

**Sectoral Border Effects:
Analysing Implicit EU Trade Integration**

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After four decades of a process of economic, political, and cultural organisation, the EU has reached a considerable level of 'overall integration'. There are however still many obstacles that pre-empt full economic integration. The aim of this paper is to explore the implicit trade obstacles or barriers that still exist among EU members, including the absence of networks and further links. Estimating a gravity-type sectoral specification which includes explicit barriers to trade (tariffs, transportation and transaction costs) in a model for high income OECDs, makes it possible to isolate the implicit EU trade integration effect. This setup allows an examination of both relative integration levels across sectors and the evolution of each sector's integration across time. We find that, during the period 1977-1999, textiles have been the most integrated sector, and that chemicals and non-metallic products are the least trade integrated sectors in the EU. The ultimate aim is to evaluate these implicit costs by backing them out with regional trade data as the absolute.

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Introduction

Explicit trade costs between countries often include tariffs, non-tariff barriers (NTBs), and quotas. Further, transportation and transaction costs (in the form of currency conversion or other information costs and time-consuming paperwork) can also constitute barriers to trade. After more than four decades since the integration process started, EU members have reached a high level of trade integration through the abolition of intra-EU trade tariffs. However, there are still (mainly implicit) trade barriers that may be pre-empting further economic integration.

The idea of this study is to estimate the level and trends of the implicit sectoral integration effects between EU members, in order to assess both the level and the evolution of EU trade integration since the 1970s.¹ For over half a century, one of the leading strands of the literature looks at trade frictions by estimating what is called the 'border effect' (or 'home bias') through the use of gravity models. Border effects reflect an apparent preference for home-produced goods, or "consumers' ignorance about better products made elsewhere, the greater ability of domestic producers to interpret and influence the tastes of domestic consumers, or the lower costs of dealing within national networks of norms and institutions (and) the continued use of national borders as locations of policy-created limitations on trade"². We use a gravity specification to capture the explicit obstacles and benefits of bilateral trade and isolate the implicit trade benefits of being in the EU. We view this as a mix of consumers, producers, and institutional links which can be captured with a joint EU effect. This type of analysis has been applied to aggregate trade flows. However, we believe that it is important to capture the heterogeneity across different sectors in the economy, and thus focus on eight manufacturing sectors.

Why gravity?

Although their theoretical justification is often challenged, gravity equations have many advantages. They are able to fit empirically many different trade models and, and as a drawback from the lack of sound microeconomic foundations, they do not rely on restrictive assumptions. Additionally, their flexible specification allows one to account for a variety of supposed 'natural' determinants of trade such as the size of countries, the distance between them, and their common characteristics and allows to control for other trade determinants, such as explicit trade costs. In this way, the gravity model provides a benchmark to measure deviations from 'normal' bilateral trade. In our case, it allows to isolate the EU effect from any other trade determinant which is common to OECD countries.

Why sectoral?

As said before, we believe that border effects may differ across the different economic sectors. Moreover, some of the explicit trade barriers, e.g. tariffs, are not uniform across industries. Hence, it seems more adequate to estimate sectoral gravity

¹ This is, from the end of the transition period between The Six.

² Helliwell (1997), page 185.

equations. Although the literature on gravity models has generally used aggregate data, some authors have suggested the possibility of disaggregating the model. For example, Harrigan (2001) notes, “most of the evidence that “gravity works” comes from aggregate data, (...) despite the fact that the models developed to explain gravity often apply also at the sectoral level“. Furthermore, he states that “Whatever the sector-specific explanations, the large cross-sector variation in trade relative to output suggests that empirical work on understanding the volume of trade should work with disaggregated data”.³

I. Literature Review

During the 1990s, gravity models became widely used as a benchmark for the bilateral trade flows among countries or regions. Some of their applications incorporate trade blocs dummies to test how ‘natural’ those blocs are (Frankel, Stein and Wei, 1993, 1997 and 1998). A second group of studies includes both internal and external trade and distance proxies (Wei, 1996; Helliwell, 1996, 1997 and 1998; Nitsch, 1999) to measure the width of the borders. The gravity setup has also been used to measure the potential trade of developing countries (Wang and Winters, 1991 and 1994; Hamilton and Winters, 1992; Baldwin, 1994) and to evaluate the effects of protection (Harrigan, 1993) and openness (Harrigan, 1996).⁴

Bergstrand (1989) has built one of the first models for a sectoral gravity equation. He builds up a gravity equation for each sector, in which the value of bilateral exports depends on the exporter’s national output expressed in terms of units of capital (proxied with exporter GDP) and its capital-labour endowments ratio (proxied by using its GDP per capita). Distance and adjacency dummies proxy transport costs and he also includes other trade barriers (e.g. tariffs)⁵, bilateral exchange rate, and two price terms. Further, Bergstrand takes the exporter’s per capita income as a weak proxy for the exporter’s K/L ratio): “will have a certain tendency linked to whether the gravity equation is estimated for a capital or labour-intensive industry”⁶. He estimates the model for 9 SITC sections,⁷ approximating differences in price levels by cross-country variation in price indices.⁸

Rauch (1999) estimates a disaggregated gravity model for three different types of goods:⁹ homogeneous, reference price, and differentiated.¹⁰ He estimates a gravity equation to explain the bilateral volume of trade between two countries plus a minimum threshold for iceberg transport costs¹¹ for each type of good with the

³ Harrigan (2001), pages 41 and 44 (respectively).

⁴ See Harrigan (2001) for a wide coverage and evaluation of empirical studies on gravity models.

⁵ Bergstrand uses a proxy using dummy variables for preferential trade agreements.

⁶ Bergstrand (1989), page 146.

⁷ SITC (Standard International Trade Classification) is one of the most commonly used trade classifications.

⁸ See Soloaga and Winters (2001) for a critique on this approach.

⁹ He aggregates products at the 5-digit SITC level.

¹⁰ The three groups are (respectively): traded in an organised exchange, not traded in an organised exchange but with some quoted price, and not having any quoted prices.

