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Is an Environmental Management System able to influence environmental and competitive performance? The case of the Eco-Management and Audit Scheme (EMAS) in the European Union

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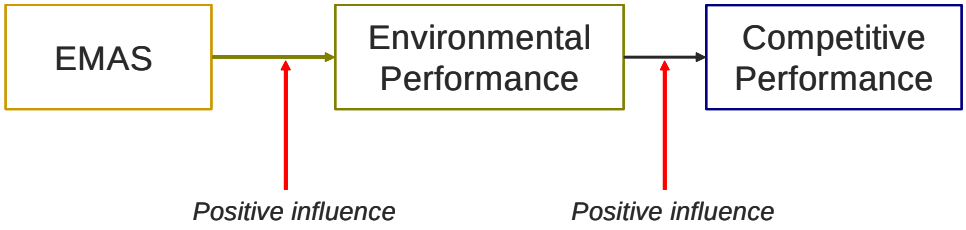
Introduction

The Environmental Management System is an increasingly diffused tool among organisations operating in different sectors, thanks to the drive and impulse coming from the voluntary certification schemes (such as EMAS and ISO 14001) in which they are mainly applied. These schemes provide a third-party guarantee of environmental "excellence", that is able to give an advantaged position (with respect to their competitors) to those organisations that, by adopting EMAS or ISO 14001, commit themselves to improve the environmental performance.
The development of these schemes has always relied on some "principles of action", that have been progressively understood and accepted by governments, practitioners and single organisations:

- First of all, as stated in the Fifth Environmental Action Programme of the European Commission [1] industrial and economic organisations cannot be considered just as a problem, but they should be involved in improvement initiatives as "part of the solution" to environmental problems;
- The implementation of these initiatives for a more "sustainable" development, should be "sustainable" on its own, meaning by this that the voluntary schemes should be able to mobilise the economic resources that are needed for their implementation (e.g.: the resources for EMAS cannot be taken from public and institutional budgets anymore, but they should emerge also on the basis of competitive and economic opportunities to be earned by the EMAS registered organisations).
- The long-term objective of the voluntary schemes, i.e.: to turn the environmental issues from a constraint into an opportunity, will remain purely utopian if these schemes are not capable of producing a real improvement in the competitive performances of the participating organisations.

This article moves from the starting point of these three basic principles and tries to demonstrate that there is a link between one of the most diffused and credible environmental voluntary certification scheme (EMAS), the environmental performance that it can provide as a result of the management system implementation and the EMAS-originated advantages that the registered organisations can perceive when facing their competitors in the market arena.
More specifically, our work is a two-steps model that aims at identifying and evaluating the positive influences that can connect EMAS to competitive performances. The first step aims at testing if EMAS and, more in general, an Environmental Management System, is really able to produce an improvement in the environmental performance (as perceived by the organisation). The second step aims at investigating if and how this performance, especially when strengthened by a third-party registration as EMAS, can really induce a better positioning of the organisation on the four most important competitive leverages: innovation, market, productivity and intangible assets.

Figure 1 The conceptual framework



Theory and Hypothesis

Using EMAS as a managerial tool for improving the environmental performance at firm level

The adoption and use of environmental management systems by companies has awaken a considerable interest in scholars and researchers in the last years, especially considering the increasing popularity and diffusion of EU and international standards such as EMAS and ISO 14001.
Empirical research on EMSs has mainly focused on two issues: the analysis of determinants for EMSs adoption and the effects of EMS implementation on the overall environmental performance.
In the present paragraph, we just propose a brief overview of the determinants for EMS adoption identified by scholars and practitioners, while, according to the aim of our research, the core of our article is mainly focused on the effects of EMS implementation on environmental performance
As concerns the first issue, scholars have identified several factors that could induce an organization to adopt an EMS (either certified or not), and other "pro-active" environmental strategies. In efforts to increase resource productivity while abating costs, an EMS could be adopted to bring about rationalization in the use of inputs (resources) such as energy and raw materials, and at the same time, to reduce outputs such as waste [2,3]. Moreover, the adoption of an EMS can improve the reputation and image of a company and, consequently, its relations with customers, investors, local communities and other stakeholders [2, 4-6].
Research findings also demonstrated that the regulatory obligations and other external pressures may stimulate pro-active behaviour at a managerial level and induce the implementation of an EMS [4, 7, 8]. In a recent study, Darnall *et al.* [8], relying on aspects of institutional theory and on a resource-based view of the firm, determined that institutional pressures (i.e. regulatory, market and social pressure), resources and capabilities (i.e. employee commitment and environmental R&D) both encourage a more comprehensive EMS adoption. Moreover, overcoming information asymmetries [9] and complying with increasing legal requirements [4], represent other specific determinants.

