Gravity, Trade Integration and Heterogeneity across Industries

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Motivations

- Trade costs are a key feature in today's trade literature

- Trade costs matter from a **welfare** point of view

- But *"direct measures are remarkably sparse and inaccurate"* (Anderson and van Wincoop, 2004)

- Indirectly infer the average level of trade impediments from trade flows
  - Trade to output ratios (Harrigan, 1996)
  - "Border effects" (eg McCallum, 1996)
  - (Inverse) "*phi*-ness" of trade (eg Head and Mayer, 2004)

This Paper

Belongs to the research effort attempting to indirectly infer trade barriers from trade flows

Theory

- Micro-founded **measure of bilateral trade integration at the industry level** with heterogeneous trade costs/substitution elasticities
- Consistent with leading trade theories: Anderson and van Wincoop (2003), Eaton and Kortum (2002), Chaney (2008), Melitz and Ottaviano (2008)

Empirics

- Data: 164 manufacturing industries (4-digit), 11 EU countries, 1999-2003
  - What is the height and ranking of trade frictions across industries?
  - What are the determinants of bilateral trade integration?
  - How does our trade integration measure compare to alternative measures?

A Model with Industry-Specific Trade Costs

- Trade flows x_{ij}^k depend on both bilateral t_{ij}^k and multilateral barriers $\Pi_i^k P_j^k$, $\sigma_k > 1$ (Anderson and van Wincoop, 2003, 2004)

$$x_{ij}^k = \frac{y_i^k x_j^k}{y^k} \left(\frac{t_{ij}^k}{\Pi_i^k P_j^k} \right)^{1-\sigma_k} \tag{1}$$

- Multilateral barriers $\Pi_i^k P_j^k$ related to domestic trade flows (Novy, 2008)

$$x_{ii}^k = \frac{y_i^k x_i^k}{y^k} \left(\frac{t_{ii}^k}{\Pi_i^k P_i^k} \right)^{1-\sigma_k} \tag{2}$$

- Interested in **bilateral** trade integration, so combine x_{ij}^k and x_{ji}^k from (1)

$$x_{ij}^k x_{ji}^k = \frac{y_i^k y_j^k x_i^k x_j^k}{y^k y^k} \left(\frac{t_{ij}^k t_{ji}^k}{\Pi_i^k P_i^k \Pi_j^k P_j^k} \right)^{1-\sigma_k} \tag{3}$$

- Get the *average* bilateral trade barrier

$$\theta_{ij}^k \equiv \left(\frac{t_{ij}^k t_{ji}^k}{t_{ii}^k t_{jj}^k}\right)^{\frac{1}{2}} = \left(\frac{x_{ii}^k x_{jj}^k}{x_{ij}^k x_{ji}^k}\right)^{\frac{1}{2(\sigma_k - 1)}} \tag{4}$$

- We do not assume trade cost symmetry ($t_{ij}^k \neq t_{ji}^k$ in general)

- We do not normalize domestic trade costs to zero ($t_{ii}^k, t_{jj}^k \geq 1$ in general)

θ_{ij}^k has a natural interpretation as a measure of trade frictions

- In a frictionless world $t_{ij}^k = t_{ji}^k = t_{ii}^k = t_{jj}^k = 1$ and hence $\theta_{ij}^k = 1$

- In a closed economy $x_{ij}^k x_{ji}^k \longrightarrow 0$ and $\theta_{ij}^k \longrightarrow \infty$

- Unaffected by multilateral resistance; role for **heterogeneity** σ_k

Other Trade Models

- A "similar" measure for θ_{ij} can be derived from Eaton and Kortum (2002), Chaney (2008), Melitz and Ottaviano (2008)

- All θ_{ij}'s scale the ratio of domestic over bilateral trade flows by parameters that indicate a particular form of **heterogeneity**
  - A low σ indicates a strong differentiation across products (Armington)
  - A low ζ indicates a high variation in productivity across goods (Ricardian)
  - A low γ indicates a high degree of firm heterogeneity

- With higher heterogeneity countries produce goods that are more different from each other or reflect larger differences in comparative advantage. Thus, consumers have a larger incentive to trade. Given a trade ratio, higher heterogeneity implies higher trade frictions

