Intra-European Trade of Manufacturing Goods: An Extension of the Gravity Model

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ABSTRACT

In this paper, we propose and test several extensions of the standard gravity model. This yields a specification that allows for (i) a more flexible income response; (ii) a competitiveness effect with a general and a specific component; and (iii) an alternative and consistent measure of remoteness. Those extensions were found to be significant factors to explain intra-EU trade. Next, we analyze the effect of EU harmonization of technical regulations on domestic and intra-EU trade. We find, at different levels of aggregation of the manufacturing sector, that harmonization of regulations has contributed to more intra-EU trade but, apparently, did not affect the so called border effect.

Key words: *Trade, EU Countries, Gravity Equation, Border Effects*
JEL Classifications: F11, F14, F15

1. INTRODUCTION

This paper has two main objectives. First, it aims to improve the standard gravity model in the way it incorporates income and price effects. In our opinion these extensions are particularly important when one deals with trade that is less aggregated than total imports or exports. Next, on the basis of the selected model, it examines to what extent product regulations have affected intra-EU trade for manufacturing goods.

Several recent studies have highlighted the importance of border effects in international trade. The border effects are supposed to measure home preferences for domestic production after controlling for the various characteristics of the trading countries. It is generally admitted that technical barriers to trade (TBT) are one of the major causes for such effects and the European Commission has devoted constant efforts to their removal. More than 80% of intra-EU trade in manufacturing is subject to harmonized technical regulations. Using panel data on bilateral trade flows between European Union (EU) countries over the period 1990-1998, this paper attempts to estimate the impact of this regulations on intra-EU trade, firstly, for the manufacturing sector as a whole and, secondly, distinguishing the type of approach used by the Commission.

Furthermore, the standard gravity model presents some unsatisfactory aspects especially when the model is applied at a disaggregated level. On the one hand, the estimated income (GDP)

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We thank Luc Bauwens, Volker Nitsch and Vitor Trindade for useful comments and discussions. This research is part of a program supported by the Belgian government (PAI P5/21).

elasticities imply an evolution of imports along a growth rate path that is quite implausible for manufacturing goods. To this end, we propose a more flexible income response that has also the advantage of reducing the problem of heteroscedasticity that is generally present with gravity-type estimations. On the other hand, the standard gravity model ignores the effects of changes in the relative unit labor costs although they are essential to explain the evolution of market shares. We incorporate in the model a competitiveness effect where we distinguish between a general and a specific component.

The paper also discusses some other methodological issues; the econometric procedure and the measure of distance and remoteness for which an alternative indicator, presumably better, is proposed.

The paper continues in section 2 with a brief survey of the literature. Section 3 presents the standard specification of the gravity model. Section 4 provides some preliminary results. In section 5, we propose several extensions to the standard model. Section 6 discusses the econometric procedure. Section 7 presents the results for the manufacturing level as a whole. Section 8 examines the impact of harmonization first for the total manufacturing goods, second at various more disaggregated levels.

2. BRIEF SURVEY OF THE GRAVITY LITERATURE

Since the pioneering work of Tinbergen (1962) and Pöyhonen (1963), the gravity model has become the standard tool to study bilateral trade[1]. Typically in a log-linear form, the model considers that the volume of trade between two countries is promoted by their economic size (income) and constrained by their geographic distances. Other characteristics of countries can easily be added. For example, Frankel et al. (1995) add dummy variables for common language and common border. Deardorff (1995) argues that the relative distance of trading partners should also have an impact on the volume of trade. Wei (1996) and Helliwell (1997) extend this concept and define 'remoteness variable' that captures third country effects. Whether and how remoteness should be included in the model has been discussed later on by Helliwell (2005) and Anderson and van Wincoop (2003).

Although its empirical success can be attributed from the model's consistently high statistical fit, it was also criticized because it lacked theoretical foundations. These foundations were subsequently developed by several authors. Anderson (1979) presented a theoretical justification for the gravity model based on CES preferences with differentiated goods in the sense of Armington (1969). Bergstrand (1985, 1989) uses also CES preferences to derive a reduced form equation for bilateral trade flows from a general equilibrium model. Helpman and Krugman (1985) derives a gravity equation from a monopolistic competition framework. Their model predicts that intra-industry trade may exist within a group of 'industrialized countries" as long as complete specialization occurs. On the other hand, Deardorff (1995) undermines the argument of monopolistic competition by showing that the gravity equation can easily be motivated in a Heckscher-Ohlin model without assuming product differentiation. He relaxes the assumption that factor prices are equalized between countries, so that countries specialize in producing different goods. In a recent paper, Eaton and Kortum (2002) develop a multi-country perfectly competitive Ricardian model with a continuum of goods from which they derive a structure that resembles the gravity model. In their model,

[1] Alternative approaches such as a complete demand system by country a la Barten et al. (1976) were never very popular. It is worthwhile noticing that we checked a specification in shares allowing for quasi-homothetic preferences. It was marginally rejected with respect to the conventional log-linear form.

specialization occurs from comparative advantage that is interactively linked to the level of technology and geographic trade barriers.

Whatever the theoretical framework in support of the gravity model, they all yield a similar functional form. Therefore, the best conclusion to be drawn is that of Deardorff (1995): “just about any plausible model of trade would yield something very like the gravity model, whose empirical success is therefore not evidence of nothing, but just a fact of life”.

3. THE STANDARD GRAVITY MODEL AND BORDER EFFECTS

Typically, the gravity model has the form:

$$m_{ijt} = \alpha + \beta_1 y_{it} + \beta_2 y_{jt} + \delta d_{ij} + Z'\theta + \varepsilon_{ijt} \quad (3.1)$$

All variables but dummies, are expressed in logarithms and, by notation, any variable x is the log of X. m_{ijt} is the volume of imports by country i from country j at period t; y_{it} and y_{jt} are real income (GDP) respectively of country i and country j at period t; d_{ij} is the distance between the trading centers of the two countries; Z is a set of characteristics that include, amongst others, border and remoteness effects and ε_{ijt} defines the error term (further discussed in section 3.5).

3.1. Border Effects

Beginning with McCallum (1995), the gravity model has been used to compare domestic trade with international trade. Using 1988 data, McCallum finds that Canadian provinces are about 20 times more likely to trade amongst themselves than they are to trade with US states after controlling for size and distance between economic centers[2]. However, data limitation makes it impossible to replicate McCallum’s research for the EU. We follow the methodology introduced by Wei (1996), which avoids the reliance on national trade data. He constructs a “border effect” measure based upon the definition that what a country imports to itself is the difference between domestic production and exports. The border effect is estimated by including a dummy variable, H, equal to 1 for all m_{iit} and 0 for all m_{ijt}. Wei (1996) estimated the border effect for OECD countries and finds, on average, that countries trade 10 times more with themselves than with foreign countries. This method has subsequently been used in several empirical studies. Helliwell (1997) revisits the OECD data and finds a border effect of 13 separating out the effect of language from the land border effect.

With particular reference to intra-EU trade, Nitsch (2000) finds evidence of substantial border effects in Europe, with domestic trade being on average larger by a factor of 16 than trade with other EU partners. His results also suggest that the magnitude of the border effect declined during the 1980s.

