The Austrian Environmental Technologies industry – development and determinants of employment

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Abstract

Technological innovations are regarded as one key factor in attaining sustainable development and reducing greenhouse gas emissions. In addition, respective technologies can create synergies between environmental protection and the economic targets formulated in the EU's Lisbon Strategy. The environmental technologies sector is supposed to be one of the fastest growing sectors in Europe, although empirical proof is not easily found as the cross-sectional activities including different sectoral assignments and technological fields can not be clearly identified from standard economic statistics.

The analysis described here aims at providing empirical evidence for the sector's positive development and growing importance in Austria and at highlighting the sectoral peculiarities. For Austria the production of environmental technologies and the related economic performance of firms have so far been subject of three surveys based on questionnaires. With these survey data the development of Austria's environmental technologies sector can be analysed for the period 1993 – 2003. Over the ten year period a clearly positive trend is identifiable. Employment increased from 11,000 to more than 17,000 persons. Turnover increased from 1.5 billion € to 3.8 billion €. Also, exports grew by 1 billion € between 1997 and 2003, reaching 2.5 billion €.

The relative importance of the environmental technology firms can also be illustrated by their contribution to GDP as well as their share in turnover and employment of total manufacturing. Their share in GDP rose from 1 percent (1993) to 1.7 percent (2003). Within total manufacturing they also gained in importance, the share in employment and turnover has been more than 3 percent in 2003.

Employment growth in the environmental technologies firms was higher than in manufacturing on average. In order to identify the determining factors for this positive development an econometric analysis was carried out. The estimates for various determinants of labour demand (domestic turnover, international turnover, R&D ratio) show, that a rise in turnover of 1 percent results in higher employment to the extent of 0.4 percent (domestic) to

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0.5 percent (international). The effect of an increase in R&D is smaller. However, there might be a time lag between R&D expenditures and resulting changes in employment. According to the estimation results relevant factors for the existence of positive expectations regarding employment in the firm are i. a. in-house innovation activities. The probability for an environmental technology producer to have positive employment expectations rises by 15 percentage points when innovations were developed within the firm during the past three years.

In addition, the hypothesis discussed in the literature, that environmental legislation positively affects the performance of environmental technology firms is also affirmed by the empirical results for Austria. For firms that regard legislation as one crucial determinant of technology demand the probability of positive employment expectations is higher by 17 percentage points compared to forms that do not share this view.

Within the environmental technologies industry in Austria there have been structural changes in the period between 1993 and 2003. Integrated, clean technologies have gained in importance, the role of end-of-pipe technologies has diminished. Especially the supply of clean energy technologies has increased substantially. This development reflects the Austrian producers' reaction to important issues like renewable energy and climate change. Thus, they strongly provide technologies that result in more energy and resource efficient production processes.

In addition, environmental technology firms are more innovative than other firms in manufacturing. An analysis from 2002 showed an average R&D ratio of 2.0 percent in manufacturing. In comparison, the sample of firms from the environmental technologies survey exhibit an R&D ratio of 3.5 percent. A total of 83 percent of environmental technology firms declared that they had introduced innovations in their technological area between 2000 and 2003. These firms regard innovations as major prerequisites for the opening of new markets and maintaining or improving their competitive position. The survey explicitly asked for the effects of innovations on the firms' competitiveness. About 90 percent of innovating firms experienced an improvement or even a clear improvement of competitiveness due to innovations.

Different stimuli from inside the firms or from their environment are relevant for triggering innovations. Regarding innovation incentives from outside the firm the relations with customers as well as suppliers are regarded as the most important factors, i.e. there are positive spill-over effects between specific customer requirements and the firms' innovation activities. An important role as innovation incentive is also attributed to EU legislation. This may be due to two factors: On the one hand many environmental standards are defined on EU level before they are implemented domestically. On the other hand the EU member states are still the main market for Austrian environmental technologies.

Exports in general show an increasing importance for turnover over the years analysed. In the mid 1990-ies about 50 percent of sales were exported, in 2003 exports had a share of 65

percent in turnover. According to international trade statistics, the Austrian environmental technologies industry has gained a favourable position, with market shares comparable to those of Denmark and Sweden.

1 Introduction

Environmental protection in various areas has gained increasing importance in the policy agenda during the past decades. The first major environmental movement in the 1970s was characterised by its local dimension: it aimed primarily to reduce the perceptible environmental pollution (water, air, waste), for which mainly end-of-pipe technologies were used. By the late 1980s, the publication of the *Brundtland Report* (1987) and the increased acceptance of the concept of sustainable development opened up a wider perspective on ecological problems. On the one hand, the focus was redirected from a national to a global level, and on the other hand, sustainable development attempted to integrate economic, ecological and social aspects. The restructuring of economic systems in accordance with sustainable development crucially depends on the availability of environmental technologies.

