

Paper prepared for presentation at the DIME conference
Bordeaux, 11. - 13. 09. 08

Sectoral Costs of Environmental Policy

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ABSTRACT

The impact of environmental policy on companies has been studied extensively. These studies typically focus on the impact of one Directive or at one particular aspect. This paper builds on the primary data that was collected for the purpose of the study 'Sectoral costs of environmental policy', carried out under the authority of the Directorate General Environment of the European Commission.

On the one hand the main focus lies on the factors that influence the height of the environmental expenditure and the choice between end-of-pipe technology and process integrated technology in order to reduce the firms environmental impact. On the other hand we look at the environmental improvements as well as the strategic (dis)advantages and impact on competitiveness induced by the expenditure and investments.

In this paper, we run a series of ordinary least square regressions to analyse which factors affect a firm's environmental expenditures and environmental performance. In addition, we analyse the correlation between environmental regulation and a firm's strategic position and competitiveness.

Keywords: Environmental policy, environmental expenditure, environmental strategy, economic impact, regression analysis

Acknowledgements

The paper benefited greatly from comments by Stephan White (European Commission) and Paul Campling (VITO). This paper builds on primary data that was collected for the purpose of the study 'Sectoral costs of environmental policy', carried out under the authority of the Directorate General Environment of the European Commission. The views in this paper are those of the authors and not necessarily reflect those of organizations they are associated with or those that funded the research.

INTRODUCTION

The impact of environmental policy on companies has been studied extensively. These studies typically focus on the impact of one Directive or at one particular aspect, for example the role of different policy instruments, the impact of policy on innovation or the role of environmental management systems.

However, only very few aim to paint an integrated picture of the economic and environmental consequences of environmental policy. The main focus of this study lies on the factors that influence the magnitude of the environmental expenditure and the choice between end-of-pipe technology and process integrated technology in order to reduce the firms environmental impact. The costs of environmental policy are examined for four of the manufacturing sectors most affected by policy and competitive pressures: the oil chain industry, electricity production, the textiles and leather industry and the iron, steel and other metals industry. On the other hand we look at the environmental improvements as well as the strategic (dis)advantages and impact on competitiveness induced by the expenditure and investments.

BACKGROUND ON THE IMPACT OF ENVIRONMENTAL POLICY ON FIRMS

The impact of environmental policy on companies and the variation in responses of those companies to environmental policies have been studied extensively. A number of variables among which firm specific, location specific and sector specific characteristics influence the manner in which environmental policy has an impact on the firms.

First, it appears that regulatory pressures are critical to achieving greater environmental improvements (OECD, 2006). Although the major share of environmental policy initiatives is nowadays decided at the European level, the implementation of environmental policies is still carried out to a large extent at the national and regional level. As a consequence, major differences continue to exist in the level or rigour of environmental regulation between European countries (Jenkins, Barton *et al.*, 2002).

Production processes and technological developments are to a large extent sector specific and the dynamic of competition takes place within an industry (Jenkins, Barton *et al.*, 2002). Therefore, the responses of companies to environmental regulation are dependent on the competitive characteristics of the sectors within which they operate (Jenkins, Barton *et al.*, 2002). This leads to the assumption that the sector is one of the main variables determining the impact of environmental regulation on firms. This is confirmed by Lund (2007) where one of the main findings is that the ETS influences the industry sectors quite differently.

In addition, Johnstone (2007) observed a wide variation in environmental performance amongst apparently similar firms, which cannot be explained fully by public policy factors. A number of firm characteristics including firm size, product diversification and the implementation of an environmental management system (EMS) are potentially at the basis of these differences in performance. The presence of an EMS in particular can have a significant positive impact on environmental performance (Johnstone, 2007) and environmental product innovation (Rehfeld, Rennings *et al.*, 2007). This corresponds with the findings of Jenkins *et al.* (2002) who find that the firms attitude and strategy towards the environment also play a major role.

Evidence suggest that the impact of environmental regulation does not only depend on environmental characteristics. For example, a study by OECD (OECD, 2006) finds that the impact of environmental regulation is unequally distributed across companies with

similar environmental characteristics which indicates that other factors such as size will play a role. Larger companies tend to be less affected than smaller companies, foreign companies and potential new entrants. This is mainly due to the fact that larger firms face lower per unit costs of compliance with environmental regulations. Hence, the impact of environmental regulation is unequally distributed across firms with similar environmental characteristics but different sizes.

