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Section E: New Instruments

Assessing the Link Between Environmental Management Systems and the Environmental Performance of Companies:

An Eco-Efficiency Approach

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1. Introduction

Policy instruments that rely on voluntarism, learning processes and procedural change, rather than direct regulatory control have in recent years come to play a more prominent role in the environmental policy mix of many industrialised countries. They have been promoted by those who maintain that traditional hierarchical regulation is ill-equipped to promote environmental improvement and that environmental policy should become more decentralised and based on shared responsibility. Critics, on the other hand, are sceptical that soft instruments can deliver real environmental improvements.

This chapter contributes to the debate on the impact of new environmental policy instruments by presenting evidence on the effectiveness of one of the most prominent of these instruments: environmental management systems (EMS). It draws on the Measuring Environmental Performance of Industry (MEPI) project, which collected and analysed environmental performance data for 280 companies and 430 production sites in 5 manufacturing sectors in 6 EU countries.

The first section discusses the rationale behind the increasing adoption of voluntary and procedurally-based instruments in general, and EMS in particular. We then review existing empirical evidence regarding the link between EMS and environmental performance, based on research carried out in Germany, Austria, Switzerland, the UK and Finland. The main part of the chapter presents the authors' own analysis. It is based on data collected during the MEPI research project and uses three different methods: 1) Statistical analysis on the firm-level (multiple regressions); 2) Statistical analysis on the production site-level (simple regressions); and 3) Longitudinal analysis on the production site-level. The final part draws conclusions about the potentials and limits of environmental management systems, and briefly explores the wider implications of the analysis for the role of soft policy instruments in the environmental policy mix.

2. Soft policy instruments and the EMS / performance link

Much has been written about a shift from traditional hierarchical regulation towards a different set of instruments in environmental policy-making (Gunningham and Grabosky 1998). The widely used term 'new instruments' includes a range of different coordinating and steering mechanisms including economic, procedural, information-based, self-regulatory, co-regulatory and voluntary instruments. They have in common that they aim to achieve their objectives by means other than the hierarchical prescription of legally-binding rules and standards which can be enforced by public authorities.

Although it can be argued whether new policies complement or replace the 'command and control' approach, it is now widely accepted that the use of alternative instruments is indeed increasing in many countries (Jordan et al 2003). Looking empirically at the factors that have led to the adoption of new environmental policy instruments in eight industrialised countries, Jordan and colleagues (2003a: 202-205) have identified a range of different drivers, some of which relate to changing ideas and beliefs, while others stem from organisational, political and economic factors. One of the key drivers is seen to be the assumption that new instruments are a more effective way of achieving environmental improvements.

Whether this assumption is borne out in reality has been widely discussed, especially with regard to economic instruments (Tietenberg 1991; Newell et al. 1999). Here, we focus on a different range of policies that have been called 'soft instrument-s'. This term describes instruments that aim to achieve environmental aims without employing direct coercion through law, or induce change by altering relative prices. They include voluntary, procedural and information-based policies. Although the term ‘soft’ may appear vague, it accurately describes the main characteristics of these policies: to attain environmental policy objectives without introducing legal or economic (i.e. ‘hard’) constraints. Prominent examples of soft policy instruments are environmental management systems, environmental product labelling, public disclosure requirements, best practice dissemination, industry codes of practice, and voluntary agreements[1]. Although soft instruments do not impose legally binding standards of environmental performance or behaviour, they do have in many cases a legal basis.

Why should we assume that instruments that provide information, attempt to modify procedures and rely on the motivations of actors are more effective than legally-binding rules and regulations? Critics have often argued that the new emphasis on soft instruments is not so much driven by changing ideas about governance, but have emerged as an attempt to scale-back environmental policy in the face of global competition, economic recession and powerful economic interest groups. We would not

[1] Here, we understand voluntary agreements as those without legally-binding commitments, sanctioning mechanisms and other enforcement procedures.

dispute that actors who aim to prevent a strengthening of environmental policies have often been supporters of soft instruments. However, soft instruments are based on a specific rationale and on a distinct model of behaviour and decision-making with regard to the environment.

The intellectual basis of soft instruments is provided by a wide range of recent theories in the social sciences that can be described as cognitive approaches (for example Schön 1983; Dryzek 1987; Fischer 1995; Weick 1996). Cognitive approaches argue that the behaviour of actors is to a large degree determined by their subjective interpretation of reality, rather than being the outcome of 'objective' and rationally-determined interests. It follows that any attempt to change behaviour needs to be based on an understanding of the frames of interpretation, discourses and knowledge sets which influence how these actors make sense of their world and action within it, and how they respond to changes in interpretive frames, discourses and so on. More specifically, soft instruments are based on the assumption that polluting behaviour is (at least in part) the result of institutionally-situated perceptions of reality (or ignorance about the state of things). Interpretive frames that stand in the way of environmentally beneficial decisions could be, for example, the assumption that reducing environmental damage is always associated with costs, that companies do not have any environmental responsibilities beyond legal compliance, or that environmental resources are free goods.

Closely related to the first, a second assumption is that by changing the sense-making of individuals and organisations, it is possible to change the attitudes and behaviours of those individuals and organisations – which, in turn, will ultimately have an impact on the environmental impacts of behaviours. This could be achieved by providing information (for example about environmental costs or best practice), through more subtle and long-term processes of learning and capacity-building, or through processes of awareness-raising about the liabilities and responsibilities of the polluter.

A third, more implicit, assumption is that 'hard' barriers should not stand in the way of the behavioural changes induced by a policy instrument. There appears to be a strong link with the Porter hypothesis that equates pollution with both environmental and economic inefficiency, and asserts that business has large potentials for cost-effective environmental measures. In this view, the well-established fact that organisations do not always exploit win-win potentials (e.g. Sorrell et al 2002) results from imperfect information, cognitive limits and inappropriate organisational structures within firms (Porter and van der Linde 1995: 131).

