Institut für Arbeitsmarkt- und Berufsforschung

Die Forschungseinrichtung der Bundesagentur für Arbeit

IAB

IAB-Discussion Paper 36/2008

Beiträge zum wissenschaftlichen Dialog aus dem Institut für Arbeitsmarkt- und Berufsforschung

Structural Change and Performance of the German Environmental Sector

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* The authors would like to thank Lutz Bellmann (IAB) and the other members of the IAB research group on the IAB Establishment Panel for very valuable support.

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Abstract

The so-called Environmental Sector produces technologies, products and services that prevent or reduce environmental damages. On the background of growing environmental problems such as climate protection this sector seems to be more and more important. Contrary to that, a theoretical model shows that this hypothesis may not be true for all sections of the environmental sector. End-of-pipe solutions that operate independently from production processes are mostly driven by environmental regulation so that the demand for these products reacts rather inelastic. This may not be the case for cleaner technologies that are in most cases an integrated part of the production process. Cost-savings are a major motivation to introduce these technologies and products. Unfortunately, the statistical recording of cleaner technologies is very problematic because these technologies or products can not easily be identified separately. This is also the case for our empirical analysis using data from the establishment panel of the Institute for Employment Research. Our analysis of structural change shows a drastic decline of the number of firms and employment in environmental sectors dominated by end-of-pipe but there are positive employment developments and expectations for those cleaner technologies that are captured by our data. This observation is confirmed by an econometric analysis explaining the driving forces of the market shares of firms in the environmental sector.

JEL classification: Structural Change, Environmental Sector, Employment

Keywords: Q 52, J 21

1 Introduction

On the background of the climate change and the growing world energy consumption the so-called environmental technologies, products and services contributing to a reduction of environmental impacts seem to be more and more important. Nevertheless, the statistical recording of the environmental sector producing these goods and services is very difficult. Firstly, the environmental sector does not represent a statistically well-defined sector like the chemical industry but it comprises firms from nearly all branches. Furthermore, not always explicitly defined environmental goods and services are needed to reduce environmental harms. The so-called cleaner technologies often include changes of production processes where the reduction of environmental impacts may be caused by organisational changes leading to lower energy consumption. Therefore, many environmentally benign technologies are not identifiable as such.

The paper tries to assess the direction and the main driving forces of the structural change of the German environmental sector from a theoretical and empirical perspective. The empirical analysis is based on data of the establishment panel of the Institute for Employment Research in Nuremberg from 1998 to 2005.

Section 2 discusses methodological aspects of empirical analyses of the environmental sector. It is followed by a discussion of a theoretical model explaining potential driving forces of structural change of the environmental sector (Section 3). A descriptive analysis in Section 4 aims to identify development trends of the environment industry during the recent years in Germany. Due to the cross-section character of this sector, most analyses in the literature are based on one point in time surveys. Fortunately, in 1999 and 2005, the questionnaire of the IAB establishment panel contains information on the environmental sector so that this unique database allows insights in the dynamics of this sector.

An econometric analysis (Section 5) tries to explore the main determinants of the market shares as performance and competitiveness indicator of environmental firms.

2 Methodological aspects of empirical analyses of the environment sector

Due to the cross-section character of environmental issues the environmental sector covers nearly all statistically well-defined branches. Therefore, we need a clear-cut and operational definition. The OECD and Eurostat define eco-industries as “activities which produce goods and services to measure, prevent, limit, minimize or correct environmental damage to water, air and soil, as well as problems related to waste, noise and eco-systems. This includes technologies, products and services that reduce environmental risk and minimize pollution and resources” (European Commission 2006:15). Furthermore, they distinguish between two general categories, pollution management and resource management. “Pollution management consists of nine eco-industry sectors that manage material streams from processes managed by humans (the technosphere) to nature, typically using “end of pipe” technology. It also includes cleaner technologies and products” (European Commission 2006:15). Following the OECD glossary of statistical terms (OECD 2008) “End-of-pipe protection refers to added technical installations for environmental control of emissions. They operate independently from the production process or are an identifiable part added on to production facilities“. Clean technology is the installation or a part of an installation that has been adapted in order to generate less or no pollution. As opposed to end-of-pipe technology, the environmental equipment is integrated into the production process.“

Resource management as a broader concept also involving environmentally friendly products includes five eco-industry sectors that take a more preventive approach to managing material streams from nature to the technosphere (European Commission 2006:15, Table 1).

