Environmental Regulations and Trade in Europe: The Role of Differentiation

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Abstract:

One of the aspects related to the pollution haven hypothesis is that by applying stringent regulations to protect the environment, countries tend to reduce their international competitiveness. Most studies that apply gravity-type equations do not find robust support to that view. Very recent studies using US data but with another set-up than gravity, do find however a significant effect of high stringency on net imports (see Ederington, Minier, 2003; Levinson and Taylor, 2003; and also Ederington et al., 2003). The first aim of this paper is to go back to the gravity literature and show that one can obtain robust negative effects of stringency, as long as gravity equations are well specified with respect to theory. Second, this article puts forward a new hypothesis based on the degree of differentiation in goods to explain the low impact of stringency on trade found so far, and tests it on a new Western and Eastern European dataset. By using alternative methods to condition out the degree of differentiation of goods produced by industries and/or countries, the paper finds a robust impact of a 'pure cost' effect of stringency lying generally from –0.3 to -3.5.

Keywords: Trade, Environmental regulations, Europe, Gravity

JEL Classification: F1, F18, Q38

INTRODUCTION

The interaction between trade flows and environmental regulations has become quite a topical issue recently. There is a common belief that by applying stringent regulations to protect the environment, countries tend to increase production costs of their manufacturers and thus, reduce their international competitiveness. There have been many empirical studies performed in this field, trying to estimate this relationship. However, most of those that try to apply gravity-type equations on bilateral trade data do not succeed in finding robust support to that argument (Harris, Konya and Matyas, 2002 provide an example).

Other types of studies using United States (US) data but with another set-up than gravity-like equations, do find however a significant effect of high stringency on net imports (see Ederington, Minier, 2003; Levinson and Taylor, 2003; and also Ederington et al., 2003). The main grounds to explain such results do not lie on the quality of the data. They are neither due to the form of the empirical set-up chosen. The reasons lie elsewhere: for abatement costs variables to pick a 'pure' cost effect, one has to account for aggregation biases that arise due to pooling of countries or industries when one estimates the impact of stringency (Ederington et al, 2003). An alternative way to produce consistent estimates is to account for endogeneity between trade and stringency measures by running instrumental variables or more generally 2SLS estimations (Levinson and Taylor, 2003; Ederington, Minier, 2003).

This paper goes back to the gravity equations literature to argue that even in that literature one can obtain robust negative effects of stringency in line with those obtained by the US studies, as long as gravity equations are well specified with respect to theory.

Further, this article proposes an alternative explanation of why the variables usually at hand to measure the impact of stringency do not reveal a significant effect on trade. The reason that we put forward is not related to environment features *per se* but is rather due to the degree of differentiation of goods. Basically, stringency reveals additional cost faced by the exporter. We argue that this extra cost is affecting more countries and/or industries that are known to produce less differentiated products than others, because consumers are more sensitive to the price of these products. Hence, we show that less developed countries and/or industries known to produce less differentiated products are suffering more from higher abatement costs.

Another way of controlling non parametrically for differentiation in order to obtain pure price effects of abatement costs on trade flows is to run Instrumental Variables (IV) or Generalised Methods of Moments (GMM) type estimations. This strategy enables to produce elasticities of trade to abatement costs that reveal pure price effects even in industries and/or countries producing highly differentiated products. From these methods we obtain a (high) magnitude of the effect that turns up to be consistent with that of Levinson and Taylor or Ederington and Minier (2003) on US data[1]. In fact, the elasticity of demand to the stringency of regulation of the exporter is found to reach 3.5 in absolute value. This result is not surprising as it is also in line with a new trade literature that estimates an elasticity of demand for imports to prices of at least the same magnitude (see for instance Eaton and Kortum, 2002; Head and Ries, 2001; Erkel-Rousse and Mirza, 2002).

Our findings are based on a new dataset, released in July 2003 by Eurostat, that provides information on abatement costs among other environment data, for some European and Eastern European countries. In that respect, our work is the first to look at the impact of environment regulation in Europe and especially the implications of Eastern European countries' accession to the European Union. It is worthwhile to mention that the debate in Europe is as important as in the United States on that issue. As a matter of fact, Europe is concerned about the competitive pressure added up by the newly acceding countries due, among other factors, to less stringent regulation policies on environment in the latter. Besides, the choice of Eastern European countries is very convenient to test one of the strong arguments of the paper on the role of differentiation. Indeed, although they have been diversifying their production in recent years, these post-communist countries are still known to be producing less differentiated products than their European neighbours.

The paper is organised in the following way: in the next section we review existing studies that perform estimations of the impact of environmental regulations on trade flows. In section 2 we present our theoretical model, while in section 3 we describe our data. Section 4 presents the results we obtained, section 5 performs some robustness checks and section 6 concludes.

[1] However, our point estimate cannot be directly compared to theirs in magnitude as they do not estimate an elasticity of imports to abatements costs but its effect on a share of net imports type variable (see table 1).

1 LITERATURE REVIEW

Since the mid-nineties, there has been a growing interest to test the pollution haven hypothesis using trade equations[2]. In its broad definition, the pollution-haven hypothesis suggests that strict environmental standards reduce domestic producers' competitiveness and result in relocation to countries with more lenient standards.

We could classify these studies into two big groups. A group that uses trade data on a group of countries (usually the OECD) and runs gravity type equations (i.e bilateral imports) and another group that concentrates on US trade data with its partners using an alternative set-up to explain *net* import (i.e imports –exports) flows.

It is also worthwhile to mention that existing studies do not differ only by the set-up taken and the geographical area under investigation. There is a third difference that lies in the use of different environmental stringency variables. There are many ways how to measure those variables and this has an impact not only on the choice of the area to be studied but might also affect the results.

1.1 GRAVITY LITERATURE

Van Beers and Van den Bergh (1997) use a gravity equation to test the impact of environmental stringency on bilateral exports. They construct their own indicators of environmental stringency (based mainly on energy intensities and recycling rates) and rank OECD countries according to their stringency into a 0-1 index. Their main result confirms in a way the pollution haven hypothesis, since they come to the finding that the OECD countries' exports are negatively and significantly affected by more stringent regulations. Surprisingly however, they also show that imports are negatively correlated with the importing country's stringency, which does not support the pollution haven hypothesis. When looking at non-resource based trade (footloose), the value of the coefficients obtained is even higher, whereas in industries qualified as 'dirty', trade flows do not appear significantly affected by exporter's stringency.

[2] We do not report here Heckscher-Ohlin-Vanek or Intra Industry Trade type studies related to the topic (see Cole and Elliott, 2003; and Tobey, 1990) as we believe they lie beyond the scope of that article.

