International Competitiveness and Environmental Regulations

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Introduction:

There has been growing concern from both analysts and policy makers about the linkage between environmental policy and international competitiveness: whether a country's imposition of stiffer environmental regulations impacts its international competitiveness. From a theoretical point of view, stringent regulations, in the form of required abatement costs imposed on manufacturing, raises production costs of a domestic firm. These higher costs shift the firm's supply curve to the left and result in a new equilibrium where the firm produces fewer goods at higher prices. As a result, a country's export competitiveness declines (Jenkins). A country could relax strict controls over environmental degradation to protect domestic firms as well as to increase trade flows in the world market. An inflexible environmental policy will encourage industries facing high stringent environmental regulations to move to countries with lower standards.

There is a large body of literature that empirically examines this issue, most of which provide no strong evidence to support the contention that environmental standards lead to loss of international competitiveness. According to Jaffe et al., relatively high environmental standards have no significant impacts on international competitiveness. As reflected in their results, the environmental compliance cost associated with farm production is too small to influence competitiveness. Using a gravity model, Harris et al. investigated the relationship between environmental regulations and international competitiveness and they also found no significant impact between these two variables. Ratnayake used the Hecksher-Ohlin-Venek model to examine the impact of environmental regulations on New Zealand's trade, and the results did not support the hypothesis that stringent environmental regulations harmed international trade. In examining the same proposition, Larson et al. and Xu found mixed results.

Some studies have found evidence that environmental regulation influence competitiveness; Metcalfe for one. He reported that European Union pork exports were significantly influenced by their stringent environmental regulations whereas regulations imposed by the U.S. and Canada had minimal impact on their competitiveness. Kalt's findings are consistent with the theoretical expectation that imposition of environmental regulations lowers U.S. manufacturing good exports. Han supported this result in his dissertation. Mulatu investigated the responsiveness of international export flows to the environmental policy using a factor endowment model and found tougher environmental regulations worsened the net exports of the dirty industry. These findings are supported by Busse who argued that stringent regulations only impact the competitiveness of iron and steel sectors.

Two different models, the gravity model and standard Heckscher- Ohlin factor endowment (H-O) model, are often used in empirical models. However, they produce mixed results based on time period, countries/ industries modeled etc. so the debate about the linkage between environmental regulations and competitiveness continues. Empirical findings are questioned because the studies lack adequate and reliable data on environmental regulations. Busse used a unique and comprehensive dataset for environmental regulations. This study uses the same source but recent data in the model.

This study follows the H-O model in that a country's export competitiveness is explained by factor intensities and compliance costs imposed on the industries. It decomposes total trade by product-based industry on the basis of pollution emission and analyzes whether stringent environmental policies impact international competitiveness for those industries.

Research Objectives:

The aim of this study is to test the hypothesis that environmental stringency adversely affects the international competitiveness in manufacturing exports. The specific objectives of this research include:

a. To identify factors that influence export competitiveness;
b. To develop a valid framework based on the H-O model to estimate changes in international trade flows as influenced by factor endowments along with environmental regulations;
c. To compare regulation's impact at different product-based industries.

Model description:

Heckscher-Ohlin model and environmental regulations:

Eli Heckscher and Bertil Ohlin first developed the factor endowment model, simply called the Heckscher-Ohlin (H-O) model, as an improvement on the Ricardian Model. The Ricardian model assumes that labor is the only factor of production which impacts international trade flows. But the factor endowment model added capital to labor in the production process and it predicts the trade pattern in goods between two countries based on differences in relative factor endowments. It assumes that the factor inputs cause trade flows: a capital abundant country exports capital intensive goods and a labor abundant country exports labor intensive goods (Suranovic).

Since its initiation, the H-O model has been used to explain international trade pattern in economics. However, Samuelson developed a mathematical equation from the Hechscher-Ohlin's two countries, two goods, two factors model, with an argument that free trade equalizes factor prices. Vanek extended this model into multiple goods and factors.

According to the H-O model, the production function is:

$$Q^s = f^s(N^s, K^s) \tag{1}$$

Where Q denotes the output of sector s, N represents the quantity that the sector chooses to employ and K represents the capital that the sector employs. The marginal product of factor N and K are positive but declining as inputs increase.

