Chapter 8

ACHIEVING ENVIRONMENTAL-ECONOMIC SUSTAINABILITY THROUGH CORPORATE ENVIRONMENTAL STRATEGIES

Empirical Evidence on Environmental Shareholder Value

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Abstract: This paper discusses the relationship between environmental and economic performance, and the influence of different positions on corporate environmental strategy. After formulating a theoretical model, results are reported for two empirical analyses: of the European paper manufacturing industry, and of a set of British and German manufacturing firms, respectively. It is found that the potential for different industries to realize a win-win relationship between environmental and economic performance differs, but that a pollution prevention-oriented approach as supported by the Environmental Shareholder Value concept, for example, enables a type of integrated management which enables firms to move closer towards environmental-economic sustainability.

1. INTRODUCTION

The effect of strategy considerations on the link between the environment and firm performance has been a focus of scholarly research for some time (Aragon-Corea 1998, Reinhardt 1999). The question addressed in the following is: "What is the relationship between the environmental and economic performance of firms in specific industrial sectors, and what is the influence of corporate environmental strategies on this relationship?". The type of relationship is distinguished in this research by means of two differently shaped curves, representing idealized functional relationships between

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environmental and economic performance. Corporate environmental strategies (CES) are distinguished here in terms of end-of-pipe and integrated pollution prevention strategies, based on the actual physical environmental performance of companies and following the Environmental Shareholder Value (ESV) concept (Schaltegger and Figge 2000) which will be detailed below.

This research applies multiple regression analysis to the data in order to address the above research question and to identify a possible relationship between the environmental and economic performance of firms. The analysis takes into account the influence of a number of important control variables such as country, the processes operated by firms, and firm size. The results of the analysis indicate that corporate environmental strategies (CES) may have an important influence on the relationship between environmental and economic performance.

The paper follows the argument made by Lankoski (2000) and Schaltegger and Synnestvedt (2002) that an inversely U-shaped curve ("Type 2" in Figure 8-1 below) would represent the "best" possible case for the relationship between environmental and economic performance, and it allows for the existence of win-win situations with profitable environmental performance improvement activities. For a firm facing a "Type 2" curve, the optimum level of environmental performance would be the one which maximises economic performance, i.e. the maximum point of the "Type 2" curve in Figure 8-1. Over time, technological progress moves the curves towards the right (as is indicated in Figure 8-1 for the "Type 2" curve): i.e. for the same level of environmental performance, a higher level of economic performance can be realised. This can also result in the optimum level of environmental performance moving to higher levels of environmental performance as indicated in Figure 8-1.

If environmental performance improvements only increase costs and reduce profits for an individual firm, this would not be possible and would thus result in the relationship represented by the "Type 1" curve in Figure 8-1 below. Under "Type 1" conditions, the optimal level of environmental performance for a firm would be the one prescribed by environmental regulations, i.e. compliance without over-compliance. Figure 8-1 below summarises these considerations by showing both relationships in a single graphic representation. A monotonously increasing curve is not included since this would imply decreasing marginal benefits from environmental improvements which would be inconsistent with economic theory.

The two types of curves can be distinguished in that the "Type 1" curve is continuously decreasing, whereas the "Type 2" curve first increases to an optimum point and then decreases continuously beyond this point. In the multiple regression analysis applied to the empirical data, the type of curve

can be straightforwardly tested for by including the linear and squared term of the environmental performance variable. So far, such a specification of the relationship between environmental and economic performance consisting of a linear and a squared term has not been tested in empirical analyses. The next section introduces the two empirical analyses which were carried out to answer the question raised in the beginning taking into account Figure 8-1.

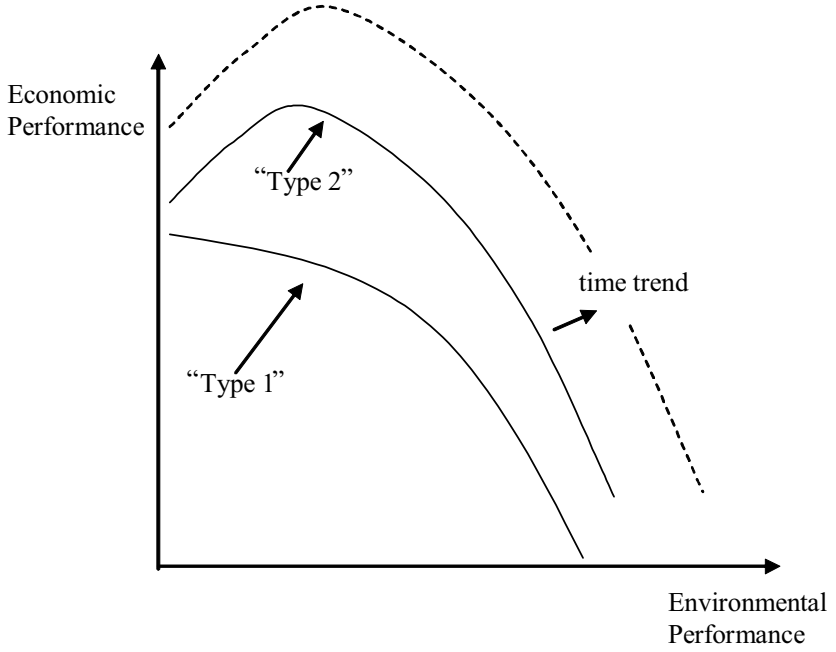

Figure 8-1. The link of environmental and economic performance (source: adapted from Lankoski 2000, Schaltegger 1988, Schaltegger and Figge 2000, Schaltegger and Synnestvedt 2002, Wagner 2003, 2005).

