Environmental Policy Tools and Firm-Level Management Practices: Empirical Evidence for Germany

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Environmental Policy Tools and Firm-Level Management Practices: Empirical Evidence for Germany.

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Abstract. On the basis of abundant facility and firm-level data for German manufacturing, originating from a recent OECD-survey, this paper empirically investigates the relevance of a variety of incentives for environmentally innovative behavior of facilities, the respective influence of pressure groups, and the impact of both regulatory and market-based policy instruments, such as eco-taxes. Since the early 1990s, Environmental Management Systems (EMS), specifically, have become a vital voluntary complement to mandatory environmental policies based on regulation and legislation. EMS may be perceived as an organizational environmental innovation that may lead to improved environmental performance. While the paper provides a descriptive analysis of the determinants for EMS-adoption and incentives that may trigger environmental innovation activities within German facilities, the major questions that will be addressed in this paper are: (1) How can public authorities support the introduction of management practices that may lead to improved environmental performance? (2) What are the main determinants of environmentally innovative behavior of firms? Specifically, we are interested in the role that market forces and regulation play in the process of complex firm decisions on innovation and environmental performance. While the relevant literature on these issues is dominated by case studies, our large-scale survey indicates that the most important reasons why firms contemplate introducing EMS are to improve the efforts to achieve regulatory compliance, to improve the corporate image, and to create cost savings with respect to both waste management and resource input. Among pressure groups, internal stakeholders − management employees and corporate headquarters − appear to be more influential with respect to EMS-adoption and environmental innovation than external forces, such as public authorities.

JEL-Classification: L50, Q50.

Keywords: Environmental Management Systems, EMAS, Environmental Policy Instruments.

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I. Introduction

In contrast to conventional innovations, *environmental innovations* produce a *double* rather than *single externality* ─ see e. g. Carraro (2000) and Rennings (2000): Besides providing the typical positive spillovers of R&D activities; innovative products and production may reduce negative environmental externalities. Although in some cases there are clear market-based incentives to improve environmental performance, e. g. cost savings realized by process improvements, the public good character of environmental innovations necessitates governmental interventions, such as regulation and research programs, for their stimulation.

For this reason, it is important to analyze the variety of measures that may provide sufficient incentives to spur environmental innovation within firms. In particular for Germany, considerable empirical effort has been spent on the identification of characteristics, determinants, and obstacles of environmental innovations at the firm level, with particular interest on the role of environmental policy ─ see e.g. Rennings, Hemmelskamp, Leone (2000:4). In particular, several research frameworks were established, such as the FIU-project[1] and the succeeding RIW[2] project, which aim at sustainability aspects of environmental innovation.

Since the early 1990s, Environmental Management Systems (EMS), specifically, have become a vital voluntary complement to mandatory environmental policies based on regulation and legislation. EMS may be perceived as an organizational environmental innovation that may lead to improved environmental performance. The impact of EMS on environmental innovation behavior and competitiveness of firms has been recently investigated by Rennings et al. (2003). Yet, except for a few studies, such as Rennings et al. (2003), the relevant German literature is dominated by case studies. Hence, there is still a lack of large-scale surveys that allow for a profound empirical analysis of environmental innovation issues.

On the basis of abundant facility and firm-level data for German manufacturing, originating from a recent OECD-survey, this paper empirically investigates the relevance of a variety of incentives for environmentally innovative behavior of facilities, the respective influence of pressure groups, and the impact of both regulatory and market-based policy instruments, such as eco-taxes. An interesting characteristic of the present study is the setup of a standardized questionnaire that, in principle, would allow for the comparison of the impact of different legal and institutional frameworks on the innovation behavior of firms across several OECD countries, such as Japan, Canada and the US. While the paper provides a descriptive analysis of the determinants for EMS-adoption and incentives that may trigger environmental innovation activities within German facilities, the major questions that will be addressed in this paper are:

- Do different types of policies, such as direct regulation, market-based instruments, and voluntary approaches, result in varying organizational responses within firms, specifically in the adoption of alternative types of EMS?
- What are the main determinants of environmentally innovative behavior of firms? Specifically, we are interested in the role that market forces and regulation play in the process of complex firm decisions on innovation and environmental performance.
- How can public authorities support the introduction of management practices that may lead to improved environmental performance?

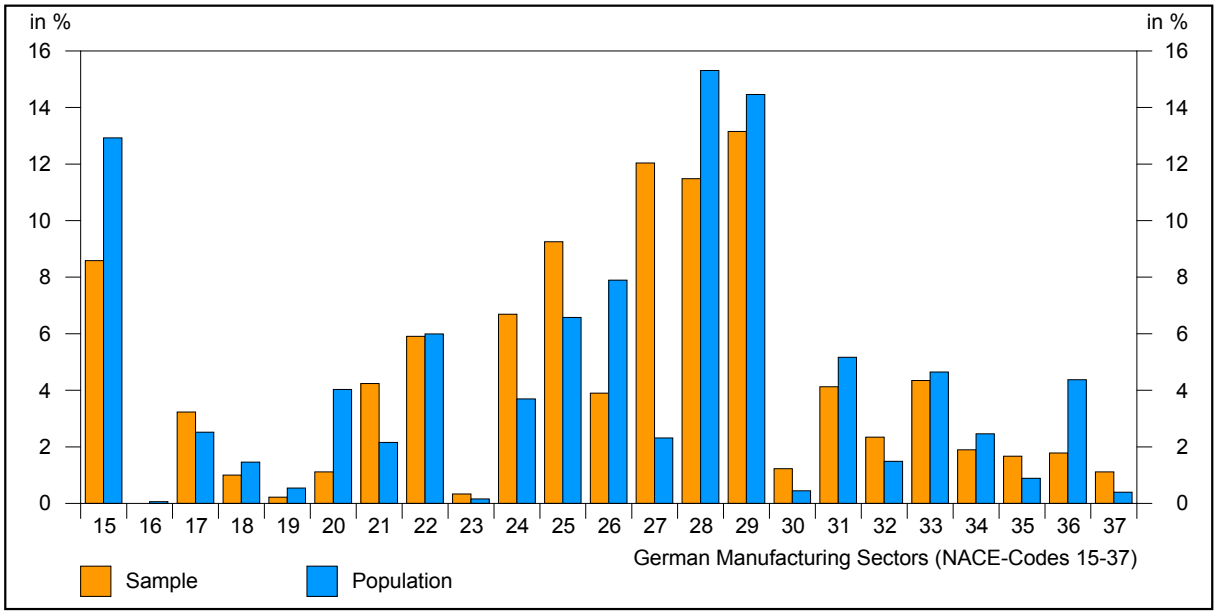
In the following section, a concise descriptive summary of our sample is provided. Specifically, we address the issue of whether or not our sample is representative for German Manufacturing. Section III offers a summary of the history of German environmental policy. Section IV specifically examines the factors leading to voluntary adoption of EMS. In Section IV, we deal with the impact of distinct pressure groups on a facility's decision to adopt EMS.

[1] FIU: German Abbreviation for "Joint Project on Innovation Impacts of Environmental Policy Instruments".
[2] RIW: German Abbreviation for "Policy Framework for Innovation toward Sustainable Development".

II. Sample Description

While contacting 5.000 facilities belonging to the German manufacturing sector, we received 899 valid questionnaires. This outcome is equivalent to a response rate of approximately 18%. The distribution of responses across individual sectors – attributed with NACE-Codes 15-37 – is displayed in **Figure II.1** and in more detail in **Table II.1**, where we compare our sample distribution with the distribution of the current population of German manufacturing facilities. One striking feature is that some sectors are heavily overrepresented: In particular this refers to the basic metals sector, NACE-Code 27, as well as to the sectors "Chemical Products" (24) and "Paper Products" (21), whereas the shares of facilities originating from the sectors "Food Products" (15), "Wood and Products of Wood" (20), and "other Non-metallic Mineral Products" (26) are relatively small and non-typical.

Figure II.1: Comparison of Frequency Distributions by Sectors for Sample and Population. Data Source: STABU (2002: 291).



Moreover, out of these 23 sectors, 7 sectors exhibit a frequency relative to the total number of facilities that is much lower than 2% in both the sample and the population. Examples are the tobacco sector (16) and the leather products sector (19), from which we received either none or two completed questionnaires, respectively. This leaves us with 16 sectors that are relevant in terms of the number of facilities. Among those, "Basic Metal Products" (27), "Fabricated Metal Products" (28), "Machinery" (29), and the food production sector (15) are the most relevant sectors of our sample.

The distribution of facilities with respect to size, measured in terms of the number of employees, is reported in the left-hand panel of **Table II.2**. The share of sample facilities with a maximum of 100 employees amounts to slightly more than 40%, whereas the respective share of facilities in the German manufacturing sector is definitely much larger than 50%. In our sample, 6.6% of the facilities occupy more than 1000 employees and, therefore, are to be considered as large in terms of employees, whereas the respective share in the current population of manufacturing facilities broadly amounts to 1%. The right-hand panel of **Table II.2** shows that less than 10%, i.e. the absolute minority of facilities, achieve a maximum of a mere 5 Mio. Euro on sales, and hence appear to be small, whereas 12.5% are large in terms of sales.

Table II.1: Comparison of Frequency Distributions by Sectors for Sample and Population. Data Source: STABU (2002: 291).