Table 1: Some of the previous studies investigating the impact of environmental regulations on trade

<table>
<tr><th>Author</th><th>Model</th><th>Period, countries</th><th>Sectors</th><th>Stringency</th><th>Main findings</th></tr>
<tr><td>VAN BEERS, VAN DEN BERGH
(Kyklos, 1997)</td><td>- Gravity
- Cross section
- OLS</td><td>21 OECD countries

1975; 1992</td><td>- Total;
- Dirty;
- Footloose</td><td>Qualitative, output oriented
- 7 broad measures,
- 2 narrow measures (energy intensity)</td><td>- STR[3] (exporter) negative, significant
- STR (importer) negative, even more significant</td></tr>
<tr><td colspan="6">$lEXP_{ij}$ (from country i to country j) = $lGDP_i$(+), $lGDP_j$(+), $lPOP_i$(-), $lPOP_j$(-), $ldistance_{ij}$(-), $adjacency_{ij}$(+), EC_{ij}(+), $EFTA_{ij}$(+), $lLnd_i$(-), $lLnd_j$(-), $lSTR_i$(-), $lSTR_j$(+)</td></tr>
<tr><td>HARRIS, KONYA MATYAS
(World economy, 2002)</td><td>- Gravity
- Models A-E:
A = CS
B = PD
C = IMP FE
D = IMP and EXP FE
E = IMP, EXP and TIME FE</td><td>24 OECD countries

1990-1996</td><td>- Total;
- Dirty;
- Footloose</td><td>Similar to Van Beers and Van den Bergh; own indices constructed (based on energy consumption and energy supply)</td><td>- STR significant only in CS or PD OLS models; signs not always what expected
- When accounting for FE, STR not significant</td></tr>
<tr><td colspan="6">$lIMP_{ijt}$ (of country i from country j) = $lGDP_{it}$(+), $lGDP_{jt}$(+), $lPOP_{it}$(-), $lPOP_{jt}$(-/+), $ldistance_{ij}$(-), $adjacency_{ij}$(+), EEC_{ijt}(+), $EFTA_{ijt}$(+), $NAFTA_{ijt}$(+), $lLnd_i$(-), $lLnd_j$(-/+), $lSTR_i$(+), $lSTR_j$(-)</td></tr>
<tr><td>GRETHER, DE MELO
(NBER, 2003)</td><td>- Gravity
- Panel
- revealed comparative advantage (RCA)</td><td>52 countries (North, South)

1981-1998</td><td>- Dirty: Pulp & Paper, Industrial Chemicals, Non Metallic Minerals, Iron & Steel, Non-Ferrous Metals
- Clean</td><td>Regulatory gap between countries (difference in GDPpc)</td><td>- Dirty: STR not significant
- Footloose: STR significant
- sectoral analysis: not all significant</td></tr>
<tr><td colspan="6">$lIMP_{ijt}$ = lY_{it}, lY_{jt}, $lInfrastructure_{it}$, $lInfrastructure_{jt}$, $lExchangeRate_{ijt}$, $Border_{ij}$, $Landlockedness_i$, $Landlockedness_j$, $l(\text{difference in GDPpc})_{ij}$(+), time FE, pair FE</td></tr>
</table>

[3] STR stands for environmental stringency

Author	Model	Period, countries	Sectors	Stringency	Main findings
EDERINGTON, LEVINSON, MINIER (NBER, 2003)	- Panel - industry and time FE - models A-C: A = Developed Vs developing countries B = footloose industries C = small Vs large environmental costs	IMP & EXP from the US 53 countries 1978-1992	- Total; - Dirty; - Footloose	- US: ratio of PACE to total costs of materials - other: indices (World Bank)	Total trade – STR not significant - US -developing: STR significant, - Footloose: STR significant - Large costs: STR not significant
$(netIMP/value\ shipped)_{it}$ (by industry i in year t) = STR_{it}(+), trade barriers, factor intensity variables (human and physical capital)					
EDERINGTON, MINIER (Canadian Journal of Economics, 2003)	- Panel - industry and time FE	US industries 1978-1992	US 4-digit SIC level manufacturing industries	PACE (US); ratio of PACE to total costs of materials	- STR significant
A) US $(netIMP/domestic\ production)_{it}$ (by industry i in year t) = STR_{it}(+), trade barriers, factor intensity variables (human and physical capital) B) STR_{it} = industry level tariffs, industry level net imports, political economy variables					
LEVINSON, TAYLOR (Georgetown University, 2003)	- Panel - industry and time FE - theoretical model	US net imports from Mexico, Canada; other OECD countries; non OECD countries 1974-1986	US 133 4-digit SIC level manufacturing industries; differentiated by most / least polluting	PACE (US) as a fraction of value added	- A) STR significant (0.05 - 0.27) - B) STR significant (1.1 - 4.4)
A) US$(netIMP/value\ shipped)_{it}$ (by industry i in year t) = STR_{it}(+), trade barriers, time dummies, industry dummies B) Instruments = geography (index of state-level PACE, wealth of states, amount of pollution by each state)					
THIS STUDY	- Panel - IMP, EXP, TIME, SECTOR FE - structural gravity	- importers: 12 EU countries, - exporters: 19 EU+CC 1996-1999	9 sectors: by ISIC; differentiated into dirty and clean; homogeneous and differentiated	Eurostat – current environmental expenditures by industry (total manufacturing)	- A) STR significant (-0.3); larger for CC - B) STR even higher (-3)
A) $lrelIMP_{ijtk}$ (of country j from i) = $lrelPRODUCTION_{ijtk}$(+), $lrelWAGE_{ijtk}$(-), $lDISTANCE_{ij}$(-),$lrelSTR_{ijt}$(-), EXP FE, IMP FE, TIME FE, SECTOR FE B) Instruments = stringency (public environmental expenditure, lagged environmental investment, lagged wages)					

Harris et al. (2002) argue that Van Beers and Van den Bergh's econometric specification could be misspecified as they use only an OLS approach to study bilateral trade (double indexed cross-section). The authors slightly modify Van Beers and Van den Bergh's tests by adding-up exporters and importers' fixed effects as well as time effects to show that the stringency variable does not confirm anymore the first findings.

Grether and De Melo (2003) work with a gravity type model as well, where they represent stringency by a regulatory gap between countries, measured by difference in GDP per capita. Again, they differentiate sectors into dirty and footloose and find support for the theory in the case of footloose sectors. However, when they control for different factors in their trade equation they conclude that the relationship between the regulatory gap and trade flows is not robust.

To sum-up, all these three popular studies based on gravity equations do not seem to suggest a robust link between environment standards and trade.