With regard to the second issue, a substantial amount of evidence has been collected which supports the positive effects of EMS adoption on corporate performance. We report some of the most recent and interesting evidence.
By examining a sample of 7,899 facilities drawn from the population of U.S manufacturing facilities from the years 1995-2001, King *et al.* [9] found evidence that the EMS adoption results in improved environmental performance, measured as a logarithm of the toxicity-weighted sum of all Toxic Release Inventory. In another study using Japanese facility-level self-reported data from an OECD survey, Arimura *et al* [10] estimated the positive effects of ISO 14001 on three environmental impact improvements.
Yet, a small amount of contrasting evidence has also been collected. Findings have emerged from other studies that formal EMSs (e.g.: ISO 14001 and EMAS) do not substantially affect a firm's environmental performance [11, 12]. One of the most significant empirical study used a panel data of 37 pulp and paper plants in Quebec over the period 1997-2003, that identified no meaningful evidence of reductions in pollution after obtaining ISO 14001 certification [13].
Whether or not an EMS proves to be beneficial, can strongly depend on time. It must be taken into consideration, in fact, that an organization will need time to adapt an EMS to its specificities, in order to obtain effective operation and achieve positive results in terms of environmental improvement, by setting objectives and planning managerial activities and technological investments. A structured EMS, as defined by the ISO 14001 standard and the EMAS Regulation, is a part of the overall management system including the organizational structure, planning activities, responsibilities, practices, procedures, processes and resources. Consequently, all of these elements

must work together in order to guarantee the continuous improvement of environmental performance. This inevitably brings about changes in a firm managerial and operational structure. These widely agreed-upon considerations may give rise to the simple argument that formal EMS implementation (e.g.: according to EMAS Regulation) needs time to generate positive effects on environmental performance. Our analysis intends just to provide an empirical evidence on positive relations between the maturity of certified EMS and environmental performance improvement..

Hypothesis 1. Organizations with a mature and certified EMS (i.e.: EMAS registered) have better environmental performance than those without.

Environmental Planning and EMS

The application of an EMS scheme may not be a sufficient condition to guarantee improvements in an organizations environmental performance. In order to make it an effective tool, a "new philosophy" must permeate all hierarchical levels in the organization that adopts an EMS: from the upper management to operational personnel.
This new philosophy rests, firstly, on the capability of indentifying and analyzing the critical elements of management, defining adequate *corrective actions* and carrying out effectively what is planned. The planning concept includes all these elements, representing, in fact, the first step of the so-called "Deming cycle" (PDCA Plan-Do–Check–Act) and, therefore, a cornerstone of an EMS.
When we llok at the concept of "planning", we should interpret it in an extended way: planning means to organize resources and define the ways for their utilization, to set up the innovative operational activities, to develop the relations with stakeholders or anything else having an effect on firm environmental performance. In other words, a firm's "planning capabilities" are a crucial factor for implementing a really effective EMS [4].
The adoption of more innovative activities or tools, that are often correlated to EMS adoption, can be interpreted as an evidence of planning capabilities and, consequently as a way to strengthen the effectiveness of an EMS.
For instance, in a study concerning Italian facilities between the years 1994-1997, evidence emerged that with the implementation of specific environmental management tools such as compensation schemes and award schemes, SO_x and NO_x pollution rates strongly improved [14]. In similar studies, Arimura *et al.* [10] and Annandale *et al.* [15] demonstrated the positive effect of the publication of environmental reports on environmental performance at firm level. Publishing these reports aims at enhancing the communication between the firm and its stakeholders (e.g.: employees, shareholders, financial institutions, investors, consumers, environmental NGOs, governments, and local residents), as well as at improving its corporate image [10]. This transparency shows a high level of awareness and involvement of the whole organization towards the environmental management approach and, as a result, the effectiveness of the EMS itself .
Also the level of competence and awareness of personnel performing tasks which might have a significant environmental impact is a key-indicator of an effective planning capability within an EMS [16]. Both ISO 14001 and EMAS schemes provide thorough descriptions of environmental training activities: "The organisation shall identify training needs with its environmental aspects and its environmental management system; it shall provide training or other action to meet these needs" [17]. As described in their analysis of Mexican manufacturing facilities, Dasgupta *et al.* [18] found that environmental training to non-environmental workers as well as environmental specialists resulted in positive effects on self-reported degree of compliance.

As abovementioned, previous studies have investigated only in an indirect way on the effectiveness of "planning" (and of the whole EMS), meanwhile our study focuses directly on the organization's planning capability and, more specifically, on the way in which it can influence the effectiveness of the EMS. The ability of an organization to achieve its environmental targets strongly depends on its

capacity of pursuing the continual improvement of the environmental performance by effectively planning the organisational activities, the economic investments and the technological measures that are needed to achieve it.

Hypothesis 2. Organizations that are able to plan effectively their environmental targets have better environmental performance improvement

Green Supply Chain Management and EMS

EMAS, differently from other EMS standards, stresses the fact that, in order to be registered, an organization has to manage and improve not only direct environmental aspects, but also "indirect" ones [19]. The EMAS Regulation defines an indirect environmental aspect *as an element of an organisation's activities, products or services that has or can have an impact on the environment and which can result from the interaction of an organization with third parties and which can to a reasonable degree be influenced by an organization* [20]. The role of the third party (usually an "intermediate" actor such as a supplier or a contractor) with whom the organization shares the management control (or whom it can influence), is therefore crucial to guarantee the improvement of the environmental performance relating to indirect aspects. In other words, the third-party represents the linkage between the organization and its interaction with the environment and, consequently, the more he/she is involved by the organisation, the more effective can be the EMS in terms of environmental improvement.

The environmental indirect aspects may include, for example: product-related issues (design, Research & Development, packaging, transportation, use and waste recovery/disposal); capital investments, granting loans and insurance services; choice and composition of services (e.g. transport or the catering trade); product range compositions and the environmental performance and practices of contractors, subcontractors and suppliers.

