Net Costs of Apprenticeship Training? New Evidence on the Basis of Wage Markups after Training in Germany*

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January 2008
Preliminary Version, please do not quote

Abstract

Apprentices cause high costs for training firms, while it remains unclear if the productivity of apprentices during the training period offsets these costs. To give an answer this paper uses the theoretical hypothesis that firms have to re-earn net costs by paying their former apprentices a lower wage in comparison to skilled employees hired from the labor market. We analyze the wage differences between job changers and job stayers after apprenticeship making both groups as similar as possible in order to avoid estimation biases induced by selection effects. This implies that we calculate the wage effect of a profession-specific change of employer on the individual deviation from the average wage markup. We use spell data from the employment statistics of the Federal Employment Agency (IABS) from 1993 to 2004. Our results indicate that in all occupation groups productivity of apprentices is higher than their cost.

Keywords: Dual Apprenticeship System, Wage Markups, Net Costs
JEL-classification: J24, J31

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1 Introduction

Beside the formal schooling system that needs a certain time to adapt to the new requirements of the labor market, firms play an important role in qualifying young people, thereby providing themselves with the supply of qualified workers they need. The vocational training system found in the German-speaking countries (Austria, Germany and Switzerland) and Denmark, requires on-the-job training to be combined with school attendance during a period of two to four years depending on the profession. In this system, firms are thus able to get to know their future personnel and to train them for their specific needs at a lower wage than regular employees. It is seen as the decisive reason for the relatively high qualification level for the non-college bound youth (Freeman and Schettkat, 2001) and regarded as a potential model for other countries because it allows enterprises to provide and pay for training in specific and general human capital (Steedman, 2001).

The apprentices cause high costs for the training enterprise, however. Besides the apprenticeship wage, they need for example training personnel and specific training facilities and material. In addition, the apprentices attend school for some days each week and are therefore not available for productive work. It is important to know if training firms have to pay more than what the apprentices re-earn with their contribution to productivity during the apprenticeship period. The crucial question therefore is if there are net-costs because firms might hesitate to hire apprentices if they have to cover training investments after the apprenticeship period. They only can recover net costs if the apprentice does not leave the training enterprise and if in addition the training enterprise can pay a wage below the market wage for skilled job entrants. There are several approaches to the question, if there are net training costs for apprentices. First, in a series of contributions, the Federal Institute for Vocational Education and Training (BIBB) calculated the costs and benefits of apprentices in different occupations (compare Beicht et al. 2004 for a recent survey). Second, Mohrenweiser and Zwick (2008) calculate the impact of different shares of professional groups of apprentices on productivity and profits. Third, Backes-Gellner and Mohrenweiser (2008) calculate the take-over ratios of apprentices for different groups of enterprises. These approaches are complementary and they tackle the question from the point of view of the enterprise.

Our paper sheds new light onto the question if enterprises are able to re-earn training investment costs after apprenticeship training. We specifically look at the problem from the point of view of the apprentice by asking if there are differences between the wage markup of skilled job entrants who change their employer after their apprenticeship training and those who stay at their training enterprise. We hereby calculate differences between professions taking individual and establishment differences into account. Using spell data from the employment statistics of the Federal Employment Agency (IABS) from 1993 to 2004, we identify employees at the end of their vocational training and at the beginning of their first job. We argue that the deviation from the profession mean should be low or

zero for apprenticeships without net costs and significantly positive for apprenticeships with net costs. The crucial condition for this hypothesis is that both groups of apprentices are comparable and the wage differences are not biased by unobserved individual or enterprise heterogeneity or selectivity into one of the groups. We therefore carefully reduce the heterogeneity between stayers and changers.

The remainder of this paper is organized as follows: Section 2 gives a brief survey of the literature and some theoretical considerations. We describe our estimation strategy in Section 3, the data and some descriptive statistics in Section 4. Results are discussed in Section 5. Section 6 concludes.

2 Literature and theoretical model

In the German-speaking countries much research has been conducted to answer several questions around the vocational training system, the so-called 'duales Ausbildungssystem'. One of the most interesting questions is if firms experience net costs during apprenticeship, and, if this would be the case, why they still train so many apprentices then. This question is especially intriguing because it is a widely accepted stylized fact that a significant part of apprenticeship training is general human capital (Acemoglu and Pischke, 1999).