3.2. Internal Distances

The application of a gravity model requires a measure of the trading distances within a country itself. Wei (1996) and Helliwell (1997, 1998) use for internal distances one quarter of the distance to the nearest neighbor. As noted by Nitsch (2000), this method relies too much on the geography of neighboring countries and too little on the geography of the home country. He shows that the square root of [A/π] where A is the area of the country provides a

[2] Notice that the size of the border effect depends on the specification of the model, in particular the way internal distance is measured.

good approximation of the average distance. Helliwell and Verdier (2001) move towards a measure of internal distances that incorporates information about the distribution of population within a country. Nitsch (2000) applies their method to Canada and obtains a scaling factor of 0.5 that is very close to his own method of using 0.56. In the present study, we follow Nitsch's method.

3.3. Remoteness

A measure of "remoteness" is now commonly included in the gravity model: Wei (1996), Helliwell (1997, 1998), Nitsch (2000) and Chen (2004). Remoteness of an importing country *i* in relation to any trading partner *j* is given as the weighted average distance between country *i* and all trading partners other than *j* (D_{ik}), where the weights are given by the GDP of the trading partners (Y_{kt}). In the studies mentioned above, remoteness r_{ij}, is defined as:

$$r_{ijt} = \ln\left[\sum_{k \neq j} \frac{D_{ik}}{Y_{kt}}\right] \tag{3.2}$$

and both r_{ij} and r_{ji} are included in the regression. However, as we will see in section 5.3.1., this measure is open to criticism and yields results that are difficult to interpret. In particular, it becomes incompatible with steady state and may yield to strange interpretations of idiosyncratic shocks in the GDP's of the trading partners.

3.4. Other Characteristics

The gravity model can easily be appended with various institutional, cultural or historical characteristics. Typically, gravity studies on European trade add a dummy variable to indicate whether two countries speak the same language, share a common land border or membership of a regional trade or currency agreement.

3.5. Estimation Method

Parallel to the search for a solid theoretical foundation, researchers have also investigated the econometric issues linked to the estimation of a gravity model. In a series of papers, Mátyás (1997, 1998), Egger (2000, 2001), and Cheng and Wall (1999) have used the advantages of panel techniques to test the trade determinants using the gravity equation. The pooled analysis then concerns the possibility to capture a variation between three dimensions: a two dimensional effect between importing and exporting countries and a time dimension.

In this paper, we follow their technique (see Wooldridge, 2002, for details) and specify the error term in equation (3.1) as:

$$\varepsilon_{ijt} = \mu_i + \upsilon_j + \xi_{ijt} \tag{3.3}$$

where μ_i and υ_j are the unobserved random effects of the importing and exporting country respectively while ξ_{ijt} is a random component over countries and time[3]. In fact, this estimation

[3] As an alternative, we could have used a version of the feasible generalized least squares (FGLS) using the Park-Kmenta or the Beck-Katz method. This method is based on the assumption that the variance and covariance matrix is unknown and finds a consistent estimator. The method consists of two sequential FGLS transformations: first, it eliminates serial correlation of the errors then it eliminates contemporaneous correlation of the errors. This method is less efficient than the model with random effects or OLS for data where the number of cross sectional units are larger than the number of time points ($N > T$) because the estimated covariance matrix tend to underestimate the true variability of the estimator. See Beck and Katz (1995, pp. 636), Judge et al. (1979, pp. 492), Greene (1997, pp. 608) and Wooldridge (2002, pp. 158, 263) for a technical explanation of using GLS and the implications when $N > T$.

method yields results that hardly differ from those obtained by OLS, with however a gain in efficiency. This point will be confirmed in section 7 where we compare, for our final model, OLS with GLS allowing for random effects.

As noted in the literature (Wooldridge, 2002 and Beck and Katz, 1995), the OLS method often violates its standard assumptions when they are applied to pooled data. This is because the pooled OLS regression assumes homoscedasticity and no correlation between the error terms whether serial or contemporaneous. However these assumptions are unlikely to hold. In contrast, the GLS method corrects for the problem of AR(1) errors, heteroscedasticity and contemporaneous correlation. Of course, diagnostic tests for heteroscedasticity and normality among others is important (see section 6).

4. PRELIMINARY RESULTS

Nitsch (2000), who has adopted equation (3.1) in his study of EU-intra trade in manufacturing, provides a good benchmark model. We start by replicating his model to EU trade in total manufacturing for 1990-1998 (data are described in the appendix). We estimated this equation by GLS allowing for random effects and follow the standard procedure of using population as an instrument for GDP. For the sake of comparison, imports and GDPs are taken in nominal terms ($\underline{m}_{ijt}$, $\underline{y}_{it}$ and $\underline{y}_{jt}$ underlined here to avoid confusion with constant price values). We also note that the reported results on the intercept and the home variable are constant over time. This is consistent with preliminary tests confirming section 6.2.2.

Denoting by A and L, dummies that indicate whether countries share the same land border and whether they share the same language, respectively; and by H, the home effect, we obtain the following result (standard errors of the coefficients are in parentheses)[4]:

$$\underset{}{\underline{m}_{ijt}} = \underset{(.57)}{-6.618} + \underset{(.01)}{.892}\,\underline{y}_{it} + \underset{(.01)}{.686}\,\underline{y}_{jt} - \underset{(.03)}{.789}\,d_{ij} + \underset{(.08)}{.761}\,r_{ijt} - \underset{(.08)}{.582}\,r_{jit} + \underset{(.05)}{.358}\,A + \underset{(.10)}{.378}\,L + \underset{(.08)}{2.589}\,H \qquad (4.4)$$

Random effects (variance): $\sigma_\mu^2 = .20$, $\sigma_\nu^2 = .45$, $\sigma_\xi^2 = .18$

$R^2 = 0.97$; $L = -1000.2$; $Het(5) = 39.1$; $N = 1260$.

These results are largely consistent with those from Nitsch (2000). All coefficients except for remoteness have the expected sign, standard errors are low and the overall fit is high. Notice, however that our dataset differs somewhat to the one employed by Nitsch (2000). His dataset is for the period 1983-1990, and does not include Sweden, Austria and Finland.

The importing and exporting income elasticities, 0.89 and 0.69 respectively, are very similar to those obtained in Nitsch (2000). The coefficient of distance variable is slightly larger from previous studies where the consensus estimate is 0.6 (Leamer, 1997). Chen (2004) suggests that reported distance coefficients that are much higher than the general agreed 0.6 elasticity could be explained by the use of different transport modes. For example, in the European Union, 57.8% of total intra-EU trade went by road whereas most global trade is transported over sea.

The coefficients of both language and adjacency dummies are statistically significant. The coefficient of the home variable (H = 2.59) suggests that, on average, an EU country trades

[4] Here and throughout, R^2 is the square of the coefficient of correlation between actual and predicted values; L is the value of the log of the likelihood function at its estimated maximum, $Het(k)$ is the Breusch-Pagan-Godfrey test for heteroscedasticity with k degrees of freedom (see section 6.3 for further details) and N is the number of observations.

about 14 times more with itself than it does with other EU countries after controlling for other variables. This result, for the EU, is fairly close to Nitsch's (2000) estimate of 16.