		Sample Facilities with EMS		Sample Facilities		Population	
NACE-Code	Sector	Total Number	Share	Total Number	Share	Total Number	Share
15	Food Products and Beverages	22	28.6%	77	8.56%	6136	12.93%
17	Textiles	3	10.3%	29	3.22%	1197	2.52%
18	Wearing Apparel, Dressing	1	11.1%	9	1.00%	695	1.46%
19	Tanning and Dressing of Leather	1	50.0%	2	0.22%	258	0.54%
20	Wood Products, except Furniture	0	0.0%	10	1.11%	1912	4.03%
21	Paper and Paper Products	14	35.9%	39	4.33%	1023	2.16%
22	Publishing and Printing	9	17.0%	53	5.89%	2844	5.99%
23	Coke, Petroleum Products and Nuclear Fuel	3	75.0%	4	0.44%	78	0.16%
24	Chemicals and Chemical Products	35	57.4%	61	6.78%	1754	3.70%
25	Rubber and Plastics Products	30	35.7%	84	9.33%	3122	6.58%
26	Other Non-metallic Mineral Products	8	22.9%	35	3.89%	3748	7.90%
27	Basic Metals	29	26.9%	108	12.00%	1099	2.32%
28	Fabricated Metal Products, except Machinery	27	26.2%	103	11.44%	7267	15.31%
29	Other Machinery and Equipment	21	17.8%	118	13.11%	6863	14.46%
30	Office, Accounting and Computing Machinery	4	36.4%	11	1.22%	212	0.45%
31	Electrical Machinery and Apparatus	10	26.3%	38	4.22%	2453	5.17%
32	Radio, Television and Communication	8	38.1%	21	2.33%	706	1.49%
33	Medical, Precision and Optical Instruments	6	15.4%	39	4.33%	2204	4.64%
34	Motor Vehicles, Trailers and Semi-Trailers	5	29.4%	17	1.89%	1169	2.46%
35	Other Transport Equipment	5	33.3%	15	1.67%	422	0.89%
36	Furniture	1	6.3%	16	1.78%	2078	4.38%
37	Recycling	4	40.0%	10	1.11%	190	0.40%
	Total	246	-	899	100%	47461	100%

Table II.2: Frequency Distributions with respect to the Number of Employees and with respect to Sales.

Employees	Number	Share
Less than 50	48	5.3%
50 – 99	273	30.4%
100 – 149	150	16.7%
150 – 199	66	7.3%
200 – 249	62	7.0%
250 – 499	130	14.5%
500 – 999	72	8.0%
> 999	68	7.6%
n. a.	30	3.3%
Total	899	100.0%

Sales (Mio. Euro)	Number	Share
Less or equal to 5	87	9.7%
> 5 -10	153	17.0%
> 10 -15	87	9.7%
> 15 - 20	77	8.6%
> 20 - 30	87	9.7%
> 30 - 50	102	11.3%
> 50 - 100	87	9.7%
> 100	112	12.5%
n. a.	107	11.9%
Total	899	100.0%

Table II.3 reveals that 6.4% of our sample facilities do not spend any money on research and development (R&D), with 42 of the total number of 58 of these facilities being single-plant institutions. Unfortunately, the share of responding facilities that do not report any figure for R&D-expenditures is as large as 27%.

Table II.3: Distribution of Annual Expenditures on Research and Development (R&D) per Employee.

Specific Annual Expenditures on R&D	Number	Share
No R&D – Expenditures	58	6.4%
> 0 – 1.000 €	101	11.1%
> 1.000€ – 2.000€	76	8.3%
> 2.000€ – 4.000€	113	12.5%
> 4.000€ – 6.000€	80	9.6%
> 6.000€ - 10.000€	99	10.9%
> 10.000€ - 30.000€	98	10.8%
> 30.000€	31	3.4%
n. a.	243	27.0%
Total	899	100.0%

Finally, with respect to market scope, more than 50% of our respondents indicate that their facility would act world wide, only a small part of our sample facilities is confined to local markets. By contrast, only 98 firms are listed at the stock exchange. In relative terms, the vast majority of 88.4% of all firms in the sample is not listed at stock markets. The headquarters of 60.2% of those firms that are listed at stock markets – in absolute terms, 59 out of 98 firms – are located in foreign countries, mostly in the USA, Great Britain, France, and in Switzerland.

III. Public Policy Background

The aim of this section is to describe the main characteristics of the German environmental policy in order to examine whether or not our survey results are consistent with this environmental policy. The “official” beginning of an explicit German environmental policy can be traced to the environmental program of 1971, when environmental policy first became an independent public task. In 1994, environmental concerns were even integrated in Art. 20a of the German constitution: “Mindful also of its responsibility toward future generations, the state shall protect the natural basis of life” (FME (2002), p.168). In this section, we briefly survey the various environmental policy instruments in Germany.

Until the end of the nineties, the German environmental policy was dominated by regulatory approaches in nearly all environmental fields. Air pollution, for example, is predominantly ruled by the Federal Emission Control Act of 1974. This law served as a basis for the Ordinance on Large Combustion Facilities of 1983, the Ordinance on Small Combustion Facilities, and the Technical Instructions on Air Pollution. These instructions prescribe the best available abatement technique for e. g. power stations, industrial plants, and livestock facilities (Kirkpatrick, Klepper, and Price (2001), henceforth KKP, p. 32).

Many laws and ordinances concerning waste have been introduced or altered during the nineties. Important examples are the Closed Substance Cycle and Waste Management Act, which came into force in October 1996, the packaging ordinance in 1991; the end-of-life vehicle ordinance of 1997, and the amendment of the waste management act of 1972 in 2000 ─ see OECD (2001), p. 131, and Schnurer (2002a). In German waste management legislation, the concept of “product responsibility” was introduced, which means that producers are responsible for their products from “cradle to grave” (KKP, p. 37). Product responsibility implies that, on the one hand, both producers and distributors of goods can be legally forced to take back the waste and packages related to their products and to recycle a certain share. On the other hand, consumers can also be obliged to return the goods after use ─ see Schnurer (2002a), p. 5).

This policy has been quite successful: At present, about one third of total waste is being recycled. The recycling quota of industrial waste, especially, amounts to about 60% (see KKP, p. 37). The reduction of water pollution is based on the Federal Water Act of 1957. Further important water regulations are the Act on Environmental Compatibility of Washing and Cleaning Agents (1975), the Water Effluent Charges Act (1976), and the Waste Water Ordinance (1997) – see OECD (2001), p. 131. Each firm or institution discharging waste water into surface waters needs a permit from the local authority, which can only be granted when waste water is treated according to the general available technology (KKP, p. 34).

Regulation of fresh and waste water was the first, and for a long time the only environmental field, to which a legislative tool has been applied that can be considered as economic instrument. In the case of the Water Effluent Charges Act of 1976, the emissions were directly targeted by charges. Yet, in fact, the effluent water charge is not a pure economic instrument, because it is embedded in other regulatory measures. For instance, reduced charges are applied to those polluters who employ the best available technology, which, however, diminishes the incentives to engage in further abatement (KKP, p. 34). Another "inefficiency arises from provisions which permit the charge to be offset against investments in new sewage systems or their repair and with investments in the treatment of a particular substance which are made in a treatment plant" (KKP, p. 34).

Ecological Tax Reform

Except for the Water Effluent Charges Act, market-based instruments do not have a long tradition in Germany. In 1999, the so-called ecological tax reform was implemented only recently. This tax reform, however, did not meet the Pigouvian idea of aiming at the pollutants, notably CO2, in a direct way. Rather, the tax was levied on certain outputs associated with the emission of CO2, for instance, electricity and gasoline. These flaws can be best explained by the motives of politicians whose idea it was to shift the tax burden from the production factor labour to the factor energy, hoping that lower labour costs would create more jobs and higher energy costs would lead to less energy consumption (double dividend). It seems as if it was not so much the idea of providing incentives to reduce emissions on a large scale, which would erode the basis of any emission tax. Rather, the apparently central impetus was the strong belief to realize a double dividend from an ecological tax reform.

The resulting additional contribution to former energy taxes raised the gasoline and diesel tax by 0,06 DM per litre every year from 1999 to 2003. Furthermore, light oil and gas taxes were raised considerably and a taxation of electricity (20 DM/MWh in 1999, and from 2000 to 2003 5 DM/MWh annually) was implemented – see KKP, p. 29, and OECD (2001), p. 125. There are some consequential exemptions, however, that reduce the incentives induced by the ecological tax reform substantially:

- Nuclear fuels and coal are not taxed and, furthermore, the domestic production of hard coal remains subsidised;
- Industry and agriculture are subject to only 20% of the standard tax rate if the charge exceeds 1000 DM/year. Companies are refunded when the costs of the new energy taxes exceed the savings from reduced social security contributions by more than 20%;
- Gas and oil used to generate electricity are not subject to the tax.

Especially the low taxation of energy-intensive industries has been accepted for reasons of competitiveness, but it has prevented the environmentally desirable effect of an ecological structural change.

Liability Act

The Environmental Liability Act of 1990 represents another market-based instrument. The central reform of the liability act states that a person who has caused damage is held liable, irrespective of whether or not he violated a law (strict liability). In particular, this perception of liability includes negative environmental impacts of typical legal production activities. As a consequence of this act, a firm must take account of environmental costs even without direct state intervention, because the firm is always liable for present as well as future damages. By contrast, up to 1990, § 823,1 of the Civil Code obliged a person to pay compensation only if he had committed an *illegal* violation of objects of legal protection (negligence rule).

Environmental Management Systems and Voluntary Agreements

Besides regulation, also environmental management systems (EMS) and voluntary agreements grow more important in Germany. Notably the Eco-Management and Audit Scheme (EMAS), which was introduced in 1995 and revised in 2001, has been adopted by numerous companies and organizations on a voluntary basis. Those firms aim at committing themselves to the evaluation and improvement of their environmental performance. By April 2002, about 2600 German companies and organizations were registered under this scheme – see UBA (2003), p. 78.

