Voluntary environmental management: A critical review from an economic perspective[*].

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Abstract

In order to inquire the possibilities for voluntary environmental protection by manufacturing firms it is necessary to acquire information on the private economic consequences from individual firms' environmental management. There is the conventional wisdom that there exists a trade-off for firms between being green and competitive. The present paper reviews the empirical literature analyzing the relationship between the manufacturing firms' environmental and economic performance, moving forward from the simple "Does it pays to be green?" to other finer questions. Findings show a more prominent no penalty for being green and the crucial influence from third factors on the actual answer to the pays to be green question. These results represent a conceptual challenge to traditional strategic theory, exhibiting empirical evidence for the viability of voluntary initiatives..

Key words: Pollution Control Costs; Firm Behaviour.
JEL classification: Q52; D21.

1. INTRODUCTION

Environmental policy is increasingly considering the role of voluntary initiatives for a better governance of the natural assets. In order to foster this movement from government to governance of the environment, it will be necessary that policy-makers are provided with information about the firms' economic incentive structure for environmental management. Unfortunately, empirical evidence in this respect is not yet available. The closest empirical research to these information requirements refers to the private economic consequences from firms' voluntary environmental management.

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This is a line of research which has been studied, mainly for the manufacturing industry, for more than thirty years. The original interest in this topic emerged due to complains by manufacturing executive managers alleging that the increasing stringency of regulations in the US during the 60s and 70s were making the generation of profits much more difficult. Consequently, the wisdom that there existed a trade-off for firms between being green and competitive was launched.

The academic research has devoted many efforts to either demonstrate or refute the trade-off wisdom. The importance of this debate derived from its implications on assumptions of rationality of agents, because it constitutes in fact a debate on whether and when managers systematically miss profit opportunities (King & Lenox, 2002). If they could increase their economic results by means of voluntary environmental management actions and they did not introduce them, their rationality would be challenged.

Unfortunately, even though the long time and amount of effort devoted to this research, the results obtained do not allow researchers to conclude in one or other direction. This lack of consensus in results might be partially caused by the lack of structural analysis of the previous studies. The literature under research is a complicate and blurred and only partial literature reviews have been conducted (Claver-Cortés *et al.*, 2005; Wagner, 2001) which do not allow to build the general picture.

The major contribution of the present paper is to introduce the reader, in the easiest way possible, into the tough empirical literature of the economic consequences of undertaking environmental management actions for manufacturing firms. With this purpose, the literature has been structured according to the research questions addressed, showing an evolution towards a finer understanding of the relationship between the variables. Additionally, a set of descriptive tables have been included

which allow the reader to compare the characteristics of the different research questions and studies. In all cases major attention is placed on the results obtained and the determinants of their variability. The theoretical backgrounds on which the studies rely have been briefly included when they constitute a valuable contribution for clarifying the relationship between the firms' environmental and economic performance.

Maintaining the initial motivation on analyzing voluntary initiatives in order to explore the scope for change of managerial environmental behavioural change, the existent broad literature has been delimited. The studies referring to the Porter Hypothesis research line or those analyzing short-time non-speculative effects have been excluded. Consequently, the review comprises the empirical studies analyzing the relationship between the firms' environmental and economic performance, and the study of the stock market reaction to firms' environmental performance.

The rest of the paper is structured as follows. Section two presents the general state of the literature Section three, four, five, seven and eight critically review the studies addressing the questions by what means does it pay to be green?, When does it pay to be green?, Until when does it pay to be green? And is there a reward for "green investing"? respectively. For each of these subsections a table including a general characterization of each of the studies under analysis is included. Finally, section nine reflects on the implications of the findings for environmental policy-making and business management and concludes.

2. THE GENERAL STRUCTURE OF THE LITERATURE

Most of the early work in this area was based on a series of studies of industries by the Council of Economic Priorities (CEP) in the early 70s for the US. Due to the initial lack data on the environmental performance of firms, the first studies included a

very small number of observations, constraining the possible methodological approaches to be conducted.

As time passed and further data became available, literature evolved towards regression models that enabled us to analyze the effects of environmental behaviour on firms' economic performance more accurately. Major improvements were, on the one hand, estimation of the quantitative effect of the firms' environmental behaviour on their economic performance. On the other hand, the effects coming from different variables affecting the environmental-economic relationship of firms could also be disentangled. With this purpose, either control variables were included in the regression models or multiple regression models were conducted in order to ascertain the intermediate effects of other variables.

The US leaded this advance in the research. Thanks to the increased information, authors were able to pose complementary questions in addition to the question of whether the variables were related (see figure 1 for a chronological order of the questions under research). In this way, the literature for the US started to structure the research in finer questions. This represented a major shift with respect to which the literature for other areas is still lagging behind. In fact it has been suggested that asking whether it pays to be green in a yes/no basis is not the most adequate approach. Understanding executive decisions about the environment like any other business decision requires finer questions to be asked. It has no sense to ask whether it pays to be green, like it has no sense to ask whether it pays to build your new plant in Singapore (Reinhardt, 1999). In any case the answer will be "it depends". But, what does it depend on?

Insert Figure 1

The literature has analyzed as potential drivers of the relationship between the environmental and economic performance of firms: the specific means utilized for undertaking the environmental management, the type of firms in which environmental initiatives were applied, the intensity of these initiatives and lastly, whether there existed a reward for green investors. Empirical findings have shown all this determinants conditioning differences in significance and in sign of the empirical estimates (see table 1).