Answers to this question can be approached by different ways. Firms are directly asked about their costs and benefits from in-house training (e.g. Beicht et al., 2004). This approach might be misleading because the firm-given information on cost and benefit is presumably subject to wrong information by the firms. In addition, the endogeneity of the training intensity and unobservable establishment heterogeneity between training and non-training enterprises cannot be taken into account in this descriptive and cross sectional approach. Therefore in a complementary estimation strategy, Wolter and Schweri (2002), Zwick (2007) and Mohrenweiser and Zwick (2008) calculate the influence of the share of apprentices on enterprise productivity or profits in multivariate panel analyses taking estimation biases from endogeneity and unobserved heterogeneity into account. They interpret a positive or insignificant correlation between the share of apprentices and enterprise performance as an indicator for the absence of net training costs. Finally, Backes-Gellner and Mohrenweiser (2008) directly analyze the requirement for the existence of net training costs that a sizeable share of apprentices stays in the enterprise.

The descriptive studies on the cost-benefit ratio of apprenticeship training lead to different conclusions. For Germany, Beicht et al. (2004), for instance find analogously to earlier studies by the BIBB a net cost of 30 to 70% of total apprenticeship costs, whereas Wolter and Schweri (2002) and Muehlemann et al. (2007) find no net costs and even net profits for most of the Swiss firms in their samples. The multivariate approaches find no net costs on average (Wolter and Schweri, 2002 and Zwick, 2007). Mohrenweiser and Zwick

(2008) differentiate between profession groups and find net costs only for ??? while the other professions seem to re-earn their costs already during the apprenticeship period. A share of about a quarter of all enterprises that never take over a significant share of their apprentices in a period of four years also sheds some doubts on the assumption that almost all enterprises in Germany have to invest in apprenticeship training (Backes-Gellner and Mohrenweiser, 2008).

The approach taken here is to explore the differences in wages between apprentices who stay and those who change to another employer after completion of the apprenticeship period on an individual level. This approach relies on the assumption that in case of an apprenticeship without net costs, the apprentice offsets the training costs during the training period and therefore should be paid the market wage after the apprenticeship, regardless of changing the employer or not. If the apprentice creates costs to the employer during the training period, the training firm has a strong interest in retaining the apprentice to benefit from his or her employment at a lower than the market wage during the first period of the employment. Firms which employ apprentices they didn't train themselves still would have to pay the market wage for them which is higher and equal to the productivity of the skilled apprentice.

In the empirical analysis the theoretical hypothesis that a difference between the wage markups of stayers and changers after the completion of the apprenticeship training indicates net costs in this profession has to be qualified, however. We have to assume that the productivity of stayers and changers controlling for all observable differences is comparable and that the wage level in firms that hire changers is similar to that of enterprises that only have stayers (controlling for establishment characteristics). Even if the productivity is the same, apprentices might prefer to stay in the home-region and therefore accept lower wages if the alternative employer would imply moving costs (Harhoff and Kane, 1997). Also asymmetric information about the contents of training programmes or the abilities of the applicant could reduce wages when changing the employer during the first employment months.

Several papers analyze the wages of skilled job entrants and wage differences between stayers and changers at the beginning of the first job: Bougheas and Georgellis (2004) find, with data from the German Socio-economic Panel (SOEP), that apprentices who change their employer experience a wage loss, but have subsequently faster growing salaries. Dustmann et al. (1997) using employment register data (IABS95) observe different sector-specific effects for apprentices changing their employer while already controlling for occupation. A positive wage premium for changers in the long run is found by Werwatz (2002) with survey data on qualification and labor market careers for the years 1985/86. Using the IABS95-data, Euwals and Winkelmann (2002) find stayers to have a significantly longer duration of their first job when controlling for occupation.

Fitzenberger and Spitz (2004) look at the wage effects of employees who work in different professions than their apprenticeship training. On the basis of the BIBB/IAB data set, wave 1998/99 they find that profession changers enjoy a positive wage markup. This markup is higher if the apprenticeship professions are taken into account instead of the practiced professions. This demonstrates that apprentices on average change if they were trained in worse paying professions. The authors also take into account endogeneity in the choice of professions. Velling and Bender (1994) calculate on the basis of the IAB sample of the history file of the employment statistics the wage consequences of profession changes taking individual and employer characteristics into account.