By focusing their EMS on the supply chain management, some organizations in recent years have begun relying on their suppliers to improve their environmental performance and create value for theirselves and for customers [21]. For instance, IBM has designed a tool for monitoring and analyzing its products emissions throughout their life-cycle. This allows companies to tweak their operations and see how changes in packaging, transportation and inventory policies can affect CO2 emissions. The aim of this tool is to quantify the trade-offs between carbon reductions and other factors affecting competitiveness (such as on-time delivery), and to identify the most sustainable solutions from both an environmental and an economic perspective.

Generally, the most common Green Supply Chain Management (GSCM) practices consist in assessing the environmental performance of suppliers, in requiring suppliers to undertake measures that ensure environmental quality of their products or in evaluating the cost of waste in their operating systems [19]. The relationship between EMS and GSCM practices has potentially complementary and significant implications for an organization's environmental performance, because when applied together (and in a synergetic way), they offer a more comprehensive means for defining and establishing sustainability among networks of organizations [22].

The positive effect of GSCM practices on environmental performance is relatively supported by empirical evidence. Geffen and Rothenberg [23], **by** analyzing three case studies of US assembly plants, stated that strong partnerships with suppliers, supported by appropriate incentive systems, aid the adoption and development of innovative environmental technologies. In addition to this, the interaction with suppliers' staff, partnership agreements and innovation development lead to improvements in environmental performance, maintaining production quality and cost goals. The improvement in environmental performance provided by an intensive inter-firm relation could be facilitated by firms proximity [24, 25]. Zhu and Sarkis [26], using empirical results from 186 respondents on GSCM practice in Chinese manufacturing enterprises, found that having higher level of adoption of GSCM practices (environmental audit for suppliers' internal management,

environmental requirements for purchased items, ISO 14001 certification, cooperation with suppliers and customers for environmental objectives) leads to higher environmental performance improvement.
Our analysis intends to provide a further contribution to empirical evidence already existing in literature on positive relations between supporting suppliers in adopting environmental measures and environmental performance improvement.

Hypothesis 3. The organizations supporting their suppliers to adopt environmental measures have better environmental performance improvement

EMAS as a managerial tool for improving competitive performance at firm level

Economic literature provides different perspectives and theories on the relationship between environmental policies and corporate environmental performance on one hand and, on the other, on their effects on firms' competitive performance, from which different predictions about these relationships may be provided. The debate developed over the last fifteen years across a wide range of theoretical questions aimed at investigating *whether, under what circumstances* and *how exactly* environmental issues are related to competitiveness. Summarizing, we can identify three major theoretical approaches in literature.
The "traditionalist" view of neoclassical environmental economics argues that the purpose of environmental regulation is to correct negative externalities, and that, consequently, environmental regulation – in internalising the costs of the negative externality – corrects a market failure, while burdening companies with additional costs. Firms complying with regulation (by increasing expenditures in environmental protection) face higher production costs and reduce the management time devoted to pursuing other tasks. This is deemed to have effects on the competitiveness at firm and sectoral level [27-31].
As opposed to the neoclassical perspective, a "revisionist" view states that improved environmental performance is a potential source of competitive advantage, as it can lead to more efficient processes, improvements in productivity, lower costs of compliance and new market opportunities [32-34]. Porter and Van der Linde [35] suggest that environmental regulation is potentially beneficial to firms. Environmental regulation can provide incentives to change firm's production routines (technological or process innovation) in a way that leads to compliance and reduced costs - through decreased resource inputs or increased efficiency-, or can even lead to new marketable products that may be preferred by environmentally-oriented final consumers or intermediate customers. Such innovations may entirely offset the costs of compliance.
A third and more recent interpretation of the impacts of environmental policies on competitiveness is proposed by the so-called "Resource-based view" approach. According to this approach, the competitiveness of companies and industries depends on the quality and quantity of the resources available and by the ability of companies/industries to optimise their use [36]. The Resource-Based View explicitly recognizes the importance of *intangible assets*, such as *know how* [37], *corporate culture* [38], and *reputation* [39]. This approach is an evolution of the Porter's approach, as it enlarges the typologies of resources that the companies and industries can rely on.
According to this revisionist view, environmental regulation is mainly considered to be "an industrial policy instrument aimed at increasing the competitiveness of firms, the underlying rationale for this statement being that *well designed* environmental regulation could force firms to seek innovations that would turn out to be both privately and socially profitable" [34]. Moreover, "*properly designed* environmental regulation can trigger innovation that may partially or more than fully offset the costs of complying with them" [35].