By encouraging organisational change, EMS are thought to have a direct impact on environmental performance. For instance, the preamble to the EMAS (Eco-Management and Audit Scheme) regulation of the European Union states:

"The objective of EMAS shall be to promote continual improvements in the environmental performance of organisations" (EMAS regulation, Art 1.2)

These improvements in performance are to be achieved through the imposition of management controls. However, this link between management and performance cannot be taken for granted. Research has documented that improving environmental performance is not usually the principal motive in a company's decision to adopt an EMS. A business survey carried out amongst Swiss firms identified 14 reasons for implementing an EMS which were considered to be 'very important' or 'quite important' by at least half of the 158 respondents (Hamschmidt 2000). The benefits included in this list ranged from 'strengthening innovation' and 'customer loyalty' to 'prevention of new environmental legislation', with 'enhancement of corporate public image' ranking highest. Only three of the 14 had a direct relationship with performance ('risk minimisation', 'certainty of legal compliance' and 'support of ecological transformation of the line of business'), and they were ranked at positions 4, 9 and 12 (Hamschmidt 2000: 4).

3. EMS and environmental performance: Evidence from other studies

Studying the effectiveness of EMS

Since the European and international environmental management standards were introduced in the mid 1990s, it is estimated that approximately 63,500 companies and production sites have adopted a certified or registered EMS[2] worldwide, and many more systems not audited by third parties exist. The fact that there is substantial experience with environmental management in companies has triggered a large number of research projects, evaluations, dissertations and doctoral theses into the effects of EMS. It is surprising that despite the recent growth of this literature (for recent reviews see for example Dyllick and Hamschmidt 1999; Steger 2000; Ammenberg 2001; Ankele et al 2002), empirical evidence about the environmental effectiveness of EMS is still sparse. One of the reasons is that many studies have focused on the direct economic costs and benefits associated with EMS. Economic benefits, are not, however, a reliable indicator of environmental effectiveness because savings can be made without reducing pollution. For example, a company can save costs by organising environmental responsibilities better or by identifying cheaper methods of waste disposal. Conversely, the adoption of an EMS may lead to unanticipated and costly pollution abating measures. For example if the use of an EMS revealed that the firm was in breach of regulation, investment in abatement technology might be obligatory.

Even those researchers who have attempted to assess the link between EMS and environmental performance have rarely been able to make valid statements about the overall environmental effectiveness of EMS. Several reasons may be given for this apparent anomaly. Of greatest importance, many studies suffer from a shortage of environmental performance data. In most countries, environmental reporting is not mandatory and most companies prefer not to publish quantitative performance data. ISO 14001 does not require disclosure of environmental information. Even where data on emissions, materials use or non-compliance incidents are provided in environmental reports or EMAS site statements, it is rarely presented in a comparable format. Despite the activity of organisations such as the Global Reporting Initiative, there is no standard approach to environmental reporting and measurement. Public emissions registers exist only in a few countries such as Britain, the United States and the Netherlands, and the quality and usability of the data in these registers varies. With data being sparse and from heterogeneous sources, only a few research projects have had the capacity to carry out the costly and time-consuming data work necessary to conduct comprehensive studies of the environmental performance consequences of EMS. Most studies only look at a very small number of companies and rely on data generated through companies' self-assessment due to the absence of verified performance information.

The quantitative analysis of environmental performance of companies also poses a series of conceptual and methodological challenges. First, environmental performance is a complex and multi-dimensional issue. There is no universally accepted approach to the inherently subjective task of weighing different environmental impacts against each other. Any overall assessment or ranking based on a judgement of how green-

[2] There are around 3,500 EMAS registrations in the EU and more than 60,000 ISO 14001 certifications world wide. Data source: EMAS website (http://europa.eu.int/comm/environment/emas) [page accessed 20 June 2004] and ISO World / Umweltbundesamt (http://www.ecology.or.jp/isoworld/english/analy14k.htm) [page accessed 20 June 2004].

house gas emissions compare to chemical spills or special waste will produce highly contested results. It is also debatable whether the fact that companies operate in different natural environments should be taken into account when considering pollution that has local impacts. Second, companies carry out distinct business activities under different economic, technological and regulatory conditions. Some businesses will always find it more difficult to improve their environmental performance than others, even if they operate in the same sector. For example, it may be that the specific demands placed on a company by its customers prevent the adoption of a cleaner technology. Third, it is difficult to decide where the system boundaries should be set with regard to environmental performance. Are companies only responsible for damage caused by operations within the firm gates or should issues such as the supply of raw materials and components, transportation to and from the company, product use and disposal be included in the assessment of environmental performance?

Given these difficulties in establishing a robust framework for performance evaluation, most studies have used proxies that can be measured through postal or telephone surveys, for example satisfaction with the EMS, perceived environmental benefits, or types of measures put in place. Although this is a justifiable response to the challenges outlined above, the reliance on ‘effort indicators’ and self-assessment limits the validity of the findings. It is important to recognise that conclusions are often based on the (empirically informed) judgement of researchers and their interviewees rather than on quantitative evidence. In the remainder of this section, we summarise the results of some of the larger and more performance-oriented studies (see Table 1).

Results from key studies

There is a surprising consistency in the broad direction of the findings, even though some studies (such as UNI/ASU 1997; Kuisma et al 2001) adopt a generally more optimistic tone than others (for example FEU 1998; Jäger et al 1998; Steger 2000; Wagner 2002). In general, researchers found that a majority of respondents reported a moderate level of environmental effectiveness stemming from EMS adoption, although a considerable variability between companies was also observed (UNI/ASU 1997; Steinle and Baumast 1997; Kuisma et al 2001). For example, 60% of firms surveyed by a study in Switzerland perceived small improvements, 10% thought that their EMS had led to large environmental improvements, and the remaining 30% experienced deterioration or were unable to make a judgement (Hamschmidt 2000). When measured in economic terms, the short-term benefits (e.g. due to lower water and energy bills) were often thought to be of a scale comparable to the costs of adopting the EMS. An overall link between profitability and EMS presence has not been found in a large sample of German manufacturing firms (Wagner 2002).

