Discussion Paper No. 03-57

The Impact of Training on Earnings – Differences Between Participant Groups and Training Forms

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Non-Technical Summary

While there is a broad literature on the general wage effect of training, little is known about the effects of different types of training and about the effects for heterogeneous training participants. This study therefore adds two aspects to the literature on earnings effects of training. First, the earnings effect of training is calculated for different "types" of employees, i.e. discriminating between qualification level, experience, job tenure, and other personal and employer attributes. Second, we distinguish between the earnings impact of different training forms. For our analysis, we use the "Qualification and Career survey", a rich German data set with information on 0.1 percent of all individuals employed in Germany in 1998/1999. We use a one-step full information maximum likelihood and a two-stage least squares estimation to regress the impact of training participation on earnings. Hereby, we correct for the endogeneity of training participation using external instrumental variables. By additionally using a broad list of employee and employer characteristics, we try to avoid omitted variable bias.

We find that the impact of participation in training on income is significantly positive. Training comprises any of the following: courses and seminars, participation in trade fairs, lectures, on-the-job training, quality circles, special tasks, and reading of specialist literature. Correcting for the endogeneity bias, the average treatment effect increases from 0.10 to 0.15. The effect of training on earnings differs for heterogeneous agents. High-skilled workers profit more from training than low-skilled workers, job entrants obtain a higher earnings increase after participation in training than workers with a long job tenure, and workers with a temporary contract profit less from training than those with a permanent job contract.

The increase in the income effects of training if endogeneity is taken into account, compared with the case where selection is assumed to be random, suggests that our instrumental variables reduce the measurement error in the OLS regression and capture heterogeneous training returns more properly. This is plausible because our dummy variable for training inadequately captures training intensity and training effort. The alternative possibility for this phenomenon, a negative selection into training, seems unlikely given previous empirical evidence that training is seldomly remedial.

A factor analysis shows that our seven continuing vocational training types are highly correlated and only two factors are independent. These factors can be labelled "external" for participation at trade fairs, lectures, courses and seminars, and reading of specialist literature and "internal training" for on the job training, quality circles, and special tasks. Without controlling for endogeneity, external training has a significant positive impact on wages, while the wage effect of internal training is insignificant. Taking endogeneity into account and instrumenting the decision to participate in internal or external training, the coefficient of external training rises from 0.05 to 0.13, while internal training stays insignificant.

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September 16, 2003

* We thank Bernd Fitzenberger, Wolfgang Franz, Alfred Garloff, Alexander Spermann, and Alexandra Spitz for helpful comments and especially Friedhelm Pfeiffer, who provided important advice throughout our work. Anja Kuckulenz thanks the Deutsche Forschungsgemeinschaft (DFG) for financial support. We thank Tobias Tönnesmann for his excellent assistance. Neither the BIBB, the IAB nor the ZA take any responsibility for the analysis or the interpretation of the data presented here.

Abstract

While there is a broad literature on the general wage effect of training, little is known about the effects of different training forms and about the effects for heterogeneous training participants. This study therefore adds two aspects to the literature on earnings effects of training. First, the earnings effect of training is calculated for different "types" of employees, i.e. discriminating between qualification level, experience, job tenure, and other attributes. Second, we distinguish between the earnings impact of external and internal training. For our analysis, we use the "Qualification and Career survey", a rich German data set with information on 0.1 percent of all individuals employed in Germany in 1998/1999. We use a one-step full-information maximum likelihood and a two stage least squares estimation to regress the impact of training participation on earnings correcting for the endogeneity of training participation. By using a broad list of employee and employer characteristics, we try to avoid omitted variable bias. We find the training earnings mark-up to be positively correlated with qualification and experience. The analysis of internal and external training reveals that this result is driven by external training only. Internal training does not have a significant earnings effect. The correction for selection into training leads to an increase in the training coefficients and a decrease of its significance.

JEL classification: C31, J24, J31

Key words: continuing training, returns to training, endogeneity, employee heterogeneity, training forms

1 Introduction

According to the seminal work by Becker (1964) and Mincer (1974), individual variation in wages and increasing wage profiles can be explained by differences in human capital and by skill increases induced by experience and continuing vocational training. Training after entering the labor force constitutes a major part of human capital investments (Heckman, 1999). If the investment is profitable, returns are higher than direct and indirect costs of training. The rent from the investment in human capital can be captured by the employer, by the employee or will be shared between the two parties.[1] This depends, above all, on who has paid for the training and on the bargaining power of employer and employee. A large microeconomic literature analyzes the impact of continuing vocational training investment on productivity and a small literature discusses the rent distribution. The empirical literature can be separated in two parts, depending on the data used. With firm data, the impact of training on productivity and profit is investigated, with employee data, the effect of training on wages is estimated. This paper adds to the latter strand of the literature. Its special emphasis is on the heterogeneity of the effects of different training types and of different groups of training participants in Germany.

In studies on the impact of training on wages, usually training incidence is measured and not the kind or specificity of training. Only some authors differentiate between on-the-job and off-the-job training (Lynch, 1992; Pischke, 2001), employer provided and not employer provided training (Blundell, Dearden and Meghir, 1999), formal and non-formal training (Pfeiffer and Reize, 2001) and, following Becker, between general and specific training (Loewenstein and Spletzer, 1997). Assuming that turnover costs do not exist, the wage effects of general and specific training should differ. Firm-specific training does not increase the productivity of workers in other jobs, and therefore no wage increase is necessary to keep the worker in the present job. In contrast, general training increases the productivity of a worker in at least one other job. Therefore, employees may profit from general training by increased wages. As a consequence, it can be assumed that the impact of training on wages depends on the degree of specificity of the training received (Lynch, 1992 or Blundell et al., 1999). In practice, it is not trivial to distinguish between general and specific training, however, since continuing vocational training often comprises both (Booth and Snower, 1996, chapter 3). Lazear (2002) argues that there is no firm-specific training; it is only the composition of the skills needed which is specific to firms. The classifications "on-the-job" and "off-the-job", "employer provided" and "not employer provided" and "non-formal" and "formal training" are usually motivated as proxies for training with more firm-specific elements (on-the-job, employer provided and non-formal) and more general training (off-the-job, not employer provided and formal), which is easier portable between jobs. Overall, empirical studies find that training measures with higher general contents have a stronger productivity effect than training measures with higher

[1] If externalities exist, also other agents (e.g. consumer, other employees, other firms) can profit from the investment.

firm-specific contents.[2] The empirical evidence is not clear cut as can be seen in table 9 and will be discussed later.

Not only the type of training may have an impact on earnings, but also the type of training participant. Heckman (1999) suggests that trainability increases with qualification and tenure and that the effect of training on productivity is larger for higher educated employees. Therefore, it can be assumed that the qualification level and tenure as well as maybe other characteristics might have an impact on the returns to training. Nevertheless, only few empirical studies discriminate between the wage effect for different groups of employees by estimating separate regressions for each group. Lynch (1992) calculates the training impact of different training types separately for different education groups, gender, and unionized versus non-unionized workers. Pannenberg (1998) uses interaction terms of training and company tenure dummies and experience dummies to differentiate the impact of training on income between employees with different company tenure and experience. He reports that wage effects of training are highest for job entrants. Lynch (1992) finds that the wage impact of training can be even negative for less educated employees, and Blundell, Dearden and Meghir (1996) find that returns to training are highest for middle or highly educated individuals.

Finally, there is wide agreement that the group of employees participating in training is different from the group that does not with respect to unobservable characteristics (Heckman, 1999; Card, 1999) . Employers might tend to offer training only to those individuals who are more trainable, while better motivated individuals may be more likely to pursue off-the-job training (Lynch, 1992). Bartel (1995) finds for technical and core training[3] that individuals whose salaries are higher than those of comparable individuals in the same firms have a higher probability to attend training.[4] Other authors also argue that those individuals who are on a career path with rapidly growing income are more likely to participate in training (Pannenberg, 1997; Pfeiffer and Reize, 2001; Pischke, 2001). Therefore, adequate instrumental variables have to be found that explain the selection into training participation to correct for treatment selection.

This study mainly adds two new aspects to the literature on earnings effects of training. First, we show that the earnings effect of training varies between different "types" of employees, i.e. discriminating between qualification level, experience, job tenure, and many other attributes. Second, we distinguish between the impact of internal and external training measures on earnings. In both cases, the endogeneity of training participation

[2]Some authors have also analysed employment effects of different training types. As Fitzenberger and Prey (1997) show for East Germany, training outside of the firm has a strong negative impact on employment probabilities, while training in the firrm has a positive effect.

[3]"Core" training is mainly management and leadership training, development training mainly entails presentation and communication workshops and management techniques, while technical programs include project management, statistics, quality control, and computer programming.

[4]Hence, she labels these types of training as career advancement training. Development training is remedial, however, i.e. the lower an individual's relative wage status, the more likely he or she is to receive this type of training.

is corrected by using instrumental variables. For our analysis, we use a rich and representative German data set with information on 0.1 percent of all individuals employed in 1998/1999 - the BIBB/IAB data set "Qualification and Career Survey".

The paper is structured as follows. In the next section, the theoretical background and our econometric methods are briefly discussed. Then, we present the data set and the variables used. This is followed by the empirical evidence, where we first present some descriptive statistics. Second, we estimate the effect of training on the earnings of heterogeneous participants in training, and third we distinguish between the wage effects of internal and external training. After that, we compare our results to the findings of the literature based on individual as well as on firm data. Finally, we conclude with a summary of our results and an outlook for further research.

2 Background Discussion

In order to explain earnings, economists traditionally use the so-called Mincer equation, a standard tool in human capital theory. Here, earnings are explained by schooling, experience, experience-squared, and a constant[5]:

$$lnY = \mu_0 + \beta_1 S + \beta_2 EX + \beta_3 EX^2 + e, \tag{1}$$

where ln Y is the natural logarithm of earnings, S schooling, EX experience, EX^2 experience-squared, and μ_0 a constant. The error term is labelled $e \sim \mathrm{N}(0, \sigma^2)$. Experience enters also as a squared term in order to allow earnings to increase with experience with a decreasing rate. In the standard Mincer equation, the growth of earnings over working life, i.e. the experience wage profile, reflects workers returns to investments in human capital and seniority wages (Franz, 2003). As Mincer puts it: "The human capital earnings function contains, among other variables, years of (work) experience, (...), which enters in a nonlinear fashion. Its coefficients are interpretable as postschool human capital investment parameters" (Mincer, 1991, p. 32). This means, however, that postschool human capital investments are proxied here by work experience or, in other words, left as a black box. In order to open the black box, we use a dummy for continuing vocational training T as an additional explanatory factor for earnings:

$$lnY = \mu_0 + \alpha T + \beta_1 S + \beta_2 EX + \beta_3 EX^2 + e. \tag{2}$$

[5] A theoretical derivation of the standard Mincer equation from earnings defined by earnings capacity minus training investments is provided by Franz (2003). Recently, Heckman, Lochner and Todd (2003) have examined the theoretical foundations and empirical support for the Mincer earnings regression.