In the early stage, environmental legislation emphasised end-of-pipe technologies, however integrated technologies that aim to avoid pollution from the outset have gained in importance over time. Integrated technologies involve a shift towards production processes that have a less negative impact on the environment. But in addition to providing solutions for environmental problems or reducing ecological pressures the environmental industry is also a key economic factor in terms of employment potential, competitiveness and innovative strength. Accordingly, there has been a shift in priorities governing national environmental policy and the fact that the legal framework for environmental policies has been established at the national as well as European level. Climate change has become a topic of priority in political discussion, and there has been a shift in preferred environmental policy tools from regulatory command and control mechanisms towards economic instruments. This shift in the focus of environmental policy has been accompanied by an increase in the importance of integrated technologies, in particular that of clean energy technologies.

The subject was taken up by the European Commission. Through the implementation of the Environmental Technologies Action Plan[3] (ETAP), the European Union aims to support the growth potential of the environmental technology industry and to actively contribute to the development and diffusion of clean technologies. With its initiative, the European Commission intends to strengthen the environmental sector's potential contribution to the Lisbon strategy, thereby combining environmental policy topics with broader European policy strategies. The ETAP aims to guide innovative capacity and technological change into a direction that establishes economic structures that put less pressure on the environment, while at the same time strengthening Europe's competitiveness.

Considering that the environmental technology industry is a cross-cutting sector, it cannot be identified in conventional economic statistics. Any estimates of its growth and employment

[3] *European Commission*, 2004.

potential are thus rather difficult to make. The market for environmental goods and services consists of enterprises with a large variety of economic activities and technological competences.

2 Economic importance of the Austrian environmental technology industry

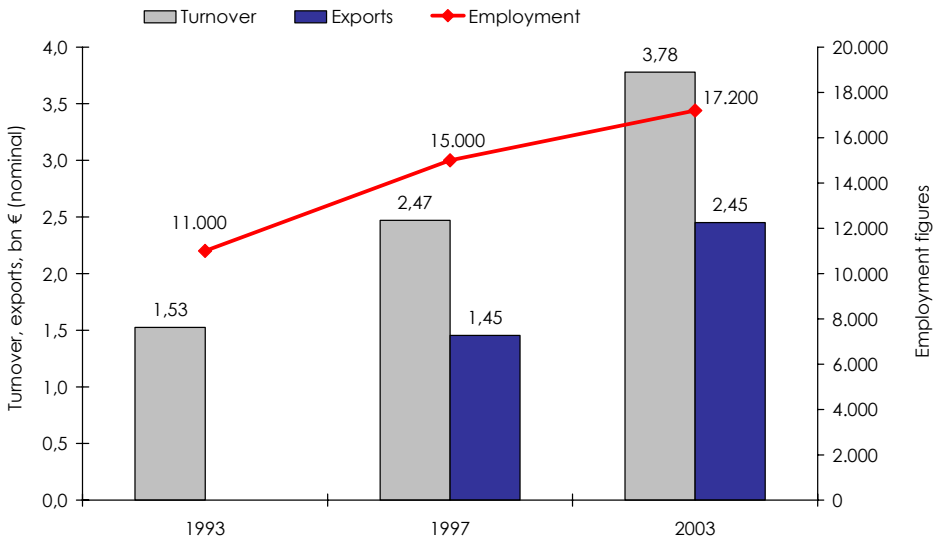
In order to gain insights on the range of environmental technologies produced in Austria as well as the economic significance of this sector the Austrian environmental technologies industry has been analysed in three studies so far (*Köppl*, 2005, 2002 und *Köppl - Pichl*, 1995). The analyses focused on the core area of : producers of clean and end-of-pipe technologies, whereas environmental services were not covered. The basis for the analyses was a survey by questionnaire, that was sent out to potential producers of environmental technologies.

With the data from the three surveys the development and importance of the sector can be illustrated for a ten year period (1993 – 2003). Fig. 1 illustrates the growth of the environmental technology industry in the period from 1993 to 2003[4]. The figure clearly demonstrates the positive development experienced by this sector. Although both turnover and export figures are given on a nominal basis, the clear positive trend over time is also reflected in employment figures. Employment increased from 11,000 to more than 17,000 persons. Turnover increased from 1.5 billion € to 3.8 billion €. Also, exports grew by 1 billion € between 1997 and 2003, reaching 2.5 billion € in 2003. Shifts can be found in the importance of production segments within the Austrian environmental technology industry (activities and environmental sectors), but there was overall steady growth (Fig. 1).