Table 1: Key studies on the environmental effectiveness of EMS

Study	Funder	Approach and sample	Results regarding EMS / environmental performance link
Dahlström et al 2003	UK Environment Agency (EA)	statistical analysis of the link between EMS and regulator's assessment of performance for 800 sites	better procedural performance but no impact on likelihood of incidents, complaints or non-compliance events
Kuisma et al 2001	Finnish Ministry of the Environment	in-depth study of Finnish paper industry; qualitative and quantitative	improvements in waste and risk management; weak on product development
Hamschmidt 2000	Swiss Agency for the Environment	self-assessment by 158 companies	10%: large improvement 60%: small improvement 30%: deterioration / unknown
Steger 2000	Ministries for the Environment in Germany and Austria	review of 24 empirical studies, most based on self-assessment questionnaire	better compliance, some cases of improvement identified but no fundamental change
FEU 1998	German Ministry for the Environment	self-assessment of 27 companies, analysis of 200 env'l statements	better compliance but no quantitative information on performance
UNI/ASU 1997	German Federal Foundation for the Environment	self-assessment of 723 companies, largely qualitative	cases of improvement identified but no quantitative information on performance

EMS appears to be related to improvements in the traditional areas of environmental management. Empirical studies of EMS in operation show that most companies focus on on-site production efficiency. The most significant improvements appear to have been made in the areas of waste management, energy use and water consumption (UNI/ASU 1997; Kuisma 2001; Steinle and Baumast 1997; Dyllick and Hamschmidt 1999). Interestingly, all of these are areas in which direct cost savings can be made because the environmental goods involved have to be purchased.

There is widespread agreement that EMS have largely failed to broaden the scope of corporate environmental management because they do not systematically address environmental concerns outside the factory gate, for example transport and logistics, sourcing of raw materials and other inputs, product design and end-of-life considerations (cf Steger 2000; Hamschmidt 2000; Kuisma et al 2001; Jäger et al 1998; Ankele et al 2002). There were also few indications that EMS has driven continuous environmental improvement (Jäger et al 1998; Steger 2000).

There is mixed evidence regarding the effect of EMS on legal compliance with environmental regulation. Steger (2000) and Jäger et al (1998) conclude that EMS do support compliance. Steger points out, however, that it is difficult to determine the actual environmental effects of better compliance because non-compliance is often concerned with formal infringements rather than material breaches. In contrast, Dahlström et al's (2003) study was unable to confirm this link. The study - which is one of the few analyses that draw on a comprehensive set of independent performance assessments - found that EMS sites have a better procedural performance (as assessed by the regulator) but did not find a significant correlation between EMS and the likelihood of incidents, complaints and non-compliance events.

There are also doubts about whether EMS represent an *autonomous* driver of performance improvements. In Steger's study (2000), most respondents held the view that the environmental objectives of the company could also have been attained without an EMS. Hamschmidt (2000) reports that while most would agree that an EMS had some influence on environmental performance, only a few saw it as a key factor. EMS do not appear to lead to fundamentally different environmental objectives and strategies, but promote streamlining of existing environmental responsibilities. Interestingly, external stakeholders tended to have a more positive view of the costs and benefits than companies themselves (Steger 2000).

4. Analysing the link between EMS and organisational environmental performance

The MEPI approach

The following analysis reports research carried out in the context of the Measuring Environmental Performance of Industry (MEPI) study (cf Berkhout et al 2001; Tyteca et al 2001) in which the authors were investigators. The MEPI project operationalised performance as the environmental efficiency of the production process: *the level of input of energy and materials and the level of output of waste and pollution per unit of product output*. Where there was insufficient data on production output, environmental indicators were normalised on turnover or number of employees. All inputs and outputs were measured in physical terms such as weight or volume (with the exception of some sectors where product output was captured as monetary value). The project covered six industrial sectors (electricity generation, pulp and paper, fertilisers, textile finishing, book and magazine printing, and computer manufacture) and six European countries (Austria, Germany, Italy, Belgium, the Netherlands and the UK). Within this limited scope, the project team aimed to collect data on environmental performance for as many companies and production sites as possible. Data were collected from four sources: corporate environmental reports; national pollution inventories (UK and Netherlands); EMAS statements; and completed surveys in the fertiliser, printing and textile sectors. We estimate that for the more concentrated sectors (paper, electricity and fertilisers) the MEPI data set covers between 50 and 80 % of production in the six countries (see table 2).

Table 2: Number of firms for which data was collected (by sector and country)

Country	Computer	Electricity	Fertilisers	Paper	Printing	Textile	All
Austria	0	9	0	8	2	1	20
Belgium	n.a.	2	4	4	4	5	19
Germany	5	27	2	43	33	13	123
Italy	4	6	7	10	5	11	43
Netherlands	0	4	7	17	0	14	42
United Kingdom	0	10	6	8	2	1	27
All countries	9	58	26	90	46	45	274

While the database with more than 15,000 performance data points for 274 firms and around 400 production sites provides a valuable research resource, it also has a number of limitations:

- The data set is incomplete, with many missing values. On average, only 28% of the performance indicators for which we collected data were available for a given firm or site in a given year. Principal component analysis (PCA) was carried out to establish that environmental performance could adequately be reflected by a subset of all indicators. For example, CO_2 emissions were found to be indicative of all air emissions in the electricity sector (cf Berkhout et al 2001). This enabled us to restrict the analysis to a smaller number of indicators for which data were more complete and to reduce the need to aggregate indicators.

