International Trade Integration: A Disaggregated Approach*†

Natalie Chen
University of Warwick and *CEPR*

Dennis Novy
University of Warwick

September 16, 2008

Abstract

This paper investigates the sources and size of trade barriers at the industry level. Modeling disaggregated trade flows in an Anderson and van Wincoop (2003) gravity framework with heterogeneous trade costs, we derive a micro-founded measure of bilateral trade integration at the industry level. This trade integration measure has an in-built control for time-varying multilateral resistance and can therefore be applied to panel data. We use it to explore trade barriers for manufacturing industries in European Union countries between 1999 and 2003. We find that the most important trade barriers are policy factors such as Technical Barriers to Trade and intransparent public procurement procedures, as well as transportation costs and informational costs. Trade integration is generally lower for countries that opted out of the Euro or do not fully implement the provisions of the Schengen Agreement. Reductions in trade barriers explain about one-half of the growth in trade over the period 1999-2003 and are therefore a major driving force of the EU Single Market.

JEL Classification: F10, F15

Keywords: Trade Integration, Gravity, Trade Costs, Multilateral Resistance, Industries, Disaggregation

*We are grateful for comments by Richard Baldwin, Pierre-Philippe Combes, Ronald Findlay, James Harrigan, Thierry Mayer and participants at the CEPR ERWIT 2007, Midwest Spring Meetings 2008, the Product Market Integration in the EU 2008 workshop at the Universidade do Minho, Fordham, Georgia Tech, HEI Geneva, Nottingham, Oxford, UC Davis, UC Santa Cruz and Utrecht School of Economics.

†Natalie Chen, Department of Economics, University of Warwick, Coventry CV4 7AL, UK. E-mail: N.A.Chen@warwick.ac.uk (corresponding author) and Dennis Novy, Department of Economics, University of Warwick, Coventry CV4 7AL, UK. E-mail: D.Novy@warwick.ac.uk.

1 Introduction

Trade costs are a staple ingredient in today's trade literature. Broadly defined, trade costs include any cost of engaging in international trade such as transportation costs, tariffs, non-tariff barriers, informational costs, time costs, different product standards, exchange rate costs and local distribution costs, among others. They feature prominently in the vast majority of theoretical papers, including the models of Eaton and Kortum (2002) and Melitz (2003). In addition, a growing empirical literature, surveyed by Anderson and van Wincoop (2004), is devoted to exploring the sources and size of trade costs. A deeper understanding of the causes of trade costs is of particular importance because it would enable a better evaluation of their welfare implications. These are suspected to be large: on their own, policy-related trade costs may be worth more than ten percent of national income (Anderson and van Wincoop, 2002).

A major challenge faced by empirical researchers is to measure overall trade costs since "direct measures are remarkably sparse and inaccurate" (Anderson and van Wincoop, 2004, p.692). Direct measures are only available for a few components, for instance transportation and insurance costs, usually proxied by the ratio of *c.i.f.* and *f.o.b.* trade values (Harrigan, 1993, Hummels, 2001a, 2007),[1] policy barriers such as specific tariff or non-tariff barriers (Chen, 2004, Harrigan, 1993, Head and Mayer, 2000), informational costs (Rauch, 1999) or time costs (Evans and Harrigan, 2005, Harrigan, 2005, Hummels, 2001b). But even for those components, data coverage is often limited to a few countries and years, and it can be hard to gather disaggregated trade cost data at the industry or product level.

Given those difficulties in obtaining accurate measures of trade costs, some researchers indirectly infer the level of trade impediments from trade flows. This approach has the obvious advantage of extending the analysis to more countries, years and more disaggregated data. One way of doing this is to compute trade to output ratios (Harrigan, 1996); another is to estimate "border effects," which mostly reflect the extent of border-related costs.[2]

This paper is part of the research effort attempting to indirectly infer trade impediments from trade flows. The first contribution of the paper is to develop a micro-founded measure of bilateral trade integration that can be applied to disaggregated panel data. We derive this measure by modeling disaggregated trade flows at the industry level in the gravity framework pioneered by Anderson and van Wincoop (2003, 2004), allowing trade costs and substitution elasticities to be heterogeneous across industries. Anderson and van Wincoop (2003) show that trade flows are determined not only by bilateral trade costs between two countries but also by average trade barriers with other countries, which they refer to as "multilateral resistance." Following the approach of Novy (2008), we derive an analytical solution for multilateral resistance variables that vary across industries and over time. In turn, this enables us to derive a micro-founded measure of bilateral trade integration that has an in-built control for time-varying multilateral resistance and can therefore be applied to panel data.

[1] Moreover, Limão and Venables (2001) use the quotes from shipping firms for a standard container shipped from Baltimore to several destinations. Combes and Lafourcade (2005) develop a new methodology to compute transportation costs and apply it to road transport by truck in France.

[2] Examples include Anderson and van Wincoop (2003), Baldwin, Forslid, Martin, Ottaviano and Robert-Nicoud (2003), Chen (2004), Eaton and Kortum (2002), Evans (2003), Head and Mayer (2000), Head and Ries (2001), McCallum (1995), Nitsch (2000) and Wei (1996).

Moreover, we show that this trade integration measure can also be derived from the Ricardian model by Eaton and Kortum (2002). The measure is thus valid for a wide range of theoretical frameworks.

We regard our approach as complementary to other research that indirectly infers trade impediments from trade flows. But we discuss how our measure of trade integration differs from ad hoc proxies commonly used in the literature such as trade to output ratios or border effects in international trade. In particular, we show that ad hoc proxies without micro-foundations can erroneously pick up changes in *multilateral* trade barriers as changes in *bilateral* trade barriers. In contrast, we are able to focus on bilateral trade integration because our micro-founded measure of trade integration is not distorted by multilateral resistance effects.

The second contribution of the paper is to bring our measure of trade integration to the data. This enables us to document and explain the variation of trade barriers across 167 manufacturing industries in 11 European Union countries over the period 1999-2003. The case of the European Union is appealing since trade integration is expected to be strong between its member states due to two factors. First, these countries have succeeded in dismantling many restrictions on trade, including tariffs and quotas that were completely eliminated by 1968. Second, the situation has been further reinforced by the implementation of the Single Market Programme (SMP), launched in the mid-1980s.

Consistent with the standard gravity literature, the variation of trade integration across country pairs can to a large extent be captured by typical gravity variables such as distance and adjacency but also by policy-related variables such as membership in the Eurozone or participation in the Schengen Agreement. But our focus lies on trade integration across industries. We investigate the role of several sectoral characteristics in explaining trade integration across industries, with a particular emphasis on policy-related variables such as the extent of Technical Barriers to Trade (TBTs). Such barriers are a predominant concern in today's global trade negotiations, and for the WTO in particular as it precisely seeks to ensure that "technical regulations and standards, including packaging, marking and labelling requirements [...] do not create unnecessary obstacles to international trade."[3] We find that trade integration is indeed lower in countries and industries where TBTs are strong, suggesting that there is room left for policy action and that further gains are possible through the reduction of those barriers. We also show that trade integration tends to be high for industries characterized by high productivity, low transportation costs, low informational costs and a high degree of transparency in public procurement. From a dynamic perspective, average trade integration has improved for most countries over the period 1999-2003, as well as individually for a large number of industries in our sample.

The third contribution of the paper is to explore to what extent the increase in trade flows over recent years can be explained by the decrease in trade barriers. For that purpose, we use our model to decompose the growth of trade into three main components – (1) the growth of manufacturing output, (2) lower bilateral trade barriers and (3) changes in multilateral resistance. We find that on average 56 percent of the growth in trade can be accounted for by changes in bilateral trade barriers and multilateral resistance, while the rest can be attributed to the growth of income and manufacturing

[3] Agreement on Technical Barriers to Trade (p.117). This Agreement, negotiated during the Uruguay Round, is an integral part of the WTO Agreement.

output. This contribution of the decline in trade barriers is quantitatively larger than the contribution found by Baier and Bergstrand (2001) or Jacks, Meissner and Novy (2008) for samples that include many non-European countries. As we focus on the European Union, our results suggest that intra-EU trade integration has proceeded faster than integration amongst other countries.

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 time-varying industry-level multilateral resistance variables and our trade integration measure. Section 3 presents our data set. Section 4 reports our main results, focusing on the determinants of trade integration, the time trend of trade integration and the decomposition of trade growth into income growth and changes in trade barriers. Section 5 provides robustness checks and Section 6 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 bilateral 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 trade flows with heterogeneous trade costs and heterogeneous elasticities of substitution at the industry level. The innovation of our approach is to derive an analytical solution for time-varying industry-specific multilateral resistance variables that can be related to observable data. With this solution at hand, we are able to derive a micro-founded measure of industry-specific bilateral trade integration that nets out multilateral resistance effects. 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 expenditure x_j^k on industry-k goods and that their preferences over these goods can be described by a standard CES utility function as

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

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 output of industry-k goods by country-i firms as y_i^k and impose market-clearing as

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

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

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

Plug equation (5) back into the demand function (2) and, as in Anderson and van Wincoop (2004), define outward multilateral resistance for industry-k goods from country i as

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

where y^k is world output in industry k. Rearrange to arrive at a gravity equation for industry k

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

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 bilateral trade, 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. Substituting the solution for p_i^k in (5) and the definition of Π_i^k in (6) into the price index (3) yields

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

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 gravity equation (7). The method we employ here is to solve for these terms analytically as a function of observable trade flows. We exploit the fact that multilateral resistance is related to the amount of trade a country conducts with itself (see Novy, 2008). Intuitively, if a country's trade barriers with the rest of the world are high (i.e., if the country's multilateral resistance is high), the country will trade a lot domestically.

To see this formally, use gravity equation (7) and consider domestic trade flows for industry-k goods

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

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

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

Note that we do not impose zero domestic trade costs since the trade cost factor t_{ii}^k may exceed unity. Equation (10) implies that for given t_{ii}^k and σ_k, it is easy to measure multilateral resistance since the quantities on the right-hand side are observable.