Our approach to measure wage differences between employer changers and stayers between the end of the apprenticeship training spell and the first skilled job goes beyond the available literature in several ways. First, we restrict our sample to job entrants directly after an apprenticeship training. This drastically reduces the heterogeneity of both groups because we only have employees with the same qualification background (know that better qualified employees tend to stay longer at their employers), exclude employees with long previous unemployment spells (we only look at presumably voluntary employer changes) and have employees of a similar age (after several years of labor market experience, employees tend to have unobservable qualification differences). Second, we analyze individual deviation with professions. This avoids estimation biases because there are systematic differences between professions (for example professions with and without net training costs). Third, we compare the wage differences of both employee groups in their first skilled job with the differences in the wage markups after apprenticeship training. This comparison additionally takes into account that skilled employees with unobservable individual or employer characteristics may already have different wage levels during their apprenticeship period.

3 Estimation Strategy

In this paper, we first use the deviation from the occupation-specific average wage at entry to the first job (in logs) as dependent variable. This approach is comparable to the specification of earlier studies (e.g. Dustmann et al., 1997). The econometric specification is a log-linear Ordinary Least Squares (OLS) and has the following form:

$$\begin{aligned} Y_i &= \alpha_0 + \beta_1\, change + \beta_2\, change\, X\, commercial + \beta_3\, change\, X\, metal \\ &\quad + \beta_4\, change\, X\, elec/IT + \beta_5\, change\, X\, hand/construc + \boldsymbol{\gamma}\ \boldsymbol{X} + \varepsilon_i\ , \end{aligned} \tag{1}$$

where Y_i is the individual deviation from the occupation-specific average wage (in log), *change* captures the change of employer (also called job change) and $change\, X$ '$profession$'

are interactions effects of change with profession groups[1]. $\mathbf{X}$ is a vector of individual and firm-specific control variables.

In a second step, we estimate the impact of a change of employer (and its interaction with occupations) on deviations from the occupation-specific average wage markup between the end of the apprenticeship and the beginning of the first job.

We assume that employees in professions that realize a wage markup for job changers in their first skilled job had net costs during the apprenticeship training. If we use the wage markup between apprenticeship wage and first skilled wage, a negative or positive selection of job changers manifests itself in differences in the skilled wage between both employee groups because the apprenticeship wage should be sensitive to unobserved employee heterogeneity as well as heterogeneity of firms. If there is a negative selection of job changers, for example, this gives us larger coefficients for the job changing interaction term in the second estimation.

4 Data and descriptive statistics

We use longitudinal official register data of the Institute for Employment Research (IAB) of the years 1993 to 2004. Constructing a subsample of individuals moving from apprenticeship to first employment, we exploit the so-called employment and benefits history (IABS04) with spell information for each individual in the sample. We observe the termination of the apprenticeship training and start of the first skilled job for every individual only once, creating a sample of repeated cross-sections.

We focus on full-time employed individuals aged 16 to 30, additionally eliminating those with either a university degree or a profession which cannot be obtained by vocational training (mostly full-time school-based training). Individuals working in agriculture, mining, education, welfare, and the public sector are excluded from the analysis in order to obtain a homogeneous sample[2].

Our main interest lays in the wage difference between apprentices who remain with their training firm ('stayer') and those changing to another employer ('changer'). Up to the year 1992, firms did not have to report a change in the status of their employee from apprentice to full-time employee. This is why we consider spell information only from the year 1993 on (compare Dustmann et al., 1997). We therefore know the precise end date of the apprenticeship and the precise start date of the first skilled job. We take the daily wage of the last spell before the end of the apprenticeship training and the first daily wage when working in a skilled job.

[1] The four profession groups are chosen in attempt to group professions with similar net costs, compare Mohrenweiser and Zwick (2008).

[2] These sectors are subject to either high subsidies or highly regulated payment schemes.

Estimations on basis of the IABS are usually subject to the problem that wages are censored at the social benefit contribution ceiling and that also experience and tenure are censored at certain dates (1970 for West German employees and 1990 for East German employees). We only consider job starters with low wages and therefore these data problems do not affect our estimations.