Adding information on training to the basic Mincer earnings equation should take away some of the explanatory power of the coefficients of work experience. Our data set allows us to capture part of the observable individual heterogeneity left in standard Mincer equations by using a large variety of additional explanatory variables, X, such as workplace characteristics, professional career and personal characteristics of the employee[6]:

$$lnY = \mu_0 + \alpha T + \beta_1 S + \beta_2 EX + \beta_3 EX^2 + \beta_4 X + e. \tag{3}$$

In the introduction, we argued that the earnings impact of training may crucially depend on the kind of training the employees receive and also on characteristics of the training participants. Therefore, we include a full set of interaction terms between training and employee characteristics in order to allow for group-specific returns to training. This specification, suggested by Wooldridge (2002), allows us to calculate the average treatment effect of training and to show that the effect on earnings varies for employees with different professional careers, workplace characteristics, school attainment, professional status, and other characteristics:

$$\begin{aligned} lnY &= \mu_0 + \alpha T + \beta_1 S + \beta_2 EX + \beta_3 EX^2 + \beta_4 X + \delta_1 T(S - \overline{S}) \\ &\quad + \delta_2 T(EX - \overline{EX}) + \delta_3 T(EX^2 - \overline{EX}^2) + \delta_4 T(X - \overline{X}) + e. \end{aligned} \tag{4}$$

Employees who participate in training are not randomly selected. We show in the introduction that unobservable employee characteristics, such as intrinsic motivation, career orientation or social behavior, influence both, earnings and training participation. Therefore, the impact of training included as a dummy variable in an OLS earnings equation tends to be biased, because the error term of the earnings equation might be correlated with the probability of receiving company training. To consider the effect of an endogenously chosen binary treatment (training), we estimate a treatment effect model that is conditional on two sets of independent variables explaining $ln\ Y$ and T. The treatment equation measures the unobserved net benefit to the individual and employer from providing training, T^*. Assuming that firms offer training only if the net benefit is positive, we find:

$$\begin{aligned} T^* &= Zg + u > 0 \\ T &= 1 \text{ if } T^* > 0 \\ T &= 0 \text{ if } T^* \leq 0, \end{aligned} \tag{5}$$

where Z is a vector of individual and employer characteristics not included in X, determining whether an individual takes part in training or not, and the error term $u \sim$N(0,1),

[6]Bartel (1995) includes objective measures of firm performance and information about the relative wage status of the individual (compared to other employees in the same job) to eliminate the heterogeneity bias in the estimation of the impact of training on wages and job performance.

$\text{corr}(e, u) = \rho$. If Z indicates participation in training, we estimate by IV, using as instruments constant, Z, S, EX, EX^2, X, and interactions of Z with all demeaned covariates. For consistency, we must assume that the covariance conditional on (S, EX, EX^2, X, Z) is constant, which might not be exactly but approximately true (Wooldridge, 2002).

Most data sets do not provide suitable additional variables that meet the requirements for qualifying them as identifying variables in an instrument regression. In the case of panel data, lagged values or differences of the explaining variable in question are often used as instruments.[7] This strategy is problematic, however, because the instruments are often only weakly correlated with the endogenous variables. Therefore, it is preferable to use external instruments z that intuitively explain the selection process in the establishment and are correlated with training incidence but not with earnings (Griliches and Mairesse, 1998).

The one-step full-information maximum likelihood estimator (FIML) is based on the entire system of equations and treats all equations and all parameters jointly. With normally distributed disturbances, the estimator is more efficient than the two stage least squares (2SLS) estimator. To test the robustness of our specification, we use both, FIML and Heckman's two-step consistent estimator. Our preferred estimation equation therefore contains the instrumented training coefficient:

$$\begin{aligned} lnY &= \mu_0 + \alpha\widehat{T}^* + \beta_1 S + \beta_2 EX + \beta_3 EX^2 + \beta_4 X \\ &\quad + \delta_1\widehat{T}^*(S - \overline{S}) + \delta_2\widehat{T}^*(EX - \overline{EX}) \\ &\quad + \delta_3\widehat{T}^*(EX^2 - \overline{EX}^2) + \delta_4\widehat{T}^*(X - \overline{X}) + e, \end{aligned} \tag{6}$$

where $\widehat{T}^*$ is the estimated participation in training from (5).

In order to take heterogeneity in the wage effect of different training types into account, we additionally differentiate between training forms. A factor analysis (see below) shows that there are two independent bundles of training forms that can intuitively be labelled: internal training, T_i, and external training, T_e. Analogously to the approach described above, we estimate:

$$\begin{aligned} lnY &= \mu_0 + \alpha_1 T_i + \alpha_2 T_e + \beta_1 S + \beta_2 EX + \beta_3 EX^2 + \beta_4 X \\ &\quad + \delta_1 T_i(s - \overline{s}) + \delta_2 T_i(EX - \overline{EX}) + \delta_3 T_i(EX^2 - \overline{EX}^2) \\ &\quad + \delta_4 T_i(X - \overline{X}) + \delta_1 T_e(S - \overline{S}) + \delta_2 T_e(EX - \overline{EX}) \\ &\quad + \delta_3 T_e(EX^2 - \overline{EX}^2) + \delta_4 T_e(X - \overline{X}) + e. \end{aligned} \tag{7}$$

[7] Lynch (1992), for example, uses "somewhat artificial exclusions of explanatory variables" (p. 309) in order to cure the endogeneity of training participation, while Goux and Maurin (2000) use time lags for identification.

When distinguishing between internal and external training in the second part of the empirical analysis, we again account for the endogeneity of training by using external instrumental variables, Z, analogously to the model presented above.

$$\begin{aligned} lnY &= \mu_0 + \alpha_1 \widehat{T}_i^* + \alpha_2 \widehat{T}_e^* + \beta_1 S + \beta_2 EX + \beta_3 EX^2 + \beta_4 X \\ &\quad + \delta_1 \widehat{T}_i^* (S - \overline{S}) + \delta_2 \widehat{T}_i^* (EX - \overline{EX}) + \delta_3 \widehat{T}_i^* (EX^2 - \overline{EX}^2) \\ &\quad + \delta_4 \widehat{T}_i^* (X - \overline{X}) + \delta_1 \widehat{T}_e^* (S - \overline{S}) + \delta_2 \widehat{T}_e^* (EX - \overline{EX}) \\ &\quad + \delta_3 \widehat{T}_e^* (EX^2 - \overline{EX}^2) + \delta_4 \widehat{T}_e^* (X - \overline{X}) + e, \end{aligned} \tag{8}$$

where $\widehat{T}_i^*$ and $\widehat{T}_e^*$ are the jointly estimated probabilities to participate in external or internal training.

The quintessence of this paper is to test the hypothesis that the impact of training on earnings depends on employee and workplace characteristics and also on the type of training. In the following section, the data and variables we use for the empirical estimation are described.

3 Data

In order to analyze the impact of training on earnings empirically, we use a rich data set, compiled from a representative sample of 0.1 percent of all individuals employed in Germany. The BIBB/IAB "Qualification and Career survey" ("Berufliche Qualifikation und Erwerbsarbeit") is jointly ascertained by the Research Institute of the Federal Labor Office (Institut für Arbeitsmarkt- und Berufsforschung, IAB Nürnberg) and the Federal Institute for Vocational Training (Bundesinstitut für Berufsbildung, BIBB Berlin). The survey is implemented every seven years, but it is not a panel. We will use the latest wave available, which is from the survey in 1998/99. It comprises more than 34.000 employees. The cross-section data on employed individuals in Germany contain detailed information on the qualification and the professional career of each individual, the organizational and technological environment of jobs, and the qualifications demanded for jobs. Furthermore, information about the employer and some personal attributes are included. Specifically, we use the following variables (see also table A1 in the appendix for the complete list with detailed descriptions and table A11 for a German translation of selected variables):

- The endogenous variable is log midpoints of earnings from 18 categories.[8]
- The key explanatory variable is participation in training during the last two years. On the one hand, it is asked whether the individual participated in courses or seminars. On the other hand, participation in different training categories is ascertained, such as participation in fairs, lectures, on-the-job training, specific company training, or taking over special tasks as well as reading technical literature.[9] By combining both questions, we obtain a dummy for participation in training. In addition, we selected those six specific training forms mentioned above from the second question plus participation in courses and seminars in order to calculate the different wage effect of these training forms. An important measurement problem of our training variables is that they do not include information on the length and costs of the training attended.
- Furthermore, individuals were asked to state in which specific fields they need further training. This information will be used for our external identifying variables for the participation in training courses, because it will be shown that these variables are correlated with training but not with wages.
- The second set of external identifying variables originates from questions on the changes in the workplace, such as downsizing or restructuring.
- Further explanatory variables are those found in the Mincer equation from the professional life, i.e. actual work experience[10], job tenure, former unemployment, and dummies for the highest educational achievement.
- Along with these standard variables, we also include some dummies capturing the professional status, such as blue-collar or white-collar worker, civil servant or different sophistication levels of tasks.
- In addition, we use the following job characteristics: computer use, profit-sharing, bonus payments, overtime work, whether a job is temporary, and main job contents.

[8]The first category includes all earnings below 600 DM, the second includes earnings from 600 DM until 1,000 DM. The following categories comprise earnings intervals of 500 DM up to 6,000 DM. From 6,000 DM to earnings of 10,000 DM, the intervals are in steps of 1,000 DM. The next category comprises earnings from 10,000 DM until 15,000 DM and the last category includes all earnings of 15,000 DM, and above. Most earnings can be found in the categories between 3,000 DM and 5,000 DM, see table A1 in the appendix for descriptive statistics.

[9]There are two questions on the participation in continuing training. First, "Please think about the last five years, i.e. the time from 1994 until today. Did you attend during this time any seminars or courses which serve your continuous process of education?" Here, only those workers who participated in training during the last two years are included. Second, "Which of the following possibilities to take part in continuous training did you use during the last two years, i.e. from the beginning of 1997 onward, in order to aquire additional knowledge?" Here, eight training categories are included. We chose not to use two of these categories, "internship" and "other kinds of training", because it is unclear what kind of training on the job is behind these variables.

[10]We have information about the time when the job market was entered, and we include dummies for discontinuations like unemployment or maternity leave.

These variables allow us to control a large part of the individual heterogeneity between the employees.[11] Some of these variables (for example working overtime) can be interpreted as indicators for intrinsic motivation.

- Additional control variables explaining earnings are personal attributes. We include a dummy for children and German nationality.

- Finally, we also control for the size of community the individual lives in and the firm size. Dummies for German states ("Länder") and dummies indicating the economic sector of the employer are included.

Only employees in West Germany are included, because in 1998 there were still large differences in the labor market structures of the two parts of the country.[12] The analysis is restricted to male employees, because the data do not allow us to model participation in the labor market simultaneously, which would be important for examining earnings effects for women. Hours worked vary widely in the data and we found a number of implausibly high reported values. Therefore, we only use full-time[13] employees and do not take reported working hours into account.[14]

In order to obtain clean evidence on the earnings effects of employee training, we include only those workers who received training from their current employer. This means that we exclude all employees who have participated in training during the last two years and changed the employer during this period. The reason for this restriction in our sample is that our data do not give information whether training was provided by an employer or whether it was sponsored by the government and aimed at unemployed. Fitzenberger and Speckesser (2000) note that the effects of training sponsored by the government for unemployed and training paid by private enterprises should be analyzed separately.

Before turning to the estimation of our extended Mincer equation, the specificity of the data has to be taken into account. In our data set, the information on income is given in interval-coded data, i.e. the income is registered by 18 narrow intervals (see the description above). In order to estimate the earnings equation consistently, we therefore need to make a distributional assumption. On the one hand, we can use an interval regression which estimates the coefficients and variances by maximum likelihood, such as ordered probit with fixed cut points. The coefficients can be interpreted here as if we had observed the exact income for each individual and estimated the earnings regression by OLS. The underlying assumption which allows us to use the ordered probit estimator is that earnings, given the set of explanatory variables, satisfys the assumptions of the

[11] Some of these variables may also be endogenous in the earnings equation. We do not control this, however, because the variables mainly serve as control variables for employee heterogeneity.

[12] See Gang and Yun (2002) or Riphahn (2001).

[13] We include only employees working 30 hours and above per week. Only 2.6 percent of the males work less than 30 hours. Also, we use a dummy for working overtime in order to take hours worked into account.

[14] The results do not change qualitatively, however, if we use log hourly wages instead of log earnings as the dependent variable.

classical linear regression model. We take log earnings as cell limits because earnings are strictly positive (Wooldridge, 2002). On the other hand, we can employ an OLS regression, simply taking the log of the mean value of each earnings category. Here, we assume that on average individual earnings in one category are the mean value of this interval. We do not find any differences in coefficients between exploratory interval and OLS regressions. In addition, the t-values of the OLS regression are very close to those of the interval regression and the standard errors only slightly deviate (the estimation results for these robustness checks are presented in table A2 in the appendix). For convenience and since the results are not influenced by the estimation method used, we will take the log midpoints of the earnings categories and estimate the earnings equation with OLS techniques instead of using maximum likelihood methods in the following analysis (see also Pfeiffer and Reize, 2001).

