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by

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Abstract

We use data on Austrian firms and employees to estimate the effects of employer-provided training on productivity, wages, and the inequality of wages within firms. While the average amount spent on employer-provided training is low in general, we find a robust positive elasticity of training on productivity of about 0.04. In-house training is more effective than external courses, and language, administrative and personal skills courses are more effective than sales training and IT-courses. We find a significant relationship between training and wages, the coefficient is about 0.05. We find no significant effect of training on the inequality of wages within firms.

JEL Classification: D21, J24

Keywords: employer-provided training, productivity, wages

1 Introduction

Human capital is one of the key determinants of economic growth. In Table 1, economic development in Austria between 1990 and 2004 is summarized (reproduced from Pender et al., 2007, p37). The numbers show that a large part, about one quarter, of the average yearly growth rate of 2.4% of GDP is due to technological progress. In addition, increased human capital, the "quality" of labour, contributes positively to economic growth. Further, if the amount of human capital is related to a person's chances on the labour market—which appears to be a reasonable assumption—, then training and human capital are also related to labour supply. The expansion of hours worked, the "quantity of labour" did also contribute to economic growth between 1990 and 2004.

Table 1: Economic growth in Austria, 1990-2004.

	Average yearly growth rate			
	1990/2004	1990/1995	1996/2000	2001/2004
Economic growth, real in % of GDP	2,38	2,62	2,83	1,46
Components:				
Capital	1,33	1,33	1,36	1,29
Of which				
Quantity	0,96	1,02	1,08	0,71
Quality	0,37	0,31	0,27	0,58
Labour	0,46	0,28	0,80	0,31
Of which				
Quantity	0,20	0,02	0,48	0,10
Quality	0,27	0,26	0,32	0,21
Technological Progress	0,59	1,01	0,68	-0,15

Source: Peneder et al. (2007), p.37.

According to the Continuing Vocational Training Survey (CVTS) of 1999 (Statistik Austria, 2001), about 72% of workplaces with at least 10 employees trained their workers. In 2005,

about 81% of workplaces trained their workers. The fraction of workers who attended employer-provided training was some 31% in 1999 and 33% in 2005. These workers were trained for about 29 (27) hours in 1999 (2005). According to the survey, employer-provided training cost some €723 million in 1999, of which about 60% were direct training costs. Indirect costs, i.e., opportunity costs from spending time in training rather than working, made up the remaining 40%. In 2005, this number was about €594 million with about 56% direct training costs.

These figures underline that employer-provided training is common and involves serious amounts of money. Our aim is the evaluation of this investment, for both employers and employees—how much does productivity increase due to employer provided training, and how much do workers benefit from attending such courses?

There are few studies that empirically investigate the relationship between employer-provided training and productivity, mostly due to a serious lack of data. Most of these studies find indeed evidence for a positive, in cases even a statistically significant association between training and productivity. However, as the availability of data is limited, most of these analyses are cross-sectional and the problem of unobserved heterogeneity is insufficiently solved.

In one of the first empirical works on this topic, Bartel (1994) found that US-firms which introduced training programmes in response to low productivity enjoyed subsequently a significant increase in productivity. The estimated return to these programmes was about 0.4%

Zwick (2002), using German data for 1997 to 2000, showed that training is positively related to productivity, even two years after the training. The relationship is stronger, the more intensive the training was. The estimated return was about 0.4%, i.e., increasing the number of

employees who receive training by one percentage point is estimated to increase overall productivity by 0.4%.

Dearden, Reed and Van Reenen (2006), using British data, also find a statistically significant association between training and productivity. In addition, they find that wages are also higher in workplaces where workers are trained, indicating that some of the productivity gains from training also accrue to workers.

2 Theoretical Background

The association between a firm's output and the inputs can be shown in a production function, typically a Cobb-Douglas specification is used (Bartel, 1995; Dearden et al., 2000). A simple production function that relates training with output Y for each firm i is:

$$Y_i = A_i K_i^{\beta} (LU_i + \tau LT_i)^{\gamma}, \quad (1)$$

where A is a (Hicks-neutral) parameter of efficiency, LU and LT indicate the numbers of untrained and trained workers and τ describes the productivity gain from training (it is greater than one if training is productivity-enhancing). β and γ are the shares of capital and labour in the production process and it is typically assumed that $\beta+\gamma=1$.

Rearranging the formula, the production function can be expressed as:

$$Y_i = A_i K_i^{\beta} L_i^{\gamma} (1 + (\tau-1) T_i)^{\gamma}, \quad (2)$$

where T denotes the intensity of training in firm I, $LT/(LU+LT)$. Taking logs and using $ln(1+x) \approx x$, for small values of x yields the following expression:

$$ln Y_i = ln A_i + \beta ln K_i + \gamma ln L_i + \gamma(\tau-1) T_i. \quad (3)$$

Under the assumption that workers who are trained are more productive than those who are not, $\gamma(\tau\text{-}1)$ is expected to be greater than 0. Reformulating equation (3) provides an expression that can be estimated on a random sample of firms:

$$\ln Y_i = \alpha + \beta X_i + \theta T_i + \varepsilon_i, \qquad (4)$$

where α is the intercept of the log-linear equation, X is a vector of firm characteristics, T is an indicator of training intensity, ε is the error-term and θ is the parameter of interest. This equation can be estimated using standard econometric methods and a statistically significant value for $\theta > 0$ indicates a positive relationship between training intensity and a firm's productivity

A causal interpretation, i.e., training *causes* productivity, can only be established beyond doubt, if training is not correlated with the unobserved factors captured in ε. A positive value for θ could also arise from selection bias, if firms whose unobserved characteristics are associated with higher productivity invest more in training than firms whose unobserved characteristics are associated with lower productivity. Such a biased estimate measures not only the association between training and productivity, but also the firms' differences in unobserved productivity. Alternatively, inverse causality may prevent a causal interpretation. Inverse causality is present, if more productive firms invest more in training because they have the money to do so—a positive coefficient would then indicate the positive impact of productivity on training.

One method to limit a selection bias is the use of panel data, where the firms are observed at (at least) two points in time. Equation (4) can then be modified to account for repeated observations on the same firms:

$$\ln Y_{it} = \alpha + \beta X_{it} + \theta T_{it} + \varepsilon_i + u_{it}, \quad (5)$$

where t indexes time. The error term can be separated into a firm-specific time-invariant component (ε_i) and an idiosyncratic part (u_{it}). The firm-specific component can be eliminated from the equation by employing firm fixed-effects and the coefficient on training can be estimated consistently as long as T_{it} does not correlate with u_{it} .