Impact of environmental policy on firms' expenditures in pollution prevention and control

Environmental policies are mainly generating an impact on companies through increased environmental expenditures and by stimulating environmental investments through process integrated methods (pollution prevention) or end-of-pipe measures (pollution treatment). The magnitude of environmental compliance costs varies across industry and typically depends on the definition that has been used. Generally, environmental expenditure is defined as the spending incurred by companies where the primary aim is to prevent or reduce the pollution which is caused during normal operations. Visible costs such as installation and maintenance of pollution-control equipment and end-of-pipe emission treatment costs are easily identified as environmental compliance cost, while expenditures on process integrated environmental investments are much more difficult to identify. In the latter case, total investment expenditures have to be divided between expenditures for economic purposes and expenditures for environmental purposes and this typically leads to an underestimation of the compliance costs. Joshi *et al.* (2002) found that in the case of the US steel industry, accounting systems identify only a small portion of the costs of regulatory compliance in a separate way. On average these costs account for less than 1 % of gross output across the manufacturing sector and are usually considered as small (Hitchens, Birnie *et al.*, 2000) A review by Vercaemst *et al.* (2007) using sectoral data on investment expenditures for the 1995-2005 period confirms that the environmental protection expenditures are relatively low and comparable to those in the US and Australia¹.

The environmental investment expenditures in figure 1 show several peaks but are never higher than 1,5 % of the sectoral production values. Since 2001 Eurostat collects data on current environmental expenditures and distinguishes between end-of-pipe and process integrated investments expenditure. On average, between 35 % and 50 % of environmental investments are classified as integrated. For the textile industry, refineries and the base metal sector an upward trend seems to be present but no firm conclusions can be drawn due to the low number of observations in some years. Overall it seems that the integrated investments form an increasingly important part of all environmental investments. This suggests that process integrated investments allow for a more cost effective compliance than with the application of end-of-pipe technologies. Finally, expenditures on environmental measures and investments in pollution prevention or control result in economic consequences for the firms and sectors as well as an improvement of the environment. Emissions of all pollutants have shown a downward trend since the signing of the Gotheburg Protocol (MNP and IASA, 2007). In addition to available end-of-pipe emission control measures, non-technical and local

¹ As part of the study 'Sectoral costs of environmental policy' (Vercaemst *et al.*, 2007), a review was carried out of the available data at Eurostat on environmental expenditures for the sectors involved: the oil chain industry, electricity production, the textiles and leather industry and the iron, steel and other metals industry. While some European national statistical offices, such as those from the Netherlands, Germany and the Czech Republic, already started data collection on environmental expenditures as early as the 1980's, it is only from 1995 onwards, following the development of SERIEE (European system for the collection of economic data on the environment), that data have been collected by national statistical offices and submitted to Eurostat.

measures are of increasing relevance, especially when multiple policy objectives are pursued.

Environmental and economic consequences of environmental regulation on firms

Regarding the impact of environmental regulation on industries and the economy, substantial research effort has been devoted to this subject. According to the conventional view, environmental regulation places an excessive burden on European industries, thereby stifling growth and damaging the competitiveness of European companies in an increasingly globalised market place (Palmer, Oates *et al.*, 1995). Regulatory pressures appear to be critical to achieving greater environmental improvements. While the stringency of the regulatory regime comes at a cost to the organisation, these costs may however be offset if the facility takes steps to reduce its impacts on the environment (OECD, 2006). A study by Johnstone (2007) confirms that the perceived environmental policy stringency is the main driver for environmental investment, technological innovation and the reported environmental performance. These findings confirm the revisionist view or the 'Porter hypothesis' (Porter, 1995; Porter and Vanderlinde, 1995) which states that properly structured environmental regulation gives rise to a win-win situation whereby pollution is reduced and productivity is simultaneously increased.

Although environmental performance at the firm level might have a positive influence on profitability, there is only little evidence of this win-win situation (Johnstone, 2007). A recent OECD study (OECD, 2006) indicates that higher levels of environmental performance lead to greater financial returns. Furthermore, according to a study by Triebswetter and Wackerbauer (2008), environmental policy can stimulate innovation and trigger a positive contribution to competitiveness, provided that the policy is coupled with a company environmental strategy and customer requirements. The main reason why environmental regulations have a small effect on competitiveness is probably that the costs of complying with regulations is a small fraction of total costs, sufficiently small to be overridden by differences in other more substantial costs such as labour and raw materials (Dean, 1992; Hitchens, Birnie *et al.*, 2000). This is confirmed by Demailly and Quiron (2007) who conclude that for the EU iron and steel sector, competitiveness losses due to ETS, if any, are small.

There is also only little evidence to support the hypothesis that environmental policy leads to the loss of comparative advantage or to an industrial flight to pollution havens (Jaffe and Stavins, 1995). Using a case study approach, Hitchens *et al.* (2000) find in a variety of countries and sectors in the European Union significant negative impact of environmental measures on the competitiveness of small and medium companies.

However, the impact of environmental regulation is unequally distributed among firms (OECD, 2006) and this might lead to increased market concentration and decreased competition. In particular, environmental regulations can constitute barriers to entry, provide a base for predatory behaviour and be harmful to competition and welfare through a variety of channels (OECD, 2006). Greater compliance costs (both absolute and relative to total costs), greater penalty costs, greater price competition between companies, greater sensitivity of demand to price increases and foreign competition are all expected to generate a negative impact of environmental regulation on the output and employment of companies (OECD, 1993; Watkiss, Forster *et al.*, 2004).

