# Environmental and Financial Performance. Is there a win-win or a win-loss situation? Evidence from the Greek manufacturing

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# Environmental and Financial Performance. Is there a win-win or a win-loss situation? Evidence from the Greek manufacturing

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## Abstract

This study examines the causal linkage between environmental and financial performance in Greek manufacturing firms. Environmental performance is measured according to accounting data following the Eco Management and Auditing Scheme guidelines and ISO certification. Return on assets and return on sales are used as indicators of financial performance. Empirical findings suggest that there seems to be a link between these dimensions irrespectively of the particular sector of activity. Contrary to similar studies a "virtuous circle" does not exist as the avoidance of environmental improving investments is related to a better financial performance. On the other hand firms with superior financial performance seem to achieve a better environmental performance. At the same time firm specific and market characteristics significantly affect this relationship. These findings provide evidence that governmental and corporate actions are necessary in order to lead to a more sustainable corporate performance in the long run.

**Key words**: environmental performance; financial performance; causality; GMM; Greece.

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## 1. Introduction

Environmental degradation has increased urgency for a transition to a low-carbon, climate resilient and resource-efficient global economy. This new corporate environment leads to more capital-absorbing investments for "greener" products (Barbera and McConnell, 1990; Trumpp & Guenther, 2015). In these circumstances, different stakeholders have proposed and implemented environmental policies such as (a) direct regulations, b) indirect regulations through environmental taxes, subsidies, tariffs and quotas and c) promotion of voluntary agreements)in order to reduce the burden on the environment.

The effectiveness of these policies on firms' behavior towards the environment depends on the response to two questions concerning the bidirectional relationship between corporate environmental (CEP) and corporate financial performance (CFP). Are resourceful firms more capable of responding to pressures from various stakeholders and overcome both the neoclassical trade-off between CEP-CFP and the managerial opportunism, engaging in long-term and costly environmental performance improving investments? At the same time, will the benefits from these investments lead to higher market share reducing costly conflicts with various stakeholders, environmental risk, and increasing production efficiency leading to better financial performance (Elsayed and Paton, 2005; Nelling and Webb, 2009)? In this context, environmental issues are confronted in management decision moving beyond the ethical perspective to the promotion of a sustainable economic success (Ambec and Lanoie 2008; Lacy, et al., 2010; Porter and van der Linde, 1995).

For more than fifty years, the emerging public awareness and the consequent public pressure did not lead to generally accepted results on the relationship between

CEP and CFP due to problems of measurement, small samples, the lack of addressing the causality problem and the issues of endogeneity (Albetrini, 2013; Blanco et al., 2009; Dixon-Fowler et al., 2013). Different theoretical drivers explain the controversial results (Preston & O'Bannon, 1997). At the one side, stakeholder theory supports that the creation of an ethical corporate image through green investments will lead to higher sales volume. At the same time slack resource theory highlights the difficulties for non-financially sound firms to engage resources on environmental improvement projects  On the other side, the high cost of relative investments, the managerial opportunism, the time lag between investment and pay-off that make future results ambiguous create trade off trends (Preston & O'Bannon, 1997; Waddock & Graves, 1997).

The aforementioned directional drivers make dynamic analysis necessary in order to determine if a virtuous circle between CEP-CFP can exist. In this regard, the contribution of our empirical findings is twofold. Firstly, this paper extends prior large-scale American studies by utilizing a panel database of Greek manufacturing plants.  The idiosyncratic characteristics of the sector examined support a negative causality. More specifically, underdevelopment of corporate social responsibility (Skouloudis et al. 2014), low level environmental regulation (Halkos and Sepetis, 2007), relatively lax regulation and high level of pollution intensity (Mulatu et al. 2010; Tsani, 2010) all reduce incentives for firms to undertake the necessary high costs for CEP improvement. Despite the efforts towards innovative production techniques (Halkos and Evangelinos, 2002; Skouloudis et al. 2014) the substantial capital expenditures and large-scale operating costs required appear to have a negligible effect on firm's productivity and therefore, on economic growth (Fujii et al. 2011). Furthermore, the inefficiency of European environmental regulations reduces flexibility and prevents firms from innovative solutions (Albertini, 2013; Jaffe and Palmer, 1997). This paper will explore what corporate or public policies should change in order to create a virtuous circle.