The policy instrument of voluntary agreements, being in perfect accordance with the co-operation principle, gained importance during the nineties. By 2001, more than 100 voluntary agreements were in effect. The majority of those consist in commitments declared by industrial associations that are non-binding, because German ministries have no legal power to sign agreements with these associations – see OECD (2001), p. 115. One of the most important voluntary agreements was reached in 1995 and updated in 2000: The German industry promised to reduce its specific CO2-emissions until 2005 by 28 % and the emissions of the Kyoto greenhouse gases until 2012 by 35 % (UBA (2003), p. 80).

Other relevant examples concern environmentally harmful products or inputs, such as asbestos in cement products and the substitution of solvents in the chemical industry (KKP, p. 39). With respect to packaging, a privately organised system was introduced on a voluntary basis. This system has to ensure "that all packaging is returned by the consumer at the least possible cost into a material-specific recycling process" (UBA (2003), p. 80). The introduction of market instruments will be completed by the implementation of tradable permits for CO2 as early as 2005, following the respective EU directive.

Information-based Policies: Environmental Labelling

In Germany, information-based policies, such as environmental labelling, have attained high significance. Since 1978, the label "Blue Angel" is awarded to products and services that are relatively more environmentally friendly than other products and services serving the same purpose (see UBA (2003), p. 83). The "Blue Angel" label is due to an initiative of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. The technical requirements for products in order to receive the label are defined by an independent Environmental Label Jury. Up to now, the Blue Angel Label has been awarded to roughly 3100 products and services of 640 label users. The label covers a broad variety of different products, such as paper products, office products and furniture, electrical products and equipment, heating plants and regenerative energy use, construction and renovation equipment, sanitary and hygiene products, canteen and kitchen products, horticulture and landscape building, transport equipment and products, batteries, and services (see UBA (2003), p. 83). In addition, the Energy Consumption Labelling Act of 1997 provides information for consumers on energy-saving appliances. Another instrument is the granting of user-benefits for environmental friendly products (UBA (2003), p. 82).

IV. Environmental Management and Performance

In this section, we present the most important findings of our survey.

Environmental Management Systems and Tools

An important issue is the allocation of responsibilities for environmental concerns. In two-thirds of our sample facilities, at least one person is named explicitly responsible for environmental concerns – see **Table IV.1**. These persons mainly belong to a specialized environmental department (38.1 %). Yet, such persons are often part of another department, most notably of the production or operation section (25 %). In many cases, environmental aspects appear to be highly relevant and responsible persons are thus within the immediate realm of the senior management (20.6 %).

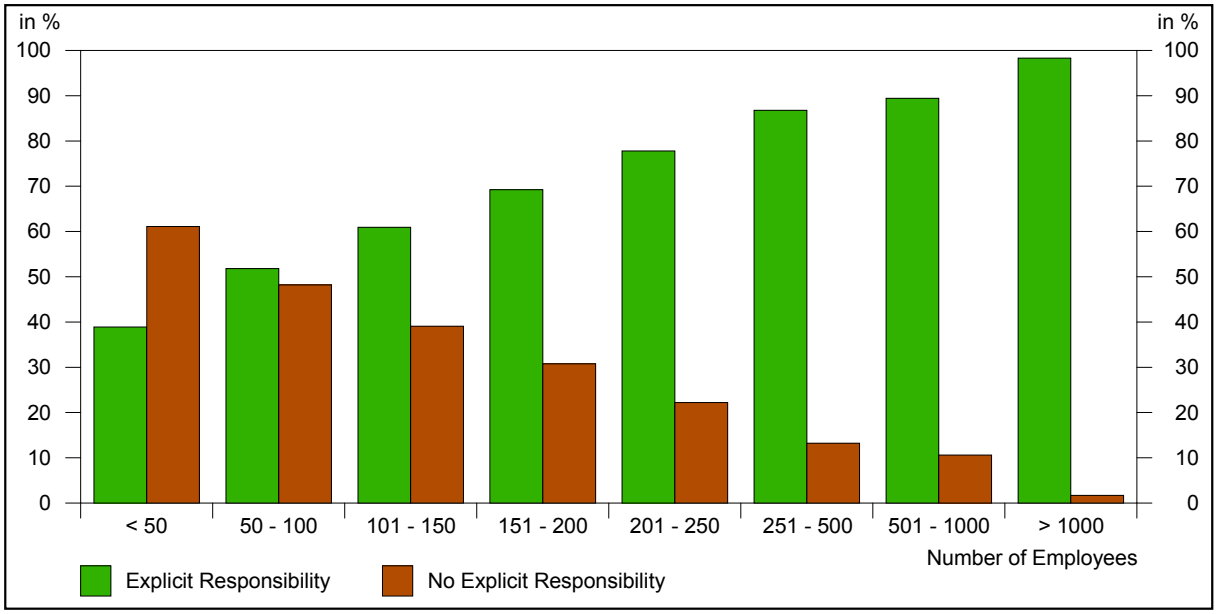
Table IV.1: Existence of Explicitly Responsible Person for Environmental Concerns.

Facilities with Explicitly Responsible	*Number*	*Share*
Persons for Environmental Concerns	591	65.7%
These Individuals belong to		
Senior Management	122	20.6%
Production/Operations	148	25.0%
Specialised Environmental Department	225	38.1%
Other Departments	96	16.3%
Total	591	100.0%

In short, if environmental aspects are relevant enough such that they are part of the job description of at least one person, these persons are mostly located in either of three areas: in a special environmental department, in the production or operation section, or in the senior management. At more than 75%, the highest shares of facilities with employees dealing at least partly with environmental issues are to be observed in the chemicals and chemical products sector (24), the rubber and plastics products sector (25), and the sector “Basic Metals” (27).

Figure IV.1 suggests that there is a strong positive correlation between facility size and the existence of employees who are responsible for environmental issues: The larger a facility is in terms of employees, the more likely the existence of a person who is explicitly responsible for such concerns. In **Figure IV.2**, a similar positive correlation can be observed between facility size and the probability of the implementation of environmental management systems. **Figure IV.2** also documents the dominance of ISO 14001 among EMS, while the implementation of EMAS seems to require a certain facility size of more than 250 employees.

Figure IV.1: Existence of Persons that are Explicitly Responsible for Environmental Concerns.



The most common practices that already have been established by the majority of our sample facilities are – according to **Figure IV.3** – environmental training programs, environmental accounting, and written environmental policies, while it seems to be rather unusual in German manufacturing to use environmental criteria for the evaluation or compensation of employees, to publish an environmental report, and to define a certain benchmark for environmental performance of a firm.

Figure IV.2: Correlation between Facility Size and Implementation of Environmental Management Systems.

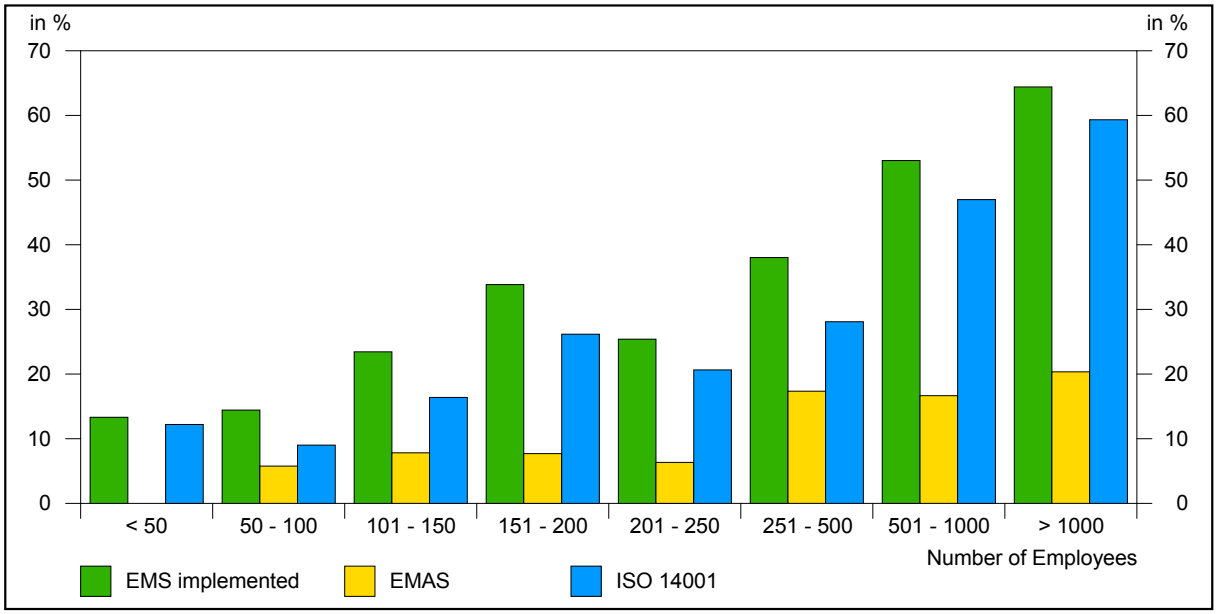
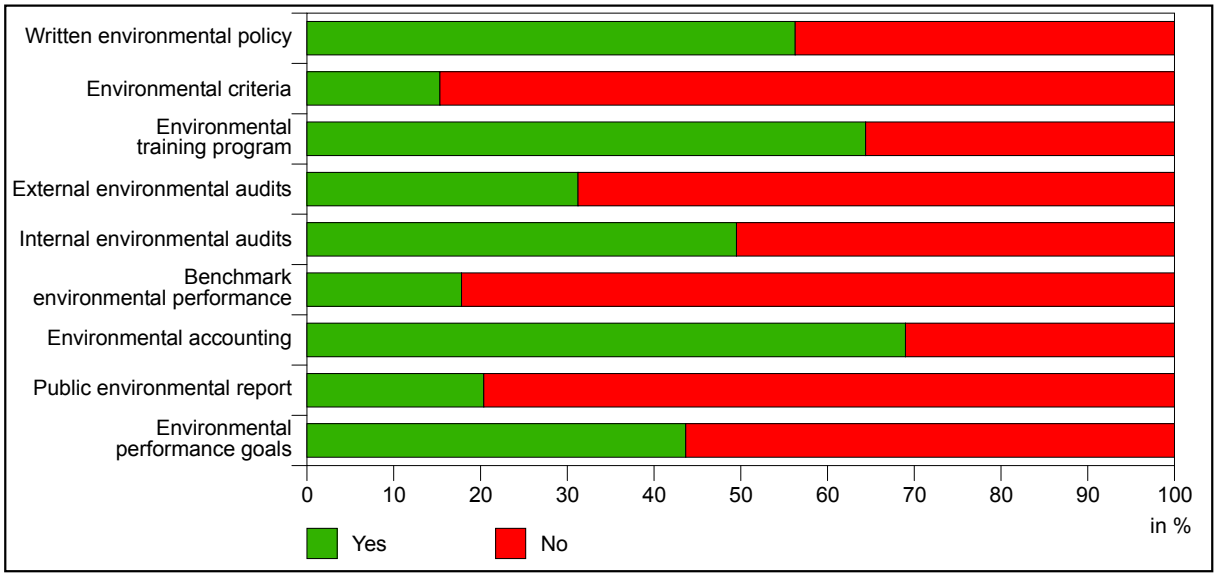


