Employment and Innovations in the Environmental Sector: Determinants and Econometrical Results for Germany

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Summary

Besides other determinants environmental regulation, institutions like environmental agencies and social customs lead to a demand for environmental goods and services. On the basis of the public choice theory it can be shown that environmental regulation is endogenous and can be influenced by the environmental awareness of voters and interest groups. Following the so-called Porter hypothesis early developed environmental legislation induces environmental innovations and creates first mover advantages connected with a high international competitiveness of the environmental industry. An empirical analysis based on the establishment panel of the Institute for Employment Research (IAB) shows that more than 900,000 persons are employed in the environmental sector in Germany. Following the results of an econometrical analysis of employment perspectives and innovation behaviour integrated environmental technologies will become more relevant whereas employment in "traditional" end-of-pipe fields like the prevention of waste water pollution or air pollution will be reduced.

Keywords: Employment, Environmental sector, Innovation behaviour

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1. Introduction

During the last twenty years the environmental sector in Germany has reached a high importance, also with respect to employment.[1] The article deals with a theoretical and empirical analysis of employment and innovation in environmental markets.

In a first step the determinants of the development of environmental markets are discussed. In most cases environmental problems represent negative external effects so that governmental measures are very important for the dynamics of environmental markets. Therefore it is useful to take a closer look at the environmental policy decision system. With respect to the international competitiveness of the German environmental sector it is important to analyse the determinants of innovation activities within this sector.

In the following an empirical analysis of the employment impacts of environmental markets based on data of the German establishment panel of the Institute for Employment Research (IAB) is presented. An econometric analysis gives some evidence for the employment perspectives and the innovation behaviour of the environmental sector.

2. Determinants of the development of environmental markets

The development of markets for environmental goods and services serving to prevent environmental damages is characterised by special driving forces differing from "traditional" markets. In the following the main determinants for the development of environmental markets are summarized:

- Environmental regulation and subsidies;
- Institutional structure of environmental regulation;
- Environmental pollution problems, state of the environment;
- State of economic development;
- Environmental awareness and social customs in the long run.

In most cases the public good character of the environment leads to the problem that the pricing system of a market economy which is responsible for the efficient allocation of private goods is not applicable. For example nobody is willing to pay for a clean air when he can use it without

[1] See e.g. Bundesumweltministerium (1996); Horbach/Blien/von Hauff (2002).

any costs. The environment causes a so-called externality problem - a polluter uses the environmental medium without paying for it. The consequence is that a "neutral" institution (normally the state) is needed to correct this error of the pricing system.

For that reason state measures are very important for the development of environmental markets. This has been confirmed by several empirical studies where producers of environmental goods were questioned.[2]