2. METHODOLOGICAL FOUNDATIONS

2.1 Methods of the 1st Empirical Analysis

This section introduces the two empirical analyses used to address the question stated in the Introduction. The research design of the first empirical analysis uses purposive survey methodology for the paper industry and focuses on firms from four European countries (Germany, Italy, the Netherlands and the United Kingdom) in the pulp and paper sector as defined by

the 2-digit NACE code. For all firms, data on various environmental performance indicators (EPIs) and financial ratios was collected. The main EPIs were SO_2 emissions, NO_x emissions, COD emissions, total energy input, and total water input, all per ton of paper produced. In order to use these in the regression analyses, two composite indices of these EPIs had to be calculated (due to the multi-collinearity between these basic indicators), using a method initially developed by Jaggi and Freedman (1992) in the adaptation used in Tyteca et al. (2002). The indicators used to calculate scores for the first (outputs-oriented) index score were SO_2, NO_x, and COD. For the second (inputs-oriented) index score, total energy input and total water input were used. The reason for using two indices was that the inputs-oriented index relates more to pollution prevention (which, as will be shown later, is also linked to a strongly ESV-oriented position, which may be either the result of conscious action or an unintended emergent result of a set of activities), whereas the outputs-oriented index mainly reflects end-of-pipe activities. This is because pollution prevention activities by definition have a stronger effect on inputs to production than do end-of-pipe programmes. Therefore, an inputs-oriented index captures mainly the effect of integrated pollution prevention strategies on economic performance. The ESV concept (Schaltegger and Figge 2000) argues that their effect on the latter should be more positive than that of end-of-pipe activities. Since both end-of-pipe and pollution prevention activities both decrease emissions, an (undesired) outputs-based index of environmental performance will reflect both strategies. Since ESV argues that end-of-pipe activities generally have a negative effect on economic performance, the relationship of such an index with the latter should be more negative.

CO_2 was not included as an EPI since the paper cycle is relatively carbon-neutral in the long term, at least as concerns wood as the basic production input. Given this, an indicator for CO_2 would have little relevance for the environmental performance of paper firms.

Given that economic performance in the short term can be approximated through profitability, it is measured in terms of profitability ratios such as return on sales (ROS), return on capital employed (ROCE) and return on equity (ROE). The first empirical analysis of the relationship between the environmental and the economic performance of firms involves an estimation procedure which is based on a panel data model in which environmental and economic performance are considered to be in a causal relationship, i.e. the EPIs are considered to influence the economic performance variables which are hence the endogenous variables. For the analysis, a pooled model based on Ordinary Least Squares (OLS) regression and ignoring the panel structure, a random effects panel data model and a fixed effects panel data model are used and compared. For testing the above research question using

this (panel) regression framework, incomplete panel data was used on a set of 37 paper firms in four EU countries (Germany, Italy, Netherlands and United Kingdom) over the period from 1995 to 1997. Table 8-1 summarises all variables of the first empirical analysis and their definition for better overview.

Table 8-1. Summary of variable definitions for all variables used in the first empirical analysis.

Concept	Variable	Description	Type[1]
Economic performance	ROCE	Return on capital employed [%], defined as: (profit + interest) / (shareholders' funds + non-current liabilities)*100	Cont.
	ROE	Return on equity [%], defined as: pre-tax profit (loss) / shareholders' funds*100	Cont.
	ROS	Return on sales [%], defined as: pre-tax profit (loss) / operating revenue * 100	Cont.
Environmental performance	COD	Emission of chemical oxygen demand per output [kt/t]	Cont.
	SO_2	Emission of sulphur dioxide per unit of output [kt/t]	Cont.
	NO_x	Emission of nitrogenous oxides per unit of output [kt/t]	Cont.
	Energy input	Total energy input per unit of output [GWh/t]	Cont.
	Water input	Total water input per unit of output [1000 litres/t]	Cont.
Control variables	Capital gearing	Ratio of shareholders' funds per total assets [%]	Cont.
	Asset turnover	Ratio of total assets per operating revenue [%]	Cont.
Country	UK	Firm located in the United Kingdom	Dum.
	Italy	Firm located in Italy	Dum.
	Netherlands	Firm located in the Netherlands	Dum.
	Germany	Firm located in Germany (reference group)	Dum.
Sub-sector	Industrial	Packaging corrugated and other boards	Dum.
	Cultural	Newsprint, magazine-grade, graphics fine paper (reference)	Dum.
	Mixed	Cultural and industrial paper production combined	Dum.
	Other	Other paper production	Dum.
Other	Firm size	Number of employees (thousands)	Cont.

[1]In the table, cont. and dum. refer to continuous (interval scale) type and dummy type variables respectively.

Panel methods are appropriate to analyse the above data since firms in the data set are observed over several years. Given that the characteristics of a single firm tend to be more similar over time than those of several different firms, a bias could be introduced using standard OLS estimation, especially concerning levels of statistical significance. Panel estimation however accounts for this potential bias. Since this research is more explorative in terms of the magnitude of any effects of environmental on economic performance (i.e. it does not make specific assumptions on the magnitude of the influence of any of the explanatory variables, but only on their likely direction, and whether this is positive or negative), statistical significance is an important aspect on which to focus and thus the choice of panel data analysis seemed appropriate. It is also justified by the fact that data availability could be improved by taking into account several years' data for each firm, since firms which have started to report on their environmental performance in terms of emissions and resource inputs usually tend to continue to do so in subsequent years, thus enabling a more precise estimation of the parameters involved.

2.2 Methods of the 2nd Empirical Analysis

The second empirical analysis uses data for European manufacturing firms from the European Business Environment Barometer (EBEB) survey. The EBEB is a bi-annual survey of the state of environmental management in practice carried out in several European countries (Baumast and Dyllick 2001). The data used here refers to the last survey round in 2001. EBEB uses several item batteries, all of which are based on the opinions/attitudes of firms rather than on their actual performance. One of these batteries allows corporate environmental strategies to be distinguished in terms of companies' positions towards shareholder value (based on the self-reported perceived effects on shareholder value of a firm's activities in the area of environmental or sustainability management). The approach which is chosen to measure corporate environmental strategies (CES) with this item battery is based on the concept of ESV developed by Schaltegger and Figge (2000). Basically, ESV argues that the amount of corporate environmental protection in itself neither spurs nor reduces shareholder value (or similarly other measures of economic performance) but links environmental performance and shareholder value in a more differentiated way by means of the theoretically derived value drivers of the original shareholder value concept (Rappaport 1986). Strategies are empirically derived based on the previously mentioned item battery of drivers of shareholder value in their relationship to environmental management, using Principal Component Analysis (PCA) and cluster analysis to categorize firms.