Integrated technologies play a prominent role within the Austrian environmental technology industry. In the integrated technologies segment, clean energy technologies are the most significant, contributing an estimated € 1.8 billion to turnover in the environmental technology industry and employing almost 7,500 people.

[4] Due to data restrictions, no estimates are available for exports in 1993.

Fig. 1: Development of the Austrian environmental technology industry

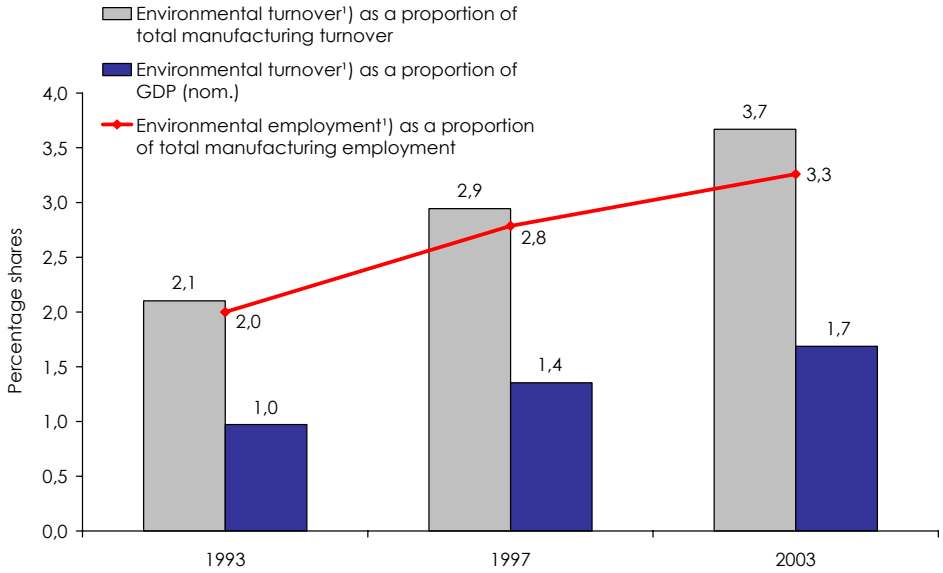


Source: WIFO surveys 1995, 2000, 2005, – estimate.

Figure 2 shows the importance of the Austrian environmental technology industry relative to total manufacturing and in terms of its contribution to GDP. In the decade between 1993 and 2003, the importance of the environmental technology industry constantly increased. In 1993, its share of manufacturing turnover had reached 2.1 percent, by 1997 it had risen to 2.9 percent, and by 2003 it had added another 0.8 percentage points to reach 3.7 percent. In terms of employment, the environmental technology industry held a share of 2 percent in 1993, which it increased by almost one percentage point by 1997. By 2003, its share of manufacturing employment was 3.3 percent.

The situation is similarly positive when it comes to the environmental technology industry's contribution to GDP. Its share of nominal GDP was 1 percent in 1993, rose to 1.4 percent by 1997, and reached 1.7 percent by 2003. Thus, the environmental technologies industry can be regarded as a genuine growth sector in Austria. In addition, this trend is likely to continue as the producers of environmental technologies have largely positive expectations regarding their future development. Almost 50 percent of respondents expect their turnover in the EU15 to increase significantly over the next years. Expectations for sales in other European countries are even greater, totalling 60 percent.

Fig. 2: Relative importance of the Austrian environmental technology industry, 1993 - 2003

