International Trade Integration: A Disaggregated Approach*

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Abstract

We investigate why the integration of international trade varies across industries. For that purpose we model disaggregated trade flows in an Anderson and van Wincoop (2003) gravity framework with heterogeneous trade costs and heterogeneous elasticities of substitution. We derive an analytical solution for time-varying multilateral resistance variables at the industry level that allows us to obtain a micro-founded measure of industry-specific bilateral trade integration. We then use this measure to explore the determinants of trade integration for manufacturing industries in European Union countries. We find that trade integration is high for industries characterized by high productivity, low transportation costs, low technical barriers to trade, low information costs and low public procurement. We also show that trade integration improved significantly over the period 1997-2003. These improvements can on average explain one third of the growth in international trade. The remainder can be explained by the growth in income and productive capacity.

JEL classifications: F10, F15
Keywords: Trade Integration, Gravity, Trade Costs, Multilateral Resistance, Industries, Disaggregation

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1 Introduction

Trade costs are a staple ingredient in today's trade literature. They feature prominently in the models of Eaton and Kortum (2002) and Melitz (2003) as well as in the vast majority of other recent papers. Whereas most research on trade impediments has involved aggregate trade data, we know relatively little about trade impediments on the disaggregated industry level. Do some industries face higher trade barriers than others? Which industries have experienced the biggest declines in trade barriers?

The aim of this paper is to develop a measure of trade integration that is specific to individual industries. For that purpose we apply the gravity framework pioneered by Anderson and van Wincoop (2003) to disaggregated trade flows at the industry level. In particular, we allow trade costs and substitution elasticities to be heterogeneous across industries. The theoretical contribution of this paper is to derive an analytical solution for time-varying multilateral resistance variables at the industry level. We are thus able to find a micro-founded expression for industry-specific trade integration that controls for multilateral resistance and that we can track over time. Using data on 187 manufacturing industries in 14 European Union countries over the period 1997-2003, we find that trade integration improved significantly over time for the majority of industries in our sample.

Apart from describing how trade integration evolved over time, we also seek to explain its variation across country pairs and industries. The variation of trade integration across country pairs can to a large extent be captured by typical gravity variables such as distance and common language use but also by policy-related variables such as membership in the Eurozone. But trade integration also varies considerably across industries. In particular, trade integration tends to be high for industries that are characterized by high productivity, low transportation costs, low technical barriers to trade, low public procurement and low information costs.

Furthermore, we ask to what extent the great increase in trade flows over recent years can be explained by better trade integration. For that purpose we use our model to decompose the growth in trade into two main components – the growth of income and manufacturing output and the improvement of bilateral and multilateral trade integration. We find that on average roughly one third of the growth in trade can be accounted for by improvements in trade integration, while two thirds can be attributed to income growth and increases in manufacturing output. This decomposition of the sources of trade growth is consistent quantitatively with the findings of Baier and Bergstrand (2001), who examine the growth in trade amongst OECD countries since the late 1950s, and the findings of Jacks, Meissner and Novy (2006), who examine the trade boom during the classical Gold Standard.

The gravity framework introduced by Anderson and van Wincoop (2003) provides a simple and intuitive way of understanding the role of trade costs. Anderson and van Wincoop (2003) show that trade flows are determined not only by bilateral trade costs between two countries, but also by their average trade barriers with other countries. They refer to the appropriate average trade barrier as "multilateral resistance." Our paper explicitly takes multilateral resistance into account at the industry level. Following the approach of Novy (2007), we derive an analytical solution for multilateral resistance that varies over time and that can thus be applied to panel data, not only to cross-sections. Our results in fact show that multilateral resistance changes considerably over time and can therefore not be treated as time-invariant.

Our approach of measuring trade integration falls into the category of papers that indirectly infer the level of trade impediments from trade flows. Examples of such studies include McCallum (1995), Head and Mayer (2000), Nitsch (2000), Head and Ries (2001), Baldwin, Forslid, Martin, Ottaviano and Robert-Nicoud (2003), Evans (2003) and Chen (2004). We regard this approach as complementary to the direct measurement of trade impediments, for example the measurement of transportation costs by Hummels (2007). Anderson and van Wincoop (2004) provide an extensive survey of empirical trade impediments. They consist of obvious candidates such as transportation costs and tariffs but also of impediments that are more difficult to measure such as language barriers and red tape.

The paper is organized as follows. In Section 2 we develop a general equilibrium model with industry-specific trade costs. In that section we also derive an analytical solution for industry-level multilateral resistance variables and our trade integration measure. Section 4 presents our data set. Sections 5 and 6 report descriptive statistics and our main results, focusing on the determinants of trade integration, the time trend of trade integration and our decomposition of trade growth into income growth and improvements in trade integration. Section 7 provides robustness checks and Section 8 concludes.

2 A Model with Industry-Specific Trade Costs

Our model closely follows the seminal paper by Anderson and van Wincoop (2003). Their general equilibrium model of trade results in a gravity equation that incorporates trade costs. The key insight from their gravity equation is that bilateral trade flows are not determined solely by the absolute trade barrier between two countries but rather by their bilateral *relative* to their average trade barrier. Anderson and van Wincoop (2003) refer to the appropriate average trade barrier as "multilateral resistance."

As a generalization, Anderson and van Wincoop (2004) model bilateral trade for an individual industry that is characterized by industry-specific bilateral trade costs and an industry-specific elasticity of substitution. We follow Anderson and van Wincoop (2004) in modelling industry-level trade flows with heterogeneous trade costs and heterogeneous elasticities of substitution. The innovation of our approach is to derive an analytical solution for time-varying industry-specific multilateral resistance variables. With this solution at hand, we are able to derive a micro-founded measure of industry-specific bilateral trade integration. Furthermore, given the solution for time-varying multilateral resistance variables, we can decompose the growth of trade in a given industry into two elements - the growth in income and productive capacity and improvements in bilateral and multilateral trade integration. Bergstrand (1989, 1990) also derives gravity equations for industry-level trade flows but does not focus on multilateral resistance.

2.1 The Basic Framework

Denote x_{ij}^k as nominal exports from country i to country j in goods associated with industry k. Suppose that consumers in country j allocate an exogenous expenditure x_j^k on industry-k goods and that their preferences over these goods can be described by a standard CES utility function given by

$$C_j^k \equiv \left(\sum_{i=1}^{J} \left(c_{ij}^k \right)^{\frac{\sigma_k - 1}{\sigma_k}} \right)^{\frac{\sigma_k}{\sigma_k - 1}} \tag{1}$$

where c_{ij}^k is real consumption of industry-k goods from country i by country-j consumers and where the elasticity of substitution σ_k is specific to industry k and assumed to exceed unity. Furthermore suppose that the factory gate price of industry-k goods from country i is denoted by p_i^k and that trade costs associated with the trade cost factor $t_{ij}^k \geq 1$ are incurred when these goods are shipped to country j such that the price faced by country-j consumers, denoted by p_{ij}^k, can be written as $p_{ij}^k = t_{ij}^k p_i^k$. The demand function for exports $x_{ij}^k = p_{ij}^k c_{ij}^k$ then follows as

$$x_{ij}^k = \left(\frac{p_{ij}^k}{P_j^k} \right)^{1-\sigma_k} x_j^k = \left(\frac{t_{ij}^k p_i^k}{P_j^k} \right)^{1-\sigma_k} x_j^k \tag{2}$$

where the price index P_j^k can be derived as

$$P_j^k = \left(\sum_{i=1}^{J} \left(p_{ij}^k \right)^{1-\sigma_k} \right)^{\frac{1}{1-\sigma_k}} \tag{3}$$

2.2 The Gravity Equation

Denote the exogenous amount of production of industry-k goods by country-i firms as y_i^k and impose market-clearing as

$$y_i^k = \sum_{j=1}^{J} x_{ij}^k \tag{4}$$

Note that since both expenditure x_j^k and production y_i^k are exogenous, the model falls into the class of trade separable models (see Anderson and van Wincoop (2003)). It is irrelevant for our model what one assumes about the underlying preference structure that leads to the expenditure allocation x_j^k or about the production technology that leads to y_i^k.

Substituting the demand function (2) into the market-clearing condition (4) and rearranging yields

$$p_i^k = \left(\sum_{j=1}^{J} \left(\frac{t_{ij}^k}{P_j^k} \right)^{1-\sigma_k} \frac{x_j^k}{y_i^k} \right)^{\frac{1}{\sigma_k - 1}} \tag{5}$$

Now plug (5) back into the demand function (2) and define outward multilateral resistance for industry-k goods from country i as

$$\Pi_i^k \equiv \left(\sum_{j=1}^{J} \left(\frac{t_{ij}^k}{P_j^k} \right)^{1-\sigma_k} \frac{x_j^k}{y_i} \right)^{\frac{1}{1-\sigma_k}} \tag{6}$$

to arrive at the unidirectional gravity equation

$$x_{ij}^k = \frac{y_i^k x_j^k}{y_i} \left(\frac{t_{ij}^k}{P_j^k \Pi_i^k} \right)^{1-\sigma_k} \tag{7}$$

Trade flows x_{ij}^k depend on supply y_i^k of the k-good from country i and demand x_j^k for the good in country j. Large bilateral trade costs t_{ij}^k reduce trade flows x_{ij}^k, whereas large average outward trade barriers of country i (i.e. large Π_i^k) and large average inward trade barriers of country j (i.e. large P_j^k) lead to more bilateral trade x_{ij}^k. Substituting the solution for p_i^k in (5) and the definition of Π_i^k in (6) into the price index (3) yields

$$P_j^k = \left(\sum_{i=1}^{J} \left(\frac{t_{ij}^k}{\Pi_i^k} \right)^{1-\sigma_k} \frac{y_i^k}{y_i} \right)^{\frac{1}{1-\sigma_k}} \tag{8}$$

which is inward multilateral resistance for industry-k goods entering country j.

2.3 Solving for Multilateral Resistance

A problem that arises in empirical work is that we do not have data for the multilateral resistance terms P_j^k and Π_i^k in equation (7). The method we employ here is to solve for these terms analytically as a function of observable observable trade flows. We exploit the fact that multilateral resistance is related to the amount of trade a country conducts with itself (see Novy (2007)). Intuitively, the higher trade barriers are with other countries, the more a country will trade with itself. To see this formally, use gravity equation (7) and consider the implied domestic trade for industry-k goods

$$x_{ii}^k = \frac{x_i^k y_i^k}{y_i} \left(\frac{t_{ii}^k}{P_i^k \Pi_i^k} \right)^{1-\sigma_k} \tag{9}$$

where t_{ii}^k are intranational trade costs for industry-k goods. Equation (9) can be solved for the product of inward and outward multilateral resistance as

$$P_i^k \Pi_i^k = \left(\frac{x_i^k y_i^k}{x_{ii}^k y_i} \right)^{\frac{1}{1-\sigma_k}} t_{ii}^k \tag{10}$$

Note that we do not impose zero domestic trade costs.

2.4 Deriving a Micro-Founded Measure of Industry-Specific Trade Integration

Since we are interested in bilateral trade integration, it is useful to combine bilateral trade flows in both directions. A gravity equation for bidirectional bilateral trade flows can be obtained by multiplying (7) by the corresponding equation for x_{ji}^k. This yields

$$x_{ij}^k x_{ji}^k = \frac{x_i^k x_j^k y_i^k y_j^k}{y_i y_j} \left(\frac{t_{ij}^k t_{ji}^k}{P_i^k \Pi_i^k P_j^k \Pi_j^k} \right)^{1-\sigma_k} \tag{11}$$

Now plug in the solution for multilateral resistance given in (10) to obtain

$$x_{ij}^k x_{ji}^k = x_{ii}^k x_{jj}^k \left(\frac{t_{ij}^k t_{ji}^k}{t_{ii}^k t_{jj}^k} \right)^{1-\sigma_k} \tag{12}$$

From (12) it is easy to solve for trade costs as

$$\frac{t_{ij}^k t_{ji}^k}{t_{ii}^k t_{jj}^k} = \left(\frac{x_{ii}^k x_{jj}^k}{x_{ij}^k x_{ji}^k} \right)^{\frac{1}{\sigma_k - 1}} \tag{13}$$

Note that it is only possible to infer relative trade costs from trade flows, in this case bilateral trade costs relative to intranational trade costs (see Anderson and van Wincoop (2004), p. 709). We do not impose trade cost symmetry so that t_{ij}^k and t_{ji}^k on the left-hand side of (13) are generally asymmetric ($t_{ij}^k \neq t_{ji}^k$). As Anderson and van Wincoop (2003, footnote 11) point out, it is problematic to infer from trade data to what extent bilateral trade barriers are asymmetric because there are multiple combinations of t_{ij}^k and t_{ji}^k that can give rise to the same trade flows x_{ij}^k and x_{ji}^k. But fortunately, taking the square root gives a consistent estimate of the *average* bilateral trade barrier. Therefore, average relative trade costs can be expressed as

$$\theta_{ij}^k \equiv \left(\frac{t_{ij}^k t_{ji}^k}{t_{ii}^k t_{jj}^k}\right)^{\frac{1}{2}} = \left(\frac{x_{ii}^k x_{jj}^k}{x_{ij}^k x_{ji}^k}\right)^{\frac{1}{2(\sigma_k - 1)}} \tag{14}$$

We interpret θ_{ij}^k as a micro-founded measure of bilateral industry-specific trade frictions, or the inverse of bilateral trade integration. Intuitively, the more two countries trade with each other (i.e. the higher $x_{ij}^k x_{ji}^k$), the lower ceteris paribus is our measure of trade frictions. In addition, an important aspect of θ_{ij}^k is that it has an in-built control for multilateral resistance. Remember from (10) that there is a positive relationship between domestic trade and multilateral resistance. If each country starts trading more with itself (i.e. the higher $x_{ii}^k x_{jj}^k$), the higher ceteris paribus are the implied bilateral trade frictions. The reason is that if domestic trade and thus multilateral resistance goes up, it must have become less attractive to trade internationally. For given bilateral trade flows $x_{ij}^k x_{ji}^k$ this means that θ_{ij}^k as a relative trade barrier increases.