Secondly, following previews empirical findings (Fujii et al. 2013; Grolleau et al. 2012) a process based index for production scale adjustment for environmental pollution was introduced using the cost of energy consumed and the value of the produced output data. The choice of monetary terms instead of the quantity of waste produced or processed was a result of sample selection limitations and the intention to avoid “green washing”. The use of plant-level data mainly by private firms, made the collection of reliable and easily verifiable corporate environmental management information or physical pollution data impossible.

The rest of the paper is divided into six sections. In the beginning there is a review of the literature and it is followed by the theory, hypothesis setting and modeling specification section. The next section concerns the data source and the variables definition. The fifth section presents the results with a brief discussion whereas the last part contains the concluding remarks of the research paper.

## 2. Review of the literature

A number of studies have proposed explanations for the existence of a virtuous circle between CEP and CFP. The majority of the studies suggest that there is a positive relationship following Porter’s “win-win” argument and the integration of slack resource and social impact hypothesis to a positive synergy hypothesis, between them (Albertini, 2013; Endriakt et al. 2014). According to this hypothesis superior CEP will lead to an improved CFP that enables reinvestments in CEP improving actions (Makni et al. 2009). Empirical findings support the two way causality for two reasons. Firstly, since pollution is regarded as the sign of an incomplete, inefficient, or ineffective use of resources, the pollution control and prevention strategies are expected to introduce innovation and operational efficiency improving competitive advantage (Porter and van der Linde, 1995; Russo and Fouts, 1997). Secondly, according to product stewardship, the integration of the voice of the environment into product design and manufacturing processes, can increase company environmental reputation and employee/customer commitment (Dogl and Holtbrugee, 2013; Waddock and Graves, 1997), enhance firm legitimacy (Hart & Ahuja, 1996) and reflect strong organizational and management capabilities (Aschehoug et al. 2012).

However, other researchers concluded that CFP is negatively associated improvement to CEP (Bansal, 2005; Sharma, 2000). Scholars suggested that CEP is not part of corporate responsibility as it mainly generated costs for the firm (Hatakeda et al. 2012; Waddock and Graves, 1997). The cost of the significant investments and modifications of production processes may increase efficiency but will reduce profitability both over a short and long period of time (Jaggi & Freedman, 1992; Blacconiere & Patten, 1994; Wu et al., 2009). Moreover, the time lags in the fruition of CEP improving investments, increases uncertainty and risk about current and future profitability (Aragon-Correa and Sharma, 2003). Moreover, the uncertainty of the outcome allows management opportunism to reduce the priority of important organizational changes (Makni et al. 2009; Waddock and Graves, 1997).

Most researches rely on time series databases using the Granger causality approach supporting either a two-way relationship or just one direction linkage. Depending on the market and the time period examined some of the research findings verified that the expected benefits of environmentally-friendly investments accrue to the firm sometime after the initial investment and vice-versa (Nakao et al. 2007). Other findings support only the one direction of the connection as either financial performance has an effect on environmental (Neiling and Webb, 2009) or environmental performance has an influence on financial one (Clarkson et al. 2011). Using, switch regression, Hatakeda et al. (2012) showed that higher financial flexibility (low debt) tends to provide more financial resources that can be used for emissions reduction.

Other researchers used panel databases to control for firm specific characteristics that are invariant over time and directly influence corporate decisions (entrepreneurial capacity, favorable managerial attitude toward corporate transparency etc.). In this context King and Lenox (2002) used a 2-stage least squares model and Elsayed and Paton (2005) followed the Generalized methods of moments estimation (hereafter GMM) approach examining the market of USA and UK respectively. Their results are mixed as the former found a significant positive impact of waste reduction on financial performance whereas the latter support a neutral impact of lagged environmental performance on financial indicators. However, lagged environmental performance has a strongly significant impact on firm performance. More recently Martínez-Ferrero and Frías-Aceituno (2013) examined an international database via GMM and came to the conclusion of the existence of a synergistic "virtuous circle" between them.