1.2 ALTERNATIVE FRAMEWORK – US DATA

Ederington et al. (2003) employ a different set-up using US data on net imports with its partners and the Pollution Abatement and Control Expenditures (PACE). The PACE survey publishes manufacturers' pollution abatement costs at the 4-digit industry level (Vogan, 1996). The authors offer three alternative explanations of why not much evidence has been found for the pollution haven hypothesis in the previous literature. First, pollution haven effect is less likely to be found among relatively equally developed countries (i.e OECD), which is the set of countries usually used in prior studies as they share similar levels of stringency. Therefore, when they differentiate the investigating US partners into developed and developing countries, they find that the stringency is significantly affecting net US imports. The second explanations that Ederington et al. (2003) offer is that prior studies do not usually focus only on footloose industries. They propose three measures for footlessness and two of them produce results consistent with the pollution haven hypothesis. The third reason for inconclusive results obtained so far could be that environmental costs constitute only a small proportion of total costs. When testing the impact of environmental regulations on trade from the most polluting industries however, the results do not confirm their hypothesis.

Two other recent studies from Ederington and Minier (2003) and Levinson and Taylor (2003) present an alternative explanation of why the pollution haven effect has not been found by the prior literature. They argue that environmental regulations and trade are endogenous to each other. Once they use instrumental variables or more generally, 2SLS equations they find a high positive effect of US abatement costs on US net imports.

This paper contributes to the existing empirical literature in three ways. First, we derive a structural gravity relation based on monopolistic competition that does not match the non-structural gravity type models applied so far.

Next, in contrast to most of the literature using gravity equations which use either constructed indices or alternative variables to represent regulatory reforms, we employ instead environmental expenditure data, provided by Eurostat as the environmental stringency variable. This data is not as detailed as the US PACE (which is 4-digit), since it is aggregated only to 2-digit level of ISIC.

Third, we bring the pollution haven debate on the European continent. Linked to the topical issue of the Eastern enlargement, many claims and guesses have been heard about the formation of the pollution haven in the East. This study investigates trade flows between EU and Candidate Countries (CC).

2 THE THEORETICAL FRAMEWORK

We follow here a model similar to that of Erkel-Rousse and Mirza (2002) or Head and Mayer (2000), who apply it on European trade data as well. Assume a representative consumer in country j, $j \in \{1,...I\}$ that maximises each of the Spence-Dixit-Stiglitz CES sub-utility functions U_j. For simplicity of notation, we consider for now a representative industry and year, whereas later on we introduce different industries k and different time t.

$$U_j = \left[\sum_{i=1}^{I} \sum_{v=1}^{n_{ij}} \alpha_{ij} x_{vij}^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}} \qquad (1)$$

x_{vij} stands for total demand of variety v addressed to its producer in (exporting) country i on (importing) market j; n_i stands for the number of varieties produced in country i and available in country j; a_{ij} stands for a geographic preference parameters, which can be viewed as a relative national quality images; σ is the elasticity of substitution between the different available varieties.

Maximising each sub-utility U_j subject to budget constraint, we obtain the consumer demand for variety v on market j, which is produced by i. Assuming n_i exporting firms from i, total demand X_{ij} addressed to country i on market j is then equal to:

$$X_{ij} = n_i x_{vij} = \left(n_i \alpha_{ij}^{\sigma} \right) \cdot \left(\frac{p_{ij}}{p_j} \right)^{-\sigma} \left(\frac{R_j}{p_j} \right) \qquad (2)$$

where p_{ij} stands for the common price of varieties v produced in country i on market j and p_j stands for the price index related to all the varieties sold on market j. R_j stands for total expenditure on the differentiated product.

The same expression can be obtained for demand related to domestic sales, X_{jj}. By expressing demand for imports in terms of demand for domestic sales (i.e. relative market share of country i with respect to that of country j) we have:

$$\log \frac{X_{ij}}{X_{jj}} = -s \cdot \log\left(\frac{p_{ij}}{p_{jj}}\right) + \log\left(\frac{n_i}{n_j}\right) + s \cdot \log\left(\frac{a_{ij}}{a_{jj}}\right) \qquad (3)$$

Notice from equation (3) that price elasticity of demand for imports is represented by the elasticity of substitution s as it is usually the case in these models of trade.

On the supply side, each firm producing in a monopolistic competition model sets a mill price[4] such as $p_{vi} = p_i = m.c_i$, where m represents the mark-up $\left(\frac{1}{1-s}\right)$ and c_i the marginal cost of factors. Assuming transport costs of an iceberg type, the relative delivered price on market j can be expressed as:

$$\frac{p_{ij}}{p_{jj}} = \frac{m_{ij}}{m_{jj}} \cdot \frac{t_{ij}}{t_{jj}} \cdot \frac{c_i}{c_j} \qquad (4)$$

Where t_{ij} represents transaction costs from country i to j.

Transaction costs can be expressed as $t_{ij} = d_{ij}^{d} b_{ij}$. They are a function of d_{ij},which represents the geographic distance between i and j, and b_{ij}, which represents a residual term encompassing components specific to trade costs that are not taken into account by geographical distance.

Factor costs are assumed to be of Cobb-Douglas type ($c_i = w_i^{h_1} \cdot eac_i^{h_2} \cdot r_i^{h_3}$), where w_i represent wages, eac_i (environmental) abatement costs and r_i other capital and material costs. It has to be noted however, that r_i is assumed not to vary with industry but to prevail for the whole economy. The relative price can be then expressed as:

$$\frac{p_{ij}}{p_{jj}} = \left(\frac{d_{ij}}{d_{jj}}\right)^{d} \cdot \left(\frac{w_i}{w_j}\right)^{h_1} \cdot \left(\frac{eac_i}{eac_j}\right)^{h_2} \cdot \left(\frac{r_i}{r_j}\right)^{h_3} \cdot t_{ij} \cdot b_{ij} \qquad (5)$$

Besides, recalling that in a traditional free entry monopolistic competition set-up *à la* Krugman (1980), the relative number of firms equals relative production $\left(\frac{n_i}{n_j} = \frac{Q_i}{Q_j}\right)$ (see Erkel Rousse and Mirza, 2002), and substituting (5) in (3), the equation of relative market share to be tested becomes:

[4] A mill price is the price that is set by the firm at the plant location before adding up transport costs.

$$\log\frac{X_{ij}}{X_{jj}} = -\boldsymbol{b}_0\cdot\log\left(\frac{d_{ij}}{d_{jj}}\right) - \boldsymbol{b}_1\cdot\log\left(\frac{w_i}{w_j}\right) - \boldsymbol{b}_2\cdot\log\left(\frac{eac_i}{eac_j}\right) + \boldsymbol{b}\cdot\log\left(\frac{Q_i}{Q_j}\right) + f_i + f_j + u_{ij}$$

where $\boldsymbol{b}_0 = \boldsymbol{sd}$, $\boldsymbol{b}_1 = \boldsymbol{sh}_1$ and $\boldsymbol{b}_2 = \boldsymbol{sh}_2$. The coefficient on production $\boldsymbol{b}$ should be constrained to 1 according to the theory. However, we prefer to test the latter rather than constrain it to unity in advance.