¹¹ To correct distance effects for differences in transportability across the commodity groups.

classical gravity equation determinants (masses, distance, etc). He finds that adjacency and common links between countries are more important for differentiated products than for homogeneous goods. Also, Rauch's results suggest that search barriers to trade are higher for differentiated than for homogeneous products, maybe reflecting the lower demand for the former outside the country in which they are produced. Along similar lines, Feenstra, Markusen and Rose (2001) argue that gravity equations for differentiated and homogeneous goods differ empirically, given their varying degrees of specialisation. Their working hypothesis is that different types of goods might face diverse entry barriers, and thus their gravity equation coefficients would differ across sectors. For a sample divided according to Rauch (1999)'s, Feenstra et al. find that the elasticity of exports with respect to own GDP rises significantly with the degree of goods' differentiation.

Lai and Trefler (1999) build a general gravity equation with given sectoral production, controlling for distance and other time-invariant influences on bilateral trade by fixed effects. They find that, although the correlation between fitted and actual trade volumes is highest for monopolistic competitive industries, it does not work too well at a sectoral level: among other things, the volume of trade is lower than predicted, and the assumption of unit elasticity of trade with respect to partner production is not met. Harrigan (2001) criticises this approach pointing out that the fixed effects approach gives consistent estimates but sweeps out much of the cross-section variation in the data.

Head and Mayer (2000) estimate industry-level border effects and then use industry-level data on European non-tariff barriers (NTBs) to assess whether the former can explain the latter. Decomposing border effects into (explicit) NTBs and the typical home-market bias in a monopolistic competition gravity model (for trade at 3-digit EU industries), Head et al. find that only a small proportion of the border effect can be attributed to measured NTBs.

II. The estimating equation

In order to evaluate the EU economic integration effects across sectors, we build up a sectoral gravity model which allows us to capture the implicit benefits of EU trade, by controlling for the explicit determinants of trade. We believe that the best sample to look at EU effects is to take countries alike,¹² and thus use a panel for each of the eight (2-digit ISIC divisions)¹³ manufacturing sectors in nearly all high-income OECD countries for the period 1977-1999.¹⁴

II.1. Modelling bilateral trade by sector

We use a model specification similar to the one in Bergstrand (1989), but for a different sectors composition (based on an industrial rather than on a trade classification), which

¹² In terms of their economic development.

¹³ ISIC stands for International Standard Industrial Classification, and it is one of the most widespread used nomenclatures for industrial production.

¹⁴ See below for the exclusions.

we find more adequate,¹⁵ and with ‘more realistic’ proxies for some of the variables (see below). The main (explicit) determinants of our sectoral bilateral trade can be classified into four groups: production and income, barriers to trade, integration effects, and transaction costs.¹⁶

(i) *Production and income*: these variables are meant to capture the output of the sector and the spending power of each country on its bilateral trade. In a sectoral context, it is essential to reflect the exporter’s productive structure and volume in each sector.

(ii) *Barriers to trade*: the main explicit barriers to trade between two countries can be classified into geographical and measures of trade resistance. Gravity models have transportation costs as the geographical barriers; tariffs and non-tariff barriers (NTBs) are examples of measures of bilateral trade resistance.

(iii) *Integration effects*: preference trade agreements (EU, EFTA, NAFTA, etc) are also important determinants of trade.

(iv) *Transaction costs*: any bilateral link between two countries would affect the transaction costs to trade with each other. Also, a favourable bilateral currency can improve the terms of trade and make an economy relatively more competitive to export its goods to its (relatively less competitive, with a stronger currency) country. In real terms, cyclical bilateral trade flows can be controlled for with real bilateral exchange rate.

Taking these four groups, the baseline estimating equation is:

$$(1) \quad M_{kijt} = \alpha_0 + \alpha_1 y_{kit} + \alpha_2 Y_{it} + \alpha_3 Y_{jt} + \beta_1 T_{ij} + \beta_2 BRES_{kjt} + \beta_3 BRER_{ijt} + \beta_4 D_{ij} + \delta EU_{ijt} + u_{kijt}$$

where M_{kijt} is the log of a real bilateral trade flow from industry k in i to j in year t , y_{kit} is the log of real production in sector k of exporting country i in year t , Y_{it} is the log of real income of country i , T_{ij} is transportation cost between i and j , $BRES_{kij}$ are measures of bilateral trade resistance, $BRER_{ijt}$ is the log of real bilateral exchange rate, EU_{ijt} is a dummy which reflects joint membership to a regional trade agreement, D_{ij} is a set of dummies which capture common links between i and j (as part of the transactions costs) and the structure of the error term (u_{kijt}) will depend on the model estimated (see below).

This specification, however, may have an endogeneity problem due to comparative advantage in production. It is reasonable to expect that a country will export more of the good relatively intensive in the factor it is relatively more abundant in. This is especially important when considering particular sectors across different countries. From the literature cited in the previous section, the only attempt to capture for comparative advantage was made by Bergstrand (1989), but using (what he also admits to be) a quite rough proxy.

Thus, we develop a two stages method which first captures the degree of comparative advantage on production, and then instruments for this into the sectoral gravity equation. The first stage draws on the literature used to test the Heckscher-Ohlin-

¹⁵ To talk about industrial policy, it is best to look at the manufacturing sectors, which in an industrial classification are well separated from raw materials and intermediate inputs.

¹⁶ See data appendix for the sources and for the construction of some of the variables described below.

Vanek (HOV) model.¹⁷ To account for this feature, we instrument for the production in each sector by using exogenous instruments based on each exporting country's endowments. We do this by estimating a Leamer-like equation to explain production in each industry with labour force, capital stock, and natural resources. For the second stage, we substitute the production variable in a sectoral gravity-type equation to measure bilateral trade.

Harrigan (1995) estimates the production of a sector in many countries as a function of capital, labour and land as a part of a HOV test. He looks at the production side of the factor proportions theory by modelling the comparative advantage determinants of production for OECD countries' industries. We estimate production according to comparative advantage using a model similar to Harrigan (1995)'s to then incorporate it into a gravity-type equation.¹⁸

Thus, a first equation would estimate the output per industry over time that is due to comparative advantage in the exporting country:

$$(2) \quad y_{kit} = \varphi + \beta CAPITAL_{kit} + \gamma LABOUR_{kit} + \delta NATRES_{it} + \varepsilon_{kit}$$

where *CAPITAL* is a measure for fixed gross capital formation, *LABOUR* is the labour force, *NATRES* are natural resources (see data appendix for proxies), and the error is assumed to be white noise.