Figure IV.3: Established Practices in order to Implement Environmental Management Systems (EMS).

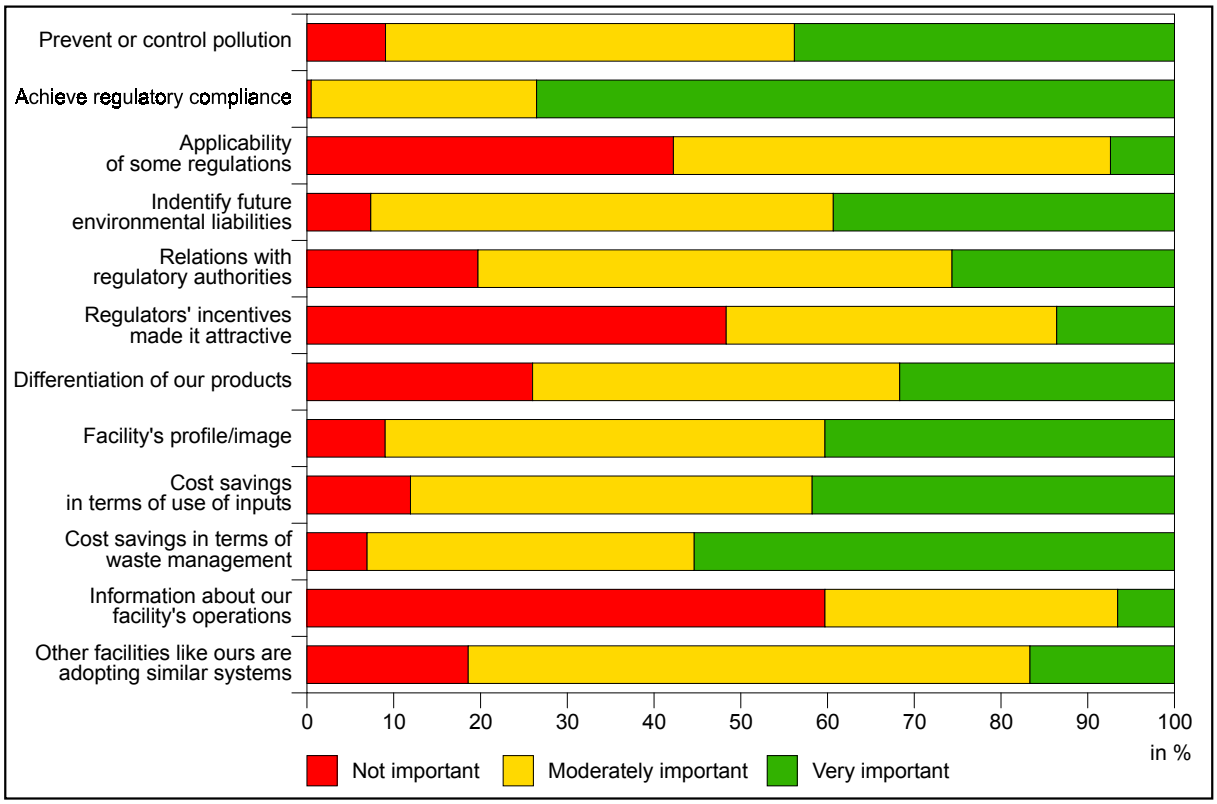


437 out of 899 facilities, which is almost the half of our sample, have considered introducing an Environmental Management EMS. 246 facilities have even established such a system already, while the implementation is in progress in 62 facilities. Important reasons why firms contemplate introducing EMS are to improve the efforts to achieve regulatory compliance, to create cost savings with respect to both waste management and resource input, to prevent or control pollution, and to foster the firm image (see **Figure IV.4**). By contrast, adopting similar systems that have already been implemented in other facilities does not seem to be an important issue. For many facilities, potential incentives provided by regulators do not appear to be sufficiently attractive to push the implementation of EMS, either.

The EMAS law of the European Union, originating from 1993, became nationally relevant in Germany in form of the Environmental Audit Law in December 1995. Despite a lot of missing values with respect to the year of the introduction of EMS ─ merely 80 respondents of 246 facilities with EMS noted this year ─ there is a clear

pattern: More than half of those firms that already have introduced EMS indicated that they initiated EMS in 1996, 1997, and 1998, precisely the years right after the German Environmental Audit Law came into effect. The national law was altered in 2001. The consequence for our sample was a slight inter-temporal peak in the frequency of firms that implemented EMS in 2002 for the first time: While about 6 % of those firms that have indicated the initial year implemented an EMS in 2001, around 12 % of these firms noted the year 2002, whereas only 2.5 % noted the year 2003.

Figure IV.4: Incentives for the potential Introduction of Environmental Management Systems (EMS).



While **Table II.1** already indicates that EMS is implemented in almost two-thirds of our sample facilities originating from the chemical industry (24), the implementation of EMS is also typical for facilities of the rubber and plastic (25) and the paper industries (21). (Yet, the number of facilities of the paper industry is not very large in our sample.) One third of our sample facilities belonging to the sector “Basic Metals” (26) and the sector “Fabricated Metals” (27) have already established EMS as well. By contrast, EMS are far from being common in other sectors, for example the wood and furniture industries. A complete survey of the implementation of EMS, specifically of EMAS and ISO1401, is given in **Table IV.2**.

Table IV.3 reports that 246 of our sample facilities, i.e., a share of 27.5% of these facilities have already implemented an environmental management system (EMS). The majority of these facilities, 56.3% or 139 facilities in absolute terms, have acquired a certification according to ISO 14001, and approximately one-third of them have been certified according to EMAS, with roughly 20% of all certified facilities having been awarded both certificates. Moreover, the implementation of an EMS is in progress in about 7% of our sample facilities, while almost two-thirds of them have not implemented any such system yet.

Sample facilities that are part of a firm listed at a stock market seem to appreciate environmental management systems: 50 out of 98 of those facilities have introduced EMS. This represents a quota of 51% as opposed to 24.4% for facilities belonging to non-listed firms. Similarly, 49.2% of those sample facilities whose firm

head quarter is located in foreign countries employ environmental management systems, whereas this share amounts to 24.1% for facilities with purely national roots.

Table IV.2: Implementation of EMAS, ISO 14001 and other EMS in our Sample Facilities across Sectors.

NACE-Code	Sector	EMAS		ISO 14001		Other Systems	
		Total Number	Share	Total Number	Share	Total Number	Share
15	Food Products and Beverages	14	17.3%	12	6.2%	2	7.4%
17	Textiles	1	1.2%	2	1.0%	0	0.0%
18	Wearing Apparel, Dressing	1	1.2%	0	0.0%	0	0.0%
19	Tanning and Dressing of Leather	0	0.0%	0	0.0%	1	3.7%
20	Wood Products, except Furniture	0	0.0%	0	0.0%	0	0.0%
21	Paper and Paper Products	5	6.2%	13	6.7%	1	3.7%
22	Publishing and Printing	3	3.7%	3	1.6%	4	14.8%
23	Coke, Petroleum Products and Nuclear Fuel	0	0.0%	3	1.6%	0	0.0%
24	Chemicals and Chemical Products	10	12.3%	25	13.0%	7	25.9%
25	Rubber and Plastics Products	10	12.3%	24	12.4%	3	11.1%
26	Other Non-Metallic Mineral Products	4	4.9%	7	3.6%	1	3.7%
27	Basic Metals	7	8.6%	23	11.9%	2	7.4%
28	Fabricated Metal Products, except Machinery	10	12.3%	24	12.4%	2	7.4%
29	Other Machinery and Equipment	4	4.9%	19	9.8%	1	3.7%
30	Office, Accounting and Computing Machinery	2	2.5%	4	2.1%	0	0.0%
31	Electrical Machinery and Apparatus	2	2.5%	9	4.7%	0	0.0%
32	Radio, Television and Communication	1	1.2%	8	4.1%	0	0.0%
33	Medical, Precision and Optical Instruments	2	2.5%	4	2.1%	2	7.4%
34	Motor Vehicles, Trailers and Semi-Trailers	1	1.2%	5	2.6%	0	0.0%
35	Other Transport Equipment	3	3.7%	5	2.6%	0	0.0%
36	Furniture	0	0.0%	0	0.0%	1	3.7%
37	Recycling	1	1.2%	3	1.6%	0	0.0%
	Total	81	100.0%	193	100.0%	27	100.0%

Table IV.3: Implementation of Environmental Management Systems.