3 Data

Since there is no single source of data available to address our research questions, we use several different surveys to construct samples which allow an empirical evaluation of the relationship between training and productivity as well as training and wages. The data sources are surveys on training, business statistics and labour costs. The data were combined by the Austrian Statistical Office, using their database on Austrian businesses.[1]

3.1 Productivity

This part of our analyses is based on the Continuing Vocational Training Surveys (CVTS), 1999 and 2005. The CVTS surveyed a representative sample of businesses with 10 or more employees in the production and service sectors (NACE codes C-K and O) on their employer-provided training. The samples were drawn, stratified by industry classifications and firm size, from the Statistical Offices' firm register (Statistik Austria, 2003). Since the samples were drawn independently, only a small number of firms were surveyed in both years.

We augment the information from the CVTS with information from the Surveys on Structural Business Statistics (SSBS), 1999 to 2005. The SSBS is an annual survey of businesses with at

[1] For reasons of anonymity, all data analyses were undertaken by the Statistical Offices.

least 20 employees in the production and service sectors (NACE codes C-K) and was first conducted in 1997 (Statistik Austria, 2001a). This survey is also based on a stratified random sample (sectors and firm size) and one part of the sample is replaced each year. The advantage of the SSBS is the availability of information that allows the calculation of the gross value added, which we use as our indicator of productivity. In addition, the SSBS contain detailed information on other production factors, such as the structure of the workforce (e.g., distribution of men and women, blue- and white-collar workers) and on capital investments.

We selected all businesses that were surveyed in the CVTS and were also surveyed in the SSBS of the corresponding year.[2] Overall, 3,351 businesses were surveyed in the SSBS and the CVTS (1,955 in 1999 and 1,396 in 2005). After elimination of one observation with missing information the sample consists of 3,350 observations.

To analyse the robustness of our results, we also identify 203 businesses that were surveyed in both years. This sample is used for firm-fixed-effects panel regressions. In addition, we matched 1,739 businesses from the SSBS 2000 with information from the 1999 CVTS to investigate whether training has long-lasting or lagged effects on productivity. See table 2 for a summary of our samples.

Our indicator of a firm's productivity is gross added value at factor costs (Black und Lynch, 2001), which was calculated from the information contained in the SSBS.[3] Productivity is measured at the actual number of working hours, i.e., actual working hours minus hours in

[2] All observations were weighted to obtain a sample representative for the distribution in size and across the economic sectors of the underlying universe of businesses.
[3] Gross added value (at factor costs) measures the output of a firm by turnover minus input costs, plus net transfers (subsidies minus taxes).

training, to obtain a precise indicator of productivity. All monetary values were deflated to 2005 prices using the harmonised consumer price index.[4]

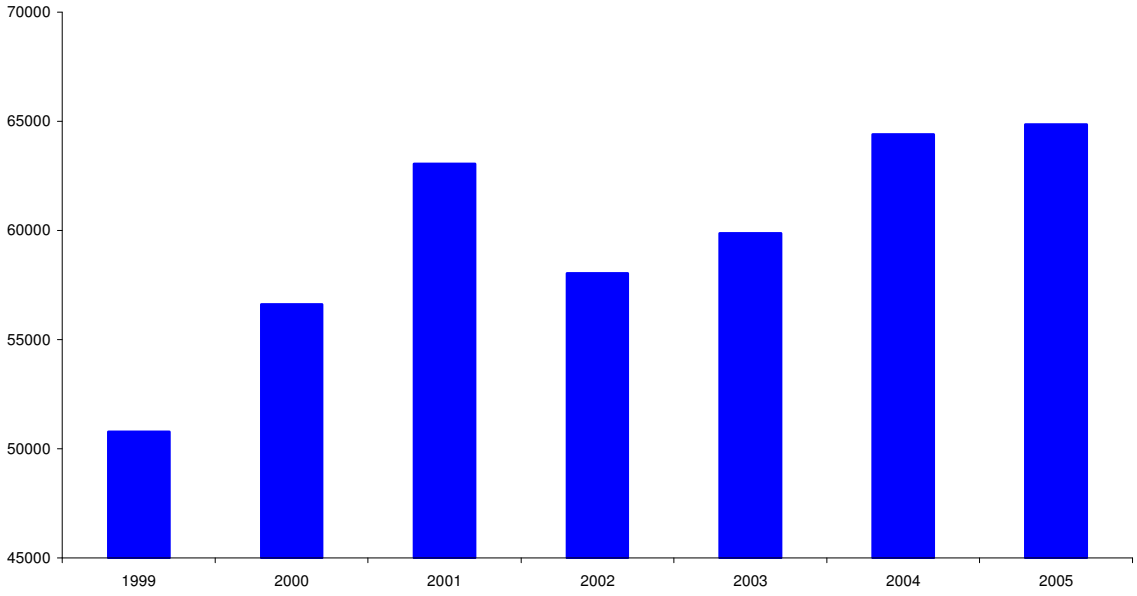
Table 2: Overview on samples.

CVTS 1999	Number of observations	2,612	
	Of which in SSBS 1999		1,955
CVTS 2005	Number of observations	1,456	
	Of which in SSBS 2005		1,396
	Observations with missing information		1
Pooled			**3,350**
Panel	203 businesses in both cross-sections		**406**
CVTS 1999	Number of observations	2,612	
	Of which in SSBS 2000		1,739
Lagged			**1,739**

Figure 1 provides an overview on the average gross value added per employee for the years 1999 to 2005. We see that productivity increased throughout this period. In 1999 it amounted to about €51,800 and to about €65,000 in 2005.

[4] Gross value added should be deflated using a production price index; however, in Austria such an index is not available for the service sector.

Figure 1: Average gross value added per worker, 1999-2005.



Note: Prices of 2005 (HCPI 1996). SSBS, 1999 to 2005 (Statistik Austria, corresponding years).

The CVTS contain several indicators on employer-provided training. We distinguish between those that provide information on the intensity of the training and those on the quality of the training. In table 3 we provide a description of the used variables and some summary statistics.

Table 3: Description of variables.

Variable	*Description*	*Mean*	*SD*
Dependent Variables			
Value added per hour	Gross value added at factor costs per actual working hour	28.04	105.75
Value added per worker	Gross value added at factor cost per worker	47,707.31	165,335.54
Training			
Costs	Costs for training per employed worker, net of subsidies	145.09	1.062.32
Hours	Number of hours in training per employed worker	5.52	42.70
Fraction of . . . training (from total training hours)			
Languages	Foreign and national languages	0.04	
Marketing	Marketing and sales training	0.16	
Administration	Admin, accounting, finances, management and office	0.10	
Personal skills	Cooperation, interview training, et cet.	0.10	
IT	Computer skills	0.16	
Technical	Technical issues and production	0.24	
Other	E.g., environmental aspects, health and safety, …	0.20	
In-house hours	Number of training hours provided in-house per employed worker	1.77	21.44
External hours	Number of training hours provided by external training per employed worker	3.76	34.92
Fraction of external hours at the following institutions (from total number of training hours)			
Institutions	Public training institutions operated by Trade Unions, Chamber of Commerce, Chamber of Labour, Adult Learning Centres	0.40	
Business	Associated businesses, such as producers, suppliers, or parent company	0.20	
Schools	Public or private schools, universities	0.00	
Private	Private training institutions	0.30	
Other		0.10	
Workforce			
Employees	Number of employed workers	63.65	1,319.44
Fraction part-time		0.15	
Fraction male white-collar		0.19	
Fraction female white-collar		0.21	
Fraction male blue-collar		0.35	
Fraction female blue-collar		0.16	
Fraction apprentices		0.06	
Fraction owner		0.04	
Turnover	Change in the number of employees relative to the average number of employees last year	0.04	0.70
Capital			

Investment assets	Investment in assets per employed worker	9,166.99	237,497.31
Investment software	Investment in software per employed worker	2,775.33	6,220.68
Capital	Capital per employed worker	29,510.21	493,674.07
Other variables			
Regional indicators	9 federal states		
NACE indicators	8 NACE categories		
Legal form indicators	5 groups of legal forms of businesses		
Year	Dummy variable for 1999		
N		3,350	

Note: All monetary variables deflated to 2005 prices using the HCPI. All statistics weighted according to CVTS.