Data

- 164 manufacturing industries, 4-digit, 11 EU countries, 1999-2003 (Eurostat)
- 15,160 observations in total (3,032 per year), only 3 zeros
- Construct x_{ii}^k as in Wei (1996)
- Elasticities of substitution σ_k
  - Product level data, 11 countries, 46 exporters, 1999-2003, $n = 4,272,279$
  - IV (Imbs and Méjean, 2009, Feenstra, 1994, Broda and Weinstein, 2006)
  - Grid search algorithm when IV estimates not consistent

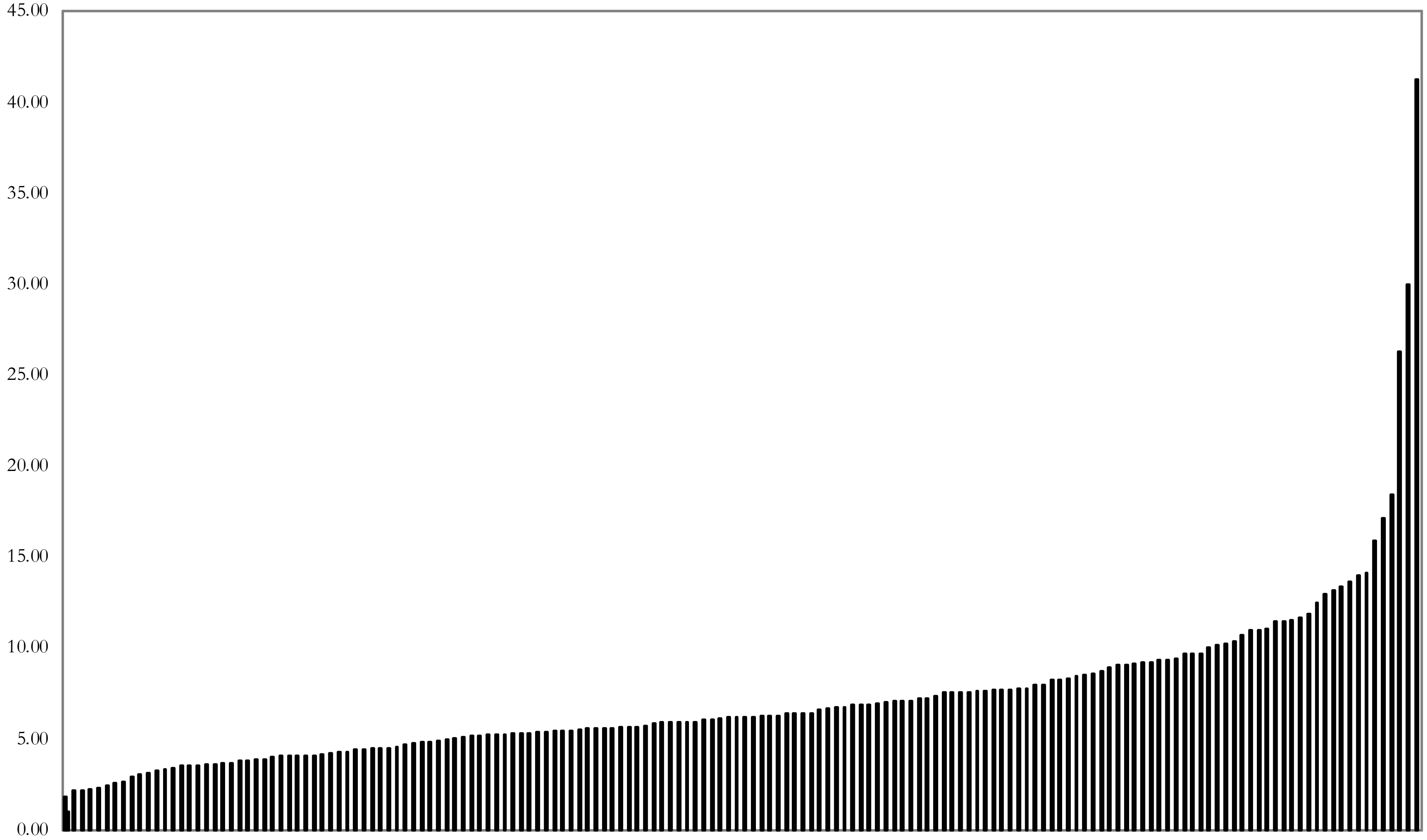

Figure 1: Elasticities of substitution σ_k across industries ordered by increasing magnitude

