



European Sustainability Management Panel Report

prepared by

Marcus Wagner, Benedikt Holzner and Hüseyin Doluca

with contributions by

Stefano Pogutz and Stefano Romito

Chair for Management, Innovation and International Business

Faculty of Business Administration and Economics, University of Augsburg

Universitätsstr. 16, 86159 Augsburg, Germany

Introduction

The political sustainable development agenda initiated by the World Commission on Environment and Development (World Commission on Environment and Development, 1987) has long reached the corporate sector. Consequently, non-financial goals such as environmental and social aspects have been integrated into corporate management, resulting in environmentally-related product or process innovations. Although there exist analyses, the development of environmental innovation and corporate sustainability has not yet been analysed over a long period in high detail. That is why we aim to address in this report how corporate sustainability and environmental innovation activities developed over the past 15 years?

The answer to this question is of interest because environmental protection increasingly attracts not only political and business but also societal and media attention. Based on a unique dataset containing partly longitudinal survey data from 2001 and 2016, we present the status quo and the development of corporate sustainability efforts among manufacturing firms in Germany, Italy and the United Kingdom (UK). We further provide disaggregated results for seven different manufacturing industries whilst differentiating firm size (small, medium and large sized firms). We find an overall increase of environmental activities and environmental management system (EMS) certification. However, some activities differ across industries and countries. Managerial activities have overall greatest popularity in Germany, while its level of adoption depends on the specific activity. EMS implementation is more common in mainland Europe than in the UK. Our results inform practitioners as well as researchers and politicians by providing insights about the development of environmental innovation and corporate sustainability activities across different manufacturing industries in three countries.

The remainder of this report is organized as follows. We start with an explanation of the research approach. Following this, results are presented in three steps: First, we compare corporate ecological sustainability between the three countries as well as over time. Second, the status quo of corporate social sustainability is shown. Third, we examine corporate ecological sustainability for Germany more in-depth with regard to industry affiliation and firm size. At the end of the report, some general conclusions are provided.

Data and Method

To gain more recent insights, data has been collected in 2016 as part of the European Sustainability Management Barometer (ESMB) survey. The ESMB survey was conducted among manufacturing companies and thus continues the work of the European Business Environment Barometer (EBEB) of 2001. The ESMB addressed firms in the Austria, Germany, Greece, Italy, Spain, Switzerland and the

UK.¹ In this report, we will present the findings for German, British and Italian companies, since for these countries sufficient responses were received to make an exploratory statistical analysis feasible. As many questions in the 2016 survey are identical to those of the EBEB in 2001, we can assess the development of sustainability management over a 15-year period, which is unique in the context of large-scale studies on corporate sustainability management.

We distributed the questionnaires to a random sample of manufacturing firms. To gain reliable information, we addressed the questionnaire to the person most knowledgeable on environmental and sustainability management. The pooled dataset contains over 1000 firm responses of which 562 come from Germany, 283 from Italy and 221 from the UK. Based on this sample, we carry out an exploratory data analysis in order to establish trends and international differences as concerns corporate sustainability and environmental innovation as well as to identify the status quo in the industrialised countries Germany, Italy and the UK. We methodologically focus on frequency counts and box-whisker plots to assess first and second distributional moments in the data.

The composition of the dataset – especially regarding firm size (and to a lesser degree also with regard to industry structure) is not fully equal in the three countries and over time, which should be considered when making comparisons. We define the company size by number of employees (Figure 1). While in 2001 the participants in Germany and the UK had a similar size distribution, this changed for 2016, when 64% of the German companies have at least 250 employees, whereas in the UK only around one-fourth of the responding firms reaches this size. Italian participants in 2016 are comparatively smaller: more than half of the Italian companies have under 50 employees. These differences in size distribution reflect however to a large degree the industrial structure in each country and are thus mostly unavoidable in a comparative survey context such as ours.

¹ It was originally intended to also include Denmark, but this became unfortunately infeasible in the implementation phase. However, in Greece and Spain surveys are still on-going and will be completed soon.

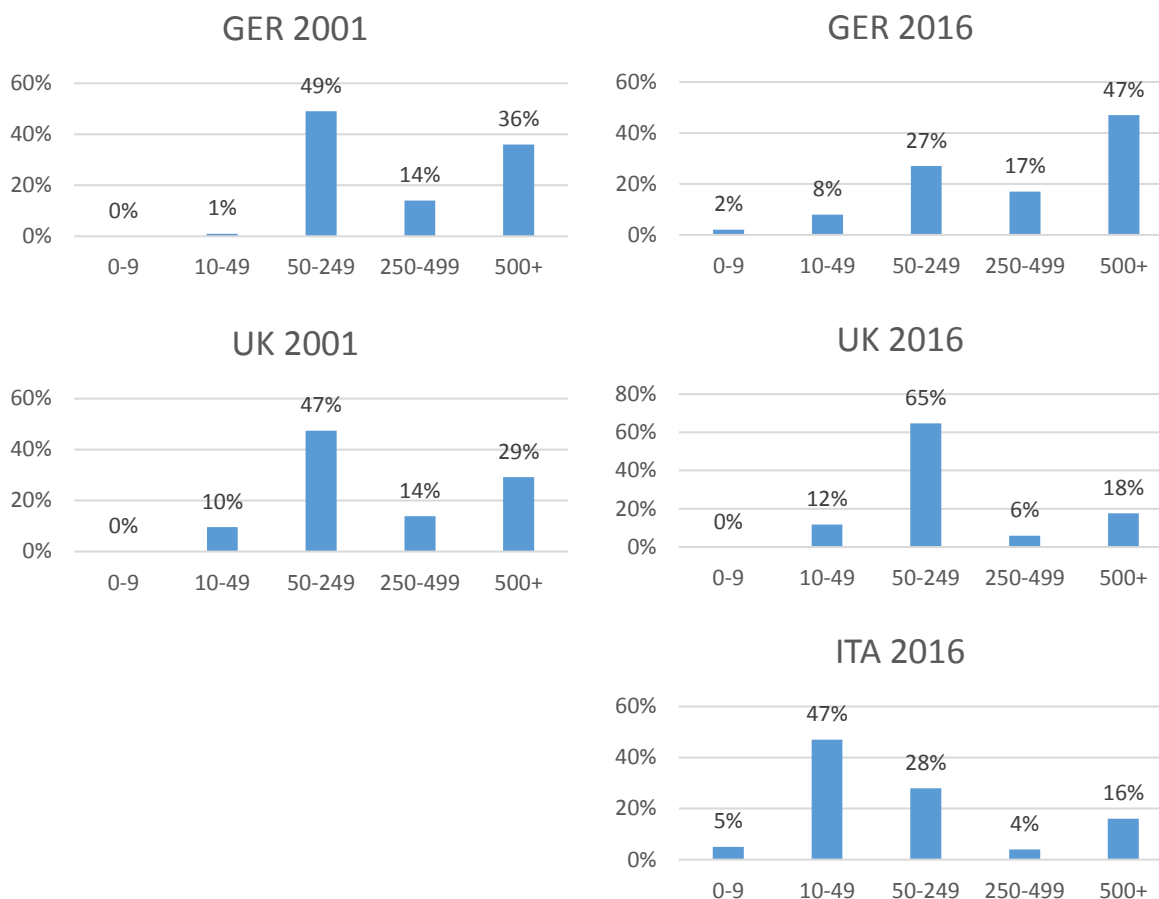


Figure 1: Company size by year and country (ITA: Italy; GER: Germany)

Analysis

We first describe the results for technological and managerial ecological sustainability and environmental management activities as concerns the national differences and the development between 2001 and 2016. In a second part, the internal and external social sustainability activities are compared between the three countries. In the final part, the German results are analysed in more depth as concerns company size and industry affiliation.

Technological and managerial ecological sustainability

In this part, we examine the results of 2001 and 2016 for Germany as well as for the UK. Since Italy did not form part of the EBEB in 2001, we can only present results for 2016. Various operational and managerial activities and environmental management system (EMS) adoption are analysed.

Operational environmental activities

In the survey 19 technological activities to improve environmental performance were listed and the participants had to state whether or not they implemented them in the prior three years. Three activities premiered in the 2016 survey, for the remaining 16, we show the 15-year comparison.

Figure 2 shows the adoption rates of the different technological activities in descending order of the 2016 shares in Germany.² Overall, the responding firms from the UK made greater progress over the past 15 years. In 2001, the responding firms in Germany adopted on average 41% of possible technological activities while in the UK this was only 34%. Fifteen years later, in 2016, the direction of this difference was reversed such that the average British firm adopted more technological activities (59%) than its German counterpart (54%). Differences also exist between German and British firms with respect to both the most-often adopted and least-often adopted activities. In Germany, the top two activities are the reduction of waste and the substitution of hazardous products, whereby the latter activity increased the most (by 32%) within the last 15 years. In terms of the largest increase, substitution of hazardous products is subsequently followed by the reduction of transport energy and substituting non-renewable materials. It is notable that in Germany recycling activities show little change compared with the remaining activities. The adoption of packaging recycling even decreased in the 15-year period under observation. The three activities that are evaluated for the first time in 2016, namely emissions offsetting, biodiversity conservation, and restoration, all differ in Germany from the other activities in terms of their adoption rates, which are lower and range between 29% and 34%. Only the usage of foreign waste streams has been less-often adopted overall as an activity, which suggests that these newly introduced activities represent more recent trends.

In contrast to the German respondents, British and Italian firms place a stronger focus on recycling. UK firms' top three activities are material, packaging and product recycling, with almost every company reutilising materials (95%). It is notable that the adoption level for no activity decreased in the 15-year period but that for nine out of 16 increased their adoption level by more than 25%. Similar to Germany, in the UK the biodiversity restoration and conservation and emissions offsetting are adopted as activities by the lowest number of firms and have identical adoption levels of 38%. Only the activity substitution of non-renewable materials has been adopted less frequently. Italian firms' top three activities are material recycling, packaging recycling and reducing air emissions, adopted respectively by 69%, 62%, and 65% of respondents. Interestingly, compared with the German and UK respondents, a higher proportion of Italian firms adopted operational activities aimed at reducing water emissions.

The activities around implementation of new cleaner technology in the production process and green design of a new product reflect the environmental innovation performance of a company, in terms of process and product innovation, respectively. Although the activities' adoption rates did increase in the 15-year period to a greater extent in the UK than in Germany, on average more German firms

² The adoption level is calculated by dividing the number of firms having undertaken the respective activity by the total number of firms responding in the representative country.

adopted technological activities. In 2016, 50% of the German, 38% of the British and 32% of the Italian firms had undertaken a green product innovation activity within the past three years. Cleaner technologies were used by 63% in Germany, 53% in Italy and 57% in the UK. In 2001, for almost every activity the share of adopting companies is higher in Germany. The only exceptions are material recycling, the use of foreign waste streams and the substitution of hazardous products.