In order to make job changers and stayers as similar as possible, we consider only persons, who maximally did not work for five days in a row (either being unemployed or taking some time off) between the end of apprenticeship and the beginning of the first job. Changers in this subgroup are considered to be 'voluntary' changers; those who were already searching for another employer during apprenticeship, either because the earlier employer didn't offer a job or for personal reasons. Further, we seek to limit the share of so-called 'lemons', i.e. individuals who have unobservable weak abilities. This limitation reduces the rate of changers in the sample from 36 to 16 percent, indicating that more than half of the changers are changing their employer involuntarily (with time gaps of more than one week).

On the firm level, information on the size of the training firm (during apprenticeship) and the employing firm as well as the economic sector of the employing firm are used as control variables (see Table A.1 for details on variables). On the individual level, age, sex, nationality and information on whether the person is employed in East Germany and if she experienced a period of unemployment or a change of occupation group after apprenticeship work as controls. Occupation groups are defined as (1) commercial profession, (2) profession in metal industry, (3) electronics, IT and chemicals, and (4) handcraft and construction (also compare the argumentation in Mohrenweiser and Zwick, 2008, why these groups capture differences in net training costs). We excluded other professions from the analysis because this group is very heterogenous.

For our analysis we define the change of employer after apprenticeship (CHANGE), and interaction terms for change of employer with our profession groups (CHANGE X PROFESSION) as variables of interest. After computing the average wage markups between apprenticeship and first employment by profession (in logs), we compare this average wage markup with the individual wage markup[3]. The deviation of the individual from the average wage markup is our dependent variable. This approach allows us, to reduce heterogeneity by excluding differences between professions and partly taking into account systematic differences between training and hiring firms.

In the sample 15.5 percent have changed their employer at the end of apprenticeship training (see Table A.2). Out of these 8 percent are in commercial professions, 2 percent hold a profession in metal industry, 2 percent are employed within electronic, IT and chemical professions and 3.6 percent in handcraft and construction. Age ranges from

[3] We use a trimmed sample, where observations below the 1% and above the 99% deviation quantile were dropped to exclude outliers.

16 to 30 being on average 21 years. We observe 38.6 percent females in the sample, 6.3 percent foreigners and 11.9 percent being employed in East Germany. Controlling for the delay of five days before starting with the first job, we still have 0.3 percent who experienced unemployment between the end of the apprenticeship and the first skilled job. Besides the change of employer, some individuals had a change of occupation group. These are around 4.4 percent. Half of the individuals before and after completion of the apprenticeship work in firms up to 50 employees. Manufacturing and trading are the largest sectors in this sample.

5 Findings

Specification I in Table 1 shows that the change of employer after apprenticeship is negatively correlated with the deviation from the occupation-specific average wage at the beginning of the first skilled job. Contrary to what Bougheas and Georgellis (2004) as well as Dustmann et al. (1997) found in their studies using absolute entry wage for all professions this correlation is not significant. This first result indicates that apprenticeship training does not cause costs to firms, meaning that apprentices in all professions offset their cost with their productivity. Firms retaining apprentices can then pay the market wage to their home-grown skilled employees.

The negative correlation in this estimation might be caused by systematic differences between changers and stayers, such that changers are in general less able for their job ('lemons') and therefore gain less. Second, even though most of the apprenticeship training in Germany is considered to teach general and transferable knowledge, there could be still asymmetries in information about the real knowledge of the former apprentice in the new firm, which cause a lower entry wage. (This question could be checked, if we look at wage differences between changers and stayers in the long run.)

Introducing interaction effects between the change of employer and the occupation groups, does reveal some differences between professions (Specification II). While people working in commercial professions and those in handcrafts and construction seem to experience a positive and significant wage deviation if they change their employer, we cannot observe any significant effect for people working in metal professions or electronics, IT, and chemicals. This result indicates that, comparing wages at the entry of the first job, only some of the professions are investment-driven. The main part of apprentices does not experience significant wage gains through changing the employer after apprenticeship. We have indicative evidence that there is no necessity for training employers to re-earn investments by low entry wages in the first skilled job.