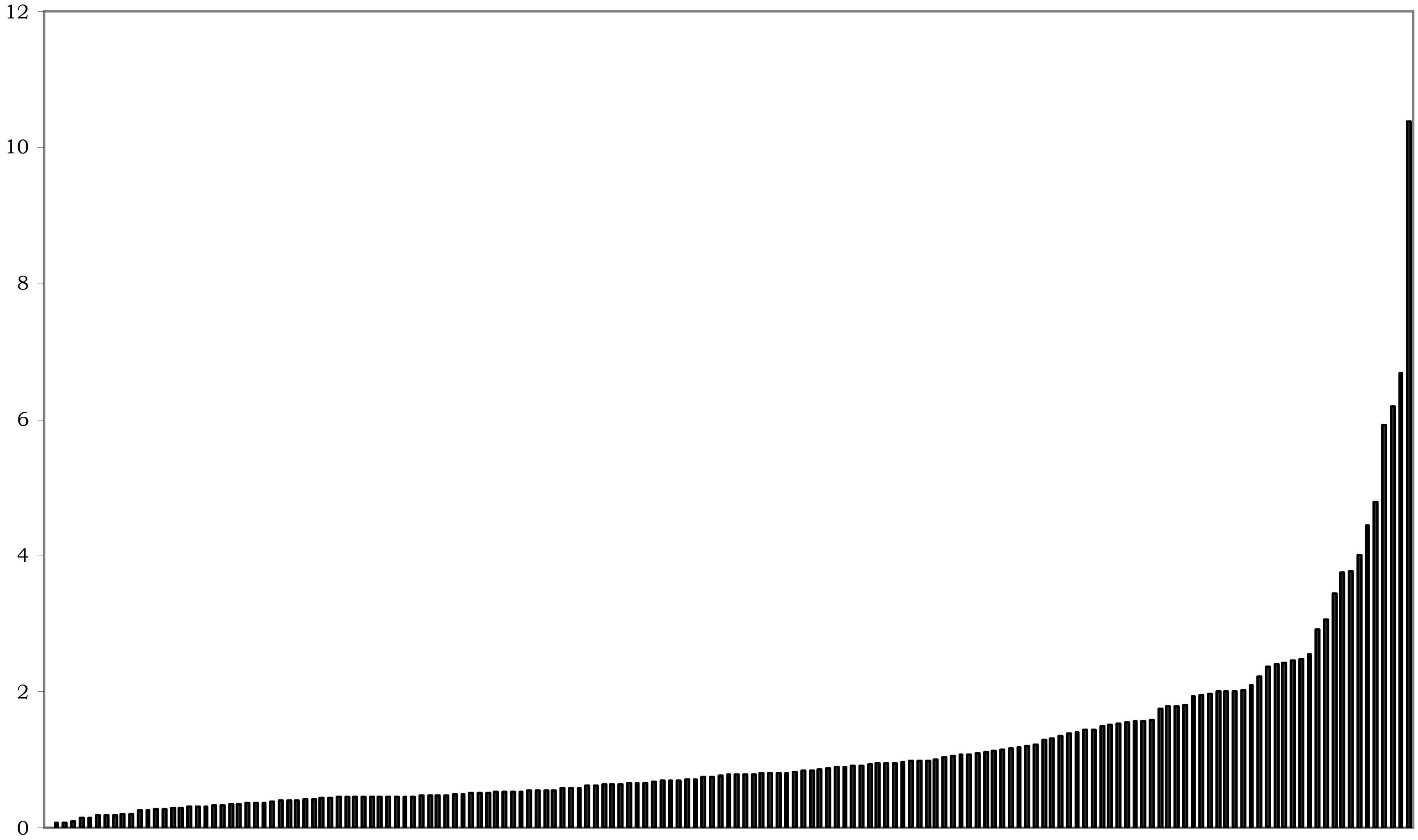

Figure 2: (Log) Average trade frictions θ^k across industries ordered by increasing magnitude