4 Empirical Evidence

This section consists of three parts. First, we present some descriptive statistics and show some robustness tests to introduce the data set. In the second part, the earnings effect of a training dummy is evaluated. And third, we estimate the earnings effect of different training types.

4.1 Descriptive Statistics

In table 1, participation in seven different training forms are shown for full-time working men. In total, 55 percent of males participated in some kind of training. As any kind of training within two years is included here, this data set reports higher participation in training than other German data sets.[15] Relying on the German SOEP, Pischke (2001) for example reports that 31 percent of employed males participated in any training in 1986. Participation rates of males in our selected training forms differ between 13 and 26 percent.[16] About 13 percent of the males report to be assigned to jobs including special tasks in order to extend their skills and gain experience and 14 percent participate in quality circles. Around 17 percent of the male full-time workers obtain on-the-job training, 18 percent attend trade fairs, and 26 percent attend seminars and presentations on specific topics or read technical literature.

[15] According to the German ministry of education and research, "Bundesministerium für Bildung und Forschung (BMBF)", no uniform statistics on training exist. There are several official sources (Mikrozensus, SOEP, IAB-Betriebspanel, CVTS, and IW-Erhebung) reporting different numbers (Kuwan et al., 2003).

[16] For all types of training, we observe a larger attendance of men than of women. This difference in participation of women and men becomes much stronger when we include also part-time workers which are mostly women.

As can be seen from the correlation matrix in the appendix (table A3), individuals often take part in several kinds of training, and therefore some training forms are highly correlated with each other. Specifically, those employees reading technical literature are rather likely to visit also trade fairs and to attend seminars and presentations. This means that we cannot discern the earnings influences of all individual training measures. A factor analysis allows the separation of independent factors underlying the individual training forms, however. The factor analysis in table 2 reports that the 7 categories of training can be divided into two independent factors with eigen values above 1. These two factors explain 52 percent of the total variation. We can intuitively distinguish between internal training, including participation in on-the-job training, company programs, and the assignment of special tasks, and external training, including courses and seminars, the visit of trade fairs, the attendance of seminars, and reading of specialist literature. Tentatively, we argue that internal training has a higher share of specific training content in comparison to our external training measures.

Table 1: Participation in Training

Type of Training	Men in % N=9800
Courses and Seminars	26.72
Trade Fair	18.09
Lecture	25.90
Specialist Literature	26.11
Quality Circle	14.07
Special Tasks	12.86
On-The-Job Training	16.70
Any Kind of Training	55.43

Source: BIBB-IAB 1998/99, own calculations.

Table 2: Rotated Component Matrix[a] of Factor Analysis: Types of Training

Factor	*Factor Value*	*Variables*	*Factor loadings[b]*
1: External Training	2.54	Trade Fair	0.78 (-0.22)
		Lecture	0.81 (-0.01)
		Specialist Literature	0.76 (-0.00)
		Courses and Seminars	0.61 (0.20)
2: Internal Training	1.07	On-The-Job	0.81 (-0.19)
		Quality Circle	0.55 (0.14)
		Special Tasks	0.53 (0.19)

Notes: [a] The factors have been rotated by promax.
[b] In the brackets, you find the factor loading of the factor not chosen.
Source: BIBB-IAB 1998/99, own calculations.

Participation in training also depends on the qualification of the employee. In table 3, the attendance of any kind of training is sorted by qualification. Analogously to the

literature (Blundell, Dearden and Meghir, 1996; Heckman, 1999; Pischke, 2001; Pfeiffer and Brade, 1995), we find that individuals with higher education participate more often in training, and private sector training mainly excludes low-skilled persons. This applies to school attainment as well as to professional or vocational training. Attendance in training of employees without a professional degree is lowest, only 28 percent have participated in some kind of training. In contrast, 85 percent and more of the employees with a university degree have taken part in continuing vocational training during the last two years.

Table 3: Participation in Training (sorted by qualification)

Education	Men in % N = 9800
School Attainment	
Without School Leaving Certificate	39,88
Lower Secondary School	42,69
Intermediate Secondary School	62,31
Entrance Examination for University for Applied Sciences	81,64
High School Diploma	78,60
Professional/Vocational Training	
Without Professional Degree	27,88
Full-Time Vocational School	51,15
Apprenticeship	50,45
Master Craftman	76,60
University for Applied Sciences	87,31
University	84,96
Total	55,43

Source: BIBB-IAB 1998/99, own calculations.
Full-time working males.

In order to check the robustness of our results with respect to the specification, we first estimate a slightly modified Mincer equation, with log earnings as the endogenous variable and including experience, experience-squared and a set of dummy variables, indicating primary and secondary education as controlling variables. The results of the Mincer equation are in line with similar studies for Germany (see Franz, 2003).[17] As expected, income is higher for workers with more experience, but it increases at a decreasing rate since the coefficient for experience-squared is negative. With more school attainment and higher professional degrees, income increases (compare table A4).

As expected, adding the training dummies to the basic earnings equation takes away some of the explanatory power of the coefficients of work experience and decreases the coefficients of the school attainment and professional degree dummies. The coefficients of the education variables decrease in the extended Mincer equation, because training replaces some of the knowledge or adds to what has been learned in school and professional

[17]Even though the estimations in Franz (2003, chapter 3) are based on a pooled sample (1984 - 1993) from the German SOEP, coefficients and t-values are very close to our results.

education. If we differentiate between different training forms, the coefficient of training on the job is the only training variable with a negative, albeit insignificant coefficient, all others are positive. The additional information on investments in human capital increases the adjusted R^2 of the OLS regression from 32 to 38 percent. With a large number of variables controlling for firm and job characteristics and some other attributes, the coefficients of experience and experience-squared are unchanged but their t-values decrease. In addition, the coefficients of school attainment, vocational training, and continuing vocational training dummies as well as their t-values decrease. Here, the adjusted R^2 rises to 50 percent, indicating that the variables controlling for workplace and personal characteristics, professional career, professional status, and other attributes uncover part of the sample heterogeneity, which is unobserved in the standard Mincer equation (see tables A4 and A5 in the appendix).

4.2 Earnings Effect of Training Participation

In this section, we present our estimation results on the effect of participation in training during the previous two years on earnings. We find that training significantly increases earnings on average by five percentage points, see table A6. It is well-known from the literature that training participants differ from those employees who do not receive training. In order to validate this, we use a Chow test for the equality of the two sets of coefficients in linear wage regression models, to check whether the coefficients differ between participants and non-participants in training. As suggested by Card (1999), the test reveals that participants and non-participants not only differ in their earnings but also in several other aspects, and therefore the earnings equations should be estimated separately for training participants and non-participants.[18] Another alternative is to add interaction terms of the training dummy with all covariates. The inclusion of a full set of interaction terms allows us to estimate one wage regression for both groups in this specification, since a joint estimation of separate coefficients of participants and non-participants for all covariates is possible. The results of the wage equation including the interaction variables can be seen in table A7 in the appendix. The average treatment effect, i.e. the wage effect for an employee with reference characteristics (all dummies are zero), with mean professional experience (22 years) and mean tenure in the firm (14 years) is 6 percent. Therefore, earnings are on average by 6 percentage points higher for participants in training than for non-participants according to this specification. Depending on the qualification of the individual and some job attributes, the impact of training on earnings is higher or lower than the average treatment effect, however. We will discuss in detail below that high qualified and experienced employees profit much more from training than low-skilled workers just entering the labor market.

In order to evaluate the impact of training on earnings properly, we have to take the

[18]The test statistic is: $F(110, 8103) = 2.83$ Prob $> F = 0.0000$.

endogeneity of training into account. We instrument the training dummy and estimate a treatment effect model using one-step full information maximum likelihood. The determinants of participation are shown in the probit equation (table 4). Investments in human capital tend to be greater when (1) the expected earnings are greater, (2) the initial investment costs are lower, and (3) the investor has longer time to recoup the investment (Heckman, 1999). People with the ability to learn quickly are more likely to seek out and be presented by employers with learning opportunities. They are usually people who, because of their abilities, were best able to reap the benefits of formal schooling. This implies that those who invested more in schooling are likely to invest more in post-school training. In the literature on participation in training, besides years of schooling, firm size, length of job tenure, work experience, part-time working, unionization, and the level of technology used in the industry have been found as main determinants (Booth, Francesconi and Zoega, 2003; Gerlach and Jirjahn, 1998; Lynch and Black, 1998; Mincer, 1991; Pfeiffer and Brade, 1995; Pfeiffer and Reize, 2001; Shields, 1998; Goux and Maurin, 2000). We also find these variables to be crucial: highly skilled employees and also those employees who work with a personal computer and in larger firms receive training more often than others. Additionally, we calculate the probability to attend training depending on experience and firm tenure and thereby confirm the result of Pfeiffer and Reize (2001): employees attend continuing vocational training more frequently with a longer company tenure (but on a decreasing scale). With more work experience, participation in training decreases, it is highest for job entrants (see figure A1 in the appendix). Furthermore, we find that employees who work overtime or who receive incentive wages participate more often in training. These variables may be indicators for intrinsic motivation of the employee which may also be positively correlated with training incidence (Heckman, 1999). Participation probability increases with the professional status while employees with non-German nationality generally obtain continuing vocational training less frequently. Regional and sectoral labor market conditions are captured by 10 dummies for German states and 46 dummies for the economic sectors.

Our external identifying variables which determine participation in training but are uncorrelated with earnings are, first, the subjective need for specific training types. This especially applies to the need for training in job-specific areas, such as presentation techniques, management topics, computer technology or finance. A greater need for these training forms indicates that individuals have already participated. If, persons have a need for training in general topics, however, such as mathematics, they have less frequently participated in training during the last two years. This suggests that these individuals have also had a need for basic training in the past but that firms are not willing to provide this kind of training (Heckman, 1999). Our second set of external identifying variables indicates whether any restructuring has been taken place in the firm, such as downsizing or restructuring of the workplace.

Table 4: Selection into Training - Endogenous Variable: Training Dummy

Identifying Variables	
Training Needs	
Mathematics	-0.17 (-1.81) *
German	-0.00 (-0.04)
System Engineering	0.18 (1.71) *
Computer Engineering	0.11 (1.72) *
Other Engineering	0.38 (0.62) ***
Safety at Work	0.11 (1.85) *
Medicine	0.23 (1.91) *
Changes in the Workplace	
Downsizing	0.03 (0.54)
Restructuring	0.15 (2.97) ***

Education and Continuous Training	
School Attainment	
Without School Leaving Certificate	-0.02 (-0.21)
Lower Secondary School	-0.06 (-1.61)
Intermediate Secondary School	Reference
Entrance Examination for University for Applied Sciences	0.09 (1.21)
High School Diploma	-0.11 (-1.66) *
Vocational Training	
Without Professional Degree	-0.10 (-1.01)
Full-Time Vocational School	Reference
Apprenticeship	0.05 (0.54)
Master Craftman	0.28 (2.64) ***
University for Applied Sciences	0.27 (2.20) **
University	0.24 (1.89) *

Professional Career	
Professional Experience	-0.00 (-0.13)
Professional Experience Squared	-0.00 (-1.52)
Company Tenure	0.04 (7.67) ***
Company Tenure Squared	-0.00 (-6.08) ***
Unemployment	0.06 (1.60)

Professional Status	
Unskilled Blue-Collar Worker	Reference
Skilled Blue-Collar Worker	0.14 (2.66) ***
Assistant Foreman	0.37 (3.99) ***
Master/Foreman	0.32 (3.06) ***
Unskilled White-Collar Worker	0.11 (1.13)
White-Collar Worker with Simple Tasks	0.12 (1.44)
White-Collar Worker with Difficult Tasks	0.37 (5.68) ***
High-Skilled White-Collar Worker	0.55 (8.01) ***
Executive White-Collar Worker	0.45 (4.66) ***
Civil Servant in Clerical Grade	0.33 (3.30) ***
Civil Servant in Higher Service	0.76 (5.81) ***
Civil Servant in Senior Service	0.97 (5.45) ***

Workplace Characteristics	
Computer Work Station	0.25 (6.29) ***
Temporary Work	-0.27 (-3.56) ***
Overtime	0.15 (4.17) ***
Incentive Wage	0.17 (4.44) ***

Individual Characteristics	
Children	0.12 (3.73) ***
Foreigner	-0.16 (-2.45) **

Number of Observations	9723
LR chi2 (130)	2667.44
Pseudo R2	0.2834

***, (**,*) signals a level of significance of 1% (5%, 10%) (z-values in parentheses are based on heteroscedasticity robust standard errors)
Source: BIBB-IAB 1998/99, own calculations.