Implementation of Environmental Management Systems				
Yes	246	If Yes:	EMAS and ISO 14001	55
In progress	62		Only EMAS	26
No	572		Only ISO 14001	138
n.a.	19		Other Systems	27
Total	899		Total	246

The comparison of our sample and the population of facilities in the German manufacturing sector reveals that participation in our survey seems to be strongly favored by EMS-certification: According to OECD (2000), a mere share of roughly 9.5% of all German facilities have been certified with respect to EMAS, ISO 14001, or both. A possible explanation might be that the likelihood for answering our questionnaire is presumably much higher in facilities with employees explicitly dealing with environmental issues. In those facilities, it is exactly these persons who are responsible for the completion of our questionnaire and, indeed, almost 95% of the 246 sample facilities employing environmental management systems exhibit employees on their pay-roll who are

specifically responsible for environmental issues, whereas only 51% of our sample facilities without EMS have such employees.

Among general management practices that are not directly related to environmental management systems, quality management and management accounting systems are those that are most frequently applied (see **Figure IV.5**), while the majority of sample facilities also employ full-cost or activity-based accounting, process or job control systems, and inventory requirement tools. Environmental activities have been, at least partially, integrated in these traditional management tools: above all in quality management, health and safety management, and management accounting (see **Figure IV.6**).

Figure IV.5: Implementation of Other Management Practices.

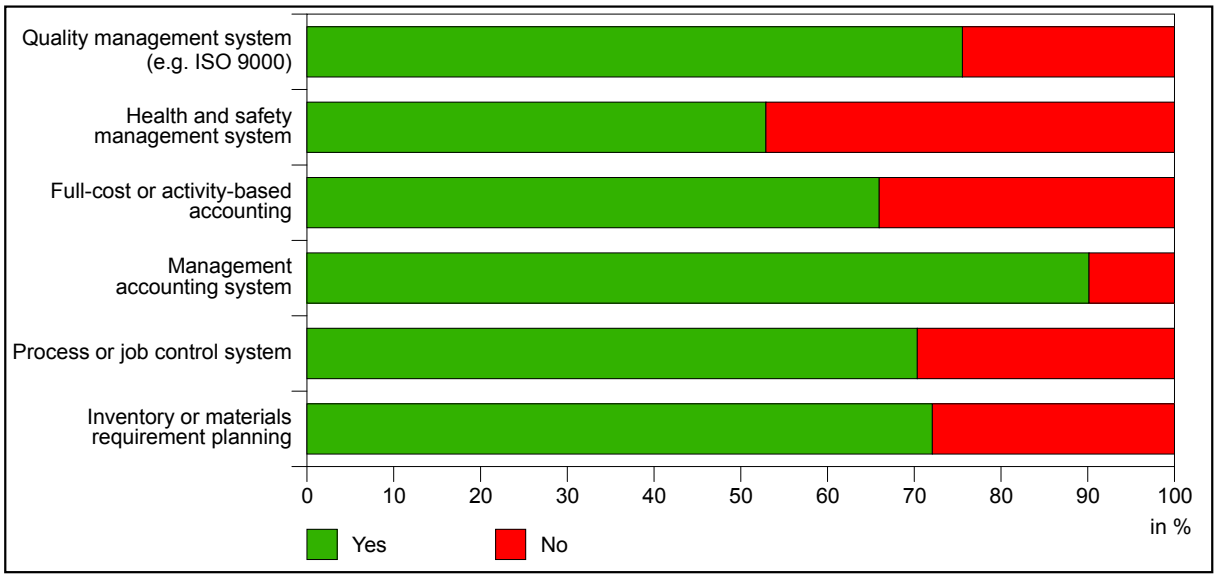
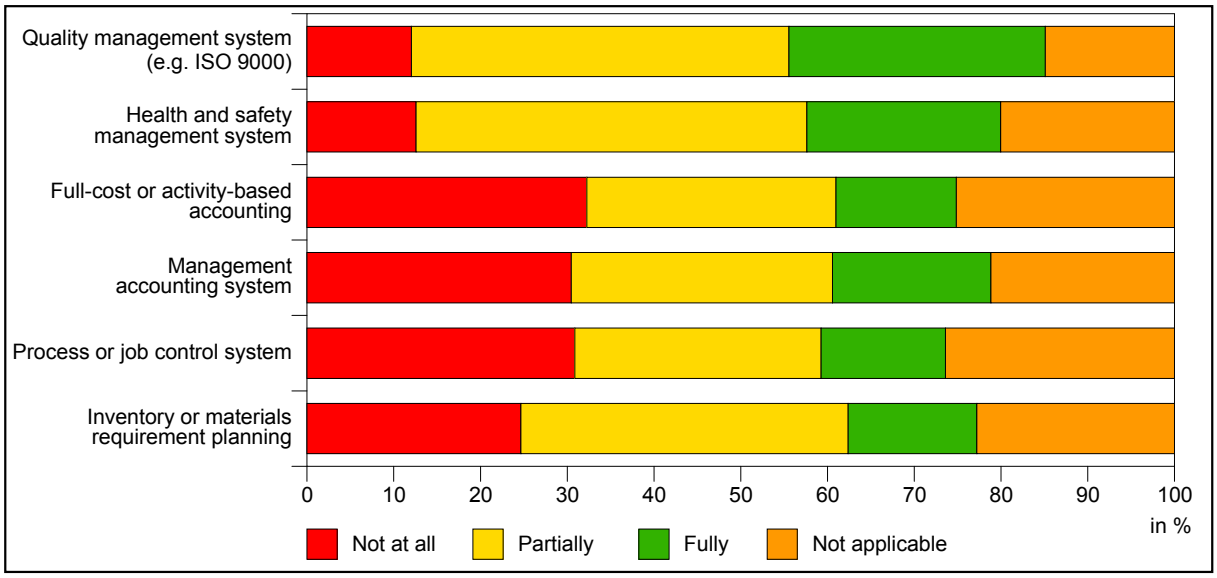


Figure IV.6: Integration of Environmental Activities with Management Practices.



The results displayed in **Table IV.4** provide ample empirical evidence on the impact of environmental departments: The shares of facilities that have established specific environmental practices, such as environmental programs or environmental performance indicators, are significantly higher in those firms where an environmental department exists. By contrast, **Table IV.5** indicates that the implementation of traditional

management practices, such as full-cost or activity-based accounting or management accounting systems, does not depend on the existence of an environmental department: The differences between facilities belonging to firms with an environmental department and those without one are not pronounced with respect to traditional management systems. Finally, a quite interesting result that might question the policy instrument of EMS is: Out of those 246 facilities that already have adopted EMS, merely 58.9% of our respondents confirm that the benefits have been as great as expected.

Table IV.4: The Impact of Environmental Departments on the Establishment of Environmental Practices.

Existence of an Environmental Department:	**YES**	**NO**
Written Environmental Policy	78.8%	37.7%
Environmental Criteria for Employees	23.1%	8.7%
Environmental Training Program	81.3%	48.2%
Carry out External Environmental Audits	50.3%	15.1%
Carry out Internal Environmental Audits	72.0%	30.8%
Benchmark Environmental Performance	28.0%	9.1%
Environmental Accounting	83.7%	56.0%
Public Environmental Report	35.0%	7.3%
Environmental Performance Indicators	64.8%	25.8%
Other Practices	7.5%	4.0%

Table IV.5: The Impact of Environmental Departments on the Implementation of Other Management Practices.

Existence of an Environmental Department:	**YES**	**NO**
Quality Management System (e. g. ISO 9000)	85.8%	61.1%
Health and Safety Management System	51.0%	45.0%
Full-cost or Activity-based Accounting	57.0%	59.9%
Management Accounting System	80.3%	85.7%
Process or Job Control System	70.5%	58.7%
Inventory or Materials Requirement Planning	70.7%	60.9%
Other Management Practices	13.0%	7.1%

Environmental Measures, Innovation and Performance

Since natural resources, in particular energy, are cost-intensive production factors, it is not surprising that approximately 90% of all facilities monitor the consumption of natural resources (see **Figure IV.7**), while a substantial majority of facilities also measure solid waste generation (82.2%) and wastewater effluent (69.1%). By contrast, only 20.1% of our sample facilities even gauge local or regional air pollution. Measurement of soil contamination is merely undertaken by 17.1%. Moreover, soil contamination as well as local or regional air pollution, are not relevant in many cases. Besides the issue of input cost saving, the use of natural resources, wastewater and solid waste generation appear to be typical environmental problems that are relevant for most of our sample facilities due to at least moderately negative impacts – see **Figure IV.8** – and thus are regularly monitored.

Figure IV.7: Regular Monitoring of Negative Environmental Impacts.