International studies from the mid 1990s have found out that the costs of environmental regulation are only of minor importance in the decision making process concerning the location of new production facilities (Ifo, 2006). A recent paper suggests that more stringent environmental regulations in the investors' country in comparison with those in the potential host country are positively correlated with both the probability of an investment abroad and also with the volume of investment abroad. On

the other hand, there is no evidence that companies operating in more polluting industries are more attracted to countries with weaker environmental standards than companies in less polluting industries (Spatareanu, 2007).

DATA

We used data collected in a firm level survey which was conducted in 2007 and was explicitly designed to investigate the impact of environmental policy on a firm's environmental expenditures and performance. We targeted 4 sectors: oil, electricity, textile and iron. We tried to reach environmental managers through different channels. In total, 64 respondents, representing 170 plants from the selected sectors in 14 EU Member States, fully completed the survey. The response rate is hard to estimate, but it can be argued that given the different paths used for distributing the survey², the response rate is rather *low*. While it is important to use the data with care to draw conclusions, the data set yields a potentially rich source of information as it is one of the first attempts to collect primary data for analysing the impact of environmental policies at the firm level as most studies on the impact of environmental regulation on competitiveness and technological change are carried out at the macro level of a region or country or at the micro level by means of case studies (Jenkins, Barton *et al.*, 2002). Moreover, a comparative analysis across countries of sectoral environmental expenditures is limited by the way existing secondary data are collected and presented. The low frequency as well as the deficient coverage of certain cost elements that might be important to the analysis makes it more difficult to come to general conclusions. Consistent long time series are only available for a few countries such as the Netherlands, Germany and the Czech Republic.

EMPIRICAL MODEL AND IDENTIFICATION

In this paper, we run a series of ordinary least square regressions to analyse which factors affect a firm's environmental expenditures (tables 2 to 5) and environmental performance (table 6). In addition, we analyse the correlation between environmental regulation and a firm's strategic position (table 7) and competitiveness (table 8) using an ordered logit regression as they have a natural ordering.

Dependent variables

Environmental Expenditures

The data holds several variables that were used to assess the environmental expenditures of a company.

A first set of variables asked the companies to judge their environmental expenditures in a qualitative way. They were asked to rate on a scale from 1 (strongly disagree) to 7 (strongly agree) whether the company made over the past 5 years considerable environmental expenditures

- in end-of-pipe equipment;
- to change the production process;
- to reformulate pre-existing products;
- to develop new products;
- to relocate to other countries.

² The contact details were mainly obtained from the national/regional contact points within the different Member States. However, for some Member States (e.g. France, UK) it turned out to be impossible to get these details because of confidentiality reasons. A postal letter was sent to these facilities. Moreover, we aimed to increase our sample size by including smaller, non-IPPC facilities. For this purpose, we asked European (e.g. EURELECTRIC) and national industry federations (e.g. Fedustria (BE)) to help us circulating the survey.

In addition, the companies were asked to judge on a scale from 1 (very low) to 5 (very high)

- the relative magnitude of its investment expenditures in pollution control (end-of-pipe technologies) compared to total investment expenditures over the past five years;
- the relative magnitude of its investment expenditures in pollution prevention (process integrated technologies) compared to total investment expenditures over the past five years;
- relative magnitude of your current (operational) expenditure on environmental protection compared to your total operating costs over the past five years.

To reduce dimensions we applied principal component analysis to variables that asked to judge the environmental expenditures in a qualitative way and we used one indicator for the qualitative assessment of the companies environmental expenditures (ENV EXP QUAL).

Some of the variables described above were asking about their judgement about expenditures in pollution control mechanisms (end-of-pipe techniques), while other questions were asking about expenditures in pollution prevention mechanisms (process integrated techniques). Therefore we disentangled the qualitative indicator of the company's environmental expenditures into a qualitative indicator for environmental expenditures in end-of-pipe techniques (ENV EXP QUAL EOP) and one qualitative indicator for environmental expenditures in process integrated techniques (ENV EXP QUAL PIN)³.

A second set of variables collected quantitative information about a firms environmental expenditures. In particular, the companies were asked whether their average annual investment expenditure on environmental protection as a percentage of total investment expenditure was less than 1%, between 1%-5%, between 5% and 10%, between 10%-20% or higher than 20%. This question was asked for the year 2005 as well as for the past five years. The same questions with the same response options were asked about the company's current expenditures on environmental protection as a percentage of total operation costs. This info was bundled in a quantitative environmental expenditures indicator (ENV EXP QUAN) using principle component analysis.

Environmental consequences

Next, we wanted to investigate to what extent the environmental performance of a company is determined by environmental policies. Therefore, we looked at the company's reductions in the level of pollutant emissions, resources consumption and waste generation. The companies were asked to score on a scale from 1 (strongly disagree) to 7 (strongly agree) whether the emission of greenhouse gasses, other air and water pollutants, the energy and water consumption, and waste generation reduced considerably. Principle component analysis was used to bundle this information and create an indicator for environmental consequences (ENV CONS). Environmental consequences can directly be affected by environmental policies and the firm's

³ ENV EXP QUAL EOP is calculated using principal components to bundle information about environmental expenditures on in end-of-pipe equipment and to relocate to other countries as well as the relative magnitude of its investment expenditures in pollution control compared to total investment expenditures.