On a second stage, we instrument production with the fitted production values (\hat{y}_{kit}) into equation (1) to control for the exporter's comparative advantage-led production. We think of this as an instrument because they are not correlated with the error term, and are correlated with the variable we are instrumenting (production).

The evolution of EU integration effects can be captured in different ways. The simplest way is to estimate a cross-section for each year, and look at the EU dummy estimated coefficients. Molinari (2000) suggests a SURE model for aggregate trade data over time. This method assumes that the cross-section equations in each year are related through their error terms, and thus 'links' them through time. It has the advantage of relating the cross-sections through time, without imposing estimated coefficients to be constant over time (as in panel data). However, this method does not capture unobservable trade determinants.

A third and more complete method is to estimate a two-way panel data model, where the estimating equation would as (1) but with the following error structure:

$$(3) \quad u_{kijt} = \mu_{kij} + \lambda_{kt} + \varepsilon_{kijt},$$

with μ_{kij} capturing unobservable individual effects, λ_{kt} unobservable time effects and ε_{kijt} stochastic part of the error. The fixed effects model (within estimator) assumes that μ_{kij} and λ_{kt} are fixed parameters to be estimated and the remainder disturbances are stochastic, and that the regressors are (only) independent from the ε_{kijt} . The random effects model (GLS estimator) assumes that all the error components are stochastic and independent from each other, and that the regressors are independent from the three error components.

¹⁷ See Leamer (1984), Maskus (1991), and Harrigan (1995) among others.

¹⁸ Although Harrigan's model generally does poorly, mainly due to missing variables bias, we only intend to isolate the comparative advantage issues involved in our sectoral gravity equation.

Although a two-way panel data specification needs to estimate many parameters, it is possible to implement it when having enough degrees of freedom (another of the advantages of *bilateral* data). This would then capture both the unobservable time *and* individual effects.

II.2. Sectoral gravity model: choice of proxies

In order to look at the EU trade integration effects across sectors and across time, we chose a sample of countries with a similar development level to the fifteen EU members. Thus, we use eight different panels (one for each manufacturing sector) of high income OECD countries data for the period 1977-1999.¹⁹

With the exception of some models (e.g. Parsley and Wei, 2001), most gravity models (whether aggregated or disaggregated), do not consider prices. This is because gravity is mostly considered to model longer-run trade flows, and thus is used with cross-section data. In other words, within a cross-section framework prices adjust to meet the equilibrium in the goods markets.²⁰ When exploiting the time dimension, however, it is necessary to capture variations across time due to pure price-effects, or potential temporary price and exchange rate imbalances.

It is not yet clear in the gravity literature whether choosing imports or exports is the best option to proxy trade flows.²¹ Imports seem to suffer from lower measurement error, given the countries' interest for monitoring them more carefully than the latter for customs purposes, but most models use exports as the dependent variable (mainly due to better price data availability).²² In a panel context, where we need prices data, import unit values are generally available for OECD countries. Thus, we choose bilateral imports as our dependent variable.

Our sample of OECD countries consists of twenty one of the twenty two high income OECD countries:²³ Australia, Austria, Belgium/Luxembourg, Canada, Denmark, Finland, France, Germany, Iceland, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, and United States. We look at eight separate sectors following ISIC Rev. 2 (ISIC2) divisions: textiles, wood, paper, chemicals, non-metals, basic metals, metals, and other manufactures. The textiles sector (ISIC2 division 32) comprises textile, wearing apparel and leather industries. The wood sector (ISIC2 33) includes manufacture of wood and wood products, including furniture. The paper sector (ISIC2 34) comprises manufacture of paper and paper products, printing and publishing. The chemicals sector (ISIC2 35) includes manufacture of chemicals and chemical and rubber products. The non-metal products sector (ISIC2 36) includes manufacture of non-metallic mineral products, except products of petroleum and coal. The basic metals industry (ISIC2 37) includes iron and steel basic industries and non-ferrous metal basic industries. The metals industry (ISIC2 38) includes manufacture of fabricated metal products, machinery, electrical machinery apparatus, appliances and supplies, and transport equipment.

¹⁹ The start of the period in the late (rather than early) 1970s was due to data availability.

²⁰ Leamer and Stern (1970).

²¹ This is a 'mere' measurement issue, but exports from country j to country i generally differ from imports to country i from country j .

²² Baldwin, 1994.

²³ We had to exclude Greece due to tariff data availability.

The other manufactures 'sector' (ISIC2 39) comprises the manufacture of jewellery and related articles, musical instruments, sporting and athletic goods, and industries not elsewhere classified.

The four groups of trade determinants mentioned before are proxied as follows:

(i) *Production and income*: the production variable is sector-specific and it is deflated using wholesale price index (WPI) of the exporting country (since we do not have sector prices for our entire sample). Income for exporting and importing countries is proxied by GDP deflated using each country's GDP deflator.

(ii) *Barriers to trade*: bilateral distance is the most commonly used proxy for transportation costs. Trade resistance can only be proxied with a measure of bilateral tariffs due the lack of homogeneous measures for NTBs.²⁴

(iii) *Integration effects*: since our focus is on the EU effects, we only include an EU dummy for joint membership to this regional trade agreement. The construction of this dummy differs across the gravity literature. Whereas some models use an EU dummy homogeneous across time, we believe that a more realistic way of capturing the different EU enlargements is to join countries from the year they became members.²⁵ Thus, the dummy has a unit value when both partners are EU members and is zero otherwise.

(iv) *Transaction costs*: common border and language would decrease transaction costs, these dummies are 1 where a pair of countries shares a border or a language, respectively (and zero otherwise). Ideally, the model should control for the time dimension by using bilateral real exchange rates by sector, but data on goods prices are not available for our sample. It still seems reasonable to assume that relative prices have not changed substantially (or at least not in any particular direction) to bias the estimations. In this context, it is possible to use a bilateral RER variable common across all manufacturing sectors. The bilateral exchange rate was then calculated as: $e * P^*/P$ nominal exchange rate (e , ratio of local currency value per unit of foreign currency) times the prices ratio (P^*/P , WPI in the foreign country over WPI in the home country).