When we change to our main estimation (see Table 2), using the deviation of the individual wage markup from the occupation-specific wage markup between last apprenticeship spell

Table 1: OLS - individual deviation from profession-specific average wage at entry to first job

	(I)		**(II)**	
	Coeff.	Std. Dev.	Coeff.	Std. Dev.
CHANGE	0.001	(0.003)	-	(-)
CHANGE X COMMERCIAL	-	(-)	0.024***	(0.004)
CHANGE X METAL-WORKING	-	(-)	-0.010	(0.007)
CHANGE X ELECT., IT, CHEMICALS	-	(-)	-0.011	(0.008)
CHANGE X HANDCRAFT, CONSTRUCTION	-	(-)	-0.035***	(0.005)
COMMERCIAL	0.024***	(0.004)	0.018***	(0.004)
METAL	0.007**	(0.004)	0.007*	(0.004)
ELECT., IT, CHEMICALS	ref.		ref.	
HANDCRAFT, CONSTRUCTION	0.082***	(0.004)	0.085***	(0.004)
AGE	0.003	(0.006)	0.003	(0.006)
AGE SQUARED	0.000	(0.000)	0.000	(0.000)
SEX	-0.023***	(0.002)	-0.023***	(0.002)
NATIONALITY	0.016***	(0.004)	0.016***	(0.004)
EAST	-0.268***	(0.003)	-0.267***	(0.003)
UNEMPLOYMENT	-0.052***	(0.017)	-0.045**	(0.017)
CHANGE PROFESSION	-0.015***	(0.005)	-0.012**	(0.005)
FIRM SIZE APP. DUMMIES	yes		yes	
FIRM SIZE EMP. DUMMIES	yes		yes	
FIRM SECTOR DUMMIES	yes		yes	
YEAR DUMMIES	yes		yes	
CONSTANT	-0.210***	(0.073)	-0.204***	(0.073)
N	43,929		43,929	
R^2	0.245		0.246	

Data Source: IABS scientific usefile 1993-2004. Std. Dev. in brackets. Own calculations.
Significance levels: * : 10% ** : 5% *** : 1%.

and first skilled job, we observe some different results as in the first estimation. Firstly, the overall effect of a change in employer remains insignificant and negative, suggesting that there are no differences between changers and stayers in their deviation from the mean wage markup by profession (Specification I).

Exploring the interaction effects (Specification II), reveals, contrary to the first estimation, that there are significant negative correlations between a change of employer for all occupation groups. For the occupation groups which were positive in the first estimation this could come from a positive selection of changers for apprenticeship or a positive selection of firms that train apprentices who change afterwards. In both cases, the changing apprentice gains a relatively higher wage before entering the first skilled job. The wage differences between stayers and changers decline when starting with the first skilled job. These results do not show any indication of apprenticeships in Germany creating net costs to training firms. Instead, we find changers in the two occupation groups commercial profession and handcraft/construction to be subject to positive selection during apprenticeship and changers in the other occupation groups to be on average 'lemons' or being employed in low-paying firms.

Table 2: OLS - individual deviation from profession-specific average wage markup between ending of apprenticeship and beginning of first job

	(I)		**(II)**	
	Coeff.	Std. Dev.	Coeff.	Std. Dev.
CHANGE	-0.004	(0.004)	-	(-)
CHANGE X COMMERCIAL	-	(-)	0.016***	(0.006)
CHANGE X METAL-WORKING	-	(-)	-0.046***	(0.011)
CHANGE X ELECT., IT, CHEMICALS	-	(-)	-0.022**	(0.011)
CHANGE X HANDCRAFT, CONSTRUCTION	-	(-)	-0.013	(0.008)
COMMERCIAL	0.004	(0.005)	-0.002	(0.006)
METAL	-0.006	(0.005)	-0.004	(0.006)
ELECT., IT, CHEMICALS	ref.		ref.	
HANDCRAFT, CONSTRUCTION	-0.006	(0.005)	-0.008	(0.006)
AGE	0.019**	(0.009)	0.018**	(0.009)
AGE SQUARED	-0.001***	(0.000)	-0.001***	(0.000)
SEX	-0.005	(0.004)	-0.005	(0.004)
NATIONALITY	0.001	(0.006)	0.002	(0.006)
EAST	0.005	(0.004)	0.005	(0.004)
UNEMPLOYMENT	0.046*	(0.026)	0.051*	(0.026)
CHANGE PROFESSION	0.016**	(0.007)	0.018***	(0.007)
FIRM SIZE APP. DUMMIES	yes		yes	
FIRM SIZE EMP. DUMMIES	yes		yes	
FIRM SECTOR DUMMIES	yes		yes	
YEAR DUMMIES	yes		yes	
CONSTANT	-0.088	(0.105)	-0.080	(0.105)
N	42,100		42,100	
R^2	0.011		0.012	

Data Source: IABS scientific usefile 1993-2004. Std. Dev. in brackets. Own calculations.
Significance levels: * : 10% ** : 5% *** : 1%.