A rich literature analyzes the *forms of regulation* as well as the *design of environmental policy instruments* for their impact on innovation and competitiveness [40, 41]. Economists have traditionally placed environmental policy instruments into two categories: those providing firms with relatively less flexibility (e.g.: Command & Control instruments) and those providing firms with incentives to look for more effective ways of achieving the environmental objective.
The EMSs, and in particular EMAS Regulation, belong to the second category (the so-called "soft instruments"), based on a voluntary approach, negotiation and shared responsibility of the actors involved. The EMS is a flexible instrument that any organization can adapt to its specificity, it can promote a behavioural change both at management and operative level, induce technological innovation and promote an optimal use of scarce resources in the logic of continuous improvements.
The general impression deriving from the analysis of the evidence emerging from previous studies is that EMS adoption, and in particular certified EMS, is actually able to exert a positive influence on competitiveness, even if the effective relevance in supporting it is not certain.
For instance, with reference to the direct effects of EMAS adoption on competitiveness, a recent European study [42] investigated the impact of the different characteristics of this EU Scheme on technical environmental innovations and economic performances in Germany, by analysing data from a unique dataset of EMAS-registered sites. The study identifies a weak relationship between EMAS and some indicators of market success. However, a positive impact on the increase of turnover and exports is found, especially when a company is able to achieve significant learning by adopting EMAS. Hence, the authors conclude that a better linkage between environmental management and innovation management could improve competitiveness.
On the other hand, the findings emerging from literature that show a positive relation between EMS, or certified EMS and competitiveness, are mainly anecdotal but just few empirical researches found generalizable results [43].
The fact is that a simple EMS adoption, even if complying with a *third part designed* standard, such as ISO 14001 or EMAS, does not *per se* assure an improvement of competitive performance. The relation is neither direct nor "automatic", but it depends on the effects of the EMS on the organisation environmental performance. In other words, if only an EMS achieves the aim for which it was designed, or the continuous improvement of environmental performances, a positive effect on firm competitiveness could be attained.
Following this conceptual framework, we argue therefore that EMAS represents an effective tool for improving the environmental performance of an organizations and, only as consequence, its competitiveness.
The few empirical studies addressing the relation between environmental performance and competitiveness focused, mainly, on the economic performance at a firm level. The evidence are very mixed on this subject: some studies found a weak or a non statistically significant relation between economic and environmental performance, while other studies achieved the opposite conclusion.
For example, Jaggi and Freedman [44], by analyzing data from American pulp and paper plants, investigated the association between water pollution and economic and market performance. Using the Pearson Correlation test for three different time periods, the study provides weak evidence that firms with good pollution performance are not being viewed positively by the market because of the negative association between pollution and economic performance in the short period. The results show the market performances indicate that the Price-Earnings ratio is negatively associated with pollution performance over a short period of time.
Similar findings emerged from the study carried out by Levy [45]. Using data from several sources, Levy found that firms with more significant reductions in toxic emissions tended to have poorer financial performance - measured as "return on sales" and "return on equity and sales" -, although the relationship was not statistically significant.

On the opposite, there is also evidence to suggest that good environmental performance can help enterprises to get a better economic result. Hart and Ahuja [46], report that efforts to prevent pollution and reduce emissions drop to the "bottom line" (ROS, ROA, ROE) within 1-2 years of initiation: operating performance (e.g.: resource productivity or savings leading to efficiency) is benefited in the following year, while at least 2 years are necessary before financial performance is affected. Klassen and McLaughlin [47] used the "financial event methodology" to prove the positive linkage between environmental and financial performance. Also Al-Tuwaijiri *et al.* [48] demonstrate, by a simultaneous equation model, that good environmental performance is significantly associated with good economic performance.
As we mentioned above, in our study, we focus on EMAS and on its capability to improve the environmental performance of registered organisations and, only as a result of that, to support their competitiveness on the market. As a consequence, the aim is to gain insights on how the environmental performance improvements enable the EMAS-registered organizations to obtain positive feedbacks from the final consumer or the intermediate client. In order to measure the competitive performance at firm levels, we referred to the conventional variables used in literature, such as market shares [28], increase of sale and turnover [45], innovation [49], image and customer satisfaction [39], etc. Hence, some dimensions are closely linked to the market (e.g: market shares and sales) or to internal efficiency (resource productivity), while others refer to "immaterial" and non-quantifiable assets (e.g: image, customer satisfaction, innovation), being nevertheless crucial for the overall competitive performance of organisations.

Hypothesis 4. EMAS-registered organizations with higher environmental performance have better competitive performance

Empirical analysis

Data description

In order to evaluate the above mentioned hypotheses, we rely on data collected within the EVER study (*Evaluation of EMAS and Ecolabel for their Revision*) carried out by a consortium of universities, research institutes and consultants coordinated by IEFE (the Institute for Energy and Environmental Policy and Economics of the "Bocconi" University in Milan) on behalf of the European Commission – DG Environment. The aim of the EVER study [50, 51] was to provide recommendations to the European Commission for the second revision of the Eco-Management and Audit Scheme.
Data were collected between spring and summer 2005 by way of interviews ("face to face" and by telephone), based upon a standard questionnaire. The questionnaire is composed of approximately 40 questions distributed in four sections: the first section focuses on the organization characteristics, the second investigates the adoption of environmental practices and their effects on environmental performance, the third section aims at identifying the barriers for EMAS adoption and the last aims at evaluating the effects of these instruments on the adopters' competitive performance.
Moreover, the standard questionnaire has been adapted, in a modular way, to several different typologies of interviewees, according to their specificities. In particular, the interviewed subjects are: EMAS stakeholder, EMAS adopters, EMAS not-adopters and EMAS public institutions. Some of the questions were, indeed, reformulated to investigate specific aspects relating to each typology of interviewee, and others are identical, in order to guarantee a certain comparability between different typologies.
This study takes into account information only on EMAS adopters and non adopters, which constitute a sub-sample of 101 observations. The EMAS adopters were selected by a random

sampling (from EMAS registered private organizations population) according to the following criteria:

- representative territorial distribution;
- representative distribution according to organization size;
- representative distribution according to the type of organization.