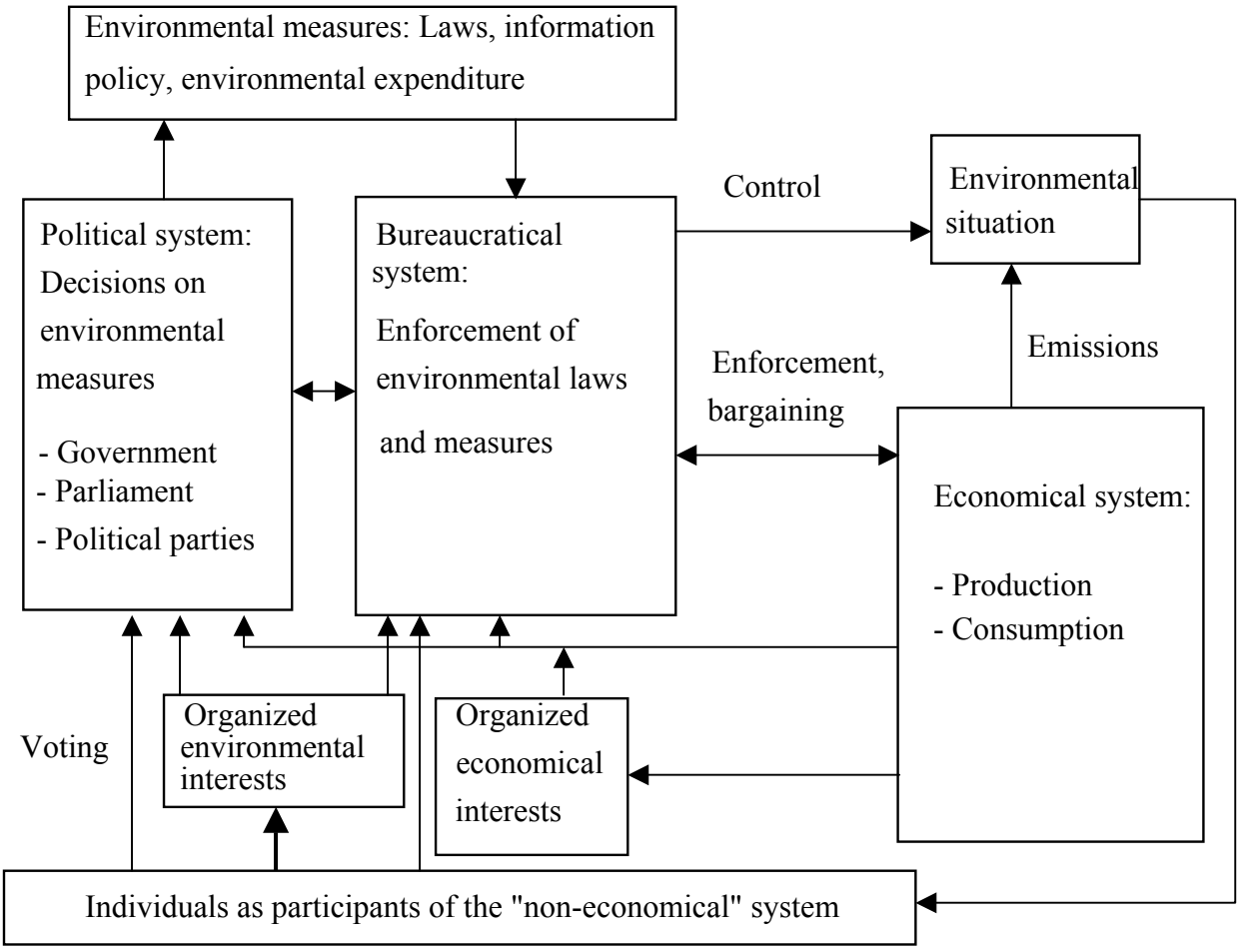
But in fact governmental measures are not completely exogenous. If we want to analyse the long-term determinants of environmental markets we have to regard the whole system of environmental policy decisions. From the point of view of the public choice theory policy decisions are dependent from the influence of voters and interest groups - an idea that is demonstrated in figure 1.

In most cases environmental pollution is caused by the so-called economic system. But individuals and enterprises are also part of the political system. Individuals can influence political decisions by their votes. The voter decisions for parties representing environmental problems do not only depend on the pollution problems of a country but also on the perception of these problems by the voters. This is a very important point because there are many severe environmental pollution problems like CO_2 emissions but only in the long run they lead to damages and therefore have little influence on voter behaviour. From this point of view the development of an environmental awareness of the voters is very important.

Another way of influencing environmental policy are interest group activities of individuals or enterprises (e.g. lobbying or financing of political parties). The intrinsic aim of interest groups consists in getting financial advantages for their group members. On the other hand a clean environment increases the utility of many individuals so that there is no incentive to become a member of an environmental interest group. This argumentation implies an asymmetry between “economic” and “environment” related interests groups in favour of the economic interests. As a consequence institutions like a ministry of environment or even the development of social customs like environmental awareness are very important for the articulation of environmental interests.

[2] See e.g. Halstrick-Schwenk/Horbach/Löbbe/Walter (1994).

Figure 1: The system of environmental policy decisions



Source: Horbach (1992).