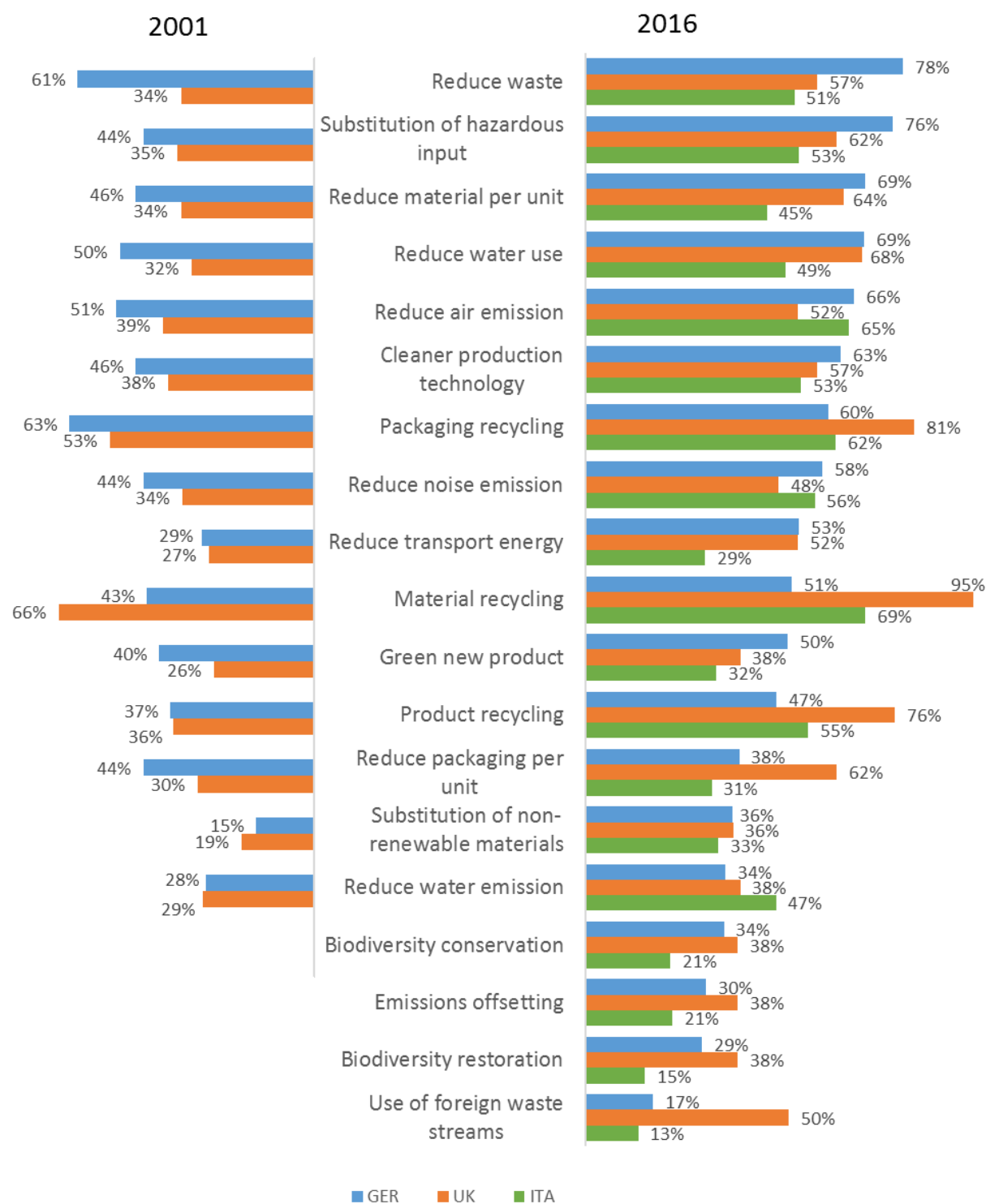


Figure 2: bar graph operational activities by country and year

However, over the period considered, British companies achieved increases of rates for almost every activity. Hence, in 2016 a differentiated picture is observed with regard to leadership of the respective activities across the three countries. UK firms seem to focus on recycling rather than on more efficient production, with the latter being predominantly done by German firms (which lead in substituting hazardous inputs as well as in reducing waste outputs).

Managerial environmental activities

We also surveyed 20 managerial environmental activities following the same method as described for the operational activities. Figure 3 shows the managerial activities covered, sorted in descending order by the 2016 results for German respondents. Overall, the managerial activities have higher adoption rates. Two-thirds of the activities have been adopted by at least two-thirds of the respondents in Germany and half of them in the UK. Clearly defined responsibilities are most adopted in Germany (90%), followed by environmental goals being part of a continuous improvement process and having measurable environmental goals (both 84%). In the UK, procedures to handle legal requirements (95%) and written environmental policies have the highest adoption rates (90%). Overall, Italian firms show a lower level of adoption of managerial environmental activities compared to German firms.

Manufacturing companies in the three countries rarely benchmark their own environmental performance with other companies. Furthermore, market research for specifically environmental-friendly (“Green”) products is more widespread among Italian firms (39%), than in Germany and the UK (23% and 24% respectively). Eco-labels show a growing popularity in Germany (44%). In Italy and in the UK, they are less widespread (20% and 19% respectively). Reviews of EMS efficiency, environmental performance indicators, and placing demand on suppliers to take environmental actions are also topics that get substantially more attention from German and Italian companies than from the British ones. German firms also publish a separate environmental report more often. In comparison, British companies put this information in the annual report more often, which makes the difference between British and German firms less pronounced. Except for this and procedures for identification and evaluation of relevant legal requirements, managerial activities are generally adopted to a greater degree by German companies, as compared to firms in Italy and in the UK.

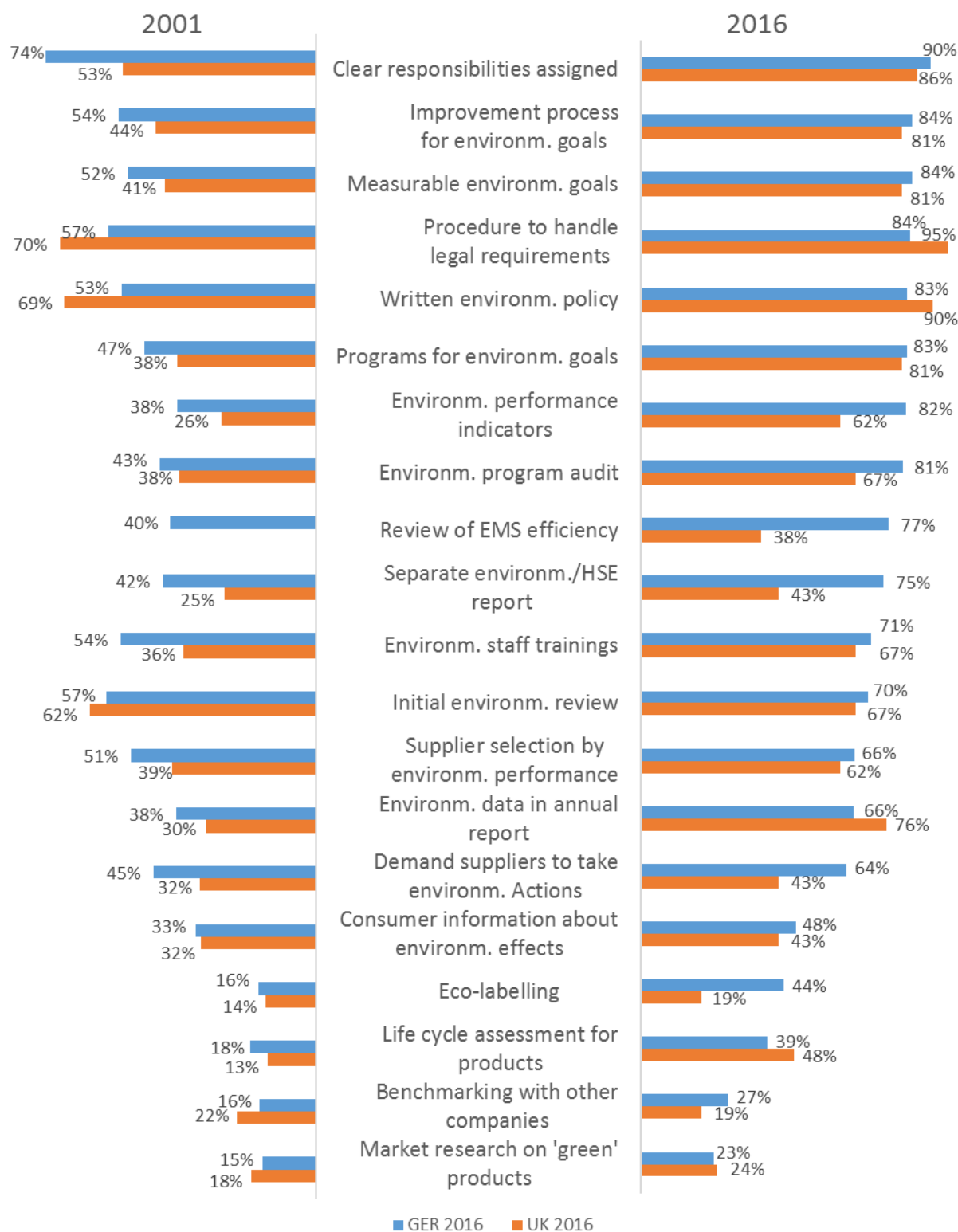


Figure 3: Managerial activities by country and year (environm.: environmental)

Environmental management systems

In this section, we show and compare the implementation of an EMS in the three countries in 2016. For Germany and the UK the comparison is also presented for 2001. EMS cover the implementation, organisation, and advancement of operational environmental management. Besides, a certified EMS

can signal the level of environmental performance to external stakeholders, which is useful to reliably assess the benefits that result from corporate environmental activities. Furthermore, we present the relation between environmental activities and the implementation of an EMS.

The diffusion of EMSs has grown over the past 15 years (Figure 4). German and Italian manufacturers tend to implement them rather more than British companies. In 2016, 79% of firms used an EMS in Germany, 74% used an EMS in Italy, and 52% in the UK. Even in 2001, the German share was bigger; with 45% adoption, they were 17% points ahead.