- A number of sectors consist of a heterogeneous set of firms, which have structurally different environmental profile because they produce different products and/or use different technologies. Some - but not all - of these differences have been captured through the analysis of sub-sectors.
- A significant share of the data has undergone little or no third party validation.
- In some sectors, the sample of firms is assumed to over-represent large companies and good performers, since we expect that these would have a higher propensity to publish data and reports.

In the remainder of the section, we report three ways in which the link between EMS and environmental performance was analysed. Throughout the analysis, the 'presence of an EMS' was operationalised as the presence of a management system that is certified to an internationally-recognised standard (ISO 14001 or EMAS). A company was counted as being EMAS certified if *all* its sites had adopted this standard. The link between EMS and environmental performance was investigated through examination of three hypotheses:

Hypothesis 1: Firms with an EMS have a better environmental performance than those without

In a first step, we aimed to establish whether companies with a certified EMS performed better than those without. Analysing every sector individually, we established significant differences between individual normalised performance levels achieved by EMS firms and those displayed by non-EMS firms based on non-parametric analysis. The analysis used those indicators that were identified as being most suitable during the PCA. Non-parametric tests were chosen since they do not assume a normal distribution of the variable analysed. Given that some environmental performance indicators had very skewed distributions, it would have been inappropriate to utilise parametric methods, since this may have introduced distortions in the results (e.g. parametric tests may distort significance levels). Missing values for any of the indicators are treated on a case-by-case basis (pairwise exclusion), i.e. if for a case data were missing on a specific indicator, this firm was then excluded in the testing for only this variable, but was included in the testing for other indicators where data were available for this case/firm. Due to the large number of missing variables, the analysis did not control for any firm characteristics other than industrial sector. The results of examining Hypothesis 1 can be summarised as follows:

Fertilisers

Non-parametric Mann-Whitney tests for significant differences between companies that were ISO 14001 or EMAS certified and companies that were neither were applied to the six relevant indicators identified in the PCA (NO_x, VOC emissions, Hazardous and municipal waste arisings, total water and energy use). The results reveal three significant links to environmental performance:

- ISO 14001 and EMAS certified companies tended to have *lower* NO_x emissions per total sales than non-ISO 14001/EMAS firms (U=2, W=5, Z=1.78, 0.10 level (2-tailed), df=14 for EMAS and ISO, since the same firms are concerned).
- ISO 14001 and EMAS certified companies have significantly *higher* hazardous waste levels per total sales (U=0, W=21, Z=-2.0, 0.05 level (2-tailed), df=9, again firms for EMAS and ISO are identical) and VOC emissions per total sales (U=0, W=21, Z=-2.0, 0.05 level (2-tailed), df=9) than non-ISO/EMAS firms.

Electricity

Using the Mann-Whitney test, none of the thirteen environmental performance indicators tested (solid waste, municipal waste, recycled waste, CO_2, NO_x, SO_2, dust, coal input, gas input, oil input, renewable fuel input, total fuel input) showed significant differences for the EMAS units (no ISO14001 certified units were available at the firm level).

Pulp and paper

Two of the nine performance indicators (water input, energy input, solid waste, hazardous waste, CO_2 emissions, chemical oxygen demand, SO_2 emissions, nitrogen and phosphorous) identified in the PCAs showed significant differences depending on whether a firm was verified according to EMAS / certified to ISO14001 or not. In particular, it was found that:

- EMAS certified companies tended to have lower COD emissions per tonne of paper than non-EMAS firms (U=127, W=155, Z=-2.463, 0.05 level (2-tailed), df=91), as did ISO 14001 certified companies (U=266, W=344, Z=-2.481, 0.05 level (2-tailed), df=93) compared to non-ISO firms.
- EMAS certified firms were found to have significantly *higher* total energy inputs per tonne of paper (U=1, W=596, Z=-4.754, 0.01 level (2-tailed), df=37) than non-EMAS firms and the same was found for ISO 14001 certified companies which also had significantly *higher* energy inputs per tonne of paper (U=18, W=579, Z=-3.761, 0.01 level (2-tailed), df=37) than non-ISO firms.

The major reason for the coincidence of EMAS and ISO findings is (as was for the fertilizer sector) that there is a strong correlation between EMAS verification and ISO certification, i.e. most firms certified to ISO are also verified under EMAS.

For the paper sector therefore, the link between EMS and performance is also ambivalent, with the majority of indicators not showing any significant differences.

Textile finishing

For this sector, only data on EMAS could be analysed, since no ISO-certified firms were in the data set. For EMAS, no significant differences were found for any of the 11 different environmental performance variables identified in the PCAs.

Printing

Only three of the 9 performance indicators tested showed a significant association with EMAS and ISO14001 in the non-parametric tests applied to the data:

- EMAS/ISO-certified firms (being in this case identical for both EMSs) have significantly *lower* sulphur dioxide emissions per employee (U=10, W=25, Z=1.839, 0.10 level (2-tailed), df=16).
- ISO/EMAS firms tended to have *lower* total water input per employee than non-certified firms (ISO: U=96, W=162, Z=-2,131, 0.05 level (2-tailed), df=43; EMAS (at slightly lower levels of significance): U=102, W=147, Z=-1.425, 0.10 level (1-tailed, 2-tailed test statistically not significant, 2 firms which are ISO-certified are not verified according to EMAS), df=43).
- ISO-certified firms tended to have *higher* total energy input per employee than non-certified firms (U=71, W=116, Z=2.043, 0.05 level (2-tailed), df=39). A similar finding, though not at such high significance was made for EMAS (U=73, W=101, Z=-1.337, 0.10 level (1-tailed, 2-tailed test not significant), df=39).

Table 3 summarises the results of testing Hypothesis 1.