In order to determinate the statistic relevance of the sample, a distribution of binomial probability for the population was assumed; and a value for the standard error was fixed. As the variance is unknown, the most disadvantaged case was considered (i.e.: the value that maximizes the function (p), and that therefore corresponds to p=0,5) and a level of confidence equal to 95% was settled.
At the moment of the composition of the sample[1], the population was constituted by 3072 EMAS adopters, while the selected sample counts 70 private organizations.
On the other hand, the sample of EMAS not adopters is constituted by 31 organizations and was selected with the same criteria as the EMAS adopters.
The joined sample – EMAS adopters and not adopters – is used to test the Hypothesis 1, 2 and 3. While Hypothesis 4 was evaluated considering only the EMAS adopters sample (56 observations after cleaning up the missing values). The main characteristics of the sampled organizations are summarized in Table 1.

Table 1 Samples' description

		Total	EMAS adopter
Regional distribution	Baltic	14	8
	Mediterranean	35	24
	Central	39	30
	Atlantic	13	8
Organization size	Small Organizations	25	19
	Medium Organizations	35	28
	Large Organizations	41	23
Sector of activity	Manifacturing	47	36
	Other industrial secrotrs	24	13
	Service sectors	30	21

Since the data from the EVER study were collected using survey techniques, it is important to address the limitations of the survey data. Two of the main standard drawbacks, of survey data in general, are social desirability bias and lack of generalizability The social desirability bias refers to the fact that individuals attempt to answer survey questions in ways that they consider socially desirable [8]. In order to limit the potential issue associated with this kind of bias, all respondents were guaranteed anonymity and the interviewers were adequately trained to inform them to be objective. Moreover our pre-test analysis of the survey did not find any indication of social desirability bias .
Furthermore, the EVER survey is not affected by the bias due to the lack of generalizability, since it targeted several industrial and service sectors in multiple European countries. This approach differs

[1] On 31st January 2005

from typical survey research examining organization' environmental practices, which focuses on a single industry within a single country [8].

Econometric Model

Having defined the theoretical model, we now propose the following equations as an empirical approach to the test four hypotheses of this study.

Equation N. 1

$$ENVPER = \alpha_0 + \beta_1 EMASAGE + \beta_2 ENVTARGET + \beta_3 GSCM + \beta_4 SIZE + \beta_5 SECTOR + \varepsilon_1$$

Equation N. 2

$$\begin{cases} MKTPERF = \gamma_0 + \gamma_1 ENVPERFORM\ ANCE + \gamma_2 EMASAGE + \varepsilon_2 \\ INNOVPERF = \delta_0 + \delta_1 ENVPERFORM\ ANCE + \delta_2 EMASAGE + \varepsilon_3 \\ RESEFF = \phi_0 + \phi_1 ENVPERFORM\ ANCE + \phi_2 EMASAGE + \varepsilon_4 \\ INTASS = \lambda_0 + \lambda_1 ENVPERFORM\ ANCE + \lambda_2 EMASAGE + \varepsilon_5 \end{cases}$$

With regards to testing Hypotheses 1, 2 and 3, we utilize a binary probit model (Equation N. 1). At this stage, we test whether EMAS maturity and specific indicators of environmental practices increase the probability of improving environmental performance. To construct an organization's environmental performance rating (i.e. the dependent variable in equation n.1) we use the survey question "*How has the environmental performance of your organisation changed in recent years?"* included in the EVER questionnaire. Although it would be ideal to use quantitative data on environmental impacts, the use of self-reported data is not uncommon in related literature [see for instance 10, 18].

The explanatory variables for the binary probit model include different characteristics of EMS, especially regarding their maturity and effectiveness. Similar to Rennings *et al.* [42], EMAS maturity was measured considering the age of registration (EMASAGE). A binary variable measuring the capability of an organization to attain its environmental targets (ENVTARGET) was constructed using the survey question "*Does your organisation attain its targets for environmental improvement?"*. In order to evaluate the relationship between supporting suppliers in adopting environmental measures and environmental performance improvement, a binary variable (GSCM) was created on the basis of the survey question "*Do you support your suppliers to adopt environmental measures?"*.

Moreover, other survey information such as size of the organization and sector of activities were used as set of exogenous variables which are expected to affect both environmental performance and the adoption and effectiveness of voluntary practices.

The econometric model shown by Equation N.2 is used to verify whether EMAS-registered organizations with higher environmental performance also have better competitive performance (Hypothesis 4). Given that the competitive performance might be achieved by relying on several competitive factors, a multivariate regression was used to estimate the simultaneous effects of the predictors variable on the different measures of competitiveness.

The basic assumptions for utilizing a multivariate regression are that the outcome variables shall be normally distributed and at least moderately correlated. Shapiro-Wilk test was applied for verifying the normal distribution of outcome variables.
According to the abovementioned literature, we have constructed four variables for measuring competitiveness: market performance (MKTPERF), innovation capability (INNOVPERF), resource efficiency (RESEFF) and intangible assets (INTASS). Similar to Ambec *et al.* [41], we can derive them by using a linear combination of specific answers to certain questions (see Table 2 for details). All the variables are moderately correlated and the relation is highly significant (see Table 3). The same approach used for the dependent variables was applied for measuring the improvement of organization's environmental performance (ENVPERFORMANCE).
Finally, to capture the influence of EMAS maturity on competitive performance the variable EMASAGE was considered in the model as a set of binary variables.
The Table 4 provides descriptive statistics for the study's variables.