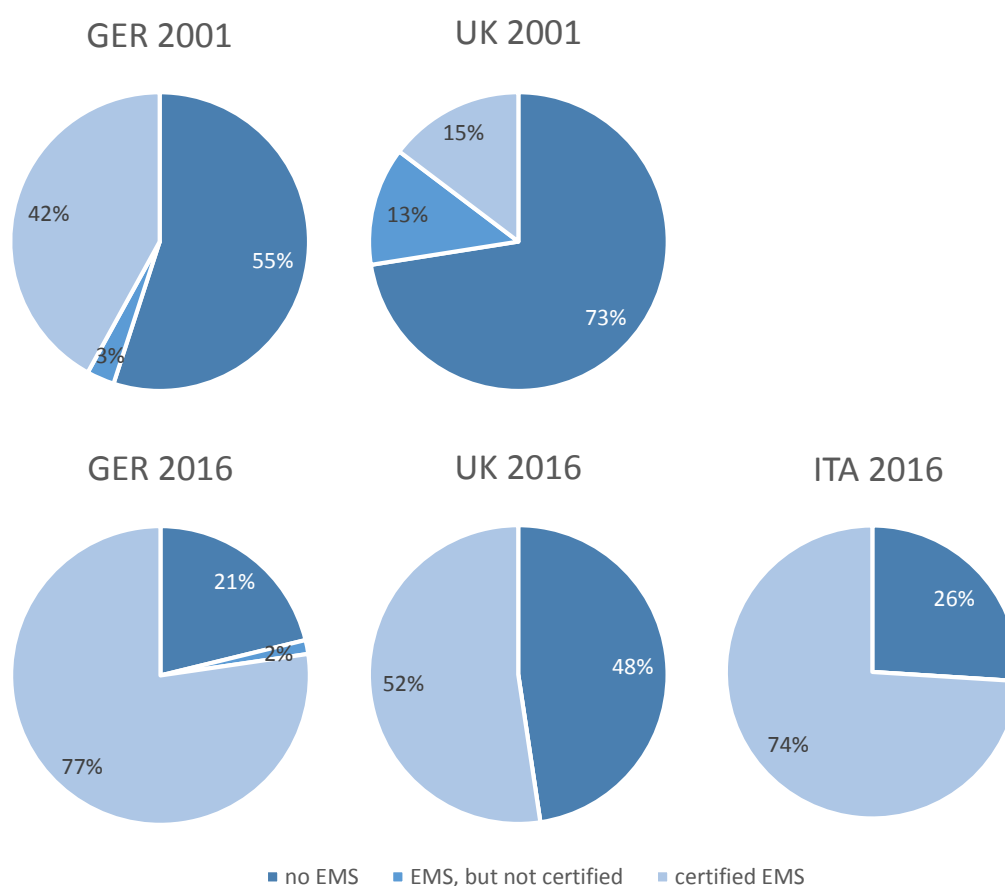


Figure 4: Adoption of EMS

There are two main certification standards for EMS: ISO 14001 (ISO) and Eco Management and Audit Scheme (EMAS). EMAS is more extensive and therefore more complex. It is rare outside Europe. In Germany and Italy, there is a tendency to certify either both standards or just the ISO 14001. In the UK, EMAS does not have a relevant share, companies there almost exclusively certify according to ISO guideline (without illustration). Non-certified systems are very rare in all three countries. For a more detailed view on EMS adoption in Germany, see Part 3.

EMS theoretically should support the implementation of environmental activities. Therefore, it is expected that companies with an EMS perform more environmental activities. We can further

assume that companies have a stronger motivation for environmental protection if they are willing to implement an EMS. We present the relation between the presence of an EMS and the number of managerial and operational activities for German, Italian and British companies in this section. We do not differentiate between the type of certification. Figure 5 confirms our assumption: Companies with an EMS have implemented more operational environmental activities covered in the survey. In 2001 and in 2016, the number of activities was clearly higher, while there were some time- and country-specific peculiarities.

For German companies with an EMS, the median remained almost unchanged. Only the quartile values increased. In 2016, the number of implemented activities was, on average, higher in the UK, where the median reached a value of 11 for companies with an EMS and nine for companies without it. Surprisingly, the firms without an EMS raised both the median and the quartile values in both countries. This suggests a somewhat limited role of certification, since evidently other factors such as regulations or increased public awareness must have driven the average number of technological activities up in firms without a certified EMS.

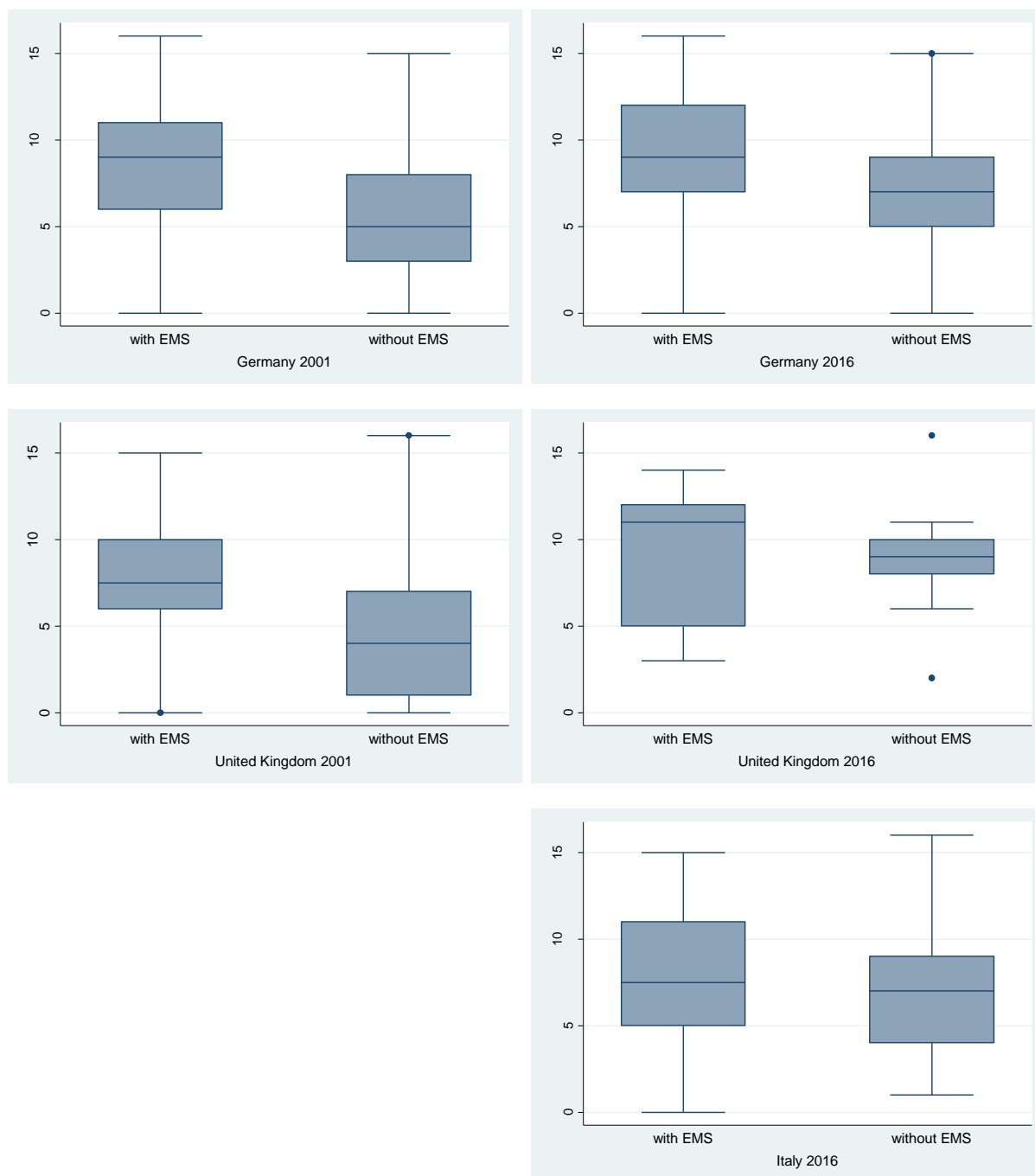


Figure 5: Boxplots of operational activities vs. EMS

For managerial activities, the existence of an EMS makes a bigger difference (Figure 6). In all surveys, the median of participants with an EMS is at least 13. For those without an EMS, only the UK 2016 respondents reached a value above six. It is worth mentioning that some of the activities analysed are required to certify an EMS. Therefore, their adoption rate is 100% in the companies with an EMS.

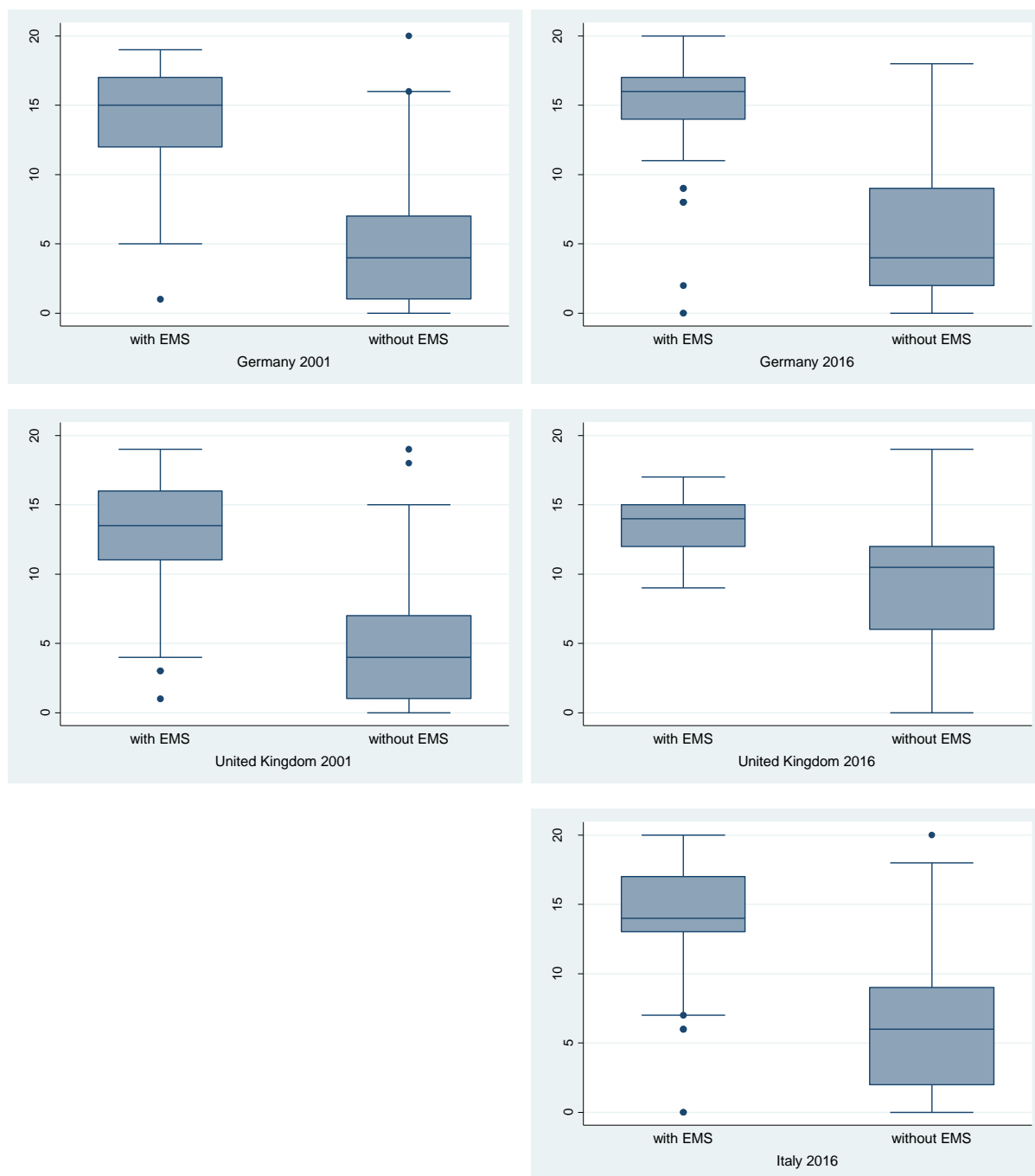


Figure 6: Boxplots of managerial activities vs. EMS

Internal and external social sustainability

Alongside the ecological activities, companies are also concerned about social issues. This section examines what internal and external efforts companies make in support of social sustainability. We describe the current dissemination levels of altogether 17 internal and 21 external activities. The results are presented for Germany, Italy and the UK in 2016.