Let's use this example to contrast θ_{ij}^k with other measures of trade integration such as trade to output ratios (i.e. $x_{ij}^k x_{ji}^k / \left(y_i^k y_j^k\right)$) that are not micro-founded but nevertheless frequently used. Suppose that bilateral trade flows are constant but that output increases so that the trade to output ratio falls. The conclusion that trade integration therefore fell would only be correct if domestic trade increased. But if domestic trade does remains constant and the increase in output is in fact caused by an increase in demand from third countries, then bilateral trade integration does not change at all and one would have erroneously inferred a deterioration of trade integration.

The industry-specific elasticity of substitution σ_k controls for differences in market power and competition across industries. Imagine an industry with a high elasticity σ_k and thus a high degree of competition and a low markup given by $\sigma_k/(\sigma_k - 1)$. As consumers in this industry are price-sensitive, a given ratio of domestic over bilateral trade implies lower bilateral frictions because a relatively small friction can be sufficient for big switches in consumer spending. Controlling for heterogeneous elasticities is thus important in order not to confuse differences in market power with differences in trade frictions.

For the interpretation of θ_{ij}^k it is helpful to think of a frictionless world with no trade costs. In that case $t_{ij}^k = t_{ji}^k = t_{ii}^k = t_{jj}^k = 1$ and hence θ_{ij}^k would be one. Intuitively, in a frictionless world the ratio of country i's trade with itself over country j's exports to i (i.e. x_{ii}^k / x_{ji}^k) should be the same as country i's exports to j over country j's trade with itself (i.e. x_{ij}^k / x_{jj}^k) because both ratios will simply reflect the relative country size of i and j. Trade costs distort this frictionless world in a way captured by θ_{ij}^k. The opposite extreme would be a closed economy in which bilateral trade $x_{ij}^k x_{ji}^k$ tends towards zero and thus θ_{ij}^k will tend towards infinity. In summary, provided that domestic trade costs do not exceed international trade costs, the bilateral measure of trade frictions θ_{ij}^k is therefore bounded by one and infinity and its inverse can be interpreted as a measure of trade integration between two countries in a specific industry. In particular, our aim is to rank industries according to their degree of integration and to relate this variation to observable industry characteristics.

2.5 Explaining the Growth in Trade

In this section we decompose the growth in bilateral trade into two basic contributions: the contribution of the growth in income and production as well as the contribution of improvements in trade integration. For this decomposition it is useful to adjust multilateral resistance in (10) for intranational trade costs by defining

$$\Theta_i^k \equiv \frac{P_i^k \Pi_i^k}{t_{ii}^k} = \left(\frac{x_i^k y_i^k}{x_{ii}^k y_i} \right)^{\frac{1}{1-\sigma_k}} \tag{15}$$

Gravity equation (11) can then be rewritten as

$$x_{ij}^k x_{ji}^k = \frac{x_i^k x_j^k y_i^k y_j^k}{y_i y_j} \left(\frac{t_{ij}^k t_{ji}^k}{t_{ii}^k t_{jj}^k \Theta_i^k \Theta_j^k} \right)^{1-\sigma_k} \tag{16}$$

The gravity equation in (16) is more practical than (11) because even if σ_k is unknown, we know all the components of (16), i.e. we know $(t_{ij}^k t_{ji}^k / (t_{ii}^k t_{jj}^k))^{1-\sigma_k}$ from (13) as

$$\left(\frac{t_{ij}^k t_{ji}^k}{t_{ii}^k t_{jj}^k} \right)^{1-\sigma_k} = \frac{x_{ij}^k x_{ji}^k}{x_{ii}^k x_{jj}^k} \tag{17}$$

and $(\Theta_i^k \Theta_j^k)^{1-\sigma_k}$ from (15) as

$$\left(\Theta_i^k\right)^{\sigma_k - 1} = \left(\frac{x_{ii}^k y_i}{x_i^k y_i^k}\right) \tag{18}$$

Now take logs and first differences of (16) to arrive at

$$\Delta \ln \left(x_{ij}^k x_{ji}^k\right) = \Delta \ln \left(\frac{x_i^k x_j^k y_i^k y_j^k}{y_i y_j}\right) + (1 - \sigma_k) \Delta \ln \left(\frac{t_{ij}^k t_{ji}^k}{t_{ii}^k t_{jj}^k}\right) + (\sigma_k - 1) \Delta \ln \left(\Theta_i^k \Theta_j^k\right) \tag{19}$$

The left-hand side of (19) is the growth of bilateral trade between i and j in industry-k goods. Now divide (19) by the left-hand side to obtain

$$100\% = 1 = \frac{\Delta \ln \left(\frac{x_i^k x_j^k y_i^k y_j^k}{y_i y_j}\right)}{\Delta \ln \left(x_{ij}^k x_{ji}^k\right)} + (1 - \sigma_k) \frac{\Delta \ln \left(\frac{t_{ij}^k t_{ji}^k}{t_{ii}^k t_{jj}^k}\right)}{\Delta \ln \left(x_{ij}^k x_{ji}^k\right)} + (\sigma_k - 1) \frac{\Delta \ln \left(\Theta_i^k \Theta_j^k\right)}{\Delta \ln \left(x_{ij}^k x_{ji}^k\right)} \tag{20}$$

The right-hand side components of (20) can be interpreted as follows. The first term is the contribution of the growth in the demand for k-goods and the growth in output of k-goods. The second term is the contribution of the decline in bilateral trade frictions. The third term is the contribution of increases in multilateral resistance over time. Intuitively, assume that bilateral trade increases over time so that the denominator $\Delta \ln \left(x_{ij}^k x_{ji}^k\right)$ is positive. If bilateral trade costs fall (i.e. $\Delta \ln \left((t_{ij}^k t_{ji}^k)/(t_{ii}^k t_{jj}^k)\right) < 0$), then the second term will be positive (remember that $\sigma_k > 1$). But if multilateral resistance also falls, then the third term will be negative. This means that the decline in multilateral resistance diverted some trade away from i and j to other country pairs. If multilateral resistance had been stable, the observed growth in bilateral trade flows would therefore have been bigger.

3 The Border Effect Literature

Before moving to the empirical section of the paper, it is useful to briefly discuss the differences and similarities between the micro-founded measure for trade frictions we derive and the commonly estimated border effect in international trade.

Our measure for trade frictions, as reported in (14), is a ratio between domestic and international trade flows, raised at the power of a term that depends upon the elasticity of substitution. In order to estimate border effects, Head and Ries (2001) Baldwin *et al.* (2003) and Head and Mayer (2004) derive a similar measure, given by the ratio between domestic and international trade flows and which is commonly referred to in the literature as the *phi*-ness of trade. However, their measure is not scaled by the elasticity of substitution. We argue that our measure for trade frictions improves over the *phi*-ness of trade in capturing the extent of trade integration as 1) it is consistently derived from theory, 2) it stresses the importance of the elasticity of substitution in measuring trade impediments and 3) it incorporates the effects of multilateral trade resistance while border effects do not.

One other important aspect that needs to be stressed relates to the economic interpretation of trade frictions relative to border effects. Theory shows that the border effect is the product of the elasticity of substitution between varieties and the tariff-equivalent of the border barrier. On the one hand, border effects can arise because the high degree of substitution between domestic and imported goods may lead to a high responsiveness of trade flows even in the case of very modest trade barriers. But on the other hand, for a given elasticity of substitution, border effects will be larger the more important the costs incurred when crossing the border.

In contrast to border effects, in our case a higher elasticity of substitution implies *lower* trade frictions. There are two main explanations for that. The first is that a high elasticity means that consumers are very price-sensitive. As a result, a given amount of bilateral trade implies that trade frictions cannot be too high. The second explanation works through differences in the degree of differentiation. An industry with a very high elasticity produces goods that are almost homogeneous, in which case there is no strong reason to trade internationally despite low trade frictions. But if we instead consider an industry with a very low elasticity so that its goods are clearly differentiated from each other, then it makes much more sense for that industry to trade internationally. Therefore, given certain amounts of trade flows, the implied trade frictions must be higher compared to an industry with a high elasticity.

Finally, and as can be seen from (), our trade frictions variable is a determinant of the volume of *international* trade (our left hand-side variable) and *not* of the ratio between domestic and international trade flows, i.e. the border effect. This implies that the factors we can consider to explain trade frictions do not necessarily need to be the same as those that explain border effects (i.e. the factors should be determinants of *international* trade frictions, while for border effects the factors should be restricted to being border-related only). In particular, in the empirical analysis we will consider factors related to transportation costs, geography or the characteristics of the goods traded between countries, which are good candidates to explain trade frictions but not to explain border effects (as they are not related to the border).

4 Data

4.1 Trade Frictions

To compute our measure of trade integration across countries, sectors and time, ($\theta^k_{ij,t}$ as given by Equation (14)), we first need data on the domestic trade of both countries i and j for sector k, x^k_{ii} and x^k_{jj}, as well as their bilateral exports x^k_{ij} and x^k_{ji}. As in previous literature (see, for instance, Wei (1996), Nitsch (2000), Evans (2003), Head and Mayer (2000), Chen (2004)), domestic trade for country i is given by the output of sector k, y^k_i, minus total exports of country i to the rest of the world in sector k.

The data are from Eurostat, the Statistical Office of the European Commission. Bilateral and total trade flows (exports and imports in thousand Euros, as well as their corresponding weight in tons) are available for all 15 EU countries between 1995 and 2004, and are disaggregated at the 4-digit Nace rev.1 level of manufacturing industries (data for the ten new Members are available over a shorter period only and so are excluded from the analysis). The data for Belgium and Luxembourg are aggregated until 1998 so we merged the two countries from 1999 onwards, and end up with 14 exporting and importing countries and 187 sectors.[1] The value of output, which is also disaggregated at the 4-digit Nace rev.1 level, is from Eurostat's New Cronos database and is in million Euros.

One important issue relates to the measurement of the elasticity of substitution for each sector k, σ^k, that enters directly into the expression for trade frictions. We address this problem in several ways. Firstly, we use the elasticities estimated by Hummels (2001) at the 2-digit SITC rev.3 level (and estimated from data at the 5-digit level). Using tables of correspondence from the SITC rev.3 to the ISIC rev.3, and then from the ISIC rev.3 to the Nace rev.1 classification, we converted those elasticities (that vary across sectors but not across countries nor time) to the Nace rev.1 level of sectors. As the 2-digit SITC rev.3 sectors are more aggregated than our 4-digit Nace rev.1 level sectors, the matching across classifications is quite straightforward, although not perfect. In the few cases where the Nace rev.1 level sectors should be matched with several SITC sectors, we just calculated the average across SITC sectors.[2] Finally, among the 62 elasticities estimated by Hummels, 4 are not significantly different from zero so we just set them to missing. The values so obtained for σ^k, that vary between 2.42 and 10.94, are then used to compute trade frictions according to (14). Note it is reassuring that those elasticities do not display too much variation because as noted by Anderson and van Wincoop (2004), it would be difficult to

[1] As a robustness check, we report results when Belgium and Luxembourg are dropped from the sample.

[2] Ideally, we should compute a weighted average where the weights are given by the share of each SITC rev.3 sector into each Nace rev.1 sector grouping, but this information is unfortunately not available.

say anything about trade impediments when the elasticities are too high.[3]

Given that those elasticities of substitution are estimated and not observed, and that the matching between the two classifications is not perfect, our second approach consists in reporting results (in the section on robustness) while assuming that the elasticity of substitution is the same for all sectors and equal to 1.5. This implies that the power that appears in the expression of (14) is simply dropped. We report regression estimates using this measure as a dependent variable, and then also include the elasticity of substitution as an additional control in the regressions.[4] Although not ideal, this approach is informative as it gives us some indication on the sensitivity of our results to the use of the Hummels (2001) elasticities. It also allows us to compare our findings to those obtained when using the *phi*-ness of trade from Head and Ries (2001), Baldwin *et al.* (2003) and Head and Mayer (2004).