III. Estimation, issues and results

What are the expected effects we look for when estimating a sectoral gravity equation?

- If the exporting country increases its production of the good ($Prod_x$), we would expect that this increases its bilateral trade;
- we do not expect any a priori signs for the income level of the partners (GDP_x and GDP_m). One of the effects operating here is that a rise in income may make people increase their imports if they consider the foreign-produced good relatively superior to the home-made one.

²⁴ It proved almost impossible to build a bilateral NTB index by sector and for every OECD country over time, which is what we would need if wanted to include it into our model.

²⁵ Since the tariffs between accessing countries and current EU members have not been reduced instantaneously, the EU dummy is not necessarily a mirror image of the bilateral tariffs variable.

- On the bilateral variables, we would expect that if a country becomes more protectionist (i.e. increases its bilateral tariff, $BilTar_{mx}$) on a certain sector, it will import less of that product;
- if a country's currency appreciates in real terms (i.e. its bilateral real exchange, $BRER_{xm}$, increases), it will become relatively more expensive in all sectors and thus we would expect that the country exports less of the good in question.
- As of the EU dummy (EU_{xm}), a positive sign of the estimated semi-elasticity would mean that joint membership to the EU makes the pair of countries trade more than two non-EU members;
- the trade resistance dummy, distance ($dist_{xm}$), is expected to have a negative effect on the bilateral trade;
- and the transaction costs dummies, adjacency (adj_{xm}) and linguistic ties ($lingties_{xm}$), are expected to have a positive effect on bilateral trade. This is because they decrease the transaction costs involved in the business, and can sometimes facilitate the formation of trade networks.

Since our data seem to have enough cross-section and time-series variability, we believe that there are unobservable individual and time effects to control for. Thus, we estimated equation (1) with two-way panel data specifications for each sector. We then estimated equation (2) by pooled OLS²⁶ to incorporate the fitted comparative advantage-led sectoral output into equation (1). This did not improve the estimation for any of the eight sectors, and the rejection for the Hausman test²⁷ in all of the sectors indicates that the model with production was well-specified.²⁸ This can be due to the aggregation level of our sectors, and, although we plan to explore it further, we will not use these instruments in this paper.

Hence, we estimated equation (1) with the two panel data models which capture unobserved individual and time effects: fixed (within estimator) and random (GLS estimator) effects. It is important to note that, in order to be able to compare across sectors, we chose to have the same specification (even if some of the variables are not significantly different from zero in some sectors). These then only differ in the sector-specific variables: bilateral imports, production and tariffs.

Table 1 discloses the results for the two-way fixed effects model for each sector. The only downside of the fixed effects model is that it will not allow isolating the effects of distance, adjacency and common language on bilateral trade. This is because the within estimator looks at the effects which are independent from the time-means, and hence all the time invariant determinants of trade will be captured by the individual effects.²⁹ The estimation shows a much higher individual than time variability, which we expect having a cross-section dimension much higher than the time-series one (21 x 20 = 420 country pairs and only 23 time points).

²⁶ We purposely avoid the control for unobservable production determinants in this case, since we want to capture only the comparative advantage-led production.

²⁷ The null hypothesis states that difference in coefficients between the two models is not systematic.

²⁸ Other IV techniques were also rejecting the endogeneity of production, i.e. that production is not endogenous.

²⁹ At a later stage, this is exactly what we will look at when estimating the implicit costs of EU integration.

Table 1 - Two-way within results;

Dependent variable: log of real bilateral imports

Variable	Textiles	Wood	Paper	Chemicals	Non-metals	Basic Metals	Metals	Other
$Prod_x$	0.609***	0.453***	0.475***	0.707***	0.207***	0.811***	0.362***	-0.157***
GDP_x	0.403***	0.323***	0.387***	0.241***	0.352***	0.265***	0.151***	0.871***
GDP_m	0.165	0.903***	0.006***	-0.031	-0.150	0.531***	0.064	-0.401***
$BilTar_{mx}$	-0.007***	0.006	-0.005*	-0.014***	-0.015***	-0.048***	-0.018***	-0.024***
$BRER_{xm}$	0.080***	0.123***	0.048***	0.023**	0.042***	0.056***	0.053***	0.064***
EU_{xm}	0.354***	0.188***	0.209***	0.087***	0.088**	0.198***	0.155***	0.119***
<i>Cons.</i>	-18.590***	-33.786***	-11.944***	-11.924***	-.416	-30.042***	-2.106	1.535
R^2	0.258	0.192	0.275	0.385	0.215	0.160	0.458	0.252
F	101.9***	68.1***	110.0***	179.3***	78.5***	54.9***	245.4***	95.8***

Note: $Prod_x$, GDP_x , GDP_m and $BRER_{xm}$ in logs; significantly different from zero at the 1% (***) , 5% (**) and 10% (*) levels.

Unfortunately, most of the models found in the (scarce) disaggregated gravity literature are unsuitable for contrasting our results. Bergstrand (1989) estimates his model for a different time period (1960s and 1970s), and uses a trade classification, rather than the industrial ISIC divisions that we use here. This means that the goods composition of each sector differs quite substantially from ours. The grouping criteria used in Rauch (1999) and Feenstra et al (2001) is based on very different criteria to the mere industrial ones.