Table 1: Descriptive Statistics for Individual Industries (summary)

4-digit Nace rev.1 Industry	ln θ^k
Bricks (2640)	10.383
Plaster (2653)	6.683
Plate-making (2224)	6.183
...	
Boilers (2822)	4.007
Bread, fresh pastry goods, cakes (1581)	3.772
Cement (2651)	3.760
Publishing of newspapers (2212)	3.450
...	
Games, toys (3650)	0.151
Machinery for textile production (2954)	0.102
Office machinery (3001)	0.085
Other special purpose machinery (2956)	0.075

The Determinants of Trade Integration

- **Geography/Transport Costs**
  Integration decreases with bilateral distance, with industry-specific transportation costs (cif/fob, weight-to-value), and is higher for adjacent countries that speak a common language

- **Policy variables**
  - Integration is lower for Finland-Austria and is higher for countries that implemented Schengen; no effect on non-EMU countries (since 2002)
  - Integration decreases with TBTs and low transparency in public procurement

- **Other costs**
  Integration increases with productivity

- **Measurement**
  Controls for intra-industry trade and sectoral aggregation

Comparison to Alternative Measures

1. $\widetilde{\theta}_{ij}^{k}$ computed using the elasticities from Hummels (2001a)

2. (Inverse) *phi*-ness of trade $\phi_{ij}^{k} = \left(\frac{x_{ii}^{k} x_{jj}^{k}}{x_{ij}^{k} x_{ji}^{k}}\right)$, assuming $\sigma_k = \sigma = 1.5$