Table 1: Classification of the Environmental sector

Pollution management	**Resource management**
Solid Waste Management & Recycling	Water Supply
Waste Water Treatment	Recycled Materials
Air Pollution Control	Renewable Energy Production
General Public Administration	Nature Protection
Private Environmental Management	Eco-construction
Remediation & Clean Up of Soil & Groundwater	
Noise & Vibration Control	
Environmental Research & Development	
Environmental Monitoring & Instrumentation	

Source: European Commission (2006).

For an empirical analysis of the environmental sector, two main different approaches are available (see also Table 2).

Supply-side approaches only include firms that have explicitly declared to produce environmentally related goods and services. But especially cleaner technologies are often developed by the polluting firms themselves e.g. by changing the organisation of their production process. They do not have the aim to sell their anti-pollution technologies so that they have no incentive to be considered in supplier lists for environmental producers. Therefore, supply-side approaches underestimate the relative importance of cleaner technologies.

Table 2: Methodological approaches for the analysis of the environmental sector

Supply-side approaches	*Demand-side approaches*
Surveys of firms offering environmental goods and services	Environmental protection expenditures in connection with Input-Output Tables
Weaknesses:	*Weaknesses:*
Self-declaration Multi-purpose products Bias towards end-of-pipe technologies	Bias towards end-of-pipe technologies Lack of data concerning protection expenditures

Another problem of supply-side analyses results from the existence of multi-purpose products. These goods like e.g. pumps can serve different purposes. Even for the producers of these goods it may be difficult to assess the share of the environmentally related use of these products.

Demand-side approaches use environmental protection expenditures to assess the importance of the environmental sector. These expenditures are defined as "the money spent on all purposeful activities directly aimed at the prevention, reduction and elimination of pollution or nuisances resulting from the production processes or consumption of goods and services. Excluded are activities that, while beneficial to the environment, primarily satisfy technical needs or health and safety requirements." Further detailed information about that definition can be found in The Industry Data Collection Handbook (Environmental expenditure statistics cited from European Commission 2006:21-22). Demand-side approaches also tend to have a bias towards end-of-pipe technologies because only explicitly environmentally related expenditures can be considered. Furthermore, due to a lack of official statistics, environmental protection expenditures can only partially be recorded. For instance, it is nearly impossible to assess the environmental expenditures of households.

Our analysis is based on the establishment panel of the Institute for Employment Research in Nuremberg. The establishment panel was founded in 1993 to get a representative picture of German establishments who have at least one employee subject to social security. The establishment panel is characterized by very high response rates of more than 70%.

The questionnaires of 1999 and 2005 contain information on the environmental sector. The following sectors have been regarded:

- Prevention of water pollution, waste water treatment;
- Waste disposal, recycling;

- Prevention of air pollution, climate protection;
- Noise abatement;
- Removal of hazardous waste, soil protection;
- Measurement technology;
- Analytics, consulting;
- Environmental research and development;
- Other environmental fields.

The firms were questioned whether they produce goods and/or services in one or several of the above categories. Furthermore, the share of the environmentally related turnover with respect to the whole turnover was included. Using this share, it is possible to determine the environmental employment under the assumption that there are no differences between employment and turnover concerning environmental production compared to other production sectors.

The panel character of the IAB database allows an analysis of the structural change of the environmental sector from 1999 to 2005. Unfortunately, only the above mentioned categories are available so that dynamic sectors like renewable energies are only partially observable. Like other supply-side analyses, there is a strong bias towards end-of-pipe technologies.

Therefore, the overall figures concerning the number of employment or establishments underestimate the unknown real size of the environmental sector. In general, the mere number of employees in the environmental sector has no great scientific value because these figures do not represent net employment effects. Contrarily to that, our analysis allows an interesting insight in the structural change of the environmental sector.

3 Theoretical background

The production of environmental products, technologies and services has specific effects on the employment of an economy. As with other fields of specialization of an economy these effects can be smaller or larger. Especially the development of employment can be more or less favourable. In standard neoclassical approaches these effects are not regarded, since the assumption of full employment excludes variations of labour demand at least for the macro-economy. In approaches of structural change, however, the industry composition is important for the employment level. In the following, a sketch of a theoretical argument is given, which shows how this can happen. It is based on work done by Appelbaum and Schettkat (1993 & 1999). A full developed theory can be taken from Blien, Sanner (2006) and Blien, Ludewig (2007). Using approaches of this kind it is possible to assess the production of environmental technology and services and the related effects on employment.