Following control variables have been added: size of firm (6), federal state (10), residence community (2), economic sector (46), demand for specific training (5), job contents (13) and a constant.

It is well known that firms offer more training after restructuring (Acemoglu and Pischke, 1999; Zwick, 2004). Therefore, participation in training is higher if restructuring has taken place in a firm. The results of the treatment wage regression are given in table 5. The standard variables in the earnings equation have again the expected coefficients: earnings increase with professional experience on a decreasing scale and with higher professional degrees and higher professional status. School attainment variables have the expected coefficients but are, except for high school diploma, insignificant.[19] Employees have higher earnings when they work overtime, obtain profit-sharing and incentive wages. The average treatment effect of training is a 15 percentage points difference in earnings

[19]The insignificance can be due to multicollineary with other covariates or it shows that for employees who do not participate in training, schooling does not have an impact on earnings.

for participants versus non-participants.[20] Hence, after instrumenting for the selection into training, the earnings effect of continuing vocational training is larger than in the OLS estimation. This result is in line with other studies (Bartel, 1995; Pischke, 2001; Pannenberg, 1997; Pfeiffer and Reize, 2001).

Table 5: Wage Effects of Training with Selectivity Correction - Treatment Effect Model

Education and Continuous Training	
Training	0.15 (3.61) ***
School Attainment	
Without School Leaving Certificate	0.41 (0.99)
Lower Secondary School	0.04 (1.65) *
Intermediate Secondary School	Reference
Entrance Examination for University for Applied Sciences	0.00 (0.01)
High School Diploma	0.09 (1.88) *
Vocational Training	
Without Professional Degree	-0.17 (-2.43) **
Full-Time Vocational School	Reference
Apprenticeship	-0.05 (-0.74)
Master Craftman	-0.02 (-0.28)
University for Applied Sciences	-0.02 (-0.13)
University	-0.01 (-0.1)

Professional Career	
Professional Experience	0.01 (1.70) *
Professional Experience Squared	-0.00 (-1.76) *
Company Tenure	0.02 (5.86) ***
Company Tenure Squared	-0.00 (-4.28) ***
Unemployment	-0.00 (-0.14)

Professional Status	
Unskilled Blue-Collar Worker	Reference
Skilled Blue-Collar Worker	0.05 (1.75) *
Assistant Foreman	0.08 (1.58)
Master/Foreman	0.16 (2.47) **
Unskilled White-Collar Worker	0.09 (2.30) **
White-Collar Worker with Simple Tasks	0.07 (1.57)
White-Collar Worker with Difficult Tasks	0.18 (3.29) ***
High-Skilled White-Collar Worker	0.07 (1.23)
Executive White-Collar Worker	0.14 (1.37)
Civil Servant in Clerical Grade	0.16 (2.42) **
Civil Servant in Higher Service	0.22 (1.16)
Civil Servant in Senior Service	0.51 (1.47)

Workplace Characteristics	
Computer Work Station	0.01 (0.48)
Temporary Work	-0.22 (-0.64)
Good Economic Situation	0.00 (0.16)
Overtime	0.06 (3.05) ***
Profit-Sharing	-0.01 (-0.21)
Incentive Wage	0.05 (2.31) **

Individual Characteristics	
Children	0.04 (2.40) **
Foreigner	-0.05 (-1.97) **

Interaction Variables	
Professional Experience	0.02 (2.93) ***
Professional Experience Squared	-0.00 (-1.40)
Company Tenure	-0.02 (-4.52) ***
Company Tenure Squared	0.00 (3.97) ***
Computer Work Station	0.03 (0.76)
Temporary Work	-0.10 (-1.29)
Good Economic Situation	0.07 (2.32) **
Overtime	-0.03 (-1.06)
Profit-Sharing	0.11 (2.15) **
Incentive Wage	-0.05 (-1.52)
School Attainment	
Without School Leaving Certificate	-0.07 (-0.92)
Lower Secondary School	-0.11 (-3.02) ***
Entrance Examination for University for Applied Sciences	0.06 (0.94)
High School Diploma	-0.00 (-0.05)
Professional Status	
Skilled Blue-Collar Worker	0.01 (0.13)
Assistant Foreman	-0.04 (-0.37)
Master/Foreman	-0.01 (-0.11)
Unskilled White-Collar Worker	-0.07 (-0.74)
White-Collar Worker with Simple Tasks	-0.14 (-1.25)
White-Collar Worker with Difficult Tasks	-0.13 (-1.29)
High-Skilled White-Collar Worker	0.15 (1.49)
Executive White-Collar Worker	0.18 (1.23)
Civil Servant in Clerical Grade	-0.17 (-1.47)
Civil Servant in Higher Service	-0.15 (-0.66)
Civil Servant in Senior Service	-0.29 (-0.77)

Number of Observations	8325
Chi-squared Stat.	10577.43

***, (**,*) signals a level of significance of 1% (5%, 10%) (z-values in parentheses are based on heteroscedasticity robust standard errors)
Source: BIBB-IAB 1998/99, own calculations.
Following control variables have been added: size of firm (6), federal state (10), residence community (2), economic sector (46), demand for specific training (5), job contents (13) and a constant.

[20]The two-step Heckman selection correction model gives quantitatively the same result. Here the estimated training coefficient is 18 percentage points.

This increase in the coefficient may be the consequence of three effects familiar from the returns to education literature (Card, 1999). First, there might be a negative selection into training: individuals with lower earnings are more likely to take part in training, and training therefore is remedial. This is contrary to most of the literature, however: Goux and Maurin (2000) show that high-wage workers are more likely to be selected for training than other workers. Dearden, Reed and Van Reenen (2000), in contrast, argue that the productivity effect is underestimated when treating training as exogenous since it is often adopted in "bad times", when productivity is low. Second, training might be measured with errors, and the OLS earning estimation may therefore be downward biased (Griliches and Hausman, 1986). These errors decrease by instrumenting the training variable if the instruments capture part of the measurement errors. In our case, the training dummy is indeed a rough measure, because a one day course has the same measure as a course that takes several weeks. A third reason may be that the returns to training are heterogeneous[21] (Card, 1999). It seems plausible that especially those employees who have a subjective need for training or are happy with their past training experience can realize a higher income increase after training. These employees might gain more human capital by training than the others and therefore have a stronger productivity improvement (Harmon, Oosterbeek and Walker, 2003). We cannot separate the impact of the individual biases on training returns, and therefore it is unclear if training is remedial or not.

Table 6: Effect of Training on Earnings for Heterogeneous Employees

Low skilled without experience		
Average Treatment Effect		0.15
Professional Experience	3*	-0.30
Professional Experience Squared	9	0.09
Company Tenure	2*	0.24
Company Tenure Squared	4	-0.13
Without School Leaving Certificate		-0.06
Temporary Work		-0.09
Assistant Foreman		-0.04
Effect of Training:		-0.14

High skilled without experience		
Average Treatment Effect		0.15
Professional Experience	3*	-0.30
Professional Experience Squared	9	0.09
Company Tenure	2*	0.24
Company Tenure Squared	4	-0.13
Entrance Examination for University of Applied Sciences		0.06
Computer Work Station		0.02
Employee with Difficult Tasks		-0.12
Effect of Training:		0.00

Low skilled with experience		
Average Treatment Effect		0.15
Professional Experience	30*	0.12
Professional Experience Squared	900	-0.04
Company Tenure	24*	-0.21
Company Tenure Squared	576	0.12
Lower Secondary School		-0.05
Low-Level Employee		-0.07
Effect of Training:		0.02

High skilled with experience		
Average Treatment Effect		0.15
Professional Experience	30*	0.12
Professional Experience Squared	900	-0.04
Company Tenure	24*	-0.21
Company Tenure Squared	576	0.12
High School Diploma		0.00
Civil Servant in Higher Service		0.13
Effect of Training:		0.27

* in years

[21] Heterogeneous not only with respect to observable but also to unobservable characteristics.

Some authors estimated very high training coefficients with 0.4 and even above. They explain the large size by the emphasis of the German wage bargaining system on the acquisition of formal qualifications as a means for wage and productivity growth and state that not training determines wages, but that those who attend training, are on a high wage growth career path (Georgellis and Lange, 1997; Pfeiffer and Reize, 2001). Also, Leuven and Oosterbeek (2002) argue that a large share of these estimated coefficients are due to returns to some unobservable characteristics.

With the incorporated interaction variables, we capture part of the usually neglected heterogeneous earnings effect of training.[22] The impact of training on earnings is larger for high-skilled workers, low-skilled workers gain less from training. Heckman (1999) stresses that more able people acquire more skills and that more skilled people become more able. Therefore, it seems not surprising that the productivity effect of training is smaller for the less skilled who accordingly get a lower wage mark-up. Employees with a long work experience gain more from training than persons who have just entered the labor market. This might indicate that continuing vocational training refreshes or updates primary vocational training and therefore is especially useful for older workers whose primary education is partly obsolete. Besides the explanation that training is more effective on the job for more experienced workers, these workers are also likely to have more bargaining power than unexperienced workers and therefore can capture a larger share if there are rents to divide.[23] As already indicated by Lazear (1979), earnings and productivity at a given point in the career do not have to correspond. He notes that employees may first get wages that are lower than their productivity and at a later stage of their professional career, they can profit from early investments in their human capital. Also, long job tenure increases participation in continuing training but diminishes the impact of training on income. Pannenberg (1998) determines wage differentials between participants and non-participants depending on tenure and comes to the same result. In his estimations, the wage effects are largest for the training that takes place two or three years after entering a company. It seems plausible that the kind of training provided to entrants in the firm increases productivity substantially since their demand for specific training is strong. Additionally, job attributes matter for the income effect of training: workers with temporary contracts do not obtain any wage mark-up or only a very small one, depending on their professional experience and other attributes. The reason clearly is that employers cannot profit from the increased productivity since the employees will probably change their job soon and will share the rent from investment in human capital with their next employer. One can even imagine that temporary workers implicitly pay for part of their training by accepting lower earnings, because they expect this investment in human capital to pay off later in form of a higher wage paid by the next employer.

[22] In contrast to our approach to distinguish only heterogeneous returns with respect to observable characteristics, Maier, Pfeiffer and Pohlmeier (2003) allow for individual heterogeneity in the returns to schooling.

[23] Muysken and Zwick (2003) argue that insiders might use up-skilling in order to skim rents.

Some examples for earnings effects of training participation for different types of employees are provided in table 6. The effects are calculated from table 5 for specific heterogeneous agents. The differences in earnings for participants and non-participants in training differ widely across qualification groups, professional career and job attributes. In the examples we defined, low-skilled workers do not gain from training when they just entered the job market and they might even have to pay for it by receiving a lower income. Low-skilled workers with experience do not participate often, but if they attend training, they do receive higher earnings. High-skilled workers gain from training, especially when they have a long professional experience. Hence, heterogeneity between selected groups of workers is important in this context and should be taken into account, not only when estimating the selection into training but also in the earnings equation[24]. In addition, different training forms should be distinguished, which we have not done so far. In the next section, we will therefore replace our training dummy with factors comprising different types of training.

4.3 Earnings Effects of Different Types of Training

In the second part of our empirical analysis, we distinguish between selected training forms. This is an attempt to differentiate between the wage effects of training forms with more or less specific contents.