Table 3: Overview of results at the firm level

Industry sector	Variable	Performance level for firms with certified EMS	Significance level
Fertilisers	NO_x per unit of sales Hazardous waste per unit of sales	lower (with ISO/EMAS) higher (with ISO/EMAS)	0.10 0.05
Pulp/Paper	COD per tonne of paper Energy input per tonne of paper	lower (with ISO/EMAS) higher (with ISO/EMAS)	0.05 0.01
Printing	SO_2 per employee Energy input per tonne of paper	lower (with EMAS/ISO) higher (with EMAS/ISO)	0.10 (EMAS), 0.05 (ISO) 0.10 (EMAS), 0.05 (ISO)
Textile finishing	No significant differences identified		
Electricity	No significant differences identified		

Overall, three conclusions can be drawn. First, the tests show that, in the large majority of cases, companies with an EMS did not perform significantly better than those without. In particular, significant differences could be identified for the environmental performance variables analysed in only three of the five sectors analysed.

Second, in those sectors where significant differences were found, there were as many instances in which EMS firms were significantly more eco-efficient as non-EMS firms. In each sector where significant differences existed, results were found pointing in both directions i.e. *pro* and *contra* EMS firms. Thirdly, no real differences could be identified between companies with EMAS or ISO systems. This is mainly because largely the same firms were verified under EMAS and certified to ISO 14001.

Overall, the few and, to some extent ambiguous, differences suggest that EMS are not the only powerful driver of corporate environmental performance. However, alternative explanations are also possible:

- The methods adopted to operationalise both the presence of an EMS and environmental performance may not be sufficiently precise and nuanced to capture an EMS-effect.
- An EMS-effect may have been disguised by the stronger influence of other explanatory variables some of which have been captured in the data (e.g. country, subsector, company size), while others have not (e.g. technologies, market conditions, management culture).
- It may be argued that poorly-performing firms tend to adopt EMS because they feel the need to address the issue or to signal commitment. In this case, the lack of significant differences could be due to a lower performance baseline, rather than the ineffectiveness of EMS.
- Conversely, it may be that the majority of companies without registered/certified EMS, have some form of internal EMS and that what is being measured in this analysis is the increment of performance change achieved through involvement of a standard management system and third-party verification.

While these and other explanations cannot be dismissed, it should be noted that the lack of significant links between EMS and performance contrasts with other hypotheses tested where significant associations were found more consistently (for example between EMS and company size, EMS and profitability).

Hypothesis 2: Sites with an EMS have a better environmental performance than those without

In a second step, we aimed to establish whether production sites with a certified EMS performed better than those without. Again, we analysed every sector individually and focused on core indicators identified through the PCA. Compared to the firm-level tests, the analysis was refined in two ways. First, different years were analysed individually. Second, the analysis was largely based on rankings derived from an aggregation of indicators based on the model of Jaggi and Freedman (1992). Three different Jaggi/Freedman ranking methods were tested and compared. Because this approach required a more comprehensive data set, the sub-set of the data with the most consistent coverage was used (i.e. electricity and paper sectors, 1995 to 1997 data). Rankings were constructed on the basis of CO_2, SO_2, and NO_x (electricity) and NO_x, water use and Chemical Oxygen Demand discharge (paper).

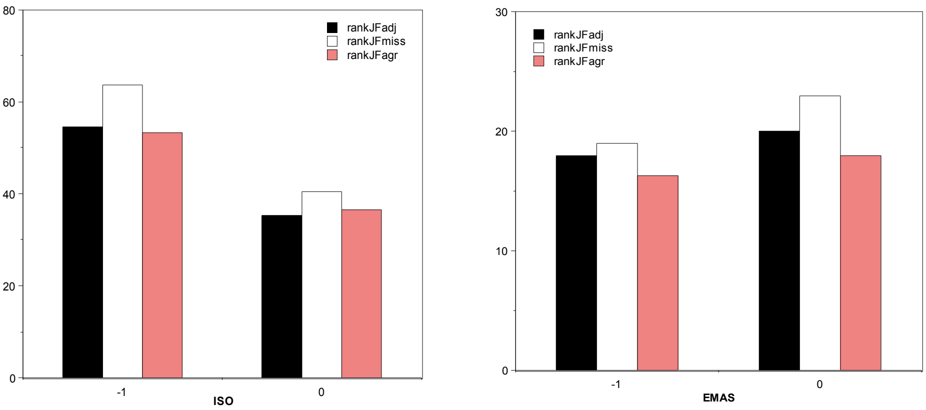
As with the firm-level analysis, some correlations between EMS and performance were found, but in general correlations were weak, sometimes ambiguous and usually not statistically significant. The results can be summarised as follows:

Electricity

In both 1996 (see figure 1) and 1997 (similar result), sites with ISO 14001 performed worse across the basket of indicators than those without. Sites with EMAS performed slightly better than non-EMAS sites in 1997, but for 1996 data no effect could be detected. None of the results was statistically significant.

Figure 1: EMS effect on the site-level (electricity)

ISO14001 (electricity, 1996) **EMAS (electricity, 1997)**



Relationship between ISO14001 and JF ranking ("-1" = site ISO certified, "0" = site not ISO certified)

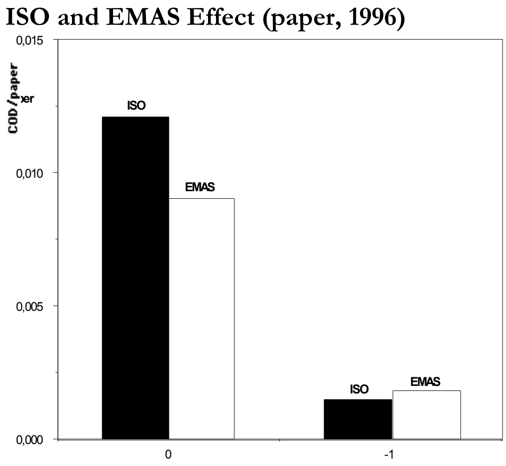
Relationship EMAS and JF ranking ("-1" = site EMAS certified, "0" = site not EMAS certified)

Paper

The analysis in the paper sector produced only one significant result: sites with both ISO and EMAS had lower COD emissions (1996 and 1997) than those without (see figure 2).