As well as CES identification, measurement of environmental competitiveness (defined as that part of the overall competitiveness of a firm which can actually be influenced by environmental management activities) has been used as a measure of economic performance in the second empirical analysis reported here. Little quantitative data is available on the environmental competitiveness of individual companies, and the most suitable approach seemed therefore to be the use of self-assessment by firms, based on a number of items (an approach which was also used by Sharma (2001) in a similar context). Environmental competitiveness was thus measured by means of an item battery which asked about the perceived effect of environmental management activities on different items such as competitive advantage and corporate image improvements. PCA was carried out on the environmental competitiveness items used in the survey to define four independent dimensions of environmental competitiveness. Environmental performance is measured in terms of an index which assesses the reduction in firms' environmental impacts in a number of categories (such as energy or water use, or the use of toxic inputs), each measured by a separate item variable. For each of the items, the survey asked about the degree to which environmental management activities over the years 1998-2000 reduced the company's environmental impact for this variable over the period 1998-2000. Respondents were asked to provide answers on a 5-point Likert scale ranging from "no reduction" and "little reduction" via "average reduction" to "strong reduction" and "very strong reduction", with the highest score corresponding to the largest reduction.

Prior to the statistical analysis for which results are reported in the next section, it was established that the sample comprising the 301 valid responses to the EBEB survey in the UK (135) and in Germany (166) was representative in both countries as far as firm size and the sectoral distribution of firms is concerned. Since 25 independent variables are used in the regression analysis, data for the UK and for Germany is pooled. Given that this second empirical analysis concerns cross-sectional data, OLS is an efficient estimation method, and the multiple linear regression equation which was estimated via OLS is defined as follows (with Table 8-2 below concisely summarising all variables used in the second analysis):

> *Environmental competitiveness component i = linear additive function (firm size, square of firm size, sector and country dummies, market growth, firm age, legal form, overall profit, dummies for EMS implementation, environmental impact index, square of environmental impact index) + residual value*

Table 8-2. Summary of variable definitions for all variables used in the second empirical analysis.

Concept	Variable	Description	Type
Economic performance	Environmental profit indices 1-4	Indices calculated based on factor analysis of items measuring environmental competitiveness	Cont.
Environmental performance	Environmental impact reduction index	Averaged index score, standardized for industry sector and country location based on variables for different areas of environmental performance	Cont.
Firm size	No. employees	Number of employees (in thousands)	Cont.
EMS implementation status	"No"	Firm has not implemented EMS (reference group)	Dum.
	"Considering"	Firm is considering EMS implementation	Dum.
	"In process"	Firm is in progress of implementing an EMS	Dum.
	"Implemented"	Firm has implemented an EMS	Dum.
Country	United Kingdom	Firm located in the United Kingdom	Dum.
	Germany	Firm located in Germany (reference group)	Dum.
Sector control variables	Food / tobacco	Firm in food and tobacco sector	Dum.
	Textiles	Firm in textile products sector	Dum.
	Pulp and paper	Firm in pulp and paper products sector	Dum.
	Printing	Firm in printing and publishing sector	Dum.
	Energy, oil etc.	Firm in energy, oil and nuclear fuels sector	Dum.
	Chemicals	Firm in chemicals and fibres sector	Dum.
	Rubber & plastic	Firm in rubber and plastic products sector	Dum.
	Non-ferrous	Firm in non-ferrous mineral products sector	Dum.
	Machinery	Firm in machines and equipment sector	Dum.
	Electrical optical	Firm in electrical and optical products sector	Dum.
	Transport products	Firm in transport products sector	Dum.
	Metals products	Firm in metals products sector (reference group)	Dum.
	Other manufacturing products	Firm in sector producing other manufacturing products	Dum.
Other control variables	Firm age	Logarithm of firm age in years	Cont.
	Market development	Measured in the survey on a 5-point scale to assess whether firm has decreasing or increasing sales	Ordinal (Ord.)
	Firm legal status	Variable taking 1 if firm is in sole proprietorship	Dum.
	Firm overall profitability	Measure in the survey on a 5-point scale to assess whether firm is profit-making or loss-making	Ord.

The regression equation means that, for each of the right hand side variables, coefficients are estimated and a test is carried out to ascertain whether these individually are significantly different from zero. The dummy variables take the value of unity if the characteristic in question is true for the firm in question, and zero otherwise. The dummy variables are therefore binary variables, for which coefficients can also be estimated and tested for significance. The residual value in the equation refers to that part of the left hand side (dependent) variable (i.e. the respective environmental competitiveness index) which cannot be explained by the full set of right hand side variables.

3. RESULTS

3.1 Results of the 1st Empirical Analysis

In the first empirical analysis, for the outputs-oriented environmental performance index, the panel regression framework described earlier was used. The estimation procedure also incorporated the squares of firm size and of the outputs-oriented environmental performance index in order to account for non-linearity in the relationship. The results were analysed separately for the three measures of economic performance which were used: return on capital employed (ROCE), return on sales (ROS) and return on equity (ROE). The Breusch-Pagan Lagrangian Multiplier and the Wu-Hausman specification tests were applied to decide on the most appropriate model. As can be seen from Table 8-3, for ROCE as the dependent variable used to measure economic performance, the model with fixed effects (FE) is the best specification since the Wu-Hausman test is significant. The FE model is also overall significant, and the hypothesis that no fixed effects exist for any firm was rejected. In the model, the linear term of the environmental index is significant (at the 1% level) and has a positive effect on ROCE. In addition, the squared term of the environmental index with a level of 10.4% is also almost significant (at the 10% level) and has a negative effect on ROCE. The result is also economically relevant, since a 10% increase in environmental performance increases ROCE by 33.02 units, all else being equal (the high increase is due to the environmental index taking values only between zero and one). The squared term is also economically relevant.