5. EXTENDING THE GRAVITY MODEL

Despite its attractiveness, a model such as equation (4.4) raises a series of questions. In this section, the following questions will be addressed:

(a) The model imposes, without testing, constant income elasticities. Although, theoretically very convenient, this restriction may be empirically not validated and, if this is the case, it could be a source of the present degree of heteroscedasticity.

(b) In principle, data on trade and income should be expressed in real terms but the choice of a deflator deserves particular attention.

(c) The model ignores a price competitiveness effect, which certainly plays an important role in the evolution of intra-European trade.

(d) As mentioned before, the definition of remoteness of the importing and exporting country are not only questionable, their coefficients are inversely signed

5.1. Price Deflator and Competitiveness

5.1.1. Choice of a Deflator

For the sake of comparison, Nitsch's equation (4.4) was estimated in current values. In principle, as we are dealing with time series, imports and incomes should be expressed in real terms. Although with the present sample the results are hardly different, the estimation in nominal terms may lead, for instance, to erroneously reject the hypothesis that the intercept is constant through time.

However, the choice of an adequate deflator is not straightforward. Indeed, several authors have criticized the traditional procedure of using the implicit deflator of imports on the grounds that it incorporates a signal of a change in quality or in other various factors of the same nature. One should also add that a substantial part of intra-EU trade is in fact intra-firm trade and the evolutions of firm's internal prices may differ from those of market prices. Therefore, some authors have opted for the GDP deflator. But the latter raises also problems. In particular, it represents above all an index of domestic costs (cf. infra). Moreover, since inflation is not homogenous across goods and services, the more disaggregated the analysis the less relevant it might be. An alternative approach consists in modeling the export prices but that requires very restrictive assumptions on the structure of preferences and of the cost function and, in our opinion, it is well beyond the scope of this paper.

We took the pragmatic view to compare the empirical merits of (both in logs) the import price deflators, p^m_{it}, and the GDP deflators, p^y_{it}, and re-estimate model (4.4) as:

$$(m_{ijt} - p^m_{it}) = \gamma\,(p^y_{it} - p^m_{it}) + RHS\ (4.4) \qquad (5.5)$$

where *RHS* (4.4) is the right hand side of equation (4.4). The estimated value of γ is close to 0.9, significantly different from both zero and unity. Thus, although the GDP deflator appears empirically better, in fact it does not matter which deflator is used as long as their ratio is incorporated in the model. We denote by p_{it} the difference between $(p^y_{it} - p^m_{it})$. We shall argue that this additional variable captures the effect of competitiveness among the EU countries.

5.1.2. The Competitiveness Effect

Indeed, with the functioning of the European Monetary System and for the last years of our sample the prospect of the European Monetary Union, maintaining competitiveness has been a major objective in the conduct of macroeconomic policy for country members and even for their non-member neighbors[5].

Now, in particular for manufacturing goods, production techniques do not differ dramatically across the EU countries and thus unit costs of capital, energy and raw materials evolve in a parallel way. However, wage formation -- as well as gains in labor productivity -- is, especially in short run, country specific. Provided that the distribution of value added remains stable over time, its deflator evolves exactly as the same rate as unit labor cost. Thus, p_{it} that compares the GDP deflator to the average price of imported manufacturing goods is generally considered as a good proxy of competitiveness. However, it only captures a general substitution effect on the domestic market[6].

As changes in competitiveness vary across countries, in order to explain imports from a specific country, we also include a measure of competitiveness based on the relative unit labor costs between the importing and exporting countries, namely:

$$rulc_{ijt} = (ulc_{it}/\textstyle\sum_k \omega_{ik} ulc_{kt})/(ulc_{jt}/\textstyle\sum_k \omega_{jk} ulc_{kt}) \qquad (5.6)$$

where ulc_i and ω_{ik} denotes respectively the unit labor cost of country i and the share of country k in total import (of manufacturing goods) of country i. The weights (ω_{ik}) are computed from the average bilateral trades during the period 1990-1998.

5.2. The Own Income Effect

While the assumption of constant own income elasticity makes sense in a macroeconomic relationship, it becomes questionable at a less aggregated level[7]. Indeed, when income grows, the structure of final demand, and therefore the structure of imports, changes. This evolution is probably more flexible than the one implied by the standard model. Consider the import ratio z_k of a commodity (in our case, an industrial sector) k for a given country i:

$$z_{ik} = M_{ik}/Y_{ik}$$

According to equation (3.1) (together with a homogenous definition of remoteness; see below), the evolution of z_{ik} on a steady state with a growth rate ζ is:

$$dz_{ik}/dt = (\beta_1 + \beta_2 - 1)\,\zeta\, z_{ik}$$

Now, the estimated sum $(\beta_1 + \beta_2)$ for manufacturing goods is significantly above unity and thus, their import ratio is supposed to grow without limit. This is not very plausible. To the

[5] For a theoretical argument, see among others Giavazzi and Pagano (1988). As a practical example, the first Government of Mitterand (France, 1981) has shown how rapidly by inflating a country can create a trade deficit with, subsequently, a stabilization adjustment in terms of incomes and prices policy. (cf. Sachs and Wyplosz, 1986)

[6] Notice that in the case of imperfect competition, p_i captures a price effect while, in the price-taker case, it represents a supply effect (i.e. a loss in profitability). In both cases, a relative loss in the competitiveness of the importing country should increase its imports.

[7] The importance of the income elasticity at a more detailed level of manufacturing is further explored in section 8.

contrary, one expects that as income increases, the share of most manufacturing goods will, at some income level, start to decline. To allow for such a shape, we specify β_1 as:

$$\beta_1 = \beta_{11} + \beta_{12}\, yc_{it} \qquad (5.7)$$

where yc_{it} is the logarithm of current per capita income, Yc_{it}, with respect to an arbitrary reference level $Yc°$:

$$yc_{it} = \ln(Yc_{it}/Yc°) \qquad (5.7')$$

We choose $Yc°$ as the average per capita GDP of the EU countries in 1995 and thus β_{11} is the estimated income elasticity at that point. The reader will notice the analogy of this specification with the quadratic version of the almost ideal demand system proposed by Banks et al. (1997) in the context of households expenditure panels. Empirically, this specification has also the advantage of reducing the problem of heteroscedasticity generally present with panel data.

5.3. Geographical Characteristics

5.3.1. Remoteness

The two remoteness variables in equation (3.2), were originally adopted by Wei (1996). However, this formulation presents drawbacks of being not homogenous with respect to distance and income[8]. Moreover the estimated coefficients are inversely signed which makes them hard to interpret. To avoid this problem, the remoteness should be measured in relative terms. In that spirit, we measure remoteness with a slightly different specification than equation (3.2):

$$r_{ijt} = \ln\left[\frac{D_{ij}/Y_{jt}}{\sum_{k \neq j} D_{ik}/Y_{kt}}\right] \qquad (5.8)$$

This new definition of remoteness is expected to give a negative sign since for a given distance from other countries *k*, greater bilateral distance reduces trade while for a given bilateral distance, greater distance from other countries increases trade. It is worth noticing that in Deardorff (1995) remoteness also enters in relative terms where the weights are the domestic price indices rather than GDPs.

Anderson and van Wincoop (2003) include importing and exporting country specific effects to control for remoteness of both the importing and the exporting country. This method is applied to a cross-section analysis. However, as we deal with panel data, it would probably not be correct that those effects remain constant because the GDP weights that enter in the definition of remoteness vary with time.