ENV EXP QUAL PIN is calculated using principal components to bundle information about environmental expenditures to change the production process, to reformulate pre-existing products, to develop new products as well as their judgment of the relative magnitude of its investment expenditures in pollution prevention compared to total investment expenditures and of the current (operational) expenditure compared to the total operating costs.

environmental strategy or indirectly through the impact the latter two variables have on the company's environmental expenditures.

Strategic advantages and competitiveness

Environmental regulations aim to improve environmental performance of companies. It is often argued that environmental regulations have a negative side effect as companies lose their strategic advantages and compete less efficiently in the market place because of the strictness of environmental policies. On the other hand, it is often argued that environmental regulation enforces companies to use the most innovative techniques, especially if these regulations induce companies to introduce pollution prevention mechanisms. We included two variables to test whether environmental regulations were having a negative or a positive impact on a firm's strategic advantages and competitiveness. The companies were asked to judge on a scale from 1 (strongly disagree) to 7 (strongly agree) whether their strategic advantages over their competitors improved over the last five years (STRAT ADV) and whether they were able to compete more effectively (COMP EFF) in the market place. Using an ordered logit regression we tested whether environmental regulations are having a direct impact on a firm's strategic advantages and its competitiveness and/or an indirect through its impact on environmental expenditures.

Independent variables

Environmental Regulation Index

In this paper, we want to test to what extent environmental policies are affecting a firm's environmental expenditures as well as its environmental performance. Therefore we looked at the impact of the most relevant European environmental legislations. The relevance of each individual environmental regulation to the plant is measured on a five-point index scale, based on the respondent's answer to the following question:

Please indicate on a scale of '1' to '5' (1: Not at all affected, 2: Slightly affected; 3: Affected; 4: Strongly affected; 5: Very strongly affected) to what extent your facility is affected by the following policies or regulations:

- Policy/regulation 1
- Policy/regulation 2
- etc.

While a total of twenty-eight environmental regulations have been pre-identified for inclusion in the survey, respondents were only asked about those regulations that are pre-defined as being relevant to the sector in which the company operates.

From the replies, five policies that affect all the four sectors in this study and that were attributed a relatively high importance by the respondents were taken into account. In particular, we looked at the impact of

- Directive 96/91/EC on Integrated Pollution Prevention and Control (IPPC)
- Directive 2001/81/EC on National Emissions Ceilings (NEC)
- Directive 2001/80/EC on the limitation of emissions of certain pollutants into the air from large combustion plants (LCP Directive)
- EU Water Framework Directive (Directive 2000/60/EC)
- EU Waste Framework Directive (Directive 75/442/EEC as amended by Directive 91/156/EEC)

The data illustrates that especially the IPPC directive has an impact on the activities of the surveyed companies. Around four-fifth of the companies in our sample said their activities were very strongly affected, strongly affected or normally affected by the IPPC directive. The waste as well as the water framework directive had also a very strong to normal affect on 69% of the companies. Half of the companies indicated that the NEC directive was having a normal to very strong affect on their activities, while the LCP directive was affecting only 36% of the respondents.

Given the limited number of observations in our sample and the multidimensional character of environmental regulation, we decided to use principal component techniques to define for each company an environmental regulation index (ENV REG) based on the severity that their activities are affected by 5 different directives (IPPC, WFD, Waste, NEC, LCP)⁴. The index indicates to what extent a company has overall been affected by environmental policies and regulations.

Including data based on subjective ratings as right-hand side variables can be useful to control for potential measurement errors. Regression estimates can be affected by measurement errors related to the heterogeneity in rating scales or anchor: for some people, 7/10 is much while for others it is not (see (Winkelmann and Winkelmann, 1998)). A second type of measurement error might rise due to mood variability: while some people can be judge that the impact of environmental regulation is on average equally strong, the variance in their judgement level can be different (see (Fredrickson and Kahneman, 1993; Ravallion and Lokshin, 2001)). One might assume that both types of measurement errors are correlated with other subjective data, so that including them can partly control for the problem (Landeghem, Swinnen *et al.*, 2008).

Environmental strategy / proactive attitude / autonomy/scale

Not only environmental regulation will affect a company's environmental expenditures. Also its environmental strategy and pro-active environmental attitude are generally expected to result in higher environmental expenditures, higher reduction of emissions and higher levels of resource efficiency. Autonomy of a plant can be important in case the approach to environmental issues of the facility is different from that of the parent company. However, the direction of the effect of autonomy, e.g. increasing or decreasing expenditure, is difficult to determine a priori.