Table 7: Participation in Internal and External Training

Qualification	*Internal*	*External*
School Attainment		
Without School Leaving Certificate	29.17	40.83
Lower Secondary School	27.63	42.65
Intermediate Secondary School	38.37	62.41
Entrance Examination for University for Applied Sciences	44.09	81.88
High School Diploma	40.94	78.59
Vocational Training		
Without Professional Degree	19.46	27.06
Full-Time Vocational School	35.53	49.12
Apprenticeship	32.39	51.06
Master Craftman	43.93	78.50
University for Applied Sciences	46.40	86.72
University	41.04	85.66
Total	33.74	56.31

Full-Time working males in percent. Number of Observations: 9800
Source: BIBB-IAB 1998/99, own calculations.

In table 7, participation in internal and external training is described by the level of education. For internal training, there is the clear trend visible that high-skilled workers

[24]Ceteris paribus, the wage effect differences between employees with low and high experience and between different skill levels are significant.

participate more often (about 40 percent) than low-skilled workers (about 30 percent). In the case of external training, this tendency is even much more obvious: While 86 percent of employees with a university degree take part in external training, less than 30 percent of the unskilled (without professional degree) participate.

Table A8 in the appendix shows the results of the simple OLS earnings equation including internal and external training. The impact of external training is significantly positive, in contrast to internal training, which has no significant effect on earnings.[25] The coefficients of the other variables in the extended income equation are as expected and similar to those found in the previous regression using the training dummy.

Table 8: Extended Earnings Equation with Training - Corrected for Selectivity by Instrumental Variable Regression

Education and Continuous Training	
External Training	0.13 (1.95) *
Internal Training	-0.02 (-0.45)
School Attainment	
Without School Leaving Certificate	0.01 (0.42)
Lower Secondary School	-0.02 (-1.99) **
Intermediate Secondary School	Reference
Entrance Examination for University for Applied Sciences	0.02 (0.72)
High School Diploma	0.06 (3.19) ***
Vocational Training	
Without Professional Degree	-0.03 (-0.86)
Full-Time Vocational School	Reference
Apprenticeship	-0.04 (-1.23)
Master Craftman	-0.01 (-0.15)
University for Applied Sciences	0.05 (0.98)
University	0.08 (1.53)

Professional Career	
Professional Experience	0.01 (9.02) ***
Professional Experience Squared	-0.00 (-6.52) ***
Company Tenure	0.00 (2.83) ***
Company Tenure Squared	-0.00 (-0.98)
Unemployment	-0.03 (-2.61) ***

Individual Characteristics	
Children	0.06 (8.00) ***
Foreigner	-0.01 (-0.39)

Professional Status	
Unskilled Blue-Collar Worker	Reference
Skilled Blue-Collar Worker	0.02 (0.51)
Assistant Foreman	-0.04 (-0.67)
Master/Foreman	0.13 (2.09) **
Unskilled White-Collar Worker	0.05 (0.95)
White-Collar Worker with Simple Tasks	-0.00 (-0.02)
White-Collar Worker with Difficult Tasks	0.11 (2.49) **
High-Skilled White-Collar Worker	0.12 (2.32) **
Executive White-Collar Worker	0.21 (2.82) ***
Civil Servant in Clerical Grade	0.14 (2.93) ***
Civil Servant in Higher Service	0.11 (1.46)
Civil Servant in Senior Service	0.38 (2.95) ***

Workplace Characteristics	
Computer Work Station	0.03 (3.18) ***
Temporary Work	-0.06 (-2.63) ***
Good Economic Situation	0.04 (4.93) ***
Overtime	0.03 (2.98) ***
Profit-Sharing	0.05 (2.99) ***
Incentive Wage	0.03 (2.82) ***

Number of Observations	8325
F(337, 7987)	31,5
R-squared	0.5114

[25] This confirms the stronger bivarate correlations between the four external training variables and earnings in comparison to the three internal training variables, see table A5.

Table 8 continued

Interaction Variables - External Training	
Professional Experience	0.00 (0.62)
Professional Experience Squared	0.00 (1.00)
Company Tenure	-0.01 (-4.21) ***
Company Tenure Squared	0.00 (3.82) ***
Computer Work Station	0.02 (0.73)
Temporary Work	-0.04 (-0.77)
Good Economic Situation	0.04 (2.49) **
Overtime	-0.03 (-1.55)
Profit-Sharing	0.06 (2.44) **
Incentive Wage	-0.02 (-1.04)
School Attainment	
Without School Leaving Certificate	0.00 (0.07)
Lower Secondary School	-0.00 (-0.12)
Entrance Examination for University for Applied Sciences	0.02 (0.58)
High School Diploma	0.03 (0.85)
Professional Status	
Skilled Blue-Collar Worker	-0.04 (-0.53)
Assistant Foreman	-0.27 (-2.12) **
Master/Foreman	0.08 (0.64)
Unskilled White-Collar Worker	0.01 (0.14)
White-Collar Worker with Simple Tasks	-0.09 (-0.86)
White-Collar Worker with Difficult Tasks	0.06 (0.58)
High-Skilled White-Collar Worker	0.08 (0.81)
Executive White-Collar Worker	0.03 (0.22)
Civil Servant in Clerical Grade	0.11 (0.97)
Civil Servant in Higher Service	-0.01 (-0.11)
Civil Servant in Senior Service	-0.13 (-0.97)

Interaction Variables - Internal Training	
Professional Experience	0.01 (1.33)
Professional Experience Squared	-0.00 (-1.98) **
Company Tenure	0.00 (0.54)
Company Tenure Squared	-0.00 (-0.27)
Computer Work Station	0.01 (0.34)
Temporary Work	0.01 (0.19)
Good Economic Situation	-0.04 (-1.38)
Overtime	0.01 (0.30)
Profit-Sharing	-0.04 (-1.02)
Incentive Wage	0.01 (0.28)
School Attainment	
Without School Leaving Certificate	-0.05 (-0.56)
Lower Secondary School	-0.06 (-2.18) **
Entrance Examination for University for Applied Sciences	0.24 (0.55)
High School Diploma	-0.02 (-0.38)
Professional Status	
Skilled Blue-Collar Worker	-0.02 (-0.34)
Assistant Foreman	0.10 (1.16)
Master/Foreman	-0.05 (-0.46)
Unskilled White-Collar Worker	-0.07 (-0.67)
White-Collar Worker with Simple Tasks	0.04 (0.4)
White-Collar Worker with Difficult Tasks	-0.11 (-1.44)
High-Skilled White-Collar Worker	-0.07 (-0.83)
Executive White-Collar Worker	0.02 (0.15)
Civil Servant in Clerical Grade	-0.27 (-2.88) ***
Civil Servant in Higher Service	0.01 (0.13)
Civil Servant in Senior Service	0.00 (0.02)

***, (**,*) signals a level of significance of 1% (5%, 10%) (t-values in parentheses are based on heteroscedasticity robust standard errors)
Source: BIBB-IAB 1998/99, own calculations.
Following control variables have been added: size of firm (6), federal state (10), residence community (2), economic sector (46), demand for specific training (5), job contents (13) and a constant.

Analogously to the analysis above, also in this specification we have to take endogeneity of training into account. Hence, we estimate a regression with instrumental variables for the two training factors. Selection into the two types of training differs, as can be seen in the appendix (tables A9 and A10), where the regression equations of selection into internal and external training are shown. The identifying variables "need for training" and "restructuring" and their coefficients as well as all other determinants of internal and external training are reported in the tables. Participation in external training is explained much better by the right hand side variables than participation in internal training, as indicated by the adjusted R^2 of 0.43 (0.17) for the estimation of participation in external (internal) training. The identifying variables also vary slightly between internal and external training. Restructuring of the workplace suggests involvement in either kind of training. Likewise, if employees report a need for training in specific topics, this increases the probability that they have taken part in training before. The demand for

training in mathematics reduces the probability of participation in internal as well as in external training during the last two years. School attainment and professional experience are of no importance in determining selection into internal training, while they are some of the main determinants indicating participation in external training. Another crucial determinant of internal training is firm size, which in contrast is no important determinant of participation in external training. Likewise, Bartel (1995) finds an increasing training incidence with length of services for core training, while the incidence of the other training forms decreases significantly. Lynch (1992) finds higher training incidence with experience for company-provided training, while the incidence of off-the-job training decreases with tenure in her estimation. Employees with temporary contracts are very unlikely to receive either kind of training. Professional status and vocational training dummies determine attendance in both types of training.

The results of the instrumental variable regression are given in table 8. The impact of external training on earnings increases after correcting for the selection bias, while the t-value decreases but nevertheless stays significant. The effect of participation in internal training on earnings stays insignificant. The endogeneity correction therefore has the same effect on external training as in our first model with training participation, i.e. the results in the first part are driven by the external training types. The coefficients are not directly comparable since we use a dummy (0,1-variable) first, while later the training factors range from -1 to +4 with mean zero, depending on how many different training types were attended. The coefficients of the other explanatory variables in the extended income equation including the two types of training do not deviate from the model with the training dummy, and the adjusted R^2 remains at 51 percent. Interaction terms of internal training and the covariates and external training and covariates differ. While company tenure has a negative impact on the return to external training, it is insignificant for internal training. In contrast, professional experience has a positive (but decreasing) impact on returns to internal training, and the interaction terms of external training and the experience variables are insignificant. If the firm is in a good economic situation, participation in external but not in internal training induces a higher wage mark-up.

5 What does the literature find?

The analysis above provides evidence for the hypothesis that heterogeneity of employees, their workplaces, and training forms have to be taken into account when estimating the individual returns to investment in continuous training. In order to provide a comprehensive picture of the effects of training, it is also important to look at the employer side and the productivity effects of training. The title by Dearden, Reed and Van Reenen (2000) "Who gains when workers train?" suggests that the shares of the rent generated by training, that can be appropriated by employers and employees, can be measured. As they do not have appropriate data combining the necessary information on employees and firms

as well as training behavior, their evidence is more indirect, however. By comparing the wage and the productivity effects of training in different economic sectors between 1983 and 1996 in the UK, they conclude that the increase in wages is less than half the increase in value added per worker. A comparable result is obtained by Hempell (2003) using the Mannheim Innovation Panel data for the German services sector in the period 1994-1998. Loewenstein and Spletzer (1997) find that the average return to formal training at a previous employer exceeds the return to past formal training at the current employer. This strand of the literature therefore shows that the rent generated from training is distributed between employer and employee. An exception is the result by Mincer (1991) who compares the effect of training on productivity with the effect on income. In his analysis, the impact of training on employee's income is positive but negative on turnover. This implies that the employees can reap the entire rent from training.

Several other papers report the productivity and wage effects of training but do not relate these effects to rent sharing between the employees trained and the employer, see the literature survey by Bartel (2000). We specifically look at both strands of the literature, differentiating between training forms in order to evaluate how our results fit in.

5.1 Literature Based on Individual Data

A summary of recent work on training with individual data is presented in table 9, mentioning the types of training used, estimation methods, and results. Studies differentiating between different types of training have used various definitions, depending on the data they use. Loewenstein and Spletzer (1997) did not find any systematic difference in the wage returns to general and specific training provided by the current employer. They trace this result back to measurement error in training and to the fact that rent sharing between employer and employee takes place for both kinds of training. Closest to our definition of training forms is Lynch (1992). She uses on-the-job and off-the-job training and analyzes U.S. data on young employees (National Longitudinal Survey Youth Cohort). Additionally, she distinguishes whether training was received during previous or current employment, and she has information on the duration of training spells. Her results differ from ours: she does not find a significant effect of training off-the-job during current employment. The positive effect of training on-the-job during current employment turns insignificant when she uses the Heckman correction for sample selection. The latter result is similar to our findings. The differences in the first result might be due to the data she uses, where only young people are included. Our results indicate that the positive wage effects of external training mainly accrue to more experienced and skilled employees. It can be assumed that our internal training measures mainly take place during work hours, while the external training variables take place during leisure time. Pischke (2001) therefore finds comparable results in a fixed effects panel estimation. Training during leisure time has a positive impact on earnings growth, while training during work hours has no effect in his estimations.