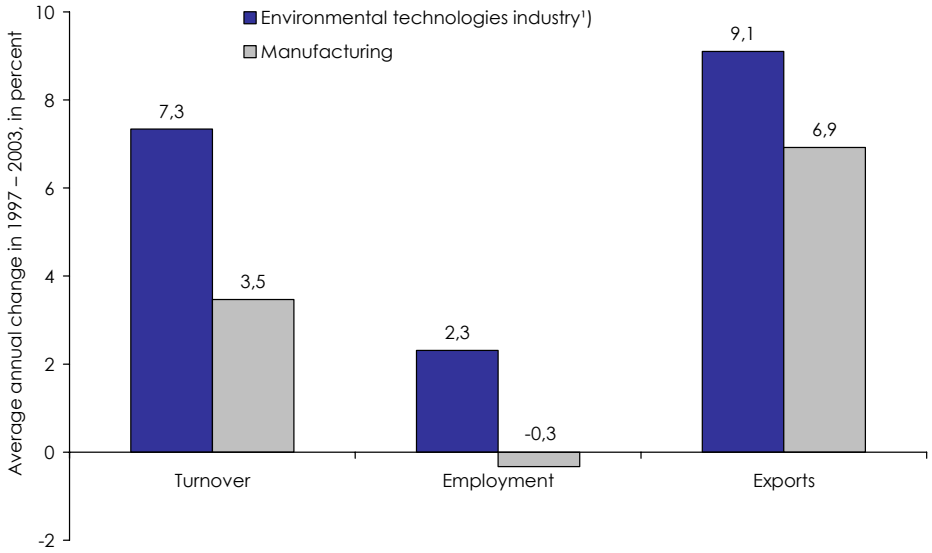


Source: WIFO surveys 1995, 2000, 2005, WIFO calculations, Statistics Austria: economic statistics, Austrian foreign trade database. - ¹) estimate.

Comparing the changes in turnover, exports and employment figures for the period 1997 to 2003 in the environmental technology industry and in total manufacturing, the outstanding performance achieved by the former becomes obvious. During this period, the environmental industry showed higher growth rates for all three parameters than did total manufacturing. While the environmental industry achieved an annual average growth rate of 7.3 percent, manufacturing grew by 3.5 percent.[5] With regard to exports, the environmental technology industry also achieved higher growth rates (9.1 percent), although the difference to manufacturing (6.9 percent) was smaller than in the case of turnover. With regard to employment, total manufacturing experienced a decline of 0.3 percent per year during the period from 1997 to 2003, while the environmental technology industry increased its employment by 2.3 percent p. a. on average (Fig. 4).

[5] The reference parameter for manufacturing is production sold (Statistics Austria, economic survey). Turnover figures for 1993 are not available from the official statistics.

Fig. 4: Economic indicators – annual growth rates in 1997 – 2003



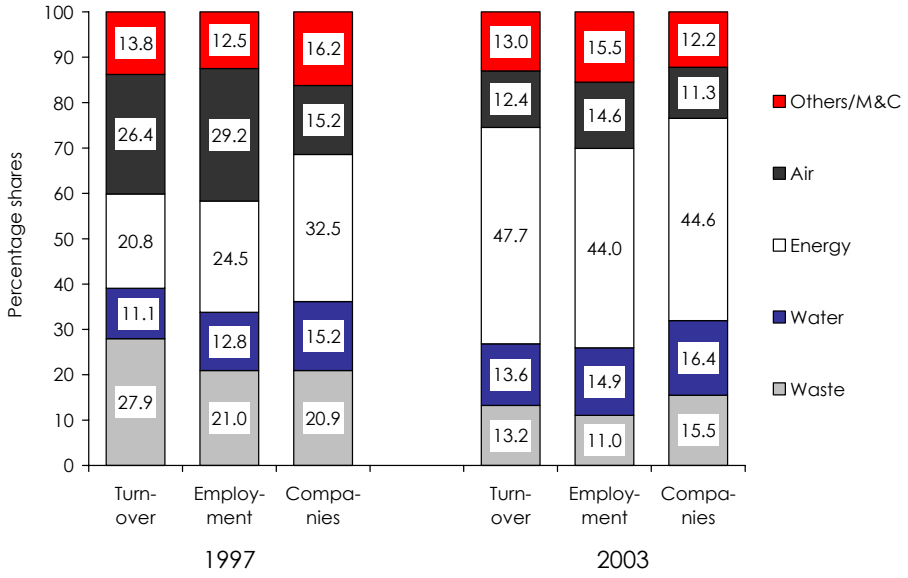
Source: WIFO surveys 2000, 2005, WIFO calculations, Statistics Austria: economic statistics, Austrian foreign trade database. - [1]) estimate.

3 Characteristics of the Austrian environmental technology industry

Over time there have been shifts in the environmental technology industry, concerning technologies produced as well as environmental areas. Broken down by environmental activities, the Austrian environmental technology industry has moved away from its focus on end-of-pipe technologies, the core of environmental industry, and towards integrated technologies. In both 1993 and 1997, end-of-pipe technologies made up 44 percent of turnover; however their contribution was down to a third by 2003. Integrated technologies contributed 54 percent to turnover in 2003, whereas 11 percent of the turnover derives from measurement and control technology and environmental monitoring. In the integrated technologies segment, energy technologies have assumed a leading position. The company sample shows 48 percent of the turnover obtained through clean energy technologies, with cogeneration plants and systems engineering (plant optimisation) as the major technologies.