The level of environmental performance which maximises ROCE in the FE model is equal to an index value of 0.12. With the index taking values between zero and one, this corresponds to a relatively low level of environmental performance.

Table 8-3. Results for ROCE as the dependent variable (outputs-based index) in the first empirical analysis.

Model type	Pooled Model		RE Model		FE Model	
Independent variable	*Coef.*	*Std. Err.*	*Coef.*	*Std. Err.*	*Coef.*	*Std. Err.*
Environmental index	0.9413	1.8787	2.6506	2.5800	***33.0213***	8.4538
Square of env. index	–0.9618	1.8805	–2.6762	2.5923	–135.906	81.1471
Firm size	0.1486	0.1130	0.1513	0.1475	0.3435	0.2946
Square of firm size	–0.0273	0.0266	–0.0257	0.3508	–0.0443	0.0682
Leverage	0.0200	0.0174	0.0005	0.0221	–0.0523	0.0336
Asset turnover ratio	–0.0276	0.0311	–0.0306	0.0347	–0.0188	0.0406
Other sub-sector	**0.3380**	0.1429	*0.3398*	0.1863	-	-
Industrial sub-sector	–0.0250	0.0772	0.0002	0.1030	-	-
Mixed sub-sector	0.0035	0.0638	0.0202	0.0868	-	-
United Kingdom	**0.1901**	0.0753	*0.1829*	0.1014	-	-
Italy	0.1570	0.1235	0.1379	0.1611	-	-
Netherlands	0.0885	0.0833	0.0520	0.1162	-	-
Constant	–0.0996	0.1144	–0.0695	0.1491	13.6172	10.7321
Number of observations	63		63		63	
R-squared	0.1857		0.1494		0.4310	
F statistic	0.95				***4.04***	
Wald χ^2			7.03			
F statistic (all $u_i = 0$)					**2.23**	
Breusch-Pagan test (χ^2)			0.42			
Hausman test ($\chi 2$)					*24.94*	

[a] Bold figures and italicised figures indicate significance at the 5% and 10% levels respectively. Figures that are both bold and italicised indicate significance at the 1% level.

Concerning ROS as a measure of firms' economic performance, it was found that the fixed effects specification is most appropriate (since the Wu-Hausman test is significant). The results show that the linear term of the environmental performance index has a positive but insignificant effect on ROS, whilst the squared term of the index has a significant and negative effect, which is also relevant in economic terms: a 10% increase of environmental performance reduces ROS by 7.2%, all else being equal. The level of environmental performance which maximises ROS in the fixed effects model corresponds to an index value of 0.0188. As for ROCE, this again corresponds to a fairly low level of environmental performance, which is consistent with the observation that a significant negative effect of environmental on economic performance exists only for ROS. For the estimations with

ROE as the dependent variable, there were similar findings as for ROS. Here again, fixed effects were found to be the most appropriate model.

As for ROS, the linear term of the index had a positive, yet insignificant, effect on ROE. In contrast to this, the squared term had a significant negative effect on ROE, with the ROE-maximising level of environmental performance corresponding to an index value of 0.0353. This effect is also relevant in economic terms, since a 10% increase in environmental performance reduces ROE by 22.6%, all else being equal.

For the inputs-related index of environmental performance (which is driven by strategies based on integrated pollution prevention) and ROCE as the dependent variable measuring economic performance, the model with random effects (RE) was found to be the best specification, as indicated by an insignificant Hausman test (i.e. the fixed effects model is no better than the random effects model, in that the estimated coefficients are not significantly different between the two models). Even though the Breusch-Pagan test is insignificant, the random effects model is still preferred over the pooled model, since the former is overall significant, but the latter is not. In the RE model, the linear term of the environmental index as well as its squared term are however insignificant. Concerning ROS, the results indicate that the pooled model is the most appropriate, since the Breusch-Pagan test is insignificant and only the pooled model is overall significant. In the pooled model however, the linear and the squared term for the environmental performance index are insignificant.

Finally, concerning ROE as the dependent variable, none of the models estimated are overall significant, nor are the Hausman and Breusch-Pagan tests. In both (the pooled and the random effects models) both the linear and squared terms of the environmental performance index and of firm size were found to be insignificant. Therefore, to sum up, the first empirical analysis testing the research question addressed by this contribution found for an outputs-based index a predominantly negative relationship, whereas for an inputs-based index no significant link is found. From these results it is concluded that for firms with pollution prevention-oriented environmental strategies, the relationship between environmental and economic performance is less negative (i.e. better) than for those with an end-of-pipe focus.

3.2 Results of the 2nd Empirical Analysis

Through factor analysis, eight items of the battery of drivers of shareholder value which were included in the EBEB survey questionnaire could be condensed into two underlying factors which are summarized in Table 8-4. The KMO measure for the factor analysis was 0.835, which is sufficiently high. Individual KMO measures based on anti-image correlations on the main

diagonal of the anti-image correlation matrix were all above 0.6. The correlation matrix of the data set is therefore considered suitable for carrying out a factor analysis on the data set (see Backhaus et al. 2000, Bühl and Zöfel 2000 for details).

Table 8-4. Rotated component matrix for ESV factor analysis*.