We use value added per actual working hour and value added per employed worker as dependent variables in the productivity regressions; their means are about €28 and €47,700.

Training intensity is measured by the number of hours in training or, alternatively, the net costs of training. While we might assume that there is a correlation between the costs of training and the quality of training, we have no direct information on the quality of training. However, we have information on the training subjects and whether the training is in-house or externally organized.

On average, training costs amounted to €145 per worker and the average worker spent 5.5 paid working hours in training per year. About one quarter of all training hours were dedicated to technical training and 16% were dedicated to marketing and sales training and another 16% to IT courses.

Most training was provided not in-house but by external training institutions. About 40% of these external training hours were provided by public associations (e.g., Chamber of Commerce) and about 30% by private training institutions.

Table 3, furthermore, shows that the average firm in our sample had about 64 employed workers, of which about 15% were part-time workers and about 6% apprentices. Amongst blue-collar workers there were more men than women, amongst white-collar workers the number of men and women were similar.

Although the data are detailed with respect to workers and training, they are less adequate in terms of capital. The SSBS provides only information on current investment and not on the stock of capital. Under the assumption that current investment is used to keep the stock of capital constant, investment can be used as a proxy for the capital in place. (Investment in software and patents can be seen as a different channel to increase productivity.)[5]

3.2 Wages

We investigate the relationship between training and wages by using the Labour Costs Surveys (LCS) and the Structure of Earnings surveys (SES) (Statistik Austria, 2006, 2007). Using these data we can estimate wage effects on the worker-level, enabling us to control for individual characteristics of workers. Our productivity analysis is primarily based on immediate effects of training, leading to potential downward bias if training effects occur lagged or are long-lasting. Using the LCS and the SES, we can investigate the effects of training on the wages two years thereafter (including potential wage contracting after training). The problem of reversed causality (i.e., productivity induces training) is, less severe in such a specification.[6]

[5] As a robustness check, we calculate for all firms in 2005 an alternative measure of the capital stock that is based on all investments from 1999 to 2005. We obtain qualitative similar results.
[6] Although we do not observe any training that took place between these two years, the estimations will still produce consistent estimates as long as training does not correlate with the error term.

The LCS is conducted every four years and surveys businesses with at least 10 employees in the production and service sectors (NACE codes C-K, excluding L) and covers about 80% of Austrian employees (Statistik Austria, 2006). The survey is a stratified random sample on sectors and firm size. The unit of observation is the firm and the data contain detailed information on the number of employed workers, wages and indirect labour costs such as contributions to social security or training costs (Statistik Austria, 2007).

The SES is also conducted every four years and contains information on the employed workers, such as sex, age, education, occupation (SCO), tenure and detailed information on the composition of wages, such as regular compensation, overtime, sick-pay, and similar (Statistik Austria, 2006). Workers are sampled according to a firm's size, in firms with 10 to 19 employees all workers are interviewed, in firms with 50 to 99 employees every fifth worker is interviewed, and so on. In firms with more than 1,000 employees, every 80th worker is interviewed (Statistik Austria, 2006). In addition, the data contain information on the firms, such as their NACE classification, region (NUTS 1), the legal form of the company and whether the workers are covered by collective bargaining.

We match information from the 2000 LCS, which contains information on training (on the firm-level) and wages (on the worker-level), with the 2002 SES with observations on 1,784 firms and their 27,182 workers. The match between the 2004 LCS and the 2006 SES results in a sample of 2,962 firms and their 75,562 workers.[7] There are 594 firms in all four surveys which will allow a longitudinal analysis.

[7] The SES sampled in 2002 firms in NACE categories C-K, in 2006 additionally also firms in M-O. The sample sizes differ accordingly.

Estimates on these firms are likely to be biased, as these firms are a selected sample as they have survived for at least six years and thus are perhaps more productive firms since they were not squeezed out of the market. Kaniovski and Peneder (2008) give the median life of Austrian firms at three to four years; however, a quarter of all firms do not survive beyond the first year. The rates of firms that survive beyond the first year are relatively flat. Descriptive statistics are presented in table 4. The summary statistics show that the average gross hourly wage in the SES was about €11.4 in both years; however, the variance was markedly greater in 2000/02 than in 2004/06.[8]

The data reflect the employment patterns well (BKA, 2007), for example, the increase in the number of female workers or the increase in part-time employment. The central explanatory variable measures training costs and is obtained from the LCS. Training costs amounted on average to €212 per worker in 2000/02 and, somewhat more, €232 in 2004/06. [9]

Other explanatory variables are personal characteristics, such as age or sex, job characteristics, such as tenure or type of contract, and firm characteristics, such as firm size, regional indicators and industry dummies. We also construct firm-level indicators of the workforce (the fraction of female workers, fraction of part-time workers, and fraction of blue-collar workers).

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[8] This difference is possibly caused by a more heterogeneous sample of workers in 2002 than in 2006.

[9] Note that the amount spent on training differs between the samples. Firms in the wage-samples invest more in training than firms in the productivity-samples; the averages are €145 compared to about €212 (or €232) per worker. This difference is probably due to different sampling methods, the sample which we use for the wage analyses is based on firms with at least 10 employees and the sample used for the productivity analyses uses firms with at least 20 employees,

Table 4: Descriptive statistics pooled wage sample.

