ENVIROMENTAL PROACTIVITY AND BUSINESS PERFORMANCE: AN EMPIRICAL ANALYSIS

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Abstract

This paper analyses the relationship between environmental proactivity and business performance on a sample of 186 industrial companies. This relationship is approached by studying a bundle of relationships between different dimensions or manifestations of environmental proactivity and different measures of business performance. The analysis in part supports the idea that environmental management can bring about competitive opportunities for companies, although it also reveals that some environmental practices produce negative effects. It is thus concluded that there is no one single response for the question of whether environmental proactivity has positive effects on business performance and that this relationship must be disaggregated into more specific and concrete relationships.

Key words: environmental proactivity, business performance

1. INTRODUCTION

The growing degradation of the natural environment is one of the main threats to human survival in the long term. Industrial companies are to a great extent responsible for this degradation and must accept compromises in order to achieve what has been called ‘sustainable development’ (Hart, 1997). The literature reveals that there exist a number of practices and initiatives that can be implemented by a company to reduce its impact on the environment (e.g. Sarkis, 2001; Shrivastava, 1995b). This has prompted a debate about the competitive effects of the voluntary adoption of environmental management practices, that is, about the competitive outcomes of a greater ‘environmental proactivity’ (Schaltegger and Synnestvedt, 2002). Against the traditional view, in recent years, a number of papers have argued that there are competitive opportunities associated with environmentally friendly management (e.g. Russo and Fouts, 1997; Sharma and Vredenburg, 1998). Nonetheless, empirical support is still scanty and sometimes contradictory (Christmann, 2000; Wagner et al., 2001).
The objective of this paper is to empirically analyze the relationship between environmental proactivity and business performance. Nonetheless, our approach presents some distinctive features that can help to understand this complex relationship:

- Most of the previous research has used measures of environmental proactivity based on environmental performance (see review in Wagner et al., 2001). This paper considers that a better environmental performance can be achieved through different types of environmental practices and that not all these practices have the same effects on business performance. It is therefore necessary to study separately the different environmental patterns and strategies that companies deploy and, consequently, to measure environmental proactivity by the degree of implementation of diverse environmental practices. Few researchers have adopted this approach (e.g. Christmann, 2000; Klassen and Whybark, 1999b; Sharma and Vredenburg, 1998), so there is still no agreement about which groups of environmental practices tend to be implemented together; that is, there is no one commonly accepted classification of dimensions of implementation of environmental management practices. Because of this, in this paper, such dimensions are explored first and their relationships with business performance are analysed afterwards.

- Just as there might be different environmental patterns, each of them can lead to different performance improvements. The literature has separately studied different performance measures and this might be one of the explanations for the conflicting results reached. Business performance has been approached through, for example: measures of financial performance, some based on accounting data (e.g. Russo and Fouts, 1997) and others based on market value (e.g. Hamilton, 1995); measures of operational or manufacturing performance (Klassen and Whybark, 1999b); or more specific measures of cost performance (Christmann, 2000). Because of this, we decided to combine different measures of business performance, thereby helping to elucidate the distinct competitive effects of environmental management.

Thus, this paper has its roots in the idea that there is no single relationship between environmental proactivity and business performance. Rather, it is assumed that this relationship depends, on one hand, on the portfolio of practices in which this proactivity is demonstrated, and, on the other hand, on the type of business performance which is considered.
The paper is structured into 6 sections. In section 2, the concept of environmental proactivity is reviewed and the most representative environmental management practices are listed. In section 3, the literature on the relationship between environmental proactivity and business performance is reviewed and some research hypotheses are proposed. Section 4 is devoted to describing the methodology followed to test the hypotheses, and the results are presented and discussed in section 5. The main conclusions are summarized in section 6.

2. ENVIRONMENTAL PROACTIVITY: ENVIRONMENTAL MANAGEMENT PRACTICES

Companies’ environmental commitment has become an important variable in most of today’s competitive scenarios. This has led researchers to distinguish between two extreme positions: environmental reactivity, typical of companies that only implement the minimal compulsory changes to meet regulations, and environmental proactivity, typical of companies that voluntarily take measures to reduce their impact on the natural environment. In general terms, two categories of papers can be distinguished according to the way they view the path from reactivity to proactivity: one-dimensional and multi-dimensional studies.

Conceptual works such as those of Hunt and Auster (1990), Roome (1992) and Winsemius and Guntram (1992) establish a number of progressive stages ranging from reactivity to the highest proactivity, that is, assuming a single and linear path that companies follow when developing their commitment to the natural environment. In other words, one more step in the way of proactivity is associated with a higher implementation of voluntary environmental management practices, but little is said about whether or not the emphasis on particular sets of voluntary practices gives rise to different proactive environmental strategies. This one-dimensional behaviour has been empirically registered in the papers of Sharma and Vredenburg (1998), Henriques and Sadorsky (1999) and Buysse and Verbeke (2003). All these studies start from a list of environmental practices and observe that the implementation of all of them can be reduced to a single factor (Sharma and Vredenburg, 1998) or that those companies with high levels of implementation of one of the practices tend to show high levels of implementation of the whole set of practices (Henriques and Sadorsky, 1999; Buysse and Verbeke, 2003). Because of this, the last two papers also identify several progressive stages along a one-dimensional path from reactivity to proactivity.
Other researchers have adopted a multidimensional and contingent view, that is, they consider that there is no single path (a single linear succession of stages) towards proactivity and that the diversity of existing environmental management practices gives rise to different manifestations of strategic proactivity. Papers such as those of Vastag et al. (1996), Azzone et al. (1997) and Klassen and Angell (1998) propose two-dimensional classifications of environmental management strategies. Bansal and Roth (2000) identify different motivations that lead to a higher environmental proactivity and consider that each motivation induces the implementation of a different portfolio of environmental practices. These papers suggest that environmental proactivity does not necessarily imply the generalised implementation of any environmental management practice; rather, it can be manifested in different ways through different sets of practices. This multi-dimensionality in the implementation of environmental practices is empirically registered by Aragon-Correa (1998), who identifies three orthogonal dimensions after subjecting the implementation measures of a set of environmental management practices to principal components analysis. Klassen and Whybark (1999a) consider three factors determining the environmental management orientation of an organization, each of them characterised by a particular set of practices. A confirmatory factor analysis proves a good fit of data to this multidimensional scheme.