Averaging across all sectors, bilateral trade elasticity with respect to each sector's production is 0.43, the exporter income elasticity is 0.37 and the importer's 0.14. A 1 percentage point rise in the bilateral tariff would decrease imports by 2%, and an appreciation of 1% in the real exchange rate would increase trade by 0.06%. Comparing the average elasticities across our eight manufacturing sectors gives much lower values than what is generally found in aggregate gravity specifications. This may be due to the influence of unobservable fixed effects, something that has not been explored in the literature. Looking at the EU effect, Frankel et al (1997) hint some results for the whole manufacturing sector in the EU. They find a border effect for EU manufactures of 0.5 (i.e. a 65% increase for joint EC membership), whereas our border estimate (0.2) gives an average of only 24%. The difference may be because they include manufacturing of food products, a sector we have (purposely) excluded in order to isolate the results from the influence of the CAP.³⁰

The time effects generally capture the cyclical elements of the estimation, which in our case, would be annual shocks for high-income OECD countries. The paper, chemical and basic metals sectors have significant time effects for most of the period (except for 1978 in the two former, and 1978-9 in the latter). For the textiles sector, the time effects are only significantly different from zero from 1985 onwards. This may be due to the

³⁰ Indeed, Frankel et al. do find a much higher border effect when estimating the equation for agriculture.

effectiveness of several Multi-Fibre Arrangements (MFA) negotiated from the 1970s until mid-1990s. The wood and metals sectors also has significant time dummies from 1986 onwards. Non-metal products have time effects not significantly different for zero in 1979 and 1983-84, and other manufactures' time effects are significant for 1982-85 and 1988-99. On the whole, this indicates that there are unobservable time effects to control for.

To compare the average EU effect across sectors, we tested the significance of the difference between each sector and the average of all the other sectors. Assuming that all the coefficients are normally distributed,³¹ we built the following Z test:

if $\frac{\bar{X} - \mu_x}{s_x/\sqrt{N}}$ is normally distributed, the null hypothesis states that $\bar{X} = \mu_x$ ³²

Thus, rejecting the null tells us whether our sector-specific EU coefficient significantly differs from the other seven sectors'.

This test suggests that textiles was, on average over the whole period, the most (significantly different from the other sectors) integrated sector, where the joint EU membership increases bilateral trade by 43% as opposed as non-EU membership. On the other extreme, the chemical and the non-metallic products sectors have an EU effect of 9%, being the least (significantly) integrated. Lastly, other manufactures have a median EU effect, increasing (significantly) trade between EU members by 13%.³³

The GLS estimator relies on the assumption of independence between the regressors and all the components of the error term. The rejection of the Hausman test for most sectors (except for the wood products, and basic metals being on the border of rejection), tells us that the GLS estimation may be giving inconsistent estimators. However, since the use of the Hausman test to choose between the fixed and the random effects models has been controversial in the literature (Baltagi, 2001). The use of fixed effects is more appropriate when working with the population of individuals, whereas the random effects model works better in the case in which the sample is randomly selected from a population. Since we are working with a population of (high income) OECD countries, we work with the fixed effects as our specification, although we still show the results for the GLS estimation in order to give a sense of the time-invariant regressors of the gravity specification.³⁴ When estimating the model by GLS (Table 2), the sectoral EU effects are robust to a change in specification.

³¹ Given our large sample size, this seems a reasonable assumption.

³² The Z statistic, $Z = \bar{X}/(\sigma_x/\sqrt{N})$, is normally distributed with unit variance and, under the null hypothesis, a mean zero. The test statistic we use is for unknown σ_x .

³³ Textiles and chemicals are significantly different from the rest with a 99.5%, non-metals with a 99%, and other manufactures with a 95% confidence level.

³⁴ Moreover, the within estimator may be inefficient (in the case where GLS is consistent), but will always be consistent.

Table 2 - Two-way GLS results;
Dependent variable: log of real bilateral imports

Variable	Textiles	Wood	Paper	Chemicals	Non-metals	Basic Metals	Metals	Other
$Prod_x$	0.681***	0.531***	0.877***	0.846***	0.290***	0.848***	0.498***	-0.067***
GDP_x	0.236***	0.335***	0.048	0.110**	0.421***	0.161***	0.144**	0.953***
GDP_m	1.123***	1.283***	1.206***	1.201***	1.073***	1.398***	1.109***	1.185***
$BitTar_{mx}$	-0.009***	0.005	-0.005	-0.014***	-0.018***	-0.047***	-0.012***	-0.025***
$BRER_{xm}$	0.099***	0.131***	0.076***	0.031***	0.079***	0.059***	0.072***	0.090***
EU_{xm}	0.406***	0.241***	0.249***	0.161***	0.153***	0.260***	0.215***	0.185***
$Dist_{xm}$	-7.5E-05***	-1.7E-04***	-1.9E-04***	-1.1E-04***	-1.4E-04***	-1.5E-04***	-1.0E-04***	-9.0E-05***
adj_{xm}	1.587***	2.081***	1.369***	1.237***	1.861***	1.309***	1.361***	1.104***
$lingtie_{xm}$	0.008	0.168	0.602**	0.361***	0.222	-0.005	0.301	0.553**
Cons.	-41.116***	-45.586***	44.292***	-44.383***	-36.359***	-50.646***	-32.973***	-44.486***
R²	0.2511	0.1913	0.2689	0.3772	0.2069	0.1578	0.4496	0.2407
F	3662.5***	2727.5***	4039.0***	5925.2***	2990.4***	2694.1***	7138.2***	3738.0***

Note: $Prod_x$, GDP_x , GDP_m and $BRER_{xm}$ in logs; significantly different from zero at the 1% (***), 5% (**) and 10% (*) levels.

Again, textiles is the sector most (and significantly) trade-integrated, with an EU effect of 50%, whereas chemicals and non-metals are the least (and significantly) integrated, with joint EU effects of 18 and 17% respectively. Other manufactures do not show an integration level significantly different from the other sectors. Running a GLS model has the advantage of estimating coefficients for the time-invariant regressors, such as distance, adjacency and linguistic ties. Although the effects are quite low in magnitude, perhaps due to the estimation method, it is possible to rank the sectoral effects of distance on bilateral trade. On one extreme, doubling the distance between two OECD countries would decrease their trade of paper by 0.02%, whereas the negative effect would be 0.01% for textiles.³⁵ On average for all sectors, the fact of sharing a border would increase bilateral trade by more than three times as opposed to two countries which are not adjacent to each other, and sharing a language would increase trade by 35%.³⁶