Overall, only a few tentative correlations between EMS adoption and environmental performance were found at the site-level. This gives additional weight to the firm-level results, particularly because the object of analysis is defined more precisely.

Figure 2: EMS effect on the site-level (paper)



Influence of ISO and EMAS certification on COD ("0" = site not certified, "-1" = site certified)

Hypothesis 3: Sites improve their environmental performance trend after adopting an EMS

In the final test, the performance of production sites over time was assessed to test the hypothesis that the adoption of an EMS had a positive impact on performance trends. The analysis was based on all performance time series of three or more years where a certified EMS was introduced during that period (but not in the first or last year of the series). We then established the trend before and after the adoption of the EMS over all available years[3] using a 'least square' method and calculated the *difference* between both trends (figure 3). The data-base contained 165 of these performance time series related to 24 different production sites in four sectors (that is, each site was represented by an average of seven performance indicators).

It should be noted that this analysis does not explore whether sites improved their performance during the observed period, but whether EMS adoption resulted in a relative change of trend in performance. In this sense, an EMS is also seen to be effective if it lowers the rate at which the performance worsens. If the adoption of an EMS did not contribute to an improvement of the performance trend, we would expect an equal distribution between improving and worsening trends.

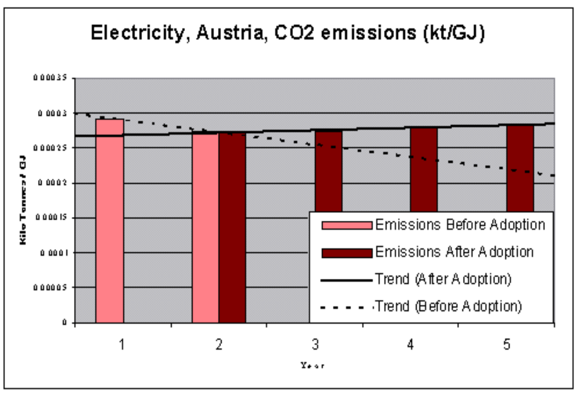


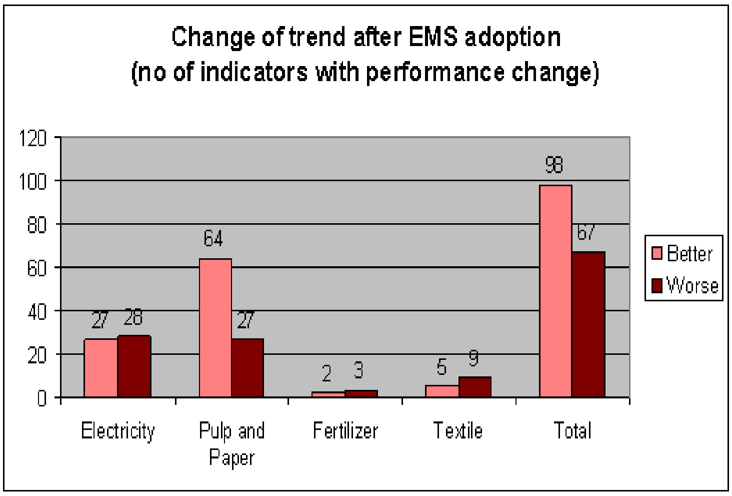
Figure 3: Example of performance trend series (EMS adopted in year 2)

[3] The year of EMS adoption is included as endpoint in the trend 'before adoption' and as starting point in the 'trend after adoption'.

When analysing the trend of all indicators individually, we found that in 98 cases (59%) the performance trend improved after EMS adoption, while in 67 cases (41%) the trend worsened (figure 4). This means that on average the adoption of an EMS appears to have had an impact on a minority of all performance measures. Further analysis generated several other findings:

- There was a high variability between sectors, with only the paper sector showing a strong EMS effect.
- There was no clear difference between the effects of EMAS and ISO14001.
- There was no strong difference between environmental indicators where the level of performance is directly related to economic costs (e.g. hazardous waste, energy use) and those where cost was not a factor (noise, most air and water emissions).

Figure 4: Change of performance trend after EMS adoption (by sector)



When the data was aggregated by production site, a similar picture emerged (table 4). Out of 24 sites, 10 (42%) saw a trend improvement on most indicators in the years after EMS adoption, while 7 (29%) saw more declining than improving indicators. Another 7 (29%) production sites displayed an equal number of improving and declining trends (see table 4).

Table 4: Results of performance trend analysis aggregated by site

Result of performance trend analysis aggregated by production site		
Production sites where:	No of sites	Share of sites
- the trend of most indicators improved after EMS adoption	10	42%
- the trend of most indicators declined after EMS adoption	7	29%
- there was a balance between improving and declining trends	7	29%
Total	24	100%

Overall, the analysis confirms the previous finding that the link between EMS and performance is weak as was also found by Wagner (2002) for energy efficiency as one component of environmental performance. That the third test has not identified a stronger effect is surprising. The longitudinal approach is a more targeted method of evaluating the 'EMS hypothesis' because it reduces the potential impact of intervening variables and should make actual performance effects visible.

