares (common currency)
- compute hypothetical relative price in $t$ for each exporter as:
  - product of its relative price in $(t - s)$
  - evolution of its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