As our data are varying over time, and given that we are interested in the time series evolution of trade integration, one final issue relates to the computation of trade frictions in *real* terms. Ideally, to deflate one would need domestic price indices for the numerator and export price indices for the denominator in (14). Export price indices are however not available, so common practice it to use domestic deflators instead (see Rose (2000) or Rose and Spiegel (2004) who use GDP price indices to deflate aggregate nominal trade flows; see also Baldwin and Taglioni (2006) who discuss the biases arising in gravity equations due to the use of inappropriate deflators for nominal trade values). If we use domestic price indices to deflate bilateral exports in the denominator of (14), then the deflators cancel out and the use of nominal or real variables yields the same values for trade frictions. We decided to adopt this approach of using nominal variables only to calculate the values of θ, but since there are reasons to believe that domestic and export price indices across countries and sectors may differ from each other (in the case of pricing-to-market practices, for instance), we need to provide robustness checks on the results so obtained. One way of doing is to estimate our regressions on cross-sectional samples only; another is to control for the omitted sectoral deflators by including a set of time-varying sector fixed effects in our regressions.[5] In both cases, we show that our main results remain mostly unchanged.

[3] To quote them, "More generally, it is difficult to learn much about trade barriers from a gravity equation for sectors where the elasticity of substitution is extremely high" (Anderson and van Wincoop (2004), p.709).

[4] If one takes the log of our trade frictions in (14), and then only uses as a dependent variable the log of the ratio of domestic to international trade flows, then the estimated coefficients on the explanatory variables will be given by the product between the true elasticities and the term including the substitution elasticities. The assumption of different elasticities across sectors implies that we should allow the estimated coefficients to vary across sectors. However this approach is not of interest for our purposes as we are interested in the true elasticities of trade frictions and not in those elasticities multiplied by a term which includes the elasticities of substitution.

[5] See Baldwin and Taglioni (2006).

The factors we consider to explain trade integration can broadly be classified into three different categories according to their implications in terms of policy and measurement issues. We now describe our variables and their sources.

4.2 Policy-Related Determinants

Baldwin (2000) stresses the importance of Technical Barriers to Trade (TBTs) in shaping trade flows between countries and across sectors. TBTs result from norms (regulations and standards) that affect the sale of goods in some markets by requiring specific product characteristics or production processes. He argues that in the case of Europe, such barriers have become more and more visible over time, especially since tariff barriers were completely eliminated by 1968.[6] We therefore wish to explore whether TBTs are indeed important in explaining intra-EU trade integration. Data on TBTs are however hard to find, so our approach to measuring TBTs uses two different sources of information.

The European Commission's Eurobarometer (2006) reports opinions and experiences of European managers about the Single Market. A total of 4,900 managers at companies were interviewed by telephone in early 2006, the sample of companies being selected according to the size of countries and of companies, and the sector of activity. Particularly useful for our purposes is the answer to the question: "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?*". For each country, we grouped the answers from all managers who replied that TBTs are indeed an important issue, and used the corresponding percentage as a country-specific indication on the relevance of TBTs. We then computed a weighted average for the two partner countries to obtain a pair-specific variable (the weights are the GDP shares of each country in the total GDP of the two partner countries).[7]

Unfortunately, this information varies across country pairs only, and we would like to introduce some cross-sectoral variation in the variable to be included in our estimations. As in Chen (2004), to capture the relevance of TBTs across sectors, we rely on another study undertaken for the European Commission (European Commission (1998)) which identifies the industries affected by TBTs and assesses, on a five-point scale, the effectiveness of different measures undertaken to eliminate TBTs: (1) measures are successful and all

[6] As explained by Baldwin ((2000), p.255), "Europe's first liberalization efforts focused on the "easy" barriers, tariffs and quotas. With these eliminated by 1968, liberalization attention turned to TBTs."

[7] Ideally, we would need to have information on how French managers view TBTs with respect to Germany for instance, but such information is unfortunately not available. Also, it might be that managers perceive barriers to be high simply because they are aware of them as they are competent managers, which in turn does not mean that they are unable to overcome them. This is obviously a limitation of the data that we are not able to fix.

significant barriers are removed, (2) measures are implemented and function well, but some barriers remain, (3) measures are adopted, but with implementation or transitional problems still to be overcome, (4) measures are proposed or implemented, but not effective or with operating problems, and (5) no solution has been adopted. The study also identifies some industries which, prior to European integration, were not affected by TBTs. This information allows us to compute, for the sample of industries affected by TBTs, an industry-specific qualitative variable taking values between one and five, with a larger value indicating a lack of market integration due to subsisting TBTs.

We then interact both country pair (in log) and industry-specific variables on TBTs and denote the resulting variable by TBT_{ij}^k for each sector k and country pair ij. A higher value indicates that TBTs are most probably important impediments to trade across countries and sectors, and we would expect such barriers to be associated with lower trade integration.

In a similar fashion, Non-Tariff Barriers (NTBs) can also be suspected to increase the costs of trade. Data on NTBs are hard to find too, so we use a survey undertaken by the European Commission (1990) which classifies sectors into three groups of High, Medium and Low NTBs. The measure we compute for each sector k is qualitative and takes on values between one and three for Low, Medium and High barriers respectively (and is equal to zero for sectors not affected by NTBs). We then interact this qualitative variable on NTBs with the country pair variable on TBTs described previously, which we denote by NTB_{ij}^k, and use it as an alternative to the TBT_{ij}^k variable in explaining trade integration.

Overall, if TBTs or NTBs are found to significantly increase the costs of intra-EU trade, we would conclude that there is still some room for policy action and that the removal of such barriers would enable to increase trade integration and welfare.

Another factor relates to information costs as an informal barrier to trade. Rangan and Lawrence (1999) argue that in pursuing cross-border economic opportunities, firms incur some costs when they search for potential partners and have to assess their reliability, so in that context multinational firms should enjoy some information advantages over other firms. In particular, they find that the responses of multinationals to exchange rate changes are both larger and more rapid, which they interpret as evidence of informational advantages. To capture the role of information costs as an informal barrier to trade, we rely on Davies and Lyons (1996) who identify (at the Nace 70 level) some EU industries as being "highly multinational". We matched those industries with the level of Nace rev.1 sectors, and then compute a dummy variable equal to one for those industries and include it as an additional regressor for trade frictions.[8] If multinational firms indeed enjoy some

[8] Examples of multinational firms are Computers and office machinery; Soap and detergents; Television

information advantages over other firms, then they should find it easier to trade with foreign countries and be characterized by lower trade impediments.[9]

Besides, it is well-known that national governments often favour domestic over foreign firms for some of their purchases, even if foreign suppliers could actually offer them a better deal (Davies and Lyons (2006)). Firms in such "public procurement" markets are hence protected from foreign imports, and sometimes to such an extent that trade may even be completely suppressed. We aim to investigate whether public procurement is indeed associated with larger trade frictions, and rely on time-varying cross-country data on the value of public procurement as a share of GDP (Eurostat). We compute the (log) average between countries i and j in year t, which we denote by $Public_{ij,t}$, and use it as an explanatory variable in our regressions.

The importance of public procurement varies enormously across industries, but unfortunately the variable above varies across countries and time only and we were unable to find similar data that varies across sectors as well. Davies and Lyons (1996) provide a list of sectors which are suspected to be strongly affected by public procurement in Europe. This allows us to compute a dummy variable equal to one for those sectors and zero otherwise,[10] and to use it as an additional explanatory variable for trade barriers in Europe.[11]

Finally, we control for several other factors that can be suspected to affect the costs of trade in Europe. Firstly, we consider the effects of non-adoption of the Euro by the United Kingdom, Denmark and Sweden by including a dummy variable, denoted by $OUT_{ij,t}$, which is equal to one for the three countries from 2002 onwards when they trade with Eurozone countries. We decided to choose the year 2002 instead of 1999 as the greater transparency created by the common currency is likely to be stronger since Euro notes and coins were made available to consumers.[12] Secondly, we check whether the countries that joined the EU the most recently in our sample (Finland, Sweden and Austria joined in 1995) display on average higher values for θ, which would indicate a lower degree of integration as compared to the other countries. This is captured by a dummy variable equal to one for each of the three countries, and is denoted by FI, SE, AT_{ij}.

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and radio; Glass.

[9] We also tried to use the Rauch (1999) classification to distinguish goods according to information costs. However the matching between his classification and ours was far from easy, and we ended up with a very small sample, precluding us from investigating the role of such informal barriers to trade.

[10] Examples of industries identified as "public procurement" are Shipbuilding; Rail stock; Pharmaceuticals; Aerospace; Telecoms.

[11] We tried to interact the two variables on public procurement to get some variation across countries, years and sectors in a single variable, but unfortunately this did not yield any significant result. We therefore decided to enter the two variables separately in our regressions.

[12] Note that the huge literature on the trade creating effects of common currencies raises the issue of endogeneity of the common currency dummy (Rose (2000)).

4.3 Non-Policy-Related Determinants

Natural candidates to explain trade integration relate to geography. These include a dummy for sharing a common land border, Adj_{ij} and one for sharing a common (official) language, $Lang_{ij}$. The two variables are from the *Centre d'Etudes Prospectives et d'Informations Internationales (CEPII).*[13] We also include both international and domestic distances where both are calculated as a weighted average of the distances between regions, using GDP shares as weights (Chen (2004)). Note that we decided to control separately for international, $Dist_{ij}$, and domestic distances (for both partners), the latter being denoted by $D_{ii} \times D_{jj}$.

We consider two variables to proxy for transportation costs that vary across sectors. Indeed, when trade is disaggregated at the industry level, the inclusion of distance does not capture that different goods are subject to different transportation costs. Since the weight-to-value ratio of shipments provides a significant explanation of freight rates (Hummels (2001, 2007)), weight-to-value is accordingly considered as a determinant of trade integration. Weight-to-value, wv_t^k, expressed in kilograms per Euro, is year and industry-specific and averaged across all country pairs ij. We do not consider bilateral weight-to-value because Hillberry and Hummels (2000) show that bilateral weight-to-value significantly falls with distance, suggesting that the commodity composition of trade is sensitive to bilateral trade costs, but also that weight-to-value is endogenous.[14] Overall, since the freight component of costs is higher for bulky, high weight-to-value raw materials than for manufactures, we expect to find a positive relationship between weight-to-value and trade frictions.

Besides, given that our trade data report both bilateral import and export flows, the ratio between the two gives another indication of transportation costs as the former include "Costs, Insurance and Freight", whereas the latter are typically registered "Free On Board". This proxy is however known to suffer from measurement error. Harrigan (1999) recommends averaging observed values for each sector across countries to minimize measurement error, so we calculate this ratio separately for each country i and j, sector k and time t, take the average between both i and j, and use it as an additional proxy for transportation costs that varies across sectors, years and pairs (and denoted by $cfob_{ij,t}^k$).

Finally, the new trade literature on heterogeneous firms rationalizes why some firms export while others do not. In particular, models such as Melitz (2003), or Melitz and Ottaviano (2005), argue that only the most productive firms will participate in foreign markets as only those will be productive enough to sunk the fixed costs of exporting abroad.

[13] This is available online at http://www.cepii.fr/francgraph/bdd/distances.htm.

[14] See also Baldwin and Harrigan (2007) who find that export unit values are positively related to distance.

This implies that sectors with more productive firms should, on average, display a higher degree of trade integration. The likely endogeneity between trade and productivity levels is, however, of great concern. To address this problem, we measure real labor productivity across sectors but for a country that is not included in our dataset, i.e. the US. The variable is given by value added (in volume) divided by the number of employees, taken from the OECD STAN database and denoted by $Prod^k_{US,t}$. The sectors are however slightly more aggregated (at the 2-digit level) than the sectors we consider in our analysis.[15]

4.4 Measurement Issues

Our goal is to provide an accurate measurement for trade frictions across countries, sectors and years. However, given the way we compute trade frictions, as in Equation (14), it is straightforward to notice that their magnitude will actually be affected by the nature of trade between countries and sectors. Consider two country pairs and sectors, and assume that the true trade friction is equal in both cases, but in one case trade is based on comparative advantage and in the other trade is of intra-industry type. Then, from (14), the trade friction computed under intra-industry trade will be much lower than under comparative advantage.[16] To control for this bias we compute, for each sector k in time t, the absolute value of the (log) difference in capital shares between countries i and j in order to proxy for differences in factor endowments between i and j. Capital shares are calculated as value-added minus personnel costs, divided by value-added (Eurostat). A large differential in capital shares will indicate that factor endowments are more different between countries, so trade will most likely be based on comparative advantage which will lead to an "over-estimate" of trade frictions. We expect to observe a positive relationship between our variable on capital shares, which we denote by $KShares^k_{ij,t}$, and trade frictions.