It is assumed that trading countries have the same technology in production; markets are perfectly competitive; there are no transportation costs; tastes and preferences are identical for both countries; and the production function exhibits constant return to scale.

According to the H-O model, a country exports the good which makes intensive use of its relatively abundant factor. For example, a home country is said to be capital-abundant has a higher ratio of capital to labor than the foreign country:

$$\frac{K_h}{N_h} > \frac{K_f}{N_f} \tag{2}$$

In this case, the home country's production possibility frontier (PPF) will reflect an ability to produce higher quantities of capital intensive goods than labor intensive goods. Accordingly, the home country will export the goods that use its abundant factor intensively, hence capital intensive goods.

Within the context of the H-O model, McGuire developed a model incorporating an environmental regulation variable that, along with capital and labor variables, explain the country's PPF. In principle, the greater pollution allows the greater subsequent harm to people in the country. The principle with regard to the incorporation of environmental pollution is that polluters must pay the costs of environmental degradation. This study follows McGuire's approach in that three production factors, *N* and *K* and an environmental policy variable (*R*) are used to produce output *Q* in a pollution intensive industry (*s*). Accordingly, the production of a pollution intensive industry has the following form:

$$Q^s = f^s\left(N^s, K^s, R^s\right) \tag{3}$$

The explanatory variables used in the above equation have a direct relationship to the firm's production, and the production function exhibits positive but decreasing return to each production factor:

$$\frac{\partial f^s}{\partial N^s} = f_N^s\left(N^s, K^s, R^s\right) > 0 \, ; \; \frac{\partial^2 f^s}{\partial {N^s}^2} < 0 \tag{4}$$

$$\frac{\partial f^s}{\partial K^s} = f_K^s\left(N^s, K^s, R^s\right) > 0 \, ; \; \frac{\partial^2 f^s}{\partial {K^s}^2} < 0 \tag{5}$$

$$\frac{\partial f^s}{\partial R^s} = f_K^s\left(N^s, K^s, R^s\right) > 0\,;\ \frac{\partial^2 f^s}{\partial R^{s\,2}} < 0 \tag{6}$$

Since the environmental regulation variable is assumed to be a production factor, its marginal product equals its price or its marginal cost at the profit- maximization condition. Mathematically it is:

$$\frac{\partial f^s}{\partial R^s} = f_R^s\left(N^s, K^s, R^s\right) = MC_R = \gamma \tag{7}$$

Where γ is the marginal cost (*MC*) of the environmental variable in terms of abatement cost. If $\gamma = 0$, then a country's imposition of environmental regulation is non-binding.

Equation 7 has an implicit form:

$$R^s = \psi^s\left(N^s, K^s, \gamma\right) \tag{8}$$

where ψ is the marginal impact on environment and $\psi_\gamma < 0$.

Substituting equation (8) into (3), we can get a mixed profit / production function:

$$Q^s = f\left\{N^s, K^s, \psi^s\left(N^s, K^s, \gamma\right)\right\} = f\left(N^s, K^s; \gamma\right) \tag{9}$$

where various combinations of *N* and *K* are used to produce a given amount of *Q*, and *R* is automatically adjusted for each combination of *N* and *K* to bring $f_R = \gamma$. When the country's environmental policy is non-binding, the marginal product of *R* equals zero, i.e., $f_R = \gamma^0 = 0$. But when regulatory policy is binding the marginal product of *R* is positive, i.e., $f_R = \gamma^* > 0$. Thus, the mixed profit-production function becomes:

$$Q^s = f\left\{N^s, K^s, \psi^s\left(N^s, K^s, \gamma^*\right)\right\} = f\left(N^s, K^s; \gamma^*\right) = f^*\left(N^s, K^s\right) \qquad (10)$$

In this case, the level of capital and labor, needs to be increased to maintain the same level of output because costs are higher due to regulatory policy, which shifts the *N*-*K* isoquant map outward.

Therefore, with each *N*-*K* combination, the output produced under the condition when regulations are non-binding (γ^0) is higher than the output produced under the condition when the regulatory policy is binding (γ^*). However, this does not mean that the output reduction due to environmental policy will be identical for each factor combination (McGuire).