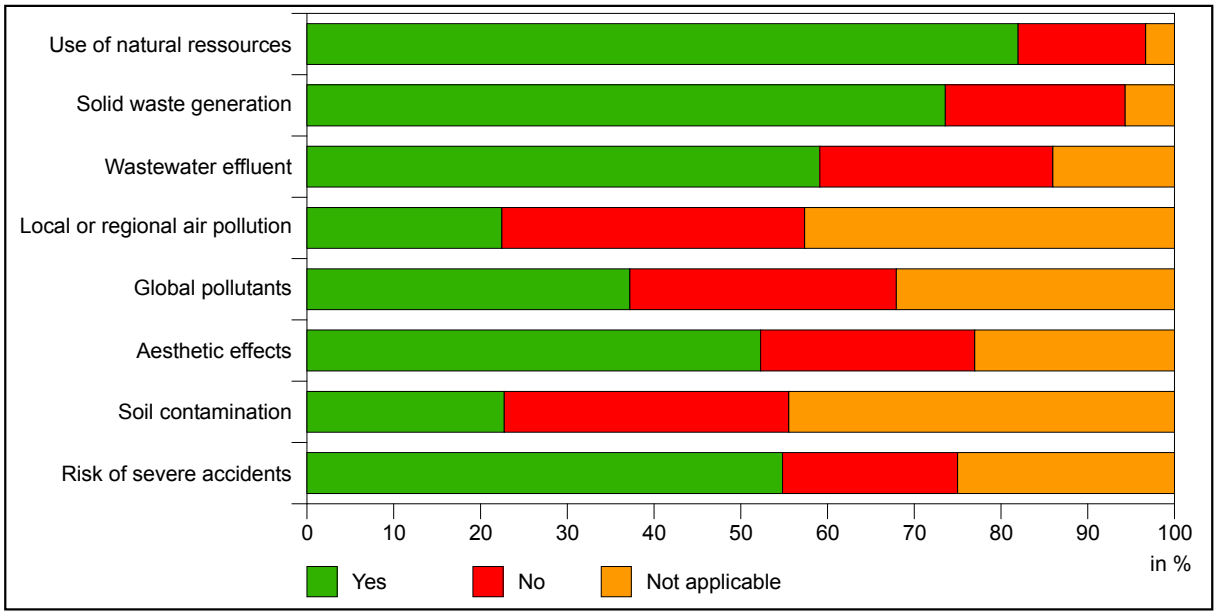
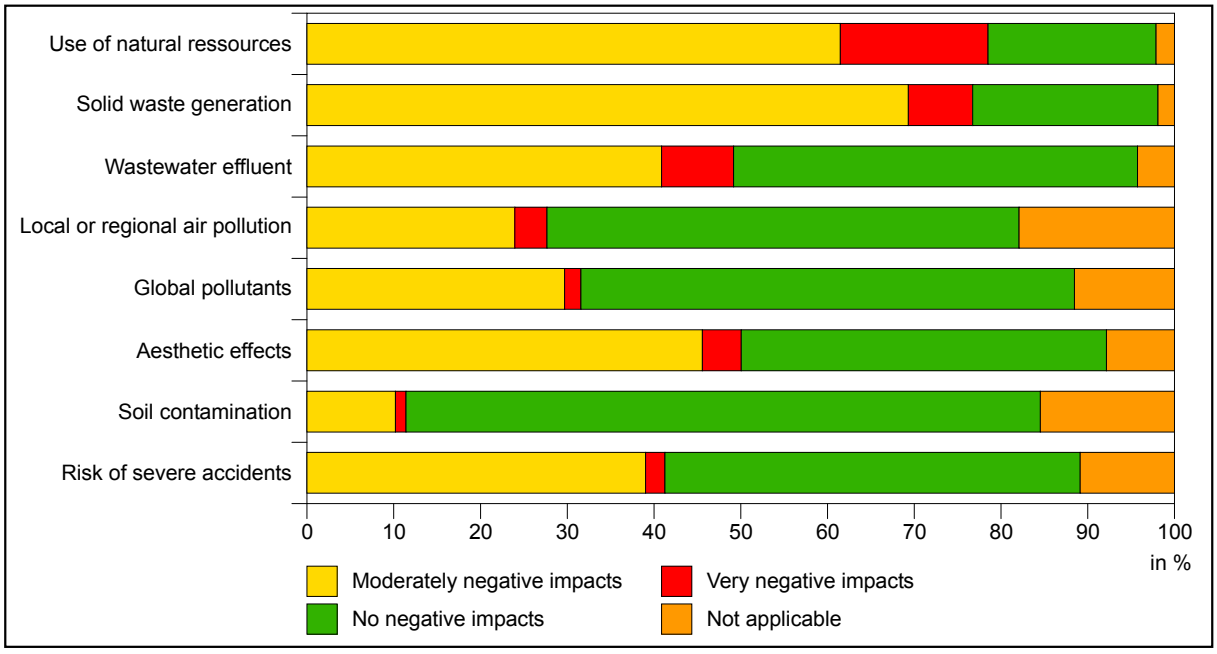


Figure IV.8: Relevance of Potential Negative Environmental Impacts.

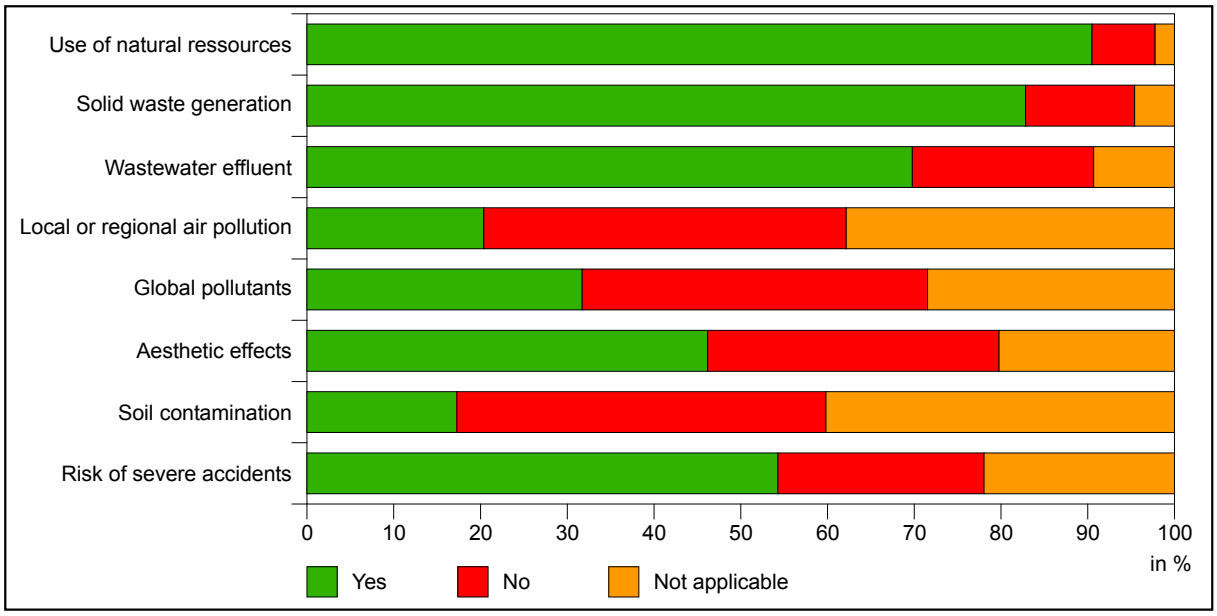


As a further consequence, a large fraction of 81.9% of our sample facilities have undertaken concrete actions to reduce the use of natural resources, while the reduction of solid waste generation (71.3%) and wastewater effluents has been on the agenda of most facilities as well (see **Figure IV.9)**. Less urgent seems to be the reduction of local or regional air pollution, global pollutants, and soil contamination, partly because these aspects are frequently not relevant.

The comparison of the **Figures IV.7, IV.8,** and **IV.9** suggests that those facilities that suffer from negative environmental impacts, such as wastewater effluents, not only measure and monitor these impacts regularly, but actually undertake concrete actions to reduce both harmful environmental consequences and the cost for their

disposal. For instance, while roughly 90% of our sample facilities regularly monitor the use of natural resources, more than 80% of them have already reacted by attempting to lower the consumption of resources.

Figure IV.9: Concrete Actions Undertaken to Reduce Environmental Impacts.



For the selection of environmentally most relevant industrial sectors given in **Table IV.6,** those shares of sample facilities are reported that have made substantial reduction efforts with respect to certain environmental impacts, such as use of natural resources and waste generation. Not surprisingly, environmental problems particularly arise in these industrial sectors due to the use of natural resources, waste water and solid waste generation and, hence, require investments in order to diminish negative environmental consequences.

Table IV.6: Reduction Efforts with respect to certain Environmental Impacts across Selected Sectors.

Shares of Facilities undertaking Efforts to Reduce Environmental Impacts	Use of Natural Resources	Solid Waste Generation	Wastewater Effluent	Risk of Severe Accidents
Paper and paper products (21)	92.3%	82.1%	76.9%	59.0%
Chemicals and chemical products (24)	90.2%	85.2%	80.3%	68.9%
Rubber and plastics products (25)	90.5%	84.5%	58.3%	66.7%
Basic metals (27)	80.6%	72.2%	61.1%	55.6%
Fabricated metal products, except machinery (28)	84.5%	75.7%	59.2%	68.9%

Table IV.7 provides convincing empirical evidence for the positive correlation between firm size and the share of facilities that undertake efforts to substantially reduce the environmental impacts of their production activities with regard to those environmental problems that are identified as most relevant.

Table IV.7: Firm Size and Reduction Efforts with respect to certain Environmental Impacts.