Table 9 Studies using Different Training Types

Literature using Individual Data

Study	*Endogenous Variable*	*Result: types of training in bold*
Bartel (1995)	wage growth	Career advancement*: OLS(+)** IV(0) Employee development: OLS(+) IV(++)
Blundell, Dearden and Meghir(1999)	wage and wage growth	**Employer provided**: OLS(+) IV(++) **Non-employer provided**: OLS(0) IV(-)
Loewenstein and Spletzer (1998)	wage	**General**: current job(+) previous job(++) **Specific**: current job(+) previous job (0)
Lynch(1992)	wage	**Off-the-job**: current job OLS(0) Heckman*** (0) previous job OLS(+) **On-the-job**: current job OLS(+) Heckman(0) previous job OLS(0) Heckman (0)
Pfeiffer and Reize (2001)	earnings	**Formal**(+) **Nonformal**(+) Switching Regression Model
Pischke(2001)	earnings growth	**During Leisure Time**(+) **During Work Hours**(0) fixed effects panel regression

Literature using Firm Data

Study	*Endogenous Variable*	*Result: types of training in bold*
Barrett and O'Connell (2001)	productivity growth	**General:**OLS(+), **Specific:**OLS(0)
Black and Lynch (1996)	sales	Percentage of **Formal Training** outside working hours in total training: OLS(+) **Computer Training:** OLS(+) **Teamwork Training:** OLS(0) **Supervisor Training:** OLS(0)
Black and Lynch (1997)	labour productivity	Several Training Measures: OLS(0)
Zwick (2002)	value added	**Formal Training:** OLS(+) Fixed Effects(++) **Training On-the-Job:**OLS(-) Fixed Effects(0)

*Career advancement consists of core and technical training. **(+) positive effect (++) higher positive effect (-) negative effect (0) insignificant effect ***Heckman correction for sample selection.

5.2 Literature Based on Firm Data

Most papers on the productivity impact of training only look at the impact of a training dummy or the training intensity, while effects of different training measures are not distinguished. Black and Lynch (1996) and Dearden, Reed and Van Reenen (2000) find that training off the job[26] has a productivity effect but not on-the-job training, and that computer training is more effective than teamwork training and supervisor training. The authors conclude that the insignificant impact of internal training on productivity is either due to the output loss since it reduces hours worked or that external training is more advanced training which results in a stronger productivity increase of the participants. Barrett and O'Connell (2001) show that general training significantly increases productivity, while specific training has no impact on productivity. They argue that the employees devote greater effort to general training than to specific training because it is transferable or regarded as a gift from the employer. A higher effort leads to a better human capital effect of training and analogously to higher productivity. Zwick (2002) finds for Germany that mainly formal internal and external training courses increase productivity, whereas

[26]In this case, on-the-job and off-the-job training refers rather to the formality of training than to the location.

self-induced learning, such as reading work-related literature or e-learning and quality circles, have lower but still significant positive effects. Training on the job, job rotation and participation in trade fairs did not have positive productivity effects. Again, it seems that training measures with higher general contents have a stronger productivity effect than training measures with higher firm-specific contents.

6 Summary of Results

Our main results are:

1. The impact of participation in training on income is significantly positive. Training comprises any of the following: courses and seminars, participation in trade fairs, lectures, on-the-job training, quality circles, special tasks, and reading of specialist literature. Correcting for the endogeneity bias, the average treatment effect increases from 0.10 to 0.15.

2. The effect of training on earnings differs for heterogeneous agents. High-skilled workers profit more from training than low-skilled workers, job entrants obtain a higher earnings increase after participation in training than workers with a long job tenure, and workers with a temporary contract profit less from training than those with a permanent job contract. If also the workers with no positive wage effects experience a productivity increase induced by training, the employers reap all the gains from training.

3. The increase in the income effects of training if endogeneity is taken into account, compared with the case where selection is assumed to be random, suggests that our instrumental variables reduce the measurement error in the OLS regression and capture heterogeneous training returns more properly. This is plausible because our dummy variable for training inadequately captures training intensity and training effort. The third possibility for this phenomenon, a negative selection into training, seems unlikely given previous empirical evidence that training is seldom remedial.

4. Without controlling for endogeneity, external training (i.e. participation at trade fairs, lectures, courses and seminars, and reading of specialist literature) has a significant positive impact on wages, while the wage effect of internal training (i.e. on the job training, quality circles, and special tasks) is insignificant. Taking endogeneity into account and instrumenting the training decision, the coefficient of external training rises from 0.05 to 0.13, internal training stays insignificant. Hence, participation in internal training does not translate into higher earnings. Here again, only the employer seems to skim productivity increases from investments in human capital (again assuming that employees' productivity is increased by the training). Therefore, only external training has a significant and positive impact on earnings and drives the result derived with a dummy for training participation.

5. Our contribution can only present indirect evidence on who gains when workers train. We have been able to answer the question "who gains from training?" in the sense of which type of employees profits from higher wages after participation in training. With our data, we were not able to present evidence for rent sharing after investment in training between employer and employee. Nevertheless, using the indirect information of income increases and assuming that productivity increases after training, we can make inferences about whether also the employer profits from training. Possibly, employers reap all the gains from the internal training measures analyzed in the second part of the paper. This is also suggested by the empirical literature using firm data. In order to obtain clearer evidence, linked employer-employee panel data with detailed information on type, length and cost of training would be required, however.

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7 Appendix

Table A1 List of Variables Used

Variable	Share / Average	Notes
	Earnings	
Less than 600 DM	0.07%	
Between 600 and 1000 DM	0.16%	
Between 1000 and 1500 DM	0.56%	
Between 1500 and 2000 DM	1.25%	
Between 2000 and 2500 DM	4.31%	
Between 2500 and 3000 DM	7.69%	
Between 3000 and 3500 DM	11.87%	
Between 3500 and 4000 DM	14.87%	
Between 4000 and 4500 DM	14.48%	
Between 4500 and 5000 DM	12.28%	
Between 5000 and 5500 DM	7.59%	
Between 5500 and 6000 DM	6.93%	
Between 6000 and 7000 DM	7.58%	
Between 7000 and 8000 DM	4.10%	
Between 8000 and 9000 DM	2.52%	
Between 9000 and 10000 DM	1.37%	
Between 10000 and 15000 DM	1.73%	
15000 DM and more	0.64%	
	School Attainment	
Without School Leaving Certificate	2.51%	
Lower Secondary School	51.23%	
Intermediate Secondary School	24.75%	
Entrance Examination for University for Applied Sciences	7.60%	
High School Diploma	13.91%	
	Vocational Training	
Without Professional Degree	12.63%	
Full-Time Vocational School	2.22%	Several years of professional training in school
Dual Apprenticeship	60.17%	Several years of professional training in school and on the job
Master Craftman	11.34%	
University of Applied Sciences	5.79%	
University	7.85%	
	Training	
Courses and Seminars	26.72%	
Trade Fair	18.09%	Participation in trade fairs
Lecture	25.9%	Participation in lectures
On-The-Job	16.70%	Initial training on the job
Quality Circle	14.07%	Participation in quality circles
Special Tasks	12.86%	Tasks aiming at extending skills
Specialist Literature	26.11%	Study of work-related literature
	Professional Career	
Professional Experience	22.69 years	Years from first job until today
Company Tenure	13.86 years	Years from starting to work for a company until today
Unemployment	27.43%	Dummy = 1 if a person was ever unemployed, otherwise 0

Table A1 continued

Variable	Share / Average	Notes
Professional Status		
Unskilled Blue-Collar Worker	15.63%	Worker without professional degree
Skilled Blue-Collar Worker	27.18%	Worker with degree from dual apprenticeship system or full-time vocational school
Assistant Foreman	3.60%	
Master/Foreman	3.25%	
Unskilled White-Collar Worker	2.22%	White-Collar worker with basic tasks
White-Collar Worker with Simple Tasks	3.98%	
White-Collar Worker with Difficult Tasks	11.36%	
High-Skilled White-Collar Worker	16.00%	
Executive White-Collar Worker	4.97%	
Civil Servant in Clerical Grade	4.55%	
Civil Servant in Higher Service	3.93%	
Civil Servant in Senior Service	2.07%	
Workplace Characteristics		
Computer Work Station	48.21%	Work routine includes using the computer
Temporary Work	4.87%	
Good Economic Situation	59.04%	Dummy = 1 if the company is in a good economic situation, otherwise 0
Overtime	78.34%	Dummy = 1 if a person works overtime, otherwise 0
Profit-Sharing	7.94%	
Incentive Wage	21.62%	
Job Content		13 Categories: training, testing, counseling, supervising, repairing, procurement, organisiation, marketing, research, negotiating, developing, manufacturing, monitoring
Individual Characteristics		
Children	49.98%	Dummy = 1 if a person has at least one child, otherwise 0
Foreigner	5.43%	Dummy = 1 if a person does not have a German Nationality, otherwise 0
Identifying Variables		
Demand for Specific Training		12 Categories: need for training in presentation techniques, foreign languages, logistics, Management, Controlling, Mathematics, German, System Engineering, Computer Engineering, Other Engineering, Safety at Work, Medicine
Changes in the Workplace		2 Categories: Downsizing, Restructuring
Other Variables		
Size of Firm		7 Categories: number of employees is 1-4, 5-9, 10-49, 50-99, 100-499, 500-999 and 1000 and above
Residence Community		3 Categories: communities with 50 000 and above inhabitants, hinterland of large cities and other communities with less than 50 000 inhabitants
Federal State		11 Categories: all Federal States of West Germany
Economic Sector		46 Categories

Table A2 Comparison: Interval Regression (INTREG) vs. Ordinary Least Squares (OLS) - Estimates of the Extended Earnings Equation

	INTREG	OLS
Education and Continuous Training		
Training		
Trade Fair	0.08 (9.95) ***	0.09 (9.86) ***
Lecture	0.06 (7.13) ***	0.06 (6.99) ***
On-The-Job	-0.03 (-3.95) ***	-0.03 (-3.83) ***
Quality Circle	0.03 (3.32) ***	0.26 (3.15) ***
Special Tasks	0.02 (2.18) **	0.02 (2.14) **
Specialist Literature	0.06 (8.12) ***	0.06 (7.89) ***
School Attainment		
Without School Leaving Certificate	-0.03 (-1.45)	-0.03 (-1.43)
Lower Secondary School	-0.05 (-6.13) ***	-0.05 (-6.11) ***
Intermediate Secondary School	Reference	Reference
Entrance Examination for University for Applied Sciences	0.09 (6.64) ***	0.14 (5.57) ***
High School Diploma	0.11 (8.48) ***	0.11 (8.35) ***
Vocational Training		
Without Professional Degree	-0.08 (-3.61) ***	-0.03 (-1.43)
Full-Time Vocational School	Reference	Reference
Apprenticeship	-0.00 (-0.03)	-0.00 (-0.20)
Master Craftman	0.08 (3.75) ***	0.08 (3.52) ***
University for Applied Sciences	0.14 (5.83) ***	0.14 (5.57) ***
University	0.27 (10.31) ***	0.27 (10.01) ***

	INTREG	OLS
Professional Career		
Professional Experience	0.01 (11.56) ***	0.01 (11.02) ***
Professional Experience Squared	-0.00 (-7.76) ***	-0.00 (-7.35) ***
Company Tenure	0.00 (10.43) ***	0.00 (9.88) ***
Unemployment	-0.03 (-4.35) ***	-0.03 (-4.17) ***
Workplace Characteristics		
Computer Work Station	0.09 (12.41) ***	0.09 (11.97) ***
Temporary Work	-0.07 (-4.42) ***	-0.07 (-4.13) ***
Good Economic Situation	0.05 (6.47) ***	0.05 (6.21) ***
Overtime	0.06 (8.09) ***	0.06 (8.00) ***
Profit-Sharing	0.10 (7.92) ***	0.10 (7.76) ***
Incentive Wage	0.03 (3.71) ***	0.03 (3.62) ***
Individual Characteristics		
Children	0.07 (10.81) ***	0.07 (10.58) ***
Number of Observations	10003	10003
Chi-squared Stat.	8513.97	
R-squared		0.4691

*** (**, *) signals a level of significance of 1% (5%, 10%) (t-values and z-values in parentheses are based on heteroscedasticity robust standard errors)
Source: BIBB-IAB 1998/99, own calculations.