Item Variable	Component/Factor	
	Value creation	Risk reduction
Through eco-products or eco-marketing we can achieve above-average market prices for our current products	0.629	0.381
Environmental management helps us to have lower costs for our processes	0.673	–0.434
Eco-products or eco-marketing help us to sell more of our current products	0.694	0.377
Environmental management in our company leads to lower capital investments for our current processes	0.744	0.048
Environmental management in our company helps us to make better use of existing equipment	0.754	–0.021
Environmental management in our company helps us to create a competitive advantage that is difficult to imitate	0.729	0.174
Through environmental management the proportion of variable costs in our company is higher	0.086	0.840
Environmental management helps our company to predict its future investments better	0.699	0.049

* Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. Rotation converged in 3 iterations. Shaded fields are considered for interpretation of factors.

The first factor can be interpreted as the (perceived) "expected return" (based on firms' self-assessment) resulting from a firm's environmental management activities and mainly refers to cost reductions, as well as to margin and sales increases, better control of capital-intensive investments, and the extension of product and process lifetimes. It is characterized by high agreement by respondents (and thus high factor loadings) to items such as the following:

- Through eco-products or eco-marketing we can achieve above-average market prices for our current products
- Eco-products or eco-marketing help us to sell more of our current products

On the second factor, mainly the item referring to (perceived) variable costs had a high positive loading. This factor has therefore been termed "expected

risk", and refers to reduced variability of profitability, as it is perceived by the firms surveyed. This is because higher variable costs through environmental management (implying, all else being equal, lower fixed costs) mean lower exposure of a company to variations in its profitability, and a high score on the "variable costs" factor therefore equates to a lower (financial) risk exposure of the firm (i.e. lower variability in a firm's returns).

Based on a cluster analysis of these two ESV-based factors, corporate environmental strategies which were oriented strongly towards shareholder value could be identified and separated from strategies which were not strongly oriented towards shareholder value, i.e. two groups of firms could be distinguished. Figure 8-2 shows a co-ordinate system with the axes defined by the two factors described and the two clusters of firms.

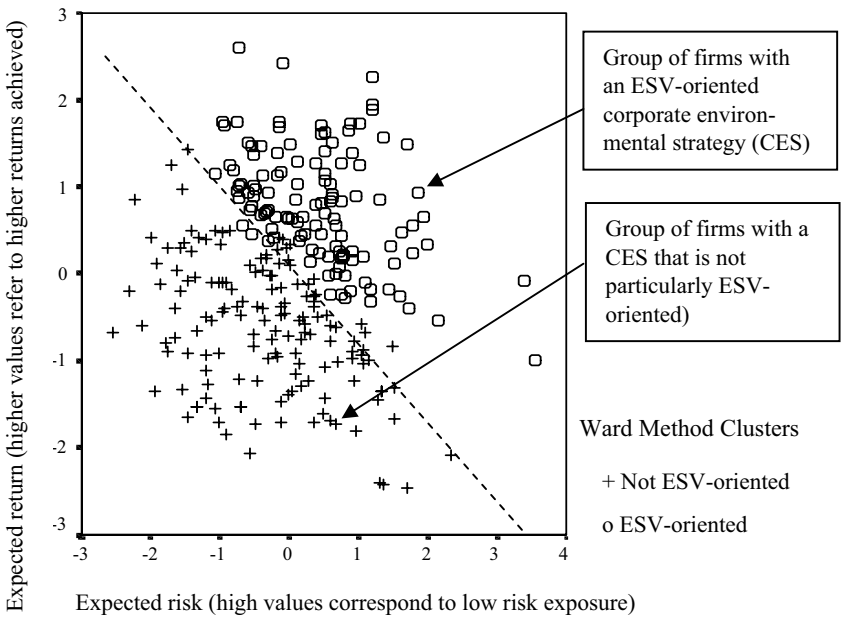

Figure 8-2. Solution of the cluster analysis for ESV factors (n = 276).

PCA carried out on the environmental competitiveness items allowed three different components (factors) of environmental competitiveness to be identified. The first factor refers to competitive advantage, product image, sales, market share and new market opportunities. It was therefore labelled "market-oriented environmental competitiveness" since it predominantly relates to the market- and product-related benefits of a company's environmental activities. The relevant items for the second factor are corporate image,

owner/shareholder satisfaction, management satisfaction, worker satisfaction and recruitment, and staff retention. This factor was therefore labelled "internally-/image-oriented environmental competitiveness" since it refers mainly to internally-oriented satisfaction and company image benefits from a company's environmental activities, based on a specific corporate environmental strategy. For the third factor which was identified, the items of short-term and long-term profits, cost savings, and productivity, are particularly relevant. These refer predominantly to a company's profitability and the factor was therefore labelled "efficiency-/profitability-oriented environmental competitiveness". The two remaining items, "improved insurance conditions" and "better access to bank loans", could not be assigned to any one of the above factors, but on examination it became clear that they potentially represent a fourth factor, since both are linked to the financial exposure of a company due to its level of environmental risk, so it was therefore decided to interpret these two items as a fourth factor labelled "financial risk-related environmental competitiveness". For further analysis, indices were calculated, based on the factors identified, which relate to four (independent) dimensions of environmental competitiveness along which firms can position themselves. These again relate to market benefits, satisfaction and reputational benefits, profitability, and risk reduction, respectively.

In the second empirical analysis, testing the influence of ESV-oriented corporate environmental strategies on the link between environmental performance and environmental competitiveness in manufacturing industry in Germany and the UK, regressions were carried out separately for the two sets of firms with and without a shareholder value-oriented corporate environmental strategy respectively, based on the regression equation introduced earlier. Regressions were also carried out separately for the four different environmental competitiveness factors. For the environmental competitiveness index referring to market- and product-related benefits through environmental management, the OLS model is overall significant for the set of firms with an ESV-oriented CES, but insignificant for the set of firms without a strong ESV position. A significant positive effect of the linear term of the environmental performance index was found for the set of firms with an ESV-oriented CES, but not for the set of firms without a specifically ESV-oriented CES.