Environmental regulation resulting from the complex political decision system represents the main driving force for the domestic demand for environmental goods and services. In the firms where the abatement equipment is implemented costs are normally raised whereas the producer firms profit from the environmental regulation. Following Porter this way of looking is too static.[3] He takes the view that the initial push of the environmental regulation creates new environmental technologies so that the concerned country will get advantages in competitiveness with respect to countries with less environmental regulations. Jaffe, Newell and Stavins state that „all of these forms of intervention have the potential for inducing or forcing some amount of technological change, because by their very nature they induce or require firms to do things they would not otherwise do"[4]. The environmental policy can reduce the social costs of environmental regulation by inducing new technologies, but this is only true when the elasticity of supply of R&D inputs is not low, otherwise the induced innovation

[3] Porter/van der Linde (1995).

must come at the expense of other forms of innovation.[5] Up to now there is no convincing proof that the so-called Porter hypothesis is empirically relevant but it can be shown that the environmental legislation in Germany has encouraged a very relevant environmental sector with a high international competitiveness.[6]

3. Employment structure of the German environmental sector

The following section gives an empirical overview of the environmental sector in Germany. The results are based on the establishment panel of the Institute for Employment Research (IAB).[7] This panel is a representative sample of all establishments in Germany. In 1999 the facilities were questioned if they offer environmental goods or services. Producers of equipment for the protection of the environment as well as suppliers of corresponding business services represent the core of the environmental industry. In a broader concept the environmental sector also comprises related services like waste management, recycling activities, treatment of contaminated soil and hazardous waste, consulting and maintenance of environment-protection equipment.

Methodological problems result from the existence of the so called integrated environmental protection measures, insufficient separation from clean products and multi-purpose products (e.g. pumps for water cleaning which can also be used for other purposes). In comparison to end-of-pipe measures integrated technologies can not be separated from the whole production process so that the "environmental part" can not be quantified.

In table 1 the results for the environmental sector are shown. Nearly 9 % of all establishments in Germany offer environmental goods and services. This does not mean that these firms only produce such goods so that the employment share (2,7 %) is much lower.[8]

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[4] Jaffe, Newell, Stavins (2002) p. 50
[5] Jaffe/Newell/Stavins (2002), p. 54-55.
[6] Halstrick-Schwenk/Horbach/Löbbe/Walter (1994).
[7] Horbach/Blien/von Hauff (2002).
[8] For methodological questions see Horbach/Blien/von Hauff (2002), p. 37-40.

Table 1: The environmental sector in Germany (1998/1999)

	Absolute Number	In % of all establishments in the panel of IAB
Number of establishments	176203	8,6
Employees (30.06.1999)	912685	2,7
	In € (milliards)	
Turnover with Environmental goods Environmental services Total environmental turnover	 25 33 58	-
Source: Horbach, Blien, von Hauff (2002).		

Besides the prevention of water and air pollution "waste disposal and recycling" represents the most important environmental sector in Germany (table 2).

Table 2: Number of establishments and employees by environmental fields in 1998

Environmental fields	Number of Establishments	Employees in environmental fields
	in %	
Prevention of water pollution, waste water treatment	12,1	18,9
Waste disposal, recycling	28,4	27,4
Prevention of air pollution, climate protection	19,4	16,3
Noise abatement	1,7	2,3
Removal of hazardous waste, soil protection	5,5	3,7
Measurement technology	6,2	6,6
Analytics, consulting	5,9	4,7
Environmental research and development	0,9	1,5
Other environmental fields	19,9	18,6
Total	100,0	100,0
Source: Horbach, Blien, von Hauff (2002).		

The high employment share of "other environmental fields" suggests a growing importance of integrated environmental technologies because this sector contains products like environmental friendly energy technologies, environmental friendly cleaning, use of rain water or solar energy.

Table 3: Employees in the environmental sector in Germany (1999) by branches

Branches	Employees	in %
Agriculture and forestry, gardening, fishery	34644	3,80
Mining, electricity, gas, water supply	28802	3,16
Chemical Industry, manufacturing of mineral oil	24316	2,66
Manufacturing of plastic and rubber products	30417	3,33
Non-metallic minerals, construction materials, glass	16408	1,80
Iron, sheet metal and metal products	15936	1,75
Steel and light metal products, railway carriage	4799	0,52
Mechanical engineering products	97051	10,63
Road vehicles, ship and airplane building	37521	4,11
Electronic engineering products	24496	2,68
Fine mechanical and optical products	8653	0,95
Wood	2742	0,30
Paper	286	0,03
Textiles	4195	0,46
Manufacturing of food	1603	0,18
Construction sector	92879	10,18
Trade	139136	15,24
Traffic and communication sector	23394	2,56
Economical and juridical consulting	1485	0,16
Architecture and laboratories	124084	13,60
Street cleaning, waste and waste water disposal	104010	11,40
Other services	18934	2,07
Associations	11340	1,24
Public administration	2092	0,23
Other sectors	63460	6,94
All sectors	912685	100
Source: Horbach, Blien, von Hauff (2002).		