Table 2 Dependent and explanatory variables for competitive and environmental performance (multivariate regression model)

Variable	Questions
MKTPERF	*By participating in EMAS, has your organization obtained higher customer satisfaction?* *By participating in EMAS, has your organization obtained an increase in market share ?*
INNOVPERF	*By participating in EMAS, has your organization improved its technical innovation capability?* *By participating in EMAS, has your organization improved its capability to innovate organizational and/or managerial structure?*
RESEFF	*By participating in EMAS, has your organization experienced cost savings through the decrease in resource use, reuse or recycling?* *By participating in EMAS, has your organization experienced cost savings through waste reduction?*
INTASS	*By participating in EMAS, has your organization achieved greater motivation and participation of employees?* *By participating in EMAS, has your organization perceived an improved image and reputation?*
ENVPERFORMANCE	*How has the environmental performance of your organisation changed in recent years?* *How does the environmental performance of your organisation compare to other organisations in your sector?*

Table 3 Correlation matrix

	MKTPERF	INNOVPERF	INTPER	RESPROD
MKTPERF	1.00			

INNOVPERF	0.40*	1.00		
INTASS	0.46*	0.58*	1.00	
RESEFF	0.41*	0.61*	0.60*	1.00

* $p < 0.001$

Table 4 Descriptive statistics

Variable	Observations	Mean	Std. Dev.
1st MODEL			
ENVPERF	101	.4554455	.5004948
EMASAGE	101	3.485149	3.354441
ENVTARGET	101	.8514851	.3573832
GSCM	101	.6732673	.4713578
SMALLSIZE	101	.2475248	.4337267
MEDSIZE	101	.3465347	.4782393
LARGSIZE	101	.4059406	.4935224
MANIFACT.	101	.4653465	.5012855
OTHERIND	101	.2376238	.4277503
SERVICE	101	.2970297	.4592288
2nd MODEL			
MKTPERF	56	6.589286	2.535399
INNOVPERF	56	6.678571	2.240999
RESPROD	56	7.678571	1.820161
INTPER	56	6.589286	2.755337
ENVPERFOR	56	8.464286	1.159377
EMASAGE	56	4.5	2.879394

Results

The results of the model application carried out in our analysis provided some evidence relating to the Hypotheses described above.

First of all, the model seems to support Hypothesis 1, i.e. there is a positive effect of the number of years during which the EMS has been implemented on the level of environmental performance perceived by the organisation itself. Even if this relation is positive, we have to acknowledge that the effect of the EMS "age" is not very high (see the dF / dx value). This implies that the influence exerted in time by the EMS on the capability to improve environmental performance is counterbalanced by other factors. On one hand, organizations identify a strong stimulus towards a higher environmental performance in the EMAS main requirement to pursue the so-called "continuous improvement". This greatly prompts EMAS registered organisations to seek new improvement opportunities, define improvement targets every year and invest economic resources

in the connected environmental programmes. Moreover, a "learning by doing" effect is detectable in the EMAS registered organisations, increasing year by year their ability to implement the EMS, to optimise the improvement opportunities and to maximise the cost-effectiveness of the money they invest in environmental improvement. On the opposite hand, some significant counter-effects hindering the capacity to positively affect the environmental performance may emerge over time, as the EMS matures. Many organizations emphasised the problems linked to the increasing marginal cost of pollution abatement, as well as the difficulties in spotting new improvement margins and opportunities every year for in their industrial site, plants or corporate activities [50].

Among the independent variables that are included in the model, the capability to carry out an effective planning and to achieve the foreseen targets seems to have the strongest impact on environmental performance. Hypothesis 2, i.e. the existence of a positive influence of target-definition and successful planning on environmental performance, is fully confirmed by the results we achieved. In this case, the intensity of the detected impact is high (see the dF / dx value) and a 95% significance is provided by the model. The most important indication emerging from this result concerns the organisations' approach in implementing their EMS. The organisations involved in the EMAS scheme clearly showed different attitudes in considering their EMS: the two opposites being a "certificate-oriented" approach (giving importance mostly to obtaining EMAS registration and preserving it as a reputational tool) and a more "strategic" approach, aiming at using the EMS to guarantee legal compliance and gradually improving the environmental efficiency of the corporate activities [50]. It is rather clear, from our results, that the more an organisation considers the EMS as an integral part of the whole management system and includes the environmental targets and programmes in the day-to-day operational planning activities, the more it is able to effectively achieve a higher environmental performance. The best performing organisations usually describe their EMS as fully integrated in the business management cycle and pointed out that improvement objectives and targets are defined within the ordinary "Planning process" that includes a feasibility assessment, the identification of economic resources within the annual budget and a full set of monitoring and continuous feedback procedures to be applied for its realisation. Furthermore, most of the better performing organisations showed a tendency to devote relevant economic resources to environment-oriented projects, to maintain their EMS, considering the EMAS registration as a starting point for their improvement strategies [50].
On the opposite, the "certificate-oriented" approach, basically aimed at guaranteeing that the EMAS requirements are fulfilled in order to obtain the registration, proved to be rather ineffective. If an organisation believes that renewing EMAS registration is enough to uphold its reputation over time, and does not rely on real resource mobilisation and efficient planning, the effects on environmental performance will be poor.