## 3. Theory, Tested Hypotheses and Modeling Issues

We explore the possible causal relationship between CEP and CFP based on positive synergy hypothesis. As argued by Makin et al., (2009) and Allouche & Laroche, (2005), higher levels of CEP lead to an improvement of FP, offering the necessary resources for reinvestment in environmental performance improving actions. In more details, the selection-effect shows that more resourceful firms will invest in CEP improvement leading to the slack resource hypothesis (Heras-Saizarbitotia et al., 2011). Then, according to social impact hypothesis, the “green” image of the firm is expected to further improve financial performance that can be reallocated, improving CEP in the future (Preston and O’Bannon, 1997; Waddock and Graves, 1997). If both forward and backward CEP-CFP relationship exists then, the simultaneous and interactive positive connection forms a virtuous circle (Waddock and Graves, 1997). On the other hand, in case achieving a higher level of CEP decreases FP, then environmental responsible investments will be limited. According to the negative hypothesis, a simultaneous and interactive negative relation between CEP and FP forms a vicious circle.

Considering the theoretical framework presented and the previous empirical findings the following hypotheses can be tested:

*$H_1$: Higher (lower) environmental performance causes higher (lower) financial performance.*

*$H_2$: Higher (lower) financial performance causes higher (lower) environmental performance.*

The two basic theoretical arguments introduced above, that is effect of firm’s financial performance on environmental performance and vice versa, may be modeled in the context of the following two equations (Eqs 1 and 2) . More precisely, we have:

$$CEP_{i,t} = \alpha_0 + \boldsymbol{\beta} EP_{i,t-1} + \delta CEP_{i,t-1} + \xi CEP_{i,t-1}^2 + \mathbf{\Gamma X}_{i,t} + \mathbf{\Delta Z}_{i,t} + \boldsymbol{u}_{i,t} \quad (1)$$

$$EP_{i,t} = \zeta_0 + \boldsymbol{\theta} CEP_{i,t-1} + \delta^* EP_{i,t-1} + \xi^* EP_{i,t-1}^2 + \mathbf{\Gamma}^* \mathbf{X}_{i,t}^* + \Delta^* \mathbf{Z}_{i,t}^* + \varepsilon_{i,t} \quad (2)$$

In Equation X, the $CEP_{i,t}$ is the energy efficiency of the $i-th$ plant under the in time $t$. In Equation X, $EP_{i,t}$ is the environmental performance of the $i-th$ plant with respect to the sector that it belongs. $\mathbf{X}_{i,t}$ is a matrix of exogenously determined plant level variables, $\mathbf{Z}_{i,t}$ is a matrix of instruments correlated to the level of financial performance. The terms $\mathbf{u}_{i,t}$ and $\varepsilon_{i,t}$ capture additional unobserved factors for each specification. $\boldsymbol{\beta}, \boldsymbol{\theta}, \Gamma, \Gamma^{*}, \Delta, \Delta^{*}, \boldsymbol{\delta}, \boldsymbol{\mu}$ are vectors of parameters to be estimated. Finally, path dependence phenomena can be examined since the lagged values $CEP_{i,t-1}, EP_{i,t-1}$ of our basic variables have been included. Due to the fact that the presence of the lagged regressors in both equations raise autocorrelation concerns in conjunction to possible endogeneity issues between the former and the disturbance terms along with the fact that the form of heteroscedasticity is not known *a priori*, point towards the direction of the GMM estimator or difference estimator of Arellano-Bond (1991) first proposed λ by Holtz-Eakin et al. (1988).