5.3.2. Adjacency and Language

We also take a different specification of the dummies for countries that share a same border and language as in our sample, three member countries that share the same language also share the same border. The effect of the language dummy is then captured by an overlapping effect of the adjacency dummy. We therefore propose an alternative specification of including

[8] Consider, for instance, a three-country case [*i*,*j*,*k*], and suppose that for some reason all trade with country *k* is suddenly replaced by trade with a more distant country *l* (with $y_k = y_l$). Then, obviously trade between country *i* and *j* should increase which is not guaranteed by expressions (3.2) and (4.4).

a dummy for countries sharing a same border and language (AL) and a dummy for countries sharing the same border but not the language (AN). We follow Helliwell (1997) and Nitsch (2000) method of assigning a value of one only in the case of bilateral trade flows.

6. ECONOMETRIC CONSIDERATIONS

Combining the proposed modifications, the model becomes:

$$m_{ijt} = \alpha + \beta_{11}\, y_{it} + \beta_{12}\, yc_{it} \cdot y_{it} + \beta_2\, y_{jt} + \delta\, d_{ij} + \rho\, r_{ijt} + \pi\, p_{it} + \lambda\, rulc_{ijt} + \mu\, AN + \nu\, AL + \eta\, H + \varepsilon_{ijt} \quad (6.9)$$

The estimation method has been defined in section 3.5. However, several methodological issues deserve comments or precisions.

6.1. Instruments

As the error term is most likely correlated with y_i and y_j, most empirical studies use the log of the population as an instrument for the log of the GDP variables. However, as noted for instance by McCallum (1995), this single instrument does not permit to deal adequately with this problem. In this spirit, we choose a larger set of instruments, namely: (i) GDP's from the two previous years; (ii) current population and (iii) gross capital formation from the current and the two previous years. The model is estimated by the two-stage least squares method. In the first stage estimation, the regressions of the GDP for each country are performed for the years 1982-1998. In order to compare the 2SLS estimates with (i) the population instrument and (ii) the new set of instruments, the Hausman test for endogeneity yields a *t*-test value of 1.38 and thus does not permit to reject the hypothesis that the new instrumented GLS and the GLS estimates using population as instrument are statistically equivalent at the 5% significance level.

6.2. Tests

The estimation of equation (6.9) is accompanied with several tests. First, we investigate for possible influential observations using the residuals, DFIT values, cooks distances and leverages (for further details, see Cook and Sanford, 1999). Second, we test constancy restrictions for both the intercept and the coefficients of the border effect.

6.2.1. Influential Observations

Given the size of the sample (1260 corresponding to nine years, 10 importing and 14 exp), we first looked to whether the various statistics exceed a certain threshold for any observation. We expressed these statistics in averages with normalized standard deviations by importing country, exporting country and year.

The statistic for leverage effects do not suggest any unusual features that would suggest an anomaly in the data; they lie in a range of values that are stable across countries and time. However, the DFIT values suggest that Ireland, UK and to a lesser extent Greece, are potential outliers. Indeed, we observe that UK imports from Ireland are somewhat atypical. A likely explanation is that these two countries are treated as having a common border. As far as time is concerned, the residuals of 1993 show a slight break. Nevertheless, from those tests, we conclude that no observations appear to be pathological.

Equation (6.9) imposes the restriction that the intercept and the border effect remain constant through time. We test those restrictions on the basis of a likelihood ratio test (LR). In other words, we transform the gravity model into an unconstrained model where we include time dummies and allow the border effect to vary over time:

$$m_{ijt} = \alpha_t + \eta_t H + RHS\,(6.9) \qquad (6.10)$$

where *RHS* (6.9) is the right hand side of equation (6.9). In the general model (6.10), the coefficients of the intercept, α_t, and the coefficient of the border effect, η_t, are allowed to change over time. The value of the log-likelihood ratio test for a constant intercept is 13.8 (the critical value of χ^2 with 8 restrictions is 15.5 at the 5% significance level) while the restriction of a constant η yield a value of 9.46. This set of restrictions can not be rejected at the 5% confidence interval. The value of the log-likelihood ratio test for both sets of restrictions is 23.26 (the critical value of the χ^2 with 16 restrictions is 26.3). Notice however that allowing a different constant for 1993 was at the margin of rejection. We also tested whether there was a trend in α_t and η_t and both sets of restrictions were rejected.

6.3. Additional Tests

Heteroscedasticity is tested, in the spirit of the Breusch-Pagan-Godfrey test, on the basis of an auxiliary regression of the square of the residuals on all the exogenous variables excluding dummies. The reported statistic, *Het*(*k*), is distributed chi-square with *k* degrees of freedom. The null hypothesis of homoscedasticity is rejected in most of the cases. Notice also, that on the basis of the Jarque-Bera test, the hypothesis of normality is always rejected. The country residuals indicate that serial correlations is present. However when estimating with a AR(1) process, the long run coefficients are not statistically different from the corresponding coefficients of a static model. In addition, the dynamics appear to be more complex than a simple AR(1) process. However, the limited time observations do not allow to have a satisfactory dynamic model. We opt for simplicity by reporting only the static results (better no dynamics than bad dynamics)[9].

We test for serial correlation and found strong evidence of an AR(1) process. The usual remedy is to include dynamics. This suggests that it is worth to investigate a dynamic version of the model but this is beyond the scope of this paper.

7. RESULTS

Equation (6.9) estimated by GLS, allowing for random effects yields:

$$\underset{}{m_{ijt}} = \underset{(.41)}{-4.854} + \underset{(.01)}{.872}\, y_{it} \underset{(.004)}{-.021}\, yc_{it} \cdot y_{it} + \underset{(.03)}{.667}\, y_{jt} \underset{(.04)}{-.799}\, d_{ij} \underset{(.07)}{-.346}\, r_{ijt} + \underset{(.04)}{.912}\, p_{it} + \underset{(.01)}{.164}\, rulc_{ijt}$$

$$+\underset{(.05)}{.172}\, AN + \underset{(.08)}{.454}\, AL + \underset{(.08)}{2.481}\, H \qquad (7.11)$$

Random effects (variance): $\sigma^2_\mu = .18$, $\sigma^2_\nu = .36$, $\sigma^2_\xi = .18$

$R^2 = 0.98$; $L = -934.41$; $Het(7) = 23.87$; $N = 1260$.

We first note that all coefficients have the correct signs and relative low standard errors. The value of *Het* reveals that heteroscedasticity is still present although it has been reduced with respect to equation (4.4). Notice that the estimation of equation (7.11) by OLS, given in column (1) of Table 7.1, shows very little differences.

[9] The second author takes full responsibility for this sentence.

Income Elasticities. The coefficients of the income elasticities of the importing and exporting countries are very similar to those of regression (4.4). Imports are more sensitive to home GDP than foreign GDP. It is worth noticing that enlarging the instruments for GDPs hardly affects the income elasticities. The own income elasticity is slightly smaller than the EU average of 1995. This result indicates that as income grows the share of total manufacturing goods has a slowly, declining income elasticity most likely in favor of services. Of course, it may substantially vary across sectors and we shall return to this issue in section 8.

