Zeitschrift für Wirtschafts- u. Sozialwissenschaften (ZWS) 117 (1997), S. 525 - 543
Duncker & Humblot, Berlin

Financing On-The-Job Training: Shared Investment or Promotion Based System? Evidence from Germany*

By Markus Pannenberg**

1. Introduction

Concern about the causes of different productivity growth rates in the United States, Japan and Germany and their effects on wage inequality and unemployment has renewed economists' interest in human capital investments. Based on endogenous growth theory training policies of firms and training decisions by workers have been singled out as a major cause of varying unemployment equilibria. Research is focused on investment in apprenticeship training on the one hand and on investment in on-the-job training on the other one. The former has attracted a lot of theoretical and empirical work (Acemoglu / Pischke 1996, Harhoff / Kane 1994). Research on the latter is driven by the idea that through on-the-job training worker's occupational skills are adjusted to technological progress and thus labor reallocation is supported. Much of the discussion on this topic considers the determinants of on-the-job training and Becker's famous finance hypothesis. This hypothesis states that the training firm and the worker share costs of and return on on-the-job training and therefore no inefficiency in the provision of on-the-job training exists.

In spite of this extensive theoretical discussion little is known about who invests in and who receives training (Barron / Black / Loewenstein 1989, Groot 1995, Lynch 1994, Lynch / Black 1995). For Germany, some work has been done recently to fill this gap (Pannenberg 1995, Pfeiffer / Brade 1995, Pischke 1996). Nevertheless, our knowledge about the contractual arrangements of financing on-the-job training used to protect against opportunistic

---

* Verantwortlicher Herausgeber / editor in charge: J. W.

** I am grateful to John Haisken-DeNew, Jörn-Steffen Pischke, Johannes Schwarze and Gert Wagner for valuable comments. Furthermore, special thanks to an anonymous referee for very detailed and helpful comments. Some of the research was undertaken while the author stayed at the Department of Economics at MIT. Financial support from the World Economy Laboratory (WEL) at MIT is gratefully acknowledged.

bargaining and the consequences these arrangements have on job mobility, wage growth and career ladders is still scarce[1]. This is mainly due to a lack of appropriate data. Therefore, most research on testing Becker's sharing hypothesis is restricted to the analysis of wage profiles. For former West Germany, however, it is possible to gain new insights into the finance of on-the-job training using longitudinal data from the German-Socio-Economic Panel (GSOEP). The GSOEP allows us to link detailed cross sectional information of on-the-job training to individual employment histories and therefore to create a data base for testing Becker's sharing hypothesis directly.

The remainder of the paper proceeds as follows. In section 2 the main theoretical arguments are briefly summarized. Section 3 describes the data base and the sample design used in empirical work. The main results of the study are presented in section 4 and 5. Section 6 contains our conclusions.

2. Firm-Specific Human Capital as a Shared Investment?

The fundamental basis of most empirical work on on-the-job training (ojt) is human capital theory. Hence, the starting point is Becker's classification of general and firm-specific human capital: On-the-job training is general if it is equally useful to many firms in a competitive labor market and firm-specific if it is of value only in the training firm. Trained workers with general human capital are paid their marginal products and bear all the costs of and return on investment in human capital. On the contrary, investments in firm-specific human capital are sunk costs and generate quasi-rents if the employee-employer relationship continues. Therefore, wage negotiations or renegotiations after the investment has been made contain elements of a bilateral monopoly: Employer and worker can do better by staying together than by choosing their next best options. The traditional Nash bargaining solution of sharing the returns of investment only yields an efficient choice of investment if the parties making the investment receive their full marginal return (Hart / Holmström 1987). Otherwise the Williamson 'hold-up' phenomenon results (MacLeod / Malcomson 1993a). Moreover, information is asymmetric: the employer knows the productivity of the employee before and after investing in firm-specific human capital, but is not aware of the employee's outside options. On the other hand the employee has information about the outside options, but does not know the change in productivity, caused by investing in firm-specific human capital. As a result investment in firm-specific human capital is subject to 'dual moral hazard'

[1] Pannenberg (1995) provides some results. This work presents an extended analysis.

(Kahn / Huberman 1988): The employer has an incentive to cheat the employee out of the quasi-rent and the employee has only an incentive to collect skills if he gets an appropriate wage.