As evidence from the above discussion, the environmental variable within the Heckscher-Ohlin framework explains successfully how regulatory policy can reduce the output level of the farm. Furthermore, the other two factor inputs, capital and labor, not only impact farm production but they also influence international trade flows by their intensive use in the production process. Since tough environmental standards negatively impact the farm's output level, imposition of such regulations can impact international competitiveness.

Empirical Model:

The approach which most strongly motivated this study is from Mulatu who proposed a standard H-O factor endowment model. This model demonstrates the relationship between export flows and factor endowments across industries:

$$NEX_i = \kappa(FE)'_i + \lambda(ER)_i + \mu_i \qquad (11)$$

where, *NEX* represents a vector of net exports by industry, *FE* is the matrix of factors endowments that include capital services and labor as human capital services, *ER* is environmental regulation measured by compliance costs, μ denotes error terms, and the index i indicates industry. According to this model, a country's net export is explained by its factor intensities and environmental regulations. This analysis adds other factors such as technology as measured by research and development (R&D), and dummy variables that identify countries. Including all these factors that explain exports, the final empirical framework of the H-O model has the following form:

$$NEX_{it} = \alpha + \beta K_{it} + \gamma SL_{it} + \delta UL_{it} + \phi RD_{it} + \lambda ER_{it} + \eta DV_{it} + \mu_{it} \qquad (12)$$

This study follows a panel data approach that captures both cross-sectional and time series variations in data.

Data sources and descriptions:

This study focuses on the factors affecting export competitiveness with special attention to the impact of environmental policy for different export industries. The standard factor endowment model used in this study requires data on net exports for different manufacturing goods (the dependent variable), and factor intensities for capital and labor, R&D expenditures and environmental regulations as explanatory variables. The panel data set for each country is collected for seventeen years, 1987-2003 on six OECD countries.

The data on exports and imports are collected from the OECD STAN Database for industrial analysis. The data are used to calculate net exports for respective industries. Capital is the gross fixed capital formation published in the OECD Database. There are two types of labor flows used in this model: skilled labor and unskilled labor. Based on the formula[1] developed by Branson and Monoyios, skilled labor was calculated:

$$SL_{it} = \frac{(\overline{w}_{it} - \widetilde{w}_t).E_{it}}{\rho} \qquad (13)$$

Where $\overline{w}$ is the average annual wage in each sector, $\widetilde{w}$ is average annual wage in the lowest-paying manufacturing industry, E is the total number of full-time employees in the industry, and ρ represents a discount rate in percentile (i.e., 10%). Unskilled labor is measured by the average annual wage in the least-paying sector multiplied by number of industry's employment. All these data were collected from the OECD STAN Database for industrial analysis.

Reliable data on environmental regulations is lacking. However, previous studies use either environmental regulation indices or data collected by survey. The data for environmental regulations used by Busse are most noteworthy. These data have been created by the Center for International Earth Science Information Network (CIESIN) which proposes an environmental sustainability index that includes two indicators, stringency of environmental regulations and environmental conventions and treaties. Considering data availability, this study attempts to use environmental regulation data from the 2002 Environmental Sustainability Index and the 2005 Environmental

[1] This formula is also used in Han; and Stern and Maskus.

Sustainability Index from CIESIN. These two year data have been extrapolated and interpolated for analysis.

Empirical results:

The dataset is collected for 14 different industries in 6 countries for 17 years for 1987 to 2003. The descriptive statistics for each variable used in the analysis is reported in Table 1. Countries are eliminated from the sample based on data availability. Different countries are used in the analysis for different industries.

Assuming that all coefficients (intercepts and slopes) are the same for all countries and the errors (μ_{it}) satisfy all the assumptions of the classical regression model, we can pool all the data and run an ordinary least squares (OLS) regression. The model can be written as

$$NEX_{it} = \alpha + \beta K_{it} + \gamma SL_{it} + \delta UL_{it} + \phi RD_{it} + \lambda ER_{it} + \eta DV_{it} + \mu_{it} \qquad (14)$$

where E(μ_{it}) = 0 and V(μ_{it}) = σ^2.

Since OLS ignores heterogeneity across country with respect to unobserved characteristics, the assumptions made about coefficients and the structure of the error term in the classical regression model may not hold. To examine the cross-sectional variation or heterogeneity of the data, a fixed-effect model was chosen because it provides considerable advantage in handling heterogeneity across countries. For this analysis the data by country were treated as panel observations.