The outcomes of the model application weakly support Hypothesis 3. Organisations making efforts to correctly manage the environmental aspects in their supply-chain do not necessarily perform better in absolute terms. The effect of a proactive Green Supply Chain Management, as measured by the model, on environmental performance is positive and not negligible, but the low significance value shows that the relationship between the two variables is not statistically supported for our empirical evidence. This might be due to a relative immaturity in the GSCM tools available, as well as in their development and actual application by the interested companies.
Despite more than 50% of the surveyed organisations are adopting tools and methods to support the actors operating in their value-chain (mostly suppliers, but also service providers, customers and retailing partners), the interviews and case-studies carried out in the EVER study clearly show that these strategies are still lagging behind with respect to many other areas of supply-chain management, especially by industrial firms [50]. The largest part of the initiatives targeted at the supply-chain that have been implemented by the interviewed organisations are:

- either information or sensitisation activities, aimed at diffusing the knowledge on the EMS and/or the commitment to environmental principles that the organisation has been undertaking (especially when certified or EMAS registered);
- or the adoption of operational tools (checklists, questionnaires, registers, etc.) for the environmental assessment, selection and qualification of the suppliers of raw materials, intermediates and services.

Only few organisations showed a more advanced approach towards the supply-chain, e.g. by developing common environmental programmes with specific suppliers (i.e.: reuse of packaging, reverse logistic, etc.) or by providing technical support to clusters of small suppliers in developing their own EMS. In three cases, the interviewed organisation was implementing an LCA (Life Cycle Assessment) on one of its products and, therefore, it was involving the relevant suppliers in a sort of data collection, monitoring and management exercise.
What is virtually missing from our empirical evidence is the adoption of "front-running" supply-chain management activities that are being developed in other business areas, such as: product co-design strategies, common innovation patterns (e.g.: "learning by interacting" with the technology providers) or joint marketing campaigns, applied to environmental issues. This is a signal that the GSCM is still not very diffused among the organisations yet and, consequently, is not able to provide effective stimuli to improve the overall environmental performance, at least in a perceivable and measurable way. Such a situation might be due to the slow uptake of the so-called "indirect environmental aspects", foreseen both by EMAS and ISO 14001, among the organisations adopting an EMS. It is widely recognised that these aspects are often undermined and/or not identified, assessed and managed in an effective way by the organisations participating in those schemes. Quite interestingly, the draft proposal of the new EMAS regulation (the so-called EMAS III) will strongly emphasise the need to further develop the managerial and technical issue relating to the indirect aspects (especially those concerning the supply chain) [20].

A last evidence emerging from our analysis refers to the relative importance of the organisation "size" as an exogenous variable. In particular, the large dimension of the organisation applying an EMS proves to be a strong determinant of its good environmental performance, as perceived in the survey. The effects reckoned for the variable LARGESIZE are positive, intense and with a high level of significance. This results is consistent with the greatest part of the available literature on the EMS-related issues, that generally identifies barriers and drawbacks for smaller companies, owing to a wide range of factors (e.g.: lack of resources, low degree of competence and knowhow, cultural gap, organisational lag, etc.). It is quite interesting to note that, as our analysis shows, these barriers are also preventing SMEs to achieve a better environmental performance, once they are able to implement an EMS and to eventually obtain a certification / registration.

Table 5 Results of binary probit model predicting environmental performance improvement

Dependent Variable **Environmental performance**	**Coefficient**	**dF/dx**	**Std. Err.**	**P value**
CONSTANT	-1.6531		.5397193	***
EMASAGE	.1003	.0396	.0444161	**
ENVTARGET	.8679	.3054	.4235474	**
GSCM	.5594	.2142	.3236967	*
SMALLSIZE	.3929	.1456	.3710019	
LARGSIZE	.9274	.3566	.332258	***
MANIFACT.	-.6101	-.2366	.3814459	

SERVICE	-.4903	-.1881	.5397193	

Log likelihood	-59.333511	
Correctly classified	68,32%	
Pseudo R2	0.1476	

*** p < 0.01 ** p < 0.05 * p < 0.1

The second step of our model application aimed at testing Hypothesis 4, i.e. that EMAS-registered organizations with higher environmental performance have better competitive performance. Some conclusions can be drawn from the results of the multivariate regression model reported in Table 6.
Only one of the equation provides statistically significant evidence of such a relationship. In fact, Equation n.2 proves that EMAS organizations that are perceived as better performing from the environmental viewpoint, are also able to improve their innovation capabilities as a key competitive factor. If we compare this result with the first step of our model, the reasons for this are easily understandable: since environmental performance is positively linked to the EMS "age" and the extent of investment planning and resource devoted to the EMS, then we can argue that this can produce a higher innovative-orientation in the organization, together with a "cumulating" knowhow and an increasing technical capacity to sustain innovation patterns. In other words, the more the organization invests in environmental innovation, the more it is capable of developing new technologies and organizational solutions in this area, and to manage them effectively. This makes it possible to improve the competitive factors based on innovation.

The outcome of our analysis does not allow to elaborate definite conclusions as regards the other equations. The results are too weak to identify any relation between environmental performance and any of the other variables involved: market performance, intangible assets and resource productivity.
In particular, as emphasised by many authors [4, 21], an EMAS registered organisation very seldom obtains positive feedbacks directly from the market (final consumers or intermediate customers). This does not allow to get an undisputable advantage with respect to competitors thanks to EMAS registration. The same can be said with reference to intangible assets, both of an internal and an external nature. The benefits that can be experienced as to employee motivations, human capital or better organisational roles and responsibilities is not easily measurable and, therefore, many EMAS organisation tend to underestimate them (or to ignore them). The relationship with the external stakeholders are linked to the effectiveness of EMAS as a communication tool, which emerged from the EVER study as one of the weakest point in the current Regulation [for more details see references 50, 51].
Even if the model provides uncertain indications as to these three equations, a last interesting result can be mentioned.
Most of the studies and researches on EMAS implementation by companies pointed out that the competitive advantages linked to the registration in the scheme are to be perceived by adopters only in the long run [4, 52]. Moreover, some studies emphasise that there is a strong relation between the extent to which these advantages are perceived and the degree of implementation of the EMS (i.e.: proportional to the experience in time) [8, 42]. On the basis of these considerations, we implicitly tested another hypothesis in our model: the age of the EMAS registered EMS (as an exogenous variable) can influence the way in which the organisations perceive the benefits from the competitive point of view. As it clearly emerges from Table 6, this hypothesis is falsified by the empirical evidence collected in the EVER study, since there is no explicit correlation in none of the Equations of the model. It does not seem to be a matter of time if a company perceives competitive benefits linked to their environmental performance or not.