	2000/2		2004/6	
	Mean	SD	Mean	SD
Dependent Variables				
log (gross hourly wage)	2.431	4.067	2.430	2.708
Explanatory Variables				
Training costs/employee, (in €1,000)	0.212	2.724	0.232	2.804
Female	0.355		0.401	
Age	37.229	11.361 [a)]	37.553	11.538 [a)]
Education				
Less than / no compulsory schooling	0.003		0.004	
Compulsory schooling	0.264		0.220	
Apprenticeship	0.442		0.414	
Secondary school (vocational)	0.088		0.105	
Secondary school (academic)	0.038		0.048	
Higher secondary school (vocational)	0.080		0.090	
Master, higher vocational school	0.041		0.045	
University	0.044		0.075	
Part-time	0.169		0.232	
Fixed-term contract	0.026		0.050	
Blue-collar worker	0.449		0.396	
White-collar worker	0.476		0.516	
Apprentice	0.044		0.041	
Marginally employed	0.031		0.047	
Firm size	3,521.38	86,659.96	1,740.02	25,483.39
N of workers	27,182		75,765	
N of firms	1,784		2,962	

Note: Statistik Austria, LCS 2000, 2004 and SES 2002, 2006. All numbers are weighted, except those marked with [a)]. Monetary values in 2005 prices, deflated using the HCPI. The larger sample size in 2004/6 is the result of not only sampling firms in NACE categories C-K, as in 1002, but also in NACE categories M-O.

Descriptive statistics for the wage panel sample are presented in table 5. We calculate Gini-coefficients for the firms' wage distributions to investigate changes over time, in particular, if there is any evidence for a relationship with employer-provided training

The amounts spent on employer provided trainings are lower in the panel sample (€ 170 per employee and year) than in the cross-sections (€ 212 and € 232 respectively). The firm characteristics like fraction of women, white-collar workers or part-time workers are about the same in the panel and cross-section samples.

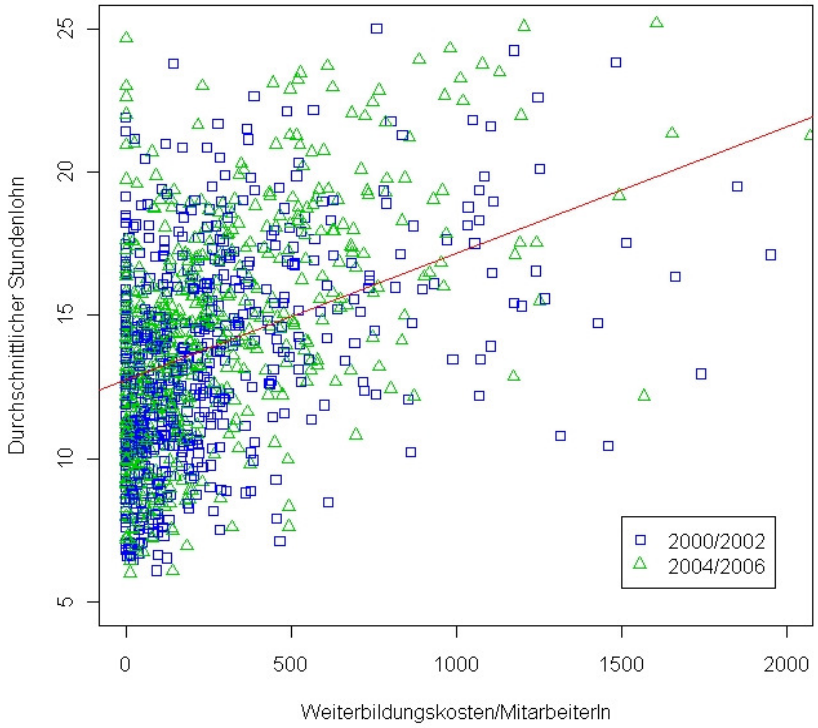
Table 5: Descriptive statistics wage sample, panel.

	Mean	Standard Deviation
Dependent Variables		
Hourly wages (€)	15.42	21.483
Gini hourly wage	0.209	0.294
p90 hourly wage	19.217	34.666
p50 hourly wage	12.038	13.904
p90/p50 hourly wage	1.581	1.634
Gross annual wage/employee, 2002	31,344.14	49,325.22
Explanatory Variables		
Training costs/employee (in € 1000)	0.170	1.140
Fraction female workers	0.338	
Fraction white-collar workers	0.439	
Fraction part-time workers	0.136	
Fraction female part-time workers	0.108	
Fraction of workers with degree	0.053	
Fraction of workers with apprenticeship	0.371	
Fraction of workers with compulsory schooling	0.286	
Fraction of workers with no formal schooling	0.003	
Fraction of workers with secondary schooling	0.288	
Tenure	8.702	16.382
Age	39.312	18.940
Actual working hours	1650.930	714.877
N of firms	594	

Note: LCS 2000 and 2004, SES 2002 and 2006.

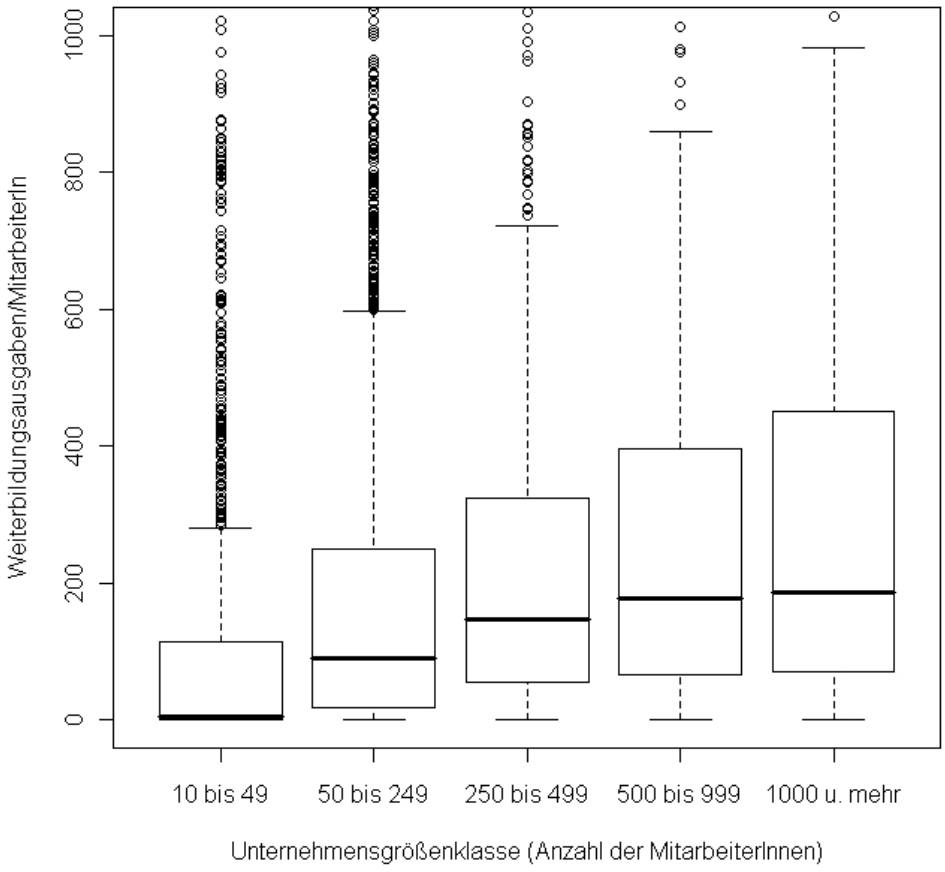
Figure 2 plots the firms' average gross hourly wage against their average training costs per employee. The average gross hourly wage was about €15 and firms spent typically less than €300 on training per employee. The relationship is positive, as indicated by the (red) regression line.