3. Standard gravity equation explaining $\ln\left(x_{ij}^{k} x_{ji}^{k}\right)$

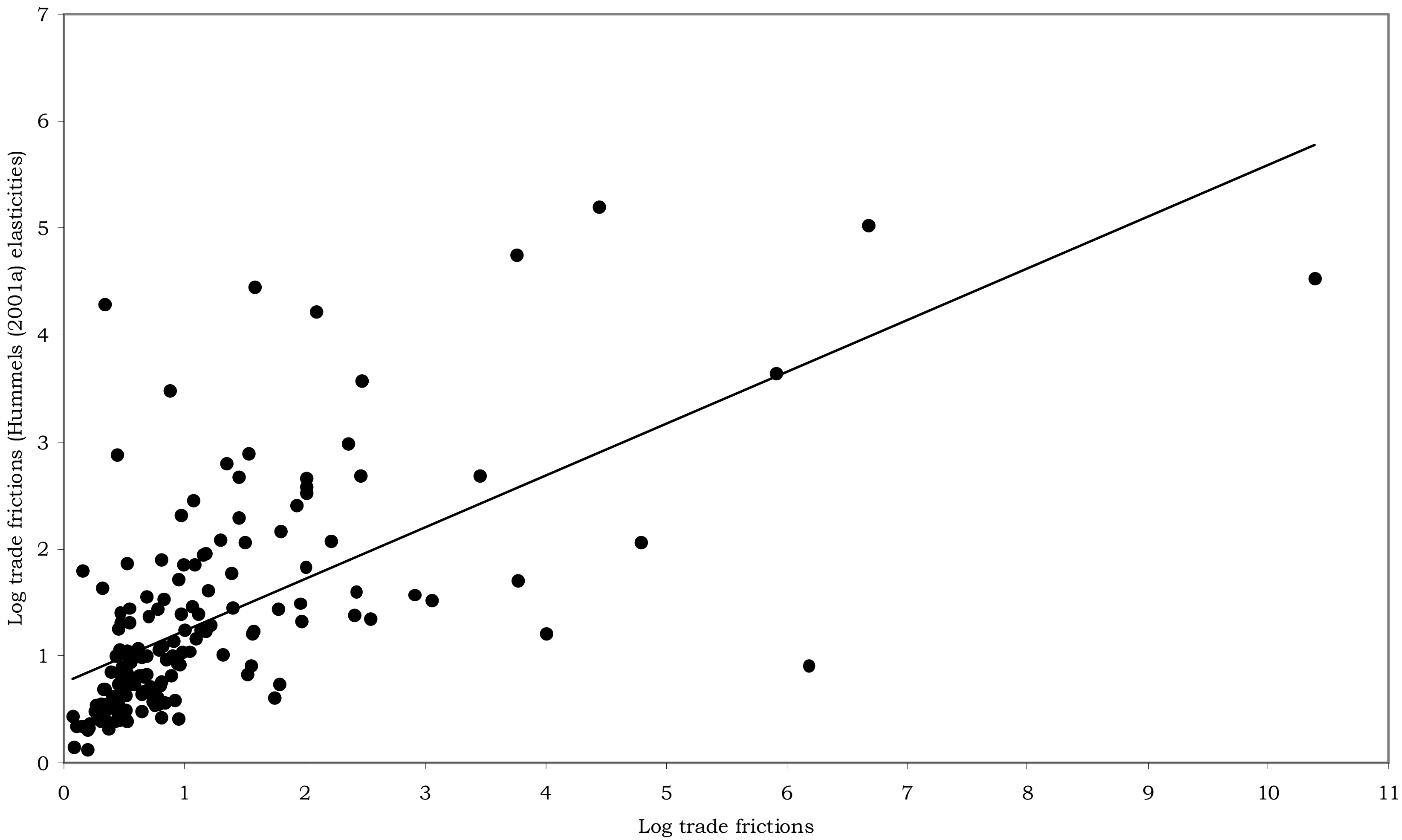

Figure 3: (Log) Average trade frictions $\widetilde{\theta}^k$ computed with the elasticities from Hummels (2001a) versus (log) average trade frictions θ^k across industries