We go back to the fixed effects model to look at the behaviour of the sectoral EU integration over time (although, as we said before, the behaviour of this coefficient is robust across both fixed effects and GLS specifications). To do so, we introduced one EU-time interacting effect per year into equation (1) and estimated a two-way fixed effects model. The estimated coefficients will give us a sense of the behaviour of EU

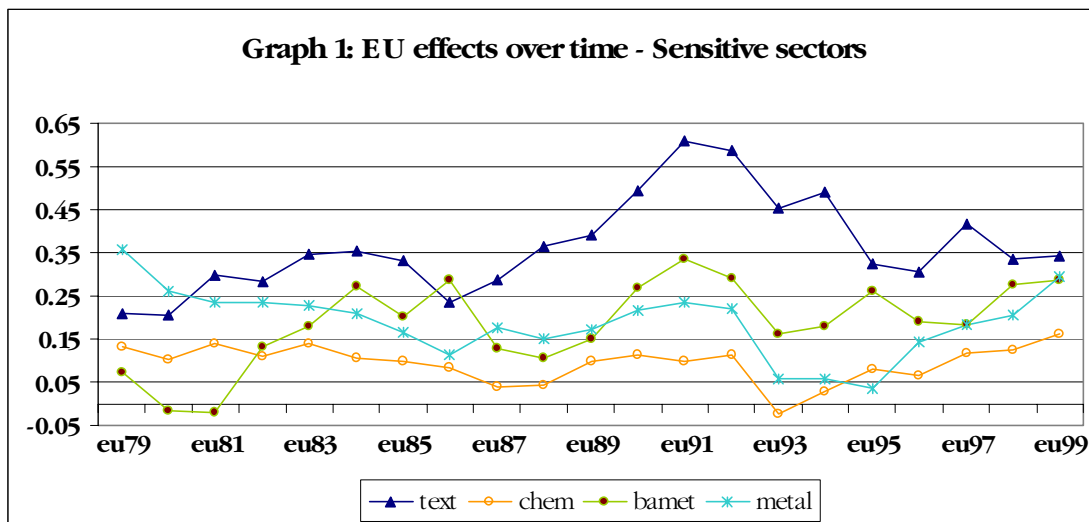
³⁵ Performing a Z test to compare each sector with the average of the others, all of the sectors reject the null of equality (i.e. are significantly different from each other) except for non-metals, which has the median effect.

³⁶ Note that this effect is only significantly different from zero for three of the eight sectors.

joint membership effects over time from the base year (1977), isolated from the time effects on all OECD countries. In all of the sectors, the first period EU effect is negative, maybe due to the end of the transition period for the three first enlarging members of the then EEC. From 1979, the sectors' EU trade integration seems to show different patterns. We compare below the EU effects for the period 1979-1999 across the eight manufacturing sectors.

The information on EU industrial policy (Swann, 1995, GATT and WTO) mentions some industries as "sensitive" or "problematic". Throughout the 1970s and mid-1980s, these are textiles, synthetic fibres, shipbuilding and steel. During the late 1980s and the 1990s, two other industries emerged as worrying: pharmaceuticals and motor vehicles. We analyse the trends of the EU effect by first looking for a repercussion of the EU policy on some of these six industries.

Graph 1 shows the evolution of the EU effect for the sectors which include the problematic industries mentioned above (textiles, chemicals, basic metals and metal products) for the period 1979-1999.



EU trade integration on *textiles* has been the only sector showing an effect significantly different from zero throughout the whole period. This effect has increased by 63% from 1979 until 1999, showing three different trends over time. Until 1985, the EU textiles effect increased by 57%, maybe due to the aid rules implemented over the 1970s and part of the 1980s.³⁷ It fell in 1986, perhaps indicating some 'shock' due to the start of the Single Market Programme, to rapidly recuperate (even faster than before). The fall in the EU effect on textiles in 1991 may have been due to the reduction in the capacity utilisation in some of the textiles production processes, the 1992-93 recession, and the impossibility of re-establishing national quotas (under the Multi-Fibre Arrangements, MFA). The apparent recovery from the mid-1990s may be in part due to the effects of the RETEX, an aid programme created to promote economic

³⁷ After a nine years revision, the Commission reported by 1985 that the industry had been able of regaining its competitiveness through a substantial restructuring process.

diversification in regions with a highly concentrated number of textiles and clothing firms.³⁸

In the three other sectors none of the EU-time effects is significantly different from zero. However, we still try to understand the behaviour of the EU trade integration over time, since the chemical sector includes pharmaceuticals and synthetic fibres, steel is a basic metal, and shipbuilding and motor vehicles are part of the metal products sector.³⁹

Over the period 1979-1999, EU trade integration in the *chemicals* sector has increased by 22%. The steady recovery of the EU chemicals effect from 1993 may have partly to do with the developments in the medicines sector. In 1995 a common approval procedure was introduced, and in 1998 the Council laid down general guidelines for Community policy on pharmaceutical products.⁴⁰

The evolution of the EU *basic metals* effects seems to be well explained by the developments in the steel sector over the period of analysis. The increase in the EU-time effect during the late 1970s and mid-1980s may obey to the different plans created to stimulate the competitiveness of the steel industry. A sounder industry does not necessarily be trade-increasing. However, if the strengthening of an industry is triggered by policies implemented at the Community level, this could be viewed as a further stimulus to increase EU trade integration. The steel aid code (tightened in 1981) promoted adjustment programmes and was available until the end of 1984. These include voluntary export restraints (VERs),⁴¹ interim minimum imports reference prices, and then mandatory output and sales quotas, and national and common aid systems.⁴² The fall during the mid- to late 1980s may be showing a slow response to the Single Market programme. Although the quota system was scheduled to finish in 1990, the early 1990s recession again led to price collapse, for which a new restructuring plan was approved in 1993, allowing state aid only to help with the adjustment costs of restructuring. Further, in 1994 the Commission had abolished all financial measures under the restructuring plan.⁴³

The EU-*metals* time effect decreased by almost 18% since 1979. The 1988 recession in some of the metal industries does not seem to have affected its pattern of EU trade integration. Shipbuilding has been a (worldwide) nationally subsidised sector throughout the 1960s and 1970s, and during 1988-1993 the Commission ran a programme (RENAVAL) to support sectoral and regional adjustment.⁴⁴ In the motor vehicles sector, a Community Framework for state aid was established in 1989, mainly to discipline the national aid. As most sectors, the motor vehicles market was

³⁸ This was implemented since 1993.