Environmental strategy (ENV STRAT) is measured by a variable, constructed by averaging the responses to statements on the importance of environmental performance in the company's marketing strategy, on whether the company has a policy to exceed minimum standards and on whether it has a policy to anticipate societal demand for environmentally responsible behaviour.

The attitude of the facility towards environmental regulation is measured by a variable measuring whether the facility aims to anticipate environmental regulation. The autonomy of the plant's management over environmental matters is measured by a variable, constructed from averaging the responses to three statements related to the facilities decision autonomy with respect to environmental investments, the involvement of the head office in environmental investments and whether approval from the head office is needed before they can do anything related to environmental investments. Neither the attitude of the company, nor the autonomy had never a

⁴ When calculating the principal component, the first Eigen value captures 43% of the total variance and is almost twice as high as the next Eigen value. Therefore, we use this first component as our environmental regulation index.

significant impact. Therefore, we decided to exclude these variables from the regressions.

The size of company is expected to have an effect on the environmental expenditures, abatement of emissions or improved efficiency in the use of resources through better access to information on technology and financial resources and through higher negotiation power with suppliers. On the other hand, the size of a facility can be an obstacle to vigorous and prompt action, as administrative constraints may increase with size and therefore limit the responsiveness of the facility. To analyse the impact of the company's size, we use two dummy variables. One dummy variable (MEDIUM) equals one when between 100 and 500 employees are employed at the company, another (LARGE) equals one when more than 500 employees are employed at the firm.

Regional and sector variables

Further, we can assume that the expenditures differ by sector, as well as by the way the regulations have been implemented.

A set of dummies was introduced to bring the sectors to which the facility belongs in the analysis. These dummies were meant to take into account, as far as possible, the sector characteristics. The sector has an influence on the variables we are trying to explain in the regression because of the characteristics of the production process and the market characteristics. The metals industry represents the largest part of the sample with 25 (39 % of) respondents, closely followed by the textile and leather industry 21 (33 % of) respondents. The electricity sector and the oil industry represent respectively 12 (20 % of) and 5 (8 % of) respondents.

The location of the facility may also have an effect because of different cultural factors. More importantly, although the major share of environmental policy initiatives is nowadays decided at the European level, and despite the existence of a number of international environmental agreements, the implementation of environmental policies is still, to a large extent, carried out at the national and regional level. As a consequence, major differences may continue to exist in the level or rigour of environmental regulation between European countries. Therefore, a set of dummy variables was used to indicate the region in which the plant operates, i.e. Northern, Southern and Central Europe, and the New Member States. In terms of geographical coverage, around half of the companies are located in Central Europe, 21% in Southern Europe, 16 % in Northern Europe and 13% in the New Member States.

Ideally, we would include these control variables all together in one regression. Unfortunately, the number of observations does not allow this as number of degrees of freedom would fall under the acceptable level. Moreover, some of the control variables are highly correlated. The companies in the oil sector are for example all located in Central Europe, while the companies in the electricity sector are highly represented in Southern Europe. Therefore, we start with a reduced form equation where we regress environmental expenditures on the environmental regulation index and then gradually add other control variables to test the robustness of our results.

RESULTS

The regression results show that environmental regulation as well as a company's environmental strategy are having a very strong impact on a firm's environmental expenditures. This result holds for all specifications, irrespective of the control variables that are introduced or the way the expenditures are measured (in a quantitative or a qualitative way). Furthermore, environmental regulation is having a significantly positive impact on expenditures in end-of-pipe techniques as well as in process integrated techniques and the coefficient of the variable measuring environmental regulation (ENV REG) does not differ significantly between the two regressions (i.e. the regression with ENV EXP QUAL EOP and ENV EXP QUAL PIN as dependent variable). Further, it are particularly medium and large scale firms, so those with more than 100 employees, who have significantly higher environmental expenditures, but there is no significant difference between the expenditures of medium and large firms.

Next, the results illustrate that companies with high environmental expenditures are typically performing better from an environmental point of view. If we distinguish between expenditures in pollution control mechanisms and pollution prevention mechanisms, we see that higher expenditures in pollution prevention leads to significantly better environmental performance, while this does not hold for expenditures in pollution control. This indicates that especially these policies that induce companies to invest in pollution prevention (process integrated techniques) are likely to have an overall beneficial effects on the environment. This is probably related to the fact that end-of-pipe technologies tend to isolate or neutralize typically one polluting substance after it has been formed, but it often leads to waste that has to be disposed of. This is a negative side effect from an environmental point of view and will reduce the environmental benefits from pollution control mechanisms. On the other hand clean or process-integrated technologies lead to less pollution, resource and/or energy use, and waste generation by changing the production process or by introducing product innovations. Therefore, expenditures on process integrated techniques tend to have a significantly more positive impact on environmental performance than expenditures on end-of-pipe techniques. The size of the company has also a significant impact. In particular the medium sized firms are outperforming the smaller (less than 100 employees) and larger (more than 500 employees) from an environmental point of view.