Shares of Facilities undertaking Efforts to Reduce Environmental Impacts	Use of Natural Resources	Solid Waste Generation	Wastewater Effluent	Risk of Severe Accidents
Less or equal to 50	74.4%	64.4%	44.4%	52.2%
51 – 100	72.9%	65.7%	44.8%	43.3%
101 – 150	84.4%	68.8%	58.6%	46.1%
151 – 200	87.7%	78.5%	64.6%	64.6%
201 – 250	85.7%	74.6%	65.1%	65.1%
251 – 500	89.3%	81.0%	74.4%	65.3%
501 – 1000	93.9%	89.4%	84.8%	65.2%
> 1000	94.9%	94.9%	79.7%	74.6%

Table IV.8 reveals that 52.4% of our sample facilities have undertaken significant technical measures that reduce the environmental impacts associated with their activities. While only 3.6% of these facilities have changed the product characteristics, the vast majority of 91.5% of these facilities have altered their production processes, a quota that is much higher than in any other country involved in this OECD-survey. Out of those facilities with altered production processes, 56.4% have changed their production technologies, but still a large minority of 41.5% of these facilities have implemented end-of-pipe technologies (see **Table IV.9)**.

Table IV.8: Distribution of the Types of Technical Measures that Sample Facilities have undertaken.

Absolute Number and Share of Sample Facilities that have Undertaken Significant Technical Measures	471	52.4 %
• Changes in Production Processes	431	91.5 %
• Changes in Product Characteristics	17	3.6 %

Table IV.9: Distribution of the Types of Changes in Production Processes.

Changes in Production Technologies	243	56.4 %
End-of-Pipe Technologies	179	41.5 %
n.a.	9	2.1 %
Total	431	100.0 %

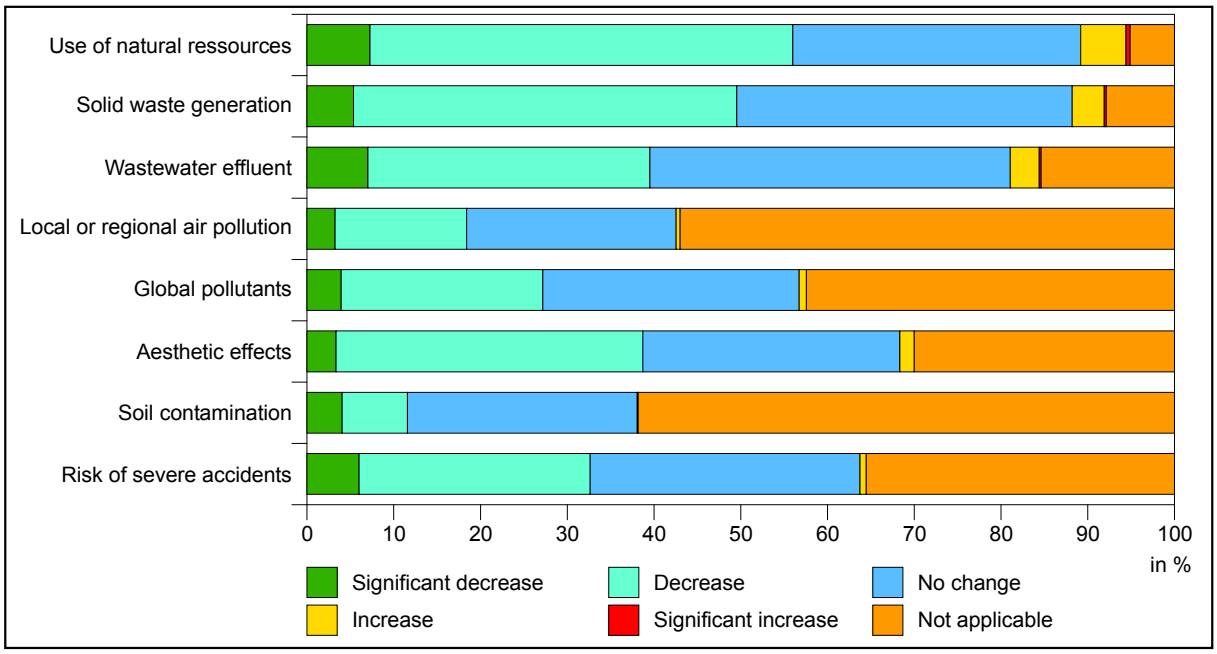
While the budget of two-thirds of our sample facilities includes general R&D-expenditures, only 3.6% of all facilities have a budget for R&D that is specifically related to environmental matters. Out of these few facilities, more than 80% have attained technical measures to reduce the environmental impact of their activities, whereas roughly 50% of the facilities without specific R&D-expenditures have undertaken such efforts. By contrast, such technical measures have been accomplished in merely 52.6% of those facilities with general R&D-expenditures, but in 46.6% of those facilities without general R&D-expenditures.

The existence of an employee explicitly responsible for environmental concerns seems to have a significant influence on the implementation of technical measures that reduce negative environmental impacts: While almost two-thirds of those facilities in which at least one of such persons works have undertaken technical reduction measures, less than one-third of those facilities without such a person has performed reductions measures. If an explicitly responsible person is located in a specific environmental or a similar department, one of the consequences seems to be that technical measures in order to reduce negative environmental impacts have

been implemented in more than 70% of the corresponding facilities, while this has happened in merely 45.7% of those facilities, where such a person belongs to another department.

More than half of our sample facilities declare that their use of natural resources has decreased – some even significantly – within the last three years (see **Figure IV.10**). Reductions with respect to waste generation and wastewater effluents have occurred in slightly less than half of the sample facilities and 37% of all facilities, respectively. While significant increases are very rarely observed for all impact categories, many facilities indicate that there have been no changes with respect to a certain type of environmental impacts. Finally, only a few facilities announce significant decreases of negative environmental impacts (3.1 % - 6.8 %).

Figure IV.10. Change in the Environmental Impacts per Unit of Output.



V. Importance of Motivations, Stakeholders and Public Environmental Policy

This section focuses on the exploration of the main determinants of environmental innovation activities of firms. It provides an analysis of the importance of different stakeholders, public environmental policies as well as intrinsic motivations of firms for their innovation activities. Note in this specific context that the introduction of Environmental Management Systems (EMS) represents an organizational environmental innovation. That is, environmental innovations not only comprise the application and development of new technologies that lead to less environmental impacts.

Motivations and Interest Groups

Our descriptive analysis of the impact of interest groups and organizations for environmental innovation activities shows that internal stakeholders seem to be more important than external forces. This conclusion is supported by the high percentages of corporate headquarters and management employees in the categories “important” and “very important” (see **Table V.1**). Public authorities as well as commercial customers play a major role, but they are not as important as corporate headquarters. Interest groups like industry and trade associations, environmental organizations, and labor unions seem to be even less important.

Commercial customers and households are more important in sectors where consumers display a high sensibility with respect to the environmental characteristics of the products. In the publishing and printing sector, for instance, 32.7% of the firms classify commercial customers as very important. Presumably, this has to do with the fact that German consumers appreciate recycled paper. The chemical industry with a respective value of

27.9% and the production of wearing apparel (44.4%) represent further examples. In any case, commercial customers appear to be more relevant for environmental activities than households.

Furthermore, it is not surprising that particularly strongly regulated environmentally intensive sectors denote public authorities as "very important" for their environmental activities – see the chemical and the non-metallic mineral products industries, where the corresponding percentages are 44.3% and 42.9%, respectively. The high relevance of public authorities for environmental activities can be supported by analyzing the available information about the motivations of firms. The results indicate a very important role of regulatory compliance, which confirms earlier investigations in the literature – see e. g. Halstrick-Schwenk, Horbach, Löbbe, and Walter (1994), and Henriques and Sadorsky (1996).

Table V.1: The Role of Interest Groups and Organizations for Environmental Activities of the Firms.

Interest Groups and Organizations	Not important	Important	Very important	Not applicable	Total
Public Authorities	14.2%	55.2%	27.6%	3.0%	100%
Corporate Headquarters	3.5%	43.8%	50.4%	2.2%	100%
Household Consumers	40.6%	20.2%	6.4%	32.8%	100%
Commercial Buyers	23.1%	49.2%	22.2%	5.4%	100%
Suppliers of Goods and Services	37.6%	45.9%	10.0%	6.5%	100%
Shareholders and Investment Funds	31.6%	12.7%	3.7%	52.0%	100%
Banks and other Lenders	44.0%	25.4%	3.8%	26.8%	100%
Management Employees	14.4%	52.2%	25.3%	8.1%	100%
Non management Employees	20.3%	55.7%	15.2%	8.8%	100%
Industry or Trade Associations	43.9%	38.5%	5.2%	12.5%	100%
Labor Unions	59.5%	16.9%	2.1%	21.5%	100%
Environmental Groups/Organizations	44.2%	32.6%	7.6%	15.5%	100%
Neighborhood/Community Groups	39.5%	32.8%	7.8%	19.9%	100%

Sectors with considerable environmental impacts reach disproportionately large values for regulatory compliance as a motivation for environmental activities (chemical industry: 68.5% for "very important", paper and paper products: 60.5%, other non-metallic mineral products: 71.4%). This finding is in line with the results on the influence of interest groups. Both the corporate profile and the image also represent an important incentive for the chemical and the rubber and plastics industries. The respective values for "very important" are 34.4% and 41.0%.

Concerning cost savings as motivation (see **Table V.2**), there are considerable differences among branches. Cost savings are particularly essential incentives for environmental activities of food products and beverages (50% "very important"), paper products (41.0%), publishing and printing (47.2%), rubber and plastic products, and non-metallic mineral products industries (44.1%). The high relevance of cost savings as incentives for environmental activities may partly be explained by the importance of integrated environmental measures: Among all reductions of emissions, 57.6% have been attained in our sample facilities by using integrated technologies, whereas only 42.4% have been due to end-of-pipe measures.