The results in Table 1 show the internal activities in descending order for the share in Germany. The most frequent activities in both Germany and the UK are offers for health protection and general

education programmes for employees, followed by an employee suggestion scheme. Specifically, in Germany nearly every company is implementing those activities (91-93%), while in Great Britain, about two-thirds of the participants do so. These activities bring direct benefits such as less sick days or a better education for the companies. However, British firms lead in terms of support for the childcare of employees and support of gender diversity. Other activities for the equal treatment of all employees like ethnic diversity plans (77% vs. 56%) or the fair distribution of wages (68% vs. 53%), are in the middle range of the activities. In Germany and the UK, respectively 51% and 33% of the participants, apply social standards like the recommendation 146 of the International Labour Organisation (ILO). A balanced scorecard incorporating sustainability aspects was implemented by 28% and 19%, respectively. The UN Global Compact is an initiative for socially responsible business policies, based on ten principles, it is meant to promote a sustainable economy worldwide. 19% of the German manufacturers and 13% of the British ones joined this agreement. Among the firms in Germany and the UK, 26% and 19% respectively use a management system based on the European Foundation for Quality Management (EFQM) model that includes societal and employee welfare goals. Only 10% of the German and none of the UK companies implemented the ISO 26000 standard. Overall, Italian firms show a lower adoption level of both internal and external sustainability activities compared with German and UK firms. On the one hand, these differences are at least partly explained by the existence of structural differences among Italy and the other two countries in terms of social structure, national welfare system, and role and power of labour unions within the firm. On the other hand, they are likely to reflect also the differences between the size distribution of the firms responding in the three countries.

Table 1: Internal social sustainability activities

	GER	UK	ITA
Health protection	93%	76%	48%
General education programme	92%	76%	89%
Employee suggestion scheme	91%	76%	66%
High level of social benefits	85%	41%	38%
Individual work time models	83%	71%	69%
Ethnic diversity plans	77%	56%	38%
Qualification activities for job returners	76%	38%	33%
Flexible work place design	70%	65%	27%
Fair distribution of wages	68%	53%	63%
Gender diversity support	68%	75%	29%
Social standards (e.g. ILO 146) implemented	51%	33%	27%
Time for education on issues relevant for society at large	49%	38%	54%
Support with child care by the company	47%	59%	27%
Sustainability balanced scorecard	28%	19%	11%
EFQM-based management system	26%	19%	6%
UN Global Compact membership	19%	13%	10%
ISO 26000 implemented	10%	0%	10%

Most of the firms surveyed offer apprenticeship positions under their external social sustainability activities. Fair trading relationships are especially supported in Germany (87%). Sport and cultural sponsoring is more popular in Germany and Italy with shares around twice those in the UK. Support for the local community is important in all three countries (51% - 71%). A company's regional integration has a positive effect when it comes to recruiting or retaining employees, but also with regard to support for sustainable regional development. This might explain the support for the region in which the firms' operations are located (51% - 67%). 64% of the German firms support justice-marked commodities (i.e., commodities for which just trading relations with customers, suppliers and other business partners exist), while only 13% declare their own products to be "Fair Trade". Apart from this, only the Social Accountability 8000 standard, which deals with social accounting in general and social marketing, is less than or equal to 15% in all three countries that were analysed.

Table 2: External social sustainability activities

	GER	UK	ITA
Apprenticeship positions	93%	71%	62%
Fair trading relationships	87%	41%	61%
Support/sponsoring of sport events	76%	35%	67%
Community support	71%	65%	51%
Support for regions where company's operations are located	67%	47%	51%
Justice-marked commodities	64%	24%	9%
Cultural sponsoring	56%	29%	65%
Social issues reporting or sustainability reporting	54%	44%	35%
Support of education initiatives	50%	19%	32%
Stakeholder dialogue initiatives	43%	47%	45%
Social performance indicators	43%	40%	20%
Promotion of human rights	42%	41%	22%
Corporate volunteering	41%	47%	18%
Corporate citizenship activities	34%	35%	15%
OECD Guidelines for Multinational Enterprises followed	30%	7%	9%
Social justice programmes abroad	30%	31%	12%
Aid to homeless	19%	12%	7%
Social marketing	16%	27%	16%
Social accounting	16%	20%	22%
Social Accountability (SA) 8000 standard implemented	15%	6%	14%
"Fair Trade" declaration of products	13%	14%	4%

Detailed analysis by industry and size for Germany

In this third part, the results for Germany will be analysed more in depth with respect to the effects of the participant companies' size and industry. Further, we will examine which companies cooperate during product planning and development concerning environmental aspects. Since some questions were not asked in the UK survey in 2001, we can no longer consider British firms in this part of the analysis.

Categorizations via industry and company size

For a better comparison, we defined seven industry classes out of 21 options offered to the participants to identify the main industry at a detailed level. Table 3 shows the classification. The recycling, utilities and transport sectors are assigned in “Other manufacturing industries” due to their low number of participant firms.

Table 3: Definition of industry classes

Industry class	Consisting of the following detailed industries:
Consumer industry	Food, food products, tobacco; Textile, textile products and clothing; Furniture, jewelry, musical instruments
Wood, paper, publishing and printing products	Wood and wood products; Pulp and paper, paper products; Publishing and printing
Chemical industry	Energy, cokes, oil products and nuclear fuel; Chemicals, chemical products and fibers; Rubber and plastic products
Glass, ceramic and metal products	Glassware and ceramics; Metal and metal products
Engineering and vehicle construction	Plant construction and engineering; Automotive production; Other vehicle construction
Electric and electronic devices	Office machines, Electronic data processing devices; Devices for electricity generation; Electrical equipment; Radio- or telecommunications; Medical-, measurement- and control engineering
Other manufacturing industries	Utilities, Recycling; Transport; Other manufacturing

The distribution of the participants across the so-defined aggregate industry classes is as shown in Figure 7. In 2001 “Glass, ceramic and metal products” together with the “Consumer industry” had the highest shares each with 18% of the participants. In the 2016 survey, most companies were part of the chemical industry, representing 16%. At the expense of all remaining industry classes, the other manufacturing companies have a larger representation in 2016 (30% against 16%). Apart from this, the structure is similar in both surveys, enabling a meaningful comparison over time. As concerns the distribution in the total population of German manufacturing firms, in 2014, the largest industry in terms of the number of companies was “Glass, ceramic and metal products”, followed by “Consumer goods” and “Engineering and vehicle construction” (Statistisches Bundesamt, 2016). These three industries represent the second, third, and fourth largest industries in our responses. Therefore, the results reported in the following pages are broadly representative for the German manufacturing sector as a whole as concerns industry distribution.

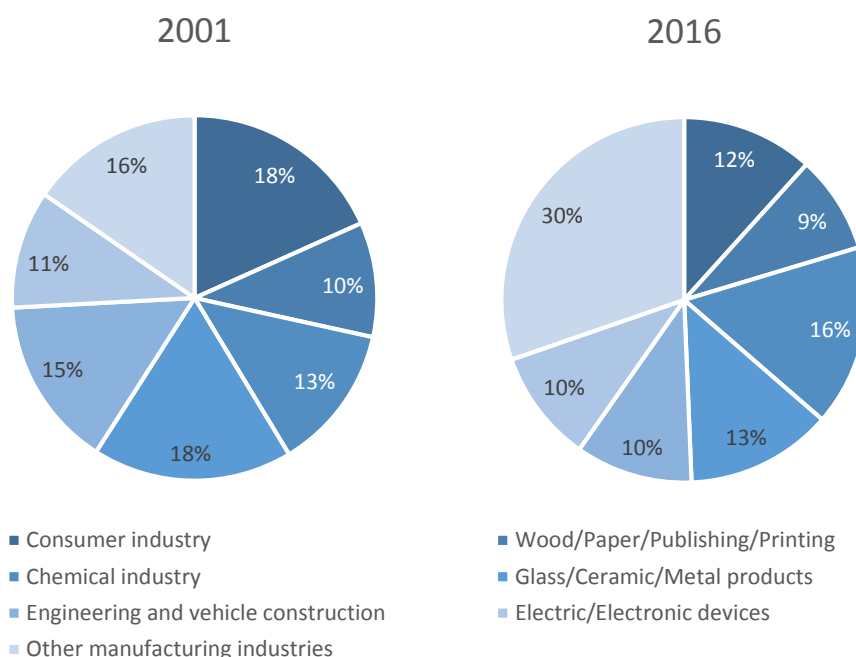


Figure 7: Aggregate industry classes by year

We further aggregated the companies by size based on the categories reported in the introduction for the number of employees. Overall, the size of respondents ranges from six to 610.000 employees. Whilst in 2001 half of the participants had between 50 and 250 employees, in 2016 firms with more than 250 employees are having the largest share (47%). Small companies with less than 50 employees were represented only in lesser numbers in 2001. In the 2016 survey, they account for 10%. This change in size composition for our responses may affect the results. The distribution in each size category based on the aggregated categories is presented in Table 4.