## 4. Data Sources and Variable Definitions

Data were collected from the Annual Survey of Industry in Greece reported by the Hellenic Statistical Authority and contains all manufacturing plants (subdivisions 15-37 of the Community classification NACE Rev. 1.1) around Greece that employ more than 10 people irrespective of size or geographic settlement. The initial panel consists of 4.852 plant level observations for the period between 1993 and 2007. In order to create a reliable database, data were filtered for excluding plants for which crucial information were missing for all periods reducing our initial sample to 1.567 plants per year. Then, firms with non-consistent series of variables were excluded from our analysis reducing further our sample by 23 %. The resulting dataset is a balanced panel consisting of 931 per year plant level observations for the period between 2001 and 2007. This period allows testing the found fade out of fists mover advantage after 2000 (Heras-Saizarbitotia et al., 2011). In order to limit the different sectoral categories wider classes that include plants from relative industries were created eight main clusters (please see Table 1).

The absence of firm level reliable toxic release database leads to the use of a process based indicator. The proxy used (energy consumption ratio – ECR) calculates the cost of energy consumption per value of output (deducted by the energy cost included in manufacturing cost), representing the production scale adjusted environmental pollution. If the scale of production increases more than energy use environmental performance improves. This calculation reveals differences in the development of organizational resources and capabilities through operational changes and innovation that are expected to be linked to the ability of the firm to generate profits. Empirical findings show that EP (an inverted score of environmental pollution per production unit) increases ROA through both return on sales and improved capital turnover (Fujii et al., 2013).

Financial performance is measured using two complementary variables. Using Return on Assets (hereafter ROA), the ability of the company to use its assets effectively is established (Nelling & Webb, 2009) and is affected by both cost reduction and productivity improvement. Return on sales (hereafter ROS) reveals the ability of the company to increase sales keeping costs low (Nakao et al., 2007).

Three groups of firm characteristics influencing financial and environmental performance are incorporated into the models (Waddock and Graves, 1997). The first one encompasses characteristics of firm's capital strength. Such characteristics are the capital intensity $(CAPINT)$, as captures by the capital-to-labor ratio and the solvency ratio$(SOLV)$, defined as the interest coverage ratio. High dependence on capital assets is expected to make firms reluctant to transform their production and process technologies to more environmentally sound ones (Elsayed and Paton, 2005; Fujii et al. 2013). In addition, solvency is a key figure for both corporate financial performance and the involvement in environmental projects. At one point “green labeling” influences corporate reputation and investors’ perception of firms’ future performance providing a type of insurance value decreasing financial cost (Peloza, 2006). At the same time the ability of a firm to meet its obligations will affect its decision to make long-term investments on environmental performance improvement (Hart and Ahuja, 1996).

The second category consists of variables that are related to the firm’s underlying knowledge conditions introducing size $(SIZE)$ and R&D intensity $(R\&D_{\text{int}})$ moderators. Size is one of the most relevant factors used for explaining willingness for organizational change. It is found that larger firms are more willing to invest in environmental performance improvements as they attract more public attention (Stanwick et al. 1998), possess more slack resources that are available for environmental investments (Clarkson, Li et al. 2011), have better access to resources, hold greater control over stakeholders and can take advantage of economies of scale (Elsayed and Paton, 2005; Orlitzky, 2001). Furthermore, the investment in “technical” capital results in knowledge enhancement leading to product and process innovation which in turn is expected to increase long term financial performance. Hence, R&D intensity may be a precursor for innovative approaches to environmental issues having a profound effect in the relationship between CEP and FP (Orlitzky, 2008; Przychodzen and Przychodzen, 2015; Rousso and Fouts, 1997).

Finally, following Bain, (1956) and Feeny et al. (2005) we focused on the Structure-Conduct-Performance (SCP) paradigm, including in our analysis industry-level determinants of competition such as market share $(MS)$ and Herfindhal-Hircham Index $(HHI)$.

Due to the great diversity of the firms examined in terms of environmental and financial performance possible heterogeneity is tested using eight dummies, one for each sector. Their inclusion seems to have statistically not significant effect leading to the creation of two new dummies controlling whether the firm examined comes from an energy intensive sector or not. Table 2 provide basic descriptive statistics for each of the variables according the sector that belongs.