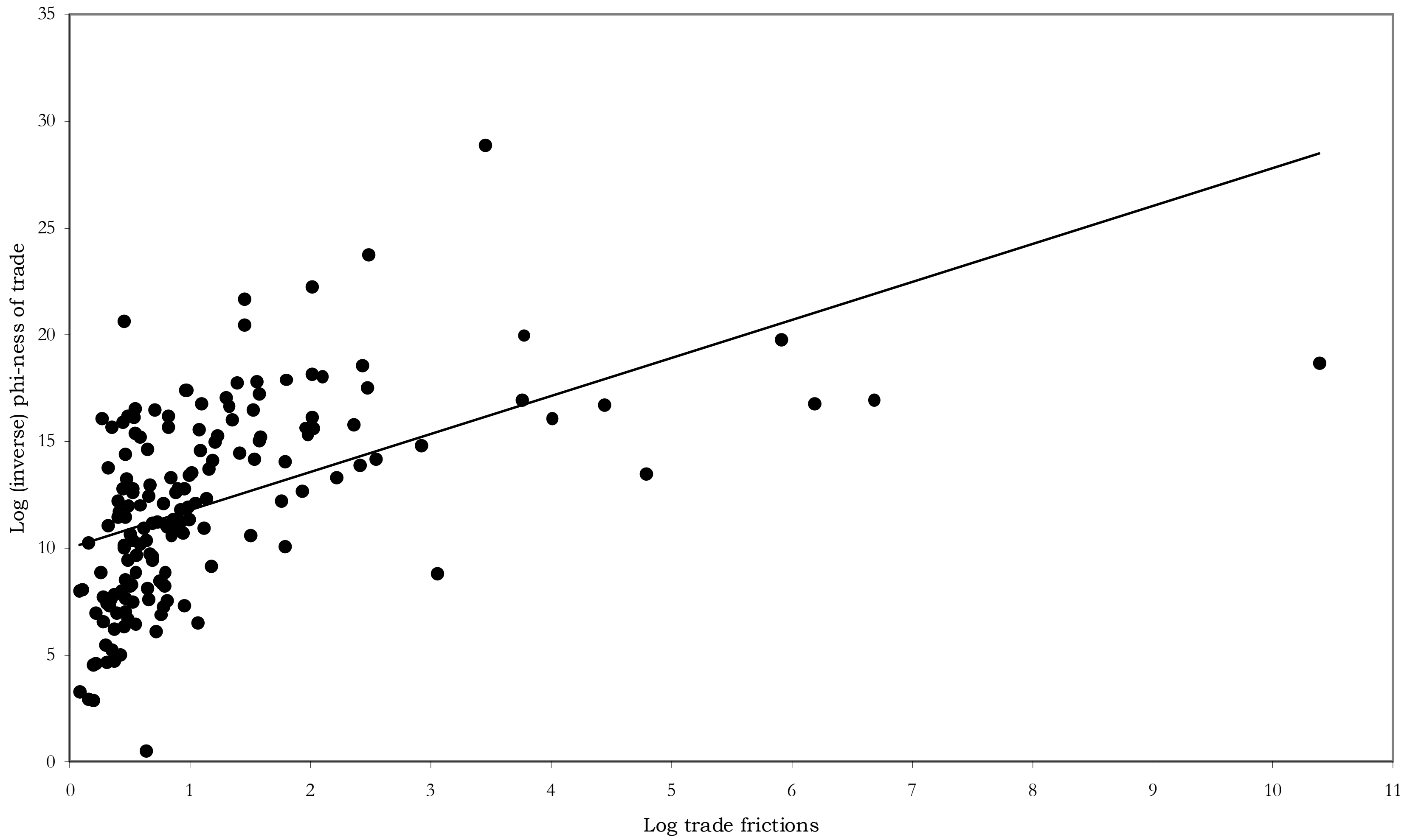

Figure 4: (Log) average inverse phi-ness of trade ϕ^k versus (log) average trade frictions θ^k across industries

Comparison to Alternative Measures (cont)

- The use of alternative dependent variables yields **regression results that are highly similar** (with a few exceptions)

- However, **policy implications are different** (using variance decompositions)
  - θ_{ij}^{k} and $\widetilde{\theta}_{ij}^{k}$ (control for heterogeneity): TBTs, then distance
  - *Phi*-ness ϕ_{ij}^{k}, gravity (ignore heterogeneity): distance only

How Our Approach Differs from Standard Gravity

- **Micro-founded Gravity**. Assuming $\ln\left(t_{ij}^{k} t_{ji}^{k}\right) = \widetilde{\beta}_k \ln D_{ij}$,

$$\ln\left(x_{ij}^{k} x_{ji}^{k}\right) = \alpha \ln\left(y_i^k y_j^k\right) + \underbrace{\widetilde{\beta}_k (1 - \sigma_k)}_{\kappa_k} \ln D_{ij} + \gamma_i^k + \gamma_j^k + \epsilon_{ij}^k$$

- **Trade frictions**

$$\ln\left(\theta_{ij}^{k}\right) = \ln\left(\frac{t_{ij}^{k} t_{ji}^{k}}{t_{ii}^{k} t_{jj}^{k}}\right)^{\frac{1}{2}} = \ln\left(\frac{x_{ii}^{k} x_{jj}^{k}}{x_{ij}^{k} x_{ji}^{k}}\right)^{\frac{1}{2(\sigma_k - 1)}} = \widehat{\beta}_k \ln D_{ij} + \psi_t + \lambda_k + \varepsilon_{ij}^k$$

- Compare $\widehat{\beta}_k$ to κ_k, then $\widehat{\beta}_k$ to $\widetilde{\beta}_k = \kappa_k / (1 - \sigma_k)$