2.4 A Micro-Founded Measure of Industry-Specific Trade Integration

The solution for multilateral resistance can be exploited to solve the model. Gravity equation (7) contains the product of outward multilateral resistance of country i and inward multilateral resistance of country j, $\Pi_i^k P_j^k$, whereas equation (10) provides a solution for $\Pi_i^k P_i^k$. It is therefore useful to multiply gravity equation (7) by the corresponding gravity equation for trade flows in the opposite direction, x_{ji}^k, to obtain a bidirectional gravity equation that contains both countries'outward and inward multilateral resistance variables. This yields

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

Substitute the solution for multilateral resistance given in equation (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 equation (12) it is easy to solve for the trade cost factors as

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

It is only possible to infer relative trade costs, in this case bilateral trade costs $t_{ij}^k t_{ji}^k$ relative to intranational trade costs $t_{ii}^k t_{jj}^k$.[4] We do not impose trade cost symmetry so that t_{ij}^k and t_{ji}^k on the left-hand side of equation (13) may be asymmetric ($t_{ij}^k \neq t_{ji}^k$). As Anderson and van Wincoop (2003, footnote 11) point out, it is problematic to infer the degree of trade barrier asymmetry from trade data 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. We therefore take the square root to get an expression for the *average* bilateral trade barrier. Thus, the average relative trade barrier 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. The more two countries trade with each other (i.e., the higher $x_{ij}^k x_{ji}^k$), the lower is our measure of relative trade frictions ceteris paribus. Conversely, if the two countries start trading more domestically (i.e., the higher $x_{ii}^k x_{jj}^k$), the higher is our measure of relative trade frictions ceteris paribus.[5]

For the interpretation of θ_{ij}^k it is also helpful to think of two opposite extreme cases - a frictionless world with no trade costs on the one hand, and a closed economy on the other. In a frictionless world, all trade cost factors equal unity ($t_{ij}^k = t_{ji}^k = t_{ii}^k = t_{jj}^k = 1$) and θ_{ij}^k would be one, implying that bilateral and domestic barriers are the same. In the case approaching a closed economy, bilateral trade $x_{ij}^k x_{ji}^k$ tends towards zero and thus θ_{ij}^k tends towards infinity, implying that bilateral barriers are prohibitive relative to domestic barriers.

Let us now contrast θ_{ij}^k with alternative measures of trade integration. First, compare θ_{ij}^k with trade to output ratios, i.e., $\left(x_{ij}^k x_{ji}^k\right) / \left(y_i^k y_j^k\right)$. These are not micro-founded measures of trade integration but nevertheless frequently used (Harrigan, 1996). Suppose that bilateral trade flows $x_{ij}^k x_{ji}^k$ are constant but that output $y_i^k y_j^k$ increases so that the trade to output ratio falls. This is usually interpreted as a decrease in bilateral trade integration. If the increase in output coincides with an increase in domestic trade $x_{ii}^k x_{jj}^k$, then equation (14) indicates that bilateral integration has indeed fallen relative to domestic integration. But if the increase in output in fact only reflects an increase in trade with third countries (a multilateral effect), then equation (14) indicates that bilateral trade integration remains unchanged. Hence, using the trade to output ratio, one would have erroneously inferred a deterioration of bilateral trade integration because trade to output ratios react to changes

[4] On this point also see Anderson and van Wincoop (2004, p.709).

[5] An increase in domestic trade does not necessarily imply a decrease in domestic welfare. If domestic trade increases due to, for instance, an improvement in domestic infrastructure, this is good for the economy but will translate into a higher relative trade barrier. Also, if both bilateral and domestic costs decrease by the same proportion, bilateral trade integration will remain unchanged although consumers will benefit from the lower trade costs.

in both bilateral and multilateral integration. The θ_{ij}^k measure in equation (14) avoids this problem because it only reflects changes in bilateral integration and does not get distorted by multilateral effects.

Second, compare θ_{ij}^k with the "*phi*-ness" of trade which is commonly used to estimate sectoral border effects (Baldwin et al., 2003, Head and Mayer, 2004, Head and Ries, 2001).[6] This measure is given by the simple ratio of bilateral to domestic trade flows. θ_{ij}^k differs in that it combines this ratio with an exponent that involves the industry-specific elasticity of substitution σ_k. Theory shows that the border effect can arise because a 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. In an industry with a high elasticity σ_k, consumers are so price-sensitive that a high ratio of domestic over bilateral trade does not necessarily reflect high bilateral trade barriers but rather a high degree of competition.[7] In contrast to the *phi*-ness measure, θ_{ij}^k is able to separate this competition effect from the trade barrier effect. As equation (14) shows, a higher elasticity of substitution implies *lower* trade frictions θ_{ij}^k. We therefore argue that θ_{ij}^k improves on the *phi*-ness measure because it accounts for differences in market power and competition across industries.

Finally, we stress that our trade integration measure is valid more generally beyond the particular framework presented above. Although we derive θ_{ij}^k in equation (14) from a model based on a CES structure in combination with the Armington assumption of goods being differentiated by country of origin, we can derive the same measure based on the Ricardian framework by Eaton and Kortum (2002). As the Ricardian gravity equation has the same structure as equation (7), we obtain exactly the same trade integration measure as in equation (14).[8]

3 Data and Descriptive Statistics

To compute our measure of trade integration θ_{ij}^k across industries, countries and time, we need the domestic trade of countries i and j in industry k, x_{ii}^k and x_{jj}^k, as well as their bilateral exports, x_{ij}^k and x_{ji}^k, at time t. As in the previous literature (for instance, Chen, 2004, Evans, 2003, Head and Mayer, 2000, Nitsch, 2000, Wei, 1996), domestic trade for country i is given by its gross output in industry k, y_i^k, minus total exports of country i to the rest of the world in that industry. The elasticities of substitution σ^k are taken from Hummels (2001a).[9] Our sample includes trade flows for 167 manufacturing industries across 11 EU countries at the 4-digit Nace rev.1 level between 1999 and 2003. The sample is balanced over time. The 11 countries are Austria, Denmark, Finland, France, Germany, Italy, Ireland, the Netherlands, Spain, Portugal and the United Kingdom. We provide a detailed description of the data and their sources in the data appendix.[10]

[6] Alternatively, border effects can be estimated from a gravity equation that combines domestic and international trade flows as the dependent variable (Chen, 2004, Evans, 2003, McCallum, 1996, Wei, 1996, Wolf, 2000).

[7] The standard CES markup is given by $\sigma_k/(\sigma_k - 1)$ and thus inversely related to σ_k.

[8] Anderson and van Wincoop (2004) discuss the relationship between their model and the Ricardian framework in more detail. In particular, the parameter that determines productivity differences across countries in the Ricardian model corresponds to the elasticity of substitution in (1) minus one.

[9] Hanson and Xiang (2004) also use the elasticities from Hummels (2001a).

[10] Due to data limitations not all possible trade flow combinations across industries and countries are available. Although it would in principle be possible to span the longer period from 1997 to 2003, this would come at the cost of losing all observations for Germany, a core EU country, because German sectoral output data are missing prior to 1999.

Our dataset comprises a total of 15,510 domestic and bilateral trade flow observations. Only six bilateral trade flows are equal to zero, which is not surprising given the huge volume of intra-industry trade in the EU.[11] Those six cases would usually feature as missing values of θ_{ij}^k. But zero trade flows may contain valuable information as to why such low levels of trade are observed. It therefore seems more appropriate to associate these cases with large trade frictions. The approach we adopt is to replace the zeros with a value of one Euro, thus associating them with large values of θ_{ij}^k.

Table 1 contains summary statistics for individual industries. Due to space constraints we list industries at the more aggregated 3-digit level, reporting averages of θ_{ij}^k over the lower-level 4-digit classifications as well as their maximum and minimum values. Industries are ordered by decreasing value of θ^k, which ranges from 146.91 to 1.32. We also report the average elasticities of substitution σ^k and the average weight-to-value ratios, measured as kilograms per Euro exported.

A first cursory glance at Table 1 attests the intuitive nature of the trade integration measure θ_{ij}^k. Trade integration is lowest for Bricks, followed by Cement, lime, plaster. The latter is also the industry with the largest average weight-to-value ratio (over 13 kg/Euro), indicating a very low transportability of the goods. Another related industry is Articles of concrete. Note that the geographic market for cement and concrete is very local since the perishable nature of such "wet" products constrains the distance over which they can be delivered.

Printing and Publishing are traded very little, too, which is hardly surprising given the reliance of such products on specific languages. This finding is consistent with earlier studies showing that trade in such sectors is subdued. Harrigan (1996) shows that the volume of trade relative to output in the OECD in 1985 is the lowest in Printing and Publishing. Finally, some of the sectors with high values of θ^k belong to the food industry, for which the perishability of many goods is most likely an important deterrent to trade. For example, Fruit and vegetables are ranked in fourth place, and Other food products display the biggest individual value of θ^k equal to 1056.

Table 2 reports the average level of θ_i for the 11 individual countries in our sample. Ireland appears as the least integrated country, followed by Spain, Denmark, Finland and Italy, whereas France, the Netherlands and Germany are the most trade integrated.

Finally, Figure 1 plots the time series evolution of θ_t, averaged across countries and industries. It is interesting to observe that despite large fluctuations from one year to the next, trade frictions display a downward trend, suggesting that the countries and industries we consider have on average become more bilaterally integrated over time.

4 Empirical Results

In the first part of this section, we analyze the determinants of trade integration across countries, industries and years. In the second part, we focus on the time series patterns of trade integration.

[11] The industries with zero trade flows are Furniture, Publishing, Other products of wood and Structural metal products. We consider those observations as "true zeros" because the corresponding output values are positive but exports are zero. We exclude the cases where output is zero but exports are positive as well as the cases where both output and exports are zero.

Third, we decompose the growth in trade over the sample period into three components – the growth of manufacturing output, lower bilateral trade barriers and changes in multilateral factors.

4.1 The Determinants of Trade Integration

We first analyze the determinants of EU trade integration. We estimate

$$\theta^k_{ij,t} = \psi_t + \lambda_K + \beta\ Geo^k_{ij,t} + \zeta\ Policy^k_{ij,t} + \alpha\ Costs^k_{ij,t} + \gamma\ Controls^k_{ij,t} + \epsilon^k_{ij,t} \qquad (15)$$

where $Geo^k_{ij,t}$ is a set of variables related to geography and transportation costs, $Policy^k_{ij,t}$ is a set of policy related factors, $Costs^k_{ij,t}$ includes other types of costs such as information costs and fixed costs of exporting, and $Controls^k_{ij,t}$ includes variables controlling for measurement issues. Given that some of the explanatory variables vary across sectors only, we include industry fixed effects λ_K but at the more aggregated level of 3-digit industries, assuming that the 4-digit groupings k are just different varieties of the corresponding, more aggregated 3-digit sector K (Hummels, 2001a). The inclusion of other explanatory variables that vary across country pairs only precludes us from controlling for country pair fixed effects.[12] ψ_t denotes year intercepts. β, ζ, α and γ are vectors of coefficients to be estimated and $\epsilon^k_{ij,t}$ is an error term. A higher value of θ^k_{ij} should be interpreted as a lower degree of trade integration.

In a recent contribution, Santos Silva and Tenreyro (2006) show that under heteroskedasticity, coefficient estimates from log-linear regressions estimated by OLS can be strongly biased. They instead recommend to use the Poisson Pseudo-Maximum Likelihood (PPML) estimator, in which case the dependent variable is expressed in levels so that zero observations can be easily included in the estimations. Martin and Pham (2008) confirm that the PPML estimator solves the heteroskedasticity bias problem, but instead show that this estimator yields severely biased estimates when the dependent variable takes on many zero values. As our dependent variable does not take on zero values but heteroskedasticity is likely to be present, the PPML estimator appears adequate for our purposes.[13] To control for possible autocorrelation in each of the individual series of the panel, robust standard errors are adjusted for clustering at the 4-digit Nace rev. 1 level in each country pair (15,510/5=3102 clusters).