## 5. Results and discussion

### *5.1 Results of the static analysis*

Starting with the simple correlation between CEP and FP our results suggest that there is a positive and strong link between them (Table 2). The hypothesis stated in section 2 was tested for two econometric specifications. The first one is static, comparing random versus fixed effects specification with the second being a dynamic one, using the GMM approach. Table 3 shows the results of static analysis. The comparison between the two models aims to explore if there are unobservable firm characteristics that may differ between firms but are constant over time and are expected to affect the linkage between financial and environmental performance. Our findings suggest that such characteristics exist as environmental performance improvement has a negative effect on FP$(ROA)$. It is therefore implied that there is no economic benefit for firms from the reduced energy consumption making Greek firms conservative in engaging in energy reduction activities. This is in line with Fujii et al. (2010) findings as it seems that the acquisition of energy-saving equipment will negatively affect return on the short term. In the case of Greece it seems that there is no cancelation of the negative financial footprint of the "green" investments as limited importance is attributed by customers to the lifecycle assessment and green supply chain management as it happens in other markets such as Japan (Fujii et al, 2013).

*5.2 Results of the dynamic analysis*

Despite the usefulness of the above results these models do not take into account the fact that there are time lags between an investment and the flourishing of its results (Elsayed and Paton, 2005). Taking this into consideration, Table 4 presents in parallel the results of the GMM estimator for dynamic panel estimation using the Arellano and Bond (1991) approach for both models. For statistical consistency reasons, first order serial correlation is required (in the differenced estimates) but not second order correlation. Rows AR (1) and AR (2) present the $m_1$ and $m_2$ statistics used to test the zero hypotheses that there is no first and second order linear correlation between the residual of the first differences. According to the results presented there is only first order correlation. Moreover in each case the Sargan test of over-identifying restrictions provides support for our choice of instrument set.

Overall, the results presented in table 4 suggest that there is a statistically significant impact of financial performance on environmental performance in both cases. On the other hand environmental performance does not have a significant effect on financial performance in both model. Only in the case of the first model where ROA is used as a proxy of financial performance the deterioration of energy consumption ratio seems to be linked with better financial performance.

In more detail, the results of the 1st model (columns 2 and 3) are in line with Friedman's (1970) aversion to relative investments as costs from energy saving investments seem to exceed the benefits in terms of lower production costs and efficiency-productivity improvements (Hatakeda et al., 2012). At the same time, in accordance to slack resource theory, the existence of a surplus of difficult to imitate resources, such as profits, make it more likely for firms to invest in the improvement of the level of their environmental performance (Clarkson et al., 2011; Russo and Fouts, 1997). Obviously firms that are not doing very well financially lack the necessary resources for long term environmental performance improving investments. The results for Model 2 verify the slack resource theory but there is no statistical significant effect of environmental performance on financial one.

The plants examined show an adverse to relative investments despite the market growth rate and the join of Euro area that rapidly reduced the country risk premium. The characteristics of the Greek economy seem to out-scale the positive prospects offered by the macroeconomic environment providing a useful analytical framework from a transitioning economy. The low competitiveness as well as the complex environmental regulations, and the less productive methods used (negative link between higher capital intensity and environmental performance) prevent firms from costly environmental performance investments. We also tested for a non-linear relationship between CEP and FP with statistical no significant results.

Attempting to explore the effect of the firm specific characteristics in the aforementioned relationship, moderators were used in both models. As previously discussed, the competitiveness within the market is expected to significantly affect environmental performance indirectly through the higher profit margins experienced in the more concentrated markets. If corporate environmental actions are considered as a regular good, the increase of the available resources will lead to an increased demand for additional units. In such a case, higher competition reduces marginal return for all firms, reducing the available resources devoted in investments that improve environmental performance (Li, 2014). This expectation was confirmed in the first model.