All these papers reveal that there are different types of proactive initiatives and practices, and that they might not always be reduced to a single dimension. Furthermore, there is no conclusive evidence about how voluntary environmental practices group into dimensions and what these dimensions are. This reasoning led us to think that in order to measure environmental proactivity it is important (1) to take into account a range of environmental practices as broad as possible, and (2) to adopt an exploratory approach since previous research does not allow us to configure implementation dimensions a priori.

With these premises, one initial objective of this research was to construct a comprehensive and broad list of environmental management practices by reviewing the literature. This process showed that some environmental practices tend to be implemented at the corporative and organisational level, thereby affecting the whole company and primarily focussing on strategic planning and organisational structure. Other practices have a more functional character, the operations and production function playing an essential role in environmental issues. Several papers have highlighted the crucial importance of this function in environmental management (Angell and Klassen, 1999; Gupta, 1994; Inman, 1999; Sarkis, 1995, 2001), thus revealing that
many environmental practices need to be implemented in the domains of the operations function and require the implication of the operations managers. Other practices mentioned in the literature are related to the marketing function since they aim at communicating the company’s progress on environmental management to the stakeholders. These observations thus led us to distinguish, for descriptive purposes only, between ‘planning and organizational practices’, ‘operational practices’ and ‘communicational practices’, in what can be understood as a functional approach to the listing of practices. Each category is further commented upon below and some representative practices within them have been gathered in Table 1.

**Planning and Organizational Practices**
These practices denote the extent to which the company has defined an environmental policy, has developed procedures for establishing environmental objectives, for selecting and implementing environmental practices, and for assessing the outcomes of such practices, or, has allocated environmental responsibilities. Practices like these were considered by Henriques and Sadorsky (1999) to identify environmental commitment profiles, in what can be seen as an approach primarily focussed on environmental planning. This set also includes practices loading into the information and education factor of Aragón-Correa (1998) and considered within the systems analysis and planning dimension of Klassen and Whybark (1999a). All these practices reflect in some way the extent to which an Environmental Management System (EMS) has been developed and implemented.

**Operational Practices**
These are practices which imply changes in the production system and the operations of the company and which can be classified into two groups: product-related practices and process related practices, that is, practices related to the ‘what’ and to the ‘how’. This product-process distinction has been already made by Sarkis (2001) and has proved to be relevant when studying the effects of environmental initiatives (Gilley et al., 2000).

Product related practices focus on designing and developing more ecological products. They should not only consist of replacing polluting and hazardous materials with other green supplies, or reducing resource consumption, but should also reflect a long term commitment and an integrated view of the value chain (De Ron, 1998). That is, they should reflect commitment to the product even after it has been sold (Angell and Klassen, 1999; O’Brien, 1999). In this sense, Shrivastava (1995b) considers ‘design for disassembly’ as one of the major environmental
technology themes, and Sarkis (1998) expands this idea by talking about design for reusability, recyclability, remanufacturing, disassembly or disposal.

Process related practices aim at developing and implementing manufacturing and operational methods and processes in such a way that impact on the natural environment is reduced. Some of them affect internal processes and encompass both remediation and control practices such as the installation of emission filters or waste separation and preparation systems, together with prevention practices such as the acquisition of clean technologies, the use of renewable energy resources, or the contemplation of environmental criteria for production planning (Bullinger et al., 1999; De Ron, 1998; Enarsson, 1998; Klassen and Whybark, 1999a). The former practices aim at reducing and controlling the negative effects of emissions and waste once they have been generated, whereas the latter practices aim at reducing resource consumption and waste generation. Some other process related practices affect external processes, and influence supply and distribution activities and, in general, company interactions with other elements of the value chain. Authors such as Murphy et al. (1994), Wu and Dunn (1994), Handfield et al. (1997), Sarkis (1998) and Min and Galle (2001) mention different practices of this type. The purchasing of ecological products, the inclusion of environmental performance criteria in supplier selection processes, the consolidation of shipments, the use of reusable or recyclable packaging and cleaner transportation methods, and the establishment of recuperation and recycling systems are some of these practices.

Communicational Practices

This category includes those practices aimed at communicating to the company’s social and institutional environment the actions taken in favor of the natural environment. Practices like these have been considered as one more side of the environmental commitment (e.g. Aragón-Correa, 1998; Florida and Davison, 1999). They tend to pursue commercial objectives and try to establish cordial relationships with the variety of stakeholders around the company. Thus, communicational practices complete the environmental development of a company by matching its public image to stakeholders’ expectations.

Neither planning and organizational practices nor communicational practices can by themselves contribute to improving environmental performance. However to a great extent they respond to the mandates of environmental certifications such as the ISO14001. Owing to the development and public recognition of environmental standards like this and to their own nature, planning and organizational practices and communicational practices might exert a positive impact on public
opinion, thereby affecting the company’s performance in markets. This reasoning led us to think that the effects of environmental management on business performance depend on the portfolio of environmental practices which have been implemented rather than on the changes they produce in environmental performance. Thus, environmental proactivity should not be measured by environmental performance indicators, but rather by the degree of implementation of different environmental management practices.

--- TABLE 1 ---

3. ENVIRONMENTAL PROACTIVITY AND BUSINESS PERFORMANCE

As for most of the management initiatives, one of the questions that primarily attracts the attention of researchers and practitioners is to know whether there are competitive advantages and opportunities associated with environmental management. In this sense, the relationship between environmental proactivity and business performance has recently been analyzed by several authors from different points of view.

The empirical research has not been conclusive (Christmann, 2000; Wagner et al., 2001) and the debate is still open. Some opinions are against the existence of a positive relationship. Walley and Whitehead (1994), for example, consider that, although the view of environmental management as a source of competitive advantage is very attractive for companies, it is not very realistic. Environmental commitment is very costly, especially when the company has already been moving in this direction and has solved the simpler problems. To a certain extent, these authors consider that although advancing in the environmental improvement of the company might be easy at the beginning, it is an economic burden in most cases. In another critical work, Newton and Harte (1997) consider that the literature on environmental management adopts a rhetorical and evangelistic position which is based on questionable ideas. These authors point out the lack of solid and empirically tested arguments to convince companies of the advantages of active environmental management.

Nonetheless, in the last few years some papers have developed new theoretical arguments and have provided empirical evidence on the existence of a positive relationship between environmental proactivity and different measures of business performance. Most of them focus on
environmental practices rather than environmental performance, thus suggesting that the outcomes of environmental proactivity depend on the environmental practices through which such proactivity is manifested. Such papers are commented upon below under three headings which, although very related, aim at establishing distinctions according to the theoretical approaches which are used.