5. Conclusions: The EMS / performance link

The results of the analysis presented here can be summarized as follows:

1. There is little evidence to suggest that companies or production sites that have adopted a certified EMS perform significantly and consistently better than those without. This finding can, however, be explained by different substantial and methodological factors and does not in itself disprove the EMS hypothesis. Possible explanations for this finding are
   - EMS are not a strong driver of environmental performance improvement.
   - EMS are a driver of environmental improvement, but this effect is concealed by other stronger determinants of environmental performance.
   - The limits of data availability do not allow an analysis sufficiently precise and nuanced to distinguish the effect of EMS on environmental performance.
2. There is certain evidence that the adoption of EMS has a positive impact on the *performance trend* across a minority of indicators. This finding appears to have special significance because performance time-series capture large-scale emissions, waste and resource use trends of industrial installations which are important in their own right. However, there are again more than one possible explanation for this finding:
   - EMS are not a consistently strong driver of environmental performance improvement.
   - EMS are a driver of environmental performance improvement, but the areas of improvement lie outside the performance dimensions captured by MEPI eco-efficiency indicators (e.g. logistics, product performance, business travel).
   - EMS are a driver of environmental performance improvement, but the effect is not sufficiently large to outweigh other factors which determine year-on-year variations (e.g. plant utilisation, product specification, investment cycle).

In our view it is unlikely that the analysis presented here has failed to detect a strong EMS / performance link merely because environmental improvements occurred in areas other than the environmental efficiency of production. Qualitative research reported in section 3 found that EMS have not usually broadened the scope of environmental management to include impacts outside the factory gate. This suggests that if an EMS / performance link exists, it would be found in the functions examined in the MEPI study. A more plausible interpretation is that EMS have proven only a relatively weak driver of environmental performance. In particular, the result of the longitudinal analysis that the trend in performance frequently worsened after the adoption of an EMS can only reasonably be explained through the presence of other influencing factors.

What could be the reasons for the limited environmental effectiveness of EMS? Our analysis does not provide a positive explanation of these findings. Interpreting the results in the light of previous research into EMS, we would like to propose a number of possible explanations. First, the results could be seen to confirm the view of other evaluation studies that EMS are a tool for performance improvement, rather than being a driver of change. Put differently, EMS may in fact be a necessary, rather than a sufficient condition for successful efforts to reduce resource use and emissions. Taken together with Hamschmidt's (2000) result that environmental performance is not usually the main motive for companies to adopt an EMS, a weak EMS / performance link becomes a plausible result.

Second, the modest effectiveness of EMS could also be due to shortcomings in the implementation and enforcement of current procedures rather than implying a fundamental criticism of EMS. A number of studies have shown that the outcome of EMS depends strongly on the way in which they are put into practice. Current environmental management standards are believed to encourage companies to implement EMS in a formalistic and procedural way (Dyllick and Hamschmidt 1999). Third, it is also possible that there is a time lag between EMS adoption and performance improvement because companies need time to adjust to newly-introduced routines and procedures. The effect of a 'learning lag' is well known in the literature on the relationship between innovation and productivity, which finds that companies suffer productivity losses during the period immediately after the introduction of an innovation (Conceição et al 2003). The MEPI performance time-series are not sufficiently long to test this hypothesis. It is also possible that improvements are made only under certain circumstances, for example in sectors with short investment cycles, or in countries with less stringent regulations and enforcement. The MEPI analysis did not collect data that would allow identification of those conditions under which EMS tend to have an impact on performance.

Fourth, procedural improvements made through the introduction of an EMS may not lead to environmental improvement because of cost barriers. Although EMS have been found to help companies to identify cost-effective environmental measures (Steger 2000), the results from this study suggest that the effect of these measures could be small when compared to the overall environmental impact of the company. It remains an open question, whether this is due to shortcomings of the EMS tool (e.g. focus on ability to manage current processes rather than improving the innovative capacity), or whether it implies a more sober view with regard to the overall potential for win-win solutions.

Given the uncertainty about how the results can be explained, policy recommendations need to be made with care. We do not believe it would be appropriate on the basis of this analysis to conclude either that EMS are ineffective, or that that policy support for EMS should be withdrawn. Any conclusion about the link between EMS and environmental performance is necessarily preliminary, because more comprehensive data are needed and long-term effects have not yet been studied. Moreover, EMS may have benefits other than environmental performance - for example in terms of regulatory certainty, internal and external communication or awareness raising - that may justify policies encouraging their diffusion.

The weak link between EMS and performance is, however, a matter of concern if EMS are envisaged as serving as a substitute for other policy instruments. Scaling-back regulation or environmental taxes for firms with EMS (often referred to as 'regulatory relief') is practiced or under consideration in many European countries, for example in the form of fewer inspections by regulators, reduced rates for plant licences, or exemptions from environmental charges (Wätzold et al 2001; Dahlström et al 2003). On the basis of the research presented, we would argue that there is currently no evidence to suggest that EMS have a *consistent* and *significant* positive impact on environmental performance. Any substantial regulatory relief based on the simple assumption that companies with an EMS perform better than those without would therefore be inappropriate.

More broadly, the findings of this study contribute to the broader debate about the effectiveness of soft policy instruments. We would share the view that there is a strong cognitive element in environmental decision-making in firms. The question is, however, whether procedural and information-based instruments with a very low degree of intervention will be able to change interpretive frames and provide the knowledge required to bring about innovation in organisations that leads to observable environmental outcomes.