Further, the results seem to be in line with empirical findings of Waddock and Graves, (1997) and Alexopoulos et. al (2011) as both the proportion of sales devoted in R&D investments as well as the size of each manufacturing plant have a positive and significant effect on environmental and financial performance. In the case of Greece and despite the more traditional production methods it seems that larger firms are more willing to undertake corporate social responsibility actions reducing corporate environmental impact. Finally, the higher dependency on fixed assets ( $CAPINT$ ) has a negative effect on environmental performance as it makes replacement and maintenance cost very high, thus creating barriers for environmental improving investments (del Rio Gonzalez, 2005).

## 6. Conclusions

In this study we examined the existence of a virtuous circle between corporate environmental and financial performance. Based on the empirical analysis of Greek manufacturing plants, we find that improvement in environmental performance does not lead in improvements in the financial condition of the plants examined. In advance slack resources are necessary for a firm to engage in environmental performance improving projects. These results imply that firms improve their financial performance by avoiding "green" investments due to their high costs, the long and uncertain payback period and the limited advantages gained from the creation of an ethical corporate image.

This study seeks to advance the literature by exploring the possible trade-off effects of the idiosyncratic market characteristics on the relationship between CEP and CFP. In this attempt, in order to avoid the limited available data, of plant level environmental index was calculated using the cost of energy consumption per value of output. This index represents the production scale adjusted environmental pollution, revealing differences in the development of organizational resources and capabilities through operational changes and innovation that are expected to be linked to the ability of the firm to generate profits.

Overall, in this study it has been clarified that idiosyncratic characteristics seem to reduce the financial benefits from CEP improving projects and only the resourceful firms are willing to take the necessary steps towards “greener” production methods. Interestingly, the empirical results suggest that slack resource theory explains the decision of managers toward costly and long term environmental performance improving investments. At the same time firm size, R&D intensity and power over market are important prerequisites.

European and national policy makers should analyze the characteristics that prevent the creation a virtuous circle as innovative “green” production methods, which are difficult to imitate, create a competitive advantage (Russo and Fouts, 1997). Europe has set targets for sustainable development until 2020 that aim to lead to a resource efficient, greener and more competitive economy. To achieve this goal, considering the markets’ characteristics, the following recommendations are made.

Firstly, the government needs to support the development of corporate social responsibility, motivating managers to overcame opportunism and focus on non-financial targets. From a different perspective, eco-innovation may well forward a shift in government policy as relative activities may well be promoted through subvention and the introduction of an appropriate legal and fiscal framework that protects them. Secondly, national and European regulation should evolve in order to meet market's needs, avoiding "window dressing" phenomena and the suppressive and inefficient legislation system.

Thirdly, financial support of firms that invest in environmental friendly production is important for markets with high level of pollution intensity. The slack national environmental legislation, the high cost of capital and operating costs, offset the impact from innovative production methods as consumers preferences are still not significantly related to environmental burden caused. Finally, organizational changes may be urged due to the need to scale up corporate size, as lucrative use of cleaner technologies requires a minimum efficient scale of installations. This need is related to availability of financial, human and technical resources as economies of scale and increased market share make relative investments more effective.

The main limitation of the research paper is the narrow scope of its sample exclusively from a European country and the way environmental reporting is measured and its reliance on a specific conceptual framework. Therefore, the findings are context specific and may not be applicable in a wider context. The generalization of the findings to other countries could be subject of future research studies. In addition, the use of alternative measures of corporate environmental performance in the analysis of the causal relationship between CEP and CFP can be examined. Using input or output oriented indexes, controlling for industry effects, introduce an insight to the effect of total emissions, pollution reduction means or methods in the above relationship.