Table V.2: The Role of Motivations for Environmental Activities.

Motivations	Not important	Important	Very important	Not applicable	Total
Prevent/Control Environmental Incidents	10.3%	36.4%	38.2%	15.0%	100%
Regulatory Compliance	2.6%	39.1%	52.4%	6.0%	100%
Corporate Profile/Image	15.4%	49.8%	26.2%	8.5%	100%
Cost Savings	10.8%	48.1%	34.2%	6.9%	100%
New Technology Development	28.3%	39.1%	15.9%	16.8%	100%
New Product Development	32.4%	31.5%	16.1%	20.1%	100%
Similar Facilities Adopting Similar Practices	49.6%	20.2%	2.7%	27.5%	100%

The Role of Public Environmental Policy

In this section we analyze the impact of public environmental policy on environmental activities of the firms. In a first step, we provide a short descriptive survey of the relevance of different environmental policy instruments (see **Table V.3**): High values for the category "very important" with respect to taxes, charges, and liability for environmental damages might be explained by the fact that these instruments, especially eco-taxes, are relatively new in Germany, such that firms have been forced to adapt their production activities in recent times (see also Section III). While liability for environmental damages, specifically, is indicated as "very important" for more than 40 % of the firms of the sectors "Paper and Paper Products", "Chemicals and Chemical Products", "Rubber and Plastic Products", and "Fabricated Metal Products" , emission taxes and effluent charges are "very important" in the following sectors: "Paper and Paper Products" (47%), "Chemicals and Chemical Products" (44%), and "Non-metallic Mineral Products (49%).

Table V.3: The Role of Environmental Policy Instruments for Production Activities of the Facility.

Environmental Policy Instruments	Not important	Important	Very important	Not applicable	Total
Input Bans	15.8%	42.5%	32.0%	9.7%	100%
Technology-based Standards	11.7%	55.8%	23.7%	8.9%	100%
Performance-based Standards	14.3%	52.3%	24.2%	9.2%	100%
Input Taxes	17.3%	44.4%	34.0%	4.3%	100%
Emission/effluent Taxes/Charges	19.6%	42.2%	30.7%	7.5%	100%
Tradable Emission Permits or Credits	40.0%	22.5%	11.5%	26.0%	100%
Liability for Environmental Damages	10.2%	46.6%	37.5%	5.7%	100%
Demand Information Measures	38.4%	35.2%	10.3%	16.1%	100%
Supply Information Measures	29.7%	48.8%	11.5%	10.0%	100%
Voluntary/Negotiated Agreements	27.8%	43.0%	13.0%	16.2%	100%
Subsidies/Tax Preferences	30.2%	36.4%	19.4%	13.9%	100%
Technical Assistance Programs	36.9%	35.3%	9.1%	18.7%	100%

By contrast, firms are "accustomed" to traditional instruments – like technology standards. "Soft" instruments, such as information measures and voluntary or negotiated agreements, hardly affect production activities. In most cases, input bans and both technology- and performance-based standards appear to be "important" or "very important" for German firms. Input bans, specifically, are "very important" in the following branches: manufacture of textiles (41%), wearing apparel (56%), and electrical machinery (53%).

Surprisingly, the majority of firms assessed the German environmental policy as only moderately stringent or not particularly stringent (see **Figure V.1**). Yet, there are considerable differences among branches. Sectors with strong environmental impacts, such as the chemical industry (37% "very stringent"), the paper and paper products (33%), and the non-metallic mineral products industries (35%), for example, tend to describe the German environmental policy as more stringent.

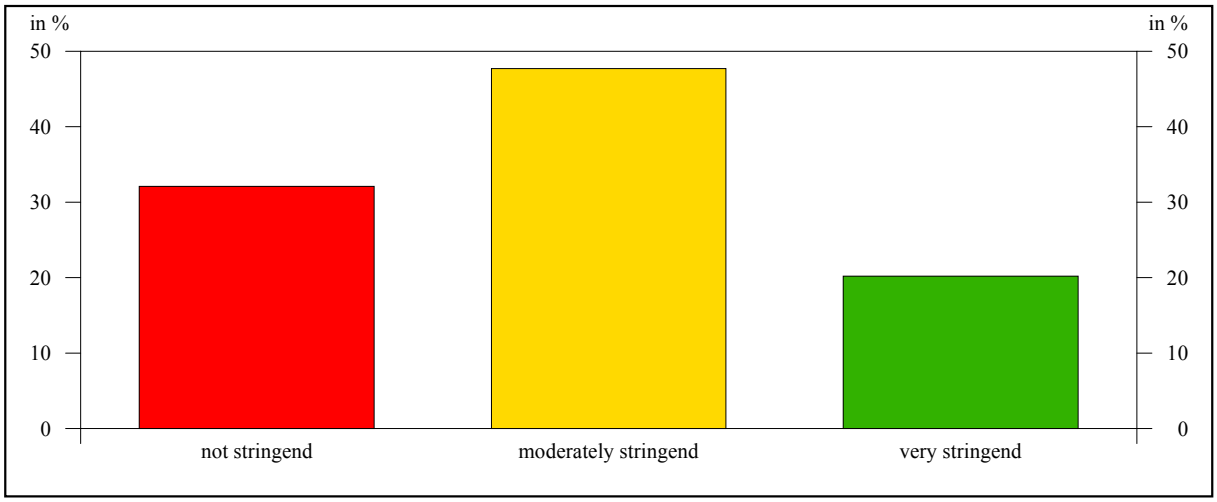


Figure V.1: Characterization of the Stringency of the German Environmental Policy.

Technology and performance-based instruments are especially relevant for the chemical industry (48% "very important") and the non-metallic mineral products (46%). Input taxes particularly affect the chemical industry (43%) and the production of paper and paper products (42%). An additional question deals with the influence and the role of public authorities concerning the introduction of environmental management systems. Only 14.4% of our sample facilities indicate that regulatory authorities encourage the introduction of environmental management schemes. The results reported in **Table V.4** exclusively originate from this minority of firms. The most important instrument of "encouragement" is the provision of preferences for public procurement. Financial support, waiving and reduction of the stringency of environmental regulations are further incentives that seem to be important as well.

Table V.4: Motivations of Regulatory Authorities to Encourage Environmental Management Programs.

Motivations	**No**	**Yes**	**Total**
Reduced Frequency of Inspections	56.3%	43.7%	100%
Fast Expediting of Environmental Permits	58.9%	41.1%	100%
Consolidating Environmental Permits	48.4%	51.6%	100%
Waiving Environmental Regulations	18.7%	81.3%	100%
Reducing Stringency of Regulatory Thresholds	13.0%	87.0%	100%
Providing Technical Assistance	44.4%	55.6%	100%
Providing Financial Support	25.0%	75.0%	100%
Providing Special Recognition or Award	42.3%	57.7%	100%
Providing Preferences For Public Procurement	7.3%	92.7%	100%
Providing Information about Value of such Systems	41.3%	58.7%	100%
Other Incentives	4.6%	95.4%	100%

Summary

This study explores the relationship between environmental policy tools and both organizational and process innovations. The following national report summarizes the results of a cross-OECD survey with respect to Germany. Based on a large sample of 899 facilities of the German Manufacturing Sector, including the basic metals, fabricated metals, machinery, and the food production sectors as the most relevant industries, we find that environmental concerns and, specifically, the existence of Environmental Management Systems (EMS) have a crucial impact on the environmental performance of German manufacturing.

The main results of our descriptive analysis of the German survey can be summarized as follows:

- While 246 facilities (27% of the sample) have already established an Environmental Management System, and the implementation of such a system is in progress in another 62 facilities (7% of the sample), almost 50% of all facilities have considered introducing an EMS, and in about 66% of our sample facilities, at least one person is explicitly responsible for environmental concerns.
- The most important reasons why firms contemplate introducing EMS are to improve the efforts to achieve regulatory compliance, to improve the corporate image, and to create cost savings with respect to both waste management and resource input.
- Both the existence of EMS and persons explicitly responsible for environmental concerns are strongly correlated with facility size: The larger the facility, the more likely the existence of both.
- Slightly more than half of all facilities have undertaken significant technical measures to reduce the environmental impacts associated with their activities. The vast majority of 91.5% of these facilities have altered their production processes. Only 3.6% of them have changed the product characteristics. Out of those facilities that have altered their production processes rather than product characteristics, 56.4% have changed their production technologies, while 41.5% of these facilities have implemented end-of-pipe technologies.
- Our analysis of the impact of interest groups on the environmental activities of German manufacturing firms reveals that internal stakeholders − management employees and, above all, corporate headquarters − are more influential than public authorities and commercial customers. Yet, it is not surprising that facilities with high environmental costs are especially concerned with regulatory compliance and influence of public authorities.
- Concerning the impact and importance of various environmental policy instruments, we find the following pattern: On the one hand, regulatory instruments, such as input bans and technology-based standards, appear to be either “important” or even “very important” for the production activities of the firms. On the other hand, the survey results also highlight the growing importance of market-based instruments, such as eco-taxes, which only recently have been introduced in Germany.
- For specific industries, such as the chemical, the rubber, and the plastics industries, maintenance of corporate profile and image seem to provide a strong incentive to engage in activities that reduce negative environmental impacts. The increasing significance of cost savings for environmental activities can partly be explained by the growing relevance of integrated environmental measures.
- Finally and surprisingly, for the majority of all facilities, the German environmental policy appears to be only moderately stringent or even not stringent at all.

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