Table 4: Firm size distribution by aggregated industry category

Industry	Year		2001			2016		
	01-49	50-249	>=250	01-49	50-249	>=250		
Consumer Industry	80%	19%	17%	18%	11%	11%		
Wood, paper, publishing, and printing	0%	14%	6%	14%	14%	6%		
Chemical industry	0%	13%	13%	23%	14%	16%		
Glass, ceramic and metal products	20%	21%	15%	0%	19%	12%		
Engineering and vehicle construction	0%	12%	17%	0%	0%	17%		
Electric and electronic devices	0%	11%	10%	14%	13%	8%		
Other manufacturing industries	0%	10%	20%	32%	29%	31%		

Operational environmental activities

We now take a closer look at the operational activities adopted in order to diminish or prevent negative environmental impacts. As can be seen from Figure 5: all the three aggregated size categories considered implement more activities over time. Furthermore, in both periods analysed, the number of operational activities rises with the size of the company. In 2016, the median of the medium-sized firms is approaching that of large firms. Large firms in 2016, for the first time,

implement all considered activities. The influence of size is particularly visible by looking at the small firms, since they implement a distinctively smaller amount of activities. This is likely the case because, typically, they have lesser resources and have to choose harder which activities to pursue. However, even for the small firms, the maximum number of activities implemented increased from seven to 15, in doing so catching up remarkably with the medium-sized firms in 2016 versus 2001 and again underscoring the considerably increased relevance of sustainable operations in all size categories in 2016.

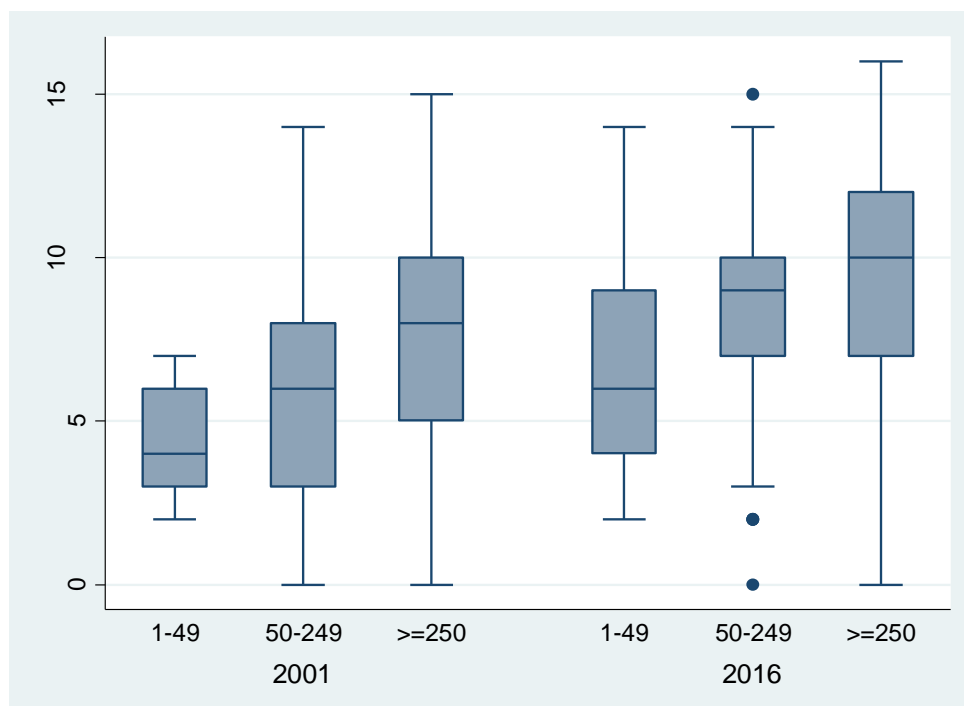


Figure 5: Boxplot of operational activities by aggregated size category in Germany

As can be seen from Table 5 these size-specific results are essentially determined by the adoption of individual activities. In most cases, large companies are more likely to implement operational activities. Nevertheless, there are exceptions, especially that small enterprises have the highest share in product recycling and in reducing the packaging per unit of product and have generally caught up considerably over the years. Overall, medium-sized companies have as well caught up with large enterprises over the past 15 years, as signified by the gap for many activities getting smaller. However, as concerns the implementation of cleaner production technologies and a “Green” new product design as crucial activities for environmental innovation large firms have kept their lead from 2001 to 2016. Thus, although all aggregate size categories’ interest in environmental innovation has considerably increased between 2001 and 2016, large companies keep their leadership. As concerns the newly introduced items on ecosystem services, small and large enterprises interestingly engage more often in the restoration or conservation of biodiversity than medium-sized ones. Opposed to

this, emissions offsetting as a comparatively new tool, is to date much more often implemented by large companies.

Table 5: Adoption of operational activities by aggregated size category in Germany

	small enterprises			medium enterprises			large enterprises		
	2001	2016	Δ	2001	2016	Δ	2001	2016	Δ
Reduce water consumption	40%	37%	-3%	42%	62%	20%	59%	78%	19%
Reduce material per unit	40%	50%	10%	43%	70%	27%	48%	75%	27%
Material recycling	40%	41%	1%	34%	44%	10%	54%	53%	-1%
Use of foreign waste streams	20%	14%	-6%	8%	12%	4%	7%	15%	8%
Substitution of non-renewable materials	0%	23%	23%	10%	40%	30%	20%	40%	20%
Substitution of hazardous input	20%	41%	21%	29%	76%	47%	59%	83%	24%
Reduce air emission	0%	36%	36%	40%	56%	15%	66%	76%	10%
Reduce water emission	40%	18%	-22%	17%	27%	10%	38%	40%	2%
Reduce noise emission	20%	36%	16%	40%	62%	22%	50%	59%	9%
Reduce waste	20%	82%	62%	51%	75%	24%	74%	77%	3%
Product recycling	20%	59%	39%	26%	48%	21%	47%	47%	0%
Packaging recycling	60%	68%	8%	61%	65%	4%	66%	59%	-7%
Reduce packaging per product unit	40%	50%	10%	40%	33%	-7%	48%	42%	-6%
Reduce transport energy	40%	41%	1%	25%	43%	18%	35%	61%	26%
Cleaner technology	0%	46%	46%	38%	54%	16%	55%	73%	18%
“Green” new product design	40%	41%	1%	32%	46%	14%	48%	60%	12%
Biodiversity restoration		32%			21%			34%	
Biodiversity conservation		36%			24%			41%	
Emissions offsetting		14%			19%			36%	

Differences bigger 25% in bold

To consider industry-specific differences in operational environmental activities, we next compare the seven aggregated industry categories defined above. In all of them, the number of implemented operational activities in 2016 is higher than 15 years ago. The chemical industry and the engineering and vehicle-constructing sector are leading in both periods. They only swapped their position over time. Except for the “Other manufacturing industries”, all remaining aggregate industries share the same median of six operational activities in 2001. In 2016, they still share a median but now it is at nine activities. Together with the second quartile now being at no less than five activities, the progress to a higher operational level is unambiguously visible across all industries.

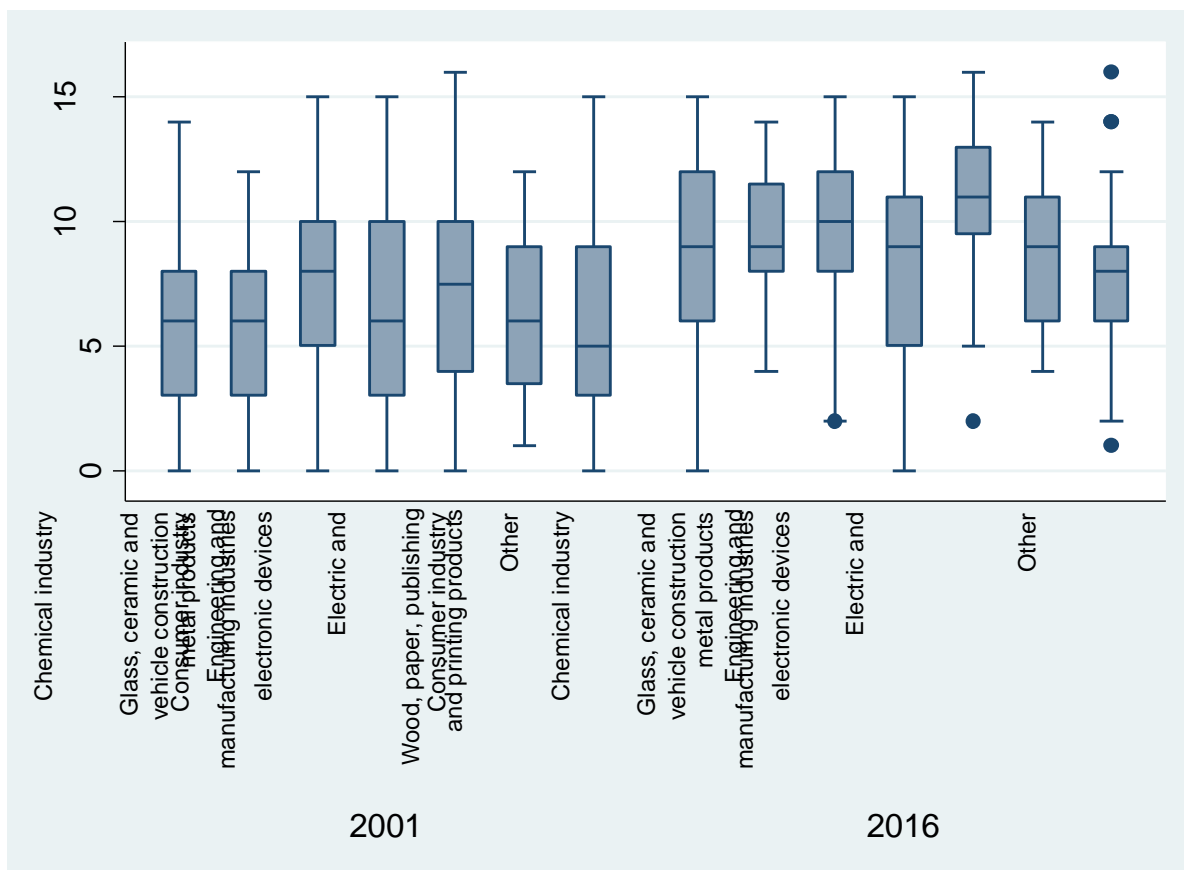


Figure 6: Boxplots of operational activities by aggregated industry category in Germany

To reveal differences between the aggregated industries, their specific adoption level for each activity is shown in Table 6. “Engineering and vehicle construction” has most often the highest level of adoption, especially regarding the reduction of various emissions. However, each aggregated industry is leading in terms of adoption for at least one activity, in turn confirming that environmental exposure is industry-specific. The consumer industry for example is the most concerned about recycling issues. The reduction of transport energy is an activity of increasing importance across all aggregated industries. Other activities, like packaging-related ones, show less consistent patterns. For example, these activities gain larger shares in the “Wood, paper, publishing and printing products” industry, but they lose share in many other aggregated industries. Overall, companies in the “Wood, paper, publishing and printing products” industry followed by firms in the consumer industry, have made the larger progress over the last 15 years resulting in average adoption rates of 54% and 52%, respectively, across all activities. Firms in the “Engineering and vehicle construction” industry (61%) and the chemical industry (56%) have even higher values and thus, the best performance in 2016. In contrast, in the “Glass, ceramic and metal products” industry the average adoption rate per activity is 47% and is thus the lowest one across all aggregated sectors.