	1	2	3
y_i	0.874 (0.01)	0.846 (0.01)	0.774 (0.01)
y_j	0.655 (0.03)	0.555 (0.02)	0.762 (0.01)
$yc_i \cdot y_i$	-0.022 (0.004)	-0.025 (0.004)	
d_{ij}	-0.796 (0.04)	-0.694 (0.03)	-0.744 (0.03)
AN	0.163 (0.06)	0.130 (0.05)	0.392 (0.06)
AL	0.451 (0.08)	0.501 (0.08)	0.831 (0.09)
r_{ij}	-0.304 (0.07)	-	-
$rulc_{ij}$	0.161 (0.01)	0.151 (0.01)	-
p_i	0.914 (0.05)	0.922 (0.04)	-
H	2.482 (0.09)	2.451 (0.10)	2.561 (0.09)
Intercept	-4.821 (0.45)	-4.892 (0.50)	-6.656 (0.44)
Random effects	(variance)		
σ^2_μ	-	0.19	0.23
σ^2_ν	-	0.43	0.44
σ^2_ξ	-	0.18	0.18
L	-936.86	-945.35	-1176.18
Estimation Method	OLS	RE-GLS	RE-GLS

Table 7.1 Additional Estimations.

Price Variables. Both the coefficient of the general effect and the coefficient of the specific effect must be taken into account. For example; if country *i* experience a loss of competitiveness of 1% with respect to all its EU partners, imports will drop by slightly more than a percent (.9 + .16). This result is somewhat in contrast to studies that have used labor costs to explain export performance (Wolf, 1997 and Carlin et al., 1999). A possible explanation is that we restrict our analysis to intra EU trade and also that our sample is more recent. Indeed, current trends in international trade and the associated increase in international competition suggest a heightened importance of relative costs in performance.

Geographic Variables. The coefficients of bilateral distance and remoteness have the correct negative signs and are significant determinants of trade flows with an estimated elasticity of -.8 and -.35 respectively. The dummies for countries that share a same language and border (*AL*) and same border but different language (*AN*) are also found to have statistically significant effects with the correct signs. The effect of countries sharing a common language and land border is three times larger than for neighboring countries speaking different languages.

The Border Effect. The estimated coefficient of the border effect is 2.48 and it remains quite robust with the present specification of the gravity equation. It implies that domestic trade is 12 times higher than intra-EU trade.

Remoteness. The coefficient of remoteness has the correct sign and is highly significant. In the literature however there is no general consensus of whether the variable should be there. To show the empirical importance of whether this variable should be there, we re-estimated equation (7.11) dropping remoteness. The results are presented in column (2) of Table 7.1. The most notable change is a drop of almost 10% in the income elasticity of the exporting country while the other variables remain robust.

Some Further Tests. As a further diagnostic check, we re-estimate the basic gravity model without the augmented variables (column 3, Table 7.1). The results reveal an increase in the elasticities of the geographic variables (*AN*, *AL*) and a minor increase of the border effect. Generally speaking, we conclude that the border effect remains quite robust to alternative specifications of the gravity model.

8. HARMONIZATION OF TECHNICAL REGULATIONS

8.1. Introduction

The removal of technical barriers to trade (TBTs) has been one of the major institutional factors affecting intra-EU trade. The Commission (CEC, 1998) calculated that, in 1996, over 79% of intra-EU trade in manufacturing was affected by harmonized technical regulations.

The gravity model has been applied for identifying the impact of policy barriers. To gauge the impact of regulations, standards and other non-tariff barriers (NTBs), the gravity model is then augmented with frequency-type measures (e.g. number of regulations in an industry, trade-weighted coverage ratios) that quantify the impact of NTBs. Balassa and Bauwens (1988) estimate the impact of product standardization by incorporating a measure of industrial concentration in a gravity equation applied to bilateral exports. Harrigan (1993) derives a gravity equation based upon on monopolistic competition model and regresses bilateral trade flows on production and NTBs. These NTBs, available from the UNCTAD database, were expressed as coverage ratios. Moenius (1999) regresses bilateral trade on counts of shared standards and a set of dummy variables that control for country-pair effects (intended to capture income and distance). Head and Mayer (2000) apply the gravity equation to estimate the border effect. The industry-level border effects were then regressed on two indirect measures of EU NTBs.

Brenton and Vancauteren (2002) use the data from the Commission (CEC, 1998) in which sectors are grouped according to a harmonization approach (New Approach, Old Approach, Mutual Recognition). The authors estimate a gravity equation to these separate groups and look for differences in border effects between different groups. Chen (2004) pursues that approach using for each industry a 1-5 scale from no harmonization, a value of 1, to complete harmonization, a value of 5.

In this section, we proceed in two steps. Firstly, we estimate to what extent harmonization of regulations has promoted intra-EU trade at the level of total manufacturing; and to this end, we construct a variable that measures the coverage ratio of these regulations for each exporting country *j* at each period. Secondly, we apply a gravity model (7.11) for sectors that are defined by the type of harmonization defined by the Commission. We also estimate the gravity model on a selected branch for each type of harmonization.

8.2. Total Manufacturing

The harmonization of technical regulations is measured by an export-weighted coverage ratio from country *j* to country *i*. The idea is that country *j* will export more easily the more they satisfy EU regulations. For convenience we express the coverage ratio in deviations by an EU average. With this normalization, when we include the coverage ratio, the border effect is not affected[10]. We assume that trade is affected starting the year that an EU Directive, which we denote as *k*, is published. It generally takes more than a year for an EU Directive to be transposed in national regulations. However, in practice firms anticipate such publications and often adjust well before.

We construct a variable defined as:

$$s_{jt} = \left[\frac{x_{jt}^{k(t-1)}}{x_{jt}} - \frac{x_{eu}^{k(t-1)}}{x_{eu}} \right] \tag{8.12}$$

The first term in brackets is a coverage ratio of the EU exports of country *j* that are subject to harmonization in total exports of country *j* in each *t* and the second term is similarly constructed for average (1990-1998) intra-EU exports. With this normalization, the coefficient of s_{jt} shows to what extent a country *j* that complies with EU harmonization more than the EU average penetrates more easily foreign markets.

Notice that during the period 1990-1998, the most important change in harmonized regulations occurred in 1993 with the introduction of the directive on machinery. The scope of manufacturing sectors that are affected by other new harmonized regulations (lifts, gas appliances, low voltage equipment, etc.) were of minor importance in 1990, 1991, 1994 and 1995.

We separate out the effect of the removal of TBTs on imports in the case for international trade (when $i \neq j$) and domestic trade (when $i = j$). To do so, we multiply s_{jt} with $(1-H)$ for the case of EU bilateral trade and interacts s_{jt} with H for the case of domestic trade. The resulting equation (with standard errors in parentheses) is:

[10] However, it does affect slightly the intercept because the EU average is computed on the 14 exporting countries and not on the 10 importing countries.

$$m_{ijt} = -5.502 + .833\, y_{it} - .021\, yc_{it} \cdot y_{it} + .661\, y_{jt} - .458\, d_{ij} - .352\, r_{ijt} + .878\, p_{it} + .158\, rulc_{ijt}$$
$$\quad (.39) \quad (.01) \quad (.004) \quad (.05) \quad (.04) \quad (.09) \quad (.04) \quad (.01)$$
$$+ .154\, AN + .490\, AL + 2.952\, s_{jt} \cdot (1 - H) + .203\, s_{jt} \cdot H + 2.381\, H \qquad (8.13)$$
$$\quad (.04) \quad (.07) \quad (.12) \quad (.61) \quad (.07)$$

Random effects (variance): $\sigma^2_\mu = .12$, $\sigma^2_\nu = .57$, $\sigma^2_\xi = .18$
$R^2 = 0.95$; $L = -892.13$; $Het(7) = 28.14$; $N = 1260$.