Environmental proactivity as a source of strategic resources and capabilities

Most of the arguments used to explain the existence of advantages associated with environmental proactivity are built on the resource-based view of the firm, which has been developed from the initial work of Wernerfelt (1984) by many authors (e.g. Barney, 1991; Grant, 1991; Mahoney and Pandian, 1992; Peteraf, 1993; Rumelt, 1984). In this sense, Hart (1995) considers that such a view of the firm must be adapted to take into account diverse environmental constraints affecting current competition, and that there are environmentally oriented resources and capabilities with the potential to generate sustainable competitive advantages. In this line, Russo and Fouts (1997) confirm over a sample of 243 companies that high levels of environmental commitment are associated with enhanced profitability, this relationship being stronger in industries showing high levels of growth. The effect on business performance is explained because proactive companies have some distinctive resources: (1) physical assets and technology, which might not be a source of differentiation by themselves, but might lead to distinctive capabilities and knowledge in environmentally proactive companies; (2) human resources and organizational capabilities, perhaps because it is easier for proactive companies to attract top candidates; and, (3) intangible resources, such as reputation and the ability to influence public policies to achieve competitive advantages.

From an exhaustive study of cases, Sharma and Vredenburg (1998) identified three key capabilities derived from environmental commitment: (1) capability for stakeholder integration, that is to say, capabilities for influencing stakeholders or mitigating their pressures; (2) capability for higher-order learning, since the company explores new alternatives and generates new interpretations of existing procedures; and, (3) capability for continuous innovation, because the greater richness of perspectives and analyses in the learning process contributes to generating technological, organizational and operational innovations on a continuous basis. These authors provide empirical evidence of a positive relationship between environmental proactivity and these capabilities and also register a flow of competitive benefits from these capabilities. Also through a
resource-based approach, Klassen and Whybark (1999b) studied the impact of environmental technologies on manufacturing performance. Their empirical results indicate that pollution prevention technologies, more typical of proactive behaviors, exert a positive effect, whereas pollution control technologies do not.

*Environmental proactivity as a source of cost and differentiation competitive advantage*

Other authors justify the potential outcomes of environmental proactivity by explaining and analyzing its contribution to improving the two basic types of competitive advantage of Porter (1980), low cost and differentiation; or, in a more disaggregated way, by reasoning more detailed lists of potential advantages and benefits. In this sense, Shrivastava (1995a,b) argues that the environmental objective is compatible with and can foster strategies based on cost leadership as well as strategies based on differentiation. This author, although recognizing the existence of important initial costs and barriers, mentions a number benefits, for example: reduction of operating costs by exploiting ecological efficiencies, increased demand by attracting ‘green’ consumers, improved relationships with stakeholders, reduction of long-term risk (associated, for example, with fluctuation in energy costs), or a higher ability to influence or to go ahead of regulation. Through a literature review, Christmann (2000) also points out the potential of certain environmental management practices in achieving low cost and differentiation advantages, although this author considers that most of the cost reductions that can be obtained depend on government regulations (e.g. liability costs, legal fees). This paper also provides empirical evidence that the higher a firm’s level of innovation in proprietary pollution prevention technologies, the larger the costs advantage it gains from environmental strategies. Taking into account many of the operational and commercial advantages mentioned above, Alvarez et al. (2001) obtained empirical evidence of a positive effect of environmental management on financial performance in a service sector.

Arguing in favor of the competitive potential of environmental management practices for generating cost savings and market gains, Klassen and McLaughlin (1996) studied the relationships between environmental proactivity and the market assessment of financial performance (equity value of the firm). These authors observed that markets value the environmental achievements of companies. Hamilton (1995) and Cordeiro and Sarkis (1997) obtained similar results.
Environmental regulation as a driver to obtain competitive advantage from environmental management

Porter and Van der Linde (1995a,b) consider that there are competitive opportunities associated with environmental management, and that environmental regulation can trigger innovation that might offset the costs of complying with it. Thus, they challenge the traditional view of economists and other policy analysts, which associates environmental regulation with losses in competitiveness and cost increments (Christainsen and Haveman, 1981; Norsworthy et al., 1979; Rose, 1983; Palmer et al., 1995).

According to Porter and Van der Linde, there is an unjustified struggle between industry and regulators. They hold that innovations prompted by regulation are of two types: product related, which can lead to better product quality and improved product features, or a reduction of production costs (e.g. through packaging reductions or material substitution), and process related, which can generate material savings, reduce downtime, or convert waste into valuable forms. Although there seems to be no consistent empirical evidence to support or reject this stance (Jaffe et al., 1995), the arguments suggest the existence of a positive relationship between environmental management and competitive advantage, although it is considered that, given the skepticism of managers, regulation might be the trigger needed to raise the interest of companies. Thus, some ideas supporting the existence of benefits associated with environmental proactivity can be found in the literature on environmental regulation.

All the papers reviewed under these three headings lead us to think that environmental proactivity can have a positive effect on business performance. However, as mentioned above this effect is expected to be dependent on the portfolio of environmental practices through which environmental proactivity is manifested. This leads us to propose the following hypothesis:

Hypothesis 1: There are positive effects of environmental proactivity on business performance and these effects are dependent on the portfolios of environmental management practices through which environmental proactivity is manifested.

This hypothesis has been proposed under the idea that there is no one single relationship between environmental proactivity and business performance. Rather, there are different
relationships between different environmental management practices and business performance. In this sense, it is also important to take into account that there are also different ways of understanding and measuring business performance (Neely, 1999) and that, according to the above-mentioned literature, environmental proactivity might affect them differently. From a functional view of the firm, at least three types of performance should be studied: operational performance, marketing performance and financial performance.

Operational performance (also production or manufacturing performance) refers to the effectiveness of the production and operations system. It has traditionally been assessed according to factors such as cost, quality, flexibility, dependability and speed (Skinner, 1969; Cleveland et al., 1989), which are referred to as competitive priorities (Hayes and Wheelwright, 1984) or performance objectives (Slack et al., 1998) of the operations function. Many of the above-mentioned papers allude directly or indirectly to the effect of environmental proactivity on these objectives, since such objectives become affected by changes in the portfolio of strategic resources and capabilities of the company (Klassen and Whybark, 1999b) and their achievement constitutes the base for many cost or differentiation advantages (Porter and Van der Linde, 1995b). Thus, the following sub-hypothesis of hypothesis 1 is proposed:

**Hypothesis 1a:** There are positive effects of environmental proactivity on operational performance.

Marketing performance refers to the effectiveness of the marketing function, that is, to the ability of the company to meet customer requirements. Although there are different ways to assess the results of marketing (Kotler, 1994), any indicator of reputation, new product launching success, or product adequacy to market needs reveals how able the company is to manage its relationships with customers and to satisfy them. Some of the resources and capabilities that Russo and Fouts (1997) and Sharma and Vredenburg (1998) attribute to environmental proactivity directly refer to the possibility to influence stakeholders (in particular to influence customers) and build reputation. Furthermore, the growing environmental commitment of final customers (Mainieri and Barnett, 1997) and the public recognition of environmental certifications such as ISO14001 also indicate that environmental management practices might be a way of differentiating the company and attracting new market segments. Thus, the following sub-hypothesis of hypothesis 1 is proposed:
Hypothesis 1b: There are positive effects of environmental proactivity on marketing performance.