A breakdown of environmental goods and services by branches shows the cross-section character of the environmental sector. Nearly all branches are producing environmental goods or services (table 3). Quantitative important branches are mechanical engineering products, the construction sector, trade, architecture and laboratories and street cleaning, waste and waste water disposal.

4. Perspectives of environmental employment in Germany

In the following the perspectives of environmental employment in Germany will be analysed by using econometric methods.

Table 4: Determinants of employment development in German establishments

a) Results of a logit analysis for 1992 to 2000

	Dependent variable: "Development of employment from 1992 to 2000" (Stagnating or falling employment from 1992 to 2000 (0) Rising employment from 1992 to 2000 (1))
Independent variables	*Coefficients, z-statistics in brackets*
Number of employees	$-8{,}6*10^{-5}$ (-1,80)*
Production of environmental goods (yes 1, no 0)	0,3259 (1,78)*
Environmental intensity (yes 1, no 0)	-0,3702 (-2,01)**
Constant	-0,5271 (-7,14)***
Number of observations	1120
Log likelihood	1449,2
Pseudo R^2	0,014

Significance levels: * < 0,10; ** < 0,05 *** < 0,01

The results of a logit analysis (table 4) based on data of the establishment panel of the Institute for Employment Research (IAB) confirm that firms producing environmental protection goods and services had a better performance with respect to other firms despite the fact that employment in environmental intensive firms[9] - the potential demanders of these goods - has declined from 1992 to 2000.

The positive trend concerning the production of environmental goods stopped at the end of the nineties. The coefficient of the respective variable is no longer significant. Concerning environmental intensive branches an opposite trend from 1998 to 2000 is observable. The employment in these branches performed better with respect to non-environmental intensive branches (see table 4b)). Besides other reasons this was mainly due to positive developments in the chemical and the iron and steel industry.

[9] In the context of this analysis branches are declared as environmental intensive if the percentage of the pollution abatement investment with respect to all investment of the considered branch was - on average - higher than 5% from 1993 to 1997.

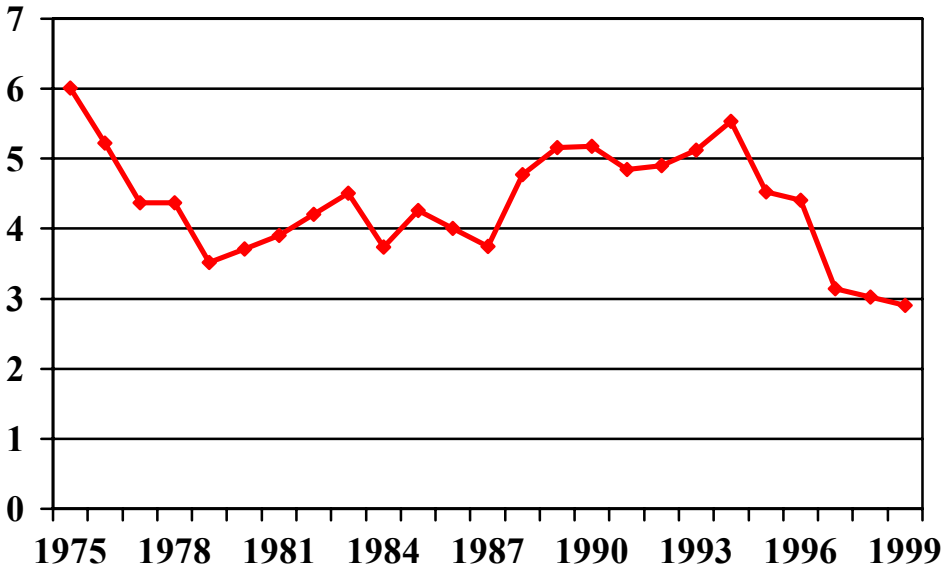
b) Results of a logit analysis for 1998 - 2000

	Dependent variable: "Development of employment from 1998 to 2000" (Stagnating or falling employment from 1998 - 2000 (0) Rising employment from 1998 - 2000 (1))
Independent variables	*Coefficients, z-statistics in brackets*
Number of employees	$-2{,}87*10^{-5}$ (-1,01)
Production of environmental goods	-0,009 (-0,11)
Environmental intensity	0,4337 (5,44)***
East or West-Germany (West 0, East 1)	-0,1767 (-3,26)***
Constant	-0,3391 (-3,8)***
Number of observations	6056
Log likelihood	7908,4
Pseudo R^2	0,01

Significance levels: * < 0,10; ** < 0,05 *** < 0,01
Source: Establishment panel of IAB, own calculations.