The previous exercise assumes that differences in factor endowments will be fully captured by differences in capital shares, the latter being computed at the *sectoral* level. One obvious limitation stems from the use of data disaggregated at the level of industries and not at the level of the products. Industries at the 4-digit level of the Nace rev.1 classification will inevitably aggregate together many different types of products into one single category, so that the volume of intra-industry trade will appear to be more important than it actually is. For instance, many different types of steel are produced, from flat-rolled to specialty steels, and it may be that the production of some types of steel require some resources or technologies in which one country has a comparative advantage. However,

[15] We also tried to include real labor productivity for the two countries and instrument it by productivity in the US but the results were not significant.

[16] With comparative advantage, the denominator of (14) will be given by the product of two balanced trade flows, while with intra-industry trade, the denominator of (14) will be given by the product of two unbalanced trade flows, leading to an "over-estimate" of trade frictions under comparative advantage.

since all these types of steel are aggregated into one industry category, it would appear as if the countries are actually exporting and importing "identical" products while in reality they are exporting one type of steel and importing another type.

This implies that the larger the number of varieties in each industry category, the more likely the sector will be aggregating together trade flows between countries with different comparative advantages in different varieties, but in the data this will show up as intra industry-trade, i.e. more balanced trade flows between i and j. From (14), the resulting trade friction will therefore appear to be smaller as the denominator will be the product of two (near) balanced (intra-industry) trade flows at the *sectoral* level, while in reality the two trade flows will be aggregates of unbalanced (inter-industry) trade flows at the level of the *products*. To control for this aggregation problem we include in our regressions the (log) number of product categories within each of the Nace rev.1 sector, which we denote by $goods^k$.[17] More varieties within a sector should be associated with a lower value for trade frictions.

The last issue that needs to be tackled relates to zero trade flows. In our dataset, about 6.5 percent of bilateral exports are equal to zero (no exports are recorded either because they actually were zero, or because they fell below a reporting threshold).[18] There are various alternatives to address this problem. The zero trade flows can simply be set to zero, but this implies that trade frictions, as given by (14), will be set to missing. Obviously this does not seem appropriate since zero trade flows actually contain information about why such low levels of trade are observed, and should therefore instead be associated with a sizeable value for frictions. The approach we adopt is very simple and consists in replacing the zero trade flows with a value of one. This allows us to include the zero trade observations in our analysis, but also to associate them with a large trade friction. We then include in our regressions a dummy variable, denoted by $Zeros^k_{ij,t}$, to control for those observations.

5 Descriptive Statistics

Table 1 contains summary statistics across sectors. Given that we have 187 sectors at the 4-digit level for which trade frictions can be calculated, due to space constraints we focus here on the more aggregated level of 3-digit industries and report averages across 4-digit classifications.[19] The average elasticity of substitution is also shown.

[17] Manova (2006) uses a similar measure to proxy for product variety within sectors.

[18] We consider those 6.5 percent of observations as "true zeros" because the value of domestic production is positive while bilateral exports are equal to zero. Note that in 2.3 percent of the sample, domestic output is zero but exports are positive, so we excluded those observations from the sample.

[19] We also report, next to the industry's name, the number (in parenthesis) of 4-digit sectors included in each 3-digit category.

The first column displays the average of the 4-digit level trade frictions we will use in our regression analysis, and which incorporates the cases when trade is zero. The variability in the values taken by θ is huge, and ranges between 1.42 and 351. Sectors are ordered by decreasing importance of θ.

As we replace zero trade flows by a value of one, their corresponding trade frictions will exhibit large values. As explained earlier, the reason for doing so is because we want to include those observations in our sample as they contain information about why such low levels of trade are observed, and should therefore be associated with important barriers to trade. For the sake of comparison, we report in the second column the values of trade frictions calculated when excluding the zero trade flows from the sample. Obviously, trade frictions become much smaller in the sectors with many zeros (for instance, in the case of Articles of concrete, plaster and cement, θ drops from 82 to 33 once we exclude the 335 zero trade flows). But most importantly, the ranking across sectors remains very similar, the correlation between the trade frictions calculated while including or excluding the zeros being large and equal to 0.98.[20]

At first glance, the nature of the sectors for which trade is less integrated makes sense from an economic point of view. Trade integration is lowest for Cement, lime, plaster which is, as a matter of fact, the sector with the largest weight-to-value, indicating a very low transportability of the goods. In addition, those goods are not much traded across countries as 27 zero trade observations are counted for that sector. This sector also only produces a small number of varieties (4 different types of goods only). Another (somewhat related) sector affected by huge trade barriers is Articles of concrete, which actually displays the largest number of zeros (equal to 335). Note that the geographic market for both cement and concrete is, indeed, very local, since the perishable nature of such "wet" products constrains the distance over which they can be delivered. Those findings stress the importance of transportability in shaping trade flows, the correlation between trade barriers and weight-to-value being indeed positive and large (equal to 0.69).

Bricks is also affected by significant barriers to trade, followed by Fruit and vegetables and Stone. Publishing and printing are traded very little as well, which is hardly surprising given the reliance of such products upon language. This observation is also consistent with earlier literature showing that trade is low in those sectors (Harrigan ()). Finally, it is worth mentioning that some of the sectors with high values for θ belong to the food industry, for which the perishability of the goods is most probably an important deterrent to trade (Fruit and vegetables; Other food products; Fish).

[20] In the section on robustness we report results when excluding the zeros and the results remain mostly unchanged.

There appears to be a positive correlation between trade frictions and transportation costs as measured by the ratio between *c.i.f.* and *f.o.b.* trade values, the latter being on average much lower for goods with small trade impediments (the correlation between this ratio and frictions is positive albeit small, and equal to 0.06). The aggregation of many different varieties within a sector also seems to be important in determining the cross-sectional variation in trade frictions: the sectors of Instruments and Agricultural and forestry machinery produce many different varieties, which may lead to the aggregation of different varieties with different comparative advantages in a single sector, and therefore to a lower value for trade frictions. The average correlation between the number of varieties and trade frictions is indeed equal to -0.21.

While our trade integration measure, which incorporates the elasticity of substitution, ranges between 1.42 and 351, it is worth mentioning that the same measure calculated assuming that the elasticity of substitution is the same for all sectors and equal to 1.5 (i.e. the *phi*-ness of trade) displays far more variability and ranges between 3907 and 1.55e+12 (when excluding zero trade observations)! The ranking of sectors according to that alternative measure is quite similar but some important differences emerge, and this may be misleading if a researcher is ultimately interested in comparing the degree of trade integration across industries.

Table 2 focuses on trade frictions across countries. We report for each country the average of trade frictions across sectors and time, both including and excluding zero trade observations. Finland appears to be the less integrated country in the sample, followed by Austria, Portugal and Spain, while on the other extreme Belgium-Luxembourg, Sweden and Germany are the most trade integrated countries. This ranking across countries changes somewhat once we exclude zero trade observations, but overall the picture remains similar (the correlation between Columns (1) and (2) is equal to 0.82). We also report two columns with the number of zero trade flows: the first reports the number of cases each country is not trading with another partner (i.e. the zero can originate from the country in question *or* its partner), while the second counts the number of times each country is not exporting some goods abroad despite being a producer.

The average distance between each country and its trade partners in the sample is also reported, and the correlation with trade frictions is large and equal to 0.81, supporting that transportation costs across countries are a strong deterrent to trade. We also report the domestic distances calculated for each country (Chen (2004)). Finally, for each country, Column (7) reports the value of public procurement as a share of GDP, averaged across years. The United Kingdom is the country where public procurement is strongest while Germany is the less affected by this type of market segmentation. However, no clear pattern emerges across countries, suggesting that regression analysis will be required in order to uncover any significant relationship between trade impediments and public procurement.

Having described the cross-sectional dimension of our dataset, both across sectors and countries, let's now consider how trade frictions have evolved over time. Using the data from a balanced sample between 1997 and 2003 (see further below for more information on the way we compute that sample), Figure 1 plots the time series evolution of our trade integration measure, averaged across countries and sectors. It is interesting to observe that trade frictions display a strong downward trend over the period, suggesting that the countries and sectors we consider have on average become significantly more trade integrated over time.

To conclude, we observe a considerable variability in the extent of trade integration across sectors, countries and over time. In addition, some of the characteristics of the countries and sectors we consider appear as likely candidates in explaining this variability. We now turn to empirical evidence using regression analysis.

6 Results

This section reports our empirical results. Firstly, we provide an analysis of the determinants of trade integration across countries, sectors and years. We investigate the relevance of the various factors described above, bearing in mind that some have different implications in terms of policy recommendations than others.

Secondly, we focus on the time series analysis of trade integration, i.e. how trade barriers have changed over time and on average over the whole sample, across countries, and across sectors. Such analysis is useful as it helps to shed new light on the debate about whether impediments to trade have declined over time (Hummels (2007)). The changes across countries and sectors are in turn informative to assess the change in the degree of market integration of the various countries and sectors.

Thirdly, we decompose the increase in trade over the sample period into two components – the contribution from the income growth in the two partner countries and the one stemming from the decrease in trade costs, the latter being further split into the proportion that is attributable to the decrease in bilateral trade costs and the one due to the decrease in multilateral trade costs ("multilateral trade resistance").

6.1 The Determinants of Trade Integration

We now analyze the determinants of intra-EU trade integration. We focus on an unbalanced sample of countries, sectors and years. We regress the log of our trade integration measure, $\ln \theta_{ij,t}^{k}$, on the various factors discussed earlier, and include separate intercepts for years and sectors. Given that some of the explanatory variables vary across sectors only, we include sector fixed effects but at the more aggregated level of 3-digit industries, assuming that the 4-digit groupings are just different varieties of the corresponding, more aggregated 3-digit level sector (Hummels (2001) adopts the same approach). The inclusion of independent variables that vary across country pairs only, such as the dummy for belonging to the most recent joiners in the sample, precludes us from controlling for country fixed effects.[21]

The regression is

$$\ln \theta_{ij,t}^{k} = \psi_t + \lambda_K + \beta Pol_{ij,t}^{k} + \zeta NonPol_{ij,t}^{k} + \vartheta Measure_{ij,t}^{k} + \epsilon_{ij,t}^{k} \tag{21}$$

where $Pol_{ij,t}^{k}$ is the set of policy-related variables, $NonPol_{ij,t}^{k}$ the set of non-policy related variables, $Measure_{ij,t}^{k}$ the set of variables to control for measurement issues (comparative advantage, aggregation and zero trade observations), ψ_t are intercepts for years, λ_K are fixed effects for each sector K which is the 3-digit Nace rev.1 level sector to which the 4-digit sector k belongs to, β, ζ and ϑ are vectors of coefficients to be estimated and $\epsilon_{ij,t}^{k}$ is a residual. A higher value for $\theta_{ij,t}^{k}$ should be interpreted as a lower degree of trade integration.

Table 3 reports our main results. Column (1) only includes aggregate, "macro" type variables that vary across countries only: international and domestic distances, adjacency, sharing a common language, the regional dummy and the one for not adopting the Euro. The effects of the different variables are (mostly) highly significant and display coefficients with the expected signs: trade integration decreases with international distances and is proportional to domestic distances. Trade integration is also higher between countries that share a common border and a common language but is lower for Finland, Sweden and Austria. Contrary to expectations, trade integration for the United Kingdom, Denmark and Sweden since the introduction of the Euro in 2002 is not lower but higher, as can be seen from the negative and significant coefficient on the $OUT_{ij,t}$ dummy variable.

In Column (2) we add our control for zero trade observations. Its coefficient is highly significant and positive, revealing that when trade is zero, the implied trade barrier is large. Note that the coefficient on the dummy for the countries that did not join the Euro is now positive and significant but at the 10 percent level only. This is now qualitatively consistent with the findings of Rose (2000) who shows that common currencies have a strong positive impact on trade. In Column (3) we further add our control for comparative advantage in affecting the magnitude of trade barriers: the larger the difference in capital shares

[21] As a robustness we will however check that our results stand with country fixed effects.

between countries in a sector, the more likely that sector's trade is based on comparative advantage and the larger the trade friction will "artificially" be. However, as argued earlier, the inclusion of that variable is not sufficient to control for aggregation biases arising from the grouping of many different varieties together within the same sector. This is achieved through the inclusion of the $goods^k$ variable (Column (4)) which displays, as expected, a negative coefficient.

In Column (5) and the following we successively include variables that vary across sectors: transportation costs, given by the ratio between *c.i.f.* and *f.o.b.* trade values, the weight-to-value ratio and the extent of TBTs (in Column (6) only). The coefficients on all three variables are significant and their effects are as expected: trade integration decreases with transportation costs, weight-to-value and the extent of TBTs across countries and sectors. The finding on TBTs is consistent with Baldwin (2000) who argues that TBTs have become relatively more important in shaping trade flows in Europe. This also suggests some room is left for policy action and that the removal of such barriers might increase welfare through a lowering in trade impediments.

In Column (7) we add public procurement, both across countries and years and across sectors. Both variables display a positive and significant coefficient. This illustrates that despite the Single Market measures that were implemented in 1992 in order to decrease public procurement in Europe, the latter is still important and as a result trade integration is lower. In Column (8), the finding of a negative relationship between θ and productivity confirms the predictions of the new trade literature that the most productive firms are more likely to participate in foreign markets, and are characterized by higher trade integration.