Geography/Transportation Costs Variables Table 3 reports our main results. Column (1) only includes variables that are related to geography and transportation costs. Across countries, standard gravity variables perform well in explaining the variation of trade integration. Trade integration decreases with international distances D_{ij} and increases with domestic distances $D_{ii} \times D_{jj}$. It is higher between countries that share a common border Adj_{ij} but is not significantly affected by a common language $Lang_{ij}$.

We also consider proxies of transportation costs that vary across industries. First, we consider the ratio of *c.i.f.* and *f.o.b.* trade values for each industry and country pair, averaged in each year

[12] As a robustness check, we show that our results hold up with country pair fixed effects, see Section 5.

[13] As a robustness check, we also report the results obtained by OLS, see Section 5.

across all EU partners in order to minimize measurement error, $cfob_t^k$ (Harrigan, 1993).[14] Second, we consider the weight-to-value ratio of exports for each industry and country pair, also averaged in each year across all partners, wv_t^k. We do not consider *bilateral* weight-to-value ratios as Hillberry and Hummels (2000) show that bilateral weight to value significantly falls with distance. This suggests that the commodity composition of trade is sensitive to bilateral costs and that weight to value is endogenous.[15] Overall, since the freight component of trade costs is higher for bulky, high weight-to-value raw materials than for manufactures, weight to value should be associated with higher values for θ_{ij}^k. As expected, higher transportation costs as proxied by $cfob_t^k$ and wv_t^k decrease trade integration, as can be seen from Column (1).

Note that when estimating the specification in Column (1) by OLS with fixed effects (results available upon request), the sign and significance of the estimated coefficients are very similar to those in Column (1). But we can reject at the one percent level the hypothesis of homoskedasticity, justifying our choice of the PPML estimator throughout the paper.

Policy Variables In Column (2) we consider the role of several policy-related factors in affecting trade integration. Across countries, we include a dummy variable for Finland and Austria, FI, AT_{ij}, as these two countries were the last in our sample to join the EU (in 1995), and they appear less integrated compared to the other countries. We also explore the effect of not adopting the Euro by including a dummy variable, $noEURO_{ij,t}$, which is equal to one for Denmark and the United Kingdom from 2002 onwards when the common currency was introduced.[16] As expected, non-adoption of the Euro has lowered the extent of trade integration for these two countries since 2002.

We also add a variable to capture the effects of the Schengen Agreement. This agreement abolished physical border controls among participating EU countries. The date of the first implementation of the agreement differs across countries. Ireland and the United Kingdom have not started implementation yet. The coefficient on this variable, $Schengen_{ij,t}$, is negative and highly significant in Column (2), suggesting that the abolition of border controls among the participating countries has helped to foster trade integration, most probably through the elimination of time delays and administrative burdens that were previously experienced at borders.

We also consider policy variables that vary across industries. First, we address the role of Technical Barriers to Trade (TBTs). TBTs result from norms (regulations and standards) that affect the sale of goods in some markets by requiring specific product characteristics or production processes. Baldwin (2000) stresses the importance of TBTs in shaping trade flows between countries and industries. He argues that in the case of Europe, such barriers have become more and more visible over

[14] Apart from insurance and other possible discrepancies between partners, the ratio of *c.i.f.* and *f.o.b.* for intra-EU trade values mostly captures transportation costs by *road*. In 1998, 57.8 percent of total intra-EU15 trade went by road, 22.8 percent by sea, 3.9 percent by rail, 3.9 percent by air, 0.9 percent by inland waterways and 0.8 percent by pipeline (European Commission, 2000).

[15] Harrigan (2005) and Baldwin and Harrigan (2007) also find that export unit values are positively related to distance.

[16] The Euro exchange rates were fixed in 1999 but Euro notes and coins and thus a greater degree of transparency only followed in 2002. The huge literature on the trade-creating effects of currency unions raises the issue of endogeneity of the common currency dummy (Rose, 2000, Baldwin, 2006). In this paper we do not attempt to explain why Denmark and the United Kingdom opted out of the Euro.

time, especially since tariff barriers were completely eliminated by 1968.[17] In addition, TBTs are a predominant concern in today's global trade negotiations and for the WTO in particular. Data on TBTs are however hard to find, so our approach to measuring TBTs uses two different sources of information: a cross-country survey of EU managers who reveal whether they consider TBTs a problem for trade, and a ranking of industries according to the relevance of TBTs. The interacted variable, TBT_{ij}^k, increases with the extent of TBTs across countries and industries. The data appendix provides details. In Column (2) TBTs are found to lower trade integration, suggesting that some room is left for policy action and that the removal of such barriers might promote trade integration. This result is consistent with Chen (2004) who finds that TBTs in Europe are associated with larger border effects in international trade.

As is often the case, results based on survey data should be interpreted with caution. In particular, the cross-country measurement of TBTs might be problematic. For instance, if a manager states that TBTs are not a problem, this does not necessarily mean that TBTs are absent or unimportant. Instead, if that manager's company or industry is protected by TBTs initiated by his country, he might actually like them. This possibility might bias our cross-country measurement of TBTs. In Column (3) we therefore report estimates when only including our industry-specific variable on TBTs, TBT^k. The results remain consistent, i.e., when TBTs are high, trade integration is low.[18]

Furthermore, it is well-established that national governments often favor domestic over foreign firms for some of their purchases, even if foreign suppliers could actually offer them a better deal (Davies and Lyons, 1996). Firms in such "public procurement" markets are hence protected from foreign imports, sometimes to such an extent that trade may be completely suppressed. In the last few years, competition has been steadily increasing in those markets, with the proportion of EU15 public procurement contracts openly advertised in the *Official Journal* of the EU steadily increasing from 8.4 percent in 1995 to 16.8 percent in 2005 (Eurostat). To investigate whether this opening of the markets has helped to lower trade frictions, we rely on time-varying cross-country data on the share of public procurement contracts advertised in the *Official Journal* and compute the average across partners. As similar data across industries are not always available, we compute an indicator variable for high public procurement sectors.[19] We interact this indicator variable with the time-varying data for each country pair, denoting the variable so obtained by $Proc_{ij,t}^k$. Column (2) reveals that the opening of public procurement markets to foreign competition has indeed been successful in fostering trade integration across countries, industries and over time.

Next, Value-Added Taxes (VATs), which differ extensively across EU countries and goods, are characterized by the so-called "destination principle": VAT for a good is paid in the country where it is sold, not where it is manufactured, implying that VATs uniformly affect domestic output and imports while they are rebated on domestic exports. It is therefore common belief that VATs discourage imports and the consumption of domestic goods. In turn, this suggests that in our model the

[17] 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."

[18] The use of this sectoral variable on TBTs might be criticized on the grounds that it captures changes in TBTs rather than levels (see the data appendix). As in Chen (2004), we experimented using a dummy variable only, which is equal to one when TBTs are present. The results remain unaffected.

[19] Examples of high public procurement industries are Shipbuilding, Rail stock, Pharmaceuticals, Aerospace, Telecoms.

imposition of VATs by country i will increase both domestic t_{ii} and importing costs t_{ji} by the same proportion, leaving bilateral trade integration θ_{ij}^k unchanged. In Column (2) we include the log of one plus the average VAT rate across partners at the sectoral level, VAT_{ij}^k, and interestingly find that higher VATs significantly lower trade frictions.

One possible interpretation relates to VAT fraud. Baldwin (2006) documents that VAT fraud is a very serious problem in the EU. Since the removal of Europe's internal borders in 1993, trade statistics are now collected by VAT authorities, creating a direct correlation between trade statistics and VAT fraud: EU firms have an incentive to over-report their exports (to get the VAT rebate) and to under-report their imports (which are subject to VAT). This inflates export statistics relative to import statistics. As a result, in the countries and industries where VATs are high, the value of θ_{ij}^k might be lower simply because intra-EU export statistics are inflated due to VAT fraud.[20]

Other Costs Another factor of interest relates to informational 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 assess their reliability. In that context, multinational firms enjoy some informational advantages over other firms. To capture the role of informational costs, we construct a dummy variable for multinational industries.[21] As expected, highly multinational industries are characterized by lower trade frictions (Column 4).

The new trade literature on heterogeneous firms rationalizes why some firms export while others do not. In particular, the models in papers by Melitz (2003), Melitz and Ottaviano (2008) and others show that only the most productive firms participate in foreign markets as only those are productive enough to cover the fixed costs of exporting abroad. Due to this selection effect we should observe that ceteris paribus, more productive industries trade more on foreign markets than less productive industries, i.e., we should observe a negative relationship between productivity and trade integration θ_{ij}^k. In fact, a growing empirical literature shows that as trade costs fall, less efficient firms exit from the market and average industry productivity increases (see Bernard, Jensen and Schott, 2006, for the U.S. and Greenaway and Kneller, 2008, for the UK). In Column (5) of Table 3 we therefore include the average real labor productivity across industries and countries. Since productivity innovations feed into exports and domestic trade, we lag the variable by one year, $Prod_{ij,t-1}^k$, reducing the number of observations by one cross section. The negative relationship between productivity and θ_{ij}^k confirms the prediction that more productive industries trade more on foreign markets.[22]

We also include a dummy variable in Column (5) that controls for the six zero trade observations in our sample, $Zeros_{ij,t}^k$. We find that trade frictions between two countries in a given industry are stronger whenever either of them does not export. As theory predicts that firms only export if they are able to cover the fixed costs of exporting, this result can be interpreted as reflecting the role of these fixed costs.

[20] If the intra-EU exports of country i are inflated because of VAT fraud, then x_{ij}^k will be high relative to x_{ii}^k, leading to a lower value of θ_{ij}^k.

[21] Examples are Computers and office machinery, Soap and detergents, Television and radio, Glass. See the data appendix for details.

[22] We also tried to use data on productivity for a country that is not included in our sample, i.e., the U.S. But those data are aggregated at the 2-digit level and proved insignificant in explaining trade integration across EU countries, possibly due to the higher level of aggregation.

Controls Finally, we control for some measurement issues and the possibility that the magnitude of θ_{ij}^k may be affected by the nature of trade. In particular, the value of θ_{ij}^k computed under intra-industry trade will be lower than under comparative advantage driven by technology or factor endowment differences across countries, even if the actual friction is the same.[23] To control for this potential bias we compute the (absolute) difference in capital shares between countries and industries in order to proxy for differences in factor endowments. For a larger differential in capital shares, trade is more likely based on comparative advantage, leading to an "over-estimate" of θ_{ij}^k. As expected, this variable, $KS_{ij,t}^k$, displays a significantly positive coefficient in Column (6) but its inclusion leaves the coefficients on the other variables unchanged.