In the fixed-effect model, it is assumed that the panel model has constant slopes, but the intercepts differ according to the cross-sectional unit (i.e., the country). The panel regression captures both cross-sectional and time-series variation in the data used. The model can be written as:

$$NEX_{it} = \alpha_i + \beta K_{it} + \gamma SL_{it} + \delta UL_{it} + \phi RD_{it} + \lambda ER_{it} + \eta DV_{it} + \mu_{it} \tag{15}$$

where the α_i is a special attribute that is constant over time, and still E(μ_{it}) = 0 and V(μ_{it}) = σ^2.

The data have been checked for any violations of the basic econometric assumptions and the results indicate that autocorrelation and heteroskedasticity exist in some instances. The test for multicollinearity, a variance inflation (VIF) being higher than 10, indicates problems in some equations. Autocorrelation and heteroskedasticity were corrected by transferring data using the estimated ρ and weighted least squares. The results for panel regression are reported in Table 2.

Table 2 displays the regression analysis for net exports explained by factor intensities and environmental regulation. The F_values for all models are statistically significant at the 1% level, that is, the null hypothesis is rejected; one cannot conclude that all coefficients are zero. The coefficients of determinant (R^2 values) are quite high for all equations. This implies that the independent variables used in the model explain a high percentage of the variability in net exports from the sample.

The variables used have a direct relationship to the standard factor endowments approach: capital, labor, technology and environmental policy impact export flows. It is expected that the basic factor inputs positively influence export competitiveness, and the environmental variable negatively influences export flows. An increase in a country's factor endowment leads to an increase in output that lowers the price of goods domestically. This encourages the foreign country to purchase more goods; as a result the country's export increases.

As shown in table 2, capital services and skilled labor showed a positive impact on net exports for most industries. A unit increase in capital services increases net exports in textiles, textile products, leather and footwear industries by 2.9 units. This implies that increasing capital investment in labor-intensive goods like textiles results in lower prices that increase a country's exports. However, the coefficient for capital services showed a significantly negative impact on net exports for non-metalic mineral products and fabricated metal products. This empirical result is unexpected. Insufficient data or the absence of other important variables in the model might be the cause of this surprising result.

From table 2, the effects of increased labor intensity in food, textiles and machinery is higher than for other capital intensive good industries. These findings are generally consistent with the results of Busse. In addition, Mulatu et al. found a positive impact of capital endowment on net export of dirty commodities. For other factor intensity variables, the results are expected but the coefficient for technology, in terms of research and development expenditures, was negative, which was not expected. Mulatu et al. and Kalt also found this surprising result. The result for a country's net exports in food, beverages and tobacco industries was as expected, though. Table 2 revealed that a unit increase in R&D expenditures is associated with a 8.4 unit increase in net exports in the food sector.

Table 2 shows that environmental regulations imposed on textile, textiles products, leather and footwear industry, iron and steel industry, machinery and equipment industry and manufacturing (n.e.c) industry negatively impact net exports. Only the coefficients for textiles, textile products, leather and footwear and manufacturing (n.e.c.) sectors are significantly different from zero at the 1% level. These findings support the hypothesis that environmental standards lead to a loss of international competitiveness (Ratnayake, Larson et al., Xu, Kalt, Mulatu, Busse, Han). This implies that environmental regulation, as a production factor, results in higher production costs and causes output prices to rise and exports to decline.

The effect of environmental regulations (as discussed earlier) depends on its marginal cost, i.e., the cost of additional pollution. Porter and Ven de Linde found environmental standard positively impacts international trade. According to their findings, keeping environmental pollution at an optimal level results in a cleaner environment and, consequently, a firm's productivity growth increases to enhance export competitiveness. This finding is consistent with research in the food safety area. People want safe food and are willing to pay more money for it if it adheres to policy regulations on food safety. These regulations do not impair export competitiveness (Buzby).

Therefore, the findings of a positive impact of environmental regulation on net exports in food, beverages and tobacco may be reasonable. But the positive effect of environmental variable on exports in other industries is difficult to explain. These unexpected results may be because of omitted variable bias or the multicollinearity problem exhibited by the data.