We also looked whether the environmental regulation was having a direct impact on environmental consequences (by regressing ENV CONS upon ENV STRAT and ENV REG). The results indicated that neither environmental regulation nor environmental strategy was having a significant direct impact on environmental performance. This does not indicate that environmental regulation has no affect at all on environmental performance. In contrary, it has a strong impact on environmental expenditures which in turn is a significant driver for environmental performance.

Finally, the regression analyses clearly indicate that companies with a good environmental strategy consider themselves to have a better strategic advantage over their competitors and to be able to compete more effectively in the market place. Further, large companies with more than 500 employees consider to have a strategic disadvantage, while companies in the electricity sector as well as companies that are more affected by environmental regulation consider themselves to have a significantly strategic advantage over their competitors. Environmental regulations seem to have a direct affect, but the indirect impact seems to be even larger as environmental expenditures, which are highly determined by environmental regulations, are having a significant positive impact on a company's strategic advantage and competitiveness in the market place. Finally, it is striking that this positive impact is entirely due to

expenditures in pollution prevention mechanisms, while expenditures in pollution control mechanisms seem to have no significant impact on the firm's strategic advantage or competitiveness.

CONCLUSION

Drivers for environmental expenditure

The impact of environmental policy on a firm's economic and environmental performance and competitive position will depend on the way different policies interact, the policy instruments that are chosen to implement regulations as well as on country, sector and company specific characteristics. Environmental regulation is a key element in stimulating environmental expenditure and consequently realising environmental improvements. However environmental strategy, which may be expressed in an environmental management system, also appears to have a strong impact on a firm's environmental expenditure. The size of the company also appears to play an important role. Medium sized and large sized companies, with more than 100 employees, are more likely to perceive their expenditures as high compared to smaller firms.

Significance and evolution of environmental cost

Environmental costs make up a low percentage of the total production value in the examined sectors. Secondary data on investment expenditure in Europe indicate that environmental investment expenditure is typically less than 0,5 % of production value. This appears to be comparable to the environmental expenditure in the US and Australia. However, our data suggest that the perception of these costs by companies is much higher, and especially higher than those of their competitors.

Benefits from environmental policy to firms and the environment

The empirical analysis reveals that investments in process integrated measures as well as investments in end-of-pipe-technology increase a firm's environmental expenditures, but it are only the former who have a significant positive impact on a firm's environmental performance. This indicates that environmental policy instruments stimulating process integrated investments rather than end-of-pipe measures have an overall beneficial effect on the environment. This is probably related to the fact that end-of-pipe technologies tend to isolate or neutralize typically one polluting substance after it has been formed, but it often leads to waste that has to be disposed of. This is a negative side effect from an environmental point of view and will reduce the environmental benefits from pollution control mechanisms. On the other hand clean or process-integrated technologies lead to less pollution, resource and/or energy use, and waste generation by changing the production process or by introducing product innovations.

Next, the survey results show that companies whose activities are higher affected by environmental regulation and companies making expenditures in pollution prevention rather than pollution control are more likely to obtain a strategic advantage over their competitors. These findings confirm the Porter Hypothesis that win-win situations can be obtained where the environment as well as the individual companies benefit from environmental regulations. Larger companies however are more likely to perceive a strategic disadvantage over their competitors which might be due to a larger global competition for larger companies.

Further research

One important further direction of research would be to further improve data quality at the micro level (e.g. data collection not only through interviews. but also through supplementary survey work) and feed this into the wider sectoral analysis (see Ifo, 2006). Our study can be considered as another step to meet this call for further research.