In these approaches on structural change, the dynamics of an economy – which can comprise a region or a macro-economy – are explained by an interaction of changes of productivity and of product demand. The effects of innovations with respect to the production process are ambivalent, since they are associated with gains of employment if the product demand is elastic, and with employment losses if the demand is inelastic. To give a first idea of this "fundamental theorem of the employment effects of technical progress", we look at a very simple numerical example which takes into account the elasticity of demand. Its significance can be made clear by looking at the relationship between price changes and turnover. If demand is elastic, a price reduction results in an increase in turnover $P \cdot Q$. If demand is inelastic, on the other hand, the result is a reduction in turnover. This characteristic follows directly from the definition of demand elasticity.

In addition to this, the elasticity of demand also conveys the effects of technical progress (or productivity increases – we use the terms as synonyms) on employment. To see this we discriminate between two effects of productivity increases. It first leads to a drop in the demand for labour. As the same product can be produced using less labour, this is also known as the displacement effect of technical progress. In addition, however, the reduction in costs as a result of technical progress also leads to a drop in price. This in turn increases demand for the particular product and therefore also demand for workers who are employed in production. Here a compensation effect therefore occurs. How strong this effect is and whether it may even "overcompensate" are then empirical questions.

Table 3 compiles the effects of an increase in productivity due to technical progress in a fictitious example. It is assumed here that the productivity advantage is passed on to the consumers in full. The productivity gain and the price reduction are therefore equal in size. The drop in price leads to a change in the quantity sold. In the case of elasticity the quantity sold will change at a greater percentage than the price. In the case of inelasticity the change in the quantity will be comparatively smaller. This means that in the case of elastic demand the net effect on turnover is positive, but in the case of inelastic demand it is negative. The content of the theorem on structural change is that employment responds in the same direction as turnover.

Table 3: Relationship between product demand and the development of employment in Appelbaum and Schettkat's approach, explained using a fictitious numerical example

	Elastic product demand	Inelastic product demand
Productivity gain due to technical progress	20%	20%
Reduction in price	-20%	-20%
Change in quantity	30%	10%
Change in turnover	4%	-12%
Change in employment	4%	-12%
Dominating effect	Compensation effect	Displacement effect

The fictitious example described above in Table 3 shows the intuition behind the relationship between technical progress, demand elasticity and employment. However, what is missing yet is a proof that the relationship between the variables is correctly described. To fill this gap, a basic model is expounded below which follows the formulation developed by Appelbaum and Schettkat (1999) and by Möller (2001) and therefore summarises the current state of the argumentation. The basic model has the advantage of providing rapid clarity regarding the relationships. It begins with a definition equation for the productivity of labour π in a firm j in which the production quantity Q is related to the level of employment N.

$$\pi_j = \frac{Q_j}{N_j} \tag{1}$$

$$P_j = \frac{z_j W_j}{\pi_j} \tag{2}$$

$$Q_j = f(P_j, y), \quad \text{mit:} \quad dQ_j/dP_j < 0, \quad dQ_j/dy > 0 \tag{3}$$

The second equation is a price-setting function with a mark-up calculation. The price is P_j, z is a mark-up factor which also includes capital expenditure and W_j is the wage rate. Finally the third equation is a demand function that falls with the price and rises with the national income y. From the base equations it follows for the growth rates, if ε_j is the price elasticity and η_j is the income elasticity of demand:

$$\hat{N}_j = \hat{Q}_j - \hat{\pi}_j \quad (1)'$$

$$\hat{P}_j = \hat{z}_j + \hat{W}_j - \hat{\pi}_j \quad (2)'$$

$$\hat{Q}_j = \eta \cdot \hat{y} - \varepsilon_j \cdot \hat{P}_j \quad (3)'$$

From (1)‘ to (3)‘ it is possible to derive the following expression for a firm’s employment development if $\hat{z} = 0$:

$$\hat{N}_j = \eta_j \hat{y} + (\varepsilon_j - 1)\hat{\pi}_j - \varepsilon_j \hat{W}_j \quad (4)$$