Stringent environmental standards for the iron and steel industry negatively influenced net exports, but the coefficient is not significantly different from zero. The reason behind this result might be due to an absence of an important factor, skilled labor, that was not included in the study due to data unavailability. Busse found that environmental variables had a statistically significant impact on iron and steel exports.

Summary and Conclusion:

This study follows the standard factor endowment approach to explain the effects of environmental regulations on net exports in different product-based industries. It constructs an econometric model which includes factor endowments and environmental regulations to examine how strict environmental policy impacts export competitiveness. Cross-sectional and time series (panel) data for 6 countries and 17 years were used in this model.

In general, factor intensities positively and the environmental variable negatively influence export flows. An increase in a country's factor endowment leads to an increase of output that lowers the price of goods in the domestic market. This encourages the foreign country to produce more goods; as a result the country's export increases. In this study, capital services and skilled labor showed positive impacts on net exports in most industries. A unit increase in capital services increases net exports in labor-intensive industries like textiles, textile products, leather and footwear industries. The results also showed that capital services endowment had a significant, negative impact in the non-metalic mineral products and fabricated metal products. This empirical result is unexpected. The result also showed the effects of increased labor intensity in food, textiles and machinery is higher than for other capital intensive good industries. Technology, as measured by research and development expenditures, also showed an unexpected negative impact on net exports. Insufficient data used and the absence data on some other important variables might be the cause of these surprising results.

The result showed that the environmental regulations imposed in the textile, textiles products, leather and footwear industry, iron and steel industry, machinery and equipment industry and manufacturing (n.e.c) industry negatively impact net exports. The coefficients of environmental regulation for only textiles, textile products, leather and footwear and manufacturing (n.e.c.) sectors are statistically significant. These findings support the hypothesis that stricter environmental standards lead to a loss of international competitiveness. The result also showed a positive influence of environmental regulations on food, beverages and tobacco exports, which is supported by the Porter hypothesis. Stringent environmental standards for iron and steel industry is found to negatively influence net exports but the coefficient is not significantly different from zero.

In examining the relationship between environmental regulation and export competitiveness, the empirical results differ in some cases from the theoretical concepts. The probable cause of these unexpected results is an absence of important factors influencing net exports and inadequate data used in the analysis. However, the empirical findings of this study can support policy makers and will help stimulate further research. These results might not directly help firm level investors with their decisions, so further research is required to examine what other variables explain net exports in this model and how these variables influence net exports at the product and processing levels for low- and high-income countries.

References:

1. Busse, M. 2004. "Trade, Environmental Regulations and the World Trade Organization" World Bank Policy Research Working Paper, No. 3361. Available online at http://econ.worldbank.org/files/37045_wps3361.pdf
2. Branson, W. R. and N. Monoyios. 1977. "Factor Inputs in U. S. Trade", J. International Economics, 7: 111- 131.
3. Buzby, J. C. "International Trade and Food Safety: Economic Theory and Case Study", U.S. Dept. Agr., Eco. Res. Report No. 828, Nov. 2003.
4. CIESIN (2003), 2002 Environmental Sustainability Index, Center for International Earth Science Information Network (CIESIN), available online at http://www.ciesin.columbia.edu/indicators/ESI
5. CIESIN (2005), 2005 Environmental Sustainability Index, Center for International Earth Science Information Network (CIESIN), available online at http://www.ciesin.columbia.edu/indicators/ESI
6. Han, K. 1996. "Environmental Regulation and International Competitiveness: Cross-industry and Cross-country Analysis" MS Thesis. University of Illinois.
7. Harris, M. N., L. Konya, and L. Matyas. "Modeling the Impact of Environmental Regulations on Bilateral Trade Flows: OECD, 1990-1996." World Economy. 25(3) (March 2002): 387-405.
8. Jaffe, A.B., S.R. Peterson, P.R. Portney, and R.N. Stavins. "Environmental Regulation and Competitiveness of U.S. Manufacturing: What Does the Evidence Tell Us?" J. Econ Lit. 33(March 1995): 132-63.
9. Jenkins, R. 1998. "Environmental Regulation and International Competitiveness: A Review of Literature and Some European Evidence" Discussion Paper Series. United Nations University. (Available online).