Insert Table 1

A last determinant which has not been directly addressed, but which has demonstrated to be relevant when reviewing the literature, is the geographical area considered. This influence comes firstly from the different information systems, mainly for the environmental behaviour of firms, of the different countries. The type of indicators, frequency of the data, level of analysis and aggregation capacity differs for the studies depending on the reference country. Secondly, from the different economic environments of the different countries. The macroeconomic variables, the business and environmental regulations, among others, can potentially influence results. And lastly, from the recognition that studies can refer either to a single country (US, UK, Spain and Germany) or to a cross-country set, mainly EU countries, determining methodological differences between the studies in the construct of the variables.

3. WHETHER THE ENVIRONMENTAL AND ECONOMIC PERFORMANCE OF FIRMS ARE RELATED.

The first question to be empirically addressed was *whether the environmental and economic performance of firms were actually related*. This research was mainly based on the CEP database, which was primarily focused on the measurement of corporate pollution management of petroleum refining, steel, pulp and paper, and

electric utility industries (see Bragdon & Marlin, 1972; Chen & Metcalf, 1980; Spicer, 1978).

Due to the scarce information available, it was only possible to obtain robust estimates for correlation tests. These evaluated the existence of a relationship between the firms' environmental and economic performance behaviour, the sign of the relationship and an insight into its magnitude. Results showed a consistent evidence of a weak positive correlation between the environmental and economic performance of manufacturing firms, the significance of which varied for the different time periods under consideration (see table 2). However, the small number of observations limited the extrapolation of results, as observations did not represent a sample from a population of reference.

Insert Table 2

Even though, certain information was extracted from this initial result. Firstly, differences in results for the sub-periods of time motivated the idea of a dynamic component in the relationship between economic and environmental firms' behaviour (Spicer, 1978). This suggestion was embraced by following studies and further researched in some instances. Secondly, it was recognised that the findings were compatible with three different causality relations (Bragdon & Marlin, 1972):

Pollution control affects profits. Pollution control would, from this point of view, reduce firm's operating costs and increase revenues more than off-setting initial investments. On the one hand, reductions in costs would be possible by: (i) an increase in the efficiency in the use of raw material inputs (eco-efficiency), (ii) lower labour costs coming from improvements in morale, performance and health, lower turnover and reduced health insurance premiums, (iii) lower taxes and legal costs thanks to the reduction of conflicts with community groups and government environmental agencies,

(iv) lower costs for the purchase and maintenance of plant and equipment, as proactive plant design leads to a substantial reduction in costs with respect to eventual future compulsory plant re-designs. On the other hand, increases in profits might result from: (i) preferential loans or special interest rates and investors' premiums for good environmental performance, and (ii) the sale of by-products, of recycled products, or of regular products to new customers.

Profits affect pollution control. Firms with higher profits would be more capable, and thus more likely, to invest in better environmental performance. This would be the case either because (i) investment for solving environmental concerns is a luxury that can only be afforded by higher profit firms or because (ii) rapidly growing firms have a higher investment turnover, making it easier to have newer and better designed equipment that can achieve higher conversion rates.

Both pollution control and profits as the consequence of a third variable. Under this view no direct causality relationship would exist between environmental and economic performance in any direction, defending a spurious character of the relationship observed. This third variable has been defended to be firms' size (Chen & Metcalf, 1980), industry-belonging (Ingram, 1978) or general good management of the firm (Bragdon & Marlin, 1972). The most important lesson from this studies was that control variables are important. Future research controlled for industry effects or restricted the analysis to a single industry while at the same time, recognised that successfully dealing with firm's environmental problems could be one of the abilities of good management and could be related to a general ability to respond to future trends and tried to control for it.

The industry effects were easier to be addressed and as soon as the availability of data enabled researchers use a larger number of observations including a broader

selection of industries. Moving from the firm-level to the industry-level unit of study it was obtained that industries with better environmental performance outperformed the others in term of systematic market risk (Mahapatra, 1984).

Overall, this first studies for the US show very similar results and establish the basis on which much of the following research relies. However these studies are subject to important limitations regarding theirs very small number of observations and a dependency on the CEP environmental performance variables.

4. BY WHAT MEANS DOES IT PAY TO BE GREEN?

The first question to be addressed in addition to whether there exists a relationship between the environmental and economic performance of firms was *which were the specific environmental management strategies yield to an improvement of the economic results*. According with microeconomic theory, it is expected the existence of an optimum combination of the diverse environmental management actions. In this point, the marginal productivity of each alternative would be the same to the cost of it and equal to the marginal benefit of pollution reduction. (King & Lenox, 2002).

Insert figure 2

Authors addressing this question shown how there is not a common economic consequence from all types of environmental management alternatives (see table 3). It were analyzed the different between pollution control and pollution prevention (González-Benito & González-Benito, 2005; Hart & Ahuja, 1996; King & Lenox, 2002; Klassen & Whybark, 1999). It was hypothesized that pollution control was as an expensive approach entailing investment in non-productive equipment to comply with existent regulations while at the same time pollution prevention was a management alternative saving the money of end-of-pipe equipments and increasing productivity and efficiency (Hart & Ahuja, 1996). Management systems have been also considered as a

third category which could not be featured in any of the other two previous (Klassen & Whybark, 1999).