After this we switch level and move on to examining an economy. This is characterised here as a region, though it could just as easily be a national economy. In order to be able to go over to examining individual sectors of a regional economy it is necessary to aggregate all firms j of the particular industry i in the relevant region r. For this we assume in the following that all the firms of an industry i are identical:

$$\hat{N}_{ir} = \eta_{ir} \hat{y} + (\varepsilon_{ir} - 1)\hat{\pi}_{ir} - \varepsilon_{ir} \hat{W}_{ir} \quad (5)$$

A multi-level problem has to be taken into account when conducting the aggregation: although it is possible to assume that the demand elasticities across all the firms of an industry can be determined in terms of forming a weighted average, the elasticity at sectoral level is of a different nature from that at the level of an economic unit. For the individual firm that is neither a monopolist nor an oligopolist in a cartel, the behaviour of the other firms appears to be given. If the firm lowers its price, demand for its products may increase very strongly because other firms, which maintain their prices, are displaced. If all the firms lower their price, however, the quantity sold may change only slightly. Under the conditions of monopolistic competition, individual firms will behave in a profit-maximising manner and only offer their products in the elastic area of demand. After the described aggregation of individual firms it is no longer possible to make such a statement for aggregates ir.

The model describes productivity gains as Hicks-neutral technical progress, which is defined in such a way that the input ratio of the production factors remains constant. In this case, which applies for example for a Cobb-Douglas production function, $\hat{\pi}_j > 0$ can simply be assumed. As a consequence, workers are displaced when product demand is inelastic (i. e. $\varepsilon_{ir} < 1$). When demand is elastic ($\varepsilon_{ir} > 1$) on the other hand, employment increases. This can be seen directly from (5). Therefore the theorem of the employment effects of increases in productivity can be derived from the basic model. The theorem dates back at least to the forties of the last century (Neisser 1942), but at that time no formal proof was published.

The model also shows that the development of employment depends on the interaction of two elasticities. If the income elasticity is high, the demand for a product can increase even under conditions of prices rising secularly. Positive employment effects are therefore possible despite price increases.

Now it is time to turn to our special case, the production of environmental services and of environmental technology. No definite answers about the size of demand and income elasticities are available for this economic sector. The only empirical results available on the crucial elasticities for a specific definition of industries were published by Möller (2001). However, his work did not include separate analyses on the environmental sector of the economy.

It is possible, however, to develop a reasonable expectation in this case. We expect that the market for environmental services and environmental technology is characterized by a relatively high income elasticity, i. e. the goods and services produced by this industry are superior. People tend to regard the environment as gaining of importance, if all their 'basic needs' are covered by their income. As long as they have to struggle for the means to nourish their families, the environmental sector is not very important. In the case of the developed countries, however, the situation is different.

With respect to the price elasticity we expect that demand reacts rather inelastic. There are several reasons for the assessment. In many cases there are legal prescriptions giving minimum standards for the protection of the environment. These have to be observed, independently of the price of the protection. In other cases people might regard the protection as essential for their living, again relatively independently of the associated cost.

If this assessment is correct, the consequences would mean bad news for the producers of end-of-pipe technologies within this sector. Concerning this sub-sector, job losses may be expected. This may not be the case for cleaner technologies because recent empirical analyses confirm that cost-savings play an important role as motivation for the introduction of cleaner technologies whereas the fulfilment of environmental regulation is crucial for the adoption of end-of-pipe technologies (see e.g. Frondel, Horbach, Rennings 2007, Horbach 2008). It seems to be realistic that environmental friendly technologies and products will be more and more introduced because of economic but not only for ecological reasons.

Following these theoretical considerations, we expect a structural change of the environmental sector characterised by a decline of end-of-pipe dominated sectors accompanied by a growing importance of sectors specialised in cleaner technologies. In Section 3, we try to test this hypothesis empirically using the data we have at hand.