10. Kalt, J. 1988. “The Impact of Domestic Environmental regulatory Policies on U.S. International Competitiveness, in Spence, M. and H. Hazard (eds.), International Competitiveness, Cambridge, MA: Harper and Row, pp. 221-262.
11. Larson, B. A., Nicolaides, E., Zubi, B.A., Sukkar, N., Laraki, K. Matoussi, M. S. Zaim, K., and Chiuchani, C. "The Impact of Environmental Regulations on Exports: Case Study Results from Cyprus, Jordon, Morocco, Syria, Tunisia, and Turkey.” World Development. 30(6) (2002): 1057-1072.
12. McGuire, M. C. 1982. “Regulation, Factor Rewards, and International”, J. Public Economics, 17: 335- 354.
13. Metcalfe, M. “Environmental Regulation and Implications for Competitiveness in International Pork Trade.” Paper presented at IATRC Symposium on International Trade in Livestock Products, Auckland, New Zealand, January 2001. Available online at http://iatrcweb.org/oldiatrc/Papers/Metcalfe.pdf.
14. Mulatu, A., R. J. G. M. Florax and C. Withagen. 2004. “Environmental Regulation and International Trade: Empirical Results for Germany, the Netherlands and the US, 1977- 1992”, Contributions to Economic analysis & Policy, 3(2): Available online at http://www.bepress.com/bejeap/contributions/vol3/iss2/art5
15. Porter, M. E. and C, ven der Linde. “Toward a new conception of the environment–competitiveness relationship.” Journal of Economic Perspectives, 9 (4), (1995): 97–118.
16. Ratnayake, R. "Do Stringent Environmental Regulations Reduce International Competitiveness? Evidence from an Inter-industry Analysis" International J. Economics of Business. 5(1) February 1998): 77-96.
17. Suranovic, S. "International Trade Theory and Policy: The Heckscher-Ohlin (Factor Proportions) Model," The International Economics Study Center, © 1997-2005, http://internationalecon.com/v1.0/ch60/ch60.html.
18. Stern, R. M. and K. E. Maskus. 1981. “Determinants of the Structure of U. S. Foreign Trade, 1958- 76”, J. International Economics, 11: 207- 224.
19. Xu, X. "International Trade and Environmental Regulation: Time Series Evidence and Cross Section Test." Environmental and Resource Economics. 17 (2002): 233-257.

Table 1: Descriptive statistics of the variables for the period, 1987-2003

Variables	Mean and standard deviation (in parenthesis)						
	Food	Tex	Wood	Paper	Tchem	Chem	Nmetal
Net exports	4549.21 (5362.91)	-15867.21 (22916.62)	-352.103 (1249.67)	-808.549 (1865.21)	3670.07 (9250.86)	5624.25 (6452.10)	-1514.41 (2286.68)
Skilled labor	151870597 (227288897)	53140210.82 (109059982)	222043..68 (402438.00)	487251111 (662688190)	339182547 (644055554)	104374225 (167323699)	1623009.51 (1971936.88)
Unskilled labor	7146732.31 (13200420.71)	6102797.91 (11834293)	157959.47 (88840.63)	14884580.43 (20913132.79)	8354478.44 (16349999.96)	5094184.18 (8611053.67)	2104599.62 (4136090.45)
Capital	4888.89 (5215.31)	1109.66 (1604.24)	348.412 (477.458)	7232.83 (7883.05)	9527.53 (13672.12)	6905.94 (9369.23)	1513.22 (2072.34)
R&D	436.390 (594.857)	101.147 (154.843)	7.830 (5.699)	690.78 (1101.54)	5316.60 (8567.91)	5619.11 (7908.35)	174.643 (249.032)
Env_Reg	0.483 (1.206)	0.483 (1.206)	0..298 (0.755)	1.096 (0.966)	0.483 (1.206)	0.772 (1.082)	0.483 (1.206)
N	85	85	68	51	85	68	85
n	5	5	4	3	5	4	5

Classification of industries according to OECD:	
Food: Food products, beverages and tobacco	Paper: Pulp, paper, paper products, printing and publishing
Tex: Textiles, textile products, leather and footwear	Tchem: Chemical, rubber, plastics and fuel products
Wood: Wood and products of wood and cork	Chem: Chemicals and chemical products
	Nmetal: Other non-metallic mineral products

Notes: N is the number of total observation, n is the number of countries (Finland, France, Italy, Netherlands, Norway and United States). Depending on data availability, we eliminate countries from the sample and use different country in different industries for analysis.