The relative perceived quality variable $\log\left(\frac{\boldsymbol{a}_{ij}}{\boldsymbol{a}_{jj}}\right)$, that of relative costs of capital and materials $\log\left(\frac{r_i}{r_j}\right)$, and other transaction costs (log b_{ij}) are assumed to be picked-up by importer and exporter fixed effects vectors f_i and f_j as well as the error term *(* u_{ij}*)*.

The theoretical framework suggests that the value of the parameter on abatement costs should depend on an interaction of substitution elasticity, or price elasticity of demand, ($\boldsymbol{s}$) and an abatement cost pass-through to prices measure ($\boldsymbol{h}_2$) as $\boldsymbol{b}_2 = \boldsymbol{sh}_2$. This is not surprising, as a proportional increase in abatement costs should translate into a decrease in relative exports through a higher price effect.

Then, one would expect the parameter on abatement costs:

1/ to be negative and statistically significant as long as an increase in abatement costs is passed through an increase in prices (i.e. $\boldsymbol{h}_2 > 0$).

2/ to be of a relatively high magnitude under two conditions:

2.1/ if there is a high pass-through between abatements costs and prices (i.e. $\boldsymbol{h}_2$ tends to unity) and

2.2/ if one believes in recent estimates of high import price-elasticities, and/or substitution elasticities in the literature (Head and Ries, 2001; Hummels, 1999; Erkel Rousse and Mirza, 2002 provide examples).

These expectations hold however, under two conditions: the first is related to the degree of differentiation in the industry. The authors who estimate high elasticities of demand to prices account for the differentiation bias (see Erkel Rousse and Mirza, 2002 for a thorough discussion). Their result emerges only when producing 'pure-price' elasticities (i.e. not altered by differentiation). The second condition has to do with perfect exogeneity of the variable of relative abatements costs. Recall that very recent studies on the US, argue that this variable is endogenous to trade and they produce consistent estimates with this view. We follow those studies but argue in what follows on an alternative hypothesis that could be also biasing the estimates and that can be very easily identified by our theoretical framework.

As a matter of fact, one can assume that an increase in abatement costs in the real world has a double effect: a pure cost effect and a Porter-type effect. Porter's argument is that high stringency stimulates innovation to produce 'better' products[5]. That effect could also be qualified as a differentiation effect and would end up being perceived by the consumer. Hence, the choice of any abatement cost measure could bias the estimates because that measure would be a proxy of the cost variable identified in theory but also pick a 'perceived quality' or more generally a 'perceived differentiation' effect. Now, we have already argued that the fixed effects should account partly for consumers' perceived quality represented by $\left(\frac{a_{ij}}{a_{jj}}\right)$. However, there might be a remaining component captured by the residuals. In that case, the abatement costs variable would end up being correlated with the residuals and the abatement costs estimator would be biased downwards. That is why we propose in what follows several ways to try to capture a pure cost effect on the estimator of abatement costs.

3 DATA

Data search proved to be a substantial challenge, since most of the data for Candidate Countries (CC) is not too commonly accessible. Especially, due to lack of environmental data, we were constrained to limit our sample to 12 importing countries[6] from EU and 19 exporting countries[7] from the EU and CC over the period 1996-1999.

Trade data come from the OECD ITCS 2002 CD ROM. The data are reported for all OECD countries with each of their world partners. The original data was in current prices in US dollars, however it has been converted into Euro using the European Central Bank (ECB) (2002) annual average exchange rates. The OECD provides disaggregated data, however since our environmental data was aggregated to 2-digit level of ISIC Rev 3, we aggregated also the trade data. The conversion tables between ISIC Rev 3 and SITC Rev 3 were found on RAMON – Eurostat's classification server.

Distance data followed CEPII geodesic distances (Gaulier et al., 2003)[8]. As our variable of bilateral distance is expressed in terms of internal distance, we also considered the internal distance they provide which represents an average distance between producers

[5] See for instance Porter and Van der Linde (1995).

[6] Belgium and Luxembourg were joint into one entity due to lack of separate trade data. Denmark and France had to be excluded.

[7] The CC are the ones scheduled to join the EU until 2007. Cyprus, Latvia and Malta were a priori excluded because of no availability of environmental data. Czech Republic and Poland were also excluded because they did not report data for current expenditure (however the data for investment existed).

[8] Despite the fact that they provide data for bilateral distances as distances between capital cities and distances between most important cities, we considered only the former. The reason lies in the common practice, established by Jon Haveman using capital distance data. Nevertheless, in the European sample, the difference exists only in the case of Germany.

and consumers in a country and is calculated by $d_{ii} = 0.67\sqrt{area/\pi}$ (see Head and Mayer, 2000).

The activity data mostly came from the STAN database (OECD, 2001). The data was in ISIC Rev 3 industrial level and we aggregated it to the main groups following he environmental data[9]. We used it to extract production and construct a variable of compensation per employee as a measure of labour cost. All that data was converted into Euro using the ECB annual average exchange rates.

For non-OECD countries the same type of data (production and compensation per employee) was completed from different sources including from International Labour Organisation LABORSTA database (ILO, 2003) and Trade and Production database (World Bank, 2001). Due to different databases, the control over the data was exercised with the help of sometimes differently aggregated data from the Eurostat publications (European Communities, 2002a and 2002b).

For the **environmental stringency variable** we use Eurostat Environmental Expenditures and Environmental Taxes database, just released by the Eurostat New Cronos in July 2003. The data source is mainly the Joint Eurostat and OECD questionnaire on Environmental Protection Expenditure and Revenues. The data received was validated by Eurostat in close cooperation with the reporting countries. The data was reported in 1000 Euro (Johansson, 2003).

We consider *"Total Current Expenditure" (CURE)* provided by the dataset as a measure of abatement costs. This variable informs on *the money spent during the year on the execution of environmental protection activities: e.g. operation of environmental equipment, measurement and monitoring, environmental management, education and administration. It is the sum of in-house current expenditure and fees and payments.*

When we come to GMM estimations, we also pick from the same dataset two other variables to serve as instruments: Lagged Total Investment as well as Total Public Expenditure. Total Investment includes all outlays in a given year for machinery, equipment and land used for environmental protection purposes. Total Public Expenditure is obtained as well from Eurostat, Environment Statistic Yearbook (2001). The public sector includes federal and local governments and communities, government agencies and other public bodies providing environmental protection services.