In general, preventive strategies were found to generate increased economic results, while on the contrary, reactive approaches resulted in either insignificant or even negative impacts on the bottom line. Moreover, no significant effect was found for environmental management systems generally (Klassen & Whybark, 1999). In order to further explore the role of environmental management systems, it were researched the particular characteristics of them that were yielding to increased economic performance, through the mediating effect of technical environmental innovations. It was found that facilities would be able to improve their economic performance by improving the environmental management characteristics that generate more adequate process innovations (Rennings *et al.*, 2006). In most cases, the effects were not found to appear contemporarily with the management initiatives. This finding was consistent with expectations, as time was presumed to be required for(Hart & Ahuja, 1996): (i) staff training and new equipment optimal functioning, (ii) renegotiation of supply and waste disposal contracts as well as for internal reorganizations, and (iii) reassigning or reducing legal and pollution control departments.

Additionally, it was also studied the differences resulting between reactive and proactive approaches to environmental management by firms (Russo & Fouts, 1997; Thomas, 2001). Different economic consequences of these two approaches were expected based on the resource-based view theory of competitive advantage of firms. This theory supports that competitive advantage is built around internal competencies of firms, arising from those assets that are inimitable and valuable. These resources can be classified as either tangible, intangible or personnel-based. Authors defended that compared with firms tending toward compliance; preventive firms differ in disposable

resources from all three types, implying differences in their ability to generate profits. Physical assets and technology (tangible resources), reputation for leadership in environmental concerns and capacity to influence public policies (intangible resources) and organizational commitment and learning, cross-functional integration and skills and participation (personnel-based resources) will all be more favourable for the performance of preventive firms. The main result obtained from empirical applications was that proactive environmental performance was significantly related with higher financial performance of firms (Russo & Fouts, 1997), though it could not be found a clear effect of actual prosecution by environmental agencies (Thomas, 2001).

A different perspective for the same research question was utilized by Judge and Douglas (1998). Authors made use of a combination of the resource-based view of firms and the planning-performance literature to propose a new theoretical model. It described how the amount of resources provided to attend to natural environmental issues, jointly with the coordination capacity among the different functions of the firms, determined the integration of environmental issues into the strategic planning process. This degree of integration of the environmental concerns on the strategic planning would in turn influence the financial and economic performance of the firm. They showed how firms providing enough resources and adequately coordinated their strategy across relevant firm's departments presented a better environmental management that in turn lead to a significant better financial and environmental performance. Then, according with their results, it is this type of coordination strategies and resources allocation that enable firms to be green and competitive.

Insert Table 3

The studies in this section show how there is not a common economic consequence from all types of environmental management alternatives. It is observed

that while preventive strategies enable firms to obtain increased economic results from their environmental management, other more reactive approaches can either result in an insignificant or even negative impact on the bottom line. This conclusion does not mean that necessarily in all circumstances preventive strategies should be preferred. As some of the previous authors suggest, there exists an optimum combination of environmental management alternatives, depending on the firms' underlying characteristics, where the marginal productivity for the different environmental actions is the same and equal to the marginal benefit of pollution reduction. The resulting optimum bundle of management alternatives could thus include a certain proportion of more reactive initiatives. Even so, the obtained evidence shows how preventive initiatives are currently underused although they provide an increased economic performance. However, caution was suggested when interpreting these results, as they may be conditioned by the current low use of preventive actions.

5. WHEN DOES IT PAY TO BE GREEN?

The second additional question referred to *when does it pay to be green?* In this case, focus moved to the underlying firms' attributes and bundles of capabilities that enabled them to obtain a positive result from environmental actions. Then, only firms with certain underlying characteristics and boundless of capabilities, depending on industrial conditions, would be able to generate increased economic results from environmental management.

Insert figure 3

Some findings have been made in this area, showing that the combination of resources and managerial choices (King & Lenox, 2002), the capacity to adequately coordinate management departments (Judge & Douglas, 1998), the strategic organizational resources coming together with pollution prevention (Klassen &

Whybark, 1999) or the general innovativeness of the firm (Christmann, 2000) are some of the relevant vectors. All these would represent complementary capabilities of firms without which the trade-off between green and competitive would appear.

Additionally, external contextual factors could also determine the relationship between the environmental and economic performance of firms. It were analyzed the effects from industry belonging (King & Lenox, 2001; Rennings *et al.*, 2003; Wagner *et al.*, 2002) and country of reference (Wagner *et al.*, 2002), only obtaining inconsistent results. The most challenging of them for the present research was obtaining that industry-belonging and not firms' behaviour was the relevant determinant of the relation for a certain application (Rennings *et al.*, 2003). Even though other studies point in the contrary direction (King & Lenox, 2001; Wagner *et al.*, 2002), policy implications of this potential evidence are observed. Note it implies a lack of economic incentives for firms to improve their environmental management. Firms devoting resources to environmental activities would not differ in economic performance compared with those in the same industry not applying any environmental measure. Thus, a hardly substitution of voluntary environmental policy for imposed environmental regulation would be in place.

Insert Table 4

In sum, studies in table 4 show how the capacity to be green and competitive differs between firms by reason of their underlying resources and capabilities. The value-added of this section was rather than identifying these factors, the creation of a common understanding respect to how some firms might find the generation of increased economic results from environmental management more difficult than much of the literature suggests. Thus, firms should examine their existing resources and

capabilities before deciding on the environmental strategies more adequate for them and even on whether they pay to be green by any mean.