Figure 2: Hourly wages and training.



Source: Statistik Austria, LCS 2000/2004, SES 2002/2006.

Figure 3: Distribution of training costs by firm size.



Source: Statistik Austria, LCS 2000/2004, SES 2002/2006.

Figure 3 presents box plots of training costs by firm size. The bold horizontal line inside the box indicates the median level of training costs. Figure 3 clearly shows that the larger the firm, the more is invested into the training of the workers. It is somehow sobering to see that about half of the firms with more than 10 but less than 50 employees spend nothing on their workers' training. In the wage regressions below, we are able to control for firm size, but not in the productivity regressions.

4 Results

4.1 Productivity[10]

In this section, we present results fort he productivity regressions from the pooled sample and further results form the lagged as well as the panel sample.

4.1.1 Pooled Sample

Table 6 tabulates the estimated elasticities from four different specifications of equation (4), the results on other variables are tabulated in the Appendix. In specification A, in addition to the vector of other control variables, we control for the costs and the amount of training in our estimation of productivity. In specification B, we additionally control for the type of training (with languages as reference). Specification C distinguishes between in-house and external provision of training and specification D uses all available indicators of training.

In all four specifications, we estimate a positive and statistically significant relationship between training costs and productivity. The elasticities vary, depending on the included explanatory variables, between 0.044 in specification A and 0.039 in specification D. The estimations indicate that firms in which 1% more is spent on training than in other, similar firms, productivity is greater by about 0.04%. The estimations further suggest that there is no relationship between the number of training hours and productivity. We also estimate the same specifications but with productivity per employed worker, and obtain elasticities that are slightly smaller, 0.03.

[10] Material presented in this section is based on Böheim and Schneeweis (2008).

Table 6: Estimates of productivity, pooled sample.

Variable	**Value added per working hour (log)**			
	A	B	C	D
	Coefficient ***(Standard Error)***			
Costs (log)	0.044***	0.042***	0.040***	0.039***
	(0.008)	(0.008)	(0.008)	(0.008)
Hours (log)	0.003	0.004		
	(0.003)	(0.003)		
Fraction of total hours:				
Languages (base)				
Marketing		-0.017		-0.021*
		(0.011)		(0.012)
Administration		0.025*		0.022
		(0.013)		(0.014)
Personal skills		0.054***		0.049***
		(0.017)		(0.017)
IT		-0.025**		-0.029**
		(0.012)		(0.012)
Technical		-0.003		-0.009
		(0.009)		(0.010)
Other		-0.009		-0.017*
		(0.009)		(0.009)
Hours in-house (log)			0.006**	0.006**
			(0.003)	(0.003)
Hours external (log)			0.002	0.003
			(0.003)	(0.003)
Fraction of total external hours:				
Institutions. (base)				
Business			0.011	0.018**
			(0.007)	(0.008)
Schools			-0.079***	-0.073***
			(0.020)	(0.021)
Private			0.001	0.004
			(0.008)	(0.009)
Other			0.018*	0.025**
			(0.010)	(0.011)
Number of observations	3,350	3,350	3,350	3,350

Note: ***, ** and * indicate statistical significant values at the 1%, 5% and 10% error level. Estimations based on CVTS 1999 and 2005 and SSBS 1999 and 2005. Results on other variables are in the Appendix.

Specification D is our preferred specification as we make use of all available information on training. Overall, the relationship between training and productivity is robust across all specifications. In addition, we find that the type of training matters for productivity, sales training or IT-course have a significantly lower association with productivity than language courses (the omitted category), whereas training in personal skills or administrative courses have a greater, positive association with productivity.[11] Training that is provided in-house is estimated to be more productivity-enhancing than external courses.

4.1.2 Lagged Sample and Panel Sample

Our results so far ignore any medium-term effects of training on productivity. It might be the case that training has a beneficial influence on productivity only after some time. We therefore estimated our regressions using a sample where we match the SSBS 2000 with the information on training from the CVTS 1999.

As shown in table 7, we find a positive association between training and productivity (measured as gross value added per worker as we have no information on working hours in the SSBS). The estimated coefficient is about 0.02 and statistically significant in specifications A and B. Although the estimated coefficient is not significant in specifications C and D, however, the point estimate has about the same numerical value. Note that the sample size is much smaller than above.

[11] An insignificant relationship between IT and productivity has also been found by other researchers, see Oliner, Sichel, Triplett and Gordon (1994).

Table 7: Estimated productivity, lagged sample

Dependent variable	**Value added per worker (log)**			
	A	B	C	D
	Coefficient			
	(Standard Error)			
Costs (log)	0.020*	0.022**	0.015	0.017
	(0.011)	(0.011)	(0.011)	(0.011)
Hours (log)	-0.002	-0.003		
	(0.004)	(0.004)		
Fraction of total hours:				
Languages (base)				
Marketing		-0.038**		-0.040**
		(0.016)		(0.017)
Administration		-0.005		-0.004
		(0.021)		(0.022)
Personal skills		-0.020		-0.020
		(0.028)		(0.028)
IT		0.018		0.017
		(0.016)		(0.017)
Technical		0.009		0.010
		(0.013)		(0.013)
Other		0.008		0.010
		(0.015)		(0.015)
Hours in-house (log)			0.002	0.002
			(0.004)	(0.004)
Hours external (log)			-0.001	-0.002
			(0.004)	(0.004)
Fraction of total external hours:				
Institutions. (base)				
Business			-0.005	-0.003
			(0.012)	(0.013)
Schools			0.005	0.007
			(0.030)	(0.030)
Private			0.003	0.006
			(0.011)	(0.011)
Other			-0.014	-0.018
			(0.017)	(0.018)
Number of observations	1,739	1,739	1,739	1.739,

Note: ***, ** and * indicate statistical significant values at the 1%, 5% and 10% error level. Estimations based on CVTS 1999 and 2005 and SSBS 1999 and 2005.Results on other variables upon request.