We are running trade equations at the industry level. However, due to the lack of the data on stringency at that level we have decided to use current environmental expenditures at the ***total manufacturing level***. We know that this measure does not very well represent the theoretical variable as the latter asks for industry level data[10]. That potential

[9] We excluded recycling since it was also excluded from the environmental expenditure data.
[10] Such a simplification can also be found in the existing environmental literature. Most of the studies that work with other-that-US data use indices representing the stringency of a country. Therefore, we also use country's stringency to assess sectoral trade.

measurement error shall be handled however, by the use of GMM estimations. GMM or any instrumental variable method can be used at each time an explanatory variable happens to be correlated to the residuals which is exactly the case when that variable is measured with error (See Davidson and MacKinnon, 1993). However, for robustness check we run regressions on a significantly smaller sample where we do have some industry data on environmental expenditure and find similar results. See section 5.

The Eurostat data has been reported for 9 manufacturing sectors (economic activities are classified by NACE Rev 1, which is fully compatible with ISIC Rev 3):

Table 2: Sectors[11]

(15-16) Manufacture of food products; beverages and tobacco
(17-19) Manufacture of textiles and textile products; manufacture of leather and leather products
(20) Manufacture of wood and wood products
(21-22) Manufacture of pulp, paper and paper products; publishing and printing
(23) Manufacture of coke, refined petroleum products and nuclear fuel
(24-25) Manufacture of chemicals, rubber and plastic products
(26) Manufacture of other non-metallic mineral products
(27) Manufacture of basic metals
(28-36) Other manufacturing (excluding recycling)

4 RESULTS

The first set of estimation results is presented in table 3. As a benchmark we report the pooled OLS results without taking into account fixed effects. Before going in details through the results it is important to note two aspects. First, for any given presented column the average point estimate on relative stringency is negative and statistically significant. The elasticity is almost -0.3 and significant at the 5% level. Second, all the other variables also show, in general, expected and significant results with respect to theory.

One deviation from the expected results is the direction of the wage coefficient. Except in the OLS method, the coefficient on relative wage appears to be not significant. The explanation could be that wages might be a reflection of productivity rather than pure costs. However, since the primary purpose of this article lies in the investigation of environmental stringency, we leave the analysis of wages outside the main analysis.

As mentioned earlier, a way of producing consistent elasticities of bilateral imports to pure abatement costs is to develop strategies where some quality effects, measurement

[11] ISIC Rev 3

errors and other endogeneities between abatement costs and trade flows are already controlled for.

One strategy would be to run regressions where we suspect $b_2 = s h_2$ to be among the highest (see theory section). To do so, we could choose a sub-sample (or a set of sub-samples) where we expect the elasticity of demand to prices s to be high for a given h_2. In that respect, we conjecture first that the sensitivity to prices of imports from Candidate Countries is higher than that for the EU countries. That is because we expect Candidate Countries to supply less differentiated type of goods than EU countries for any given industry. Hence, the effect of abatements costs on imports should be higher in case the exporter belongs to a Candidate Country (i.e. lower for the EU exporters).

Although not for the same reason, this conjecture follows that of Ederington et al. (2003) that pollution haven effect is more obvious when trading between developed and developing countries[12]. From Table 3, column 3, we can see that indeed the coefficient on current expenditure when the EU countries are exporters deviates positively (0.31) from the *average* coefficient on expenditure (-0.42), although it is still negative in net $\tilde{b}_{2,EU} = -0.42 + 0.31 = -0.11$.

Another option that contributes at picking a 'pure' cost effect from the abatement cost variable is to class the industries in function of the degree of differentiation of their products. We use the classification of Rauch (1999) and adapt it as in Erkel-Rousse and Mirza (2002) to our data. Column 4 reports the results: we find that indeed the effect of abatement costs is (negatively) higher when the industries are known to produce relatively homogenous products as the deviation from the average effect is negative. Column 5 produces the same results when we interact current expenditure by industry. One can see that for industries that are classified as homogenous the effect of abatement costs is higher than for industries that are classified as differentiated.

We also performed a regression where we interact relative current expenditure with a dummy variable that indicates whether sectors produce 'dirty' or 'clean' goods (see Column 6)[13]. However, the pollution haven hypothesis is not supported in this case as industries that tend to produce 'dirty' goods have a coefficient that deviates positively and statistically from the average effect. One explanation could be that the characterisation of such broad sectors into dirty and clean is not appropriate. Another possible explanation is that our set-up might not be adapted to analyse possible differences between dirty and clean sectors because there is no reason why we should consider that consumers are more sensitive to prices of dirty rather than clean sectors[14].

[12] These authors have another explanation. They claim that higher effects on US net imports could be obtained from developing countries' instead of rich countries' partners because stringency in levels or in tendency are very different from that of the US which creates more variability in the data.

[13] The differentiation of sectors into 'dirty' and 'clean' followed Mani and Wheeler (1999) among other authors (see annex, table A1)

[14] We could have also looked at footloose sectors. However, following Low (1992), footloose sectors represent only a very tiny proportion of the trade in Europe and no broad sector was possible to be characterised as footloose in general. Also, our set-up might not emphasise the difference on trade between

Table 3[15]: Relative imports equation

ln relative imports[16] $_{ijkt}$	1- OLS	2- Fixed Effects	3- EU[17]	4- HOM[18]	5- SECTORS	6- DIRTY[19]
Constant	-2.566*** (0.115)	-4.211*** (0.203)	-4.247*** (0.200)	-4.490*** (0.298)	-4.088*** (0.311)	-4.277*** (0.203)
ln relative wages$_{ijkt}$	0.412*** (0.050)	-0.339* (0.183)	-0.316* (0.182)	-0.014 (0.164)	0.120 (0.181)	-0.302 (0.185)
ln relative production$_{ijkt}$	1.017*** (0.035)	1.214*** (0.042)	1.216*** (0.042)	1.200*** (0.041)	1.140*** (0.045)	1.184*** (0.041)
ln relative distance$_{ij}$	-1.164*** (0.053)	-1.425*** (0.041)	-1.429*** (0.041)	-1.404*** (0.037)	-1.404*** (0.035)	-1.425*** (0.041)
ln relative current environmental expenditure$_{ijt}$ (CURE)	-0.299*** (0.029)	-0.298** (0.127)	-0.420*** (0.128)	-0.360*** (0.122)	-0.292** (0.126)	-0.352*** (0.126)
ln CURE$_{ijt}$ *EU			0.314*** (0.038)			
ln CURE$_{ijt}$ *DIRTY						0.107*** (0.220)
ln CURE$_{ijt}$ *HOM				-0.068*** (0.019)		
ln CURE$_{ijt}$ *sector "17-19" (hom[20])					-0.167*** (0.039)	
ln CURE$_{ijt}$ * sector "20" (hom)					-0.343*** (0.039)	
ln CURE$_{ijt}$ * sector "21-22" (diff[21])					0.009 (0.038)	
ln CURE$_{ijt}$ * sector					-0.059*	

footloose and non footloose industries because it is more adapted to estimate elasticities that are closely linked to sensitivity to prices. Here again, there is no reason why we can claim that footloose industries produce goods to which consumers are more sensitive.