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## Appendix

**Table 1: Plants per Manufacturing sector**

| Year | Food products, beverages and tobacco | Textiles and textile products | Wood and wood products<br><br>Pulp, paper and paper products; publishing and printing | Coke, refined petroleum products and nuclear fuel<br>Chemicals, chemical products and man-made fibres<br>Rubber and plastic products | Other non-metallic mineral products | Basic metals and fabricated metal products | Machinery and equipment n.e.c. | Electrical and optical equipment |
|---|---|---|---|---|---|---|---|---|
| 2001 | 168 | 150 | 115 | 151 | 97 | 104 | 63 | 83 |
| 2002 | 168 | 150 | 115 | 151 | 97 | 104 | 63 | 83 |
| 2003 | 168 | 150 | 115 | 151 | 97 | 104 | 63 | 83 |
| 2004 | 168 | 150 | 115 | 151 | 97 | 104 | 63 | 83 |
| 2005 | 168 | 150 | 115 | 151 | 97 | 104 | 63 | 83 |
| 2006 | 168 | 150 | 115 | 151 | 97 | 104 | 63 | 83 |
| 2007 | 168 | 150 | 115 | 151 | 97 | 104 | 63 | 83 |
| Total | 1176 | 1050 | 805 | 1057 | 679 | 728 | 441 | 581 |

**Table 2: Basic statistics and correlation matrix**

| | Mean | Standard Deviation | Energy Cost Ratio | ROA | ROS | Herfindahl Index | Market Share | R&D intensity | Size | Capital Intensity |
|---|---|---|---|---|---|---|---|---|---|---|
| **Energy Cost Ratio** | 0,029 | 0,069 | 1 | | | | | | | |
| **ROA** | 0,056 | 0,255 | -0,408 | 1 | | | | | | |
| **ROS** | 0,115 | 3,963 | -0,302 | 0,387 | 1 | | | | | |
| **Herfindahl Index** | 0,099 | 0,115 | -0,059 | 0,003 | -0,02 | 1 | | | | |
| **Market Share** | 0,009 | 0,027 | -0,019 | 0,087 | 0,012 | 0,006 | 1 | | | |
| **R&D intensity** | 0,002 | 0,015 | -0,018 | 0,011 | 0,043 | 0,104 | 0,022 | 1 | | |
| **Size (Total Assets)*** | 18,39 | 51,474 | 0,028 | -0,05 | 0,023 | -0,002 | 0,437 | 0,098 | 1 | |
| **Capital Intensity** | 0,46 | 0,358 | 0,009 | -0,04 | -0,03 | 0,044 | -0,269 | -0,076 | -0,69 | 1 |
| **Solvency** | 9,018 | 213,551 | -0,013 | 0,014 | 0,004 | 0,014 | -0,006 | -0,004 | -0,02 | 0,024 |

*** in millions €**

**Table 3: The impact of financial performance on environmental and vice versa using static panel data anlysis**

| | ROA | | ROS | | ECR | | | |
|---|---|---|---|---|---|---|---|---|
| | **Fixed Model** | **Random Model** | **Fixed Model** | **Random Model** | **Fixed Model** | **Random Model** | **Fixed Model** | **Random Model** |
| **ROA** | - | - | - | - | -0.013 | -0.012 | - | - |
| | | | | | (0.002) | (0.002) | | |
| **ROS** | - | - | - | - | - | - | 0.001 | 0.001 |
| | | | | | | | (0.002) | (0.001) |
| **ECR** | 0.427* | -0.046 | -0.073 | -0.160 | - | - | - | - |
| | (0.188) | (0.024) | (0.143) | (0.100) | | | | |
| **Market Share** | 0.623* | 0.588* | - | - | -0.185 | -0.013 | - | - |
| | (0.238) | (0.997) | | - | (0.122) | (0.066) | | |
| **Herfindahl Index** | - | - | -0.575 | -0.115 | - | - | 0.027 | -0.017 |
| | | | (0.199) | (0.073) | | | (0.020) | (0.014) |
| **R&D intensity** | 0.492 | 0.055 | 0.421 | 0.785 | 0.113 | 0.067 | 0.112 | 0.071 |
| | (0.143) | (0.127) | (0.710) | (0.544) | (0.073) | (0.068) | (0.073) | (0.068) |
| **Firm Size** | -0.315*** | -0.015 | -0.010 | 0.003 | -0.004** | 0.001 | -0.004*** | 0.001 |
| | (0.004) | (0.002) | (0.019) | (0.007) | (0.002) | (0.001) | (0.002) | (0.001) |
| **Solvency** | -0.541 | 0.090 | -0.722 | 0.616 | -0.099 | -0.179 | -0.099 | -0.174 |
| | (1.023) | (0.804) | (5.085) | (3.134) | (0.520) | (0.454) | (0.521) | (0.454) |
| **Capital Intensity** | 0.302*** | -0.015 | 0.118*** | -0.005 | 0.007 | 0.006 | 0.008 | 0.007 |
| | (0.012) | (0.008) | (0.058) | (0.029) | (0.006) | (0.005) | (0.006) | (0.005) |
| **Energy Intensity** | 0.006 | 0.010 | 0.066 | 0.001 | -0.001 | 0.026 | -0.003 | 0.032 |
| **Sector Dummy** | (0.069) | (0.005) | (0.345) | (0.019) | (0.035) | (0.004) | (0.035) | (0.004) |
| **Constant** | 0.521 | 0.282 | 0.215 | 0.039 | 0.093 | 0.020 | 0.083 | 0.016 |
| | (0.060) | (0.035) | (0.297) | (0.123) | (0.032) | (0.022) | (0.030) | (0.021) |
| $chi^2$ | 49.81 | | 14.34 | | 17.78 | | 39.36 | |
| Hausman test (Prob > $chi^2$) 0.000 | **0.000** | | **0.045** | | **0.013** | | **0.005** | |
| Number of observations | 931 | | 931 | | 931 | | 931 | |