4 Structural Change and future developments of the German environmental sector

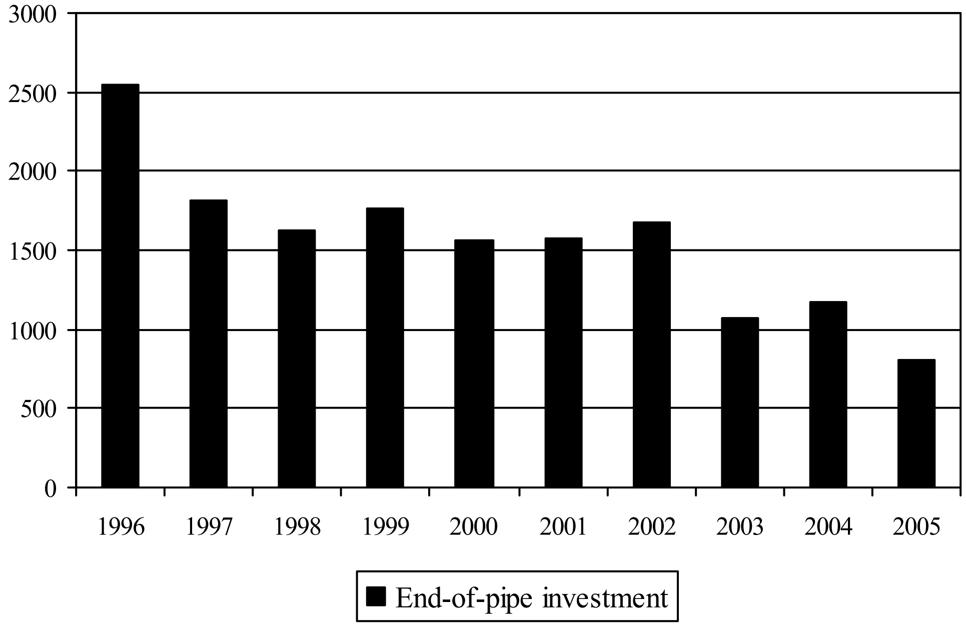
On the basis of our database, the establishment panel of the Institute for Employment Research, we observe a drastic decline of the number of establishments (-37%) and for employment (-35%) in the environmental sector following the definition of Section 2 from 1999 to 2005. A partial explanation for this trend can be detected by analysing further information from the Statistical Office in Germany. Since 1997, the statistical office collects data on the environment industry. Unfortunately, the statistic is restricted to a maximum of 5000 firms that declared to belong to this sector. Comparable to our results, a clear decline of the number of firms especially in the construction sector (-18%) itself and related sectors such as glass, ceramics and stones (-25%) is visible. Especially the construction sector predominantly produces end-of-pipe products such as sewage-works or noise abatement equipment.

Table 4: Results from the official German statistics on goods and services for the environment

Branches	Number of firms		Growth rate 2001 - 2005 in %	Turnover in Bill. EUR		Growth rate 2001-2005 in %
	2001	2005		2001	2005	
Manufactoring	979	900	-8.1	8.96	8.75	-2.3
Textiles	27	29				
Chemical Industry	35	38				
Rubber and plastics	98	101				
Glas, ceramics, stones	175	131				
Metals	165	136				
Machinery	303	294				
Medical, precision and optical instruments	43	47				
Motor vehicles	66	62				
Construction Sector	1423	1161	-18.4	2.73	2.33	-14.7
Service Sector	4610	4094	-11.2	2.63	2.35	-10.7

Source: Statistical Office Germany, own calculations.

Figure 1: Investment in End-of-Pipe Technologies in Germany from 1996 to 2005 in Mill. EUR



Source: Statistical Office Germany (2007).

The demand side shows a clear decline of investment in end-of-pipe technologies (-50% from 1998 to 2005) confirming our results for the supply side. Interestingly, the overall environmental expenditure (manufacturing, state, investment and current expenditure summing up to approximately to 35 Bill. EUR in 2004) remained nearly constant so that the relative importance of environmental issues has not been reduced but the identification of explicitly environmentally related goods and services is more and more difficult. Improvements of the environmental performance of a firm are often realized by the polluting firm itself e.g. by modifying production processes based on cleaner technologies. Therefore, the environmental sector seems to remain a very important sector in Germany but the statistical observation will be more and more difficult due to the growing importance of cleaner technologies.

A further confirmation of this hypothesis can be found by analysing the environmental industry with respect to the development of the relative importance of environmental protection fields from 1999 to 2005 (see Table 5).

Table 5: Establishments and employees by environmental fields in 1999 and 2005

Environmental fields	Number of establishments in %		Distribution of employment In %	
	1999	2005	1999	2005
Prevention of water pollution, waste water treatment	12.1	14.9	18.9	13.0
Waste disposal, recycling	28.4	16.1	27.4	29.8
Prevention of air pollution, climate protection	19.4	22.1	16.3	22.1
Noise abatement	1.7	2.9	2.3	2.1
Removal of hazardous waste, soil protection	5.5	6.5	3.7	5.4
Measurement technology	6.2	7.4	6.6	6.5
Analytics, consulting	5.9	6.2	4.7	5.4
Environmental research and development.	0.9	7.5	1.5	4.7
Other environmental fields	19.9	16.4	18.6	11.0
All fields	100	100	100	100

Source: Establishment Panel of IAB, own calculations.