Table 8-5 summarises the results for the internally-/image-related index of environmental competitiveness as the independent variable. For easier reading, insignificant results for industry sector dummy variables are suppressed. For this environmental competitiveness dimension referring to internal satisfaction- and company internal-/image-related benefits through environmental management, the model was found to be overall significant for both subsets of firms (i.e. based on the model's F statistic, the

hypothesis that all coefficients are jointly zero was rejected). Most importantly, in the subset of firms with an ESV-oriented CES, the environmental impact reduction index was found to have a significant positive effect (at the 5% level) and the square of the index was found to have a significant negative effect (at the 1% level). No significant influence of the index was found for the subset of firms without a specific focus on shareholder value in their CES, indicating a more positive link for an ESV-oriented strategy.

Table 8-5. Results for image-related environmental competitiveness in the second empirical analysis*.

Subset of firms with:	ESV-oriented CES		No ESV-oriented CES	
Equation variables:	*Coef.*	*Std. Dev.*	*Coef.*	*Std. Dev.*
Intercept	***2.278***	0.327	***2.696***	0.308
Country	0.026	0.101	–0.065	0.099
Firm size	–0.004	0.010	*0.249*	0.133
Square of firm size	0.000002	0.00007	–0.040	0.028
Non-ferrous	–0.192	0.192	*–0.401*	0.230
Machinery	**–0.409**	0.186	–0.046	0.204
Firm legal status	0.026	0.100	0.055	0.102
Firm age	–0.016	0.047	0.048	0.048
Overall business performance	0.051	0.042	0.008	0.042
Market development	**0.130**	0.053	–0.003	0.043
Considering EMS implementation	0.206	0.175	0.259	0.186
EMS implementation in progress	0.061	0.145	0.229	0.138
EMS implemented	**0.307**	0.120	**0.266**	0.124
Environmental impact index	**0.832**	0.234	0.292	0.192
Squared environmental impact index	***–0.176***	0.065	–0.073	0.052
Number of observations	94		112	
R-squared	0.498		0.287	
F statistic	*3.061*		*1.474*	

* Bold figures and italicised figures indicate significance at the 5% and 10% levels respectively. Figures that are both bold and italicised indicate significance at the 1% level.

For the third dimension of environmental competitiveness, relating to efficiency-/profitability, only the model estimated for the subset of firms with an ESV-oriented CES was overall significant (1% level). For this model, the environmental index was found to be positive and significant (at the 10% level, with its negative square almost significant), but insignificant for the other set of firms. Finally, for the fourth dimension of environmental

competitiveness relating to the influence of environmental risk on financial conditions (and summarised in Table 8-6), both models which were estimated, for the subset of firms with an ESV-oriented CES as well as for the subset of firms without a strong ESV position, were overall significant (at the 5% and 10% levels, respectively). For the subset of ESV-oriented firms, the environmental impact reduction index (being of particular relevance to the research question analysed in this contribution) was found to have again a significant positive influence at the 10% level. For the subset of firms with no strong ESV position, neither the linear nor the squared term of environmental impact reduction had any significant influence on the financial risk-related dimension of environmental competitiveness.

Table 8-6. Results for risk-related environmental competitiveness in the second empirical analysis*.

Subset of firms with:	ESV-oriented CES		No ESV-oriented CES	
Equation variables:	*Coef.*	*Std. Dev.*	*Coef.*	*Std. Dev.*
Intercept	***2.196***	0.340	***2.629***	0.259
Country	0.050	0.105	–0.004	0.083
Firm size	*–0.020*	0.010	–0.019	0.112
Square of firm size	**0.0002**	0.00007	0.016	0.024
Pulp and paper products	–0.346	0.457	**–0.565**	0.245
Non-ferrous mineral products	0.042	0.199	*–0.336*	0.195
Firm legal status	–0.057	0.104	–0.118	0.086
Firm age	–0.017	0.049	0.063	0.041
Overall business performance	0.071	0.044	0.040	0.035
Market development	**0.144**	0.055	0.020	0.036
Considering EMS implement	0.291	0.182	–0.124	0.156
EMS implementation in progress	0.086	0.152	0.180	0.116
EMS implemented	0.062	0.125	0.085	0.108
Environmental impact index	*0.471*	0.242	0.026	0.167
Squared environmental impact index	–0.088	0.067	0.002	0.047
Number of observations	94		112	
R-squared	0.390		0.304	
F statistic	**1.945**		*1.582*	

* Bold figures and italicised figures indicate significance at the 5% and 10% levels respectively. Figures that are both bold and italicised indicate significance at the 1% level.

To sum up, the overall result of the second empirical analysis reported in this contribution is that for all four regressions carried out on the subset of firms with an ESV-oriented CES, the environmental impact reduction index was

found to have a significant and positive influence on the different dimensions of environmental competitiveness (market-, internally-, profitability- and risk-related environmental competitiveness). In addition, for firms not pursuing a shareholder value-oriented corporate environmental strategy, after controlling for other relevant influences environmental performance has no significant relationship with any of the four dimensions of environmental competitiveness which were identified, indicating that strategy (as revealed by the stated effects of a firm's activities on important economic parameters, such as sales or costs) does make a difference. Firms that have a shareholder value-oriented CES seem more likely to achieve a positive relationship between environmental and economic performance whereas companies that do not have such a strategy seem less likely to bring about such a positive relationship.

As indicated earlier (and to be detailed in the next two sections, on conclusions and recommendations), a pollution prevention-oriented strategy can be seen as a special case of an ESV-oriented CES, which lends further support to the consistency of the results and points to the weaknesses of an end-of-pipe focus. Nevertheless, it should be noted that the results of course do not preclude a company from pursuing a corporate environmental strategy which is not focussed primarily on shareholder value. The reported results imply however that, in this case, a positive link between environmental and economic performance would be less likely.