The next regression in Column (9) adds our control for the multinationality of the firms. Its coefficient is very significant and negative, suggesting that multinationals probably enjoy some information advantages over other firms, and so find it easier to trade with foreign countries. Column (10) replicates the specification in (9) but the variable on TBTs is now replaced by the one on NTBs. The results remain qualitatively similar, and indicate that in sectors that are affected by NTBs, trade frictions are on average higher. It is worth noting that all other variables remain significant, with the exception of the non-Eurozone dummy.

Finally, as the main focus of the paper is on the sectoral aspect of trade integration, in Column (11) we replicate the regression in (9) but including country pair fixed effects interacted with year dummies. This enables to eliminate any variation in trade frictions that is due to country pair characteristics that vary over time. All country pair characteristics are now dropped, so that only the coefficients on the sectoral variables are estimated.

Our results remain strongly unaffected, which strengthens the role of the various sectoral characteristics in explaining trade integration in Europe.

To conclude, in this section we showed that the use of a micro-founded measure of industry-specific bilateral trade integration proves useful in the investigation of the likely determinants of trade impediments across EU countries. It is found that trade frictions increase with distance, transportation costs across goods, the extent of TBTs and NTBs, public procurement and are still more important for the countries that joined the EU most recently in our sample. In contrast, trade impediments are lowered by common borders, common languages, stronger productivity, and the multinationality of the firms.

6.2 The Evolution of Trade Integration Over Time

To analyze the time series evolution of trade integration, we need a sample that is balanced over time. Given the size of our dataset, several combinations of countries, sectors and years are possible. We decided to focus on two balanced samples. The first covers the period 1997 to 2003 and includes ten countries (Austria, Denmark, Finland, France, Ireland, Italy, the Netherlands, Portugal, Spain and the United Kingdom) and 174 sectors, for a total number of observations equal to 16.625. However, to include Germany in the analysis as well, we need to restrict the sample to the shorter period between 1999 and 2003.[22] The second sample includes the ten countries listed previously as well as Germany, 178 sectors between 1999 and 2003, for a total number of observations equal to 17.350. In this section we present the results obtained using the first sample only as the period covered is longer (the results pertaining to the second sample that includes Germany are discussed in the section on robustness).

As explained by Hummels (2007), to investigate changes in transportation costs over time, one needs to control for systematic differences in trade costs between trade partners and for changes in the characteristics of the products that are traded (i.e. change in the composition of goods traded). As transportation costs are naturally a major component of our trade integration measure, we follow Hummels (2007) in choosing the empirical specification to estimate. We use a regression where the dependent variable is again the log of our trade friction measure for sector k, between countries i and j, at time t, i.e. $\ln \theta_{ij,t}^{k}$. The independent variables include a separate intercept for each country pair-sector, the weight-to-value ratio in logs, and year dummy variables. The country pair-sector intercepts control for the fact that cars traded between Germany and Spain have higher transportation costs in all periods than shoes traded between France and Italy, while the weight-to-value controls for compositional change over time such as for instance Spain trading higher quality shoes.

[22] This is because sectoral output data are missing for Germany prior to 1999.

The regression takes the form:

$$\ln \theta_{ij,t}^{k} = \gamma_{ij}^{k} + \psi_t + \alpha \ \ln wv_{ij,t}^{k} + \varepsilon_{ij,t}^{k} \tag{22}$$

where γ_{ij}^{k} are country pair dummies interacted with sector intercepts (at the 4-digit Nace rev.1 level), ψ_t are year dummies and $\varepsilon_{ij,t}^{k}$ is the regression residual. Having controlled for compositional change, the evolution of trade integration over time is given by the estimated coefficients on the year dummies, ψ_t.

The first row in the first panel of Table 4 reports the annualized growth rate of the coefficients on the year dummies (not reported) that are obtained from the estimation of Equation (22) over our pooled (and balanced) sample of ten countries and 174 sectors between 1997 and 2003. Trade integration has, on average, significantly increased by 0.795 percent per annum. This is consistent with the pattern we observed in Figure 1.

The next rows in Table 3 repeat the same exercise but for each country separately. Countries are ordered by decreasing magnitude of the change in trade integration over the period. We can see that on average, trade impediments have significantly been reduced for most countries over the period. However, recall that the sample is balanced over time, but not across sectors, so it is hard to rank countries as not all the same sectors are considered for each country (this is reflected in the large differences in the number of observations available for each country). Bearing this in mind, trade frictions appear to have decreased more in the case of Spain (by 1.335 percent each year) and to a smaller extent in the case of Denmark (0.377 percent per annum) while no significant change can be detected for Ireland (however the sample available for that country is much smaller than for the other countries). It seems unlikely that the finding of a systematic increase in trade integration for most countries in the sample is driven exclusively by the use of nominal variables in the computation of our trade integration measure θ.

We then repeated the same exercise for each sector separately. To conserve space, we do not report the annualized growth rates for each sector (but they are available upon request). Instead, Figure 2 plots those growth rates for the sectors that experienced a significant change in trade integration over time. It is interesting to note that the vast majority of sectors (for which the growth rate is significant from a statistical point of view) experienced a decrease in trade frictions, which is consistent with our finding that on average, trade impediments have significantly decreased over the period. Distilled potable alcoholic beverages display the strongest decrease in θ over the period of approximately 9.24 percent per annum. Other sectors where trade integration significantly increased are Underwear, Accumulators, Ice cream, Publishing of sound recording or Pharmaceutical preparations. Other sectors are instead characterized by an increase in frictions over the same period. Trade integration is today lower for Articles of concrete (4.41 percent per year), followed by Cold rolling of narrow strips, Non-electric domestic appliances, Other publishing or Other glass.

6.3 Decomposing the Growth in Trade

In this section we decompose the growth in trade across countries and sectors into two fundamental factors – one that captures the contribution of the income growth of the two partners and the other the contribution of the decline in trade costs, the latter reflecting to what extent the process of trade integration has strengthened between country pairs and sectors over time.

Using Equation (20), we deflate all variables to constant prices using the GDP deflators of each country.[23] We then calculate, for each year, the value of each factor for each country pair and sector. In order to give more weight to the pairs and sectors which contribute more significantly to the growth in trade, we then compute a weighted average across countries and sectors where the weights are given by the inverse of the standard error obtained from regressing the growth in trade, individually for each country pair and sector, on a constant term.[24]

Table 5 reports the growth in trade for our balanced sample between 1997 and 2003 and the respective contributions of economic expansion and the decline in trade costs in explaining the growth in trade across countries and sectors. We carry out this exercise for the whole sample and various subsamples of our dataset. The first row refers to the whole sample, in which trade has on average grown by 5.81 percent over the period. We see that 58.78 percent of this trade expansion can be accounted for by changes in trading partners' income growth, whereas declines in trade costs account for about 41.22 percent of the growth in trade. These proportions are similar to the findings of Baier and Bergstrand (2001) who argue that two-thirds of the growth in trade amongst OECD countries between 1958 and 1988 was explained by the growth of output. They are also consistent with the findings by Jacks, Meissner and Novy (2006) who find that roughly 44 percent of the global trade boom between 1870 and 1913 can be explained by reductions in trade costs, the remaining 56 percent being attributable to economic expansion.

[23] In contrast to trade frictions, it can be seen that if we use domestic price indices to deflate the variables that appear in the expressions for each of the different factors, the deflators do not cancel out so we need to deflate using GDP deflators.

[24] The factors so calculated sometimes display extreme values for some countries and sectors, which are hard to explain. Before taking the weighted average across countries and sectors, we have therefore excluded those outliers from the sample, where outliers are defined as being larger (in absolute value) to the mean of each factor plus twice its standard deviation. After doing so we end up with a sample with 14.207 observations.

Of particular interest is our ability to further decompose the contribution of the decrease in trade costs into the proportion due to changes in bilateral trade costs and that due to changes in trade costs with and between the other countries in the sample ("multilateral trade resistance"). The last two columns of the table show this decomposition. For the whole sample, the increase in trade can be accounted for by a 90.42 percent decline in bilateral trade costs between partners. However, trade would have been increased by more had the trade costs with and between other partners in the sample not gone down as well (as the contribution from trade resistance is negative and equal to -49.20 percent).

The next rows of the table report the same decompositions but for various subsamples of the dataset. On average, trade has gone up by more for Finland, Sweden and Austria (7.22 percent), but relative to the other countries in the sample the contribution of the decline in trade costs has been modest (23.71 percent against 46.33 percent). This indicates that those countries have experienced a slower rate of integration over the period relative to the other countries in the sample, the expansion in income being the predominant explanation for the growth in trade.

We then report the results for the countries that have remained outside the Eurozone. Since the introduction of the Euro in 2002, the three countries have seen their trade with Eurozone countries decrease by 3.16 percent. Moreover, the contribution of trade costs is negative which indicates that the overall trade costs of those countries have actually risen since 2002 (both bilateral and multilateral costs have decreased, but the magnitude of the latter is much larger than that of the former). Consistent with some of the regressions we reported earlier, this result emphasizes the trade-creating effects of sharing a common currency.

The sample is then split according to whether countries share a common border or are distant from each other (the country pairs are distinguished based on whether the distance separating them is longer or shorter than the median distance in the sample). The contribution of trade costs decline to the growth in trade appears to be more important for countries that do not share a common border or are farther apart, suggesting that the deepening of trade integration has been stronger for the countries to which geography is a natural impediment to trade.

We then focus on subsamples split according to some characteristics that also vary across sectors. The first is the degree of transportability of the goods as captured by the weight-to-value of exports calculated for each sector, country pair and year. We split the sample according to the median value of weight-to-value (equal to 0.225 kilogramme per Euro) and for both subsamples we then decompose the growth in trade into its various components. It can be seen that the contribution of the decline in trade costs is strongest for goods that are on average easier to transport (with a small weight-to-value). This contrasts with our finding that the contribution of the decline in trade costs has been stronger for more distant countries, for which transportation costs are more important. One possible explanation could be that weight-to-value captures the role of distance as low transportability goods are usually traded at shorter distances (Hillberry and Hummels (2000)). To check this possibility, we split the whole sample into four subsamples according to both distance and the degree of transportability of the goods, but the results remain unchanged: the contribution of the decline in trade costs is stronger for countries that are more distant from each other, whatever the transportability of the goods, and is again stronger for highly transportable goods at any distance. We therefore conclude that a low transportability of the goods is actually a trade impediment which can hardly be affected by the process of EU integration, so the extent to which the decline in trade costs can contribute to the growth in trade of sectors with a low transportability is limited by the physical characteristics of the goods.[25]

We then construct three subsamples according to the extent of TBTs, the degree of multinationality and public procurement (across sectors). It is worth noting that in the case of TBTs, the contribution of the decline in trade costs has been strongest where trade was originally more inhibited, i.e. in sectors affected by high TBTs. This stresses again that over the period the extent of trade integration has become more acute in the cases where trade impediments were originally more important. The results according to multinationals and public procurement are different. The contribution of the decline in trade costs has been strongest for multinational firms which were previously identified as being characterized by lower trade barriers. In addition, the contribution of trade costs decline has been smallest in public procurement sectors, suggesting that the deepening of trade integration has been slower where public procurement is strong.

To summarize, our results reveal that between 1997 and 2003, the growth in trade across EU countries and sectors can be explained by the expansion in income of the partner countries but also by the decline in trade costs (whether bilateral or multilateral), the latter reflecting the extent to which the process of trade integration has intensified over time. In addition, in some cases the contribution of the decline in trade costs has been more important where trade impediments were originally stronger, i.e. between distant countries that do not share a common border, and in sectors affected by strong TBTs. Exceptions are Finland, Sweden and Austria, the sectors producing goods characterized by a low transportability, non-multinational firms and sectors affected by public procurement.

[25] To further check whether weight-to-value does not simply reflect the role of distance, we regressed weight-to-value on distance and used the residuals so obtained to split the sample according to high and low weight-to-value (cleansed from the effect of distance) and long and short distances, but the results remained unaffected.

Finally, both bilateral and multilateral trade costs matter but bilateral costs dominate multilateral trade costs in explaining the growth in trade.

7 Robustness

In this section we review a number of alternative specifications we implemented to ensure the stability of our conclusions.

The Determinants of Trade Integration First we verify that the results stand in our balanced sample between 1997 and 2003. The first regression in Table A1 reports our main specification. Despite the much smaller number of observations, most variables keep on being significant at standard significance levels and display coefficients with the expected sign, the exceptions being the dummy for not joining the Euro and productivity.

Returning to the unbalanced sample, we then want to check that the inclusion of zero trade flows does not affect our results. Column (2) reports the same specification as in Column (9) in Table 3 but excluding zero trade observations. The dummy for sectors affected by public procurement remains positive albeit poorly significant, while productivity completely looses significance. The latter result could reflect that the less productive sectors are indeed less likely to export abroad and are thus characterized by a larger number of zeros.

In Column (3) we report our findings when excluding Belgium-Luxembourg. Remember that the reason for doing so is because the data for the two countries were merged together. All results stand.