The academic research should then put effort on improving the understanding of the firms' characteristics which determine the sign of the relationship between environmental and economic performance. In order to cope with this objective, simultaneous equation systems would be an interesting analytical tool. This methodology enables researchers to use structural models, which are particularly adequate as they account for potential mutual interrelations between the variables(Wagner *et al.*, 2002). This methodology has been also suggested as relevant for other topics of research which share a mutual effect between the variables (Bruyn & Heintz, 1999).

6. UNTIL WHEN DOES IT PAY TO BE GREEN?

This third additional question, addressing the *optimal intensity of environmental initiatives* though was quite early posed (Hart & Ahuja, 1996) took some more time to be empirically addressed. The economic theory predicts that there exists a private optimum level of abatement, where the marginal private cost of abatement equals the marginal private benefit of the last abated unit. Whenever the initial abatement level of a firm is below its private optimum, additional abatement generates an increase in its economic performance. Thus, although initially agents can be situated below their optimum abatement level, after subsequent abatement efforts they might achieve their optimum (that will differ on the base of the type of firms and available environmental management actions). After the optimum is reach, it will not be possible any more to increase firms' economic performance though further abatement. The object of the present section is gathering an insight on where this threshold is situated.

Insert figure 4

Although the initial state of this research, there is evidence that the average threshold is situated well below the requirements established by the current environmental US regulations. Until the present, firms are capable to generate economic gains for over compliance with environmental standards. Particularly, it was found that the adoption of an own stringent global environmental standard lead to a lower bound estimate of an increase in $8.6 billion per firm (Dowell *et al.*, 2000) and that the poor environmental performance by firms represented an average penalty on the intangible-asset value of firms of $380 million (Konar & Cohen, 2001).

Other contributions have been done in this research question applying the first-mover advantage literature. It considers the potential consequences from learning effects, time compression diseconomies and asset mass efficiencies. Learning effects refer to situations in which first movers are in advantage of later adopters while they remain before in the learning curve for a certain technology, which can be for a long time. Time compression diseconomies recognize that some tasks simply take time to be accomplished and that firms will suffer diseconomies when spending extra resources to accelerate completion. Lastly, asset mass efficiencies pertain to situations in which firms need to invest above a certain threshold on a certain technology before fully understand and gain from it. Under this perspective it was found a significant positive effect of investing early and also of investing early and a lot, but a significant and negative effect of intense investment if not conditioned to being early. The theoretical background above was used for interpreting results, concluding that there either existed time compression diseconomies or a loss of focus of the firm on its former strengths.

Insert Table 5

The studies presented in this section show that, in general, the private optimum abatement level for the manufacturing firms is well below the requirements established

by the current environmental US regulations. Firms obtain economic gains (enhanced intangible-asset value) for over comply these requirements. Exploring the situation of the optimum abatement level at an industry or economy wide scope is an interesting task with major implications for policy-making and business environmental management. However, it is a complicate venture at the same time. Each firm has its specific optimum abatement level depending on its marginal cost and benefit abatement functions which depend, among other things, on their available abatement strategies, capabilities and resources: Aggregation to an upper scope is a difficult but useful task that should be undertaken in the future.

7. IS THERE A REWARD FOR GREEN INVESTMENTS?

This forth question basically addresses *whether there is a significant difference in the market returns for environmental responsible firms with respect to the general market*. Three main responses exist a priori to this question (Guenster *et al.*, 2006; Hamilton *et al.*, 1993). Firstly, it can be the case that the market does not value environmental responsibility, and thus no significant difference would be found. Secondly, the market can expect returns on good environmental performers firms to be lower (higher) than the rest of firms in the market because the formers can be deemed less (more) risky. Conventional financial markets theory states that assets are priced efficiently so that their expected returns reflect a fair compensation for associated investment risk. Thus, after adjustment for these risk differences, there should be no abnormal difference in return for environmental leaders. Thirdly, it can be that the market does not price environmental performance efficiently. If the market reacts to environmental performance with a drift, then firms can be under- or overvalued and risk-adjusted returns can be anomalous. The studies addressing this question and their findings are included in table 6 below.

Insert Table 6

The results obtained by researchers in this area are consistent either with the idea of no penalty for investing in the "green" portfolio (Cohen *et al.*, 1997), or with a positive return from green investing (Clarkson *et al.*, 2004; Cormier *et al.*, 1993; Derwall *et al.*, 2005; Guenster *et al.*, 2006; Yamahita *et al.*, 1999). The latter evidence has obtained either from a significantly worse valuation of environmental laggards (Yamahita *et al.*, 1999) or from a significantly better valuation of leaders in terms of environmental protection (Derwall *et al.*, 2005; Guenster *et al.*, 2006). These effects were estimated to be quantitatively relevant, representing a liability for high-polluting firms of $560 million in average for high-polluting firms, or 16.6 percent of their market capitalization (Clarkson *et al.*, 2004). In addition, high-polluting firms were also missing the opportunity to benefit from a significant 2-3% increase in returns (Yamahita *et al.*, 1999), ROA and Tobin *q* (Guenster *et al.*, 2006) from per unit of upgrading the environmental scores, and the positive market reaction to environmental investments existing for the good environmental performers(Clarkson *et al.*, 2004).

When interpreting this results pointing to a positive valuation of the environmental performance by the capital markets, it is broadly recognised that a misspricing situation is in place (Derwall *et al.*, 2005; Guenster *et al.*, 2006; Yamahita *et al.*, 1999). Thus, investors could exploit temporary miss-pricing of corporate environmental performance criteria (Guenster *et al.*, 2006).