4. CONCLUSIONS

4.1 Conclusions from the 1st Empirical Analysis

The results of the first empirical analysis to apply panel regression models to the European paper industry confirm the inversely U-shaped relationship between environmental and economic performance for an outputs-oriented environmental performance index in the fixed effects models for which an argument was made at the start of the paper. The positive part of the relationship was however found to be relatively weak. For the inputs-oriented environmental performance index, where the pooled models are most appropriate, no significant relationship could be detected. From these results it is concluded that for firms with pollution prevention-oriented environmental strategies, the relationship between environmental and economic performance is more positive (less negative).

In order to clarify the link between the first and second empirical analyses, and between ESV and a pollution prevention orientation, a cluster analysis was also carried out on the ESV items which were used in the EBEB questionnaire for the set of paper firms in the first empirical analysis.

Unfortunately, these firms were surveyed on their ESV orientation only after the initial data collection, so that not all firms provided this additional information. Table 8-7 below summarises the responses:

Table 8-7. Descriptive statistics of ESV responses from firms in the first analysis (not all firms are included).

	N	Min	Max	Mean	Std. Dev.
Through eco-products or eco-marketing we can achieve above-average market prices for our current products.	14	1.00	3.00	1.714	0.726
Environmental management helps us to have lower costs for our processes.	14	3.00	5.00	3.857	0.770
Eco-products or eco-marketing help us to sell more of our current products.	14	1.00	4.00	2.071	0.730
Environmental management in our company leads to lower capital investments for our current processes.	14	1.00	4.00	2.071	0.829
Environmental management in our company helps us to make better use of existing equipment.	14	2.00	5.00	3.000	1.038
Environmental management in our company helps us to create a competitive advantage that is difficult to imitate.	14	2.00	5.00	3.214	0.802
Through environmental management the proportion of variable costs in our company is higher.	14	2.00	4.00	2.786	0.699
Environmental management helps our company to predict its future investments better.	14	2.00	5.00	3.214	1.122

Given the low number of firms, PCA was not necessary, and the cluster analysis was carried out using the above items directly. This however makes a presentation as in Figure 8-2 difficult, since it would have to be in a space of more than two dimensions. As for the EBEB set of firms, the 2-cluster solution distinguishes two sets of firms which have significantly different ESV orientation. For the basic indicators used to construct the inputs- and outputs-oriented indices of the first analysis above, tests were carried out for significant differences in the mean values of the indicators between the two sets of firms, the results being summarized in Table 8-8.

As can be seen from Table 8-8, only the difference for water use is significantly in favour of the ESV-oriented firms. This means that firms which pursue an ESV-oriented strategy are not significantly penalized in terms of their economic performance, but show generally equal or better environmental performance than firms without an ESV orientation.

Table 8-8. Testing for differences in basic indicators of first empirical analysis based on ESV orientation.

	Cluster	Mean	Std. Dev.	Mean Rank
Average energy use 1995-97 per tonne of paper produced	No ESV-oriented CES	9967.717	7860.705	4.80
	ESV-oriented CES	10289.068	6088.408	5.25
Average water use 1995-97 per tonne of paper produced	No ESV-oriented CES	52302.912	20273.346	6.00
	ESV-oriented CES	17844.999	4106.845	3.00
Average sulphur di-oxide emissions 1995-97 per tonne of paper produced	No ESV-oriented CES	0.009	0.019	8.64
	ESV-oriented CES	0.001	0.001	6.36
Average nitrogenous oxide emissions 1995-97 per tonne of paper produced	No ESV-oriented CES	0.001	0.001	8.00
	ESV-oriented CES	0.001	0.001	7.00
Average COD 95-97 per tonne of paper produced	No ESV-oriented CES	0.004	0.002	7.00
	ESV-oriented CES	0.008	0.009	7.00
Average ROCE 95-97	No ESV-oriented CES	11.287	7.046	6.20
	ESV-oriented CES	10.823	4.154	4.80
Average ROE 95-97	No ESV-oriented CES	16.021	14.237	5.80
	ESV-oriented CES	16.035	10.107	5.20
Average ROS 95-97	No ESV-oriented CES	5.909	5.305	5.40
	ESV-oriented CES	3.872	3.442	4.50

4.2 Conclusions from the 2nd Empirical Analysis

Expanding on the first empirical analysis, the second empirical analysis which was carried out to address the topic discussed here used a set of novel measures for environmental competitiveness to address the criticism raised by Lankoski (2000) and is based on two groups of firms not significantly differing in industry membership, country location and firm size. Lankoski (2000) raises the issue that any causal effect of environmental performance on overall economic performance is likely to be small and thus difficult to detect with common measures of overall economic performance. This certainly holds true for the large majority of firms, as they employ a wide range of activities which all have a major influence, to varying degrees, on overall economic performance and competitiveness, and thus has direct relevance for the broad sample of firms from the manufacturing sector which was used

in the second empirical analysis. This is why the second empirical analysis focused on environmental competitiveness, i.e. that part of overall corporate competitiveness and economic performance of the company which is created and influenced by environmental management.

For the second empirical analysis the main result was that, for all four regressions which were carried out on the subset of firms with an ESV-oriented CES, the environmental impact reduction index was found to have a significant and positive influence on the different dimensions of environmental competitiveness (i.e. on market-, internally-, profitability- and risk-related environmental competitiveness). In contrast to this, for all four regressions carried out on the subset of firms with no strong ESV position in their corporate environmental strategy, no significant influence of the environmental impact reduction index on any of the four environmental competitiveness dimensions analysed was found. Therefore for firms which do not pursue a value-oriented corporate environmental strategy, after controlling for other relevant influences environmental performance has no significant relationship with any of the four dimensions of environmental competitiveness which were identified, indicating that (revealed) strategy makes a difference, or to put this in other words: firms that have a shareholder value-oriented CES either because of conscious choice or as an emergent strategy (Mintzberg and Quinn 1999) seem the most likely to achieve a positive relationship between environmental and economic performance. In contrast to this, firms which do not have such a strategy seem less likely to bring about such a positive relationship.