Financial performance refers to the importance of the pecuniary outcomes derived from business activity. Measures of financial performance can be based on accounting data (e.g. Hart and Ahuja, 1996; Russo and Fouts, 1997) or market value (e.g. Hamilton, 1995; Klassen and McLaughlin, 1996; Cordeiro and Sarkis, 1997), the second approach being used to analyze the market reactions to environmental events. Although financial measures present important limitations which recommend the use of other measures of performance (Neely, 1999), they are the most commonly used and could be understood as indicators of the general business performance. Although there are many other variables involved, the ultimate consequence of any competitive advantage derived from environmental proactivity is expected to be an improvement in financial performance. Thus, the following sub-hypothesis of hypothesis 1 is proposed:

Hypothesis 1c: There are positive effects of environmental proactivity on financial performance

4. METHODOLOGY

Data

From the 2002 Dun & Bradstreet census of the 50,000 largest Spanish companies, we selected all the entries with more than 100 employees in three industrial sectors: chemical products (except pharmaceutical companies), electronic and electrical equipment, and furniture and fixtures. The approached population thus consisted of 428 companies, 156 of which were in the chemical sector, 211 in the electronic and electric equipment sector, and 61 in the furniture sector.

After a pretest on 9 companies, a postal questionnaire was addressed to the production and operations manager of each company, who in some cases delegated certain questions to those in charge of environmental management or quality. In all the cases, the questionnaire was preceded by a phone call to identify the appropriate addressee, to announce the sending of the questionnaire and to ask for collaboration. A presentation letter was attached to each
questionnaire and, some days after the mailing, a second phone call was made to all the companies that had not replied. This procedure yielded a global response rate of 43.38%, which in turn corresponds to rates of 40.38%, 45.50% and 44.26% for the chemical, electronic equipment and furniture industries, respectively.

**Measures**

*Environmental proactivity*

Each operations manager was asked to score the degree of implementation of each practice included in Table 1 according to a six-point scale (1 “not at all; only what regulation requires” – 6 “to a great extent; it has been a priority for our company”). In order to identify the dimensions or strategies underlying the implementation of environmental practices, principal component analysis was applied to whole set of items. Table 2 shows the structure matrix after a varimax orthogonal rotation. A total of four factors resulted with eigenvalues higher than one, together accounting for 67.66% of the variance. Planning and organizational practices load on factor 1. Product operational practices, which refer to the use of environmental criteria for product design, present the highest loadings on factor 3. With respect to process operational practices, those referring to logistics and supply chain management tend to load on factor 2 and those referring to internal processes of the company tend to load on factor 4. Communicational practices are shared by factors 1 and 2. This is not surprising if we take into account that: (1) the planning and organizational practices respond, in many cases, to the requirements of certifications such as ISO14001, which are usually associated with a desire to make environmental consciousness public; and (2) process operational practices related to logistics and supply chain management require the collaboration of other agents, and it is very useful to make environmental commitment known outside the company. If we take into account these remarks, the four factors respectively reflect four dimensions through which environmental proactivity can show up: planning and organization, logistics processes, product design, and internal production processes.

Some additional questions included in the questionnaire acted as controls for the validity of data. Each company was asked to mark its situation as regards ISO14001 certification according to four stages: (1) certification not considered, (2) certification considered for the near future, (3) certification in process, and (4) certification awarded. The ‘planning and organization’ factor (factor 1) captures most of the environmental management practices required for ISO14001
certification. Thus, it is expected that the more advanced the ISO14001 stage at which the company is, the higher its score at factor 1. An ANOVA F-test (F = 58.425, p = 0.000) and subsequent Tukey tests show that the mean of factor 1 at each stage is significantly higher than in the previous one, thus confirming the expected pattern. This result not only proves the convergent validity of factor 1, but it also indicates that managers completed the questionnaire consistently and it therefore constitutes a proof of the validity of the collected data.

--- TABLE 2 ---

Performance
To measure operational performance, each surveyed manager was asked to score the relative position of his company with respect to their competitors according to the five competitive objectives considered in Slack et al. (1998): cost, quality, flexibility, reliability and speed. Specifically, managers marked over a five-point scale whether they considered their companies very inferior (1), somewhat inferior (2), equivalent (3), somewhat superior (4), or very superior (5) to their competitors according to the items included in Table 3. A single item was considered for each competitive objective except for flexibility, where two items referring to design and mix flexibility and volume flexibility were included. Principal components analysis indicated that the six performance items load on two factors that explain 63.082 of the variance (Table 3). The first factor captures operational objectives such as low cost, processing speed, and design and mix flexibility. Such performance objectives, specially the first two, are expected outcomes of mass production systems with a variety of assembly lines. In this sense, this factor has been labeled 'mass operational performance'. The second factor captures performance objectives such as reliability, volume flexibility and quality. They are the typical performance requirements and outcomes of lean production systems (Womack et al., 1990). Thus this factor has been labeled 'lean operational performance'. Nonetheless, it must be taken into account that these labels have been assigned only to facilitate the description of results and they do not try to reflect exhaustively the meaning of each factor. Thus, irrespective of the label given to each factor, the results reveal that there are two differentiated groups of operational performance objectives for the companies in the sample, i.e. two orthogonal measures of operational performance must be considered. These measures were constructed for 185 companies of the sample since one company did not complete all the required items.

--- TABLE 3 ---
To measure marketing performance, a similar procedure was followed for the three items in table 4. A single measure was built through principal component analysis, which presents satisfactory symptoms of construct validity (factor loadings) and reliability (Cronbach’s $\alpha$) according to the usual standards (Flynn et al., 1990). As for operational performance, this measure was built for 185 of the 186 companies in the sample.

--- TABLE 4 ---

To measure financial performance, data about the return on assets (ROA) were collected from the Dun&Bradstreet 2002 database. Information about benefits and total assets was available for a total of 180 companies, thus ROA was calculated by dividing the first figure by the second one.