According to (8.13), harmonization of EU regulations has played a significant role in explaining intra-EU trade. The coefficient of $s_{jt} \cdot (1–H)$ is strongly significant and positive. However for the case of domestic trade, we do not find any significant impact of harmonization of technical regulations on a possible reduction of border effects. The coefficient of $s_{jt} \cdot H$ is .20 and not significantly different from zero[11]. It is worth noticing that the introduction of s_{jt} has reduced the size of the other coefficients. The most notable change is a reduction in the income elasticity of the exporting country *j*.

The major conclusion is that harmonization of technical regulations has increased intra-EU trade with almost no impact on the border effect. This result is in the same line as Head and Mayer (2000) who find also, using another methodology, that non-tariff barriers before and during the Single Market Program cannot explain the size of estimated border effects[12].

8.3. Disaggregated Data

In this section, we disaggregate trade of manufacturing sectors in six categories that correspond to the different approaches used by the European Commission to the removal of technical barriers to trade. We first distinguish between sectors where harmonized regulations apply (Tech. Reg.) and no regulations (No T.R.) apply. The former is divided in four categories: mutual recognition (M.R.), new approach (N.A.), old approach (O.A.) and multiple harmonization approaches (other T.R.). Details of the construction of the data and the harmonization approaches are given in the appendix.

8.3.1. Harmonized Technical Regulations and No Regulations

The first two columns of Table 8.2 report the results of the gravity model (7.11) applied to two broad aggregates: Tech. Reg. (column 1) and No T.R. (column 2). Notice that here and in all subsequent regressions p_{it} is measured as the log of the ratio between the GDP deflator and unit price index at the level of each category while relative unit labor costs ($rulc_{ij}$) are still taken at the aggregate level of manufacturing. Each category contains 1260 observations and is estimated by GLS allowing for random effects.

The overall fit is high in each of the two regressions. For most of the variables, standard errors are low. The proportion of sectors that are subject to harmonized regulations represents about 80% of total manufacturing. This explains why the coefficient estimates for Tech. Reg. are very similar to those obtained for the manufacturing as a whole (eq. 7.11). For the same

[11] We also ran equation (8.13) on a sample that omits all the observations for domestic trade. As expected the most notable change is an increase in remoteness, r_{ijt}, from -0.35 to -0.23. This shows the sensitivity of this coefficient to the measurement of internal distances.

[12] The authors use two indirect measures of EU non-tariff barriers (NTBs). The first measure is based on a 1980s survey of EU firms conducted by the European Commission. From this survey, the authors construct three variables representing the magnitude of the NTBs in terms of standard differences, public procurement and customs formalities. The second set of indicators comes from Buigues et al. (1990), which classified European industries into three levels of barriers: low, moderate, and high.

group, we find that the general price index, p_{it}, is close to unity and statistically not different from one. Therefore, we constrained it to unity, which amounts to use the implicit price of GDP as a deflator.

For sectors subject to no regulations (No T.R.) and mutual recognition, the income elasticities have been reduced while the weighted per capita income elasticity, $yc_i \cdot y_i$, has the expected sign in all categories.

Differences in the coefficients of bilateral distance and remoteness are also pronounced in both categories. It is not surprising that the coefficient of bilateral distances, which supposedly represents transportation costs, varies across categories.

In general, for most coefficients of the auxiliary variables, we find the same magnitude as before. In particular, the coefficient of the border effect, H, is the same for both categories.

For each category, we test whether the border effect was constant over time and this hypothesis was never rejected.

8.3.2. Categories of Harmonized Technical Regulations

The estimation of the model for the various harmonization approaches is presented in the next columns of Table 8.2: mutual recognition (M.R.), new approach (N.A.), old approach (O.A.) while the sixth column is a remainder sector where multiple harmonization approaches are applied (other T.R.). Furthermore, since each of these approaches consists of products that are different in nature, we also estimate the model on a most representative sector of each category. We selected *footwear, leather, wool* and *cotton* for the No T.R., *machinery* for the N.A., *basic chemicals* for the M.R. and *processed food* for the O.A.

We reject the restriction that the border effect is constant over time only for the N.A. category. However, we find that this effect was solely due to the sector *other machinery, no else classified*. Indeed, this sector shows an important decrease in the evolution of the border effect but the nature of this group is not well defined and yields various atypical coefficients. We therefore decided to exclude this group from the analysis.

For sectors subject to no regulations (No T.R.), the income elasticities have been reduced while the weighted per capita income elasticity, $yc_i \cdot y_i$, has the wrong sign. Although we can imagine various explanations we do not have a convincing reason for this latter result.

The coefficient of the border effect varies across categories. We notice that the border effect is surprisingly small for basic chemicals in the M.R. group and the coefficient is estimated with little precision. However, one should keep in mind that the size of these coefficients depends heavily on the way internal distances are measured. The fact that coefficients do not vary over time confirm the previous results that harmonization of technical regulations improves bilateral trade but did not significantly affect domestic trade.

The results show a large variability among the categories. In particular, the income elasticity of the exporter, bilateral distances and remoteness move, in absolute values, jointly and are large in several cases.