Table 6: Adoption of operational activities by aggregated industry category in Germany

	Consumer industry			Wood/Paper/Publishing/ Printing			Chemical industry		
	2001	2016	Δ	2001	2016	Δ	2001	2016	Δ
Reduce water consumption (1)	52%	74%	22%	51%	60%	9%	55%	76%	21%
Reduce material per unit (2)	40%	63%	23%	43%	90%	47%	62%	76%	14%
Material recycling (3)	33%	44%	11%	40%	60%	20%	48%	65%	17%
Use of foreign waste streams (4)	0%	7%	7%	8%	20%	11%	10%	14%	4%
Substitution of non-renewable materials (5)	8%	52%	44%	17%	50%	33%	21%	46%	25%
Substitution of hazardous input (6)	35%	63%	28%	49%	80%	31%	56%	70%	16%
Reduce air emission (7)	44%	70%	26%	40%	65%	25%	62%	62%	0%
Reduce water emission (8)	27%	26%	-1%	17%	30%	13%	45%	35%	-10%
Reduce noise emission (9)	41%	52%	11%	49%	65%	16%	43%	65%	22%
Reduce waste (10)	56%	59%	0%	43%	90%	47%	83%	92%	9%
Product recycling (11)	25%	63%	38%	46%	45%	-1%	36%	60%	24%
Packaging recycling (12)	59%	74%	15%	46%	65%	19%	64%	65%	1%
Reduce packaging per product unit (13)	49%	44%	-5%	26%	55%	29%	50%	51%	1%
Reduce transport energy (14)	46%	63%	17%	17%	35%	18%	26%	60%	34%
Cleaner technology (15)	40%	70%	16%	43%	70%	27%	55%	76%	22%
“Green” new product design (16)	32%	56%	24%	31%	55%	39%	50%	65%	15%
Biodiversity restoration (17)		37%			20%			27%	
Biodiversity conservation (18)		37%			30%			38%	
Emissions offsetting (19)		26%			40%			24%	

	Glass/Ceramic/Metal products			Engineering/Vehicle construction			Electric/Electronic devices			Other manufacturers		
	2001	2016	Δ	2001	2016	Δ	2001	2016	Δ	2001	2016	Δ
(1)	59%	63%	4%	50%	88%	38%	39%	52%	13%	40%	70%	30%
(2)	43%	77%	34%	54%	80%	25%	53%	70%	17%	38%	61%	24%
(3)	43%	40%	-3%	52%	54%	2%	44%	57%	13%	45%	41%	-4%
(4)	18%	20%	2%	12%	17%	5%	3%	0%	-3%	9%	16%	6%
(5)	14%	20%	6%	17%	25%	8%	8%	48%	40%	23%	36%	13%
(6)	30%	87%	57%	56%	92%	36%	50%	78%	28%	43%	77%	34%
(7)	66%	73%	7%	39%	83%	45%	44%	57%	12%	57%	63%	6%
(8)	31%	30%	-1%	25%	54%	29%	14%	26%	12%	32%	36%	4%
(9)	51%	70%	19%	54%	71%	17%	14%	39%	25%	49%	48%	-0%
(10)	59%	60%	1%	64%	92%	28%	66%	91%	25%	57%	69%	12%
(11)	36%	43%	7%	52%	58%	6%	44%	61%	17%	25%	33%	8%
(12)	69%	57%	-12%	77%	71%	-6%	75%	70%	-5%	51%	49%	-2%
(13)	38%	30%	-8%	56%	50%	-6%	55%	44%	-11%	32%	30%	-2%
(14)	21%	50%	29%	32%	63%	31%	17%	48%	31%	34%	54%	20%
(15)	54%	63%	-1%	48%	80%	32%	33%	78%	45%	43%	50%	-7%
(16)	33%	53%	31%	60%	75%	15%	61%	65%	4%	23%	37%	14%
(17)		13%			29%			26%			40%	
(18)		10%			41%			26%			49%	
(19)		30%			29%			22%			33%	

Differences greater than 25% in bold

Managerial environmental activities

The following section analyses more in depth the managerial activities in terms of size and industry differences. As Figure 7 shows, the number of managerial activities implemented increased in all three size categories over the 15-year period. Especially the mid-sized companies increased their median from four to 15 activities. While the number of implemented activities differed strongly among the company size in 2001, the median now is almost equal across all three size categories and the differences manifest mostly in the quartile values. Still, large companies implement more activities and only outliers in this size category implement less than 11 of the managerial activities as

Figure 7 shows. This also implies that competitive differentiation based on managerial activities becomes increasingly difficult for large firms.

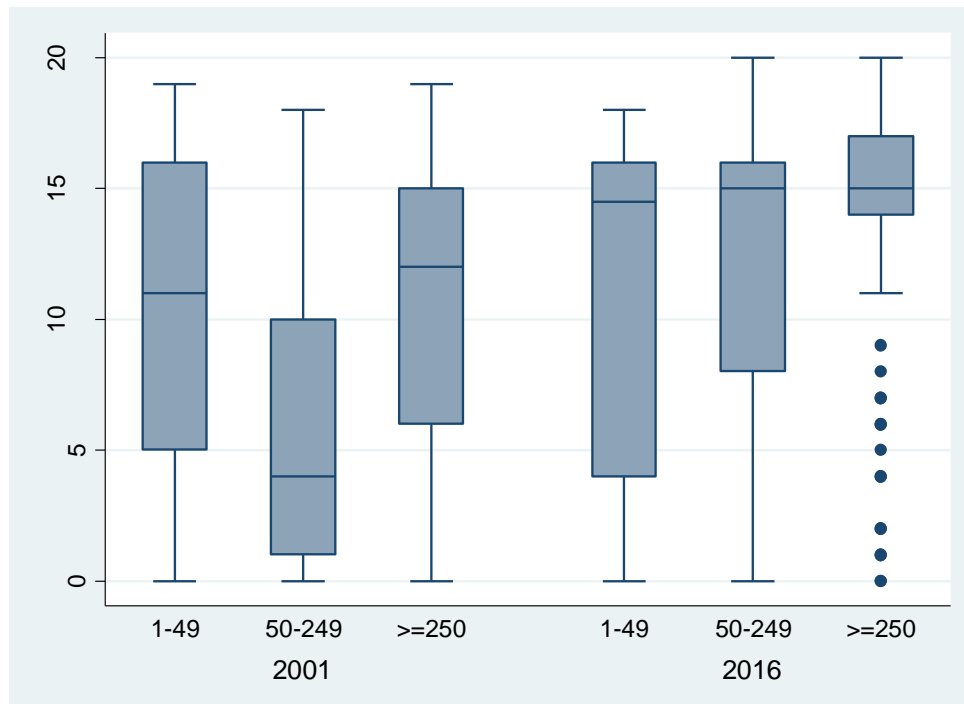


Figure 7: Boxplot of managerial activities by aggregated size category in Germany

This development can also be seen in Table 7. The adoption share of almost each activity increased for medium-sized and large enterprises. Environmental performance indicators, reviews of the EMS efficiency or an audit for the environmental program have been activities rarely adopted in manufacturing companies with 50-249 employees in 2001 (23% to 25% adoption rates). Over time, these activities became more common in this size category and it is evidenced by higher adoption shares in 2016 (71% to 78% adoption rates). Measurable environmental goals and a separate report for environmental, health and safety topics evolved similar. In large firms, eight activities are essentially standards in practice with about nine out of 10 firms implementing them, partly because they are mandatory elements required for EMS certification. Eco-label usage increased massively in companies with more than 50 up to 250 employees where it now has an adoption share of 59%, which is the highest across all three size categories. As in 2001 the adoption share of medium-sized companies for this activity is a little higher than the one of large companies (46% versus 43%). One explanation for this may be that eco-labelled products are often more regional products and therefore produced mainly by smaller companies. It is possibly also harder for large companies to establish the environmental quality level required for an eco-label uniformly over a much larger volume of inputs, as has been the case in food production and paper manufacturing.

Table 7: Adoption of managerial activities by aggregated size category in Germany

	small enterprises			medium enterprises			large enterprises		
	2001	2016	Δ	2001	2016	Δ	2001	2016	Δ
Supplier selection by environm. performance	60%	55%	-5%	42%	62%	20%	59%	70%	11%
Demand suppliers to take environm. actions	40%	32%	-8%	31%	54%	23%	58%	72%	15%
Written environm. policy	60%	68%	8%	36%	78%	42%	70%	92%	22%
Procedure to handle legal requirements	80%	64%	-16%	39%	78%	39%	74%	93%	19%
Initial environm. review	40%	68%	28%	43%	64%	21%	73%	73%	0%
Measurable environm. goals	80%	73%	-7%	33%	79%	46%	70%	90%	20%
Programs for environm. goals	60%	68%	8%	31%	75%	44%	63%	90%	27%
Clear responsibilities	80%	77%	-3%	63%	91%	28%	87%	93%	6%
Environm. staff trainings	40%	73%	33%	35%	62%	27%	73%	77%	4%
Improvement process for environm. goals	60%	77%	17%	41%	78%	37%	68%	90%	22%
Environm. data in annual report	60%	50%	-10%	24%	64%	40%	52%	70%	18%
Separate environm./HSE report	60%	68%	8%	28%	73%	45%	56%	80%	24%
Environm. program audit	60%	68%	8%	25%	78%	53%	60%	88%	28%
Review EMS efficiency	60%	64%	4%	24%	76%	53%	56%	82%	26%
Environm. performance indicators	60%	73%	13%	24%	71%	47%	51%	89%	38%
Benchmarking with other companies	20%	9%	-11%	11%	24%	13%	19%	30%	11%
Eco-labelling	0%	59%	59%	17%	46%	29%	16%	43%	27%
Consumer information about environm. effects	40%	59%	19%	25%	41%	16%	39%	51%	12%
Market research "Green" products	20%	9%	-11%	11%	16%	5%	18%	28%	10%
Product Life Cycle Assessment	40%	23%	-17%	8%	27%	19%	26%	46%	20%

Differences greater 25% in bold
 environm. = environmental

Finally, as Figure 8 shows, the differences across aggregated industry categories decreased in a way that the median of almost each industry is the same, namely 15 implemented managerial activities in 2016. The "Wood, paper, publishing and printing product" industry's median is with a median value of 16 even a bit higher. 15 years ago, the average value for this sector was four and thus the lowest across all aggregated industries, which witnesses a remarkable improvement. The "Electric and electronic devices" industry and the consumer industry have a larger quartile spread than the other five aggregated industries, which suggests that in the former the variability with regard to environmental management is considerably higher. This suggests that some firms in these two industry categories still lag more behind, in particular 15 years ago, they already had the second and third lowest median across all seven aggregated industries. Still, for the manufacturing sector in Germany overall, we see a remarkable shift towards increased adoption of managerial activities supporting environmental protection. However, it is somewhat less evident that this has resulted in a complementary increase in the adoption of operational and technological activities to protect the environment. Neither can we ascertain from our survey, that this increase in activities has also improved actual environmental performance in terms of lower emissions and resource consumption. This is particularly difficult to establish, since in the last two decades globalization processes have continued to fragmentize value chains by means of outsourcing and offshoring. This makes a reliable assessment of actual environmental performance very difficult, since it requires to increasingly account for a shift of polluting activities outside of the direct firm boundaries, which is highly challenging due to constraints in data quality.