For 203 companies, we have information from the CVTS 1999 and 2005. With this small panel sample, we investigate whether an increase in training intensity can be associated with

productivity gains. The results are reported in table 8. Firm-fixed-effects regressions give estimated elasticities of about 0.02. However, the estimates are statistically not significant

Table 8: Estimated productivity, panel sample

Dependent variable	**Value added per working hour (log)**			
	A	B	C	D
	Coefficient			
	(Standard Error)			
Costs (log)	0.025	0.019	0.024	0.017
	(0.022)	(0.023)	(0.022)	(0.023)
Hours (log)	0.002	0.003		
	(0.007)	(0.008)		
Fraction of total hours:				
Languages (base)				
Marketing		0.003		0.002
		(0.038)		(0.040)
Administration		0.012		0.029
		(0.043)		(0.045)
Personal skills		-0.016		-0.001
		(0.056)		(0.059)
IT		0.025		0.029
		(0.028)		(0.032)
Technical		0.005		0.022
		(0.026)		(0.028)
Other		-0.022		-0.017
		(0.028)		(0.027)
Hours in-house (log)			0.002	0.003
			(0.006)	(0.007)
Hours external (log)			-0.002	-0.001
			(0.008)	(0.008)
Fraction of total external hours:				
Institutions. (base)				
Business			-0.029	-0.043
			(0.025)	(0.028)
Schools			-0.017	-0.031
			(0.051)	(0.056)
Private			0.028	0.015
			(0.024)	(0.027)
Other			0.022	0.024
			(0.030)	(0.030)
Firm-fixed effect included				
Number of observations	406	406	406	406

Note: ***, ** and * indicate statistical significant values at the 1%, 5% and 10% error level. Estimations based on CVTS 1999 and 2005 and SSBS 1999 and 2005.Results on other variables upon request.

4.2 Wages[12]

Since the wage information from the CVTS and the SSBS is only available at the firm level, we estimate wage regressions using micro data from the LCS and SES. We estimate three specifications, where specification A controls for sex, age, tenure, occupation and several firm characteristics, such as the firm's sex ratio, the fraction of part-time workers in a firm, average tenure, firm size, industry, region and an indicator for collective bargaining. In specification B we additionally include information on the worker's contract, the number of overtime hours, and information on annual leave. In specification C, we include additionally to specification A several indicators for compensation schemes, such as e.g., shift work.

The results are given in table 9. In all specifications, we obtain positive and statistically significant associations of training and wages. The estimated coefficients are around 0.05. Workers in firms who invest 1000 Euro more on training earn about 5% higher wages. The other results are consistent with economic theory and earlier research, such as workers with more formal education have higher wages than those with less, and so on.

[12] This section is based on material presented in Böheim and Wakolbinger (2009).

Table 9: Estimated wages.

	2000/2			2004/6		
	A	B	C	A	B	C
	log(hwage)	log(hwage)	log(hwage)	log(hwage)	log(hwage)	log(hwage)
Training costs/employee (€ 1000)	0.067***	0.07***	0.05***	0.052***	0.053***	0.037***
	(0.01)	(0.01)	(0.01)	(0.005)	(0.005)	(0.004)
Individual characteristics						
Female	-0.145***	-0.154***	-0.107***	-0.131***	-0.135***	-0.097***
	(0.008)	(0.008)	(0.011)	(0.005)	(0.005)	(0.005)
Age	0.011***	0.006***	0.01***	0.011***	0.007***	0.01***
	(0)	(0)	(0)	(0)	(0)	(0)
Part-time		0.051***			-0.04***	
		(0.01)			(0.008)	
temporary contract		-0.012			-0.053***	
		(0.016)			(0.009)	
Education (Base: compulsory school)						
Apprenticeship	0.202***	0.058***	0.194***	0.206***	0.042***	0.197***
	(0.008)	(0.006)	(0.008)	(0.006)	(0.004)	(0.005)
High school degree/master craftsman	0.279***	0.124***	0.256***	0.268***	0.101***	0.25***
	(0.01)	(0.008)	(0.012)	(0.007)	(0.005)	(0.006)
University degree	0.497***	0.347***	0.41***	0.421***	0.253***	0.366***
	(0.021)	(0.02)	(0.022)	(0.012)	(0.011)	(0.011)
Employee classification (Base: white collar)						
Blue collar		-0.168***			-0.16***	
		(0.01)			(0.006)	
Apprentice		-0.956***			-0.967***	
		(0.016)			(0.011)	
Marginal employment		-0.164***			-0.202***	
		(0.018)			(0.013)	
Tenure within firm	0.008***	0.007***	0.006***	0.009***	0.008***	0.007***
	(0)	(0)	(0.001)	(0)	(0)	(0)
Firm size (Base: less than 50 employees)						
50 -249 emp.	0.017**	0.013**	0.014**	0.041***	0.023***	0.026***
	(0.008)	(0.007)	(0.007)	(0.006)	(0.005)	(0.005)
250 - 499 emp.	0.039***	0.022***	0.022***	0.072***	0.04***	0.05***
	(0.009)	(0.008)	(0.008)	(0.006)	(0.005)	(0.006)
500 - 999 emp.	0.073***	0.052***	0.043***	0.082***	0.056***	0.049***
	(0.009)	(0.007)	(0.009)	(0.006)	(0.005)	(0.006)
> 1000 emp.	0.115***	0.085***	0.075***	0.102***	0.067***	0.066***
	(0.009)	(0.008)	(0.009)	(0.006)	(0.006)	(0.006)
Number of observations	27,182	27,182	27,182	75,562	75,562	75,562

Note: ***, ** and * indicate statistical significant values at the 1%, 5% and 10% error level. Estimations based on LCS 2000 and 2004 and SES 2002 and 2006. Robust standard errors, Results on other variables in the Appendix.

Of course, we cannot interpret these estimates as causal. Furthermore, our analysis is a partial analysis, holding all other things constant—thus we may not see such big gains if all firms increased their training. In particular, since firms will select the workers they want to train, and most likely they select those workers who benefit most from training, we might not see wages gains if firms were to train all other workers, too.

4.3 Inequality of wages

Using the panel sample of 594 firms that were sampled in all four surveys, we estimate the firms' wage distributions, measured by the Gini index, using firm fixed-effects panel regressions. (We do not have panel information on the individual workers).

We do not find statistically significant effects and, consequently, cannot reject the null hypothesis of no relationship between training and the distribution of wages in a firm.[13] Indeed, the only statistically significant coefficient that is obtained from these regressions is on the average tenure. The positive coefficient point estimate indicates that the greater the change in the average tenure in a firm, the more unequal the wage distribution became.

[13] We also use the p90/p10 measure which provides the same qualitative results.

Table 10: Estimated Gini indices, fixed-effects regressions.

	Specification A	**Specification B**
	Gini	Gini
Training costs/employee (€1000)	-0.014	-0.015
	(0.032)	(0.032)
Fraction women	0.013	0.01
	(0.053)	(0.053)
Fraction white collar workers	0.052	0.058
	(0.072)	(0.073)
Fraction part-time workers	0.077	0.076
	(0.079)	(0.078)
Fraction female part-time workers	0.15	0.149
	(0.12)	(0.117)
Fraction employees compl. Apprenticeship	0.024	0.016
	(0.045)	(0.045)
Fraction employees High school/master craftsman	0.076	0.066
	(0.049)	(0.052)
Fraction employees university degree	-0.083	-0.084
	(0.272)	(0.27)
Average tenure within firm	0.004*	0.004*
	(0.002)	(0.002)
Average age of employees		0.001
		(0.002)
Number of employees (1000)	0.006	0.007
	(0.012)	(0.012)
Wage/employee (€1000)		0.000
		(0.000)
Number of firms	594	594

Note: ***, ** and * indicate statistical significant values at the 1%, 5% and 10% error level. Estimations based on LCS 2000 and 2004 and SES 2002 and 2006. Robust standard errors.