One explanation for the decline of the environmental sector during the last years can be found when we regard the demand for environmental goods. The share of environmental investment with respect to total investment in Germany has declined since 1994 (see figure 2).

Figure 2: Shares of environmental investment with respect to total investment in Germany - in % -



Source: Statistical office in Germany, own calculations.

It is difficult to explain this development because it is not clear if the decline of environmental investment represents a lower importance of environmental problems and concerns or a rising relevance of the so called integrated environmental measures. Environmental investment statistics can only record end-of-pipe technologies whereas integrated environmental measures are characterised by reorganizations of the production process, improved measurement and/or control methods or completely different designed production processes leading to less environmental damages.[10] For that reason it is useful to differentiate between sectors of environmental goods: It is possible that a decline of "traditional" end-of-pipe sectors like the reduction of air emissions by filters and waste water treatment will be accompanied by an increase of scientific research in environmental fields, precision engineering or measurement technologies.

Table 5: Employment structure for selected branches in the German Environmental sector from 1992 to 2001 - Employment shares in %

Branches	1992	1995	1998	2001
Agriculture and forestry, gardening, fishery	4,0	3,1	3,5	2,4
Mining, electricity, gas, water supply	6,2	9,0	4,7	8,4
Chemical Industry, manufacturing of mineral oil	2,0	1,4	2,2	7,1
Non-metallic minerals, construction materials, glass	2,6	2,2	2,5	0,8
Iron, sheet material and metal products	5,3	3,4	2,4	1,7
Steel and light metal products, railway carriage	2,1	2,1	5,3	1,5
Mechanical engineering products	11,2	7,0	8,2	2,2
Road vehicles, ship and airplane building	4,5	3,7	3,3	11,8
Electronic engineering products	3,2	3,0	3,4	3,9
Construction sector	13,1	12,7	10,1	11,4
Trade	7,9	15,2	12,0	11,2
Traffic and communication sector	6,1	5,6	4,7	3,1
Architecture and laboratories	8,5	9,5	10,6	9,8
Street cleaning, waste and waste water disposal	17,8	15,8	14,8	10,2
Other services	5,3	6,1	12,4	14,4
Total	100,0	100,0	100,0	100,0
Source: Establishment panel of IAB, own calculations.				

This hypothesis can be confirmed by regarding the sectoral structure of the environmental firms from 1992 to 2001 (table 5). These calculations show the increasing relative importance of integrated measures because of the growing employment share of „other services" from

[10] Halstrick-Schwenk/Horbach/Löbbe/Walter (1994).

1992 to 2001 with respect to declining shares of branches like “mechanical engineering products”.

In a further step the employment expectations of the firms questioned in 2001 have been analysed by dividing into different environmental sectors (table 6).

Table 6: Employment expectations from 2001 to 2005

a) All environmental sectors

	Dependent variable: “Development of employment from 2001 to 2005” (Stagnating or falling employment from 2001 - 2005 (0) Rising employment from 2001 - 2005 (1))
Independent variables	*Coeffizients, z-statistics in brackets*
Number of employees in 2001	$-7{,}8*10^{-5}$ (-1,31)
Production of environmental goods	0,0335 (0,29)
East or West-Germany	-0,1587(-1,84)*
Environmental intensity	0,2502 (2,17)**
Lack of qualified employees (yes 1, no 0)	0,7348 (8,59)***
Constant	-1,5089 (10,06)***
Number of observations	3661
Log likelihood	3558,38
Pseudo R^2	0,039

Significance levels: * < 0,10; ** < 0,05 *** < 0,01

The econometrical results of a logit analysis show that the size of the facilities is negatively correlated with an increasing employment. Furthermore the negative sign of the variable „East or West-Germany“ signifies that the new “Länder” will face a worse employment with respect to the “old Länder”.