The previous reasoning presumes that differences in factor endowments can 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. Industry classifications inevitably aggregate many different types of products into one single category so that the volume of intra-industry trade can appear 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 resources or technologies in which one country has a comparative advantage. However, since all these types of steel are aggregated into one category, it appears as if the countries export and import "identical" products while in reality they export one type of steel and import another type.

It follows that the larger the number of varieties in each industry category, the more likely the industry aggregates trade flows that represent different comparative advantages in different varieties. But the data only indicate intra-industry trade, i.e., more balanced trade flows between i and j. The resulting θ_{ij}^k would therefore be smaller because the denominator would be the product of two more or less balanced (intra-industry) trade flows at the *sectoral* level, while in reality the two trade flows would be aggregates of unbalanced (inter-industry) trade flows at the *product* level. To control for this aggregation bias, we include the number of product categories within each industry, $Goods^k$. A larger number of varieties should be associated with a lower value for θ_{ij}^k, which is indeed the case in Column (6). But the inclusion of this control does not affect any of the other estimated coefficients.

Finally, in Column (7) we replicate the specification of Column (6) but replace the country-varying variable on TBTs by the sectoral variable, TBT^k. It is reassuring that all results remain unchanged, providing some evidence that they are not biased by the use of cross-country survey data on TBTs.

4.2 The Evolution of Trade Integration Over Time

To investigate the evolution of trade integration over time, we run the following regression

$$\theta_{ij,t}^k = \gamma_{ij}^k + \psi_t + \alpha \ \ln wv_{ij,t}^k + \varepsilon_{ij,t}^k \tag{16}$$

where γ_{ij}^k are country pair dummies interacted with industry intercepts (at the 4-digit level) to control for systematic differences between trade partners in each industry. The *bilateral* weight-to-value $wv_{ij,t}^k$

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

controls for compositional change over time (see Hummels, 2007).[24] The evolution of θ_{ij}^k is given by the estimated coefficients on the year dummies ψ_t. The PPML estimator is again used to estimate (16).

The annualized growth rate of the coefficients on the year dummies obtained from estimating equation (16) is equal to -2.27 percent over our pooled sample with a t-statistic of 1.83. This result is not highly significant, but given the large year-to-year fluctuations in Figure 1 and the short time period considered this might not be surprising. However, we can still conclude that trade integration has on average improved between 1999 and 2003.

We also estimate equation (16) separately for each industry. Figure 2 plots the annualized growth rates for the individual industries, distinguishing between significant (at the ten percent level) and insignificant growth rates.[25] Most industries did not experience any significant change over time (108 industries out of 163). However, among the industries that did, the vast majority (44 out of 55 significant) experienced an increase in trade integration. Office machinery displays the strongest improvement, while trade integration worsened for Articles of concrete, Other glass, followed by Paper and Chemicals. Note that according to equation (14), in the few cases where θ_{ij}^k increases over time, the worsening in bilateral trade integration could reflect a fall in domestic trade costs, $t_{ii}^k t_{jj}^k$, rather than an increase in bilateral trade costs, $t_{ij}^k t_{ji}^k$.

Lacking any product or firm-level data, we are not able to investigate whether the deepening of trade integration over time is due to the extensive or intensive margin of trade. On the one hand, Hummels and Klenow (2005) report evidence in favor of the extensive margin, while Helpman, Melitz and Rubinstein (2008) and Besedeš and Prusa (2007) argue that the intensive margin is quantitatively more important. To investigate this issue we would ideally need to observe more years and more highly disaggregated data. We leave this question for future research.

4.3 Explaining the Growth in Trade

In this section we decompose the growth of bilateral trade into three basic contributions – (1) the growth of manufacturing output, (2) lower bilateral trade barriers and (3) changes in multilateral factors. These three contributions can be obtained by rearranging equation (11) as

$$\begin{aligned} x_{ij}^k x_{ji}^k &= y_i^k y_j^k \left(\frac{t_{ij}^k t_{ji}^k}{t_{ii}^k t_{jj}^k} \right)^{1-\sigma_k} \frac{x_i^k x_j^k}{y^k y^k} \left(\frac{\Pi_i^k P_i^k \Pi_j^k P_j^k}{t_{ii}^k t_{jj}^k} \right)^{\sigma_k - 1} \\ &= y_i^k y_j^k \left(\theta_{ij}^k \right)^{2(1-\sigma_k)} \frac{x_i^k x_j^k}{y^k y^k} \left(\frac{\Pi_i^k P_i^k \Pi_j^k P_j^k}{t_{ii}^k t_{jj}^k} \right)^{\sigma_k - 1} \end{aligned} \tag{17}$$

[24] In contrast to the previous section, we now consider the *bilateral* weight-to-value as distance is not included in the regression.

[25] Equation (16) is estimated separately for only 163 industries due to an insufficient number of observations for the other 4 industries. To conserve space we do not report the annualized growth rates for each industry but they are available upon request.

Using the solution for the multilateral resistance terms in (10), we can express the last two fractions on the right-hand side of equation (17) in terms of observable variables, yielding

$$x_{ij}^k x_{ji}^k = y_i^k y_j^k \left(\theta_{ij}^k\right)^{2(1-\sigma_k)} \frac{x_{ii}^k}{y_i^k} \frac{x_{jj}^k}{y_j^k} \tag{18}$$

We now take logs and first differences of equation (18) and divide by the left-hand side to obtain our decomposition equation

$$100\% = \underbrace{\frac{\Delta \ln\left(y_i^k y_j^k\right)}{\Delta \ln\left(x_{ij}^k x_{ji}^k\right)}}_{\text{(First factor)}} + \underbrace{2(1-\sigma_k)\frac{\Delta \ln\left(\theta_{ij}^k\right)}{\Delta \ln\left(x_{ij}^k x_{ji}^k\right)}}_{\text{(Second factor)}} + \underbrace{\frac{\Delta \ln\left(\frac{x_{ii}^k}{y_i^k}\frac{x_{jj}^k}{y_j^k}\right)}{\Delta \ln\left(x_{ij}^k x_{ji}^k\right)}}_{\text{(Third factor)}} \tag{19}$$

The denominator on the right-hand side of equation (19) is the growth of bilateral trade between countries i and j in industry k. The first factor thus represents the contribution of output growth in the growth of bilateral trade. The second factor is the contribution of the decline in bilateral trade frictions in that industry. If bilateral trade frictions decline, then $\Delta \ln\left(\theta_{ij}^k\right) < 0$ and as $\sigma_k > 1$, it follows that the contribution of the second factor is positive (given positive trade growth $\Delta \ln\left(x_{ij}^k x_{ji}^k\right) > 0$). The third factor is the contribution of changes in multilateral factors. In particular, from equation (17) it can be seen that this factor captures changes in world demand shares and changes in multilateral resistance relative to domestic trade costs. Suppose that multilateral resistance falls all else being equal, i.e., $\Delta \ln\left(\Pi_i^k P_i^k \Pi_j^k P_j^k\right) < 0$ so that $\Delta \ln\left(\frac{x_{ii}^k}{y_i^k}\frac{x_{jj}^k}{y_j^k}\right) < 0$, implying that the third factor is 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.

For each country pair, industry and year, we calculate each factor in equation (19) where all variables are deflated using GDP deflators. Table 4 reports the growth in trade and its respective the contributions of each factor.

[*to be completed*]

5 Robustness

In this section we report a number of alternative specifications we implemented to ensure the robustness of our conclusions. First, in Column (1) of Table A1, we estimate our main specification by OLS and with fixed effects. As explained above, under heteroskedasticity such approach is likely to lead to biased coefficients, but a comparison with the results obtained with the PPML estimator is nevertheless of interest. The magnitude of the estimated coefficients differs somewhat as compared to those obtained with PPML. While sharing a common language now significantly increases trade integration, informational costs are no longer significant. Second, we verify in Columns (2) and (3) that the results are robust to the inclusion of country pair fixed effects interacted with year dummies and to the exclusion of the six series that contain zero trade observations.

We also want to make sure that our results are not driven by observations that are economically small. For instance, in Table 3 we find that the effect of remaining outside the Eurozone is typically significant. But the dummy that captures the effect is equal to unity in only 1860 cases out of a total of 15510 observations (i.e., 12 percent of the sample), and roughly half of those cases involve Denmark, one of the smallest economies in our sample. We therefore run a PPML regression where the observations are weighted by the bilateral export share of total exports. The results, reported in Column (4), reveal that a significant non-Eurozone effect is still present, although smaller in size. Sharing a common language now increases trade integration while informational costs are no longer significant.

With panel data, one issue relates to the computation of θ_{ij}^{k} in *real* terms. Ideally, for deflating one would need domestic price indices for the numerator and export price indices for the denominator in equation (14). Export price indices are not available, so common practice it to use domestic deflators instead (Baldwin and Taglioni, 2006). In that case, the deflators in (14) cancel out and using nominal or real variables yields the same values for θ_{ij}^{k} (which is the approach we have followed in the paper). Since there are reasons to believe that domestic and export price indices differ from each other, for instance in the case of pricing-to-market practices, we need to tackle this empirical problem up-front.

One way of doing this is to include a set of time-varying sector (3-digit) fixed effects, which leaves our results unaffected (Column 5). A second way is to run cross-sectional regressions only, as we do in Table A2. This approach comes at the cost of strongly reducing the number of observations for each regression so that not all variables are significant in all years, but overall the results largely hold up.[26] It is interesting that the magnitude of the coefficient on the non-Eurozone dummy substantially increases between 2002 and 2003, suggesting that the negative effect of not adopting the Euro might have strengthened over time. There is also some evidence that the importance of TBTs increased in the last three years. Finally, the coefficients on distance remain stable.[27]

In order to compare how θ_{ij}^{k} performs relative to alternative measures of trade integration, we use the *phi*-ness of trade as a dependent variable in Column (6) of Table A1. This implicitly assumes that the elasticity of substitution is equal to 1.5 for all industries so that the exponent in equation (14) becomes unity. The PPML estimator does not converge in that case, and as a second best we estimate the regression by OLS and compare the results to Column (1) where the dependent variable is our measure of trade integration and the estimation is also OLS. Although their signs remain mostly unchanged, the size of the estimated coefficients is radically different. Moreover, with the exception of the language dummy, sharing a common border, opting out of the Euro, TBTs and informational costs are no longer significant and thus no longer play an important statistical role in explaining the variation of trade integration across industries and countries.[28]

[26] Lagged productivity is omitted for 1999.

[27] This contrasts with Coe, Subramanian and Tamirisa (2007) and Berthelon and Freund (2008) who find evidence of a decreasing and an increasing effect of distance over time, respectively.

[28] We also tried to use the elasticities from Broda and Weinstein (2006) for the U.S. in computing θ_{ij}^{k}. However, this led to large outliers in θ_{ij}^{k} and the overall results were poor. They are available upon request.

6 Concluding Remarks

This paper explores the sources and size of trade impediments. Measuring these impediments directly is often difficult because of data limitations. Instead, we indirectly infer trade impediments from observable trade flows. 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 novel micro-founded measure of bilateral trade integration that controls for time-varying multilateral resistance and that can be applied to disaggregated panel data.