4.3 Overall Conclusions

The ESV concept (Schaltegger and Figge 2000) provides theoretical justification for the above conclusions. In short, ESV stipulates that for a defined level of environmental performance, economic performance can be improved more, the more strongly that a company's environmental management activities are linked to the key drivers of its shareholder value (Rappaport 1986). The ESV concept derives from this that efficiency improvements which are brought about by means of an integrated pollution prevention strategy usually require only limited additional investments, compared against the add-on equipment which would be required for an end-of-pipe strategy, and may also result in reduced operating costs and therefore higher profit margins. All these aspects have a favourable effect on the drivers of shareholder value and should thus lead to a more positive relationship between environmental and economic performance. This explains theoretically why a pollution prevention orientation empirically results in a more positive

relationship between environmental and economic performance. Table 8-9 briefly summarises the overall conclusions.

Overall, the research therefore shows that, depending on the specific conditions, it is possible to find a predominantly positive, a mainly neutral (i.e. insignificant), or a predominantly negative relationship between environmental and economic performance (or alternatively, environmental competitiveness). This also implies, that both the theoretically derived conceptions of the relationship which are described by the differing views introduced in Figure 8-1 (represented by the "Type 1" and "Type 2" curves) have their merits, but under different conditions.

Table 8-9. Overall conclusions from both empirical analyses.

Research aspect	Finding
Functional relationship	No significant relationship for inputs-based index; largely negative relationship for outputs-based index (except ROS: inversely U-shaped relationship); 2nd empirical analysis: mostly an inversely U-shaped to positive relationship is found for firms with an ESV-oriented strategy, no significant link otherwise
Strategy influence	Weakly confirmed in the 1st empirical analysis: no significant effect of environmental on economic performance for inputs-based index; largely negative effect for outputs-based index; also confirmation for basic indicators. 2nd empirical analysis: ESV-oriented strategy improves the relationship between environmental performance and environment-related competitiveness
Firm size effects	Largely no firm size effects on economic performance in both analyses
Economic factors	Negative effect of leverage (stronger for outputs-based index) in 1st analysis; in 2nd analysis, influences of market development and EMS status
Sub-sector effects	"Mixed" sub-sector has negative effect on economic performance; in 2nd analysis, effects of different industry sectors, varying with dependent variable
Country influence	Positive effects of UK location on economic performance in both analyses

5. RECOMMENDATIONS

The key question in this paper was about the relationship between environmental and economic performance, and whether the focus of an (ESV-oriented) corporate environmental strategy (as revealed by the perceived effects of a firm's activities) has a significant effect on this. The analysis shows that in environmentally intensive industries such as paper manufacturing, it may be difficult to bring about a positive relationship but that this is made easier

through a focus on integrated pollution prevention (which can be seen as a special case of an ESV-oriented CES, as will be detailed below). It also shows that for firms with a strategy based on the ESV concept (Schaltegger and Figge 2000), the relationship between environmental performance and the different dimensions of competitiveness is more positive than for firms without such a strategy.

This means that, contrary to the commonly held view that the simple amount of environmental protection (or more precisely, the level of environmental performance related to this amount) is either negatively or positively related to the economic performance (or, more specifically, the environmental competitiveness) of firms, the theoretical argument of ESV that such a relationship depends strongly on factors which are internal to the firm is confirmed empirically. Particularly relevant amongst the internal factors are the corporate environmental strategies and resulting environmental management activities pursued by a company, which emerge as major factors moderating the relationship between environmental and economic performance. For a defined level of environmental performance, according to ESV, economic performance can be improved more, the more strongly the environmental management activities of a company are linked to the key drivers of its shareholder value.

Only if a company's environmental management activities (resulting from its CES, which ideally would be ESV-oriented) have a positive effect (or a minimized detrimental effect) on the drivers of shareholder value, can high environmental competitiveness can be achieved simultaneously with high levels of environmental performance. According to Rappaport (1986) and Schaltegger and Figge (2000), important value drivers are investments in current and fixed assets, profit margin, cost of capital, and value growth duration (i.e. the time period during which a competitive advantage can be sustained). For example, end-of-pipe activities (such as flue gas desulphurisation) often require large investments in fixed assets (possibly also increasing the cost of capital), and thus have a detrimental effect on this value driver for shareholder value.

Accordingly, one would expect an end-of-pipe strategy (leading to environmental improvements mainly through reductions in the undesired outputs of production processes, such as emissions to air and water) to show limited positive, or even negative, effects of environmental performance on economic performance, as was found in the first empirical analysis. A corporate environmental strategy which is based on end-of-pipe activities therefore cannot be considered to be an ESV-oriented strategy. In contrast to this, efficiency improvements which are brought about through integrated pollution prevention often do not require additional investments and may additionally result in reduced operating costs and therefore increasing profit margins.

This concerns improvements such as in a company's energy efficiency or water efficiency as well as increased resource efficiency, i.e. reduced amounts of production inputs per unit of product output (Schaltegger and Figge 2000).

Corporate environmental strategies which focus on environmental management activities leading to such efficiency improvements, which include integrated pollution prevention-based strategies, thus have a strong ESV orientation. This is particularly so because from a materials flow perspective, efficiency gains can also result in indirect cost reductions which are revealed by methods such as activity-based costing. In summary, it is therefore recommended that companies should first cross-check their corporate environmental strategy against the principles of the ESV concept.

With the relevance of the concept now empirically validated, this will provide valuable top-down guidance for strategy development. Secondly, a company can screen its environmental management activities based on its drivers of shareholder value to establish a bottom-up perspective of the degree to which its activities create economic value and improve competitiveness. In particular, the significant differences between end-of-pipe and integrated pollution prevention activities should be a focus of this screening which can guide corporate environmental strategy development.

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