Table 1: Descriptive statistics of the variables (continued)

Variables	Mean and standard deviation (in parenthesis)						
	Bmetal	Iron	Nfer	Fmetal	Mach	MachN	ManfN
Net exports	-1680.88 (9245.92)	-2831.78 (4226.17)	-326.853 (6960.99)	-2501.28 (2951.41)	-14751.11 (21486.63)	-3802.75 (6643.49)	-7831.02 (13249.04)
Skilled labor	17721227.93 (27893818)		16311978.72 (2789731.58)	114994514 (190977335)	1716057162 (3393877107)	14146964.28 (6507053.81)	18106988.80 (23310141.10)
Unskilled labor	3385619.29 (5785098.70)	1823717.37 (3073398.27)	1336.69 (1438.23)	7075716.46 (12304331.61)	17935132.96 (35263518.31)	344809.94 (139488.69)	3930485.06 (7541650.66)
Capital	2353.68 (2896.46)	1531.37 (1575.14)	108.819 (158.906)	2076.74 (3075.90)	10052.85 (17285.58)	773.973 (600.220)	909.611 (985.054)
R&D	205.034 (284.358)	100.976 (136.946)	0.325 (1.253)	377.884 (661.666)	18916.09 (32564.67)	309.881 (311.162)	128.209 (243.695)
Env_Reg	0.320 (1.299)	0.325 (1.253)	0.325 (1.253)	0.320 (1.299)	0.483 (1.206)	0.095 (0.985)	0.483 (1.206)
N	68	68	68	68	85	68	85
n	4	4	4	4	5	4	5
Classification of industries according to OECD: Bmetal: Basic metals Iron: Iron and steel Nfer: Non-ferrous metals				Fmetal: Fabricated metal products, except machinery and equipment Mach: Machinery and equipment MachN: Machinery and equipment nec ManfN: Manufacturing nec			

Notes: N is the number of total observation, n is the number of countries (Finland, France, Italy, Netherlands, Norway and United States). Depending on data availability, we eliminate countries from the sample and use different country in different industries for analysis.

Table 2: Panel regression results of net exports in different industries for the period, 1987-2003

Variables	Model: $NEX_{it} = \alpha_i + \beta K_{it} + \gamma SL_{it} + \delta UL_{it} + \phi RD_{it} + \lambda ER_{it} + \eta DV_{it} + \mu_{it}$						
	Food	Tex	Wood	Paper	Tchem	Chem	Nmetal
Intercept	7284.355	-493.723***	-226.968**	-2999.210	33315***	13604***	-361.861
	(4381.634)	(108.934)	(122.199)	(3227.138)	(8515.758)	(4180.041)	(565.784)
Skilled labor	0.000002	0.00016***	0.00079***	0.00003***	-0.00002	-0.00004	-0.00063***
	(0.00002)	(0.00002)	(0.00026)	(0.000004)	(0.00002)	(0.00006)	(0.00022)
Unskilled labor	-0.00077***	-0.0034***	-0.012***	-0.00079***	-0.0014**	0.0008	0.00007**
	(0.0002)	(0.0003)	(0.0015)	(0.00014)	(0.0008)	(0.0008)	(0.00004)
Capital	0.029	2.934***	0.470**	-0.142	1.452***	2.063***	-0.897***
	(0.429)	(0.382)	(0.251)	(0.166)	(0.424)	(0.491)	(0.052)
R&D	8.433**	-23.498**	10.667	-0.631	-0.805	-2.634***	-1.782**
	(3.970)	(11.810)	(8.081)	(0.840)	(0.691)	(0.606)	(0.713)
Env_Reg	1156.093***	-143.509**	264.535***	378.732	3539.970***	115.588**	27.865
	(422.646)	(58.267)	(49.106)	(289.178)	(820.176)	(56.481)	(90.287)
d1	-7735.586**	2132.817	2050.200***	270.061	-33830***	-20804***	601.327
	(4486.412)	(3115.203)	(217.859)	(3240.917)	(8579.038)	(5976.440)	(575.335)
d2	-4646.123	-6030.108***	1091.511***	2147.169	-37356***	-6.008	5635.717***
	(4816.942)	(2138.378)	(149.089)	(3164.075)	(7856.755)	(921.400)	(1261.385)
d3	2049.158	-1782.564	1629.696***		-23660***	-7482.739**	1272.557**
	(4104.7764)	(1929.918)	(187.977)		(8441.315)	(4334.112)	(708.445)
d4	314.954	-13209***			-27473***		-608.287
	(4766.800)	(1930.979)			(8377.612)		(645.826)
R2	0.81	0.99	0.98	0.80	0.76	0.77	0.97
Adj_R2	0.78	0.99	0.98	0.77	0.73	0.73	0.96
F_value	34.72	34241.47	407.10	24.95	25.91	22.13	257.29