The absolute number of companies in the area of prevention of water pollution controls and waste water treatment actually fell by more than 4500 companies from 1999 to 2005. Correspondingly, the number of employees decreased in this segment of the environmental sector by 89500 over the same time period.

According to the "Profile of the German Water Industry 2005" (ATT et al. 2005:15), this development can be explained by the pattern of change observed in the management of waste water disposal. Formerly belonging to the local administrations, it is becoming an independent business under public law (such as an incorporated public institution). According to this publication, the percentage of government managed activity in this area declined to 14.9% in 2003. The percentage of administrative unions or private law companies in the form of stock corporations and limited liability companies increased to 15.9% and 30.2%, respectively by 2003. Furthermore, the number of registered public-private venture companies rised from 3.3 % to 28.8% from 1986 to 2003. In contrast, the percentage of purely private water supply companies is very small (3.5%), but with an upward trend. The Profile also indicates the number of Public-Private-Partnerships (PPP) is growing. (ATT et al. 2005:13.).

The reason for the dominance of public law companies lies in the fact that communities have a duty to supply water and treat waste water. These duties are not transferable, although the performance of these tasks can be assigned to third parties, i.e., private companies. Several areas of responsibility can be outsourced to private companies. The high levels of public investment and support for sewage treatment mostly benefits private sector businesses which, according to a survey of total public expenditures in 2002 conducted by the German Association of Gas and Water Management (BGW) and the German Association for Water Management, Waste Water and Waste (ATV-DVWK), provide 69% of the services in the areas of planning, construction and operations. In this way, for example, third party services in the area of construction attained 91% (BGW and ATV-DVWK 2003:8). The outsourcing of specific tasks has improved the efficiency in residential water management capabilities and led to a decline in the number of companies (Rothenberger 2003). This decline can also be attributed to the integration of public and private companies (PPP). The modernization strategy of the German Parliament in 2002 aimed at promoting the integration of water supply and waste water management through equal tax treatment. In addition, business mergers and other cooperative approaches were supported to create efficient, customer oriented and competitive service providers. The aim was to realize the synergistic potential promised by the consolidation of water supply and sewage treatment companies (Rothenberger 2003).

The German Parliament's modernization strategy, according to the Rothenberger study, with the aim of reforming the community business laws, also allowed for the rescission of the "locality principle", which prohibited the communal businesses from operating outside of the local municipal area (Rothenberger 2003). The decline in the number of businesses and the number employed reported here can be seen as evidence that the expansion and the modernization in this segment of environmental business has reached a high level.

Furthermore, the decrease in the number of companies in the segment water pollution control and treatment can also be explained by the drop in water consumption as a result of company modernization programs, changes in consumer behavior, or corporate behavior forced by rising costs or increased environmental awareness. In eastern Germany, especially, as a result of outwards migration, the over-dimensional waterworks, pipeline networks and waste disposal facilities have become unnecessary and unprofitable by today's standards (ATT et al. 2005).

In the waste disposal and recycling field the number of employees declined by 65500 persons accompanied by a loss of 30850 firms. The only moderate loss with respect to employment led to a nearly constant relative importance of about 30% among all environmental fields. The strong absolute decrease in the number of companies in this segment of the environmental sector may be partially explained by the trend in corporate consolidations. According to the Federal Environment Agency, the "Closed Cycle Waste Management Act" establishes extended possibilities for the privatization of waste disposal (Umweltbundesamt 2005). The decrease in the number of companies can be attributed to privatization tendencies in the waste management segment, although it may be assumed that the companies do not disappear from the market entirely, rather merge into larger units. Since 1997, DSD (*Duales System Deutschland*), a public stock corporation, has been responsible for the collecting and recycling of consumer packaging through the award of contracts to local waste disposal companies. In the contracting process, only those companies that demonstrate the most efficient and most cost effective production methods are awarded a contract. This type of award process encourages the consolidation process in the waste management segment, which leads to the decline in the figure for socially insured employees.