Findings above have supported authors to recommend investors to incorporate environmental performance information in their investment assessments. This investing behaviour has been labelled in the literature as "green investing". In fact, a side effect on the literature presented here is the one assessing for the existence of "green investors". Their existence requires not only that consumers care about the environment,

but they must have access to good environmental quality information about the firms' performance and act upon that information (Stoeckl, 2004). Cormier *et al*. (1993) reports a weak evidence for their existence in Canada. The consequences on corporate behaviour from the presence of these "green investors" has been assessed also theoretically, concluding that "green investors" give incentives for firms to change their corporate behaviour, the strength of which substantially depend on the fraction of investors screening their investments (see Aslaksen & Synnestvedt, 2003 for a review; and Heinkel *et al.*, 2001 as an example).

However, until the present, it has not been reached an agreement on whether the reward (or no penalty) for green investment is a stable or temporary effect. Evidence above defending a miss-pricing situation would correspond to a temporary effect that will be dissipated when the market adequately incorporates the information on the environmental behaviour of firms. Further research will be needed in order to better clarify the response of capital markets to the environmental performance of firms.

8. CONCLUSIONS

The systematic characterization of the empirical studies addressing the economic consequences from environmental management and the market assessment of manufacturing firms' environmental behaviour shows the necessity to overcome the general question of whether it pays to be green and start posing more adequate ones.

From the studies presented above it can be extracted a mixed empirical evidence. It has been shown that firms' decisions on environmental action are like any other business decision. The answer to general questions such as "Does it pay to be green?", "Does it pay to improve quality?" or "Does it pay to build your new plant in Singapore?" is in all cases "it depends". Instead of whether it pays to be green, it would

be recommendable to ask “Under what circumstances do particular kinds of environmental investments deliver benefit to shareholders?” (Reinhardt, 1999).

The literature review has identified the major moderating factors to be taken into account for a rigorous analysis of the pays to be green hypothesis. These are the type of firm, the means by which the environmental management is undertaken, the intensity of abatement and the existence of green investors affecting the capital markets. The present state of the empirical research has not been able yet to identify the specific circumstances, which have to hold for each of the moderating factors, in order to obtain an increased economic performance from a better environmental behaviour. Nevertheless, it has been empirically demonstrated that actually, in certain occasions, it pays to be green. Thereafter, in these situations, there is scope for voluntary environmental action.

Managers and policy-makers which are embraced in these circumstances will be loosing opportunities for improving their economic performance if they underestimate the potential economic strengthening by environmental action. Notwithstanding, the opposite is also true, and some firms might find the generation of increased economic results from environmental management more difficult than much of the literature suggests. Therefore, the decision of whether to undertake a certain (or any) environmental action has to be an informed one specific to the situation.

In order to take the most advantage of the possibility of including voluntary environmental initiatives into policy-making it will be necessary that the individuals who are crafting and modifying rules understand how particular combinations of rules affect actions and outcomes in a particular situation (Ostrom, 2005, ch.1). With this purpose the academic research should put its efforts on identify and model the background forces which condition the bottom line effects from environmental

voluntary action. If the individuals who are crafting and modifying rules do not understand how particular combinations of rules affect actions and outcomes in a particular situation, rule changes may produce unexpected and , at times, disastrous outcomes (Ostrom, 2005, ch.1). Policy-makers, ignoring the evidence of an existing proportion of firms following a voluntary environmental protection strategy could induce an unexpected reduction in social welfare by public intervention. When the public administrations establish environmental policies with a general scope, these may change the contextual factors in which the firms are embraced. Therefore it is possible that a part of the firms that initially had economic incentives for voluntary environmental action, no longer perceive this situation, moving from an initial proactive strategy to a latter compliant position. As a result, the derived economic results will be modified.

Further understanding and recognising the scope for voluntary environmental action by manufacturing firms should be pursued in order to initiate the way towards a more efficient environmental regulatory climate.

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10. TABLES AND FIGURES

Table 1: Empirical review of the firms' economic consequences from environmental performance: The relevant research questions under research.

CHARACTERIZATION OF THE MAIN RESEARCH QUESTIONS								
RESEARCH QUESTION	METHODOLOGY	EVIDENCE	STUDIES	OBS.	SECTOR	ENVIRONMENTAL VARIABLES[ii]	ECONOMIC VARIABLES[iii]	BACKGROUND THEORY
Are firms' environmental and economic performance related?[1]	Correlation	Weak Positive	6	Small	refining, steel, pulp and paper, and electric utility industries	Management Self- Reported	Diverse Profitability/ Risk	None
[1] *(Bragdon & Marlin, 1972; Chen & Metcalf, 1980; Ingram, 1978; Jaggi & Freedman, 1992; Mahapatra, 1984; Spicer, 1978)*								
By what means does it pay to be green?[2]	Regression	Weak Positive One negative result	5	Medium/ Large	Diverse	Diverse Self- Reported	Accounting Profitability	· Resource-Based view of competitive advantage · Traditional Microeconomics · Planning-performance
[2] *(González-Benito & González-Benito, 2005; Hart & Ahuja, 1996; Judge & Douglas, 1998; King & Lenox, 2002; Klassen & Whybark, 1999; Rennings et al., 2006; Russo & Fouts, 1997; Thomas, 2001)*								
When does it pay to be green?[3]	Regression	Weak Positive One negative result	5	Medium/ Large	Diverse	Diverse Self- Reported		· Resource-Based view of competitive advantage · Traditional Microeconomics · Planning-performance · Industrial Organization theory · Complementary assets
[3] *(Christmann, 2000; Judge & Douglas, 1998; King & Lenox, 2001, 2002; Klassen & Whybark, 1999; Rennings et al., 2003; Wagner et al., 2002)*								
Until when does it pay to be green?[4]	Regression	Weak Positive	2	Medium/ Large	Manufacturing	Pollution/ Management (Actual/ Self-Reported)	Mixed Growth	· Traditional Microeconomics
[4] *(Dowell et al., 2000; Konar & Cohen, 2001; Nehrt, 1996)*								
Is there a reward for green investment?[5]	Mixed	Weak Positive	4	Medium/ Large	Not Specified	Pollution (Actual/ Self-Reported)	Accounting/ Market Profitability	- Efficient capital markets
[5] *(Clarkson et al., 2004; Cohen et al., 1997; Cormier et al., 1993; Derwall et al., 2005; Guenster et al., 2006; Yamahita et al., 1999)*								