6 Conclusions

Conclusions are quite difficult to draw at that point. Intuitively we would have expected the second and third occupation group (metal industry as well as electronics, IT and chemicals) to be the investment-driven apprenticeships. We couldn't find support for this hypothesis. Up to now, we have the impression that 'lemons' override the effect, we wanted to disentangle. Another reason could be that changers are systematically changing to firms which pay a low wage compared to the market as such.

We plan to investigate whether there are profession-specific wage differences *within* firms regarding the place of training (outside or inside the firm) of the employee. Within productive apprenticeships, wage differences between changers and stayers at the entry to a first skilled job must be insignificant. Employees trained by the firm itself should, according to the investment argument for some professions, receive lower wages than trainees from other firms. On the other hand, the firms' own trainees may also be more productive than trainees from other firms. We will investigate which effect dominates conditioning on size, sector and structure of the firm.

References

Acemoglu, D. & Pischke, J.-S. (1999), 'Beyond Becker: Training in Imperfect Labour Markets', *The Economic Journal* **109**(453), F112–F142.

Backes-Gellner, U. & Mohrenweiser, J. (2008), 'Is Apprenticeship Training Really a Human Capital Investment?', *mimeo* .

Beicht, Ursula, G. W. & Herget, H. (2004), *Kosten und Nutzen der betrieblichen Berufsausbildung in Deutschland*, Bertelsmann, Bielefeld.

Bougheas, S. & Georgellis, Y. (2004), 'Early Career Mobility and Earnings Profiles of German Apprentices: Theory and Empirical Evidence', *LABOUR* **18**(2), 233–263.

Dustmann, C., Euwals, R. & van Soest, A. (1997), 'Wages in the First Job after Apprenticeship: Movers versus Stayers', *MittAB* **30**(3), 671–674.

Euwals, R. & Winkelmann, R. (2002), 'Mobility after Apprenticeship - Evidence from Register Data', *Applied Economics Quarterly* **48**(3-4), 256–278.

Fitzenberger, B. & Spitz, A. (2004), 'Die Anatomie des Berufswechsels: Eine empirische Bestandsaufnahme auf Basis der BIBB/IAB-Daten 1998/1999', *MittAB* **36**(4), 509–524.

Freeman, R. & Schettkat, R. (2001), 'Skill Compression, Wage Differentials and Employment: Germany vs. the US', *Oxford Economic Papers* **53**(3), 582–603.

Harhoff, D. & Kane, T. J. (1997), 'Is the German Apprenticeship System a Panacea for the U.S. Labor Market?', *Journal of Population Economics* **10**(2), 171–196.

Mohrenweiser, J. & Zwick, T. (2008), 'Apprenticeship Training and Firm Productivity', *mimeo* .

Muehlemann, S., Schweri, J., Winkelmann, R. & Wolter, S. C. (2007), 'An Empirical Analysis of the Decision to Train Apprentices', *LABOUR* **21**(3), 419–441.

Steedman, H. (2001), 'Benchmarking Apprenticeship: UK and Continental Europe Compared', *CEP Discussion Paper* (513).

Velling, J. & Bender, S. (1994), 'Berufliche Mobilität zur Anpassung struktureller Diskrepanzen am Arbeitsmarkt', *MittAB* **27**(3), 212–231.

Werwatz, A. (2002), 'Occupational Mobility after Apprenticeship - How Effective is the German Apprenticeship System?', *Applied Economics Quarterly* **48**(3-4), 279–303.

Wolter, S. C. & Schweri, J. (2002), 'The Cost and Benefit of Apprenticeship Training: The Swiss Case', *Applied Economics Quarterly* **48**(3-4), 349–367.