b) Environmental research

	Dependent variable: “Development of employment from 2001 to 2005” (Stagnating or falling employment from 2001 - 2005 (0), rising employment from 2001 - 2005 (1))
Independent variables	*Coefficients, z-statistics in brackets*
Number of employees in 2001	-0,0002 (-2,81)**
Environmental research (yes 1, no 0)	0,5771 (1,75)*
East or West-Germany	-0,2214 (-2,91)**
Environmental intensity	0,3486 (3,10)**
Lack of qualified employees	0,7960 (10,50)***
Constant	-1,5307 (11,62)***
Number of observations	5111
Log likelihood	4637,86
Pseudo R^2	0,048

Significance levels: * < 0,10; ** < 0,05 *** < 0,01

Concerning the environmental sector there are no significant results for all environmental goods and services but we can observe positive signs for the respective variables in special environmental fields like environmental research (10%-significance level), measurement and control techniques (5%) and other environmental fields (10%). This result can be interpreted as an additional argument for the growing importance for integrated environmental techniques.

c) Measurement and control techniques

	Dependent variable: "Development of employment from 2001 to 2005" (Stagnating or falling employment from 2001 - 2005 (0), rising employment from 2001 - 2005 (1))
Independent variables	*Coefficients, z-statistics in brackets*
Number of employees in 2001	-0,0002 (-2,80)*
Measurement and control techniques	0,4845 (2,07)**
East or West-Germany	-0,2150 (-2,83)**
Environmental intensity	0,3487 (3,10)**
Lack of qualified employees	0,7981 (10,53)***
Constant	-1,5361 (11,72)***
Number of observations	5111
Log likelihood	4636,68
Pseudo R^2	0,048

Significance levels: * < 0,10; ** < 0,05 *** < 0,01

d) Other environmental sectors

	Dependent variable: "Development of employment from 2001 to 2005" (Stagnating or falling employment from 2001 - 2005 (0), rising employment from 2001 – 2005 (1))
Independent variables	*Coefficients, z-statistics in brackets*
Number of employees in 2001	-0,0002 (-2,82)**
Other environmental sectors	0,4103 (1,79)*
East or West-Germany	-0,2197 (-2,89)**
Environmental intensity	0,3435 (3,04)**
Lack of qualified employees	0,7978 (10,53)***
Constant	-1,5368 (11,67)***
Number of observations	5111
Log likelihood	4637,63
Pseudo R^2	0,048

Significance levels: * < 0,10; ** < 0,05 *** < 0,01

Source: Establishment panel of IAB (2002), own calculations.

Table 7: Development of employment by environmental sectors - in % -

Environmental fields	The number of employees will probably ... up to 2004			
	remain constant	increase	fall	total
Prevention of water pollution, waste water treatment	34,4	15,8	49,8	100,0
Waste disposal, recycling	66,1	19,1	14,8	100,0
Prevention of air pollution, climate protection	66,7	24,9	8,4	100,0
Noise abatement	43,6	17,9	38,5	100,0
Removal of hazardous waste, soil protection	52,2	42,6	5,2	100,0
Measurement technology	40,5	51,1	8,4	100,0
Analytics, consulting	37,6	45,6	16,8	100,0
Environmental research and development	5,4	94,6	0,0	100,0
Other environmental fields	55,8	29,4	14,8	100,0
Total	55,1	29,3	15,6	100,0
Source: Horbach, Blien, von Hauff (2002).				

The results presented in table 7 confirm this argumentation: Altogether 55,1 % of the firms expected that the production of environmental goods will remain constant. At the expense of end-of-pipe measures integrated environmental technologies will become more important. Following the results of the establishment panel employment will mainly fall in the prevention of water pollution, waste water treatment and noise abatement. The majority of firms expected a stagnation concerning the fields waste disposal, recycling, prevention of air pollution, climate protection, noise abatement and removal of hazardous waste and soil protection whereas the employment in environmental fields which can be more or less attributed to integrated technologies is mainly expected to increase.

As a consequence the measurement of environmental employment will be more and more difficult because a great part of integrated measures concern the whole production process and can not be quantified separately.