**Analysis**

Hypothesis testing was conducted through multiple regression analysis. The four measures of business performance (mass operational, lean operational, marketing and financial performance) were interpreted as dependent variables and the four dimensions of environmental proactivity as independent variables. In order to isolate the relationship studied, four control dimensions were added to the group of independent variables:

1. Company size, measured as hundreds of employees. This variable was included to control the effect of scale economies and it is a typical control variable in studies attempting to explain business performance (e.g. Christmann, 2000; Klassen and Whybark, 1999b; Russo and Fouts, 1997).
2. Plant equipment age, measured by the number of five-year intervals from the acquisition of the main productive equipment in use. This variable was included to control the rigidities imposed by existing equipment, which might directly affect productivity. Klassen and Whybark (1999b) also consider this control variable.
3. The industrial sector, which required the introduction of two binary variables distinguishing the chemical and electronic and electrical equipment sectors, respectively. Since industrial differences have turned out to be important in previous research (see Russo and Fouts, 1997), these variables were included to control the different circumstances and sets of competitive forces acting in each sector.
(4) The use of advanced production and operations management (POM) approaches. The literature attributes performance improvements to advanced POM techniques and tools such as Total Quality Management (Flynn et al., 1995; Samson and Terzirovski, 1999), advanced manufacturing technologies (Brandyberry, 1999), Just-in-Time (Brox and Fader, 1997; Fullerton and McWatters, 2001), information-technology-based integrated management systems such as ERPs (Feeny and Ives, 1997), and collaboration with suppliers (Dyer, 1997; Dyer and Ouchi, 1993). It is therefore convenient to control the possible differences between companies with respect to these advanced practices. Thus, a control variable was built through principal component analysis from the degree of implementation of these five advanced management practices (Table 5). The implementation of each of them, considered typical of advanced and highly developed operations systems, was scored on a six-point scale (1 “not at all” – 6 “completely; to a great extent”). This variable was therefore included in an attempt to control the degree of development of the production and operations management function.

--- TABLE 5 ---

In order to assess the relationships among independent variables, different statistical tests shown in Tables 6 and 7 were conducted according to the properties of the different scales combined in the study. The electronic sector concentrates the largest companies with the newest equipment and the most advanced production management techniques. On the other hand, the chemical sector has the oldest equipment and is characterized by the highest levels of implementation of planning and organizational environmental management practices. More relevant for hypothesis testing, it was observed that company size and, especially, the use of advanced POM systems are significantly correlated to different dimensions of environmental proactivity. This indicates that companies committed to environmental management are also committed to the implementation of advanced production management methods. They therefore show a certain general proactivity which leads the company to adopt the most innovative management systems. In what has become a popular methodological approach for the treatment of collinearity (e.g. Christmann, 2000; Russo and Fouts, 1997) two explanatory models were considered. The first model only includes the control variables as independent variables. The second model incorporates the four orthogonal dimensions of environmental proactivity. Given that each model was estimated for four dependent variables, a total of 8 multiple regressions were analyzed. Results are presented in Table 8.
5. DISCUSSION OF RESULTS

The explanatory model 1 in Table 8 includes only the control variables and reveals that the use of advanced POM practices and, to a lesser extent, the company’s size and the industry are relevant for explaining business performance. The coefficients of the first variable are positive and significant for a confidence level of 99%. This result confirms the positive effects that the literature attributes to advanced POM techniques and tools. These effects appear registered for the four measures of performance.

A more surprising result is that of company size. This variable has a negative and significant influence on lean operational and marketing performance at the 95% and 90% confidence levels respectively. Thus, the volume of production does not benefit, and even harms, operational objectives such as volume flexibility, reliability and quality as well as the satisfaction and receptivity of customers or the company reputation. Additional analyses which are not included in the purpose of this paper would be required to explain this outcome. At first glance, these observed diseconomies of scale could be explained with arguments such as the arising of coordinating problems insofar as the company grows and becomes more bureaucratic or because the key resources and capabilities in the studied industries are easily attainable and able to be generated by small companies. Nonetheless, the variable company size might also be revealing differences among industries since, as shown in Table 7, it presents a significant relationship with one of the variables discriminating industrial sectors. Thus, the effect of company size might be a consequence of the collinearity among control variables.

The data also reveal certain industrial differences. The electric and electronic equipment industry tend to be less competitive on mass operational performance, that is, they show lower effectiveness in objectives such as costs, speed and design and mix flexibility. This might also be an effect of collinearity between control variables or reflect a lower interest of the electronic industry in these operational objectives. Nonetheless, although the explanatory power ($R^2$) of
regressions in model 1 is low, the significant results obtained for several control variables suggest the appropriateness of having included them in the analysis.

The effect of control variables persists in explanatory model 2, which incorporates the four dimensions of environmental proactivity. With respect to mass operational performance, the implementation of environmental practices related to the transformation of internal production processes appears to have a negative effect at the 90% level. That is, environmental practices such as the installation of emission filters and waste separation and preparation systems, the use of renewable energy resources or the contemplation of environmental criteria for planning and programming production are not compatible with operational objectives such as cost, speed and design and mix flexibility. This is to some extent reasonable since these environmental practices involve the incorporation of additional operations in the production process or the selection of resources, batch sizes or production sequences that are not optimal in terms of cost or time. Some of the practices loading on this dimension of environmental proactivity are oriented to control rather than prevention. Therefore, observations are also consistent with the results obtained by Klassen and Whybark (1999b), who concluded that preventive technologies instead of control technologies have a positive effect on operational performance.

On the contrary, the implementation of environmental practices related to the transformation of logistics processes turns out to have a positive and significant effect on lean operational performance at the 95% level. This result contradicts the allegation that the use of recyclable materials or the reutilization of components act in detriment of company quality and reliability, an argument typically used by managers to criticize environmental management. It also reveals that the environmental transformation of supply chains in terms of shipment consolidation, ecological packaging and reuse of containers yields certain operational advantages. Thus, data provides partial support for hypothesis 1a, revealing that although environmental practices can help to achieve certain operational objectives, they can also harm other operational objectives.