Table 2: Empirical review of the firms' economic consequences from environmental performance: Are firms' environmental and economic performance related?

ARE FIRMS' ENVIRONMENTAL AND ECONOMIC PERFORMANCE RELATED? [i]								
YEAR	AUTHOR	METHODOLOGY	RESULTS	OBS.	SECTOR	COUNTRY	ENVIRONMENTAL VARIABLES[ii]	ECONOMIC VARIABLES[iii]
1972	Brangdom and Marlin	Correlation	+/no sign	12-18	Pulp and paper	US	Management (Self-reported)	Accounting Profitability
1978	Spicer	Correlation	+/no sign	18	Pulp and paper	US	Management (Self-reported)	Accounting/ Market/ Mixed Profitability/ Risk
1978	Ingram	Iterative binary splits	+/ non sign	287	Food, chemicals, industrial, manufacturing, transportation, manufacturing.	US	Disclosures (Self-reported)	Market Profitability
1980	Chen and Metcalf	Correlation	+/no sign	18	Pulp and paper	US	Management (Self-reported)	Accounting/ Market/ Mixed Profitability/ Risk
1984	Mahapatra	Correlation	+/no sign	67	Manufacturing and primary industries	US	Investment (Actual)	Market Profitability/ Risk
1992	Jaggi and Freedman	Correlation	+/no sign	13	Pulp and paper	US	Pollution (Self-reported*)	Accounting/ Market/ Mixed Profitability/ Risk

Table 3: Empirical review of the firms' economic consequences from environmental performance: By what means does it pay to be green?

BY WHAT MEANS DOES IT PAY TO BE GREEN? [i]								
YEAR	AUTHOR	METHODOLOGY	RESULTS	OBS.	SECTOR	COUNTRY	ENVIRONMENTAL VARIABLES[ii]	ECONOMIC VARIABLES[iii]
1996	Hart and Ahuja	Regression	+/no sign	127	Manufacturing and primary industries	US	Pollution (Self-reported*)	Accounting Profitability
1997	Russo and Fouts	Regression	+	243	All	US	Management (Actual)	Accounting Profitability
1998	Judge and Douglas	Regression	+	196	Primary	US	Management/Investment (Self-reported)	Accounting Profitability (Self-reported)
1999	Klassen and Whybark	Regression	+/no sign/ -	69	Furniture	US	Investment (Self-reported)	Accounting Profitability (Self-reported)
2001	Thomas	Regression	no sign	131	All	UK	Management/ Pollution (Actual/Self-reported)	Market Performance

2002	King and Lenox	Regression	+	614	Manufacturing	US	Pollution (Self-reported*)	Accounting/ Mixed Profitability/ Growth
2005	González-Benito and González-Benito	Regression	no sign	186	chemical, electronics and furniture	Spain	Management (Self-reported)	Accounting Profitability (Self-reported)
2006	Rennings *et al.*	Regression	+/no sign	1277	All	Germany	Management (Self-reported)	Accounting Profitability (Self-reported)

Table 4: Empirical review of the firms' economic consequences from environmental performance: When does it pay to be green?

WHEN DOES IT PAY TO BE GREEN? [i]								
YEAR	AUTHOR	METHODOLOGY	RESULTS	OBS.	SECTOR	COUNTRY	ENVIRONMENTAL VARIABLES[ii]	ECONOMIC VARIABLES[iii]
1998	Judge and Douglas	Regression	+	196	Primary	US	Management/Investment (Self-reported)	Accounting Profitability (Self-reported)
1999	Klassen and Whybark	Regression	+/no sign/ -	69	Furniture	US	Investment (Self-reported)	Accounting Profitability (Self-reported)
2000	Christmann	Regression	+	88	Chemical	US	Management (Self-reported)	Accounting Profitability (Self-reported)
2001	King and Lenox	Regression	+/no sign	652	Manufacturing	US	Pollution (Self-reported*)	Mixed Growth
2002	King and Lenox	Regression	+	614	Manufacturing	US	Pollution (Self-reported*)	Accounting/ Mixed Profitability/ Growth
2002	Wagner *et al.*	Regression	-/no sign	37	Paper	Europe	Pollution (Self-reported)	Accounting Profitability
2003	Rennings *et al.*	Regression	+/no sign	241	High tech, banking, insurance and construction	Europe	Management/ Pollution (Not specified)	Market Profitability

Table 5: Empirical review of the firms' economic consequences from environmental performance: Until when does it pay to be green?