Notes: (i) Figures in parentheses are standard errors robust to heteroscedasticity.

(ii) Hausman is the Hausman test for fixed effects over random effects.
(iii) Serial correlation is the test for first order serial correlation in fixed effects models presented by Baltagi (1995).

**Table 4: Dynamic Effects – ( Arellano and Bond)**

| | ROA | Energy Consumption Ratio | ROS | Energy Consumption Ratio |
|---|---|---|---|---|
| Dependent Variable $_{t-1}$ | 0.205* (0.023) | -0.135** (0.052) | -0.288 (0.019) | -1.138* (0.051) |
| Dependent Variable $_{t-2}$ | 0.004 (0.004) | 0.004 (0.005) | 0.007 (0.001) | 0.004 (0.005) |
| ECR $_{t-1}$ | 0.183** (0.089) | - | -0.455 (0.310) | - |
| ROA$_{t-1}$ | - | -0.012*** (0.004) | - | - |
| ROS $_{t-1}$ | - | - | - | -0.002** (0.001) |
| Herfindahl Index | - | - | 0.098 (0.254) | -0.004 (0.009) |
| Market Share | 0.633** (0.307) | -0.246* (0.069) | - | - |
| R&D Intensity $_{t-1}$ | 0.167* (0.085) | -0.049** (0.037) | 0.710 (1.121) | -0.050* (0.018) |
| Size (log Assets) $_{t-1}$ | 0.026** (0.006) | -0.006* (0.001) | 0.013 (0.033) | -0.006*** (0.001) |
| Capital Intensity $_{t-1}$ | 0.021 (0.016) | 0.009*** (0.004) | 0.062 (0.093) | 0.010* (0.004) |
| Solvency Ratio $_{t-1}$ | -0.815 (0.995) | -0.043 (0.188) | 0.000 (0.000) | -0.048 (0.188) |
| Energy Intensity Sector Dummy | 0.015 (0.096) | 0.030 (0.270) | -0.106 (0.536) | 0.231 (0.975) |
| **Time Trend** | Yes | Yes | Yes | Yes |
| **No. of groups** | 931 | 931 | 931 | 931 |
| **No. of instruments** | 22 | 17 | 22 | 17 |
| **AR (1)** | -2850 | -8007 | -3356 | -8.128 |

| | | | | |
|---|---|---|---|---|
| **AR (2)** | -0.960 | -1341 | -6392 | -1199 |
| **Sargan test** | 41688 | 195115 | 47418 | 19736 |

Notes: (i) Figures in parentheses are standard errors robust to heteroscedasticity.
*P<0.10, **P<0.05, ***P < 0.01