We are concerned that the results might be affected by our inability to observe the domestic and export price indices which would ideally be required to deflate trade values when computing trade frictions. One way of checking the robustness of our results is to estimate the regressions on cross-sectional samples only. Table A2 in the Appendix reports such estimates for the unbalanced sample and the same specification as in Column (9) of Table 3. Labor productivity in the US (which varies across sectors and time only) is now omitted.

The dummy for non-adoption of the Euro is not significantly different from zero in any of the years, but this is not so surprising as we observed earlier that the significance of that variable was very unstable. Public procurement across countries is not significant in all years either, but on average there is some evidence that public procurement is a source of market segmentation as trade frictions are higher in some of the years. Of interest is to note that the coefficient on this variable actually tends to increase over time, suggesting that the measures implemented by the Single Market programme were not successful in eliminating public procurement. The same can be said of TBTs as its estimated coefficient also tends to increase over time. Transportation costs, as captured by the ratio between *c.i.f.* and *f.o.b.* trade values, and the dummy for public procurement sectors, are not significant in all years either, but overall we can still conclude that both matter in affecting trade integration. Conversely, the coefficient on the dummy for multinational firms gets more negative over time, suggesting that informational advantages have been important in strengthening the degree of trade integration since 1997. This is actually consistent with the decompositions of the growth in trade we described earlier, as we found that the contribution of trade costs decline was most important for multinationals as compared to other firms. Similarly, sharing a common language lowers trade frictions, and this effect is also becoming stronger over time. All other results stand.

Another way to control for the omitted sectoral deflators is to include a set of time-varying sector fixed effects (at the 3-digit level) in the regressions. As can be seen in the fourth column of Table A1, our results largely stand. This is reassuring as we can confidently conclude that the use of nominal trade values in computing trade barriers does not bias our main conclusions.

As explained earlier, the elasticities of substitution σ^k used to compute trade integration are only estimated and not observed, and so are likely to be measured with error. To check whether our results are affected by measurement bias in the elasticities, we report in the last two columns of Table A1 our findings when assuming that the elasticity of substitution is equal to 1.5 for all sectors. Obviously this goes against our model which predicts different elasticities across sectors, but the dependent variable is now the same as in Head and Ries (2001), Baldwin *et al.* (2003) and Head and Mayer (2004). The sizes of the estimated coefficients tend to be radically different from those obtained with our micro-founded measure, but the sign and significance of the various factors remain mostly unchanged, albeit with some exceptions: sharing a common border becomes insignificantly different from zero and the dummy for public procurement sectors changes sign. We also tried to control directly for the elasticities by including them as an explanatory variable.[26] The estimated coefficient on the elasticity is, as expected, positive and significant, and its inclusion leaves all other coefficients unchanged.[27]

Finally, let's mention that we also tried to use the elasticities provided by Broda and

[26] As noted earlier, the model predicts that the elasticities, if not incorporated into the measure for trade frictions, should affect the estimated coefficients and not the intercepts, meaning that our approach of including elasticities as an additional control is not fully correct.

[27] The larger the elasticity of substitution, the smaller the true trade frictions, meaning that the dependent variable will be overvalued. This predicts a positive correlation between the elasticity and the "wrong" trade friction measure.

Weinstein (2006) in computing trade frictions. Broda and Weinstein (2006) estimate elasticities at the 5-digit SITC rev.3 level for the US over the period 1990-2001. However, as those are available at a much more disaggregated level than our Nace rev.1 level sectors, in many cases the computation of averages across SITC sectors yielded huge values for σ^k, leading to considerable values for trade frictions. In addition, the elasticities they provide are not defined in the same way as the ones we need for our analysis. But most importantly, when using their elasticities, the results we obtained were not as conclusive as the ones reported in the paper (many variables changed sign or became insignificant). We therefore decided to focus on the results using the elasticities from Hummels (2001) only.[28]

The Evolution of Trade Integration Over Time Earlier, when we described the evolution of trade integration over time, we relied on a balanced sample that did not include Germany. As this country is one of the core countries in the EU, we wish to compare how our results would change if we included it in the sample. We therefore computed a second balanced sample including Germany but over the shorter period 1999-2003. We then ran the regression in (22) and calculated the change over time in trade frictions. The results are reported in the second panel of Table 4. It appears that over this shorter period of time, trade frictions have, on average, decreased even more than between 1997-2003 when Germany was excluded. This result is most probably driven by the fact that trade frictions have been very strongly decreased in Germany over the period (by 1.423 percent per annum on average).

8 Conclusion

We investigate why the integration of international trade is more advanced in some industries than in others. For this purpose we use the gravity framework pioneered by Anderson and van Wincoop (2003) and apply it to industries with heterogeneous trade costs and heterogeneous elasticities of substitution. The model yields a micro-founded measure of bilateral trade integration at the industry level that controls for time-varying multilateral resistance. We find that trade integration is high in industries that are characterized by high productivity, low transportation costs, low technical barriers to trade, low public procurement and low information costs. These systematic differences across industries suggest that modelling trade costs as a "one-fits-all" trade impediment is at odds with the empirical evidence from disaggregated trade data. Instead, when dealing with industry-level data it is important to allow for trade cost heterogeneity across industries.

Moreover, we show that trade integration improved significantly over the period 1997-

[28] The results obtained using the Broda and Weinstein (2006) elasticities are available upon request.

2003. These improvements can on average explain one third of the growth in trade and are therefore a major driving force of international economic integration.

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Table 1: Descriptive Statistics

3-digit Nace Sector (# of 4-digit)	$\theta^k_{ij,t}$	$\theta^k_{ij,t}$ excl. zeros	σ^k	$Zeros^k_{ij,t}$	$cfob^k_{ij,t}$	wv^k_t	$Goods^k$
Cement, lime, plaster (3)	351.00	185.66	2.52	27	13.34	18.52	4
Bricks (1)	344.86	205.71	2.65	40	15.78	4.70	8
Fruit, vegetables (3)	235.52	173.78	2.46	26	120.22	1.08	19
Stone (1)	122.74	98.41	2.65	16	12.82	1.82	7
Articles of concrete, plaster, cement (6)	82.46	33.41	3.24	335	46.42	3.43	3
Other food products (9)	50.53	29.43	4.87	60	38.53	0.58	12
Processing of nuclear fuel (1)	23.34	23.34	2.70	0	6.75	0.00	na
Jewellery (2)	23.19	21.87	3.48	13	12.75	0.01	8
Ceramic tiles, flags (1)	20.27	18.94	2.65	5	8.48	1.71	10
Prepared animal feeds (2)	19.20	18.27	3.61	50	15.73	1.90	5
Other non-metallic mineral products (2)	17.73	14.67	2.96	16	6.32	0.70	16
Sawmilling, planing of wood (1)	14.40	13.28	3.36	11	7.73	2.17	24
Furniture (5)	12.52	11.13	3.64	101	7.78	0.25	15
Ceramic goods (6)	11.79	11.04	3.29	21	10.80	0.65	10
Processing of iron, steel (5)	11.14	7.19	3.53	25	15.95	1.04	11
Glass (5)	11.02	9.74	3.09	27	14.55	0.82	13
Builders' carpentry, joinery (1)	9.96	9.21	3.99	21	4.95	0.47	16
Wooden containers (1)	9.72	9.70	3.99	1	2.99	2.16	5
Publishing (5)	7.45	7.11	4.88	48	11.69	0.18	7
Rubber products (3)	6.38	4.79	3.82	32	3.09	0.29	31
Structural metal products (2)	6.23	5.95	4.79	28	3.14	0.37	11
Printing (2)	5.63	5.72	6.26	50	12.90	0.37	19
Paper, paperboard (5)	5.52	5.49	4.50	10	5.55	0.46	15
Other products of wood (2)	5.34	5.20	4.13	9	2.25	0.36	12
Tubes (2)	5.20	5.10	3.53	3	6.78	0.83	7
Tanks, reservoirs (2)	4.83	4.62	4.76	22	6.71	0.29	8
Basic iron and steel (1)	4.69	4.69	3.53	0	1.25	2.34	121
Weapons, ammunition (1)	4.51	4.43	4.88	5	165.93	0.15	13
Veneer sheets (1)	4.40	4.40	3.99	0	1.94	1.73	25
Fish (1)	4.34	4.09	4.71	8	4.65	0.38	34
Grain mill products (2)	3.90	3.80	5.04	9	98.82	1.95	19

Table 1 (continued)

3-digit Nace Sector (# of 4-digit)	$\theta^k_{ij,t}$	$\theta^k_{ij,t}$ excl. zeros	σ^k	$Zeros^k_{ij,t}$	$cfob^k_{ij,t}$	wv^k_t	$Goods^k$
Tobacco (1)	3.89	3.69	6.62	11	9.36	0.21	5
Machine-tools (1)	3.67	1.55	7.95	153	0.98	0.09	145
Other fabricated metal products (5)	3.44	3.38	4.89	13	106.26	0.39	34
Pulp, paper, paperboard (2)	3.07	2.98	4.28	5	2.53	1.59	52
Coke oven products (1)	2.88	2.88	5.01	0	21.63	8.89	na
Plastic products (4)	2.87	2.87	5.36	0	1.54	0.28	51
Ships, boats (2)	2.84	2.66	7.40	46	227.17	0.17	26
Miscellaneous manufacturing (3)	2.79	2.76	4.99	4	3.03	0.11	33
Wearing apparel (4)	2.72	2.72	5.66	1	3.08	0.11	48
Steam generators (1)	2.72	2.61	7.87	17	121.21	0.22	12
Cutlery (3)	2.68	2.68	4.85	0	1.30	0.10	44
Paints, varnishes (1)	2.58	2.58	6.37	0	2.72	0.38	38
Dairy products (2)	2.58	2.50	6.77	20	1.61	0.51	19
Leather clothes (1)	2.53	2.46	5.66	2	2.45	0.01	6
Musical instruments (1)	2.46	2.44	4.88	3	16.73	0.05	42
Lighting equipment (1)	2.43	2.43	5.17	0	1.36	0.09	65
Bodies for motor vehicles (1)	2.37	2.29	7.11	15	6.73	0.29	19
Soap, detergents (2)	2.37	2.37	5.74	0	4.14	0.53	41
Other chemical products (6)	2.37	2.31	6.46	21	44.76	0.30	20
Sports goods (1)	2.29	2.18	4.88	6	354.19	0.12	17
Basic chemicals (7)	2.24	2.22	6.09	42	10.50	0.86	66
Railway locomotives (1)	2.23	2.16	7.40	8	4.53	0.16	35
Insulated wire, cable (1)	2.22	2.22	5.88	0	1.60	0.18	12
Luggage, handbags (1)	2.21	2.22	6.18	0	1.73	0.07	9
Electrical equipment (2)	2.21	2.18	5.94	6	34.48	0.05	34
Domestic appliances (2)	2.19	2.15	5.75	7	1.82	0.17	31
Other transport equipment (1)	2.16	2.12	7.11	7	20.81	0.30	1
Knitted, crocheted articles (2)	2.04	2.04	6.90	1	2.61	0.03	7
Electricity distribution apparatus (1)	2.02	2.02	5.88	0	0.98	0.04	73

Table 1 (continued)

3-digit Nace Sector (# of 4-digit)	$\theta^k_{ij,t}$	$\theta^k_{ij,t}$ excl. zeros	σ^k	$Zeros^k_{ij,t}$	$cfob^k_{ij,t}$	wv^k_t	$Goods^k$
Games, toys (1)	2.02	1.98	4.88	1	3.80	0.10	34
Electronic valves, tubes (1)	1.97	1.96	5.88	1	9.28	0.02	56
Aircraft, spacecraft (1)	1.97	1.89	7.55	4	4.21	0.00	55
Medical equipment (1)	1.90	1.90	6.00	0	1.12	0.03	44
Accumulators (1)	1.90	1.89	5.88	0	1.69	0.30	47
Knitted, crocheted fabrics (1)	1.88	1.88	6.90	0	1.04	0.10	5
Motorcycles, bicycles (3)	1.86	1.84	7.11	9	9.44	0.14	14
Man-made fibres (1)	1.85	1.82	6.59	3	30.74	0.43	25
Made-up textile articles (1)	1.84	1.84	7.46	0	0.93	0.11	41
Other general purpose machinery (4)	1.83	1.83	6.99	5	1.81	0.14	43
Pesticides (1)	1.81	1.69	6.75	5	164.39	0.20	28
Footwear (1)	1.78	1.78	7.22	0	1.02	0.05	35
Other textiles (4)	1.76	1.75	7.82	7	40.81	0.23	15
Watches, clocks (1)	1.74	1.74	8.13	1	1.70	0.03	72
Dressing, dyeing of fur (1)	1.74	1.74	8.09	1	7.38	0.02	5
Agricultural, forestry machinery (2)	1.73	1.72	8.36	12	1.91	0.18	74
Parts for motor vehicles (1)	1.72	1.72	7.28	0	1.70	0.18	30
Motor vehicles (1)	1.72	1.67	7.25	4	2.22	0.13	53
Instruments (1)	1.71	1.71	6.78	0	1.91	0.04	118
Other special purpose machinery (6)	1.69	1.66	8.18	27	12.54	0.10	40
Electronic motors (1)	1.67	1.67	7.02	0	0.97	0.09	79
Tanning, dressing of leather (1)	1.63	1.63	8.92	0	2.99	0.11	43
Machinery (4)	1.62	1.62	7.21	4	8.07	0.09	42
Pharmaceuticals (2)	1.60	1.60	9.05	0	7.11	0.07	39
Television, radio (1)	1.60	1.59	9.44	3	2.17	0.01	13
Optical instruments (1)	1.53	1.53	7.70	0	1.30	0.01	61
Television, radio receivers (1)	1.46	1.46	9.44	0	1.42	0.04	53
Office machinery, computers (2)	1.42	1.42	10.94	0	2.76	0.03	20