[15] *** significant at 1% level; ** significant at 5% level; * significant at 10% level; robust standard errors reported in brackets
[16] *i*= exporter, *j*= importer, *t*=time, *k*=sector
[17] EU is a dummy of value 1 if the exporting country is an existing EU member and 0 is the exporting country is a CC.
[18] HOM is a dummy of value 1 for homogeneous sectors and 0 for differentiated (based on Rauch, 1999).
[19] DIRTY is a dummy of value 1 for dirty sectors and 0 for clean sectors.
[20] '*hom*' stands for homogeneous, whereas '*diff*' stands for differentiated (after Rauch, 1999).
[21] According to Rauch (1999) the Pulp & Paper (21) sector is homogeneous and Publishing & Printing (22) is differentiated. However, since on average the latter sub-sector is much more important in production terms in the EU and the CC, we characterised sector 21-22 as differentiated (European Communities, 2002a and 2002b).

“24-25” [22] (diff)					(0.034)	
ln $CURE_{ijt}$ *sector “26” (hom)					-0.136*** (0.035)	
ln $CURE_{ijt}$ * sector “27” (hom)					-0.127*** (0.040)	
ln $CURE_{ijt}$ * sector “28-36” (diff)					-0.125*** (0.035)	
EXP FE	No	Yes	Yes	Yes	Yes	Yes
IMP FE	No	Yes	Yes	Yes	Yes	Yes
TIME FE	No	Yes	Yes	Yes	Yes	Yes
SECTOR FE	No	Yes	Yes	Yes	Yes	Yes
Observations	2757	2757	2757	2552[23]	2552[23]	2757
R^2	0.5014	0.7829	0.7882	0.8115	0.8177	0.7845

Another way of estimating a pure cost effect of stringency on trade flows, or more specifically to disentangle the pure cost effect from all other effects like perceived quality but also measurement errors or endogeneity, is to apply appropriate econometric methods. Indeed, the existence of these factors would bias the estimation of the parameter on abatement costs because they would produce a correlation between this cost vector and that of the residuals. A convenient way to proceed then is to run instrumental variables regressions or General Methods of Moments. We present hereby the latter because GMM are known to account not only for non-orthogonality between the residuals and the explanatory variables of interest but also to produce efficient estimates in case of heteroscedasticity or autocorrelation.

Table 4 presents the results where current expenditure has been instrumented by all the rest of the explanatory variables plus, in an alternative manner, combinations of ln Total Public Expenditure, ln lagged Investments in Environmental Equipment and ln lagged Wages. Total Public Expenditure could act as a good instrumental variable as we expect it to be correlated with current expenditure without being especially correlated with the residuals of bilateral trade. We have also chosen lagged private Environmental Investment as a potential good instrument. The main reason is that the previous year’s investment might affect today’s environmental expenditure. This effect might be negative, in case firms invest into environmental protecting processes in previous years and pay lower fees and payments in later years. On the other hand, it could also have a positive correlation: environmental friendly investment may imply more staff to work

[22] We decided to exclude sector 23 (Manufacture of coke, refined petroleum products and nuclear fuel) from the sectoral analysis. Although there is not much doubt that this sector is relatively homogeneous, the demand is not much price elastic.
[23] Without sector 23

with these new investment. Nevertheless, we do expect some correlation between lagged investment and current expenditure and no *a priori* correlation with the residuals.

However, instead of assuming *a priori* endogeneity of Current Environment Expenditure and exogeneity of the chosen instruments we perform two tests that tend to confirm these assumptions in the data. In table 4, the Durbin-Wu-Hausman test (DWH) rejects the exogeneity of current expenditure variable at the 5% level of significance (i.e. current expenditure seems to be correlated with the residuals) and the Chi2-Hansen test, which p-value appears to be higher than 0.10 suggests that the sets of instruments at hand pass the test of overidentification (i.e. there is orthogonality between the instruments and the residuals).

Turning to the results, table 4 shows that relative expenditures on the environment confirm their negative impact on exports. By instrumenting the variable we obtain a cost effect estimate on trade that is much stronger than in our previous estimations, and of similar magnitude than that obtained by recent studies. First, it is to be noted that the (very) high values obtained in studies on US data (Levinson and Taylor, 2003; Ederington, Minier, 2003) are confirmed on our EU data. Besides, our elasticity of import demand to an increase in abatement costs appears to be around 3.5 which is a lower bound of estimates of import price-elasticities or substitution elasticities s obtained in very recent literature (Eaton and Kortum, 2002; Head and Ries, 2001; Hummels, 1999; Erkel Rousse and Mirza, 2002). This result is very consistent with our theory under incomplete pass through which suggests that in that case the elasticity of imports to abatement costs is always lower than that of price or substitution (i.e. $h_2 \leq 1$ and $b_2 \leq s$).

Table 4: Generalised Method of Moments estimations on Relative Imports equation

ln relative imports$_{ijkt}$[24]	1- GMM with IV: ln lagged investment; ln public environmental expenditure	2- GMM with IV: ln lagged investment; ln public environmental expenditure; ln lagged wages
Constant	-2.868*** (0.414)	-2.866*** (0.414)
ln relative wages$_{ijkt}$	0.359 (0.393)	0.347 (0.390)
ln relative production$_{ijkt}$	1.363*** (0.087)	1.364*** (0.087)
ln relative distance$_{ij}$	-1.698*** (0.109)	-1.697*** (0.108)
ln relative current environmental expenditure$_{ijt}$	-3.465** (1.376)	-3.367** (1.317)
DWH P-value	0.048	0.050
Hansen test: Chi-sq. P-value	0.336	0.610
Observations	454	454
R^2	0.7379	0.7387

[24] *i*= exporter, *j*=importer, *t*=time, *k*=sector

5 ROBUSTNESS CHECK

We perform robustness checks from two different angles. The first one uses the scarce database of environmental stringency (current environmental expenditure) that we could access to ***at the industry level***. The second check has a particular dimension: it investigates to which extent our new dataset is driving our new results compared to that of the remaining gravity literature.

5.1 ENVIRONMENTAL DATA DIFFERING BY SECTORS

We perform the same regressions than before allowing for environmental stringency to differ accross sectors. We drop importer's fixed effects here as it appears to produce multicollinearity[25]. The results in Table 5 very much resemble the results presented in Table 3. The environmental stringency variable behaves in the same way and with the same significance. Also in column 3, 4 and 5, the results still suggest that the effect of abatement costs is closely and negatively related to the degree of differentiation.