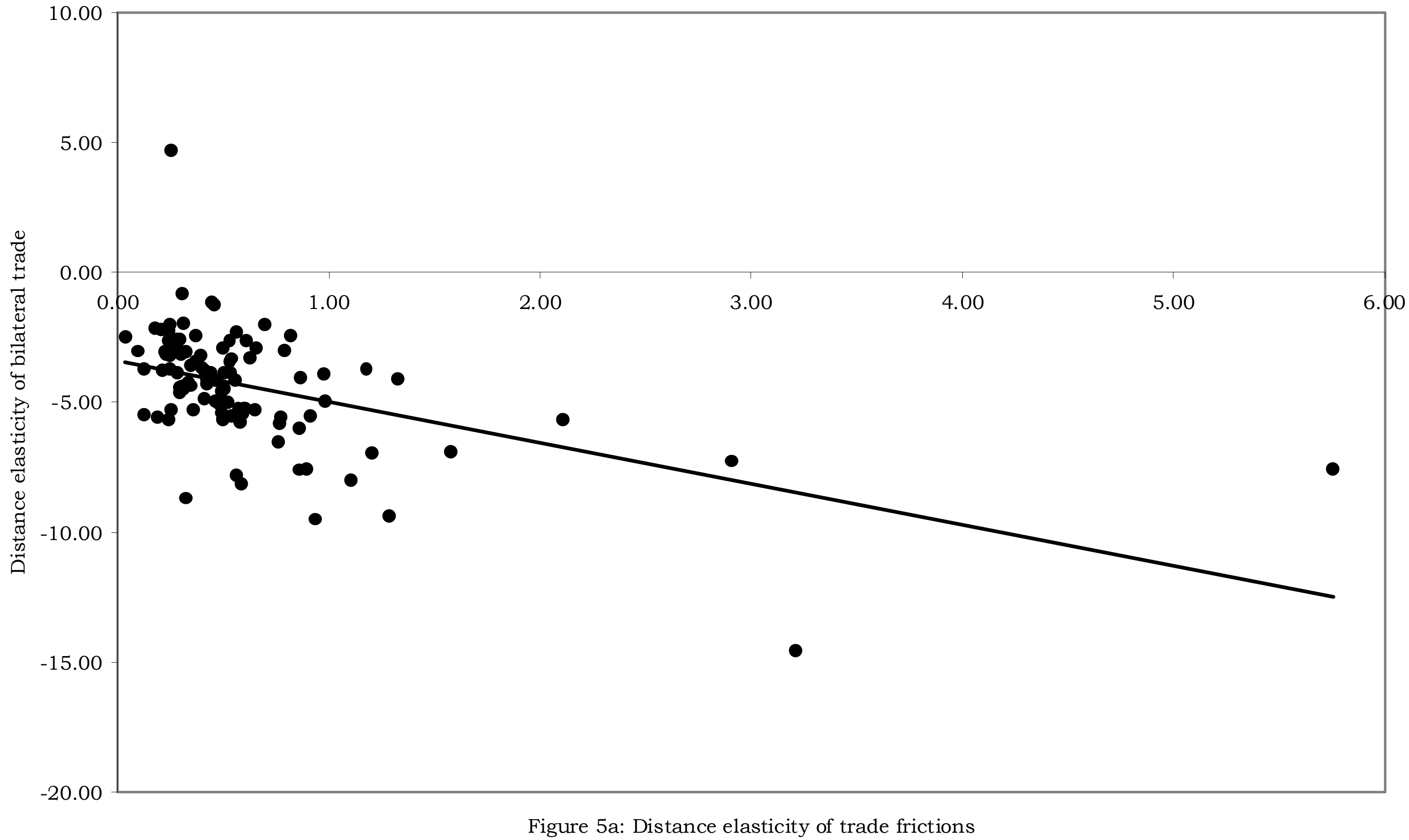

Figure 5a: Distance elasticity of bilateral trade κ_k vs the distance elasticity of trade frictions $\widehat{\beta}_k$