Zwick, T. (2007), 'Apprenticeship Training in Germany - Investment or Productivity Driven?', *Zeitschrift für Arbeitsmarktforschung* **40**(2/3), 193–204.

Table A.1: Variable Definition

Variable	Type*	Definition
Variable of interest		
CHANGE	0/1	1 if individual has changed employer after apprenticeship
CHANGE X PROFESSION	0/1	1 if individual has changed employer after apprenticeship and is employed in a specific profession
PROFESSION DUMMIES	1	commercial professions
	2	metal-working industry
	3	electronics, IT and chemicals
	4	handcraft and construction
Explanatory variables		
AGE	c	age of individual at time of first employment
AGE SQUARED	c	squared age of individual at time of first employment
SEX	0/1	1 if individual is female
NATIONALITY	0/1	1 if individual has non-German nationality
EAST	0/1	1 if individual lives in Eastern Germany
UNEMPLOYMENT	0/1	1 if individual experienced unemployment after apprenticeship
CHANGE PROFESSION	0/1	1 if individual changed the occup. group after apprenticeship
FIRM SIZE APP.	0/1	size of the training firm, dummies for categories from 1 = less than 10 to 8 = more than 5,000 employees
FIRM SIZE EMP.	0/1	size of the employing firm, dummies for categories from 1 = less than 10 to 8 = more than 5,000 employees
FIRM SECTOR DUMMIES	1	water and power
	2	manufacturing
	3	construction
	4	trading
	5	traffic and communication
	6	finance
	7	hotel and restaurant industry
	8	rent and lease
	9	services
Y1994 TO Y2004	0/1	year dummies for 1994 to 2004, ref.: 1993

Notes: * c = continuous variable

Table A.2: Summary statistics

Variable	Mean	Std. Dev.	Min	Max
deviation entry (in log)	0.036	(0.233)	-0.963	0.627
deviation markup (in log)	0.013	(0.287)	-2.188	1.392
change	0.155	(0.362)	0	1
change X commercial	0.080	(0.271)	0	1
change X metal-working	0.020	(0.139)	0	1
change X elect., IT, chemicals	0.020	(0.139)	0	1
change X handcraft, construction	0.036	(0.186)	0	1
commercial	0.439	(0.496)	0	1
metal	0.186	(0.389)	0	1
elect., IT, chemicals	0.124	(0.329)	0	1
handcraft, construction	0.252	(0.434)	0	1
age	21.128	(2.061)	16	30
age squared	450.631	(92.446)	256	900
sex	0.386	(0.487)	0	1
nationality	0.063	(0.243)	0	1
East	0.119	(0.324)	0	1
unemployment	0.003	(0.053)	0	1
change profession	0.044	(0.205)	0	1
firm size app. < 10	0.186	(0.389)	0	1
firm size app. 10 - 49	0.297	(0.457)	0	1
firm size app. 50 - 99	0.112	(0.315)	0	1
firm size app. 100 - 249	0.137	(0.344)	0	1
firm size app. 250 - 499	0.089	(0.284)	0	1
firm size app. 500 - 999	0.073	(0.260)	0	1
firm size app. 1000 - 4999	0.078	(0.269)	0	1
firm size app. > 5000	0.029	(0.166)	0	1
firm size emp. < 10	0.192	(0.394)	0	1
firm size emp. 10 - 49	0.304	(0.460)	0	1
firm size emp. 50 - 99	0.113	(0.316)	0	1
firm size emp. 100 - 249	0.134	(0.341)	0	1
firm size emp. 250 - 499	0.085	(0.279)	0	1
firm size emp. 500 - 999	0.068	(0.252)	0	1
firm size emp. 1000 - 4999	0.075	(0.264)	0	1
firm size emp. > 5000	0.029	(0.167)	0	1
water and power	0.014	(0.119)	0	1
manufacturing	0.354	(0.478)	0	1
construction	0.148	(0.356)	0	1
trading	0.187	(0.390)	0	1
traffic and communication	0.038	(0.192)	0	1
finance	0.099	(0.299)	0	1
hotel and restaurant industry	0.034	(0.181)	0	1
rent and lease	0.082	(0.274)	0	1
services	0.044	(0.205)	0	1
year dummies	yes	-	-	-
Observations	42,100			

Data Source: Sample drawn from IABS scientific usefile 1993-2004. Own calculations.