	Tech. Reg.	No T.R.	N.A.	M.R.	O.A.	Other T.R.	No T.R. (i)	N.A. (ii)	M.R. (iii)	O.A. (iv)
y_i	0.873	0.825	0.874	0.865	0.975	0.877	0.675	0.870	0.791	0.900
	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)	(0.02)	(0.04)	(0.04)	(0.04)	(0.03)
y_j	0.742	0.494	0.921	0.576	0.724	1.032	0.621	1.566	1.573	0.838
	(0.03)	(0.03)	(0.06)	(0.04)	(0.05)	(0.04)	(0.06)	(0.08)	(0.10)	(0.07)
$yc_i. y_i$	-0.025	-0.012	-0.035	-0.009	-0.065	-0.036	0.022	-0.051	-0.134	-0.101
	(0.004)	(0.005)	(0.006)	(0.005)	(0.006)	(0.006)	(0.012)	(0.012)	(0.01)	(0.01)
d_{ij}	-0.901	-0.402	-0.974	-0.932	-0.844	-1.389	-0.904	-1.615	-1.401	-1.477
	(0.04)	(0.05)	(0.05)	(0.06)	(0.06)	(0.06)	(0.11)	(0.11)	(0.12)	(0.10)
AN	0.162	0.207	0.344	0.055	0.255	0.214	0.085	0.118	0.592	0.732
	(0.06)	(0.06)	(0.08)	(0.07)	(0.09)	(0.10)	(0.16)	(0.16)	(0.17)	(0.14)
AL	0.453	0.586	0.623	0.074	0.604	0.445	0.101	0.265	0.544	0.981
	(0.09)	(0.10)	(0.12)	(0.10)	(0.12)	(0.11)	(0.04)	(0.24)	(0.26)	(0.21)
r_{ij}	-0.501	-0.336	-0.958	-0.576	-0.364	-1.021	-1.456	-1.586	-1.484	-0.754
	(0.07)	(0.08)	(0.12)	(0.10)	(0.11)	(0.09)	(0.20)	(0.20)	(0.25)	(0.18)
$rulc_{ij}$	0.152	0.142	0.082	0.272	0.144	0.128	0.395	0.130	0.163	0.116
	(0.01)	(0.01)	(0.03)	(0.02)	(0.02)	(0.02)	(0.04)	(0.04)	(0.05)	(0.03)
p_i	1	0.722	0.764	0.914	1	0.866	0.874	0.504	0.408	0.714
	(-)	(0.06)	(0.06)	(0.06)	(-)	(0.06)	(0.13)	(0.13)	(0.14)	(0.11)
H	2.419	2.448	2.732	1.465	2.615	2.554	1.791	3.237	0.290	1.482
	(0.09)	(0.10)	(0.14)	(0.10)	(0.12)	(0.11)	(0.23)	(0.22)	(0.24)	(0.20)
α	-4.422	-7.665	-9.887	-3.124	-8.439	-5.612	-10.142	-11.357	-6.944	-5.391
	(0.45)	(0.50)	(0.63)	(0.54)	(0.62)	(0.58)	(1.23)	(1.19)	(1.28)	(1.06)
σ_μ^2	0.22	0.21	0.04	0.06	0.40	0.34	0.40	0.31	0.40	0.33
σ_ν^2	0.40	0.43	0.37	0.46	0.34	0.40	0.58	0.51	0.60	0.44
σ_ξ^2	0.17	0.25	0.18	0.06	0.18	0.18	0.18	0.11	0.11	0.17
$R^{2\,(a)}$	0.92	0.90	0.87	0.88	0.88	0.89	0.82	0.73	0.72	0.85
$WT^{(b)}$	0.83	0.69	0.69	0.89	0.80	0.80	0.90	0.86	0.94	0.79

Table 8.2 Estimates of various disaggregation levels.

Notes: Standard errors are reported in parentheses. (a) R^2 is the squared correlation between actual and predicted values. (b) *WT* is the Wooldridge test for unobserved, random effects: $(\sigma_\mu^2 + \sigma_\nu^2)/(\sigma_\mu^2 + \sigma_\nu^2 + \sigma_\xi^2) > 0$ (See Wooldridge, 2002, pp. 259). NACE codes are for (i) Footw., Leath., Wool, Cott.; 431, 432, 433, 435, 441, 442, 451 (ii) Mach.; 321, 322, 323, 324, 325, 326, 327 (iii) Basic Chem.; 251 (iv) Proc. Food; 412, 413, 414, 415, 416, 417, 418, 419, 421.

The effect that accounts for the weighted income per capita elasticity becomes more important at the less aggregated level. We notice that there is a positive elasticity growth with income for the sectors *footwear, leather, wool* and *cotton* in the N.A. group.

The results on the coefficients of the competitiveness variables, p_i and $rulc_{ij}$ are statistically significant with expected signs in all groups. There is a much wider variability in unit labor cost elasticities. We notice a very high impact on EU imports in *footwear, leather, wool* and *cotton*.

It is worth mentioning that at this detailed level, coefficients are estimated with less precision. A possible explanation is that for the sake of comparison at a less aggregated level we kept GDP for both countries to explain the size effect rather than for instance production.

9. CONCLUSION

In this paper, we propose some extensions of the standard gravity model. A special attention is given to the impact of harmonization of regulations in explaining EU bilateral trade and domestic trade.

We consider several methodological issues. From an economic point of view, we provide a theoretical consistent measure of remoteness. We add competitiveness that is composed into a general and bilateral component and accounted for a flexible income response. The proposed gravity equation has then been validated on different levels of aggregation within the manufacturing sector.

Major empirical results are as follows. First, at the level of manufacturing as a whole, we find that the border effect is quite robust to a standard specification of the gravity equation such as the one estimated by Nitsch (2000). In particular, we find that domestic trade in the EU is about 14 times larger than EU-bilateral trade. Secondly, we find that the border effect has not declined for 1990-1998. Thirdly, we find that harmonization of technical regulations cannot explain border effects while it has a positive impact on EU imports.

At more detailed levels, we observe a large variability of the coefficients, in particular, for the exporting income elasticity, bilateral distances and remoteness but the main conclusion remains: the border effect does not exhibit any declining trends for sectors that are regulated by EU harmonization.

APPENDIX

DATA

Trade Data

Trade data are taken from Eurostat (Comext Database) and are collected at the three digit NACE industrial classification (NACE70) which covers around 120 manufacturing industries. The data is available in values (euros) and volumes (tons). We deflate the imports data by an import unit price index – using 1995 as the base year – in order to obtain a real flow of trade. Our sample covers the period 1990-1998. The importing are the following ten EU countries: Denmark, France, Germany, Greece, Italy, Ireland, the Netherlands, Portugal, Spain, and United Kingdom while the exporting countries are the previous 10 countries + the remaining

EU countries: Belgium and Luxembourg treated as one, Finland, Sweden and Austria. The choice of 10 importing countries was limited by data availability: Sweden, Finland, Austria and Belgium/Luxembourg are omitted because there is no production data reported before 1995. The sample therefore covers a total of 1260 (=10*14*9) observations.

Other Data

Internal distances d_{ii}, are taken from Nitsch (2000), which were calculated by using the disk area procedure to obtain the average distance between economic centers. He shows that the radius of a circle (given by the inverse of the square root of π times the square root of the area) may be a good approximation for the average distance. For distances between countries d_{ij}, we follow the conventional method in the gravity literature and measure the direct (great circle) distance between the economic centres (capital cities).

This paper requires bilateral trade and production data in a compatible classification for 10 European countries over the period 1990-1998. Since we do not have any data on national trade, we follow Wei's (1996) methodology based upon the assumption that for any country *i*, domestic trade (imports from itself) is defined as the difference between its production and exports[13]. We extracted production data from New Cronos with reference to the domain of the 'business structural database'. The long time series, "covering enterprises with 20 persons employed and more", in NACE revision 1 (code at 3 digit level) were converted to NACE70 (code at 3 digit level) in order to match with trade data extracted from Eurostat (Comext) database. The concordance lists the NACE revision 1 and the NACE70 at a 5 and 4 digit level code, respectively. Some in-between-year observations are missing from the New Cronos database. Missing data, then, are approximated by applying a trend of the gross rate of value-added (in quantity) in each NACE sector. Finally, gross capital formation (1995 prices) GDP (1995 prices), unit labor costs (1995 prices) and population are obtained from the New Cronos database. For the Netherlands, Denmark and Spain, some missing values of unit labor costs were unavailable. For these countries, we approximated these missing observations using labor cost indexes that were computed by the European Commission (DG-ECOFIN).