It is worth mentioning that the logistics processes dimension of environmental proactivity also takes in the implementation of environmental technologies and clean equipment (see Table 2), thereby suggesting that these technologies may in turn be superior in other aspects apart from environmental preservation. This leads us to think that, as pointed out by Porter and Van der Linde (1995a,b), the improvement of environmental performance can be the trigger or the excuse to initiate innovation and renovation processes which will yield other diverse competitive benefits.
With respect to marketing performance, the dimension of environmental proactivity related to the transformation of product design is the only one which appears to be significant. That is, according to the results obtained, the company’s reputation and capability to meet customers’ expectations can be improved through the conception of environmentally friendly products. In contrast, the dimension related to planning and organizational environmental practices does not appear to be significant. If we take into account that these group of practices uses to be associated to the environmental certification of the company, this result might reveal that that consumers are not impressed or influenced by environmental certifications. Rather, they seem to require and to be able to identify more objective proofs of environmental proactivity, especially through the scrutiny of product designs. They value products with ecological components and materials, designed to minimize environmental impact during manufacturing and usage, and prepared to be recycled or reused. Thus, data provides support for hypothesis 1b.

With respect to the measure of financial performance, ROA, none of the dimensions shows significant effects. Hypothesis 1c is therefore not supported by data. Although, as commented above, some dimensions contribute positively to certain operational objectives and marketing performance, no evidence has been found that these improvements translate into higher profitability. This might be due, on one hand, to the fact that profitability does not only depend on operational capabilities or on the capability to satisfy customers, but on the company’s financial structure, the appropriateness of certain strategic decisions in the past, or the change in diverse economical, political or social parameters affecting the competitive scenario. On the other hand, this result might be due to the fact that operational and marketing improvements do not offset the investments required to implement the environmental practices which yield such improvements. In this way, although the company has more efficient processes, a better reputation, or greater capabilities to meet customers’ requirements, it might not be able to compensate for investments and improve financial results. This observation might indicate that the effects of environmental practices on profitability do not appear immediately but in future years, once initial investments have been paid off.

Overall, the results in Table 8 confirm hypothesis 1 since they reveal, on one hand, that environmental proactivity can exert certain positive effects on performance and, on the other hand, that these effects depend on the dimension of environmental proactivity which has been developed, that is, on the portfolio of management practices that has been implemented.
Nonetheless, it must be taken into account that the positive effects registered in this study are neither abundant nor strong and that also certain negative effects have been detected. The study also reveals that the effects depend on the type of performance considered. Although additional research would be necessary to study each one of the links between environmental proactivity dimensions and performance measures outlined in this paper, our results reveal that there is no one single answer to the question of whether environmental proactivity has positive effects on business performance. They also show that the relationship between environmental proactivity and business performance must be disaggregated into more specific and simple relationships to be untangled.

6. CONCLUSIONS

This research has tackled the relationship between environmental proactivity and business performance. On one hand, a multidimensional view of environmental proactivity has been adopted such that four dimensions have been identified, which respectively reflect the environmental transformation of planning and organization practices, logistics processes, product design attributes and internal production processes. On the other hand, four measures of performance based on relative perceptions have been considered: mass operational performance, which summarizes valuations of cost, speed, and design and mix flexibility; lean operational performance that summarizes valuations of quality, reliability and volume flexibility; marketing performance, which reflects aspects such as company reputation, customers’ satisfaction and success of new product launches; and, financial performance, based on the company profitability during the last three years.

Our research findings reveal that some dimensions of environmental proactivity have a positive and significant effect on certain operational performance objectives and on marketing performance. In particular, the environmental practices related to the transformation of logistics processes contribute to lean operational performance, whereas those practices related to product design enhance marketing performance. Thus, this paper to some extent supports the existence of a positive relationship between environmental proactivity and business performance, in line with the work of Christmann (2000), Klassen and Whybark (1999b), Russo and Fouts (1997), Sharma and Vredenburg (1998), and Shrivastava (1995a,b). However, certain negative effects of environmental practices related to the transformation of internal production processes on mass
operational performance have also been registered. Thus, the results indicate that not all the manifestations of environmental proactivity yield similar benefits; rather, outcomes depend on the portfolio of practices through which such proactivity is demonstrated. It also reveals that the effects of environmental proactivity depend on the measures of business performance that are considered. In particular, this multiform and complex structure of the relationship between environmental proactivity and business performance constitutes an explanation for some of the conflicting results found in previous research.

The results specifically allow us to conclude that operational performance objectives such as quality, reliability and volume flexibility can be improved with more ecological supply chain management and with adequate recycling and reverse logistics systems. It has also been observed that customers tend to value the ecological features of products, but seem not to be influenced by environmental certifications. This might reflect the greater maturity and objectivity of green customers.

Finally, no evidence was found to support that environmental proactivity ends in higher profitability, at least in the short term. This leads us to think that, in spite of the better operational and marketing performance that can be achieved, it is difficult to offset the initial investments required to implement environmental practices. In this sense, longitudinal studies should be conducted in future research in order to know the long-term effect of environmental proactivity on profitability and financial performance.

This research, however, is not exempt from limitations. On one hand, it is worth mentioning that some measures of business performance used in this research are based on managers’ perceptions, which might be to some extent subjective. On the other hand, statistics can confirm relationships but do not provide evidence on causality. Thus, alternative interpretations of data analysis might also be proposed. In this sense, it may be that companies with better performance feel more capable of developing environmental practices.

In spite of these limitations, this study reveals the complexity of the relationship between environmental proactivity and business performance. It indicates that this relationship must not be tackled as a single one. Rather, it must be approached in a disaggregated way, as a bundle of relationships between different patterns or strategies of environmental management and different types of performance indicators. In line with the results and suggestions of Hart and Ahuja (1996),
this paper has also offered some results that reveal the need to study the effects of environmental proactivity from a longitudinal and dynamic point of view. That is to say, it is not only important to determine which effects are derived from environmental proactivity but it is also important to determine when such effects are produced. It is also important to take into account that some recent papers suggest that the relationship between environmental proactivity and business performance is subjected to multiple circumstances and moderating variables and that it should be studied from a contingent point of view (e.g. Christmann, 2000; Aragón-Correa and Sharma, 2003; Reinhardt, 1999). All this leads us to conclude that future research should analyse the competitive effects of environmental proactivity by developing contingent, dynamic and disaggregated approaches.
REFERENCES