UNTIL WHEN DOES IT PAY TO BE GREEN? [i]								
YEAR	AUTHOR	METHODOLOGY	RESULTS	OBS.	SECTOR	COUNTRY	ENVIRONMENTAL VARIABLES[ii]	ECONOMIC VARIABLES[iii]
2000	Dowel *et al.*	Regression	+/no sign	89	Manufacturing and primary industries	US	Management (Self-reported)	Mixed Growth

2001	Konar and Cohen	Regression	+	321	Manufacturing	US	Pollution (Actual/Self-reported*)	Mixed Growth
1996	Nehrt	Regression	+/-	50	Pulp and paper	Global	Investment (Actual/Self-reported)	Accounting Profitability

Table 6: Empirical review of the firms' economic consequences from environmental performance: Is there a reward for green investment?

IS THERE A REWARD FOR GREEN INVESTMENT? [i]								
YEAR	AUTHOR	METHODOLOGY	RESULTS	OBS.	SECTOR	COUNTRY	ENVIRONMENTAL VARIABLES[ii]	ECONOMIC VARIABLES[iii]
1993	Cormier *et al.*	Regression	+/ non sign	74	Industrial and Mining	Canada	Pollution (Actual)	Market Profitability
1997	Cohen *et al.*	Correlation	non sign	163-433	85 categories	US	Pollution (Actual/ Self-reported)	Accounting/ Market Profitability/ Risk
1999	Yamashita *et al.*	ANOVA/ Correlation/ Regression	+/ non sign	49	Not specified	US	Pollution/ Management (Actual/ Self-reported)	Accounting/ Market Profitability/ Risk/ Growth
2004	Clarkson *et al.*	Regression	+	29	Pulp and paper	US	Pollution (Self-reported)	Market Profitability
2005	Derwall *et al.*	Regression	+/ non sign	180-450	Not specified	US	Pollution (Actual)	Market Profitability
2006	Guenster *et al.*	Regression	+	154-519	Not specified	US	Pollution (Actual)	Accounting/ Mixed Growth/ Profitability

[i] The studies have been included in each of the empirical questions they address, being possible that a study is present in more than one.
*Information self-reported to governmental institutions.
[ii] Environmental variables have been classified attending to the type of information contained and its source (inside brackets). The type of information has been classified in polluting behaviour (pollution), environmental management (management), investment efforts for environmental protection (investment) and information disclosures to the market (disclosures). The type of information has been classified in actual, when the researcher or the institution generating the primary data collected it from verified behaviour, and self-reported, when the original data collection process was based on self-reports from firms.
[iii]Economic variables have been classified attending to the type and information content of the variable. Additionally, when the source is from self-reports, a remark has been included inside brackets. Considered types of variables are included in the first line, being: accounting, market and mixed variables. The different information contents they embrace are either firms' profitability, risk and growth

Figure 1: Chronological order of the research questions analyzing the relationship between the environmental and economic performance of manufacturing firms.

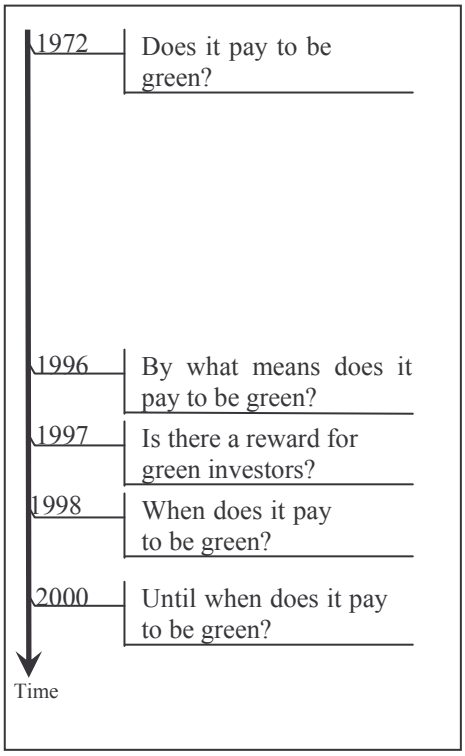
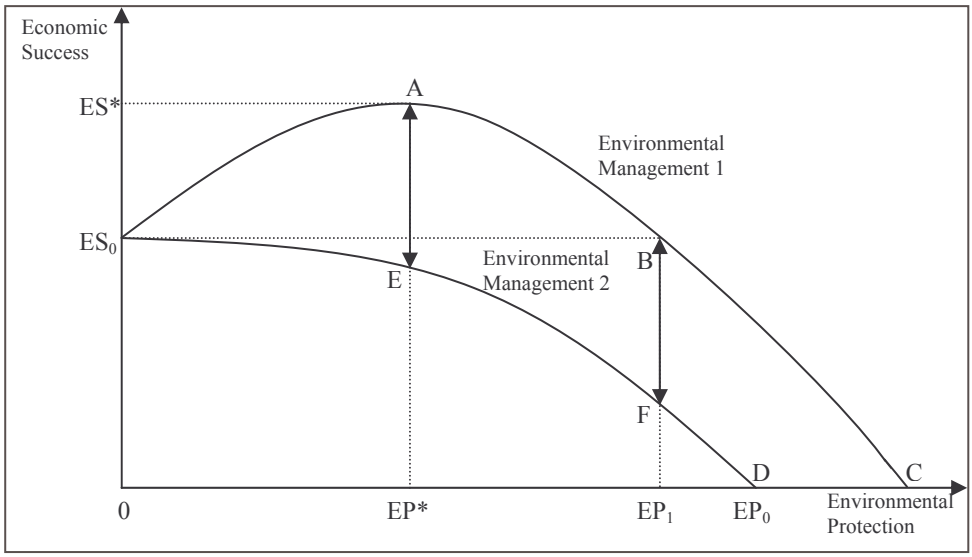