5 Summary

We have investigated the association between employer-provided training and productivity and wages respectively. For our analysis, we have combined several sources of data on Austrian firms.

For the analysis of training and productivity, we have used data from the Continuing Vocational Training Surveys of 1999 and 2005 and have linked these with data from the Surveys on Structural Business Statistics. We have found a positive elasticity of about 0.04 of training

on productivity. Furthermore, using a lagged but smaller sample, we have estimated elasticities of about 0.02 (of training on next year's productivity). Firm-fixed effects regressions using a very small sample of 203 firms give elasticities of about 0.02, too, however these estimates are statistically not significant. Although the data are the currently best available data in Austria, they do not allow us to rule out that selection or reversed causality biases the obtained results.

For the analysis of training and wages we have used data from the Structure of Earnings Surveys of the years 2002 and 2006 and have linked them with data from the Labour Cost Surveys of the years 2000 and 2004. This lagged structure (wages are measured two years later than training) has allowed us to rule out reversed causality effects. While the majority of Austrian small and medium sized firms spend little or no money on employees' training, we have found a robust positive coefficient of 0.05.

Concerning the effects of training on the equality of wages within a firm, we would expect the following result: If only high wage workers are trained, the wages within a firm will diverge and, vice versa, we will observe a convergence of wages, if only low wage workers have access to training. We have estimated the effects of training on the distribution of wages within firms and do not find a statistically significant relationship. In other words, our results show neither that training leads to more wage inequality nor to more wage equality within firms.

Since in general wages correlate with productivity (Dostie, 2006), and since we estimate a positive elasticity of training on productivity, we conclude that employer-provided training is beneficial for both firms and workers. While the results cannot be interpreted causally, in the sense that more training leads to more productivity or wages, the results confirm earlier stud-

ies and indicate at least that the link between employer-provided training and productivity warrants further research.

Because the available data do not allow establishing a causal link, we hesitate to give advice on how to improve economic policy incentives for employer-provided training on the basis of our results. It is in addition important to distinguish between the firms that train their workers without any additional incentive and those firms who will respond to such an incentive to gauge the size of the deadweight loss. We strongly believe that any policy advice requires more evidence on how firms decide on whom to train, which types of training to provide and how much to spend on employer-provided training.

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Appendix

Table A1: Estimates of productivity, pooled sample.

Variable	**Productivity per hour (log)**			
Specification	A	B	C	D
	Coefficient			
	(Standard error)			
Costs (log)	0.044***	0.042***	0.040***	0.039***
	(0.008)	(0.008)	(0.008)	(0.008)
Hours (log)	0.003	0.004		
	(0.003)	(0.003)		
Fraction of total hours				
Languages (base)				
Marketing		-0.017		-0.021*
		(0.011)		(0.012)
Administration		0.025*		0.022
		(0.013)		(0.014)
Personal skills		0.054***		0.049***
		(0.017)		(0.017)
IT		-0.025**		-0.029**
		(0.012)		(0.012)
Technical		-0.003		-0.009
		(0.009)		(0.010)
Other		-0.009		-0.017*
		(0.009)		(0.009)
Hours in house (log)			0.006**	0.006**
			(0.003)	(0.003)
Hours external (log)			0.002	0.003
			(0.003)	(0.003)
Fraction of total external hours				
Institutions (base)				
Business			0.011	0.018**
			(0.007)	(0.008)
Schools			-0.079***	-0.073***
			(0.020)	(0.021)
Private			0.001	0.004
			(0.008)	(0.009)
Other			0.018*	0.025**
			(0.010)	(0.011)
Capital				
Inv. in Assets (log)	0.005***	0.005***	0.005***	0.005***
	(0.001)	(0.001)	(0.001)	(0.001)
Inv. in Software (log)	0.001	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Personnel				
Number of employees (log)	0.005**	0.005*	0.006**	0.006**
	(0.003)	(0.003)	(0.003)	(0.003)
Fraction part-time	-0.017	-0.022	-0.019	-0.024
	(0.016)	(0.016)	(0.016)	(0.016)
Fraction white collar male (Base)				
Fraction white collar female	-0.050**	-0.050**	-0.053***	-0.053***
	(0.020)	(0.020)	(0.020)	(0.020)
Fraction blue collar m	-0.052***	-0.053***	-0.054***	-0.055***
	(0.016)	(0.016)	(0.016)	(0.016)
Fraction blue collar f	-0.063***	-0.063***	-0.068***	-0.068***
	(0.019)	(0.019)	(0.019)	(0.019)
Fraction apprentices	-0.120***	-0.120***	-0.127***	-0.127***

	(0.030)	(0.030)	(0.030)	(0.030)
Fraction owners	-0.146***	-0.137***	-0.149***	-0.139***
	(0.040)	(0.040)	(0.040)	(0.040)
Change since 1 year	-0.050***	-0.054***	-0.051***	-0.055***
	(0.011)	(0.012)	(0.011)	(0.011)
Region				
Upper Austria (Base)				
Burgenland	0.017*	0.018*	0.014	0.014
	(0.010)	(0.010)	(0.010)	(0.010)
Carinthia	0.001	0.001	-0.002	-0.001
	(0.009)	(0.009)	(0.009)	(0.009)
Lower Austria	0.000	-0.002	-0.002	-0.004
	(0.006)	(0.006)	(0.006)	(0.006)
Salzburg	0.000	0.001	0.000	0.001
	(0.009)	(0.009)	(0.009)	(0.009)
Styria	-0.003	-0.005	-0.004	-0.005
	(0.008)	(0.008)	(0.008)	(0.008)
Tyrol	0.025***	0.025***	0.024***	0.024***
	(0.009)	(0.009)	(0.009)	(0.009)
Vorarlberg	0.024**	0.023**	0.024**	0.024**
	(0.011)	(0.011)	(0.011)	(0.011)
Vienna	0.016**	0.014*	0.014*	0.011
	(0.008)	(0.008)	(0.008)	(0.008)
ÖNACE Classification				
Nace 10	-0.007	-0.002	-0.013	-0.009
	(0.157)	(0.157)	(0.157)	(0.156)
...				
Nace 74	-0.123***	-0.121***	-0.124***	-0.124***
	(0.034)	(0.034)	(0.034)	(0.034)
Legal form				
Limited liability (Base)				
Limited partnership	0.013*	0.014**	0.013*	0.013*
	(0.007)	(0.007)	(0.007)	(0.007)
Stock corporation	-0.038**	-0.040**	-0.039**	-0.041**
	(0.016)	(0.016)	(0.016)	(0.016)
Individual enterprise	-0.005	-0.005	-0.002	-0.003
	(0.006)	(0.006)	(0.006)	(0.006)
Other	0.000	-0.002	-0.002	-0.005
	(0.009)	(0.009)	(0.009)	(0.009)
Other				
Control variables				
1999	-0.002	-0.004	-0.001	-0.002
	(0.005)	(0.005)	(0.005)	(0.005)
Change since 1 year missing	0.140***	0.142***	0.139***	0.140***
	(0.041)	(0.041)	(0.041)	(0.041)
employees LSE CTVS	-0.005	-0.007	-0.004	-0.008
	(0.008)	(0.008)	(0.008)	(0.008)
Constant	4.940***	4.950***	4.965***	4.969***
	(0.062)	(0.062)	(0.062)	(0.062)
R-squared	0.195	0.199	0.200	0.204
Number of observations	3,350	3,350	3,350	3,350

Note: ***, ** and * indicate statistical significant values at the 1%, 5% and 10% error level. Estimations based on CVTS 1999 and 2005 and SSBS 1999 and 2005.