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FIGURES AND TABLES

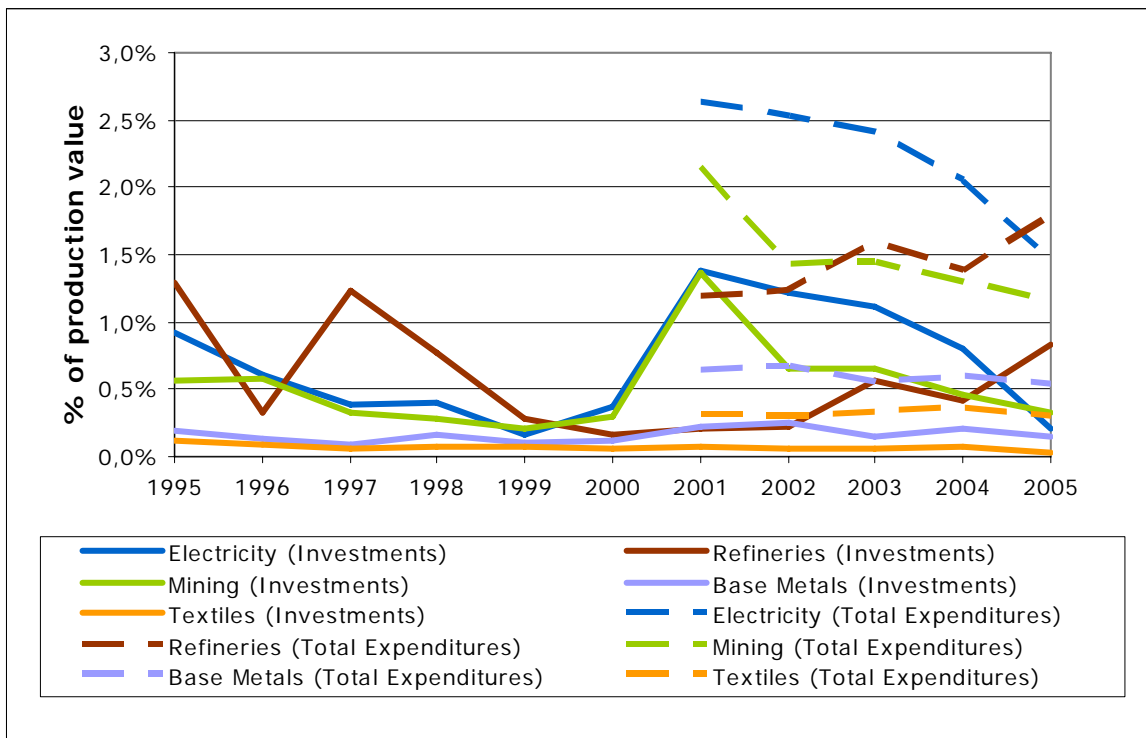


Figure 1. Trends in annualised environmental investments as a percentage of production value for different sectors within the European Union

Table 1. Descriptive Statistics

	%			
Share of companies that were (very strongly) affected by				
IPPC				82
WFD				69
Waste				69
NEC				47
LCP				36
Share of companies located in				
Central Europe				51
Southern Europe				21
Northern Europe				16
New Member States				13
Share of companies in the				
Metal sector				39
Textile and Leather sector				33
Electricity sector				20
Oil sector				8
Share of companies that judge to have a strategic advantage over competitors				69
Share of companies that judge to be able to compete more effectively in the market place				73
	Mean	St. Dev.	Min	Max
Environmental regulation index (ENV REG)	0.00	1.47	-2.67	3.78
Environmental strategy	5.60	0.95	3.33	7.00
Pro-active attitude	5.89	1.01	2	7.00
Autonomy	4.88	1.01	2.33	7.00
Environmental expenditures, qualitative indicator (ENV EXP QUAL)	0.00	1.74	-3.77	4.00
Environmental expenditures index of pipe techniques, qualitative indicator (ENV EXP QUAL EOP)	0.00	1.36	-2.70	2.63
Environmental expenditures in process integrated techniques, qualitative indicator (ENV EXP QUAL PIN)	0.00	1.53	-3.22	3.92
Environmental expenditures, quantitative indicator (ENV EXP QUAN)	0.00	1.70	-3.92	3.11
Environmental consequences (ENV CONS)	0.00	1.50	-3.78	3.32

Table 2. Regression results (OLS). Independent variable = ENV EXP QUAN

	ENV EXP QUAN	ENV EXP QUAN	ENV EXP QUAN	ENV EXP QUAN	ENV EXP QUAN
ENV REG	0.506 (3.69)***	0.449 (3.28)***	0.444 (3.01)***	0.366 (2.68)***	0.420 (2.86)***
ENV STRAT		0.427 (2.00)**	0.431 (1.95)**	0.348 (1.61)	0.432 (2.03)***
Northern Europe			0.096 (0.17)		
Southern Europe			-0.083 (0.16)		
New Member State			-0.098 (0.15)		
Oil sector				0.918 (1.26)	
Electricity sector				-0.016 (0.03)	
Textile sector				-0.835 (1.87)*	
Medium					0.946 (1.74)*
Large					0.501 (0.80)
Adj R ²	0.1737	0.2135	0.1721	0.2630	0.2247

Table 3. Regression results (OLS). Independent variable = ENV EXP QUAL

	ENV EXP QUAL	ENV EXP QUAL	ENV EXP QUAL	ENV EXP QUAL	ENV EXP QUAL
ENV REG	0.524 (3.88) ^{***}	0.470 (3.63) ^{***}	0.477 (3.45) ^{***}	0.514 (3.81) ^{***}	0.481 (3.63) ^{***}
ENV STRAT		0.556 (2.76) ^{***}	0.596 (2.89) ^{***}	0.633 (3.04) ^{***}	0.521 (2.78) ^{***}
Northern Europe			-0.267 (0.49)		
Southern Europe			-0.634 (1.26)		
New Member State			-0.018 (0.03)		
Oil sector				-0.374 (0.50)	
Electricity sector				-0.693 (1.32)	
Textile sector				0.174 (0.38)	
Medium					1.606 (3.19) ^{***}
Large					0.988 (1.70) [*]
Adj R ²	0.1825	0.2611	0.2452	0.2575	0.3717