Food: Food products, beverages and tobacco
Tex: Textiles, textile products, leather and footwear
Wood: Wood and products of wood and cork
Paper: Pulp, paper, paper products, printing and publishing
Tchem: Chemical, rubber, plastics and fuel products
Chem: Chemicals and chemical products
Nmetal: Other non-metallic mineral products

Notes: ** and *** indicate significant at 5% and 1% level, respectively. Standard errors are given in parenthesis.d1- d4 are country dummies.

Table 2: Panel regression results (continued)

Variables	Model: $NEX_{it} = \alpha_i + \beta K_{it} + \gamma SL_{it} + \delta UL_{it} + \phi RD_{it} + \lambda ER_{it} + \eta DV_{it} + \mu_{it}$						
	Bmetal	Iron	Nfer	Fmetal	Mach	MachN	ManfN
Intercept	8749.135***	-10137**	809.077	8498.578***	72403***	-18238***	41689***
	(1404.953)	(4844.119)	(682.357)	(1374.929)	(21523)	(1800.600)	(2207.233)
Skilled labor	-0.00004			-.00013***	-0.00001	0.0008***	0.00008**
	(0.00004)			(0.0002)	(0.000009)	(0.0001)	(0.00004)
Unskilled labor	-0.0023***	-0.00008	-0.002***	0.000016	-0.00013	-0.031***	-0.0038***
	(0.0002)	(0.00051)	(-0.0003)	(0.0036)	(0.0011)	(0.0041)	(0.0002)
Capital	1.396***	1.313**	0.854**	-5.133***	-0.230	2.300	-0.991
	(0.386)	(0.778)	(0.379)	(1.218)	(0.610)	(1.925)	(0.860)
R&D	-2.028	-11.015**	4.963	43.355	0.332	-3.568**	-6.900***
	(3.544)	(3.416)	(4.320)	(77.375)	(0.526)	(1.957)	(2.45)
Env_Reg	266.172	-504.861	500.287	2488.542***	-1206.864	570.786***	-431.247**
	(342.081)	(839.074)	(397.511)	(600.225)	(1216.237)	(70.639)	(205.129)
d1	-7886.092***	10637**	-459.126	-954.930	-70074***	19323***	-41602***
	(1452.218)	(5345.158)	(789.319)	(6789.543)	(21609)	(1578.317)	(2234.114)
d2	-9189.476***	8179.865	-6890.726***		-75064***	15.475	-41199***
	(1419.962)	(4945.689)	(783.400)	19488**	(21529)	(215.335)	(2262.180)
d3	-131.108	7513.930	8491.839***	(8635.336)	-72351***	16449***	-42626***
	(416.789)	(5622.422)	(732.213)		(21576)	(1469.883)	(2985.976)
d4				-69024***	-107011***		-45980***
				(19563)	(22019)		(2356.566)
R2	0.96	0.95	0.94	0.99	0.90	1.00	0.99
Adj_R2	0.96	0.94	0.94	0.99	0.89	1.00	0.99
F_value	189.88	172.911	138.91	3267.94	72.93	7221.04	1353.23

Bmetal: Basic metals
Iron: Iron and steel
Nfer: Non-ferrous metals
Fmetal: Fabricated metal products, except machinery and equipment
Mach: Machinery and equipment
MachN: Machinery and equipment nec
ManfN: Manufacturing nec

Notes: ** and *** indicate significant at 5% and 1% level, respectively. Standard errors are given in parenthesis. d1- d4 are country dummies.