Source: Authors' calculations

Table 2: Descriptive Statistics

	θ_{ij}^k	θ_{ij}^k excl. zeros	Zeros (total)[1]	Zeros (decl. only)[2]	$Dist_{ij}$	$Dist_{ii}$	$Public_{ij}$
Finland	30.84	17.59	486	326	1943	362	1.91
Austria	24.81	14.28	358	171	1159	228	1.92
Portugal	24.59	11.62	658	531	1687	205	2.22
Spain	22.48	14.95	201	101	1473	452	2.28
Italy	17.82	13.42	226	72	1344	441	1.78
Denmark	14.58	11.60	202	101	1110	148	2.60
United Kingdom	14.04	14.62	123	56	1138	271	3.86
Ireland	13.70	9.22	332	274	1274	139	2.29
France	12.60	8.49	152	58	1034	415	2.19
Netherlands	11.58	8.63	174	104	901	114	1.51
Germany	11.35	8.62	134	48	1002	342	1.10
Sweden	11.27	9.54	91	47	1388	468	3.07
Belgium-Luxembourg	10.75	9.53	67	27	880	113	1.86

Notes: In [1] zeros are all zero trade observations, whether for the country or its partner; in [2] the numbers refer to zero trade exports for the country in question only.

Table 3: The Determinants of Intra-EU Trade Frictions

	(1)	(2)	(3)	(4)	(5)	(6)
Macro variables						
$\ln Dist_{ij}$	0.623 (87.284)	0.553 (82.322)	0.563 (78.427)	0.577 (81.192)	0.576 (83.371)	0.563 (77.968)
$\ln(Dist_{ii} \times Dist_{jj})$	-1.046 (-44.364)	-0.832 (-37.041)	-0.852 (-35.436)	-0.883 (-37.144)	-0.883 (-38.596)	-0.853 (-36.651)
Adj_{ij}	-0.026 (-3.106)	-0.051 (-6.482)	-0.052 (-6.160)	-0.045 (-5.415)	-0.048 (-5.988)	-0.059 (-7.182)
$Lang_{ij}$	-0.137 (-12.663)	-0.133 (-12.983)	-0.140 (-12.810)	-0.140 (-13.010)	-0.144 (-13.625)	-0.104 (-9.499)
FI, SE, AT_{ij}	0.150 (27.353)	0.130 (25.091)	0.142 (25.608)	0.147 (26.989)	0.147 (27.852)	0.145 (27.398)
$OUT_{ij,t}$	-0.021 (-1.966)	0.018 (1.851)	0.013 (1.250)	0.013 (1.267)	0.018 (1.864)	0.031 (3.122)
$\ln Public_{ij,t}$	–	–	–	–	–	–
Micro variables						
$Zeros^k_{ij,t}$	–	1.241 (40.670)	1.287 (37.003)	1.213 (34.579)	1.199 (36.230)	1.187 (36.044)
$\ln KShares^k_{ij,t}$	–	–	0.025 (4.185)	0.010 (1.736)	0.007 (1.240)	0.008 (1.451)
$\ln Goods^k$	–	–	–	-0.148 (-40.645)	-0.140 (-39.428)	-0.141 (-39.348)
$\ln cfob^k_{ij,t}$	–	–	–	–	0.034 (10.761)	0.035 (10.835)
$\ln wv^k_t$	–	–	–	–	0.247 (32.536)	0.249 (32.587)
$\ln TBT^k_{ij}$	–	–	–	–	–	0.117 (9.522)
$\ln NTB^k_{ij}$	–	–	–	–	–	–
$Public^k$	–	–	–	–	–	–
$\ln Prod^k_{US,t}$	–	–	–	–	–	–
$Mult^k$	–	–	–	–	–	–
c	0.511 (7.243)	0.288 (4.273)	0.296 (4.115)	0.729 (10.163)	1.034 (14.742)	0.211 (1.929)
Sample	Whole	Whole	Whole	Whole	Whole	Whole
Period	1995-2004	1995-2004	1995-2004	1995-2004	1995-2004	1995-2004
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
3-digit sector fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
N	55265	55265	49690	49685	49669	49185
R^2	0.278	0.352	0.356	0.376	0.412	0.408

(continued on the next page)

Table 3 (continued)

	(7)	(8)	(9)	(10)	(11)
Macro variables					
$\ln Dist_{ij}$	0.564 (78.054)	0.548 (71.753)	0.549 (72.396)	0.555 (73.175)	–
$\ln(Dist_{ii} \times Dist_{jj})$	−0.863 (−36.994)	−0.827 (−33.290)	−0.819 (−33.328)	−0.828 (−33.641)	–
Adj_{ij}	−0.054 (−6.445)	−0.053 (−5.793)	−0.054 (−5.885)	−0.050 (−5.454)	–
$Lang_{ij}$	−0.104 (−9.477)	−0.091 (−7.756)	−0.087 (−7.376)	−0.089 (−7.533)	–
FI, SE, AT_{ij}	0.145 (27.433)	0.137 (24.418)	0.138 (24.856)	0.137 (24.717)	–
$OUT_{ij,t}$	0.022 (2.156)	0.018 (1.626)	0.019 (1.725)	0.017 (1.521)	–
$\ln Public_{ij,t}$	0.043 (4.003)	0.040 (3.458)	0.042 (3.706)	0.035 (3.042)	–
Micro variables					
$Zeros^k_{ij,t}$	1.188 (36.073)	1.207 (31.562)	1.196 (31.591)	1.197 (31.637)	1.174 (29.754)
$\ln KShares^k_{ij,t}$	0.009 (1.599)	0.013 (2.137)	0.012 (2.109)	0.012 (2.005)	0.010 (1.650)
$\ln Goods^k$	−0.141 (−39.345)	−0.116 (−30.014)	−0.085 (−18.836)	−0.086 (−18.849)	−0.088 (−19.656)
$\ln cfob^k_{ij,t}$	0.035 (10.836)	0.036 (10.091)	0.036 (10.440)	0.036 (10.446)	0.035 (10.253)
$\ln wv^k_t$	0.249 (32.540)	0.265 (30.648)	0.238 (32.299)	0.238 (32.308)	0.239 (32.654)
$\ln TBT^k_{ij}$	0.130 (10.085)	0.136 (10.141)	0.134 (10.084)	–	0.100 (3.605)
$\ln NTB^k_{ij}$	–	–	–	0.126 (7.285)	–
$Public^k$	0.055 (2.264)	0.051 (2.106)	0.042 (1.729)	0.042 (1.750)	0.059 (2.575)
$\ln Prod^k_{US,t}$	–	−0.035 (−2.604)	−0.037 (−2.768)	−0.032 (−2.358)	−0.031 (−2.345)
$Mult^k$	–	–	−0.449 (−15.459)	−0.448 (−15.454)	−0.466 (−16.004)
c	0.132 (1.178)	0.104 (0.791)	0.058 (0.445)	0.285 (2.117)	0.802 (1.716)
Sample	Whole	Whole	Whole	Whole	Whole
Period	1995-2004	1995-2004	1995-2004	1995-2004	1995-2004
Year fixed effects	Yes	Yes	Yes	Yes	No
3-digit sector fixed effects	Yes	Yes	Yes	Yes	No
Pair x year fixed effects	No	No	No	No	Yes
N	49185	42615	42615	42615	42615
R^2	0.408	0.394	0.403	0.403	0.773

Notes: t-statistics in parentheses.

Table 4: Evolution over Time – Average and Countries

Balanced Sample 1	Annualized Growth Rate (%)	N	Balanced Sample 2	Annualized Growth Rate (%)	N
Whole sample	−0.795 (−13.18)	16625	Whole sample	−0.912 (−11.89)	17350
Spain	−1.335 (−11.79)	4942	Spain	−1.646 (−10.46)	4390
Portugal	−1.281 (−8.46)	3332	Germany	−1.423 (−8.11)	4420
Austria	−1.077 (−7.35)	2310	Portugal	−1.274 (−6.62)	3060
France	−0.838 (−7.22)	4648	Denmark	−0.991 (−4.64)	2130
Italy	−0.712 (−6.52)	4914	Austria	−0.953 (−4.82)	2325
UK	−0.511 (−4.77)	4312	Netherlands	−0.913 (−4.86)	2205
Netherlands	−0.477 (−3.72)	2492	France	−0.574 (−4.00)	4080
Finland	−0.398 (−2.80)	3094	UK	−0.545 (−3.43)	3785
Denmark	−0.377 (−2.19)	2380	Finland	−0.499 (−2.69)	2925
Ireland	−0.246 (−0.93)	826	Italy	−0.483 (−3.36)	4505
–	–	–	Ireland	−0.222 (−0.63)	875

Notes: Numbers represent the annualized growth rates of the coefficients on the year dummies obtained from regressing Equation (22) for each country separately. Country-pair fixed effects interacted with sector dummies and weight-to-value are included in all regressions (not reported). t-statistics in parentheses. Sample 1 (2) refers to the balanced sample without (with) Germany between 1997-2003 (1999-2003).

Table 5: Decomposition of Trade Growth

	Growth in trade 1997-2003, average	Contribution of income growth	Contribution of trade costs decline	Bilateral costs	Mult co
Full sample	5.81%	58.78%	41.22%	90.42%	-49
FI, SE, AT_{ij}	7.22%	76.29%	23.71%	87.32%	-63
Rest of sample	5.40%	53.67%	46.33%	91.33%	-45
OUT_{ij} (2002 onwards)	-3.16%	198.31%	-98.31%	1.53%	-99
Rest of sample	6.68%	63.70%	36.30%	98.74%	-62
$Adj_{ij}= 0$	4.48%	51.36%	48.64%	88.51%	-39
$Adj_{ij}= 1$	9.68%	80.33%	19.67%	96.01%	-76
Long distance[1]	5.79%	46.63%	53.37%	78.23%	-24
Short distance	5.84%	68.29%	31.71%	99.97%	-68
High weight-to-value[2]	6.46%	76.67%	23.33%	65.20%	-41
Low weight-to-value[2]	5.80%	35.79%	64.21%	119.97%	-55
Long distance[1]; High weight-to-value[2]	6.38%	67.52%	32.48%	40.51%	-8.
Long distance[1]; Low weight-to-value[2]	6.35%	24.12%	75.88%	119.75%	-43
Short distance[1]; High weight-to-value[2]	6.52%	82.80%	17.20%	81.74%	-64
Short distance[1]; Low weight-to-value[2]	5.28%	46.91%	53.09%	120.18%	-67
High[3] TBT_{ij}^k	6.77%	35.77%	64.23%	88.56%	-24
Low[3] TBT_{ij}^k	4.88%	81.34%	18.66%	92.25%	-73
$Mult^k= 1$	7.46%	21.59%	78.41%	119.93%	-41
$Mult^k= 0$	5.48%	66.37%	33.63%	84.40%	-50
$Public^k= 1$	7.59%	91.07%	8.93%	65.08%	-56
$Public^k= 0$	5.65%	55.77%	44.23%	92.79%	-48

[1]Median distance is 1293 km; [2]Median weight-to-value is 0.225 kg/Euro; [3]Median TBT_{ij}^k is 8.05.