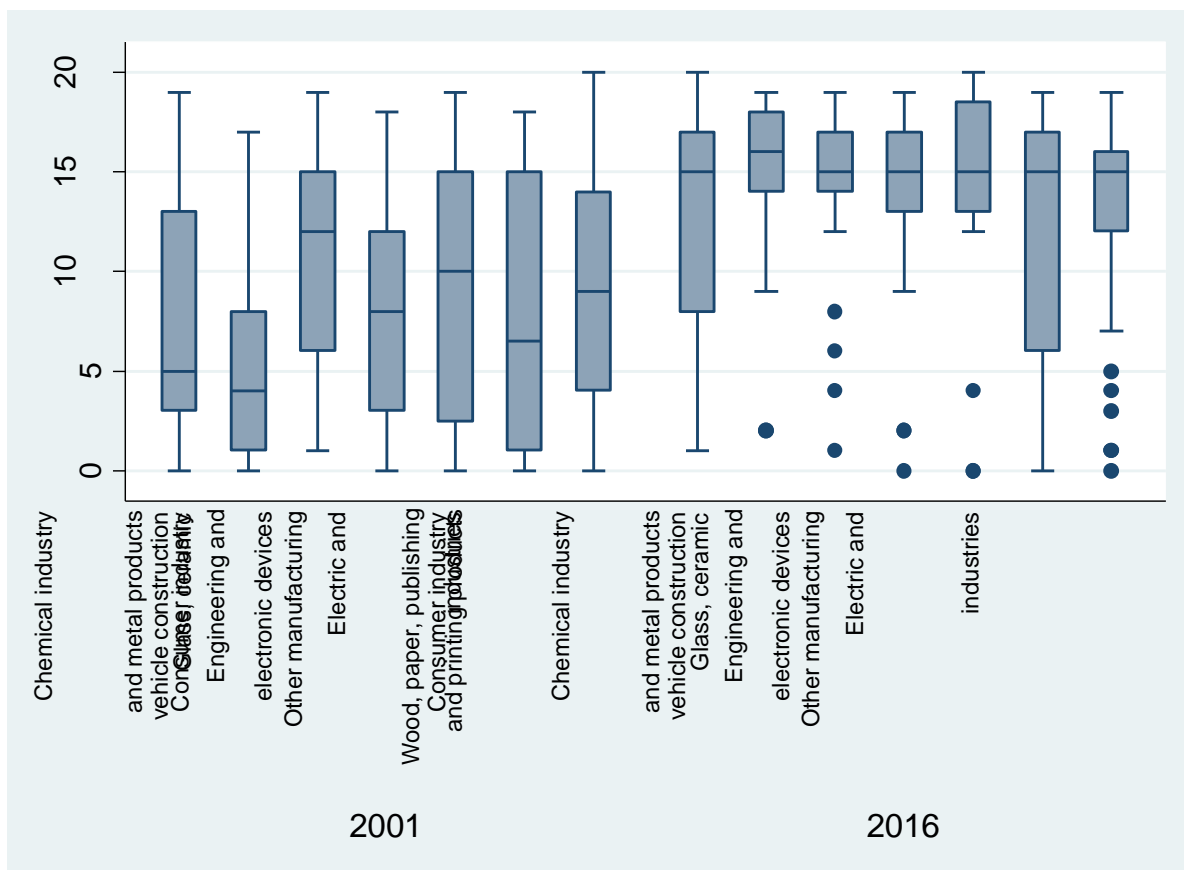


Figure 8: Boxplots of managerial activities by aggregated industry category in Germany

Table 8 shows the adoption shares by aggregated industry for individual managerial activities in detail, which supports the results derived from the Box-Whisker plots in Figure 8. All activities have (often significantly) increased adoption shares in all industries. However, there are still industry-specific differences. The companies in the “Wood, paper, publishing and printing products” industry raised their shares the most, which corresponds to the earlier observation in this respect. More specifically, for 15 out of the 20 activities surveyed the firms increased their adoption share by more than 25%. Chemical industry companies and firms in the “Glass, ceramic and metal products” industry have most often the largest adoption share. Manufacturers of “Electric and electronic devices” show the least improvement. In half of the activities surveyed, they have a lower adoption share than in any of the other aggregated industries. The definition and introduction of measurable environmental goals as well as the publication of environmental reports are examples for activities where the industry lags behind. Some activities are still not broadly implemented by manufacturing firms in Germany, as for example conducting market research for “Green” products, an activity with relatively low adoption rates across all industries. In only three aggregated industries, more than a quarter of the participants stated that they pursue this type of research. As stated before, the overall trend is that companies adopted more environmentally-related managerial activities and used the past 15 years for the implementation of a growing number of different activities. There are still

industry-specific differences though, and in the future, the focus needs to be on implementing more of those activities that have received minimum attention so far. These are more often not only qualitative game-changers in terms of contributions to sustainable development, as well as in terms of enabling competitive differentiation. Furthermore, it has to be assured that actual performance is raised as clearly as activities are.

Table 8: Adoption of managerial activities by aggregated industry category in Germany

	Consumer industry			Wood/Paper/Publishing/ Printing			Chemical industry		
	2001	2016	Δ	2001	2016	Δ	2001	2016	Δ
Supplier selection by environm. performance (1)	52%	63%	11%	52%	65%	13%	57%	65%	8%
Demand suppliers to take environm. actions (2)	48%	59%	11%	46%	70%	24%	50%	68%	18%
Written environm. policy (3)	44%	78%	34%	29%	85%	56%	74%	95%	21%
Procedure to handle legal requirements (4)	50%	89%	39%	28%	90%	62%	81%	83%	3%
Initial environm. review (5)	46%	70%	25%	47%	60%	13%	76%	65%	-11%
Measurable environm. goals (6)	45%	82%	36%	32%	90%	58%	62%	92%	30%
Programs for environm. goals (7)	40%	78%	38%	29%	90%	61%	62%	81%	19%
Clear responsibilities (8)	71%	82%	11%	65%	95%	30%	86%	92%	6%
Environm. staff trainings (9)	40%	70%	30%	32%	75%	43%	69%	81%	12%
Improvement process for environm. goals (10)	56%	74%	18%	43%	90%	47%	65%	95%	30%
Environm. data in annual report (11)	30%	56%	26%	26%	55%	29%	58%	78%	20%
Separate environm./HSE report (12)	38%	70%	32%	32%	80%	48%	57%	87%	30%
Environm. program audit (13)	36%	74%	38%	23%	90%	67%	61%	89%	28%
Review EMS efficiency (14)	37%	63%	26%	16%	85%	69%	57%	81%	24%
Environm. performance indicators (15)	38%	86%	47%	23%	85%	62%	56%	89%	33%
Benchmarking with other companies (16)	15%	22%	7.0%	21%	45%	24%	22%	27%	5%
Eco-labelling (17)	32%	67%	35%	17%	80%	63%	17%	38%	21%
Consumer information about environm. effects (18)	37%	56%	19%	26%	55%	29%	46%	46%	0%
Market research "Green" products (19)	23%	33%	10%	13%	40%	27%	22%	24%	2%
Product Life Cycle Assessment (20)	10%	22%	12%	22%	40%	18%	31%	60%	29%

	Glass/Ceramic/Metal products			Engineering/Vehicle construction			Electric/Electronic devices			Other manufacturers		
	2001	2016	Δ	2001	2016	Δ	2001	2016	Δ	2001	2016	Δ
(1)	50%	63%	13%	55%	79%	24%	60%	78%	18%	40%	63%	23%
(2)	39%	80%	41%	53%	75%	22%	46%	61%	15%	39%	51%	13%
(3)	54%	90%	36%	58%	88%	30%	53%	70%	17%	65%	87%	22%
(4)	61%	90%	29%	58%	92%	34%	63%	83%	20%	67%	83%	16%
(5)	66%	70%	4%	64%	58%	-6%	50%	70%	20%	65%	80%	15%
(6)	57%	87%	30%	62%	88%	26%	50%	70%	20%	54%	87%	33%
(7)	51%	87%	36%	60%	88%	28%	44%	70%	25%	46%	89%	42%
(8)	72%	90%	18%	82%	92%	10%	72%	87%	15%	81%	94%	13%
(9)	46%	63%	17%	70%	79%	9%	58%	65%	7%	67%	73%	6%
(10)	59%	90%	31%	71%	88%	16%	58%	65%	7%	58%	87%	29%
(11)	34%	70%	36%	51%	63%	12%	33%	52%	19%	52%	70%	18%
(12)	33%	87%	54%	46%	67%	21%	46%	52%	7%	52%	80%	28%
(13)	41%	90%	49%	50%	88%	38%	44%	61%	16%	53%	84%	31%
(14)	36%	90%	54%	46%	88%	42%	46%	61%	15%	47%	80%	33%
(15)	33%	90%	57%	48%	88%	40%	34%	61%	27%	40%	80%	40%
(16)	16%	20%	4%	16%	50%	34%	3%	22%	19%	19%	20%	1%
(17)	12%	30%	18%	10%	33%	23%	9%	30%	21%	16%	47%	32%
(18)	34%	40%	6%	29%	42%	13%	26%	52%	26%	37%	53%	16%
(19)	10%	20%	10%	8%	33%	25%	12%	22%	10%	17%	11%	-6%
(20)	21%	27%	6%	21%	50%	29%	11%	48%	36%	16%	31%	16%

Differences greater 25% in bold
environm. = environmental

Environmentally-related cooperation activities

Knowledge can be extended through cooperation. Specifically in order to determine demand more reliably and to develop a better product, cooperating with customers and suppliers can be useful (Belderbos et al., 2004). This also applies environmental improvements. We therefore asked the

participants in our surveys if they cooperate during product planning or development with suppliers and customers to implement environmental improvements. This section shows the answers, disaggregates them by aggregated industry and size categories and examines the relationship with environmental innovation capabilities. As Figure 8 shows, 79% of the German manufacturing firms cooperate with suppliers or customers for environmental purposes in 2016. This means an increase of more than a fourth within the last 15 years.