Following control variables have been added: size of firm (6), federal state (10), residence community (2), economic sector (46), demand for specific training (5), job contents (13) and a constant.

Table A3 Correlations* between Types of Training and Income

	Trade Fair	Lecture	Specialist Literature	On The Job	Quality Circle	Special Tasks	Courses and Seminars	Income
Trade Fair	1.00							
Lecture	0.41	1.00						
Specialist Literature	0.41	0.49	1.00					
On-The-Job	0.06	0.11	0.11	1.00				
Quality Circle	0.13	0.20	0.21	0.16	1.00			
Special Tasks	0.16	0.24	0.24	0.19	0.17	1.00		
Courses and Seminars	0.26	0.50	0.36	0.12	0.28	0.24	1.00	
Income	0.31	0.38	0.38	0.03	0.19	0.19	0.31	1.00

* correlations are all significant at 5 percent level Source: BIBB-IAB 1998/99, own calculations.

Table A4 Standard Earnings Equation & Extended Earnings Equation including Different Types of Training

	Earnings Equation	Earnings Equation Including Training
log (Earnings)	***Coefficient***	***Coefficient***
Professional Experience	0.02 (17.50) ***	0.02 (15.56) ***
Professional Experience Squared	-0.00 (-11.52) ***	-0.00 (-9.95) ***
School Attainment		
Without School Leaving Certificate	-0.07 (-2.77) ***	-0.05 (-1.80) *
Lower Secondary School	-0.10 (-10.84) ***	-0.06 (-6.89) ***
Intermediate Secondary School	Reference	Reference
Entrance Examination for University for Applied Sciences	0.15 (8.05) ***	0.11 (6.36) ***
High School Diploma	0.17 (9.87) ***	0.14 (8.70) ***
Vocational Training		
Without Professional Degree	-0.15 (-5.46) ***	-0.12 (-4.53) ***
Full-Time Vocational School	Reference	Reference
Apprenticeship	-0.00 (-0.15)	-0.01 (-0.56)
Master Craftman	0.17 (6.12) ***	0.10 (3.64) ***
University for Applied Sciences	0.22 (6.99) ***	0.14 (4.71) ***
University	0.33 (10.25) ***	0.25 (7.96) ***
Training		
Courses and Seminars		0.05 (5.80) ***
Trade Fair		0.10 (9.65) ***
Lecture		0.09 (8.62) ***
On-The-Job		-0.01 (-0.92)
Quality Circle		0.07 (6.78) ***
Special Tasks		0.04 (4.20) ***
Specialist Literature		0.08 (8.04) ***
Number of Observations	8325	8325
F (11, 8313) / F (18, 8306)	295.66	257.91
R-squared	0.3155	0.3750

***, (**,*) signals a level of significance of 1% (5%, 10%) (t-values in parentheses are based on heteroscedasticity robust standard errors)
Source: BIBB-IAB 1998/99, own calculations.

Table A5 Extended Earnings Equation with Control Variables - Different Types of Training included

Education and Continuous Training	
Training	
Courses and Seminars	0.00 (0.37)
Trade Fair	0.05 (4.86) ***
Lecture	0.04 (4.26) ***
On-The-Job	-0.01 (-1.54)
Quality Circle	0.02 (2.06) **
Special Tasks	0.01 (0.76)
Specialist Literature	0.04 (4.80) ***
School Attainment	
Without School Leaving Certificate	-0.01 (-0.45)
Lower Secondary School	-0.02 (-2.37) **
Intermediate Secondary School	Reference
Entrance Examination for University for Applied Sciences	0.05 (3.47) ***
High School Diploma	0.07 (4.81) ***
Vocational Training	
Without Professional Degree	-0.06 (-2.30) **
Full-Time Vocational School	Reference
Apprenticeship	-0.01 (-0.43)
Master Craftman	0.03 (1.08)
University for Applied Sciences	0.09 (3.21) ***
University	0.19 (6.36) ***

Professional Career	
Professional Experience	0.01 (8.92) ***
Professional Experience Squared	-0.00 (-6.49) ***
Company Tenure	0.01 (5.16) ***
Company Tenure Squared	-0.00 (-2.08) **
Unemployment	-0.03 (-3.75) ***

Professional Status	
Unskilled Blue-Collar Worker	Reference
Skilled Blue-Collar Worker	0.07 (4.92) ***
Assistant Foreman	0.08 (4.15) ***
Master/Foreman	0.16 (6.61) ***
Unskilled White-Collar Worker	0.06 (2.98) ***
White-Collar Worker with Simple Tasks	0.03 (1.56)
White-Collar Worker with Difficult Tasks	0.1 (6.29) ***
High-Skilled White-Collar Worker	0.21 (12.14) ***
Executive White-Collar Worker	0.3 (12.22) ***
Civil Servant in Clerical Grade	0.06 (2.52) **
Civil Servant in Higher Service	0.14 (5.43) ***
Civil Servant in Senior Service	0.3 (10.29) ***

Workplace Characteristics	
Computer Work Station	0.04 (4.41) ***
Temporary Work	-0.07 (-3.4) ***
Good Economic Situation	0.04 (5.21) ***
Overtime	0.04 (5.49) ***
Profit-Sharing	0.07 (5.11) ***
Incentive Wage	0.03 (3.54) ***

Individual Characteristics	
Children	0.07 (9.58) ***
Foreigner	-0.04 (-2.33) **

Number of Observations	8325
F(122, 8202)	71.57
R-squared	0.5021

***, (**,*) signals a level of significance of 1% (5%, 10%) (t-values in parentheses are based on heteroscedasticity robust standard errors).
Source: BIBB-IAB 1998/99, own calculations.
Following control variables have been added: size of firm (6), federal state (10), residence community (2), economic sector (46), demand for specific training (5), job contents (13) and a constant.

Table A6 Extended Earnings Equation with Control Variables - Training included as a Dummy

Education and Continuous Training	
Training	0.05 (6.21) ***
School Attainment	
Without School Leaving Certificate	-0.01 (-0.71)
Lower Secondary School	-0.03 (-3.38) ***
Intermediate Secondary School	Reference
Entrance Examination for University for Applied Sciences	0.06 (4.88) ***
High School Diploma	0.08 (5.85) ***
Vocational Training	
Without Professional Degree	-0.05 (-2.02) **
Full-Time Vocational School	Reference
Apprenticeship	-0.00 (-0.17)
Master Craftman	0.04 (1.91) *
University for Applied Sciences	0.10 (3.79) ***
University	0.20 (7.52) ***

Professional Career	
Professional Experience	0.01 (10.11) ***
Professional Experience Squared	-0.00 (-7.21) ***
Company Tenure	0.01 (5.51) ***
Company Tenure Squared	-0.00 (-2.12) **
Unemployment	-0.03 (-4.14) ***

Workplace Characteristics	
Computer Work Station	0.04 (5.06) ***
Temporary Work	-0.06 (-3.31) ***
Good Economic Situation	0.04 (5.36) ***
Overtime	0.05 (6.26) ***
Profit-Sharing	0.08 (6.45) ***
Incentive Wage	0.02 (3.01) ***

Individual Characteristics	
Children	0.07 (11.07) ***
Foreigners	-0.04 (-2.62) ***

Number of Observations	10003
F(111, 9891)	88.47
R-squared	0.5044

***, (**,*) signals a level of significance of 1% (5%, 10%) (t-values in parentheses are based on heteroscedasticity robust standard errors)
Source: BIBB-IAB 1998/99, own calculations.
Following control variables have been added: size of firm (6), federal state (10), residence community (2), economic sector (46), demand for specific training (5), job contents (13) and a constant.

Table A7 Extended Earnings Equation with Interaction Variables - Training included as a Dummy and in Interaction Variables

Education and Continuous Training	
Training	0.06 (6.54) ***
School Attainment	
Without School Leaving Certificate	0.01 (0.24)
Lower Secondary School	-0.00 (-0.04)
Intermediate Secondary School	Reference
Entrance Examination for University for Applied Sciences	0.03 (0.77)
College Entrance Exam	0.08 (2.75) ***
Vocational Training	
Without Professional Degree	-0.07 (-1.78) *
Full-Time Vocational School	Reference
Apprenticeship	-0.02 (-0.44)
Master Craftman	0.02 (0.46)
University for Applied Sciences	0.09 (1.49)
University	0.15 (2.68) ***

Professional Career	
Professional Experience	0.01 (4.85) ***
Professional Experience Squared	-0.00 (-4.16) ***
Company Tenure	0.01 (5.23) ***
Company Tenure Squared	-0.00 (-2.26) **
Unemployment	-0.02 (-1.80) *

Professional Status	
Unskilled Blue-Collar Worker	Reference
Skilled Blue-Collar Worker	0.07 (4.36) ***
Assistant Foreman	0.07 (2.58) ***
Master/Foreman	0.13 (2.76) ***
Unskilled White-Collar Worker	0.09 (3.29) ***
White-Collar Worker with Simple Tasks	0.05 (2.02) **
White-Collar Worker with Difficult Tasks	0.16 (6.50) ***
High-Skilled White-Collar Worker	0.20 (7.60) ***
Executive White-Collar Worker	0.30 (6.43) ***
Civil Servant in Clerical Grade	0.16 (4.68) ***
Civil Servant in Higher Service	0.23 (3.55) ***
Civil Servant in Senior Service	0.55 (8.26) ***

Workplace Characteristics	
Computer Work Station	0.03 (1.82) *
Temporary Work	-0.04 (-1.59)
Good Economic Situation	0.03 (2.34) **
Overtime	0.05 (4.25) ***
Profit-Sharing	0.06 (2.41) **
Incentive Wage	0.05 (3.95) ***

Individual Characteristics	
Children	0.06 (6.03) ***
Foreigner	-0.05 (-2.77) ***

Interaction Variables	
Professional Experience	0.01 (1.90) *
Professional Experience Squared	-0.00 (-0.50)
Company Tenure	-0.01 (-2.48) **
Company Tenure Squared	0.00 (1.35)
Computer Work Station	0.03 (1.45)
Temporary Work	-0.05 (-1.36)
Good Economic Situation	0.02 (1.07)
Overtime	-0.01 (-0.74)
Profit-Sharing	0.02 (0.81)
Incentive Wage	-0.04 (-2.75) ***
School Attainment	
Without School Leaving Certificate	-0.04 (-0.85)
Lower Secondary School	-0.05 (-3.01) ***
Entrance Examination for University for Applied Sciences	0.04 (1.04)
High School Diploma	0.00 (0.16)
Professional Status	
Skilled Blue-Collar Worker	-0.02 (-0.68)
Assistant Foreman	-0.00 (-0.07)
Master/Foreman	0.43 (0.79)
Unskilled White-Collar Worker	-0.04 (-0.98)
White-Collar Worker with Simple Tasks	-0.03 (-0.86)
White-Collar Worker with Difficult Tasks	-0.07 (-2.06) **
High-Skilled White-Collar Worker	0.02 (0.70)
Executive White-Collar Worker	0.02 (0.28)
Civil Servant in Clerical Grade	-0.15 (-3.51) ***
Civil Servant in Higher Service	-0.14 (-1.95) *
Civil Servant in Senior Service	-0.27 (-3.72) ***

Number of Observations	10003
F(220, 9781)	
R-squared	0.5169

***, (**,*) signals a level of significance of 1% (5%, 10%) (t-values in parentheses are based on heteroscedasticity robust standard errors)
Source: BIBB-IAB 1998/99, own calculations.
Following control variables have been added: size of firm (6), federal state (10), residence community (2), economic sector (46), demand for specific training (5), job contents (13) and a constant.