This structural shift towards clean and energy technologies indicates that Austrian producers of environmental technologies have reacted to issues and political discussions like climate change, sustainable development and initiatives to raise the share of green electricity. Fig. 5 demonstrates the shift in shares of various technology areas between 1997 and 2003.

Figure 5: Technology areas in the Austrian environmental technology industy: shares in turnover, employment and firms



Source: Köppl (2005), WIFO-calculations.

The link between the level of economic development and the technological position of a country has been emphasised in economic policy discussions for many years. Expenditure on R&D and innovations are crucial for a country like Austria, which cannot compete with low costs at an international level but needs to ensure its competitive position through producing high quality technologies. The expenditures on R&D and innovation activities of an economy – or, at the microeconomic level, of a company – are key factors for ensuring growth and a dynamic economic performance.

The environmental technology producers covered in the sample are shown to be more innovative than the average of manufacturing. R&D expenditures in 2003 amounted to 3.5 percent of turnover[6] (compared to an R&D spending of 2.0 percent for manufacturing in 2002, based on figures provided by *Statistics Austria*). Differentiating by activities, the average R&D expenditure of producers of end-of-pipe technologies (4.0 percent) is slightly above the average for producers of clean technologies (3.7 percent). Broken down by environmental areas, companies producing waste disposal technologies are shown to be very research-intensive (achieving R&D expenditures of 6.7 percent), followed by companies producing air pollution control technologies (4.3 percent). In total, 83 percent of the environmental technology producers reported having introduced innovations in their product segment

[6] This value results from all firms in the sample, irrespective of whether they produce only environmental technologies or other products as well. R&D expenditures are significantly higher at 5.6 percent in 2003 when there is an exclusive concentration on environmental technologies production. In this case, the percentage of R&D spending only considers expenditure for R&D on environmental technologies for "mixed" companies.

between the years 2000 and 2003. Environmental technology producers regard innovations as an important prerequisite for the opening of new markets and for securing their competitiveness. The increasing importance of international markets is also reflected in a rising share of innovations that represent a novelty on the global market. In 1997 the share was 60 percent compared to 75 percent in 2003.

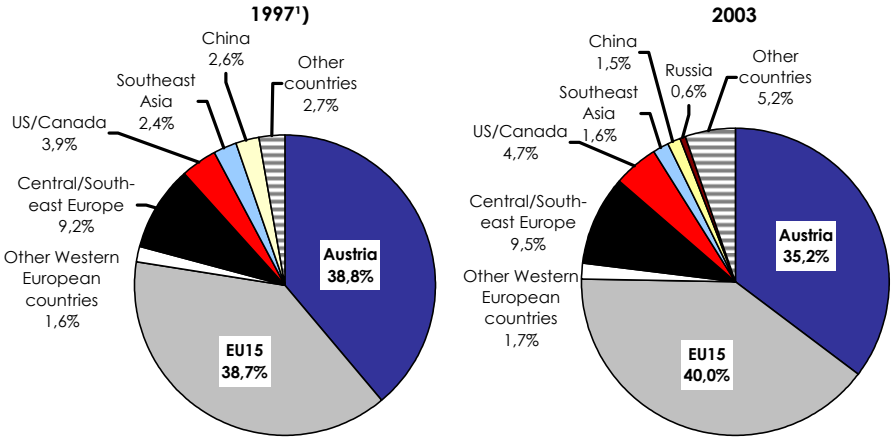
R&D and innovation ultimately aim to defend and improve a company's competitive position internationally. The survey specifically asked about the effects of innovations on the companies' competitiveness. More than a third of the innovating firms reported that their competitive position had clearly improved as a result of their innovation. For half the companies, the innovation contributed to an improvement of their competitive position, and only 10 percent stated that their innovation activity did not result in any change.

International markets are of increasing importance for the Austrian environmental technology industry, which is reflected in the development of exports over time. In the mid 1990s, about 50 percent of environmental technologies were sold on the Austrian market and the rest were exported. By 1997, the share of exports in turnover had risen to over 60 percent. By 2003 the share reached 65 percent. This value corresponds to total manufacturing's export share. The environmental technology industry thereby mirrors the dimensions of manufacturing in terms of increased internationalisation and exports over time.