Table 6 Results of multivariate regression model predicting competitive performance of EMAS registered organization

	Equation 1		*Equation 2*		*Equation 3*		*Equation 4*	
Independent Variable	**Market performance**		**Innovation capabilities**		**Intangible assets**		**Resource productivity**	
	Coefficient	*Std. Err*	*Coefficient*	*Std. Err*	*Coefficient*	*Std. Err*	*Coefficient*	*Std. Err*
CONSTANT	.3960108**	2.663971	-.7299709	2.163735	3.565903*	1.871218	-.1891199	2.805155
ENVPERFOR	.6388674*	.3108502	.6388674***	.3108502	.4364561*	.2183465	.6087822*	.3273246
EMASAGE-2	2.29305	1.33194	2.012019 *	1.081831	1.342447	.9355774	2.718862*	1.40253
EMASAGE-3	.2192499	1.18934	.2771291	.9660079	-.2446053	.8354127	1.772241	1.252372
EMASAGE-4	.4136974	1.192238	2.460737**	.9683618	1.121615	.8374484	2.256701*	1.255424
EMASAGE-5	.9097297	1.334115	2.183173*	1.083597	1.680574*	.9371049	2.953593**	1.40482
EMASAGE-6	.5652767	1.329762	2.069071*	1.080062	-.5448439	.9340474	.7971058	1.400236
EMASAGE-7	2.10973	1.334115	2.183173*	1.083597	.2805737	.9371049	1.953593	1.40482
EMASAGE-8	2.160675	1.922084	2.369391	1.561158	2.160675	1.350104	5.123253**	2.02395
EMASAGE-9	-.4013642	1.376886	1.211378	1.118337	-.0685912	.9671483	1.866567	1.449858
EMASAGE-10	2.187516	1.62923	1.297275	1.323296	-.1606754	1.144399	3767467	1.715575
R-squared	0.2058		0.3293		0.2397		0.2543	

*** p < 0.01 ** p < 0.05 * p < 0.1

Conclusions

The Environmental Management Systems, in spite of the many years of their application, have not still achieved a high degree of "maturity" in their implementation. Moreover, they are not fully integrated in those corporate management dynamics (e.g.: R&D, supply chain management, communication, etc.) that would enable an organization to effectively exploit its operational tools and instruments (proposed by ISO 14001 and EMAS). This is particularly clear with respect to "supply chain management" and its effect on organization's performance and on the capabilities of valorising the certification towards the market and the stakeholders.

For other aspects, the EMS seem to be implemented in a more comprehensive and effective way by EMAS registered organisations. For instance environmental planning capabilities are usually stronger and well "rooted" in the organization and, consequently, are able to generate positive effects on environmental performance. This confirms that an actual performance improvement can be achieved only when those elements of an EMS that can be fully integrated in the management dynamics of the firm, start to work effectively [4].

Another important result emerged from our study concerning the role of EMAS in improving competitive performance of the registered organizations. The implementation of an EMS according to EMAS requirements undoubtedly provides a powerful impulse for the organization innovation capabilities [42], but our work also clearly emphaisises that simply adopting EMAS is not a

sufficient condition. The outcome of our model application shows, in fact, that only if an organization obtains a real environmental performance improvement by way of its EMS, then it can achieve better innovation capabilities. Moreover, the EMS "maturity" is not a determinant *per se* of competitive performances (even if it has a positive effect on environmental performance improvement), With this regards, it is the extent to which an EMS permeates into the organizational structure that is able to strongly influence competitiveness. This implies that also a "young" EMS, if well designed and implemented (as well as adequately supported by investments), can provide considerable competitive benefits.

With reference to the other competitive performances, our study shows that a positive effect of a well-implemented EMS (complying with EMAS) on resource productivity, market performance and intangible asset is not strongly supported by the statistical analysis. The sample size is certainly a relevant constraint of the analysis, but it is not the only reason. The competitive advantages linked to EMAS, as well as ISO 14001, adoption, are still scarcely perceived by the adopters also because EMAS and ISO 14001 are not properly designed for providing them. This is particularly true for market performance and intangible assets, as corporate reputation,(we can mention, for example, the relevant constraints in the use of the EMAS logo for competitive purposes).
In order to improve the use of EMAS and ISO 14001 as a competitive tools, on one hand, the registered organizations should strengthen their abilities to perform external communication within the EMS and, on the other hand, the policy makers should support the market potentials of these certification schemes, for instance, by increasing the awareness of customers and citizens on their environmental guarantees and the connected opportunities (e.g.: through public communication campaigns. It is particularly appreciable that the draft proposal of the new EMAS III Regulation presented by the European Commission is heading in this direction.

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