From an empirical perspective, we use this micro-founded measure to explore the key determinants of trade integration across countries and industries in the European Union. We show that cross-country trade integration is lower for those countries in our sample that joined the EU most recently and that opted out of the Euro common currency, but it is higher for countries that have implemented the Schengen Agreement. We also document a considerable variation of trade integration across industries. Consistent with the literature on firm heterogeneity, we find that industries with higher productivity trade more on international markets. Trade integration is hampered by transportation costs as captured by industry-specific weight-to-value and *c.i.f./f.o.b.* ratios. Trade integration is also severely hampered by policy factors, in particular Technical Barriers to Trade and intransparent public procurement procedures. Our findings suggest for public policy that gains from improved international trade integration are possible through the elimination of TBTs and through more transparent advertising of public procurement contracts.

Moreover, we find that trade integration has improved on average between 1999 and 2003. We also find that roughly 56 percent of the growth in trade can be accounted for by improvements in trade integration through a decrease in bilateral and multilateral trade barriers, while the rest can be attributed to increases in manufacturing output.

To conclude, our measure yields sensible systematic differences in trade integration across industries, suggesting that modeling trade costs as a "one-fits-all" impediment is clearly at odds with empirical evidence. Instead, when dealing with industry-level data it is important to allow for trade cost heterogeneity across industries.

Ultimately, of course even highly disaggregated industry-level data "can never be as fine as reality, so some degree of aggregation bias is inevitable" (Anderson and van Wincoop, 2004, p.729). Thus, the use of industry-level data does not allow us to explore the determinants and change of trade impediments at the firm or product level. In our view, analyzing trade barriers at these very fine levels of disaggregation is a natural and important next step.

References

Anderson J.E. and E. van Wincoop, 2002, Borders, Trade, and Welfare, *Brookings Trade Forum.* In: Collins and Rodrik, Eds., Washington: Brookings Institution, 207-244.

Anderson J.E. and E. van Wincoop, 2003, Gravity with Gravitas: A Solution to the Border Puzzle, *American Economic Review* 93(1), 170-192.

Anderson J.E. and E. van Wincoop, 2004, Trade Costs, *Journal of Economic Literature* 42(3), 691-751.

Baier S.L. and J.H. Bergstrand, 2001, The Growth of World Trade: Tariffs, Transport Costs, and Income Similarity, *Journal of International Economics* 53(1), 1-27.

Baldwin R.E., 2000, Regulatory Protectionism, Developing Nations, and a Two-Tier World Trade System, *Brookings Trade Forum.* In: Collins and Rodrik, Eds., Washington: Brookings Institution, 237-293.

Baldwin R.E., 2006, The Euro's Trade Effects, *European Central Bank Working Paper* 594.

Baldwin R.E., Forslid R., Martin P., Ottaviano G.I.P. and F. Robert-Nicoud, 2003, The Core-Periphery Model: Key Features and Effects. In: Heijdra and Brakman, Eds., The Monopolistic Competition Revolution in Retrospect, Cambridge University Press, 213-235.

Baldwin R.E. and J. Harrigan, 2007, Zeros, Quality and Space: Trade Theory and Trade Evidence, *NBER Working Paper* 13214.

Baldwin R.E. and D. Taglioni, 2006, Gravity for Dummies and Dummies for Gravity Equations, *NBER Working Paper* 12516.

Bergstrand J., 1989, The Generalized Gravity Equation, Monopolistic Competition, and the Factor-Proportions Theory in International Trade, *Review of Economics and Statistics* 71(1), 143-153.

Bergstrand J., 1990, The Heckscher-Ohlin-Samuelson Model, the Linder Hypothesis and the Determinants of Bilateral Intra-Industry Trade, *Economic Journal* 100(403), 1216-1229.

Bernard A.B., Jensen J.B. and P.K. Schott, 2006, Trade Costs, Firms and Productivity, *Journal of Monetary Economics* 53(5), 917-937.

Berthelon M. and C. Freund, 2008, On the Conservation of Distance in International Trade, *Journal of International Economics* 75(2), 310-320.

Besedeš T. and T.J. Prusa, 2007, The Role of Extensive and Intensive Margins and Export Growth, *NBER Working Paper* 13628.

Broda C. and D.E. Weinstein, 2006, Globalization and the Gains from Variety, *Quarterly Journal of Economics* 121(2), 541-585.

Chen N.A., 2004, Intra-National Versus International Trade in the European Union: Why Do National Borders Matter?, *Journal of International Economics* 63(1), 93-118.

Coe D.T., Subramanian A. and N.T. Tamirisa, 2007, The Missing Globalization Puzzle: Evidence of the Declining Importance of Distance, *IMF Staff Papers* 54(1), 34-58.

Combes P.-P. and M. Lafourcade, 2005, Transport Costs: Measures, Determinants, and Regional Policy Implications for France, *Journal of Economic Geography* 5(3), 319-349.

Davies S. and B. Lyons, 1996, Industrial Organization in the European Union – Structure, Strategy, and the Competitive Mechanism, Oxford University Press.

Eaton J. and S. Kortum, 2002, Technology, Geography and Trade, *Econometrica* 70(5), 1741-1779.

European Commission, 1998, Technical Barriers to Trade. The Single Market Review, Subseries III: Dismantling of Barriers 1.

European Commission, 2000, EU Transport in Figures – Statistical Pocket Book, Directorate General for Energy and Transport.

European Commission, 2006, Internal Market: Opinions and Experiences of Businesses in EU-15, *Flash Eurobarometer 180*, TNS Sofres/EOS Gallup Europe.

European Commission, 2008, VAT Rates Applied in the Member States of the European Community, DOC/2412/2008 – EN.

Evans C.L., 2003, The Economic Significance of National Border Effects, *American Economic Review* 93(4), 1291-1312.

Evans C.L. and J. Harrigan, 2005, Distance, Time, and Specialization: Lean Retailing in General Equilibrium, *American Economic Review* 95(1), 292-313.

Greenaway D. and R. Kneller, 2008, Exporting, Productivity and Agglomeration, *European Economic Review* 52(5), 919-939.

Hanson G.H. and C. Xiang, 2004, The Home-Market Effect and Bilateral Trade Patterns, *American Economic Review* 94(4), 1108-1129.

Harrigan J., 1993, OECD Imports and Trade Barriers in 1983, *Journal of International Economics* 35(1/2), 91-111.

Harrigan J., 1996, Openness to Trade in Manufactures in the OECD, *Journal of International Economics* 40(1/2), 23-39.

Harrigan J., 2005, Airplanes and Comparative Advantage, *NBER Working Paper* 11688.

Head K. and T. Mayer, 2000, Non-Europe: The Magnitude and Causes of Market Fragmentation in the EU, *Weltwirtschaftliches Archiv* 136 (2), 285-314.

Head K. and T. Mayer, 2004, The Empirics of Agglomeration and Trade, *Handbook of Regional and Urban Economics*, Chapter 59, North-Holland.

Head K. and J. Ries, 2001, Increasing Returns Versus National Product Differentiation as an Explanation for the Pattern of US-Canada Trade, *American Economic Review* 91(4), 858-876.

Helpman E., Melitz M.J. and Y. Rubinstein, 2008, Estimating Trade Flows: Trading Partners and Trading Volumes, *Quarterly Journal of Economics* 123(2), 441-487.

Hillberry R. and D. Hummels, 2000, Explaining Home Bias in Consumption: Production Location, Commodity Composition and Magnification, Purdue University, mimeo.

Hummels D., 2001a, Toward a Geography of Trade Costs, mimeo.

Hummels D., 2001b, Time as a Trade Barrier, mimeo.

Hummels D., 2007, Transportation Costs and International Trade in the Second Era of Globalization, *Journal of Economic Perspectives* 21(3), 131-154.

Hummels D. and P.T. Klenow, 2005, The Variety and Quality of a Nation's Exports, *American Economic Review* 95(3), 704-723.

Jacks D.S., C.M. Meissner and D. Novy, 2008, Trade Costs, 1870-2000, *American Economic Review* 98(2), Papers & Proceedings, 529-534.

Limão N. and A.J. Venables, 2001, Infrastructure, Geographical Disadvantage and Transport Costs, World Bank Economic Review 15, 451-479.

Martin W. and C.S. Pham, 2008, Estimating the Gravity Model when Zero Trade Flows Are Frequent, mimeo.

McCallum J., 1995, National Borders Matter: Canada-US Regional Trade Patterns, *American Economic Review* 85(3), 615-623.

Melitz M.J., 2003, The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity, *Econometrica* 71(6), 1695-1725.

Melitz M.J. and G.I.P. Ottaviano, 2008, Market Size, Trade, and Productivity, *Review of Economic Studies* 75(1), 295-316.

Nitsch V., 2000, National Borders and International Trade: Evidence from the European Union, *Canadian Journal of Economics* 33(4), 1091–1105.

Novy D., 2008, Gravity Redux: Measuring International Trade Costs with Panel Data, mimeo.

Rangan S. and R.Z. Lawrence, 1999, Search and Deliberation in International Exchange: Learning from Multinational Trade about Lags, Distance Effects, and Home Bias. *NBER Working Paper* 7012.

Rauch J.E., 1999, Networks Versus Markets in International Trade, *Journal of International Economics* 48 (1), 7– 35.

Rose A.K., 2000, One Money, One Market: Estimating the Effect of Common Currencies on Trade, *Economic Policy* 30, 7-45.

Santos Silva J.M.C. and S. Tenreyro, 2006, The Log of Gravity, *Review of Economics and Statistics* 88(4), 641–658.

Wei S.-J., 1996, Intra-National versus International Trade: How Stubborn Are Nations in Global Integration? *NBER Working Paper* 5531.

Wolf H.C., 2000, Intranational Home Bias in Trade, *Review of Economics and Statistics* 82(4), 555-563.