When analysing export revenues by countries, a strong focus on the EU 15 can be identified (Fig. 6). Forty percent of the total turnover generated by the Austrian environmental technology industry was obtained in the EU15. The German market alone generated 22 percent of the turnover of Austrian companies. The share of sales in Central and Southeastern Europe (9 percent) remained constant relative to 1997. The US and Canada, key markets for environmental technologies world-wide, contribute 4.7 percent to the turnover of the companies in the sample.

The Austrian environmental technology industry has thus gained a good competitive position on international markets. For coming years it can be expected, that new markets (e.g. China, India) emerge and gain in importance. However, competition in these markets is likely to increase as well. Given this challenge, ongoing research and innovation activities of the industry will be necessary in order to ensure a comparable future development of turnover and exports.

Fig. 11: Markets for Austrian environmental technologies, 1997 and 2003



[1]) *Köppl*, 2000.
Source: Köppl (2005).

4 Determining factors for employment and employment expectations in the environmental technologies industry

The environmental technologies industry's growth and employment potential is to a large extent determined by exogenous factors, stemming from economic and environmental policies. One major factor, as resulting from the surveys, is legislation *(ECOTEC, 1999, 2002; US Department of Commerce, 1998; Köppl - Pichl, 1995, 1997; Köppl, 2000, 2005)*. The effect of environmental regulation on competitiveness can be assessed from two perspectives[7]: on the one hand regulation increases demand for environmental technologies and services on the domestic market. On the other hand there can be first mover advantages on foreign markets for technology producers if other countries follow in implementing tighter environmental standards and demand for respective technologies also increases. Thus, firms that have developed solutions early on for the domestic market are in a favourable position for exporting their technologies due to lower production costs and previous learning effects.

Econometric analyses regarding the environmental technology industry's labour demand cannot directly measure the effect of regulation. Assuming, however, that the regulatory framework represents a determining factor for domestic sales and exports, the development of domestic and foreign markets covers this aspect indirectly. The model regarding the

[7] *Porter - van der Linde* (1995). *Jaffe - Newell - Stavins, (2002)* emphasize that the kind of environmental regulation also has an influence on technological developments and technology diffusion.

determining factors for employment expectations, presented in the following paragraphs, thus implicitly includes the influence of legislation in the EU.

As described above, the Austrian environmental technology industry exhibits an increasing export orientation over time. It can therefore be assumed that employment is not only determined by the domestic sales potential but also by the development of foreign demand. A second relevant factor for rising turnover, that is tested using the survey data, is the R&D ratio of the environmental technology industry.

These two aspects are chosen because they are discussed in the literature as relevant determinants for an industry's employment demand. There are, however, ambivalent empirical results regarding the effects of foreign trade *(Landesmann, 2001; Yun, 2005; Greenaway - Hine - Wright, 1999)*: labour demand varies depending on whether demand is met by imports or through increases in productivity of domestic firms. The effects of innovation activities on employment also differ. Labour demand seems to increase more frequently as a result of product innovations than of process innovations.

Based on the approaches discussed in literature, an econometric model for labour demand in the environmental technology industry was developed. In this model labour demand depends on domestic and foreign sales of environmental technologies as well as on environment related R&D (see equations (1a) and (1b)[8]).

(1a) $$\ln L_{it} = \alpha + \beta_{1it} \ln UI_{it} + \beta_{2it} \ln E_{it} + \beta_{3it} \ln F_{it}/U_{it} + \varepsilon$$

(1b) $$\ln L_{it} = \alpha_i + \beta_{1it} \ln UI_{it} + \beta_{2it} \ln E_{it} + \beta_{3it} \ln F_{it}/U_{it} + \varepsilon_i$$ (Fixed effects model)

L_{it}:	Average annual employment
UI_{it}:	Domestic environmental sales
E_{it}:	Environmental exports
F_{it}/U_{it}:	Environment related R&D ratio = R&D expenditure/ environmental sales
i:	Index of firms
t:	2000, 2003
α:	Constant
β:	Elasticities
ε:	Error term

For the estimates data fort two years (2000 and 2003) are available. Equation (1a) is applied to the whole survey dataset (113 firms). For the fixed effects model (equation 1b) only those

[8] For other analyses regarding environmental innovations and employment see *Frondel - Hobach - Rennings*, 2004; *Horbach*, 2003; *Ziegler - Rennings*, 2004.

firms are chosen, for which all the variables are available for both years (70 firms). Thus, effects on the coefficients due to differing numbers of firms in the two years are avoided. However, the dynamics in the environmental technologies industry, i.e. market entries and exits cannot be captured with this approach.