³⁹ In the metals sector, the behaviour of the EU dummy in our first specification indicates that 'nothing really important happened' across OECD countries until 1986.

⁴⁰ According to the OECD, the pharmaceuticals sector is among the few with remaining national price controls.

⁴¹ Prices (and hence profitability) of the steel industry increased during the late 1970s, but in 1980 the VERs on output collapsed, and prices dropped again.

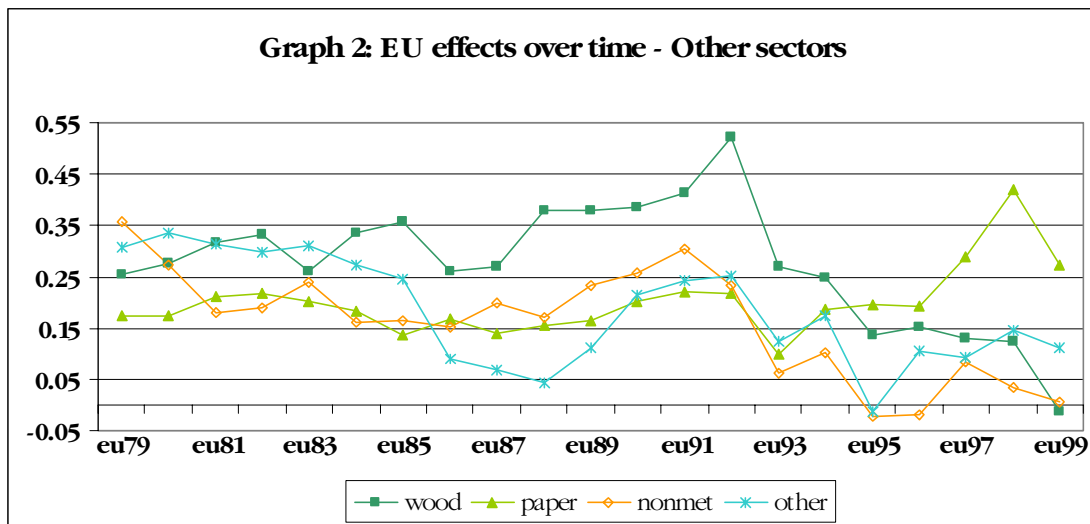
⁴² In 1981 the Council adopted a new aid code, stimulating aid towards reducing the steel production capacity with a systematic and specific restructuring programme.

⁴³ Except for the social payments from capacity closures taking place before the end of 1995.

⁴⁴ Stricter conditions on state aid entered into force on 1 January 1999, and for a period of five years.

depressed during the 1992-93 recession, which also affected the EU metal trade integration. A mandatory Community-wide approval system for new automobiles came into force in 1996 (and in 1998 for other vehicles).⁴⁵ These measures may have helped the EU metals integration to steadily recover from 1995 onwards.

Finally, and for completeness, we briefly describe the other four sectors in our sample. Graph 2 shows the evolution of the EU effects on wood, paper, non-metals and other manufactures sectors.



The EU integration on the *wood* sector was not significantly different from zero during the period 1995-1999. Even without considering this period, the EU wood effect fell by 2% (in 1979-1994). Its time evolution is highly correlated with that of *non-metals* EU-time effect, where only 1995-96 is significant, and which decreased by 98% over 1979-1999. The *paper* EU-time effects have increased by 56% over the period 1979-1999, although they were significantly different from zero in 1981-84, 1986, and 1990-1999. Finally, *other manufactures* EU effects show an unstable (but not significantly different from zero for the whole period), decreasing by 63% during 1979-1999.

IV. Further Research

As mentioned earlier, a possible extension of this analysis would be to compare the individual fixed effects across sectors. This can be done by estimating sectoral gravity equations and looking at the evolution of the residuals to evaluate the progress of EU trade integration. Since the gravity model has proved to be a good tool to account for the main determinants of trade, it is reasonable to expect that the residuals will capture all the *implicit and unmeasured* barriers to trade (after , controlling for the time-invariant determinants of trade). These implicit costs can be in the form of imperfect information flows, risk and uncertainty (Nahuis, 2002), time-delays, etc. Further, an interesting variable to include would be a NTBs index per sector. This would allow

⁴⁵ However, OECD (2000) points out that the persistent price dispersion across national markets seems to indicate remaining obstacles to full harmonization and competition.

estimating the gravity specification with most of the explicit determinants of trade existent in reality.

So far, our model allowed us to look at the EU effect across sectors, without being able to say anything about the absolute level of EU sectoral integration. It could be possible to find a benchmark as basis of comparison, data availability permitting it. One way would be to incorporate bilateral regional data within a country. Although not for several years, these data exist for Canadian provinces and US states.⁴⁶ Including a dummy for regional bilateral trade would then account for what's left for trade across EU countries. This would, however, entail the adoption of some simplifying assumptions, such as common coefficients across the data. An alternative would be to use Wei (1996)'s internal trade measure, as the difference between a country's total (goods) production and its total exports to foreign countries. Unfortunately, this would only be available on an aggregate level. Further, Brakman et al (2002) test whether German border regions are economically fully integrated with foreign neighbouring regions. They estimate a market potential function for regional wages: with complete economic integration (i.e. without a border effect) one expects no significant differences between intra-country and inter-country trade flows or price movements.

V. Conclusion

We look at the sectoral behaviour of a gravity-type equation in order to compare the EU effects, both on average and over time. We found that, on average, the textiles sector is by far the most integrated: two EU countries trade 43% more than two non-EU countries. The non-metal products and the chemical sectors are the least trade-integrated sectors in the EU, both with an EU integration effect of 9%.