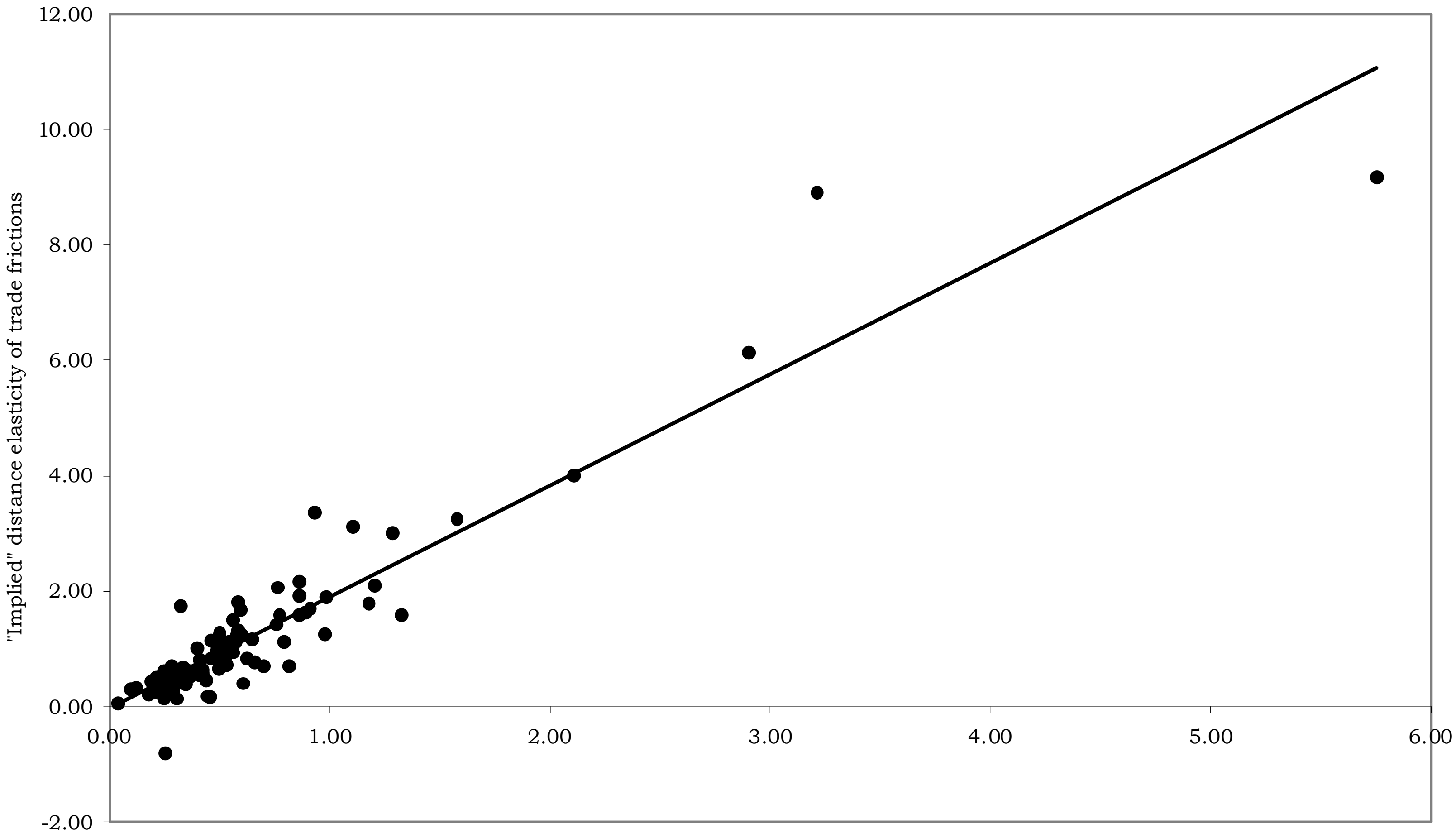

Figure 5b: Distance elasticity of trade frictions

Figure 5b: "Implied" distance elasticity of trade frictions $\widetilde{\beta}_k$ vs the distance elasticity of trade frictions $\widehat{\beta}_k$

Conclusions

- We derive a micro-founded measure for industry-specific bilateral trade integration, consistent with leading trade models
- It differs from other trade integration measures/specifications as it controls for **heterogeneity** across industries
- It provides a measure of the height and ranking of trade frictions across manufacturing industries – has been used by the OECD for trade frictions in services industries (Nordas et al., 2009)
- Empirical analysis of trade integration across EU countries, industries and time. We find significant policy barriers, especially Technical Barriers to Trade
- However, industry data *"can never be as fine as reality, so some degree of aggregation bias is inevitable"* (Anderson and van Wincoop, 2004). The ultimate aim is to analyse trade barriers at the firm or product levels

Technical Barriers to Trade (Baldwin, 2000)

- European Commission's Eurobarometer (2006): opinions and experiences of EU managers about the Single Market: **country-specific**

  "Could you tell me whether you consider that for your company it is very important, rather important, rather unimportant or not important at all that future Single Market Policy tackles the question of removing remaining technical barriers to trade in goods?"

- European Commission (1998): **sector-specific**

$$\begin{cases} 5: & \text{"No solution"} \\ 4: & \text{"Measures proposed but operating problems"} \\ 3: & \text{"Measures adopted but problems"} \\ 2: & \text{"Measures function well but barriers remain"} \\ 1: & \text{"TBTs are removed"} \end{cases}$$

- Interaction between the two varies across countries and sectors, TBT_{ij}^{k}