Given a logarithmic OLS estimate the resulting coefficients can be interpreted as elasticities. The estimation results for model (1a) show, that an increase in domestic sales by 1 percent leads to a rise in employment in the environmental technologies industry by 0.4 percent (Table 1). An increase in export sales by 1 percent raises employment by 0.5 percent. The effects of environment related R&D are clearly lower and less significant (0.1 percent). The reason for this could be a time lag between R&D expenditure and increases in employment resulting from innovations. As R&D expenditures in previous years were not included in the survey data, the effect of past R&D on employment cannot be analysed.

The elasticities of labour demand in the fixed effects model in comparison are slightly lower. Here, a 1 percent increase in domestic sales raises employment by 0.1 percent, the effects of an increase in exports are higher (0.3 percent). The R&D ratio affects labour demand by 0.1 percent.

Table 1: Labour demand in the Austrian environmetnal technology industry

	OLS-estimates without firm effects			"Fixed effects model"		
	coefficients	*t*-value		coefficients	*t*-value	
Domestic environmental sales	0,3896	7,62	***	0,1259	2,21	**
Environmental exports	0,4689	12,11	***	0,3093	7,62	***
Environmental R&D ratio	0,1003	1,64	*	0,1220	1,74	*
Constant	3,1120	16,69	***	3,4659	17,71	***
Number of firms		113			70	
		R^2 = 0,8286			R^2 within = 0,6802	
					R^2 between = 0,7829	
					R^2 overall = 0,8008	

Source: WIFO-survey 2005, WIFO-calculations. – Significance levels: * 10 percent, ** 5 percent, *** 1 percent.

In addition to the estimates regarding the elasticities of labour demand also those factors were identified that affect the firms' employment expectations, i.e. the expectation that the firm's number of employed will increase over the next three years. Especially, it was analysed whether the prospects regarding the development of various markets (domestic, EU 15, rest of Europe) affect the employment expectations differently. Not only various market expectations but also different product segments (clean technologies, end-of-pipe technologies, measurement and control technologies) were taken into account.

In general, the increasing internationalisation of the industry as well as the stronger focus on clean technologies provides a favourable basis for further growth potential and positive employment expectations for the Austrian environmental technologies industry.

In the empirical model the following factors that potentially affect employment expectations were taken into account:

- In-house innovation activities: compared to total manufacturing the environmental technologies industry carries out more innovation activities than firms on average. The share of innovating firms was 44 percent[9] in the year 2000 in manufacturing (according to the Community Innovation Survey III). In comparison the share of the environmental technologies industry was 83 percent of innovating firms. Innovations are developed either in-house or in cooperation with other firms, research institutes or the parent enterprise. In our analysis we assessed whether in-house innovations have a stronger effect on employment expectations.
- Firms of different sizes also vary in terms of their respective employment dynamics. Especially when active on international markets firm size may be a determining factor for employment expectations.
- The environmental technologies market exhibits an increasing shift from end-of-pipe to clean technologies. It is also analysed whether producers of clean technologies have more positive employment expectations than producers of end-of-pipe technologies. The respective equation also includes sales prospects for various market segments.
- The importance of the prevailing regulatory framework for the environmental technologies industry was already discussed above. In the model EU legislation is included as one determining factor for demand.

The empirical estimates regarding the determinants of employment expectations were calculated using a Probit model that is described in equation (2). In order to interpret the model's coefficients marginal effects were estimated. The coefficients represent a change in probabilities resulting from a change in the independent Dummy variables.

(2) $$L^e = \alpha + \beta_1 G + \beta_2 I + \beta_{3k} UG_k + \beta_{4ij} S_{ij} + \varepsilon$$

[9] *Falk - Leo*, 2004.

L^e:	employment expectations	$L^e = 1$	Increasing employment
		$L^e = 0$	Constant or decreasing employment
G:	Importance of EU legislation as determining factor for demand (Dummy variable)		
I:	In-house innovation activities (Dummy variable)		
UG_k:	Sales size ranges (Dummy variable) k = small enterprises (-2 mill. € turnover), medium sized enterprises (> 2 - 10 mill. €), large enterprises (> 10 mill. €)		
S_{ij}:	Development of market segments (Dummy variable) i = domestic, EU 15, rest of Europe		
	j = clean technologies, end-of-pipe technologies, control and measurement technologies		
α:	Constant		
β:	Marginal effects		
ε:	Error term		

Three types of the model have been applied. In the first one employment expectations depend on sales prospects for the various technology areas on the domestic market. In the other two the sales prospects in the EU and the rest of Europe respectively were chosen as the determining variable.