Table A8 Extended Earnings Equation with Internal and External Training

Education and Continuous Training	
External Training	0.05 (6.93) ***
Internal Training	-0.01 (-1.75) *
School Attainment	
Without School Leaving Certificate	-0.01 (-0.28)
Lower Secondary School	-0.03 (-2.97) ***
Intermediate Secondary School	Reference
Entrance Examination for University for Applied Sciences	0.04 (2.21) **
High School Diploma	0.07 (4.25) ***
Vocational Training	
Without Professional Degree	-0.07 (-2.11) **
Full-Time Vocational School	Reference
Apprenticeship	-0.02 (-0.88)
Master Craftman	0.02 (0.62)
University for Applied Sciences	0.07 (2.02) **
University	0.15 (4.27) ***

Professional Career	
Professional Experience	0.01 (9.39) ***
Professional Experience Squared	-0.00 (-6.70) ***
Company Tenure	0.01 (5.08) ***
Company Tenure Squared	-0.00 (-2.18) **
Unemployment	-0.03 (-3.33) ***

Individual Characteristics	
Children	0.07 (9.43) ***
Foreigner	-0.02 (-0.65)

Professional Status	
Unskilled Blue-Collar Worker	Reference
Skilled Blue-Collar Worker	0.04 (1.91) *
Assistant Foreman	0.04 (1.60)
Master/Foreman	0.13 (4.43) ***
Unskilled White-Collar Worker	0.06 (1.96) **
White-Collar Worker with Simple Tasks	0.00 (0.12)
White-Collar Worker with Difficult Tasks	0.09 (4.03) ***
High-Skilled White-Collar Worker	0.17 (7.45) ***
Executive White-Collar Worker	0.23 (7.39) ***
Civil Servant in Clerical Grade	0.04 (1.52)
Civil Servant in Higher Service	0.12 (3.53) ***
Civil Servant in Senior Service	0.32 (7.81) ***

Workplace Characteristics	
Computer Work Station	0.04 (4.53) ***
Temporary Work	-0.08 (-3.59) ***
Good Economic Situation	0.04 (5.02) ***
Overtime	0.04 (4.79) ***
Profit-Sharing	0.06 (4.33) ***
Incentive Wage	0.03 (3.37) ***

Number of Observations	8325
F(335, 7988)	
R-squared	0.5245

Table A8 continued

Interaction Variables - Internal Training	
Professional Experience	0.00 (0.53)
Professional Experience Squared	-0.00 (-0.87)
Company Tenure	0.00 (1.68) *
Computer Work Station	0.00 (0.27)
Temporary Work	-0.00 (-0.14)
Good Economic Situation	-0.01 (-1.22)
Overtime	-0.00 (-0.12)
Profit-Sharing	-0.00 (-0.38)
Incentive Wage	0.00 (0.02)
School Attainment	
Without School Leaving Certificate	-0.01 (-0.28)
Lower Secondary School	-0.03 (-2.99) ***
Entrance Examination for University for Applied Sciences	-0.03 (-2.35) **
High School Diploma	-0.03 (-2.04) **
Professional Status	
Skilled Blue-Collar Worker	-0.03 (-1.87) *
Assistant Foreman	-0.00 (-0.14)
Master/Foreman	-0.02 (-0.89)
Unskilled White-Collar Worker	0.00 (0.12)
White-Collar Worker with Simple Tasks	-0.01 (-0.66)
White-Collar Worker with Difficult Tasks	-0.03 (-1.62)
High-Skilled White-Collar Worker	-0.02 (-1.32)
Executive White-Collar Worker	-0.07 (-2.69) ***
Civil Servant in Clerical Grade	-0.03 (-1.40)
Civil Servant in Higher Service	-0.02 (-0.83)
Civil Servant in Senior Service	-0.05 (-1.51)

Interaction Variables - External Training	
Professional Experience	0.00 (1.98) **
Professional Experience Squared	-0.00 (-0.25)
Company Tenure	-0.01 (-4.42) ***
Computer Work Station	0.01 (1.28)
Temporary Work	-0.04 (-1.40)
Good Economic Situation	0.02 (2.10) **
Overtime	-0.01 (-1.25)
Profit-Sharing	0.01 (0.84)
Incentive Wage	-0.02 (-2.44) **
School Attainment	
Without School Leaving Certificate	-0.01 (-0.43)
Lower Secondary School	-0.02 (-1.73) *
Entrance Examination for University for Applied Sciences	0.01 (0.88)
High School Diploma	0.02 (1.42)
Professional Status	
Skilled Blue-Collar Worker	-0.01 (-0.54)
Assistant Foreman	-0.04 (-1.38)
Master/Foreman	0.00 (0.06)
Unskilled White-Collar Worker	-0.03 (-0.78)
White-Collar Worker with Simple Tasks	-0.04 (-1.22)
White-Collar Worker with Difficult Tasks	-0.05 (-1.9) *
High-Skilled White-Collar Worker	-0.02 (-0.61)
Executive White-Collar Worker	-0.00 (-0.06)
Civil Servant in Clerical Grade	-0.10 (-3.27) ***
Civil Servant in Higher Service	-0.06 (-1.97) **
Civil Servant in Senior Service	-0.09 (-2.48) **

***, (**,*) signals a level of significance of 1% (5%, 10%) (t-values in parentheses are based on heteroscedasticity robust standard errors)
Source: BIBB-IAB 1998/99, own calculations.
Following control variables have been added: size of firm (6), federal state (10), residence community (2), economic sector (46), demand for specific training (5) and a constant.

Table A9 Selection into Internal Training

Identifying Variables	
Restructuring	0.24 (7.32) ***
Training Needs	
Mathematics	-0.12 (-2.21) **
German	0.08 (1.23)
System Engineering	0.13 (1.85) *
Computer Engineering	0.06 (1.32)
Other Engineering	0.26 (6.04) ***
Safety at Work	0.11 (2.77) ***
Medicine	0.13 (1.66) *

Education and Continuous Training	
School Attainment	
Without School Leaving Certificate	0.03 (0.44)
Lower Secondary School	0.00 (0.13)
Intermediate Secondary School	Reference
Entrance Examination for University for Applied Sciences	-0.03 (-0.63)
High School Diploma	-0.02 (-0.55)
Vocational Training	
Without Professional Degree	-0.03 (-0.47)
Full-Time Vocational School	Reference
Apprenticeship	-0.02 (-0.33)
Master Craftman	-0.06 (-0.85)
University for Applied Sciences	-0.08 (-0.94)
University	-0.15 (-1.77) *

Professional Career	
Professional Experience	0.00 (0.64)
Professional Experience Squared	-0.00 (-2.51) **
Company Tenure	0.01 (-1.55)
Company Tenure Squared	-0.00 (-1.59)
Unemployment	-0.00 (-0.20)

Professional Status	
Unskilled Blue-Collar Worker	Reference
Skilled Blue-Collar Worker	0.06 (2.03) **
Assistant Foreman	0.34 (5.29) ***
Master/Foreman	0.05 (0.84)
Unskilled White-Collar Worker	-0.10 (-1.94) *
White-Collar Worker with Simple Tasks	-0.05 (-1.03)
White-Collar Worker with Difficult Tasks	0.11 (2.58) ***
High-Skilled White-Collar Worker	0.07 (1.68) *
Executive White-Collar Worker	-0.10 (-1.76) *
Civil Servant in Clerical Grade	0.22 (3.25) ***
Civil Servant in Higher Service	0.15 (2.05) **
Civil Servant in Senior Service	-0.02 (-0.19)

Workplace Characteristics	
Computer Work Station	0.20 (7.55) ***
Temporary Work	-0.11 (-2.75) ***
Overtime	0.09 (4.31) ***
Incentive Wage	0.17 (6.45) ***

Individual Characteristics	
Foreigner	-0.04 (-1.16)

Number of Observations	9723
F(102, 9620)	17.92
R-squared	0.1714

***, (**,*) signals a level of significance of 1% (5%, 10%) (t-values in parentheses are based on heteroscedasticity robust standard errors)
Source: BIBB-IAB 1998/99, own calculations

Following control variables have been added: size of firm (6), federal state (10), residence community (2), economic sector (46), demand for specific training (5) and a constant.

Table A10 Selection into External Training

Identifying Variables	
Restructuring	0.07 (2.51) **
Training Needs	
Mathematics	-0.13 (-2.77) ***
German	-0.13 (-2.66) ***
System Engineering	0.21 (3.62) ***
Computer Engineering	0.17 (4.44) ***
Other Engineering	0.19 (5.88) ***
Safety at Work	0.15 (4.63) ***
Medicine	0.10 (1.45)

Education and Continuous Training	
School Attainment	
Without School Leaving	-0.05 (-1.10)
Lower Secondary School	-0.05 (-2.55) **
Intermediate Secondary School	Reference
Entrance Examination for University for Applied Sciences	0.16 (4.08) ***
High School Diploma	0.06 (1.57)
Vocational Training	
Without Professional Degree	-0.02 (-0.42)
Full-Time Vocational School	Reference
Apprenticeship	0.05 (0.91)
Master Craftman	0.29 (4.96) ***
University for Applied Sciences	0.31 (4.60) ***
University	0.38 (5.24) ***

Professional Career	
Professional Experience	0.01 (2.64) ***
Professional Experience Squared	-0.00 (-3.40) ***
Company Tenure	0.02 (6.69) ***
Company Tenure Squared	-0.00 (-4.70) ***
Unemployment	-0.05 (-3.01) ***

Professional Status	
Unskilled Blue-Collar Worker	Reference
Skilled Blue-Collar Worker	0.07 (3.65) ***
Assistant Foreman	0.17 (3.69) ***
Master/Foreman	0.35 (6.04) ***
Unskilled White-Collar Worker	0.05 (1.31)
White-Collar Worker with Simple Tasks	0.04 (1.18)
White-Collar Worker with Difficult Tasks	0.26 (8.02) ***
High-Skilled White-Collar Worker	0.66 (18.96) ***
Executive White-Collar Worker	0.72 (14.03) ***
Civil Servant in Clerical Grade	0.23 (4.52) ***
Civil Servant in Higher Service	0.54 (8.35) ***
Civil Servant in Senior Service	0.78 (9.78) ***

Workplace Characteristics	
Computer Work Station	0.19 (8.87) ***
Temporary Work	-0.12 (-4.15) ***
Overtime	0.11 (6.25) ***
Incentive Wage	0.03 (1.48)

Individual Characteristics	
Foreigner	-0.11 (-4.73) ***

Number of Observations	9723
F(112, 9610)	73.09
R-squared	0.4322

***, (**,*) signals a level of significance of 1% (5%, 10%) (t-values in parentheses are based on heteroscedasticity robust standard errors)

Following control variables have been added: size of firm (6), federal state (10), residence community (2), economic sector (46), demand for specific training (5), job contents (13) and a constant.

Table A11 Translation of Selected Variables

English	German
Training	
Quality Circle	Qualitätszirkel
Trade Fair	Fachmesse
internship	Praktikum
lecture	Fachvortrag
Specialist Literature	Fachliteratur
School Attainment	
without school leaving certificate	Ohne Abschluss
lower secondary school	Hauptschule
intermediate secondary school	Realschule
entrance examination for university for applied sciences	Fachhochschulreife
high school diploma	Abitur
Vocational Training	
without professional degree	Ohne Ausbildung
full-time vocational school	Berufsfachschule
apprenticeship	Lehre
master craftsman	Meister
university for applied sciences	Fachhochschule
university	Universität
Professional Status	
unskilled blue-collar worker	Angelernter Arbeiter
skilled blue-collar worker	Facharbeiter
assistant foreman	Vorarbeiter
master/foreman	Meister
unskilled white-collar worker	Ausführender Angestellter
white-collar worker with simple tasks	Angestellter mit einfacher Tätigkeit
white-collar worker with difficult tasks	Angestellter, der schwierige Aufgaben nach allgemeiner Anweisung selbstständig erledigt
high-skilled white collar worker	Angestellter, der selbstständige Leistungen in verantwortungsvoller Tätigkeit erbringt oder begrenzte Verantwortung für die Tätigkeit anderer trägt
executive white collar worker	Angestellter mit umfassenden Führungsaufgaben und Entscheidungsbefugnissen
civil servant in clerical grade	Beamter im einfachen oder mittleren Dienst
civil servant in higher service	Beamter im gehobenen Dienst
civil servant in senior service	Beamter im höheren Dienst

Figure A1 Participation in Training depending on Experience and Tenure