The rising relative importance of "prevention of air pollution and climate protection" (see Table 5) reflects the growing political relevance and demand for climate protection measures.

The increase of the relative shares of "Measurement technology", "Analytics, consulting" and "Environmental research and development" points to a rising importance of cleaner technologies (see also Horbach 2003). The area of environmental research, in contrast to all other environmental segments discussed here, even shows a positive balance in absolute figures. The number of employees increased by 13760 employees and the number of companies operating in this environmental field by nearly 6600 firms, respectively. The increase in the number of employees and firms may be the result of more development funding especially with respect to cleaner technologies. The recently introduced legislation, regulations, and requirements – such as the "Renewable Energy Law" of 2000 (2004) or the "Combined Heat and Power Law" from 2002 – come as the results of the Kyoto Protocol or the Climate Convention and illustrate the government's response towards meeting the prescribed goals. In order to attain these goals, more funds have been made available for environmental research through grant programs which, in turn, raises its importance.

The IAB database also contains information on the employment expectations of the environmental sector. In the fields of water pollution and environmental research high percentages of firms expect a positive employment development. The positive result for environmental research points to a growing importance of the research intensive cleaner technologies in the future. In the air pollution and waste disposal sector nearly half of the firms are not able to assess the employment development, probably caused by the uncertainty about future regulations.

Table 6: Expected number of employees in 2010 - in % -

Environmental fields	Higher	Nearly the same	Lower	Impossible to assess	Sum
Prevention of water pollution, waste water treatment	30.9	29.9	12.8	26.4	100
Waste disposal, recycling	10.0	35.2	10.2	44.6	100
Prevention of air pollution, climate protection	12.8	29.9	11.9	45.4	100
Noise abatement	6.1	74.8	4.6	14.5	100
Removal of hazardous waste, soil protection	11.1	56.9	6.5	25.5	100
Measurement technology	12.8	49.9	10.5	26.8	100
Analytics, consulting	17.2	64.6	6.6	11.6	100
Environmental research and development.	28.8	51.4	6.0	13.8	100
Other environmental fields	12.8	42.8	9.7	34.7	100
All fields	16.0	40.8	9.7	33.5	100

Source: Establishment Panel of IAB, own calculations

5 Determinants of the market shares of environmental firms: An econometric analysis

The assessment of future employment perspectives may also be enlightened by analysing the determinants of the relative performance of a firm. The variable *market share* describing the share of the turnover of the firm with reference to the whole branch seems to be a useful indicator.

Table 7: Determinants of Market Shares in the Environmental Industry

Dependent variable: MarketShare			
Determinants and control variables		Sector Dummies	
Age	-0.20 (-0.24)	Sec2	-0.45 (-0.26)
Envdivers	-0.22 (-0.78)	Sec4	-2.43 (-2.06)*
Envinnovation	1.96 (2.42)*	Sec5	2.85 (1.43)
Exports	0.05 (1.57)	Sec6	-2.87 (-2.22)*
Further Education	2.20 (3.35)**	Sec7	0.39 (0.35)
Highqual	1.97 (0.99)	Sec8	-3.59 (-3.14)**
Integ	2.60 (1.75)$^{+}$	Sec9	-2.82 (-1.99)*
Productivity	$7.42*10^{-6}$ (1.87)$^{+}$	Sec12	-4.53 (-3.63)**
Region	2.14 (2.73)**	Sec13	-5.10 (-3.47)
Size	0.01 (4.69)**	Sec14	-3.02 (-2.19)*
Subsidies	2.34 (2.33)*	Sec15	5.39 (2.16)*
Tarif	1.33 (1.41)	Sec16	5.12 (0.69)
		sec17	-2.07 (-0.81)
		Constant	-2.70 (-1.87)$^{+}$
Number of observations: 822. R^2 = 0.44. T-statistics are given in parentheses; $^{+}$, * and ** denote significance at the 10%, 5% and 1% level, respectively. Because of considerable heteroskedasticity we used White corrected standard errors.			

Source: Establishment Panel of IAB, own estimations.

The further variables of our econometric analysis can be described as follows (for a detailed definition of the variables see the Appendix): *Envinnovation* is a dummy variable that describes the product innovation activities of the firm. The variable gets the value one if the firm belonging to the environmental sector improved or developed new products from 2002 to 2004.