5. Innovations in the German environmental sector

In 2001 the facilities were questioned if product innovations or improvements of products had been realized. In an econometric analysis these innovation questions were used as endogenous variables to find out if the firms belonging to the environmental sector are more innovative than the other firms. The results of a logit analysis (table 8) show that this was the case from 1999 to 2001. Environmental intensive firms also realized innovations above average. These firms are on the one hand the main demanders of environmental goods and services. On the other hand especially integrated environmental techniques are often developed by the environmental firms itself together with suppliers of machinery equipment. Unfortunately the data basis contains no information about the nature of the innovation activities so that the high level of innovation activities can also attributed to innovations in environmental intensive fields leading to more emissions.

The econometric results also show a significant correlation between the size of the facilities and the level of innovation activities. From a theoretical perspective this result can be explained by scale effects of innovation expenditures.[11] Furthermore the econometric estimations show that there is no significant difference concerning the innovation activities between West- and East-Germany and that innovative firms have problems in getting qualified employees.

Table 8 a): Determinants of product innovations

	Dependent variable: "new product or service during the last two years" (yes (1), no (0))
Independent variables	*Coefficients, z-statistics in brackets*
Environmental intensity	0,3182 (2,27)**
Lack of qualified employees	0,5327 (5,01)***
East or West-Germany	0,1188 (1,10)
Production of environmental goods	0,4536 (3,49)***
Number of employees	0,0002 (3,84)***
Constant	-3,0534 (-5,68)***
Number of observations	5242
Log likelihood	2796,09
Pseudo R^2	0,03

Significance levels: * < 0,10; ** < 0,05 *** < 0,01

[11] See e.g. Frisch (1993).

Table 8 b): Improvement and further development of products

	Dependent variable: "Improvement and further development of products" (yes (1), no (0))
Independent variables	*Coefficients, z-statistics in brackets*
Environmental intensity	0,4397 (4,91)***
Lack of qualified employees	0,6676 (10,65)***
East or West-Germany	-0,0057 (-,09)
Production of environmental goods	0,2720 (3,21)***
Number of employees	0,0014 (12,15)***
Constant	-1,1251 (-0,12)***
Number of observations	5236
Log likelihood	6341,87
Pseudo R^2	0,131

Significance levels: * < 0,10; ** < 0,05 *** < 0,01
Source: Establishment panel of IAB (2002), own calculations.

Table 9 a): Product innovations - in % -

Environmental fields	„New product or service during the last two years"		
	yes	No	total
Prevention of water pollution, waste water treatment	8,1	91,9	100,00
Waste disposal, recycling	10,1	89,9	100,00
Prevention of air pollution, climate protection	6,7	93,3	100,00
Noise abatement	8,7	91,3	100,00
Removal of hazardous waste, soil protection	7,3	92,7	100,00
Measurement technology	22,0	78,0	100,00
Analytics, consulting	23,3	76,7	100,00
Environmental research and development	40,0	60,0	100,00
Other environmental fields	14,2	85,8	100,00
Total	11,4	88,6	100,00
Chi-Quadrat 23,87 (1%-significance level)			
Source: Establishment panel of IAB (2002), own calculations.			

A breakdown of the innovation activities by environmental sectors (table 9) shows that the more integrated sectors like measurement technology or analytics and consulting realize innovations above average. Contrary to that the shares of new products of the typical end-of-pipe

sectors like prevention of water pollution, waste water treatment and prevention of air pollution, climate protection are low.

Table 9b): Improvement and further development of products - in % -

Environmental fields	Improvement and further development of products during the last two years (2000 to 2001)		
	Yes	No	Total
Prevention of water pollution, waste water treatment	45,2	54,8	100,0
Waste disposal, recycling	38,9	61,1	100,0
Prevention of air pollution, climate protection	47,1	52,9	100,0
Noise abatement	34,8	65,2	100,0
Removal of hazardous waste, soil protection	32,7	67,3	100,0
Measurement technology	54,0	46,0	100,0
Analytics, consulting	63,3	36,7	100,0
Environmental research and development	50,0	50,0	100,0
Other environmental fields	39,0	61,0	100,0
Total	43,0	57,0	100,0
Chi-square: 13,75 (significance level: 10%)			

Source: Establishment panel of IAB (2002), own calculations.

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