Table 5: Structural gravity results performed with the environmental data differing by sectors

ln relative imports[26] $_{ijkt}$	1- OLS	2- Fixed Effects	3- EU[27]	4- HOM[28]	5- SECTORS	6- GMM with IV: ln lagged investment; ln public environmental expenditure; ln lagged wages
Constant	-2.488*** (0.197)	-4.384*** (0.494)	-4.887*** (0.472)	-4.390*** (0.476)	-4.131*** (0.441)	-0.350 (3.930)
ln relative wages $_{ijkt}$	0.592*** (0.112)	-0.120 (0.214)	-0.199 (0.216)	-0.220 (0.214)	-0.131 (0.223)	3.110 (2.150)
ln relative production $_{ijkt}$	1.039*** (0.106)	1.001*** (0.106)	0.996*** (0.104)	0.953*** (0.109)	0.911*** (0.107)	3.357*** (0.723)
ln relative distance $_{ij}$	-1.051*** (0.089)	-0.955*** (0.078)	-0.955*** (0.080)	-0.961*** (0.076)	-0.973*** (0.073)	-2.817*** (1.031)
ln relative current environmental	-0.287*** (0.081)	-0.413*** (0.843)	-0.550*** (0.096)	-0.326*** (0.095)	-0.212** (0.106)	-2.747*** (0.709)

[25] the Variation Inflation Factor (VIF) statistic conducted from Stata suggests the existence of multicolinearity between Current Environmental Expenditure vector (CURE), Wages and other importer and industry fixed effects vectors (VIF higher than 15 on average). However, when we exclude the importer effects VIF drops to less than 10 on average (8 for CURE), which suggests no multicolinearity associated at least with the latter variable. Results are available upon request.

[26] *i*= exporter, *j*=importer, *t*=time, *k*=sector

[27] EU is a dummy of value 1 if the exporting country is an existing EU member and 0 is the exporting country is a CC.

[28] HOM is a dummy of value 1 for homogeneous sectors and 0 for differentiated (based on Rauch, 1999).

[29] DIRTY is a dummy of value 1 for dirty sectors and 0 for clean sectors.

expenditure$_{ijkt}$ (CURE)						
ln CURE$_{ijkt}$ *EU			0.328*** (0.092)			
ln CURE$_{ijkt}$ *HOM				-0.075 (0.054)		
ln CURE$_{ijkt}$ * sector "17-19" (hom[30])					-0.469*** (0.111)	
ln CURE$_{ijkt}$ * sector "20" (hom)					-0.449*** (0.105)	
ln CURE$_{ijkt}$ * sector "21-22" (diff[31])					0.092 (0.112)	
ln CURE$_{ijkt}$ * sector "24-25" [32] (diff)					-0.132 (0.097)	
ln CURE$_{ijkt}$ *sector "26" (hom)					-0.234** (0.102)	
ln CURE$_{ijkt}$ * sector "27" (hom)					-0.067 (0.113)	
ln CURE$_{ijkt}$ * sector "28-36" (diff)					-0.121 (0.117)	
EXP FE[33]	No	Yes	Yes	Yes	Yes	Yes
TIME FE	No	Yes	Yes	Yes	Yes	Yes
SECTOR FE	No	Yes	Yes	Yes	Yes	Yes
DWH P-value						0.000
Hansen test: Chi-sq. P-value						0.010
Observations	549	549	549	529[34]	529[34]	78
R^2	0.5041	0.7000	0.7057	0.6921	0.7158	0.3363

[30] '*hom*' stands for homogeneous, whereas '*diff*' stands for differentiated (after Rauch, 1999).
[31] According to Rauch (1999) the Pulp & Paper (21) sector is homogeneous and Publishing & Printing (22) is differentiated. However, since on average the latter sub-sector is much more important in production terms in the EU and the CC, we characterised sector 21-22 as differentiated (European Communities, 2002a and 2002b).
[32] We decided to exclude sector 23 (Manufacture of coke, refined petroleum products and nuclear fuel) from the sectoral analysis. Although there is not much doubt that this sector is relatively homogeneous, the demand is not much price elastic.
[33] We decided to exclude importer's fixed effects due to multicollinearity in such small sample.
[34] Without sector 23

Column 6 reports the results for GMM estimation. Due to the lack of observations and lack of instruments at the industry level, the instruments that we already used in the prior specification could not pass the overidentification test. We report though only one result where the program signals exact identification (i.e. number of estimators equals the number of instruments. In that configuration, Davidson and MacKinnon (1993) suggest the results should be consistent although they need to be backed by alternative instrumental variables' estimations that pass the overidentification test and produce the same results. So, our GMM result in column 6 has to be considered with some caution but in any case, GMM produces high effects of industry level stringency here as well (-2.5).

5.2 OUR DATA ON TRADITIONAL GRAVITY

Are our obtained results, different from those of the gravity literature, due to our new dataset or to our new structural specification? If they are due to our dataset then we should expect that by substituting our new environment data to that used in the prior gravity literature, we could obtain different results.

We follow mostly Van Beers and Van den Bergh (1997) and Harris et al. (2002) to test their gravity model on our data[35]. For better presentation of the results and comparison with previous findings, table A2 (see annex) has been constructed containing the results by Van Beers and Van den Bergh and Harris et al. The models followed are basically the same, however, it has to be noted that due to different notations, for Van Beers and Van den Bergh's as well as for our estimations, the trade flows observed are from country *i* to country *j*, whereas for Harris et al., *i* is defined as the importing country. This does not influence the results, however it does influence their interpretation. Whereas in the first and the last estimation we expect $\ln STR_{it}$ (Stringency) to be negative, the same is true for $\ln STR_{jt}$ in the second estimation.

Moreover, there are different econometric specifications taken into account, i.e. while Van Beers and Van den Bergh are dealing only with a cross-section, Harris et al. stress the importance of fixed effects. Therefore, by characterising Van Beers and Van den Bergh's results as not totally satisfactory, we compare our results with Harris et al. However, it should be noted that when we introduce exporter, importer and time fixed effects in our specification, this tend to produce high multicollinearity[36]. So we produced only exporter and importer fixed effect regressions alternatively. That said, as suggested by the annex, our new dataset produces the same insignificant results than those produced by Harris et al. on the impact of stringency. This finding contribute to the argument that our findings in the prior section are not due to the new data at hand but tend to be the result of a different specification of trade equations.

[35] We had to add three variables to our dataset to perform this test: Gross Domestic Product was taken from the Eurostat (2002) yearbook and converted to constant 1996 prices. Population and land data were taken from the International Financial Statistics online database (IMF, 2003).