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Table A.1: Test Statistics for EMS effects in the Electricity & Fertiliser Sectors (Exact Tests; ISO & EMAS firms identical; FU: Functional Unit, here: MWh)

Variable (Electricity, EMAS only)	Mann-WhitneyU	Wilcoxon W	Z	Exact significance (2-tailed)	Exact significance (1-tailed)	Variable (Fertilisers, EMAS/ISO)	Mann-WhitneyU	Wilcoxon W	Z	Exact significance (2-tailed)	Exact significance (1-tailed)
CO_2 emissions per FU	39.00	42.00	-0.887	0.417	0.208						
NO_x emissions per FU	30.00	33.00	-1.307	0.225	0.112	NO_x per total sales	2.00	5.00	-1.776	0.103	0.051
SO_2 emissions per FU	39.00	42.00	-1.022	0.347	0.173	VOC per total sales	0.00	21.00	-2.000	0.071	0.036
Dust emissions per FU	18.00	21.00	-0.120	0.943	0.471						
Total solid waste per FU	24.00	27.00	-1.188	0.276	0.138	Hazardous waste per total sales	0.00	21.00	-2.000	0.071	0.036
Municipal waste per FU	21.00	1149.00	-0.180	0.917	0.458	Municipal waste per total sales	0.00	10.00	-1.852	0.133	0.067
Recycled waste per FU	21.00	924.00	0.000	1.000	0.512	Total water per total sales	20.00	23.00	-0.301	0.807	0.403
Coal input per FU	21.00	1452.00	-0.367	0.833	0.407						
Total fuel input per FU	1.00	2.00	-0.878	0.667	0.333						
Gas input per FU	20.00	21.00	-0.464	0.750	0.375						
Total oil input per FU	24.00	25.00	-0.160	0.926	0.463						
Renewables input per FU	0.00	1.00	-1.464	0.333	0.167						
Total energy input per FU	0.00	1.00	-1.342	0.500	0.250	Total energy per total sales	9.000	12.000	-1.256	0.260	0.130

Table A.2: Test Statistics for EMS effects in the Paper Sector (Exact Tests; ISO & EMAS separate; FU: Functional Unit, here: tonne of paper produced)

Variable (Paper, EMAS only)	Mann-Whitney U	Wilcoxon W	Z	Exact significance (2-tailed)	Exact significance (1-tailed)	Variable (Paper, ISO only)	Mann-Whitney U	Wilcoxon W	Z	Exact significance (2-tailed)	Exact significance (1-tailed)
CO_2 per FU	132.00	1167.00	-0.088	0.943	0.472	CO2 per FU	175.00	211.00	-0.124	0.913	0.456
SO_2 per FU	37.00	47.00	-0.822	0.444	0.222	SO2 per FU	27.00	37.00	-1.455	0.160	0.080
Total solid waste per FU	63.00	1009.00	-0.067	0.967	0.483	Total solid waste per FU	120.00	148.00	-0.505	0.632	0.316
Recycled waste per FU	97.00	107.00	-0.808	0.441	0.220	Recycled waste per FU	150.00	178.00	-1.282	0.208	0.104
COD per FU	127.00	155.00	-2.463	0.012	0.006	COD per FU	266.00	344.00	-2.481	0.012	0.006
Nitrogen per FU	44.00	47.00	-0.954	0.381	0.191	Nitrogen per FU	189.00	217.00	-0.992	0.332	0.166
Phosphorus per FU	22.00	25.00	-1.185	0.278	0.139	Phosphorus per FU	60.00	70.00	-1.044	0.318	0.159
Total energy input per FU	1.00	596.00	-4.754	0.003	0.003	Total energy input per FU	18.00	579.00	-3.761	0.009	0.009
Total water input per FU	443.00	498.00	-0.136	0.898	0.449	Total water input per FU	579.00	684.00	-0.486	0.634	0.317

Table A.3: Test Statistics for EMS effects in the Textile Sector (Exact Tests; ISO & EMAS separate; FU: Functional Unit, here: unit of textiles produced)

Variable (Textiles, EMAS only)	Mann-Whitney U	Wilcoxon W	Z	Exact significance (2-tailed)	Exact significance (1-tailed)	Variable (Textiles, ISO only)	Mann-Whitney U	Wilcoxon W	Z	Exact significance (2-tailed)	Exact significance (1-tailed)
CO_2 per FU	35.00	56.00	-1.121	0.280	0.139	COD per FU	76.00	427.00	-0.097	0.944	0.472
NO_x per FU	79.00	100.00	-0.093	0.940	0.470	Phosphorus per FU	6.00	97.00	-1.189	0.305	0.152
VOC per FU	5.00	6.00	-0.543	0.750	0.375						
Recycled waste per FU	71.00	477.00	-0.587	0.577	0.289	Total solid waste per FU	20.00	686.00	-1.046	0.344	0.172

Table A.4: Test Statistics for EMS effects in Printing sector Sector (Exact Tests; ISO & EMAS separate)

Variable (Printing, EMAS only)	Mann-Whitney U	Wilcoxon W	Z	Exact significance (2-tailed)	Exact significance (1-tailed)	Variable (Printing, ISO only)	Mann-Whitney U	Wilcoxon W	Z	Exact significance (2-tailed)	Exact significance (1-tailed)
Carbon dioxide per employee	4.00	7.00	-1.461	0.198	0.099	Carbon dioxide per employee	5.00	6.00	-0.372	0.857	0.429
Sulphur dioxide per employee	10.00	25.00	-1.839	0.071	0.034	Sulphur dioxide per employee	10.00	25.00	-1.839	0.071	0.034
Total waste per employee	73.00	508.00	-1.139	0.267	0.133	Total waste per employee	63.00	498.00	-1.539	0.129	0.064
Hazardous waste per employee	42.00	252.00	-0.543	0.621	0.311	Hazardous waste per employee	55.00	245.00	-0.127	0.926	0.463
Total ink input per employee	186.00	252.00	-0.779	0.445	0.223	Total ink input per employee	179.00	245.00	-0.939	0.356	0.178
Isopropyl alcohol input per employee	11.00	336.00	-0.200	0.923	0.462	Isopropyl alcohol input per employee	33.00	39.00	-0.121	0.928	0.464
Total fuel input per employee	105.00	633.00	-0.256	0.812	0.406	Total fuel input per employee	121.00	166.00	-0.467	0.654	0.327
Total energy input per employee	73.00	101.00	-1.337	0.190	0.096	Total energy input per employee	71.00	116.00	-2.043	0.041	0.021
Total water input per employee	102.00	147.00	-1.425	0.161	0.081	Total water input per employee	96.00	162.00	-2.131	0.033	0.016