Table 1: Descriptive Statistics for Individual Industries

3-digit Nace Industry	θ^k	min θ^k	max θ^k	σ^k	wv^k
Bricks	146.91	5.52	994.94	2.65	4.92
Cement, lime, plaster	109.88	23.21	480.73	2.52	13.36
Stone	54.67	8.29	552.31	2.65	2.14
Fruit, vegetables	41.58	6.11	387.65	2.46	1.03
Articles of concrete, plaster, cement	25.12	2.24	581.78	3.24	3.11
Ceramic tiles, flags	18.15	2.00	266.85	2.65	1.75
Sawmilling, planing of wood	14.75	2.33	106.51	3.36	2.28
Jewellery	14.00	1.95	72.17	3.48	0.01
Other food products	11.31	1.53	1056.31	4.81	0.58
Wooden containers	10.27	2.46	87.53	3.99	2.14
Furniture	9.98	1.81	157.52	3.64	0.25
Ceramic goods	9.66	0.86	157.07	3.27	0.71
Prepared animal feeds	9.57	1.04	42.25	3.61	1.75
Glass	8.93	0.80	122.86	3.09	0.84
Builders' carpentry, joinery	8.69	2.74	48.50	3.99	0.51
Processing of iron, steel	6.90	1.71	30.51	3.53	1.10
Publishing	6.66	1.02	78.18	4.88	0.17
Printing	6.39	1.60	21.38	5.58	0.29
Other non-metallic mineral products	5.88	1.23	34.85	2.96	0.57
Other products of wood	5.85	1.79	25.51	4.13	0.37
Structural metal products	5.84	2.27	37.71	4.79	0.36
Tanks, reservoirs	4.48	1.40	22.47	4.76	0.29
Tubes	4.30	1.73	21.12	3.53	0.94
Weapons, ammunition	4.09	2.35	8.80	4.88	0.13
Paper, paperboard	4.00	1.37	12.18	4.64	0.37
Leather clothes	4.00	2.97	5.20	5.66	0.02
Rubber products	3.90	0.80	10.21	3.88	0.26
Fish	3.73	1.35	12.61	4.71	0.33
Pulp, paper, paperboard	3.50	1.36	12.60	4.28	1.71
Other fabricated metal products	3.29	1.24	17.52	4.89	0.39
Plastic products	2.95	1.29	11.41	5.36	0.28
Grain mill products	2.79	1.65	8.76	5.05	1.69
Miscellaneous manufacturing	2.78	1.41	8.01	4.99	0.13
Wearing apparel	2.74	0.70	15.42	5.66	0.09
Cutlery	2.64	1.17	7.08	4.85	0.10
Musical instruments	2.58	1.13	5.09	4.88	0.05
Ships, boats	2.57	1.27	4.70	7.40	0.27
Steam generators	2.53	1.39	6.08	7.87	0.20
Dairy products	2.47	1.57	5.60	6.77	0.52
Luggage, handbags	2.45	1.41	4.20	6.18	0.07

(continued next page)

Table 1 (continued)

3-digit Nace Industry	θ^k	min θ^k	max θ^k	σ^k	wv^k
Soap, detergents	2.39	1.43	10.55	5.74	0.57
Other transport equipment	2.30	1.39	5.05	7.11	0.27
Tobacco	2.29	2.02	2.54	6.62	0.26
Paints, varnishes	2.27	1.41	4.93	6.37	0.44
Basic chemicals	2.22	1.07	6.40	6.09	0.87
Knitted, crocheted articles	2.14	0.71	5.77	6.90	0.04
Electrical equipment	2.11	0.94	4.70	5.94	0.06
Railway locomotives	2.10	1.31	4.74	7.40	0.13
Lighting equipment	2.10	1.19	4.26	5.17	0.09
Insulated wire, cable	2.10	1.26	3.27	5.88	0.19
Electricity distribution apparatus	2.01	1.33	2.80	5.88	0.04
Sports goods	2.00	0.68	3.79	4.88	0.12
Knitted, crocheted fabrics	1.99	1.07	3.35	6.90	0.10
Other chemical products	1.97	1.00	6.01	6.46	0.34
Domestic appliances	1.94	1.04	4.05	5.75	0.18
Made-up textile articles	1.89	1.12	2.93	7.46	0.11
Man-made fibres	1.87	1.41	2.51	6.59	0.42
Footwear	1.85	1.12	3.25	7.22	0.04
Medical equipment	1.84	1.43	2.63	6.00	0.03
Other general purpose machinery	1.84	1.25	4.28	7.00	0.13
Agricultural, forestry machinery	1.83	1.19	3.03	8.36	0.17
Accumulators	1.83	1.12	4.66	5.88	0.32
Aircraft, spacecraft	1.80	0.83	6.57	7.55	0.00
Electronic valves, tubes	1.79	1.04	2.84	5.88	0.02
Parts for motor vehicles	1.75	1.06	4.50	7.28	0.17
Watches, clocks	1.68	1.10	3.11	8.13	0.03
Other textiles	1.68	0.96	3.13	7.82	0.17
Other special purpose machinery	1.66	1.09	3.25	8.17	0.08
Pesticides	1.66	1.22	2.40	6.75	0.28
Tanning, dressing of leather	1.62	1.14	3.35	8.92	0.08
Pharmaceuticals	1.62	1.11	3.39	9.05	0.06
Machinery	1.57	0.88	2.86	7.21	0.09
Electronic motors	1.56	1.24	2.06	7.02	0.09
Dressing, dyeing of fur	1.53	1.19	1.97	8.09	0.02
Motorcycles, bicycles	1.52	1.08	1.93	7.11	0.10
Optical instruments	1.52	1.21	2.10	7.70	0.01
Games, toys	1.51	1.11	2.23	4.88	0.10
Motor vehicles	1.50	1.21	2.16	7.25	0.12
Office machinery, computers	1.32	0.91	2.12	10.94	0.02

Notes: Authors' calculations. For θ^k, σ^k and wv^k, the numbers reported are averages for each 3-digit industry. wv^k is in units of kg/Euro.

Table 2: Descriptive Statistics for Individual Countries

	θ_i	min θ_i	max θ_i
Ireland	9.25	1.208	261.49
Spain	8.92	0.677	1056.30
Denmark	8.45	0.954	782.81
Finland	8.43	1.195	552.31
Italy	7.70	0.701	1056.30
United Kingdom	7.61	0.912	994.94
Portugal	6.37	0.677	414.15
Austria	6.23	0.714	154.63
Germany	5.56	0.714	480.73
Netherlands	5.24	0.970	123.36
France	5.23	0.701	414.15

Notes: Authors' calculations. The numbers reported for θ_i are averages for each country across industries.

Table 3: The Determinants of EU Trade Integration

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Geography/Transport Costs							
$\ln D_{ij}$	0.949^a (9.097)	0.818^a (7.074)	0.959^a (9.053)	0.827^a (7.213)	0.769^a (7.025)	0.797^a (7.530)	0.914^a (8.886)
$\ln(D_{ii} \times D_{jj})$	-1.024^b (−2.199)	-0.908^b (−2.253)	-1.319^a (−3.793)	-0.928^b (−2.331)	-1.062^a (−2.750)	-1.127^a (−3.273)	-1.535^a (−4.962)
Adj_{ij}	-0.397^a (−3.160)	-0.435^a (−3.023)	-0.379^a (−2.692)	-0.430^a (−3.001)	-0.471^a (−3.381)	-0.440^a (−3.580)	-0.382^a (−3.192)
$Lang_{ij}$	0.043 (0.389)	−0.107 (−0.781)	−0.069 (−0.471)	−0.122 (−0.882)	−0.137 (−0.960)	−0.155 (−1.119)	−0.128 (−0.893)
$\ln cfob_t^k$	0.099^a (3.710)	0.068^a (3.765)	0.063^a (3.556)	0.067^a (3.702)	0.093^a (4.508)	0.071^a (3.470)	0.066^a (3.306)
$\ln wv_t^k$	1.081^b (2.009)	0.473^b (2.231)	0.385^c (1.848)	0.520^b (2.337)	0.721^a (4.627)	0.693^a (4.597)	0.627^a (4.168)
Policy Variables							
FI, AT_{ij}	–	0.315^a (4.240)	0.195^a (2.845)	0.314^a (4.243)	0.377^a (5.148)	0.394^a (5.131)	0.284^a (3.984)
$noEURO_{ij,t}$	–	0.243^a (3.419)	0.156^b (2.053)	0.238^a (3.347)	0.246^a (3.102)	0.241^a (3.118)	0.147 (1.827)
$Schengen_{ij,t}$	–	-0.514^a (−3.993)	-0.345^a (−2.896)	-0.507^a (−3.960)	-0.455^a (−3.208)	-0.440^a (−3.224)	-0.271^b (−2.011)
$\ln TBT_{ij}^k$	–	1.021^a (3.667)	–	0.967^a (3.630)	1.003^a (3.801)	1.034^a (4.302)	–
TBT^k	–	–	0.595^a (3.764)	–	–	–	0.613^a (4.408)
$\ln Proc_{ij,t}^k$	–	-2.354^a (−3.117)	-2.115^a (−2.906)	-2.367^a (−3.132)	-3.502^a (−3.599)	-3.397^a (−3.421)	-3.159^a (−3.259)
$\ln VAT_{ij}^k$	–	-4.996^a (−2.908)	-4.846^a (−2.879)	-4.932^a (−2.872)	-4.653^a (−2.863)	-4.104^b (−2.460)	-3.972^b (−2.429)
Informational Costs							
$Mult^k$	–	–	–	-0.342^b (−2.557)	-0.473^a (−3.509)	-0.357^a (−2.594)	-0.310^b (−2.308)
Productivity							
$\ln Prod_{ij,t-1}^k$	–	–	–	–	-0.225^b (−1.964)	-0.275^b (−2.572)	-0.360^a (−3.358)
$Zeros_{ij,t}^k$	–	–	–	–	2.220^a (18.386)	2.088^a (14.471)	2.028^a (12.380)
Controls							
$KS_{ij,t}^k$	–	–	–	–	–	0.311^c (1.715)	0.332^c (1.705)
$\ln Goods^k$	–	–	–	–	–	-0.163^a (−3.866)	-0.164^a (−4.269)
N	15510	15510	15510	15510	12408	12408	12408

Notes: The dependent variable is $\theta_{ij,t}^k$. Poisson Pseudo-Maximum-Likelihood (PPML) estimations. Robust standard errors are adjusted for clustering at the 4-digit Nace rev.1 level in each country pair (3102 clusters). Year and 3-digit fixed effects are included in all regressions. The sample period is 1999-2003. t-statistics in parentheses. ^{a}, ^{b} and ^{c} indicate significance at 1, 5 and 10 percent levels, respectively.

Table 4: Decomposition of the Growth in Trade [*to be completed*]

	Trade growth 1999-2003, average	**Factor (1) Contribution of output growth**	**Factors (2)+(3) Contribution of trade costs decline**	Factor (2) Bilateral costs	Factor (3) Multilateral factors
Full sample	2.62%	**43.93%**	**56.07%**	153.81%	-97.74%
FI, AT_{ij}	5.01%	**5.14%**	**94.86%**	254.53%	-159.67%
Rest of sample	1.94%	**54.92%**	**45.08%**	125.29%	-80.21%
$noEURO_{ij}$ (from 2002)					
$EURO_{ij}$ (from 2002)					
$Adj_{ij}=0$					
$Adj_{ij}=1$					
Long distance[1]					
Short distance					
High weight-to-value[2]	2.95%	**87.90%**	**12.10%**	23.48%	-11.38%
Low weight-to-value	2.79%	**13.80%**	**86.20%**	266.53%	-180.33%
High[3] TBT^k					
Low TBT^k					
High[4] TBT_{ij}^k					
Low TBT_{ij}^k					
$Mult^k=1$	5.36%	**23.93%**	**76.07%**	169.14%	-93.07%
$Mult^k=0$	2.05%	**48.09%**	**51.91%**	150.62%	-98.71%

Notes: [1]Median distance is 1286 km; [2]Median weight-to-value is 0.245 kg/Euro; [3]Median TBT^k is 2. [4]Median TBT_{ij}^k is 3.31. are obtained according to (19) in the text.