Table 1: Environmental Management Practices

<table>
<thead>
<tr>
<th>PLANNING AND ORGANIZATIONAL</th>
<th>OPERATIONAL (PRODUCT RELATED)</th>
<th>OPERATIONAL (PROCESS RELATED)</th>
<th>COMMUNICATIONAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Explicit definition of environmental policy</td>
<td>• Substitution of polluting and hazardous materials/parts</td>
<td>• Emission filters and end-of-pipe controls</td>
<td>• Periodic elaboration of environmental reports</td>
</tr>
<tr>
<td>• Clear objectives and long-term environmental plans</td>
<td>• Designs focused on reducing resource consumption and waste generation during production and distribution</td>
<td>• Process design focused on reducing energy and natural resources consumption in operations</td>
<td>• Sponsoring of environmental events / collaboration with ecological organizations</td>
</tr>
<tr>
<td>• Well defined environmental responsibilities</td>
<td>• Designs focused on reducing resource consumption and waste generation in product usage</td>
<td>• Production planning and control focused on reducing waste and optimizing materials exploitation</td>
<td>• Environmental arguments in marketing</td>
</tr>
<tr>
<td>• Full-time employees devoted to environmental management</td>
<td>• Design for disassembly, reusability and recyclability</td>
<td>• Acquisition of clean technology/equipment</td>
<td>• Regular voluntary information about environmental management to customers and institutions</td>
</tr>
<tr>
<td>• Natural environment training programs for managers and employees</td>
<td></td>
<td>• Preference for green products in purchasing</td>
<td></td>
</tr>
<tr>
<td>• Systems for measuring and assessing environmental performance</td>
<td></td>
<td>• Environmental criteria in supplier selection</td>
<td></td>
</tr>
<tr>
<td>• Environmental emergency plans</td>
<td></td>
<td>• Shipments consolidation</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Selection of cleaner transportation methods</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Recyclable or reusable packaging/containers in logistics</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Ecological materials for primary packaging</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Recovery and recycling systems</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Responsible disposal of waste and residues (separation and preparation)</td>
<td></td>
</tr>
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<td>Practices</td>
<td>Mean (S.D.)</td>
<td>Factor 1 Planning and Organizational</td>
<td>Factor 2 Logistics Processes</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
<td>---------------</td>
<td>-------------------------------------</td>
<td>----------------------------</td>
</tr>
<tr>
<td>Explicit definition of environmental policy</td>
<td>4.53 (1.71)</td>
<td>.788</td>
<td>.233</td>
</tr>
<tr>
<td>Clear objectives and long-term environmental plans</td>
<td>4.30 (1.81)</td>
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<td>.243</td>
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<td>Well-defined environmental responsibilities</td>
<td>4.45 (1.59)</td>
<td>.814</td>
<td>.167</td>
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<td>Full-time employees devoted to environmental management</td>
<td>4.06 (1.97)</td>
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<td>.170</td>
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<td>Natural environment training programs for managers and employees</td>
<td>3.74 (1.58)</td>
<td>.745</td>
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<td>4.25 (1.69)</td>
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<td>Environmental emergency plans</td>
<td>4.50 (1.72)</td>
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<td>Substitution of polluting and hazardous materials/parts</td>
<td>4.24 (1.39)</td>
<td>.331</td>
<td>.068</td>
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<tr>
<td>Designs focused on reducing resource consumption and waste generation</td>
<td>3.97 (1.39)</td>
<td>.374</td>
<td>.262</td>
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<tr>
<td>during production and distribution</td>
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<td></td>
<td></td>
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<tr>
<td>Designs focused on reducing resource consumption and waste generation in</td>
<td>3.76 (1.38)</td>
<td>.330</td>
<td>.330</td>
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<tr>
<td>product usage</td>
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<td></td>
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<tr>
<td>Design for disassembly, reusability and recyclability</td>
<td>3.44 (1.50)</td>
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<td>.372</td>
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<td>Preference for green products in purchasing</td>
<td>4.70 (1.26)</td>
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<td>.256</td>
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<tr>
<td>Environmental criteria in supplier selection</td>
<td>3.64 (1.80)</td>
<td>.650</td>
<td>.404</td>
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<td>Shipments consolidation</td>
<td>3.82 (1.62)</td>
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<td>.617</td>
</tr>
<tr>
<td>Selection of cleaner transportation methods</td>
<td>2.26 (1.31)</td>
<td>.245</td>
<td>.665</td>
</tr>
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<td>Recyclable or reusable packaging/containers in logistics</td>
<td>3.97 (1.41)</td>
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<td>.620</td>
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<td>Ecological materials for primary packaging</td>
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<td>.606</td>
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<td>Recuperation and recycling systems</td>
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<td>Emission filters and end-of-pipe controls</td>
<td>4.98 (1.29)</td>
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<td>Process design focused on reducing energy and natural resources consumption in operations</td>
<td>4.58 (1.29)</td>
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<td>Production planning and control focused on reducing waste and optimizing materials exploitation</td>
<td>4.37 (1.23)</td>
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<td>Acquisition of clean technology/equipment</td>
<td>4.02 (1.43)</td>
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<td>Periodic elaboration of environmental reports</td>
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<td>Sponsoring of environmental events / collaboration with ecological organizations</td>
<td>2.26 (1.46)</td>
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<td>Environmental arguments in marketing</td>
<td>3.33 (1.66)</td>
<td>.457</td>
<td>.421</td>
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<tr>
<td>Regular voluntary information about environmental management to customers and institutions</td>
<td>3.23 (1.66)</td>
<td>.548</td>
<td>.573</td>
</tr>
</tbody>
</table>

Cronbach’s α: 0.9519 0.8707 0.8984 0.8512

Total explained variance: 67.664%. Varimax orthogonal rotation.
Table 3. Measure of operational performance

<table>
<thead>
<tr>
<th></th>
<th>Mean (S.D)</th>
<th>Factor 1</th>
<th>Factor 2</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Mass</td>
<td>Lean</td>
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<tr>
<td>Operational Performance</td>
<td></td>
<td>Operational</td>
<td>Operational</td>
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<tr>
<td>Operational costs (supply, production, distribution, …)</td>
<td>3.25 (.978)</td>
<td>.821</td>
<td>.051</td>
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<tr>
<td>Time needed for designing and/or manufacturing products</td>
<td>3.32 (1.095)</td>
<td>.731</td>
<td>.228</td>
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<tr>
<td>Pace of new product launching and range of products in catalogue</td>
<td>3.63 (.975)</td>
<td>.709</td>
<td>.246</td>
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<tr>
<td>Product Quality (degree of conformity to specifications)</td>
<td>3.93 (.832)</td>
<td>.427</td>
<td>.583</td>
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<tr>
<td>Flexibility to adapt production to different volumes of demand</td>
<td>4.05 (1.934)</td>
<td>.069</td>
<td>.832</td>
</tr>
<tr>
<td>Capacity to meet customers’ requirements in time</td>
<td>3.87 (.915)</td>
<td>.211</td>
<td>.834</td>
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</table>