We find that shocks affected OECD countries trade from the late 1970s (as indicated by significant unobservable time effects), but this does not seem to be the case for most of the sectoral EU effects. When looking at the evolution of the EU sectoral effects over time, the only sector for which EU trade integration seems to be strong for the period 1979-1999 is on textiles. In all the other sectors (even those considered problematic) also show the repercussion of the different common industrial policies implemented by the Commission and the Council of the EU, although the effects are not significant in most of the years. There is still good scope to look into the EU trade-integration effects, especially concerning the measurement of implicit trade costs.

Data appendix

GDP and population data were taken from *OECD Annual National Accounts (Comparative tables based on exchange rates and PPPs and Population and Employment, respectively)*. GDP deflators come from International Financial Statistics (IMF).

Distance, adjacency and linguistic ties (used for the pooled OLS estimation) were taken from: "Trade Blocs and the Americas: The Natural, The Unnatural, and the Super-Natural", by J. Frankel, E. Stein and S-J Wei, *Journal of Development Economics*, June, 1995; and "Open Regionalism in a World of Continental Blocs", by S-J Wei and J. Frankel, *NBER Working Papers* 5272.

⁴⁶ Wolf (1997 and 2000) and van Wincoop (2000) use US interstate trade data.

Labour force was obtained from World Bank's World Development Indicators (WDI). Since labour force data are available for all countries, and it was more statistically significant than employment when estimating the pooled OLS model. Gross fixed capital formation was taken from WDI. Natural resources were proxied by using production in mining and quarrying (from the industrial production statistics), which generally comprises the ISIC Rev. 2 major division 2 (Mining and Quarrying). This includes production of Coal Mining (division 21), Crude Petroleum and Natural Gas (22), Metal Ore Mining (23), and Other Mining (29). Building a time series of this proxy, meanwhile possible, has involved the compilation of various complementary sources.⁴⁷ The sources used are: for the earlier data, *OECD Structural Statistics for Industry and Services - Industrial Surveys ISIC rev. 2*, and for the mid- to late 1990s we used the *United Nations Yearbook Statistics value added* variations. Values of fixed capital and mining and quarrying production were converted to (current) US dollars.

Data on bilateral imports were taken from World Bank *Trade and Production Database*. Since this database does not include Belgium/Luxembourg, Switzerland, and Iceland, we included these high income OECD countries from the *OECD Bilateral Trade Database*, which is available at 2-digit ISIC levels for the period 1980-98. Import unit values from *International trade and competitiveness indicators: Quarterly data* (OECD). Production data was aggregated from 3-digit ISIC2 major groups into 2-digit divisions from *UNIDO* and *Trade and Production*. The main source for WPI is IFS. In both bilateral imports and exporter's production, we had to exclude some 3-digit major groups in order to have a dataset compatible with the available tariffs data. On the chemicals sector, we excluded Petroleum refineries (ISIC2 major group 353), Manufacture of miscellaneous products of petroleum and coal (354), and Manufacture of plastic products not elsewhere classified (356); on the metals sector, we excluded Manufacture of professional and scientific, and measuring and controlling equipment not elsewhere classified, and of photographic and optical goods (385).

Bilateral exchange rates were taken from IFS. Tariffs data have been the harder series to build, due to the scarcity of data (even for OECD countries) for the late 1970s and 1980s. We built a series of bound tariffs rates weighted by own imports.⁴⁸ Since it is not clear that tariffs would follow a linear trend, where only some years of the period were available, we filled in the years in between the data points repeating the previous year (i.e. tariffs in steps). The sources used were:

(i) 1977-1987: Deardorff and Stern (1986) have post-Kennedy Round base rates and Tokyo Round offer rates weighted by own country imports 3-digit ISIC manufacturing industries (excluding petroleum and the major groups mentioned above). We took the first tariffs as the base rates for the Tokyo Round (i.e. for the period 1977-1979). The Tokyo Round negotiations concluded in 1979, and had an implementation process to be spread over a period of up to 8 years, which we took as 8 equal steps. This information was available for all industrial countries except for Spain, Iceland and Portugal, we calculated change in the ratio of customs duties over total F.O.B. imports. We then disaggregated these sectorally using the earliest year of available tariff data.

(ii) 1988-1998: data from *Indicators of Tariff and Non-tariff Trade Barriers* (OECD-UNCTAD) for the years 1988 and 1993, and then completed with Uruguay Round transition period (depending on the sector). We took the bound rates so as to have a homogeneous sample with (i). Imports data comes from OECD International Trade by Commodities Statistics (ITCS) in HS88 6-digit subheadings. For all the countries (except for Austria, where data were available from 1995

⁴⁷ Details on these sources are available upon request.

⁴⁸ The tariffs weighting is still controversial in the literature. It seems that during the 1970s and 1980s this was the method chosen, whereas during the 1990s unweighted averages were preferred. Although weighting can overstate the importance of low tariff items, a simple average may give too much weight to trade when this is not too important (Gasiorek et al, 2002). Since the earlier data is already aggregated weighting by own imports, we were forced to continue with this method for the later data.

onwards), each tariff was weighted taking the imports during the same year (for 1988 we had to use 1990 imports because no previous data were available).

(iii) 1999: data from *Tariffs & Trade* database (OECD). The database has bound tariffs, submitted to the WTO after full implementation of the Uruguay Round tariff commitments. Most bindings became effective in 2000, and hence imports for 2000 (in HS96 6-digit subheadings) were taken from the ITCs.

Bilateral tariffs were then calculated according to the different preferential trade agreements (PTAs) among some OECD countries. For the EU, we calculated the different enlargements, with the transition periods indicated in each accession treaty, both for the adoption of the common external tariff and the abolition of internal tariffs. EFTA members had zero tariffs from the beginning of our period, except for Iceland, which had a longer transitional period (which had finished by 1980). The free trade agreements between EFTA members and the EEC were signed in 1973, and implemented for most industrial products in 1977, and hence trade was free between all EC9 and EFTA countries.⁴⁹ ANZCERTA, free trade area between Australia and New Zealand, started in 1983 and had a (maximum) transitional period of six years, and the FTA between Canada and the USA started in 1989 and had a (maximum) transitional period of ten years.

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⁴⁹ For "sensitive" products the remaining duties were all removed by the end of 1983 (and for Finland, at the end of 1984). Switzerland signed a separate FTA with the EEC.

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