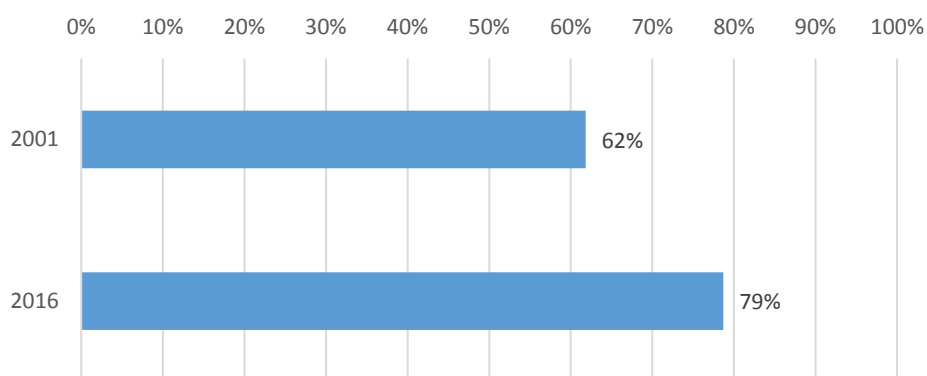


Figure 8: Environmentally related cooperation activities

As Figure 9 shows, particularly the share of cooperating medium-sized firms increased during this time period. With 75%, they now almost reach the cooperation levels of large companies (83%) whereas in 2001 there was still a difference of 22%. Compared to this, only 65% of the companies with less than 50 employees cooperated in 2016, which represents a decline of 15% versus 2001 and goes against the overall trend.

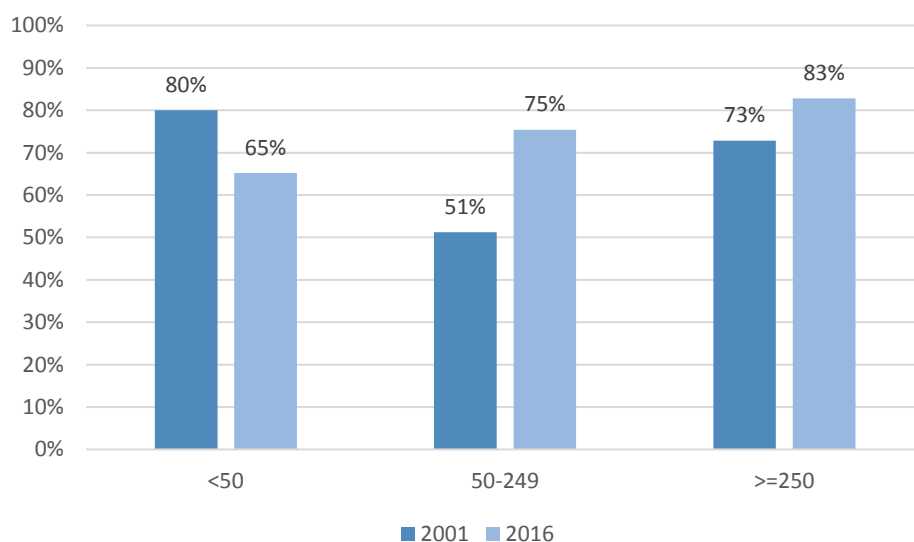


Figure 9: Environmentally related cooperation activities by aggregated size category

In all aggregated industry categories, the share of cooperating companies increased (Figure 10). The chemical industry remained the one with the largest share of cooperating firms (92%). The other sectors changed positions. For “Engineering and vehicle construction” companies, as well as for firms in the “Electric and electronic device” industry, similar high levels of cooperation are found in 2016 (88% and 91%), which made them move up compared to 2001. Firms in the “Glass, ceramic and metal products” industry had the smallest growth from 2001 to 2016 and as a result, now they have the second-smallest share (77%). Over all industries, it seems that the awareness of the advantages of cooperation has considerably increased since 2001, and in 2016 a greater number of firms make use of this important mechanism for knowledge transfers.

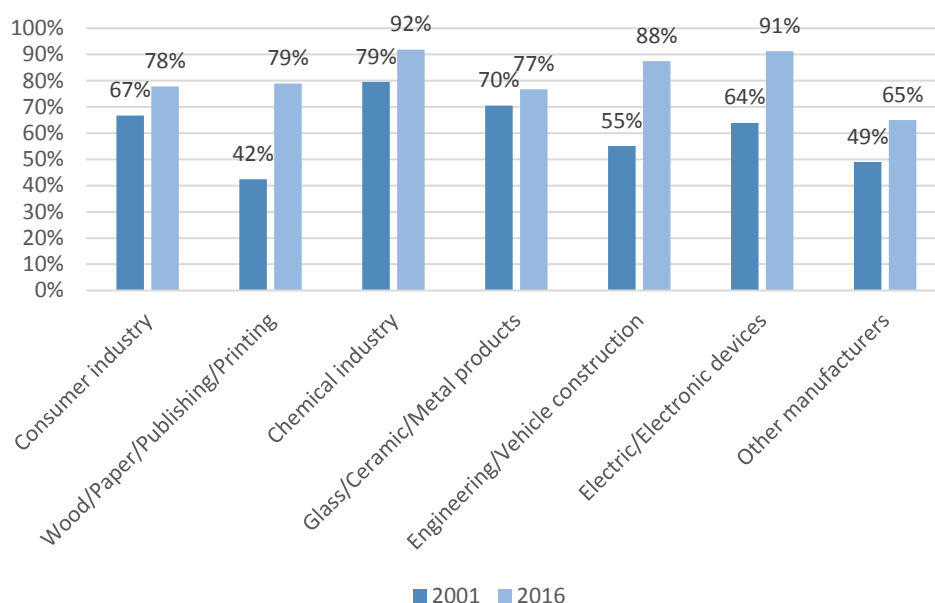


Figure 10: Environment-related cooperation activities by aggregated industry category

Environmental management systems

As was already established in the first part of this report, across countries, more companies have certified EMSs in 2016. Here we examine in more detail which standard the German manufacturing firms prefer. As can be seen from Figure 11, in 2001, EMAS and ISO 14001 had almost the same share. More specifically, 15% of the companies certified their systems according to both standards, 17% (ISO 14001) and 10% (EMAS) choose one of them. Compared to this, in 2016, most EMSs are certified in accordance with both standards (46%). The share of firms certified according to ISO 14001 increased to 21%, whereas the share of purely EMAS-verified firms remained effectively constant. However, due to the large increase of dual certifications, the overall share of EMAS certifications also increased by around 30%, and thus both ISO 14001 and EMAS certifications increased in absolute terms.

As can be further seen from Figure 11, almost all EMSs are certified today. The ISO 14001-only certification has become increasingly popular, while certifying only to EMAS has become less popular from 2001 to 2016. One explanation may be that as EMAS verification is more complex, additional costs for an additional ISO 14001 confirmation are lower. The advantages of dual certification, including the signaling benefits, are perhaps also explained by the issue raised earlier that firms find it increasingly more difficult to differentiate based on individual managerial activities. As well, since ISO 14001 is better known internationally, while EMAS is most trusted in Europe, there are complementarities arising from dual certification.

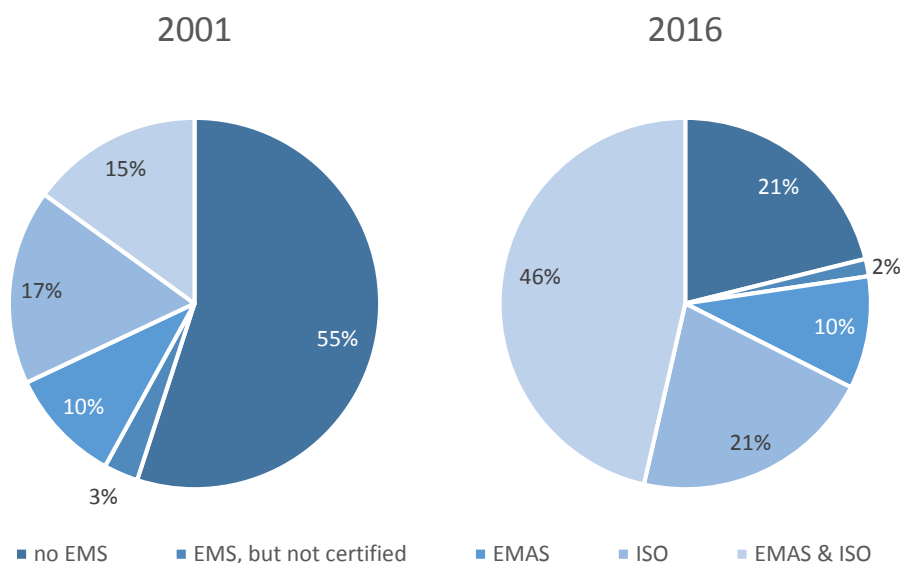


Figure 11: Type of EMS (deviation to 100% due to rounding)

The spread as well as certificate preferences differ between industry classes. In addition, the attitude of some aggregated industries changed over time.

The size of a company is crucial for whether companies implement an EMS and which they choose (Table 9). Those with at least 250 employees rarely have no EMS (16%). Between small and medium-sized companies, there is no difference in this regard. The smaller the company, the higher is the probability for an EMAS certificate. It is the other way round with ISO 14001 and dual certification, likely because large companies more often have an international orientation, for which they need the ISO 14001 certificate. Accordingly, having only the EMAS certification is used by 2% of them and thus also much less than in the past.

Table 9: EMS adoption by aggregated size category

Size	none		not certified		EMAS		ISO		ISO & EMAS	
	2001	2016	2001	2016	2001	2016	2001	2016	2001	2016
small companies	40%	29%	0%	0%	40%	38%	0%	4%	20%	29%
medium companies	80%	29%	1%	1%	10%	18%	5%	9%	5%	43%
large companies	42%	16%	10%	2%	6%	2%	17%	29%	25%	51%

Conclusions

Our explorative research highlights the historical development as well as the status quo of corporate sustainability and environmental innovation activities among manufacturing firms in Germany, the UK and Italy. We have analyzed in high detail the adoption of managerial and operational environmental management and social sustainability activities as well as environmental management systems and environmentally related interfirm cooperation, whilst differentiating for different firm sizes, countries and industries.

Overall, efforts related to corporate sustainability and environmental innovation have increased from 2001 to 2016. The inter-country comparison suggests that in 2001 as well as in 2016 German firms have overall higher implementation levels of managerial and operational environmental management and social sustainability activities as well as of EMS implementation, compared to firms in UK and Italy. However, on this basis no conclusions can be drawn with regard to individual activities because there are activities in which UK and Italian firms have higher implementation levels than German ones.

In Germany, the increase of operational environmental management activities within the 15-year time span analyzed is largely independent of firm size. Nevertheless, medium-sized firms over-proportionally increased their adoption of operational activities such that they nearly caught up with the increased adoption level of large firms. An even more pronounced alignment is found for managerial environmental management activities, such that in 2016 managerial activities of medium-sized and large firms are essentially at par, indicating that creating competitive advantages based on managerial activities becomes very difficult.