Cronbach’s α: 0.6860 0.7073

Total explained variance: 63.082%, Varimax orthogonal rotation.
### Table 4. Measure of marketing performance

<table>
<thead>
<tr>
<th>Media (D.T.) Factor</th>
<th>Company reputation and image</th>
<th>Alignment between company’s offer and market expectations</th>
<th>Success of new product launches</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3.94 (.84)  .841</td>
<td>3.77 (.82)  .863</td>
<td>3.68 (.93)  .820</td>
</tr>
</tbody>
</table>

**Explained variance:** 70.83%

**Cronbach’s α:** 0.7909
Table 5. Measure of implementation of Advanced POM Approaches and Systems

<table>
<thead>
<tr>
<th>Item</th>
<th>Mean (S.D.)</th>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Quality Management</td>
<td>4.96 (1.29)</td>
<td>.625</td>
</tr>
<tr>
<td>Advanced Manufacturing Technologies (AMT)</td>
<td>4.45 (1.16)</td>
<td>.709</td>
</tr>
<tr>
<td>Just-in-Time production</td>
<td>4.02 (1.36)</td>
<td>.674</td>
</tr>
<tr>
<td>Integrated information systems (ERPs)</td>
<td>4.76 (1.38)</td>
<td>.620</td>
</tr>
<tr>
<td>Collaboration with suppliers</td>
<td>3.94 (1.18)</td>
<td>.760</td>
</tr>
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</table>

Explained variance: 46.187 %
Cronbach’s $\alpha$: 0.7011
<table>
<thead>
<tr>
<th></th>
<th>Company Size</th>
<th>Plant Equipment Age</th>
<th>Advanced POM Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant Equipment Age</td>
<td>-.006</td>
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</tr>
<tr>
<td>Advanced POM Systems</td>
<td>.341***</td>
<td>.084</td>
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<tr>
<td>Planning and Org. Practices</td>
<td>.211***</td>
<td>.098</td>
<td>.320***</td>
</tr>
<tr>
<td>Logistics Processes Practices</td>
<td>.229***</td>
<td>-.004</td>
<td>.298***</td>
</tr>
<tr>
<td>Product Design Practices</td>
<td>.167**</td>
<td>-.058</td>
<td>.297***</td>
</tr>
<tr>
<td>Internal Production Processes</td>
<td>.024</td>
<td>.092</td>
<td>.306***</td>
</tr>
</tbody>
</table>

*** p < 0.01     ** p< 0.05
Table 7. Relationships between ordinal and categorical independent variables
(ANOVA F-tests)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical Industry</td>
<td>1.111***</td>
<td>40.837*** (+)</td>
<td>1.009 (+)</td>
<td>13.441*** (+)</td>
<td>0.098</td>
<td>2.068</td>
<td>0.094</td>
</tr>
<tr>
<td>Electronic Industry</td>
<td>6.025** (+)</td>
<td>21.307*** (-)</td>
<td>5.003*** (+)</td>
<td>0.832</td>
<td>0.322</td>
<td>0.180</td>
<td>0.316</td>
</tr>
</tbody>
</table>

*** p < 0.01   ** p< 0.05   Sign of the relationship in brackets
Table 8. Relationship between environmental proactivity dimensions and performance measures

<table>
<thead>
<tr>
<th></th>
<th>Explanatory Model 1</th>
<th>Explanatory Model 2</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.349 (0.274)</td>
<td>0.214 (0.266)</td>
<td>0.188 (0.262)</td>
<td>0.088*** (0.023)</td>
<td>0.411 (0.278)</td>
<td>0.198 (0.269)</td>
<td>0.203 (0.267)</td>
<td>0.088*** (0.024)</td>
</tr>
<tr>
<td>Company Size</td>
<td>-0.003 (0.013)</td>
<td>-0.026** (0.013)</td>
<td>-0.018* (0.012)</td>
<td>-0.000 (0.001)</td>
<td>-0.009 (0.013)</td>
<td>-0.030** (0.013)</td>
<td>-0.022* (0.013)</td>
<td>0.001 (0.001)</td>
</tr>
<tr>
<td>Plant Equipment Age</td>
<td>-0.009 (0.097)</td>
<td>-0.097 (0.094)</td>
<td>0.041 (0.092)</td>
<td>-0.008 (0.006)</td>
<td>-0.001 (0.098)</td>
<td>-0.097 (0.094)</td>
<td>0.047 (0.094)</td>
<td>-0.008 (0.008)</td>
</tr>
<tr>
<td>Chemical Industry</td>
<td>-0.263 (0.240)</td>
<td>0.133 (0.233)</td>
<td>-0.206 (0.229)</td>
<td>-0.002 (0.021)</td>
<td>-0.348 (0.254)</td>
<td>0.156 (0.246)</td>
<td>-0.254 (0.244)</td>
<td>0.001 (0.022)</td>
</tr>
<tr>
<td>Electronic Industry</td>
<td>-0.424* (0.220)</td>
<td>0.148 (0.214)</td>
<td>-0.243 (0.210)</td>
<td>-0.012 (0.019)</td>
<td>-0.486** (0.222)</td>
<td>0.203 (0.215)</td>
<td>-0.236 (0.213)</td>
<td>-0.012 (0.020)</td>
</tr>
<tr>
<td>Advanced POM Systems</td>
<td>0.219*** (0.079)</td>
<td>0.310*** (0.077)</td>
<td>0.396*** (0.075)</td>
<td>0.021*** (0.007)</td>
<td>0.229** (0.099)</td>
<td>0.217** (0.096)</td>
<td>0.344*** (0.096)</td>
<td>0.026*** (0.009)</td>
</tr>
<tr>
<td>Planning and Organizational Practices</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.047 (0.085)</td>
<td>-0.028 (0.083)</td>
<td>-0.006 (0.082)</td>
<td>-0.001 (0.007)</td>
</tr>
<tr>
<td>Logistics Processes Practices</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.065 (0.079)</td>
<td>0.198** (0.077)</td>
<td>0.042 (0.076)</td>
<td>-0.004 (0.007)</td>
</tr>
<tr>
<td>Product Design Practices</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.087 (0.081)</td>
<td>0.064 (0.078)</td>
<td>0.153** (0.078)</td>
<td>-0.009 (0.007)</td>
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<td>R²</td>
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<td>.103</td>
<td>.137</td>
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<td>2.135*</td>
<td>4.084***</td>
<td>5.612***</td>
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*** p < 0.01  ** p < 0.05  * p < 0.10  
Standard errors in brackets