Table 4. Regression results (OLS). Independent variable = ENV EXP QUAL EOP

	ENV EXP QUAL EOP	ENV EXP QUAL EOP	ENV EXP QUAL EOP	ENV EXP QUAL EOP	ENV EXP QUAL EOP
ENV REG	0.329 (2.99) ^{***}	0.301 (2.75) ^{***}	0.316 (2.73) ^{***}	0.287 (2.55) ^{**}	0.272 (2.48) ^{**}
ENV STRAT		0.292 (1.72) [*]	0.331 (1.92) [*]	0.334 (1.93) [*]	0.275 (1.76) [*]
Northern Europe			-0.284 (0.62)		
Southern Europe			-0.603 (0.156)		
New Member State			0.113 (0.830)		
Oil sector				0.054 (0.09)	
Electricity sector				-0.798 (1.83) [*]	
Textile sector				-0.456 (1.20)	
Medium					1.530 (3.66) ^{***}
Large					1.205 (2.51) ^{**}
Adj R ²	0.1123	0.1395	0.1323	0.1554	0.2897

Table 5. Regression results (OLS). Independent variable = ENV EXP QUAL PIN

	ENV EXP QUAL PIN	ENV EXP QUAL PIN	ENV EXP QUAL PIN	ENV EXP QUAL PIN	ENV EXP QUAL PIN
ENV REG	0.387 (3.15)***	0.344 (2.87)***	0.342 (2.66)**	0.417 (3.42)***	0.367 (2.83)***
ENV STRAT		0.500 (2.42)**	0.474 (2.47)**	0.526 (2.80)***	0.422 (2.30)**
Northern Europe			-0.127 (0.25)		
Southern Europe			-0.388 (0.83)		
New Member State			-0.095 (0.16)		
Oil sector				-0.448 (0.67)	
Electricity sector				-0.364 (0.77)	
Textile sector				0.654 (1.59)	
Medium					0.921 (1.87)*
Large					0.442 (0.78)
Adj R ²	0.1238	0.1872	0.1553	0.2170	0.2243

Table 6. Regression results (OLS). Independent variable = ENV CONS

	ENV CONS	ENV CONS	ENV CONS	ENV CONS	ENV CONS	ENV CONS
ENV EXP QUAL	0.444 (4.77)***					
ENV EXP QUAL EOP		-0.080 (0.66)	-0.080 (0.64)	-0.057 (0.44)		-1.65 (1.31)
ENV EXP QUAL PIN		0.628 (5.80)***	0.633 (5.69)***	0.608 (5.49)***		0.602 (5.82)***
ENV REG					0.132 (1.03)	
ENV STRAT					0.239 (1.20)	
Northern			0.148 (0.33)			
Europe			-0.059 (0.15)			
New			0.201 (0.41)			
Member State						
Oil sector				-0.556 (0.95)		
Electricity sector				-0.503 (1.22)		
Textile sector				0.173 (0.641)		
Medium						1.008 (2.2)**
Large						0.134 (0.28)
Adj R ²	0.2563	0.3608	0.3316	0.3654	0.0144	0.4294

Table 7. Ordered logit regression results. Independent variable = STRAT ADV

	STRAT ADV	STRAT ADV	STRAT ADV	STRAT ADV	STRAT ADV	STRAT ADV
ENV EXP QUAL	0.584 (4.02)***					
ENV EXP QUAL EOP		0.030 (0.16)	0.051 (0.27)	0.011 (0.06)		0.107 (0.52)
ENV EXP QUAL PIN		0.700 (3.96)***	0.752 (4.09)***	0.727 (4.00)***		0.745 (4.08)***
ENV REG					0.313 (1.92)*	
ENV STRAT					0.760 (2.98)***	
Northern			0.191 (0.30)			
Europe			0.914 (1.43)			
New			0.880 (1.29)			
Member State						
Oil sector				0.570 (0.72)		
Electricity sector				1.141 (1.80)*		
Textile sector				0.057 (0.10)		
Medium						-0.672 (0.91)
Large						-1.531 (1.91)*
Pseudo R ²	0.0825	0.0961	0.1101	0.1141	0.0679	0.1177

Table 8. Ordered logit regression results. Independent variable = COMP EFF

	COMP EFF	COMP EFF	COMP EFF	COM EFF	COM EFF	COM EFF
ENV EXP QUAL	0.305 (2.18)**					
ENV EXP QUAL EOP		-0.206 (1.08)	-0.189 (1.00)	-0.141 (0.69)		-0.207 (1.00)
ENV EXP QUAL PIN		0.545 (3.08)***	0.608 (3.30)***	0.503 (2.73)***		0.535 (2.97)***
ENV REG					-0.042 (0.24)	
ENV STRAT					0.551 (2.20)**	
Northern Europe			-0.0311 (0.05)			
Southern Europe			1.163 (1.91)*			
New Member State			0.678 (0.93)			
Oil sector				0.312 (0.39)		
Electricity sector				0.664 (1.07)		
Textile sector				0.672 (1.17)		
Medium						0.009 (0.01)
Large						-0.526 (0.70)
Pseudo R ²	0.0236	0.0489	0.0702	0.0575	0.0246	0.0541