The traditional human capital solution to this problem (Becker 1975, Hashimoto 1981) is to choose a contract in which the costs of and the return on investment in firm-specific human capital are shared by both parties and wage renegotiation, after the investment has been taken, is excluded. This sharing hypothesis supposes that the workers pay their part of specific on-the-job training in the form of a lower starting wage and realize their part of return on investment in the form of a steeper wage profile over time.

Some authors doubt the empirical significance of Becker's sharing hypothesis. MacLeod / Malcomson (1993a,b) develop a theoretical framework with renegotiation. They show that employers who invest in firm-specific human capital can capture the whole return of their investment if the outside option of the employee is a job offer from another firm. Their main point is that returns on specific investments by the employer are not reflected in the outside option of the employee. Therefore, the employee cannot bargain away any of the return on investment. Prendergast (1993) stresses, since much investments in firm-specific human capital are difficult to quantify, that it is probably difficult to compensate workers by means of the traditional sharing solution. Hence, to induce efficient firm-specific investment, other compensation schemes are needed. Prendergast proposes a model with career ladders. In this model the possibility of promotion to a different job with a higher wage ensures investment in firm-specific human capital.

Becker's sharing solution provides hypotheses of the impact of financing on-the-job training, i.e. the investment decision, on starting wages and wage profiles. Therefore, employing direct measures for on-the-job training and the structure of financing ojt, we can test the sharing solution by running appropriate separate regressions of starting wages and wage growth on the on-the-job training variables. Moreover, an important result of standard human capital theory under the assumption of a frictionless economy is that investment and turnover decisions can be investigated separately (Chang / Wang 1996[2]). Since the shared investment hypothesis is based on the idea of tying workers to the firm by generating mobility costs due to former investment in human capital, an additional test is provided by assessing the impact of financing on-the-job training on subsequent job mobility. To shed

[2] Chang / Wang's analysis is basically related to Hashimoto (1981). Their departure from standard human capital theory is the assumption of asymmetric information of the type that the current employer knows more about the workers human capital than any other potential employer.

some light on the competing hypothesis on the link between promotion and on-the-job training, we investigate the determinants of financing on-the-job training and promotion within a firm in a second step.

3. Data and Sample Design

As mentioned above, the data set used for the empirical analysis is drawn from the German Socio-Economic Panel (GSOEP). The GSOEP consists of representative longitudinal data from West German households and persons[3]. We use panel data for the survey years 1984 to 1991. The longitudinal data are linked to detailed information on vocational trainining collected in wave 6 (1989). Therein respondents were asked what types of training they received in the last *three* years, about the number of courses, the duration of each training spell, and the form of financing on-the-job training. Relying on this information, we select a subsample of all persons in the GSOEP, who took part in wave 6. Respondents with training spells are required to be employed (full-time) just before the training began and have to stay with their current employer during the training spell. This enables us to assign the on-the-job training precisely to a certain employer. Taking into account that most of the analyzed training spells start after the interview in 1988 (80%), all respondents with no training spell also have to be employed (full time) at the date of the interview in 1988. Moreover, due to the fact that training patterns for the public service and for self-employed persons are different compared to the private sector, we exclude all respondents, who worked in public service or were self-employed. Given all these requirements, the remaining subsample consists of 2747 individuals including 372 (14%), who had undergone on-the-job training.

Information concerning the finance of on-the-job training is based on two questions about financial assistance and 'out-of- pocket' expenses for training[4]. We create our variable 'finance' as follows[5]:

(1) self-financed training: no financial assistance from the employer, from employment office or from somewhere else,

---

3 For details see Wagner / Burkhauser / Behringer (1993).

4 (1) *Do you get financial assistance or continued payment from your employer, employment office, or somewhere else during further training?* yes, from the employer; yes, from the employment office; yes, from somewhere else; no, no assistance. (2) *What were your out-of-pocket expenses for this training?* amount in DM; incurred no cost.

5 There were 6 observations in our originally selected subsample with the source financial assistance from ‚employment office' or from ‚somewhere else'. They were excluded from our subsample.

(2) shared- financed training: financial assistance from employer and out-of-pocket expenses > 0,

(3) employer-financed training: financial assistance from employer and incurred no cost.

Other (dummy-)variables we use in our econometric analysis of the consequences ojt has on subsequent employment histories are *multiple ojt, duration of ojt, financial support employer* and interaction terms of *ojt* and *other characteristics*[6].