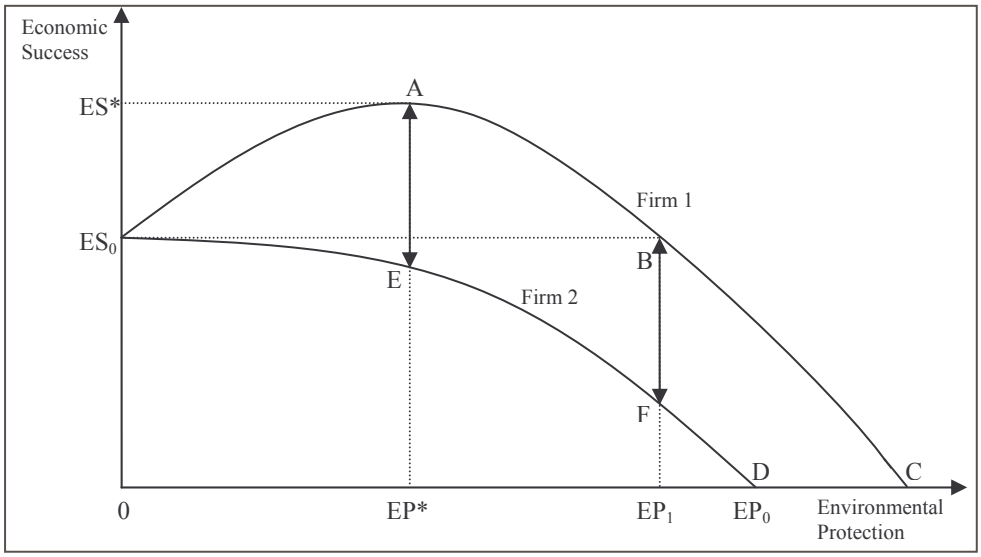
Figure 2: Possible relations between corporate environmental protection and economic success: By what means does it pay to be green?
Comparable firms being at the same level of environmental performance are considered for comparing the economic effects of different environmental management concepts. This provides information about the vertical distance between the lines ES_0-E-F-D and ES_0-A-B-C**.**



Adapted from Schaltegger and Synnestvedt (2002).

Figure 3: Possible relations between corporate environmental protection and economic success: When does it pay to be green?

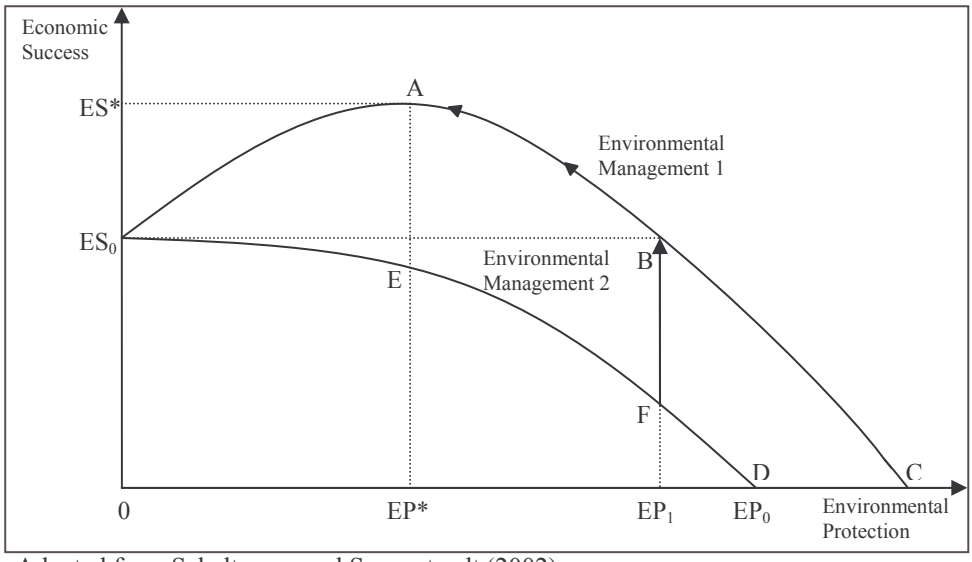
Different companies using the same environmental management concept are compared for analyzing the economic effects of different characteristics and boundless of capabilities. This provides information about the vertical distance between the curves ES_0-E-F-D and ES_0-A-B-C**.**



Adapted from Schaltegger and Synnestvedt (2002).

Figure 4: Possible relations between corporate environmental protection and economic success: Until when does it pay to be green?

Comparable companies have to firstly move to their most cost-efficient environmental management concept (the upper curve ES_0-A-B-C) to latter initiate environmental learning process in the company (moving along ES_0-A-B-C) to finally reach the optimal level of environmental protection (EP*) and its associated economic performance (ES*).



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