Appendix

Table A1: The Determinants of Intra-EU Trade Frictions – Robustness

	(1)	(2)	(3)	(4)	(5)	(6)
Macro variables						
$\ln Dist_{ij}$	0.467 (44.254)	0.561 (76.262)	0.575 (73.451)	0.552 (73.216)	4.315 (108.087)	4.257 (103.871)
$\ln(Dist_{ii} \times Dist_{jj})$	−0.553 (−14.210)	−0.859 (−36.246)	−0.846 (−31.968)	−0.825 (−33.796)	−6.687 (−52.558)	−6.803 (−52.225)
Adj_{ij}	−0.117 (−8.919)	−0.042 (−4.784)	−0.037 (−3.852)	−0.054 (−5.996)	0.003 (0.067)	0.009 (0.202)
$Lang_{ij}$	−0.082 (−2.009)	−0.086 (−7.527)	−0.173 (−11.878)	−0.084 (−7.200)	−0.697 (−11.912)	−0.723 (−12.010)
FI, SE, AT_{ij}	0.182 (21.093)	0.140 (25.974)	0.138 (24.194)	0.135 (24.407)	1.188 (40.249)	1.135 (37.670)
$OUT_{ij,t}$	−0.002 (−0.171)	0.018 (1.764)	0.014 (1.191)	0.020 (1.813)	0.181 (3.207)	0.158 (2.742)
$\ln Public_{ij,t}$	0.124 (5.455)	0.033 (2.964)	0.063 (5.314)	0.045 (3.929)	0.394 (6.773)	0.346 (5.791)
Micro variables						
$Zeros^k_{ij,t}$	1.354 (4.376)	–	1.156 (29.932)	1.098 (29.009)	5.628 (45.809)	5.533 (42.501)
$\ln KShares^k_{ij,t}$	0.042 (3.854)	0.021 (3.666)	0.009 (1.433)	0.016 (2.679)	0.123 (3.967)	0.170 (5.250)
$\ln Goods^k$	−0.089 (−12.432)	−0.086 (−19.858)	−0.094 (−19.242)	−0.083 (−18.071)	−1.241 (−48.806)	−1.062 (−40.567)
$\ln cfob^k_{ij,t}$	0.022 (4.083)	0.043 (12.117)	0.035 (9.416)	0.045 (10.464)	0.295 (20.622)	0.282 (18.393)
$\ln wv^k_t$	0.166 (14.542)	0.216 (29.952)	0.233 (30.511)	0.282 (35.847)	0.917 (32.466)	0.848 (26.587)
$\ln TBT^k_{ij}$	0.175 (7.813)	0.134 (10.283)	0.142 (10.296)	0.138 (10.396)	1.032 (15.425)	1.115 (15.848)
$Public^k$	0.082 (3.081)	0.036 (1.506)	0.041 (1.637)	0.065 (2.635)	−0.419 (−1.952)	−0.462 (−2.162)
$\ln Prod^k_{US,t}$	−0.019 (−0.816)	−0.012 (−0.889)	−0.041 (−2.939)	–	−0.419 (−4.893)	−0.501 (−5.832)
$Mult^k$	−0.320 (−6.777)	−0.437 (−15.410)	−0.421 (−13.616)	−0.424 (−14.885)	−1.274 (−13.986)	−1.873 (−18.783)
σ^k	–	–	–	–	–	0.377 (9.592)
c	−0.891 (−4.055)	−0.062 (−0.480)	−0.083 (−0.602)	−0.150 (−1.260)	0.742 (1.052)	−1.017 (−1.360)
Sample	Balanced	Excl. zeros	Excl. Belg-Lux	Whole	Whole	Whole
Period	1997-2003	1995-2004	1995-2004	1995-2004	1995-2004	1995-2004
Year fixed effects	Yes	Yes	Yes	No	Yes	Yes
3-digit sector fixed effects	Yes	Yes	Yes	No	Yes	Yes
Pair x year fixed effects	No	No	No	No	No	No
3-digit sector x year fixed effects	No	No	No	Yes	No	No
N	13898	41676	37984	42615	46831	42615
R^2	0.366	0.346	0.407	0.398	0.518	0.519

Notes: t-statistics in parentheses.

Table A2: The Determinants of Intra-EU Trade Frictions: Cross-sectional samples

	1997	1998	1999	2000	2001	2002	2003
Macro variables							
$\ln Dist_{ij}$	0.562	0.538	0.562	0.572	0.564	0.538	0.510
	(26.137)	(26.037)	(27.886)	(27.200)	(29.152)	(24.140)	(20.145)
$\ln (Dist_{ii} \times Dist_{jj})$	−0.727	−0.694	−0.842	−0.958	−0.864	−0.894	−0.844
	(−10.252)	(−9.810)	(−14.110)	(−14.890)	(−13.655)	(−11.042)	(−8.975)
Adj_{ij}	−0.050	−0.066	−0.029	−0.036	−0.039	−0.069	−0.089
	(−1.813)	(−2.359)	(−1.319)	(−1.590)	(−1.796)	(−2.513)	(−3.143)
$Lang_{ij}$	−0.038	−0.072	−0.105	−0.078	−0.094	−0.169	−0.134
	(−1.130)	(−1.911)	(−3.531)	(−2.672)	(−3.468)	(−4.143)	(−3.631)
FI, SE, AT_{ij}	0.113	0.137	0.155	0.129	0.105	0.142	0.187
	(7.001)	(8.816)	(10.871)	(8.636)	(7.366)	(8.660)	(9.707)
$OUT_{ij,t}$	–	–	–	–	–	−0.014	0.008
						(−0.810)	(0.364)
$\ln Public_{ij,t}$	−0.017	−0.063	0.071	0.039	0.063	0.170	0.158
	(−0.452)	(−1.370)	(2.258)	(1.277)	(2.356)	(3.743)	(4.270)
Micro variables							
$Zeros^k_{ij,t}$	–	0.276	–	1.108	1.019	1.078	1.155
		(3.087)		(27.052)	(5.379)	(19.590)	(20.271)
$\ln KShares^k_{ij,t}$	0.001	0.004	−0.007	0.002	0.020	0.001	0.055
	(0.063)	(0.224)	(−0.564)	(0.128)	(1.534)	(0.080)	(3.194)
$\ln Goods^k$	−0.118	−0.063	−0.051	−0.095	−0.086	−0.078	−0.095
	(−10.213)	(−5.052)	(−3.603)	(−8.295)	(−7.834)	(−4.907)	(−6.455)
$\ln cfob^k_{ij,t}$	0.059	0.089	0.109	0.078	−0.004	0.005	0.014
	(5.640)	(8.680)	(5.819)	(6.940)	(−0.353)	(0.439)	(1.591)
$\ln wv^k_t$	0.269	0.251	0.290	0.307	0.209	0.331	0.342
	(13.598)	(8.942)	(14.025)	(12.996)	(14.068)	(14.436)	(16.617)
$\ln TBT^k_{ij}$	0.094	0.072	0.132	0.098	0.128	0.154	0.233
	(2.294)	(1.652)	(4.132)	(2.846)	(3.886)	(4.012)	(4.859)
$Public^k$	−0.102	0.151	0.182	−0.041	0.008	−0.006	0.183
	(−1.624)	(2.128)	(2.378)	(−0.560)	(0.147)	(−0.084)	(3.176)
$\ln Prod^k_{US,t}$	–	–	–	–	–	–	–
$Mult^k$	−0.231	−0.469	−0.369	−0.289	−0.407	−0.520	−0.516
	(−2.856)	(−5.858)	(−6.290)	(−3.843)	(−5.408)	(−5.560)	(−5.587)
c	−0.166	−0.121	−0.301	0.436	−0.119	0.123	−0.351
	(−0.459)	(−0.313)	(−1.038)	(1.381)	(−0.391)	(0.343)	(−0.808)
Sample	Whole	Whole	Whole	Whole	Whole	Whole	Whole
3-digit sector fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	4742	4773	5812	5470	5676	5355	5253
R^2	0.347	0.353	0.384	0.369	0.367	0.486	0.488

Notes: t-statistics in parentheses.

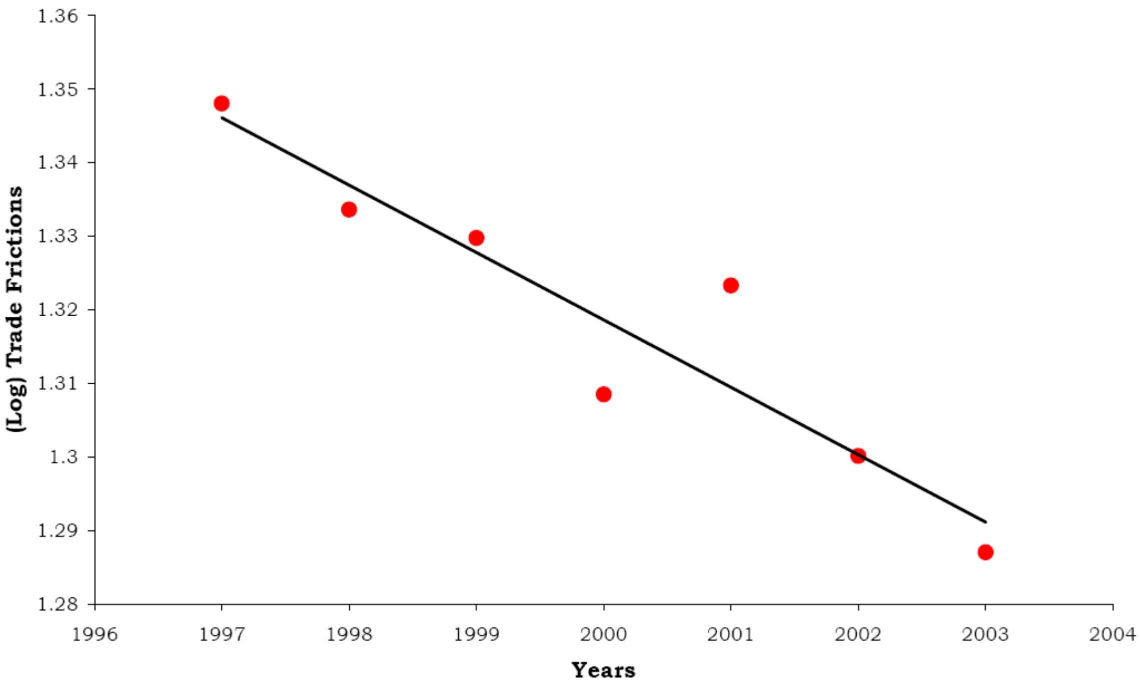

Figure 1: Trade Frictions 1997-2003, average across countries and sectors (balanced sample)

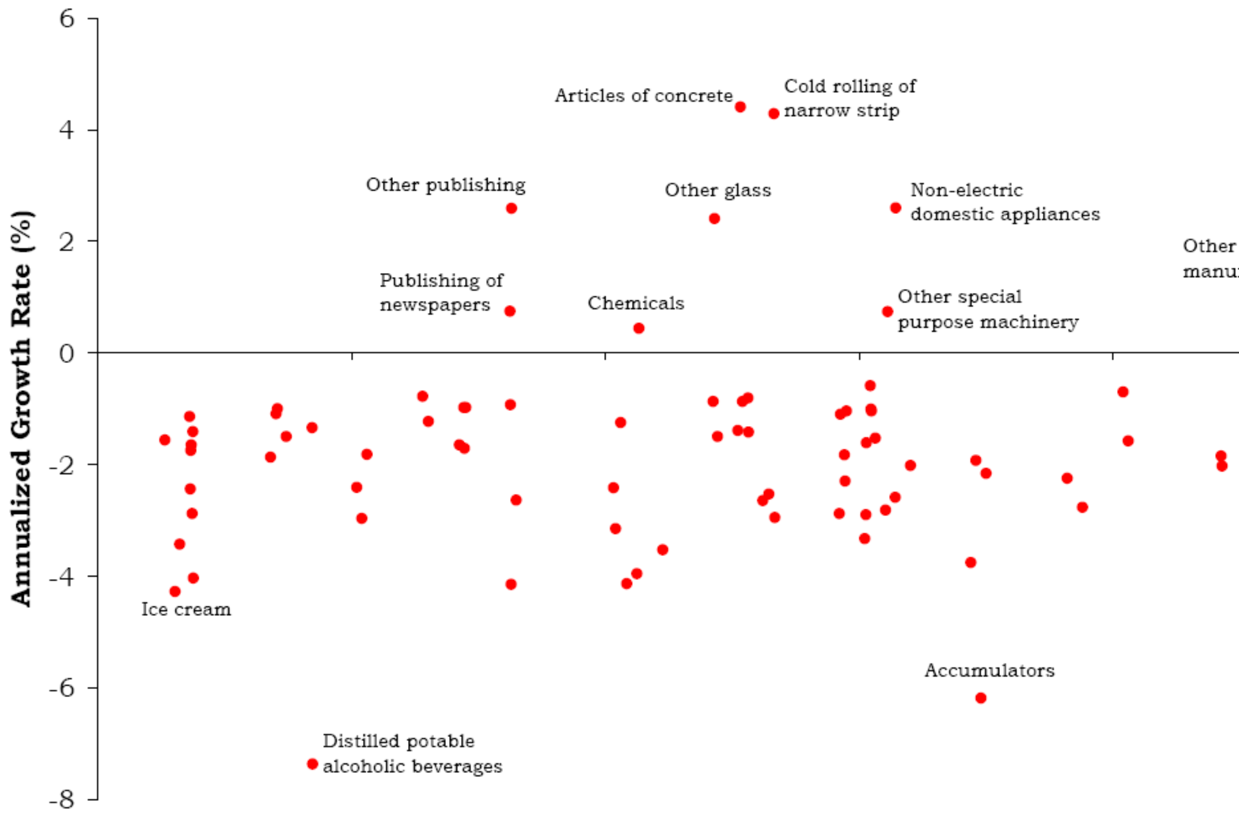

Figure 2: Annualized Growth Rates per Sector (significant only), 1997-2003 (balanced sample)