[36] Variation Inflation Factor statistic provided upon request.

6 CONCLUSION

In this paper we managed to show that environmental regulations are indeed an important variable in the determination of trade flows. Following the existing literature, we proposed some different pieces of missing puzzles in the pollution haven debate. Despite the fact that the prior gravity literature did not provide conclusive results up to now, we modified the empirical gravity test in a way that is more directly adapted to the theory. The paper has used a newly released dataset on US-type environmental stringency, i.e. abatement costs incurred by manufacturing industry. The use of this data enabled us to bring the debate of pollution havens to the European continent, especially linked to the very topical implications of the Eastern enlargement of the EU. Finally, we managed to improve our analysis by assessing the endogeneity of environmental expenditures and performing GMM type estimations.

Our results show that the elasticity of relative stringency is negative and statistically significant at the 5% level. We have also shown that the elasticity of trade to abatement costs depends on the degree of differentiation of the goods provided. In particular, environmental stringency matters more to trade between the EU and the Candidate Countries, since the latter are expected to produce less differentiated products, than to trade among the existing EU members. Also, we have clearly shown that trade in sectors, characterised as relatively homogeneous, is much more sensitive to changes in the environmental regulations. All the results obtained proved to be very robust.
We have applied GMM estimations as an alternative way to account non parametrically for differentiation, in order to produce pure cost effects of environmental regulations. The results obtained satisfy the recent literature on US studies as well as trade studies. The elasticity of trade to abatement costs increased to reach –3.5 and remained significant at 5% level.

What are the implications for policy? Does this mean that high stringency on environment is bad for firms' competitiveness? It is very important to note that in this paper we managed to disentangle the pure cost effect from all other effects that alter it on trade. The pure costs happen to be indeed significantly high. But there might be many other effects that are produced by stringency, such as perceived quality by the consumer, that could end up being favourable to trade. Our framework suggests that effect and accounts for it in a non parametric manner. But it does not quantify it. Of how much environmental standards increased trade via an increase in perceived quality or innovation (as Porter's hypothesis suggest) are still open questions.

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ANNEX

Table A1: Differentiation of sectors into dirty and clean

Dirty sectors :

(21-22) Manufacture of pulp, paper and paper products; publishing and printing
(23) Manufacture of coke, refined petroleum products and nuclear fuel
(24-25) Manufacture of chemicals, rubber and plastic products
(26) Manufacture of other non-metallic mineral products
(27) Manufacture of basic metals

Clean sectors:

(15-16) Manufacture of food products; beverages and tobacco
(17-19) Manufacture of textiles and textile products; manufacture of leather and leather products
(20) Manufacture of wood and wood products
(28-36) Other manufacturing (Fabricated metal products, except machinery and equipment; transport equipment; furniture; manufacturing n.e.c.)

Table A2[37]: Traditional gravity results – comparison and new estimations

	TEXP (i=exporter)	OLS Estimation Results for TIMP (j=exporter)					TEXP (i=exporter)				
	Van Beers – Van den Bergh	Harris et al.					this study				
	CS	*CS*	*pooled OLS*	*IMP FE*	*IMP and EXP FE*	*IMP, EXP, TIME FE*	*pooled OLS*	*EXP FE*	*IMP FE*	*DIRTY, EXP FE*	*FOOTLOOSE EXP FE*
Variable											
Constant	2.30**	22.069**	23.848**	174.002**	147.202**	171.673**	-16.45**	206.28	143	537*	113
$\ln GDP_{it}$	1.61**	1.459**	1.677**	2.265**	2.174**	1.796**	0.78**	2.26*	0.7**	4.7*	1.9
$\ln GDP_{jt}$	1.02**	1.491**	1.431**	1.481**	1.063**	0.685	0.75**	0.65*	3.5	0.87*	0.6
$\ln POP_{it}$	-0.80**	-0.535**	-0.760**	-9.902**	-10.300**	-10.900**	-0.03	-15.28	0.01	-38.5*	-9
$\ln POP_{jt}$	-0.18	-0.580**	-0.541**	-0.572**	1.684	1.077	0.25	0.33	-13.1	0.38	0.3
$\ln DIST_{ij}$	-0.71**	-0.689**	-0.627**	-0.736**	-0.948**	-0.949**	-1.05**	-1.10**	-1.1**	-1.19**	-1.48**
$ADJACENCY_{ij}$	0.35**	0.488**	0.588**	0.500**	0.351**	0.350**	0.64**	0.54**	0.64**	0.5**	0.17
EEC_{ijt}	0.38**	0.401**	0.387**	0.123**	0.104**	0.097**	0.54*	dropped	0.68*	dropped	dropped
$EFTA_{ijt}$	-0.09	0.004	-0.122*	0.082	0.123*	0.131*	n.a.	n.a.	n.a.	n.a.	n.a.
$NAFTA_{ijt}$	n.a.	n.a.	0.751**	1.034**	0.798**	0.793**	n.a.	n.a.	n.a.	n.a.	n.a.
$\ln LAND_{i}$	-0.10**	-0.069*	-0.082**	n.a.	n.a.	n.a.	0.07	dropped	0.08	dropped	dropped
$\ln LAND_{j}$	-0.06	-0.097**	-0.097**	-0.091**	n.a.	n.a.	-0.08	-0.07	dropped	-0.14*	0.03
$\ln STR_{it}$[38]	-0.24**	-0.246**	-0.252**	0.068	0.067	0.092	0.05	-0.14	-0.01	-0.29	-0.03
$\ln STR_{jt}$	-0.30**	0.029	0.012	-0.049	-0.026	-0.001	0.01	0.005	0.28	-0.17*	-0.08
Observations	420	552	3864	3864	3864	3864	3160	3160	3160	367	364
Adj. R^2	0.882	0.859	0.855	0.884	0.911	0.911	0.5288	0.5410	0.5322	0.89	0.85

[37] ** significant at 1% level; * significant at 5% level; standard errors not reported here, however we used the *robust* specification.

[38] the coloured-field coefficient is expected to be negative

Table A3[39]: Classification of dirty and footloose industries (Low, 1992):

DIRTY	FOOTLOOSE
251 pulp and waste paper	59 chemical materials
334 petroleum products	661 lime, cement, construction materials
335 residual petroleum products	67 iron and steel
51 organic chemicals	69 metals manufactures
52 inorganic chemicals	
562 fertilisers	
59 chemical materials	
634 veneers, plywood	
635 wood manufactures	
64 paper, paperboard	
661 lime, cement, construction materials	
67 iron and steel	
68 non ferrous metals	
69 metals manufactures	

[39] SITC Rev 3