The estimation results (Table 2) show that in-house innovation activities have a significant positive effect on environmental technology producers' employment expectations. The probability that a firm expects an increase in its number of employed rises by 15 percentage points, if it had carried out in-house innovations during the past three years.

Medium sized firms also have a higher probability (22 percentage points) for positive employment expectations. Positive sales prospects on the domestic market are highly significant for all kinds of technologies. The probability for expecting higher employment is highest if the firm produces clean technologies and expects increasing demand (41 percentage points). But also for end-of-pipe and control and measurement technologies the effect on the probability of positive employment expectations is significant (30 percentage points).

The empirical results also show that the probability for positive employment expectations is 17 percentage points higher for firms that regard legislation as one major driver for demand. This result supports the hypothesis of interrelations between environmental legislation and a favourable development of the environmental technologies industry.

When analysing the effects of market prospects in the EU and the rest of Europe only the differentiation for technology areas is significant for explaining changes in probabilities for positive employment expectations.

Table 2: Employment expectations in the Austrian environmental technology industry

	Equation A			Equation B			Equation C		
	Market expectations								
	Domestic			EU 15			Rest of Europe		
	marginal effects	*z*-value		marginal effects	*z*-value		marginal effects	*z*-value	
EU legislation as demand driver	0,1691	2,17	**	0,0811	1,06	–	0,0769	0,98	–
In-house innovation activities	0,1546	1,89	*	0,0114	0,13	–	0,1216	1,47	–
Size range – Medium sized firm	0,2218	2,64	***	0,1099	1,26	–	0,0968	1,07	–
Size range– Large firm	0,0349	0,33	–	–0,0829	–0,81	–	–0,1463	–1,38	–
Market expectations – Clean technologies	0,4084	4,85	***	0,3818	3,97	***	0,3350	2,85	***
Market expectations – End-of-pipe technologies	0,2975	3,65	***						
Market expectations – Measurement & control technologies	0,2932	3,08	***						
Market expectations – End-of-pipe and measurement & control				0,2682	2,94	***	0,2347	2,05	**
Number of firms	163			136			121		
Pseudo R^2	0,2184			0,1556			0,1191		

Source: WIFO-survey 2005, WIFO-calculations. – Significance levels: * 10 percent, ** 5 percent, *** 1 percent.

5 Conclusions

Technological developments are regarded as crucial for reducing environmental problems, either as end-of-pipe solutions that remove emissions to water, air or soil or as integrated technologies that avoid or reduce environmental pressures from the outset. The latter option is especially relevant in terms of climate change, energy efficiency, and a restructuring of economic systems in accordance with the concept of sustainable development. In addition, the economic relevance of environmental technologies is increasingly emphasized. This sector is assumed to have a high potential for contributing to growth and employment. The economic development of the environmental technologies industry is however difficult to assess as it is a cross-cutting area including firms from different sectors and with a wide range of technological competences. For Austria the performance and structure of environmental technology producers has been analysed by three surveys over a ten year period (1993 – 2003). The results show a very dynamic development with regard to turnover, employment and exports as well as an increasing shift from end-of-pipe solutions towards integrated, clean technologies. In the period analysed turnover more than doubled (from 1.5 billion € in 1993 to 3.8 billion € in 2003) and employment rose from 11.000 to 17.000 persons. Also, the ongoing internationalisation of the sector is reflected by an increasing share of exports in turnover. The environmental technology industry's development as compared to total manufacturing has been more favourable, with higher growth rates in all three parameters. In addition, the

sector is shown to be more innovative (measured by the share of R&D expenditures in turnover) than firms in manufacturing on average.

The paper attempts to analyse the factors determining the positive development in employment in the Austrian environmental technology industry. Relevant determinants for labour demand are domestic sales and exports. A lesser effect is generated by R&D expenditures, although there probably is a time lag between engaging in research activities and resulting increases in employment due to the marketing of new technologies.

Likewise the firms' prospects for sales on the domestic and foreign markets, in-house R&D activities and environmental legislation are identified as affecting the expectations regarding an increase in employment in the future.

These results endorse on the one hand the hypothesis that regulation is a major driver for demand for environmental technologies and thus for exploiting the sector's growth potential. On the other hand they reflect the growing importance of international market for Austria's environmental technology producers. In order to continue the positive trend depicted in the survey data and ensure the sector's competitive position internationally it will, however, be necessary to maintain or even enlarge research and innovation activities.

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