Table A2: Estimates of wages, cross-section

	2000/2			2004/6		
Specification	A	B	C	A	B	C
Dependent variable	log(hwage)	log(hwage)	log(hwage)	log(hwage)	log(hwage)	log(hwage)
Training costs (€ 1000)	0.067***	0.07***	0.05***	0.052***	0.053***	0.037***
	(0.01)	(0.01)	(0.01)	(0.005)	(0.005)	(0.004)
Individual characteristics						
Female	-0.145***	-0.154***	-0.107***	-0.131***	-0.135***	-0.097***
	(0.008)	(0.008)	(0.011)	(0.005)	(0.005)	(0.005)
Age	0.011***	0.006***	0.01***	0.011***	0.007***	0.01***
	(0)	(0)	(0)	(0)	(0)	(0)
Part-time		0.051***			-0.04***	
		(0.01)			(0.008)	
temporary contract		-0.012			-0.053***	
		(0.016)			(0.009)	
shift-work		0.072***			0.095***	
		(0.006)			(0.003)	
Education (Base: compulsory school)						
Apprenticeship	0.202***	0.058***	0.194***	0.206***	0.042***	0.197***
	(0.008)	(0.006)	(0.008)	(0.006)	(0.004)	(0.005)
High school degree/master craftsman	0.279***	0.124***	0.256***	0.268***	0.101***	0.25***
	(0.01)	(0.008)	(0.012)	(0.007)	(0.005)	(0.006)
University degree	0.497***	0.347***	0.41***	0.421***	0.253***	0.366***
	(0.021)	(0.02)	(0.022)	(0.012)	(0.011)	(0.011)
Employee classification (Base: white collar)						
Blue collar		-0.168***			-0.16***	
		(0.01)			(0.006)	
Apprentice		-0.956***			-0.967***	
		(0.016)			(0.011)	
marginal employment		-0.164***			-0.202***	
		(0.018)			(0.013)	
Tenure within enterprise	0.008***	0.007***	0.006***	0.009***	0.008***	0.007***
	(0)	(0)	(0.001)	(0)	(0)	(0)
Occupation						
head in administration	0.677***	0.526***	0.457***	0.663***	0.534***	0.52***
	(0.028)	(0.028)	(0.054)	(0.018)	(0.018)	(0.018)
…						
unskilled labour	0	-0.11***	0	0.002	-0.125***	-0.001
	(0.013)	(0.009)	(0.012)	(0.008)	(0.006)	(0.008)
Supplements, worked hours, holidays						
Supplements in reference month (€ 1000)			0.383***			0.373***
			(0.03)			(0.013)
Extra payments (€ 1000)			0.019***			0.012***
			(0.006)			(0.001)
Number of paid extra		0.001***			0.002***	

hours/month						
		(0)			(0)	
Payments for extra hours (€1000)			0.143***			0.158***
			(0.009)			(0.007)
holidays 2002		0.005***			-0.002**	
		(0.001)			(0.001)	
Firm						
Fraction women	-0.096***	-0.081***	-0.105***	-0.147***	-0.112***	-0.167***
	(0.02)	(0.018)	(0.018)	(0.013)	(0.012)	(0.012)
Fraction white collar	0.118***	0.011	0.12***	0.093***	-0.007	0.095***
	(0.018)	(0.016)	(0.017)	(0.011)	(0.011)	(0.01)
Fraction part-time	-0.125***	-0.1***	-0.095***	-0.083***	-0.066***	-0.055***
	(0.029)	(0.026)	(0.028)	(0.017)	(0.014)	(0.016)
Fraction female part-time	0.011	-0.027	0.016	0.006	-0.019	0.019
	(0.033)	(0.03)	(0.031)	(0.02)	(0.018)	(0.019)
Fraction completed apprentice-ship	0.143***	0.16***	0.099***	0.048***	0.076***	0.046**
	(0.023)	(0.019)	(0.021)	(0.018)	(0.014)	(0.017)
Fraction high school degree	0.185***	0.256***	0.141***	0.258***	0.3***	0.229***
	(0.03)	(0.026)	(0.027)	(0.021)	(0.018)	(0.02)
Fraction university degree	0.384***	0.444***	0.222***	0.16***	0.232***	0.142***
	(0.055)	(0.051)	(0.059)	(0.029)	(0.026)	(0.026)
Firm size (Base: less than 50 employees)						
50 -249 emp.	0.017**	0.013**	0.014**	0.041***	0.023***	0.026***
	(0.008)	(0.007)	(0.007)	(0.006)	(0.005)	(0.005)
250 - 499 emp.	0.039***	0.022***	0.022***	0.072***	0.04***	0.05***
	(0.009)	(0.008)	(0.008)	(0.006)	(0.005)	(0.006)
500 - 999 emp.	0.073***	0.052***	0.043***	0.082***	0.056***	0.049***
	(0.009)	(0.007)	(0.009)	(0.006)	(0.005)	(0.006)
> 1000 emp.	0.115***	0.085***	0.075***	0.102***	0.067***	0.066***
	(0.009)	(0.008)	(0.009)	(0.006)	(0.006)	(0.006)
ÖNACE Classification						
Industrial products	0.155***	0.098***	0.132***	0.119***	0.068***	0.1***
…	(0.013)	(0.01)	(0.012)	(0.009)	(0.008)	(0.008)
other services	0.106***	0.088***	0.081***	0.109***	0.06***	0.068***
	(0.024)	(0.019)	(0.023)	(0.012)	(0.011)	(0.012)
Nuts 1 Region (Base: East (Vienna, Lower Austria, Burgenland)						
South	-0.056***	-0.042***	-0.046***	-0.055***	-0.041***	-0.049***
	(0.007)	(0.006)	(0.007)	(0.005)	(0.004)	(0.005)
West	0.003	0.007	0.005	0.021***	0.026***	0.021***
	(0.006)	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)
Number of observations	27,182	27,182	27,182	75,765	75,765	75,765

Note: ***, ** and * indicate statistical significant values at the 1%, 5% and 10% error level. Estimations based on LCS 2000 and 2004 and SES 2002 and 2006. Robust standard errors.