Age is a control variable to capture the age of a firm. It gets the value one if the firm was founded after 1990. The variable e*nvdivers* describes the number of different environmental fields offered by the firm. This variable allows testing the hypothesis if the diversification of products is advantageous for a firms´ performance. *Integ* captures the orientation of firms towards cleaner technologies. *Further Education* indicates the support of additional education measures for employees by the firm and is expected to improve the innovative capacities of the firm. Furthermore, environmental innovation activities are supported by a high qualification of the staff of a firm: *Highqual* describes the share of employees with a university degree to capture these human capital effects. *Exports* describes the share of exports on turnover and can be interpreted as an indicator for international competitiveness.

The dummy variable *region* controls for structural differences between East- and West-Germany. *Size* describes the size of the firm by the number of employees in

2005. *Subsidies* measures the influence of the existence of subsidies for wages or investment. The variable *tarif* measures the existence of a collective wage agreement or not. It is included because collective wage agreements may reduce the international competitiveness of a firm. *Productivity* is an indicator for the competitiveness of the firm and denotes the turnover per employee.

Our estimation results (see Table 7) show that environmental product innovations (*envinnovation*) trigger the economic performance of a firm belonging to the environmental market. Successful product innovations lead to an - at least temporary - competition advantage in favour of the firm and therefore to a higher market share (see also Chennels, van Reenen 1999). Measures improving the innovative capacity of a firm also seem to support the performance of the firm – indicated by the significant influence of the variable *further education*. A further interesting result is that firms concentrating on environmental fields that are closely related to cleaner technologies are more likely to increase their market share (variable *integ*). This result may also be interpreted as further confirmation of the growing importance of cleaner technologies compared to end-of-pipe. Furthermore, the results also show a positive influence of subsidies for the performance of a firm. Subsidies may create an artificial competition advantage for the firm allowing an increase of its market share. A higher turnover *productivity* that may be interpreted as indicator of the competitiveness of a firm also triggers the market share of the firm. The significantly positive influence of the firms´ size is not surprising. Interestingly, the *age* of the firm seems not to be relevant signalling that also young firms may reach high market shares. Furthermore, the degree of diversification of environmental products and services is not so relevant. It is also possible to attain high market shares by offering only few different but innovative products.

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Appendix: Description and descriptive Statistics of the Variables

Variables	Description	Mean	Std. Dev.
MarketShare	Share of turnover of the respective firm with respect to the turnover of the whole branch (in 2004) (* 1000)	5.1	16.37
Age	Foundation of the firm after (1) or before 1990 (0)	0.51	0.50
Envdivers	Number of different environmental fields offered by the firm	2.07	1.44
Envinnovation	1 Environmental product innovations from 2002 to 2004 0 No product innovations	0.52	0.50
Exports	Share of exports on turnover in %	9.09	20.52
Further Education	Support of additional education measures for employees (1 yes, 0 no)	0.76	0.43
Highqual	Share of employees with an university degree	0.13	0.21
Integ	1 Predominantly integrated environmental fields 0 Predominantly end-of-pipe	0.19	0.39
Productivity	Turnover per employee in 2004 (in thousand EUR)	180.31	317.14
Region	1 West-Germany 0 East-Germany	0.59	0.49
Size	Number of employees in 2005	233.13	1649.0
Subsidies	Subsidies for wages or investment (1 yes, 0 no)	0.34	0.47
Tarif	Collective wage agreement (1 yes, 0 no)	0.53	0.50

Appendix (continued)

Sector Dummies	1 yes, 0 no for all sector dummies	Mean	Std. Dev.
Sec1	Agriculture, forestry	0.03	0.18
Sec2	Mining, energy and water supply	0.06	0.24
Sec3	Food products and beverages	0.003	0.06
Sec4	Consumer goods	0.01	0.11
Sec5	Production goods	0.12	0.32
Sec6	Investment goods	0.15	0.36
Sec7	Construction sector	0.18	0.39
Sec8	Retail and wholesale trade	0.15	0.36
Sec9	Transport and communication	0.02	0.14
Sec10	Banking and assurances	0.001	0.03
Sec11	Restaurants and accommodation	0.001	0.03
Sec12	Education sector	0.01	0.11
Sec13	Health and social services	0.01	0.08
Sec14	Other services especially for enterprises	0.17	0.38
Sec15	Other services	0.07	0.26
Sec16	Non governmental organisations	0.004	0.07
Sec17	Public services	0.002	0.05

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IAB-Discussion Paper 36/2008

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