Data on Harmonization of Technical Regulations

The data on technical regulations come from the Commission's review of the impact of the Single Market in the EU (CEC, 1998). This study provides information at the 3-digit level of the NACE classification of whether trade is affected by technical regulations and the dominant approach used by the Commission to the removal of such barriers in the EU. We derived the trade data according to the same NACE industrial classification applied to a panel of 15 EU countries of 1990-1998. We disaggregate the dependent variable, imports of manufacturing, into 6 categories: (i) new approach, (ii) old approach, (iii) mutual recognition, (iv) a combination of multiple approaches, (v) an aggregate of all harmonization approaches, and (vi) sectors where differences in national regulations do not constrain any trade flows.

In Table A, we show for 1998 for each country the share of EU imports in manufacturing that are (i) regulated by the different harmonization approaches: mutual recognition, old approach, new approach and a combination of any approach, (ii) regulated by an aggregate of the four types of harmonization approaches, and (iii) where technical barriers to trade do not apply.

[13] This definition has become the standard methodology for empirical studies that can not rely on national data. See for example: Helliwell (1997, 1998) for OECD countries; Nitsch (2000) and Chen (2004) for EU countries.

On aggregate, the share of manufacturing regulated by one of each of the harmonization approaches represents a very large proportion of intra-EU trade affected by EU harmonized technical regulations[14]. More than 75% of intra-EU imports are in sectors where differences in technical regulations are important. The share ranges from 59% for Greece to 85% for Ireland.

The table demonstrates that there is a considerable variation across EU members in the share of trade affected by the different approaches to the removal of TBTs. For example, sectors where mutual recognition is used comprise a relatively large share of EU imports from Ireland (32%), Greece (30%) and Portugal (29%) but a small share of EU imports from Finland (5%) and Sweden (10%).

	EU Imports from Member States					
	Old App.	New App.	Mutual Recognition	Other	Tot. Tech. Reg.	No Tech. Reg.
Austria	26.29	17.97	11.40	15.08	70.74	29.26
Bel-Lux	30.03	10.62	13.74	19.25	73.64	26.36
Denmark	24.98	17.39	16.54	13.95	72.86	27.14
Finland	38.89	12.20	5.04	22.34	78.47	21.53
France	30.74	11.12	17.32	14.14	73.32	26.68
Germany	31.12	17.53	14.70	16.47	79.82	20.18
Greece	17.28	5.60	29.65	6.72	59.25	40.75
Ireland	22.06	9.45	32.34	20.73	84.58	15.42
Italy	17.98	20.90	17.84	15.78	72.5	27.50
Nether.	27.17	7.95	22.22	17.71	75.05	24.95
Portugal	25.32	8.92	28.78	10.05	73.07	26.93
Spain	39.73	8.86	11.31	11.26	71.16	28.84
Sweden	33.91	16.43	10.45	18.21	79	21.00
UK	21.29	14.08	24.61	16.71	76.69	23.31
Intra-EU	27.91	13.39	18.14	16.03	75.47	24.53

Table A The Importance of the Harmonization Approaches to Technical Regulations: Coverage of EU (15) Imports from Member in 1998, %.

Sectors characterized by the new approach comprise relatively larger shares of EU imports from Italy (20%), Austria, Denmark, Sweden, Germany (17%), but are less important from Greece (5%), Portugal, Ireland, Netherlands and Spain (8%). Sectors that are prone to the old approach comprise the largest share of total EU imports, relatively to the other approaches. It is of particular importance for Spain, Sweden and Finland (over 30%).

This table concludes that the removal of technical regulations varies by the different approaches and by EU members and there is considerable variation across EU members in the share of trade affected by technical regulations. However, we also recognize that this share is not only affected by differing national regulations but also by the level and composition of import volumes.

EU APPROACH TO THE REMOVAL OF TECHNICAL BARRIERS TO TRADE

EU policy related to technical regulations and testing and certification requirements is currently based upon two approaches: enforcement of the mutual recognition principle and, if

[14] Previous analysis of the Single Market Program in the existing EU countries suggests that the removal of technical barriers to trade may be of great significance. CEC (1998) calculates that over 79% of total intra-EU trade may have been affected by technical regulations in 1996. In the graph, we only consider manufacturing.

this fails, the harmonization of technical standards across member states. Each approach will now be discussed in turn.

The Mutual Recognition Principle

The basic EU approach to this issue of differences in national regulations is the principle of mutual recognition, which was developed on the basis of a European Court of Justice case law, the Cassis de Dijon and Dassonville judgments. The mutual recognition approach is based on the idea that products manufactured and tested in accordance with the technical regulations of one member state can offer equivalent levels of protection to those provided by corresponding domestic rules and procedures in other member states. Thus, once a product is legally certified for sale in any member state it is presumed that it can be legally placed on the market of any member state, and as such has free circulation throughout the whole of the Single Market. The application of the mutual recognition principle requires a degree of trust between different countries and regulatory authorities that another country's regulation can offer equivalent levels of protection and that such regulations are effectively implemented ensuring that products actually conform to the requirements of the regulations. Hence, the principle of the mutual recognition plays a significant role in the internal market since it ensures free movement of goods (and services) without making it necessary to harmonize national regulations. 'Mutual Recognition' tends to apply where products are new and specialized and it seems to be relatively effective for equipment goods and consumer durables, but it encounters difficulties where the product risk is high and consumers or users are directly exposed.

Harmonization of Technical Standards

Where 'equivalence' between levels of regulatory protection embodied in national regulations cannot be presumed, the EU has sought to remove TBTs through agreement on a common set of legally binding requirements (=harmonization). Subsequently, no further legal impediments can prevent market access of complying products anywhere in the EU market. EU legislation on harmonizing technical specifications has involved two distinct approaches, the 'old approach' and the 'new approach'.

Old Approach

The initial approach adopted in the EU to harmonizing technical specifications was based upon extensive product-by-product or even component-by-component legislation carried out by means of detailed directives. Now known as the 'old approach' this type of harmonization proved to be slow and cumbersome. In the 1980s the ineffectiveness of this approach was recognized when it became apparent that new national regulations were proliferating at a much faster rate than the production of harmonized EU directives (Pelkmans, 1987). This failure arose because the process of harmonization had tended to become highly technical as it sought to specify individual requirements for each product category (including components). This resulted in extensive and drawn-out consultations. In addition delays arose because the adoption of old approach directives required unanimity in the Council of Ministers. As a result the harmonization process proceeded extremely slowly. The old approach applies mostly to products (chemicals, motor vehicles, pharmaceuticals and foodstuffs) by which the nature of the risk is clearly apparent.

New Approach

In an attempt to overcome the drawbacks of the 'old approach' to the elimination of technical barriers to trade, the Commission launched in 1985 its 'New Approach to Harmonization and Technical Standards', focusing on the need to reduce the intervention of the public authorities and on accelerated decision-making procedures prior to a product being placed on the market. For example, a key element in the adoption of the 'new approach' is that the Council on the basis of majority voting can adopt directives. The new approach applies to products, which have "similar characteristics" and where there has been widespread divergence of technical regulations in EU countries. What makes this approach 'new' is that it only indicates 'essential requirements' and leaves greater freedom to manufacturers on how to satisfy those requirements, dispensing with the 'old' type of exhaustively detailed directives. The new approach directives provide for more flexibility by using the support of the established standardization bodies, CEN, CENELEC (European Standardization Committee for Electrical Products) and the national standard bodies. The standardization work is achieved in a more efficient way, is easier to update and involves greater participation from industry.

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