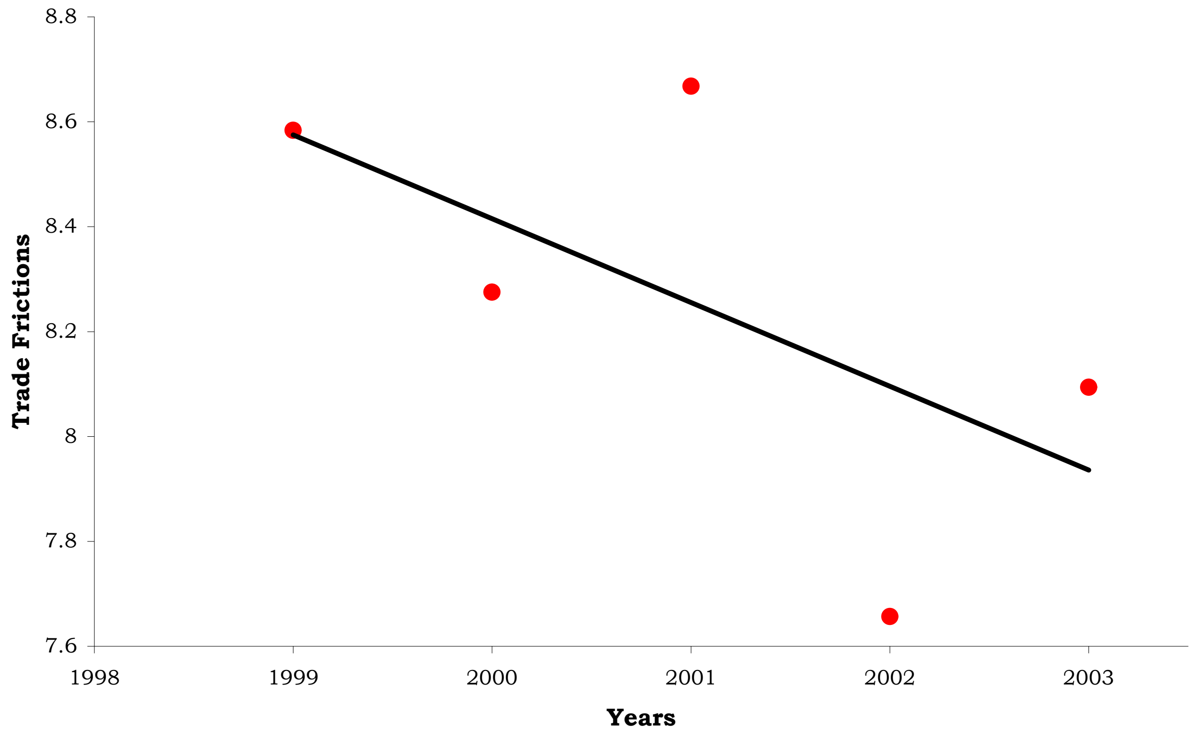

Figure 1: Trade frictions θ_t,1999-2003, averaged across countries and industries.

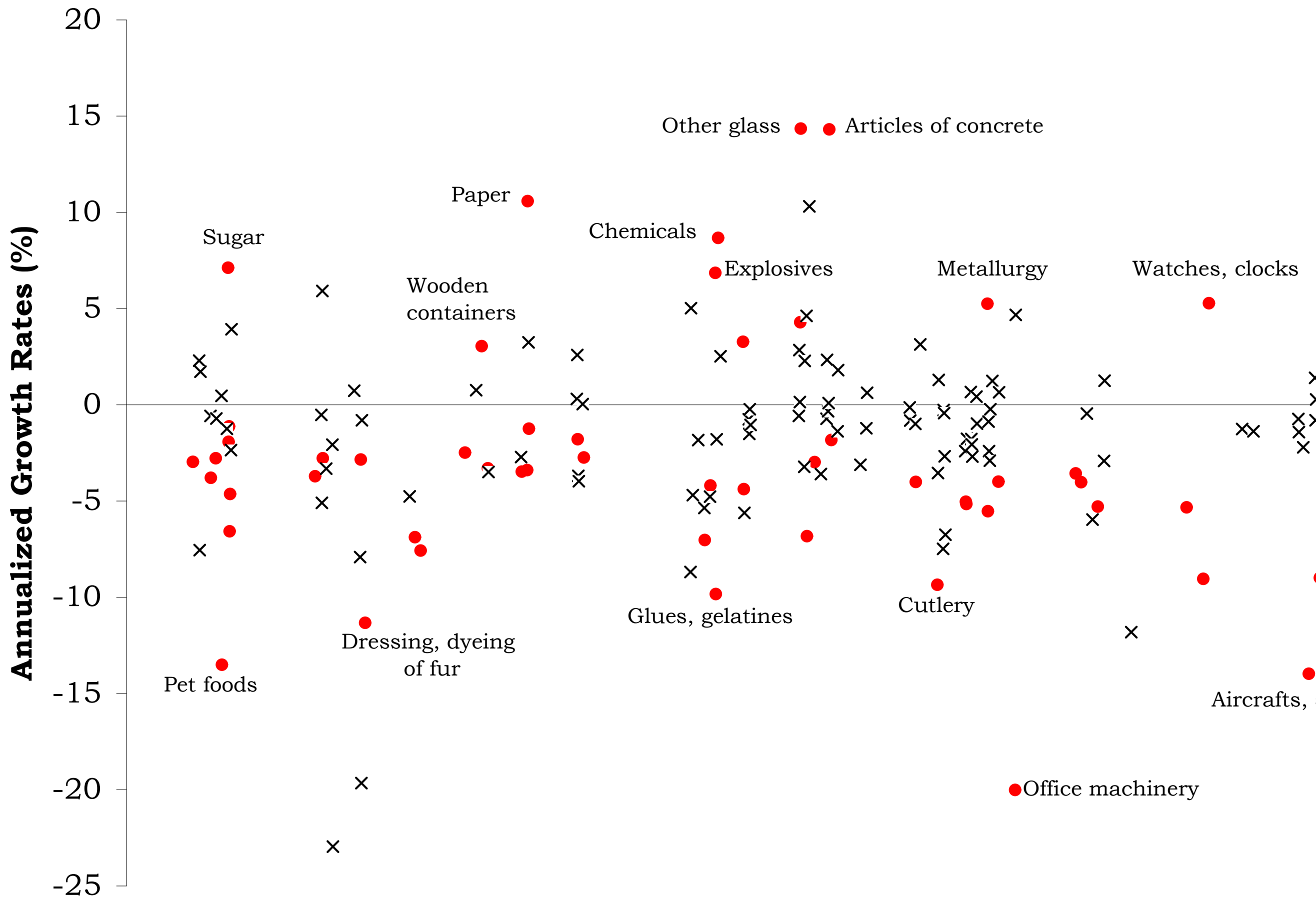

Figure 2: Annualized growth rates per industry, 1999-2003, see regression (16).
• indicates significance at the 10 percent level. x indicates insignificantly different from zero.

Appendix A

Table A1: The Determinants of EU Trade Integration – Robustness

	(1)	(2)	(3)	(4)	(5)	(6)
Geography/Transport Costs						
$\ln D_{ij}$	0.492^{a}	–	0.787^{a}	0.670^{a}	0.805^{a}	3.784^{a}
	(22.469)		(7.358)	(7.489)	(7.529)	(28.708)
$\ln(D_{ii} \times D_{jj})$	-0.886^{a}	–	-1.120^{a}	-1.052^{a}	-1.188^{a}	-7.523^{a}
	(−11.651)		(−3.219)	(−2.893)	(−3.488)	(−16.203)
Adj_{ij}	-0.058^{b}	–	-0.446^{a}	-0.189^{b}	-0.438^{a}	−0.092
	(−2.565)		(−3.621)	(−2.037)	(−3.532)	(−0.780)
$Lang_{ij}$	-0.350^{a}	–	−0.151	-0.425^{a}	−0.146	-2.554^{a}
	(−8.262)		(−1.092)	(−3.430)	(−1.028)	(−11.898)
$\ln cfob_t^k$	0.015^{a}	0.075^{a}	0.069^{a}	0.050^{b}	0.107^{a}	0.153^{a}
	(3.215)	(4.039)	(3.374)	(2.214)	(3.807)	(5.438)
$\ln wv_t^k$	0.662^{a}	0.654^{a}	0.686^{a}	0.330^{c}	0.876^{a}	2.001^{a}
	(6.844)	(4.888)	(4.462)	(1.832)	(4.843)	(6.279)
Policy Variables						
FI, AT_{ij}	0.224^{a}	–	0.393^{a}	0.329^{a}	0.392^{a}	1.840^{a}
	(12.607)		(5.037)	(5.408)	(5.114)	(17.239)
$noEURO_{ij,t}$	0.037^{a}	–	0.246^{a}	0.104^{b}	0.255^{a}	0.085
	(2.827)		(3.147)	(2.256)	(3.309)	(1.068)
$Schengen_{ij,t}$	-0.131^{a}	–	-0.434^{a}	-0.392^{a}	-0.407^{a}	-0.600^{a}
	(−5.083)		(−3.160)	(−4.684)	(−3.016)	(−3.904)
$\ln TBT_{ij}^k$	0.132^{b}	1.055^{a}	1.051^{a}	0.768^{a}	0.970^{a}	−0.020
	(2.511)	(4.833)	(4.361)	(3.871)	(4.546)	(−0.153)
$\ln Proc_{ij,t}^k$	-1.090^{a}	-3.961^{a}	-3.400^{a}	-2.983^{a}	-3.889^{a}	-7.752^{a}
	(−3.185)	(−3.502)	(−3.402)	(−3.795)	(−3.353)	(−2.754)
$\ln VAT_{ij}^k$	-1.826^{a}	-4.765^{a}	-4.069^{b}	-2.843^{b}	-4.101^{b}	-12.670^{a}
	(−4.882)	(−3.465)	(−2.415)	(−2.214)	(−2.491)	(−5.355)
Informational Costs						
$Mult^k$	−0.051	-0.371^{b}	-0.347^{b}	−0.198	-0.456^{a}	−0.420
	(−0.730)	(−2.560)	(−2.521)	(−1.095)	(−3.027)	(−1.485)
Productivity						
$\ln Prod_{ij,t-1}^k$	-0.140^{a}	-0.253^{b}	-0.280^{a}	-0.270^{a}	-0.304^{a}	-1.645^{a}
	(−4.490)	(−2.074)	(−2.609)	(−2.589)	(−2.820)	(−9.972)
$Zeros_{ij,t}^k$	2.128^{a}	1.905^{a}	–	2.003^{a}	2.094^{a}	12.741^{a}
	(10.965)	(6.682)		(7.655)	(17.781)	(12.578)
Controls						
$KS_{ij,t}^k$	0.046	0.410^{b}	0.315^{c}	0.437^{c}	0.311^{c}	0.242
	(1.283)	(2.183)	(1.734)	(1.725)	(1.818)	(1.416)
$\ln Goods^k$	-0.110^{a}	-0.149^{a}	-0.162^{a}	-0.134^{a}	-0.145^{a}	-1.196^{a}
	(−8.742)	(−3.660)	(−3.767)	(−4.284)	(−3.404)	(−15.233)
Estimator	OLS	PPML	PPML	PPML	PPML	OLS
Fixed Effects	t, K	$t \times ij, K$	t, K	t, K	$t \times K$	t, K
Weighted	No	No	No	Yes	No	No
Sample	Whole	Whole	Excl. zeros	Whole	Whole	Whole
N	12408	12408	12388	12408	12408	12408
Adj-R^2	0.811	–	–	–	–	0.688

Notes: In (1) the dependent variable is the log of $\theta_{ij,t}^k$ and in (2) to (5) the dependent variable is $\theta_{ij,t}^k$. In (6), the dependent variable is the (log) *phi*-ness of trade. Fixed effects OLS regressions in (1) and (6); Poisson Pseudo-Maximum-Likelihood (PPML) estimations in (2) to (5). Robust standard errors are adjusted for clustering at the 4-digit Nace rev.1 level in each country pair (3102 clusters). The sample period is 1999-2003. Weighted regression in (4) where the weights are given by bilateral exports as a share of total exports. t-statistics in parentheses. ^{a}, ^{b} and ^{c} indicate significance at 1, 5 and 10 percent levels, respectively.

Table A2: The Determinants of EU Trade Integration – Cross-Sectional Samples

	1999	2000	2001	2002	2003
Geography/Transport Costs					
$\ln D_{ij}$	0.964^a	0.873^a	0.807^a	0.786^a	0.811^a
	(6.530)	(5.044)	(6.691)	(9.093)	(6.708)
$\ln(D_{ii} \times D_{jj})$	-0.599	-1.498^a	-1.401^a	-1.115^a	-0.721^c
	(−1.474)	(−3.599)	(−3.503)	(−3.917)	(−1.846)
Adj_{ij}	-0.264^c	-0.234^c	-0.535^a	-0.338^a	-0.529^a
	(−1.784)	(−1.915)	(−3.674)	(−3.115)	(−3.357)
$Lang_{ij}$	-0.032	-0.189	-0.139	-0.274^c	0.014
	(−0.188)	(−1.563)	(−0.753)	(−1.838)	(0.078)
$\ln cfob_t^k$	0.121^a	0.145^b	-0.027	-0.005	0.156^a
	(4.132)	(2.423)	(−0.907)	(−0.190)	(4.994)
$\ln wv_t^k$	0.542^b	1.123^a	1.462^a	1.243^a	0.392^c
	(2.331)	(3.314)	(6.253)	(4.811)	(1.665)
Policy Variables					
FI, AT_{ij}	0.160	0.236^b	0.413^a	0.394^a	0.516^a
	(1.546)	(2.496)	(3.851)	(6.374)	(5.998)
$noEURO_{ij,t}$	–	–	–	0.209^b	0.479^a
				(2.285)	(3.717)
$Schengen_{ij,t}$	-0.634^a	-0.395^a	-0.543^a	-0.448^b	-0.037
	(−3.542)	(−3.410)	(−2.851)	(−2.378)	(−0.144)
$\ln TBT_{ij}^k$	0.644^a	0.362^b	0.946^a	0.828^a	1.211^a
	(3.646)	(2.296)	(4.758)	(4.562)	(6.265)
$\ln Proc_{ij,t}^k$	-5.310^b	-2.699^b	-4.635^a	-4.247^b	-4.630^a
	(−2.248)	(−2.302)	(−2.583)	(−2.366)	(−3.765)
$\ln VAT_{ij}^k$	-4.618^b	-4.551^a	-2.989	-2.960^c	-6.331^a
	(−2.207)	(−2.637)	(−1.481)	(−1.913)	(−3.529)
Informational Costs					
$Mult^k$	0.200	0.203	-0.596^a	-0.570^a	-0.578^a
	(1.422)	(1.142)	(−2.666)	(−3.384)	(−3.565)
Productivity					
$\ln Prod_{ij,t-1}^k$	–	-0.336^a	-0.292^c	-0.206^c	-0.427^a
		(−3.092)	(−1.825)	(−1.910)	(−3.182)
$Zeros_{ij,t}^k$	–	–	–	2.265^a	1.903^a
				(18.520)	(10.014)
Controls					
$KS_{ij,t}^k$	0.484^c	0.122	0.228	0.245^c	0.615^b
	(1.719)	(0.737)	(1.048)	(1.737)	(2.280)
$\ln Goods^k$	-0.085^c	-0.142^b	-0.245^a	-0.156^a	-0.092^b
	(−1.939)	(−2.409)	(−5.285)	(−4.198)	(−2.121)
N	3102	3102	3102	3102	3102

Notes: The dependent variable is $\theta_{ij,t}^k$. Poisson Pseudo-Maximum-Likelihood (PPML) estimations. Robust standard errors are adjusted for clustering at the 4-digit Nace rev.1 level in each country pair (3102 clusters). 3-digit fixed effects are included in all regressions. The sample period is 1999-2003. t-statistics in parentheses. ^{a}, ^{b} and ^{c} indicate significance at 1, 5 and 10 percent levels, respectively.

Appendix B: Data

Trade data, weight-to-value and c.i.f./f.o.b. Bilateral and total export and import trade flows (thousand Euros), and their corresponding weight (tons) are used for 11 EU countries between 1999 and 2003 at the 4-digit Nace rev.1 level of manufacturing industries. *Source: Eurostat.*

In Section 4.1, the bilateral weight-to-value ratio of exports (kilograms per Euro exported) is calculated separately for the two partners in each industry and in each year, and is then averaged across all partners. In Section 4.2, the bilateral weight-to-value ratio of exports is calculated for each country, industry and year. In both cases, we calculate the log of one plus weight-to-value as weight-to-value often takes on values much smaller than one.

The ratio between bilateral import ("Costs, Insurance and Freight," *c.i.f.*) and export ("Free On Board," *f.o.b.*) flows is calculated separately for the two partners in each industry and in each year, and is then averaged across all partners, dropping the few cases where the ratio is smaller than one. We then use the log of the ratio.

Output Gross value of output (million Euros) at the 4-digit Nace rev.1 level. *Source: Eurostat's New Cronos database.*

Elasticities of Substitution We draw on estimates by Hummels (2001a) who uses data on bilateral trade flows, import tariffs and transport costs to estimate elasticities of substitution at the 2-digit SITC rev.3 level of industries. We use his OLS estimates (he also reports IV estimates which yield higher values for the elasticities). The elasticities are converted 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. In the few cases where the Nace rev.1 level industries have to be matched with several SITC industries, we calculate the average across SITC industries. Ideally, one would compute a weighted average where the weights are given by the share of each SITC rev.3 industry into each Nace rev.1 industry grouping, but this information is not available. Among the 62 elasticities, 4 are not significantly different from zero so we set them to missing. *Source: Hummels (2001a).*

Gravity Variables Dummies for sharing a common land border and for sharing a common (official) language. *Source: Centre d'Etudes Prospectives et d'Informations Internationales (CEPII).* International and domestic distances, which are weighted averages of the distances between regions using GDP shares as weights. *Source: Chen (2004).*

Schengen Agreement For each country, the dummy is equal to one in the years in which the provisions of the Schengen Agreement are fully implemented. We then take the average between the two partners. The resulting variable takes on values of zero, one half and one. The years of first implementation are chosen depending on the month in which the Agreement went into force: Austria (1998-2004), Denmark (2001-2004), Finland (2001-2004), France (1995-2004), Germany (1995-2004), Italy (1998-2004), Netherlands (1995-2004), Portugal (1995-2004), Spain (1995-2004) while Ireland and the United Kingdom have not yet fully implemented the Agreement.

Technical Barriers to Trade We use two sources. The European Commission's Eurobarometer 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 industry of activity. We use 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 group the answers from all managers who replied that TBTs are indeed an important issue, and use the percentage so obtained as a country-specific indication on the relevance of TBTs. *Source: European Commission (2006).*

To capture the sectoral relevance of TBTs, industries are classified on a five-point scale according to the effectiveness of different measures undertaken by the Single Market Programme to eliminate TBTs: measures are successful and all significant barriers are removed (value of 1), measures are implemented and function well but some barriers remain (value of 1), measures are adopted but with implementation or transitional problems still to be overcome (value of 3), measures are proposed or implemented but not effective or with operating problems (value of 4), and no solution has been adopted (value of 5). Some industries are also identified as being not affected by TBTs prior to European integration (and are given a value of 1). Our industry-specific qualitative variable takes on values between 1 and 5, with larger values indicating a lack of market integration due to persisting TBTs. *Source: European Commission (1998).*

We then interact the log of one plus the average across partners of the share of managers replying that TBTs are important with the industry-specific variable on TBTs.

Public Procurement We use two sources. For each country, we use the proportion of public procurement contracts advertised each year in the *Official Journal* of the EU. *Source: Eurostat.* The sectors strongly affected by public procurement in Europe are identified at the Nace 70 level, are then converted at the Nace rev.1 level and identified by a dummy variable. *Source: Davies and Lyons (1996).* We calculate the log of one plus the average across partners of the proportion of public procurement contracts advertised in the *Official Journal* of the EU, which we then interact with the sectoral dummy.

Value-Added Taxes For each country, we use the standard VAT rate and replace it by the reduced VAT rates that apply to some categories of goods, as of January 1^{st}, 2008. We do not have information on the evolution of reduced VAT rates across goods over time, but we do not expect those to have changed much as the standard VAT rates changed very little during the time period we consider. We then compute the log of one plus the average across partners of the VAT rates that apply in each country and industry. *Source: European Commission (2008).*

Multinationality "Highly multinational" industries are identified at the Nace 70 level, are then converted at the Nace rev.1 level and identified by a dummy variable. *Source: Davies and Lyons (1996).*

Productivity Real labor productivity is value added divided by the number of employees at the 4-digit Nace Rev.1 level, deflated by GDP deflators. We then use the log of the average across partners of real labor productivity. *Source: Eurostat's New Cronos database.*

Capital Shares Capital shares are value added minus personnel costs, divided by personnel costs. We then calculate the log of one plus the absolute difference in capital shares between countries for each industry and in each year. *Source: Eurostat's New Cronos database.*

Number of Product Categories *Source: Eurostat's Prodcoms.*

GDP Deflators Value of GDP (million Euros) and volume of GDP (millions of 1995 constant Euros). The deflator is computed as the ratio between the value and the volume of GDP. *Source: Eurostat's New Cronos database.*