However, the data have some limitations. First, the information on the nature of training, i.e. whether the training is general or firm specific, is not given explicitly. Rather, since the employees were employed full time at the start of the training spell and did not change the employer during on-the-job training, we assume that most training has both, a significant firm specific and a general component. Second, in contrast to most textbook definitions of on-the-job training, our definition includes *job related* training spells outside the firm (for example at an education center of the employer) as well as those within the firm, but out of regular working time. As the employee was full time employed and did not change his job during the whole training spell, we think that – at least in the German context with its highly standardized system of vocational education – this is a natural extension. Third, we cannot link the starting date of the training spells to wages exactly. Therefore we choose the wage given at the interview preceeding the starting date of on-the-job training as the 'starting wage'.

4. The Impact of Financing OJT on Starting Wages, Wage Profiles and Job Mobility

A first glance at the empirical evidence of the human capital sharing solution is given by the empirical distribution of the variable 'finance'. One-sided investments seem to be prevalent: With 57% most on-the-job training is financed by employers, a considerable part is born by the employees (33%), but shared-investment plays only a minor role (10%).

The 'standard' test in the literature applied to Becker's shared investment hypothesis is a regression of starting wages on an on-the-job training variable[7] and on other relevant factors. In such a regression, the training coefficient should be negative. If we extend the 'standard test' and employ our in-

---

6 All variables employed in the empirical analysis are described in Appendix 1. Their descriptive statistics are given in Appendix 2.

7 See for example: Barron / Black / Loewenstein (1989).

formation on employer-supported (shared-financed or employer-financed) and self-financed ojt instead of the dummy ojt, the coefficient of employer-supported ojt should be negative and different compared to the one for self-financed ojt. We estimate two starting wage equations with the described ojt variables and various control variables, such as gender, schooling, potential experience, tenure, nationality, firm size, industrial classification of the employer and the log of weekly hours worked (including overtime)[8]. To capture non-linear effects of potential experience and tenure on income (Murphy / Welch 1990) we also include quartics in potential experience and quadratics in tenure[9]. As dependent variable we use the log of monthly gross wage / salary at the beginning of the 'training spell', for respondents with no training spell the wage in 1988 respectively[10]. The exogenous variables are also taken from the survey year just preceeding the training spell. Employing the log of weekly hours worked as an exogenous regressor instead of using hourly wages as the dependent variable might cause bias problems if the individuals choose their working hours with respect to labor supply theory. To check this argument we ran a regression with the hourly wage as dependent variable. The results are very similar[11]. Earning functions are usually estimated by ordinary least squares (OLS). However, using the Breusch-Pagan Test we have to reject the existence of homoscedastic errors. Hence, we compute Whites appropriate covariance matrix (Greene 1993)[12]. Table 1 reports the results.

Investment in on-the-job training affects the starting wage positively and significantly (column 1). This result holds if we extend the 'standard' test by means of including dummies for employer-supported and self-financed on-the-job training instead of the dummy *ojt* (column 3): Both estimates are significantly positive. A test with the null hypothesis that the coefficients are identical cannot reject the null [χ^2 (1) = 0.01]. Hence, with respect to the predictions of human capital theory that workers share training costs through lower starting wages we find no support for Becker's sharing hypothesis[13]. Our result rather indicates that German employers seem to use other incentive mechanisms than generating sunk costs for employees.

---

8 See for a detailed description of the variables and their descriptive statistics Appendix 1 and 2.

9 Higher-order terms of tenure (tenure^3 or tenure^4) are not significant.

10 For training spells with ‚starting wages' in 1986 (4% of all training) or in 1987 (20% of all training) we include control time dummies.

11 E.g. the estimated coefficient of ojt is 0.15 (t=6.9)

12 Instead of using Whites method, we also estimated a model with multiplicative heteroscedasticity. The estimates are very similiar to the presented results.

13 A referee pointed out that if there is persistence in training part of the results might be due to past on-the-job training, which we cannot observe in our data. However, the fixed effects estimator presented below is robust against this objection.

Table 1

Starting Wages and On-The-Job Training

	Ia		Ib	
variable	coefficient	(*t*-value)	coefficient	(*t*-value)
constant	5.28**	18.5	5.28**	18.5
schooling education (in years)	0.07**	17.3	0.07**	17.2
potential experience (years)	0.08**	4.7	0.08**	4.7
potential experience^2 (years)	-0.04×10^{-1} **	-3.0	-0.04×10^{-1} **	-3.0
potential experience^3 (years)	0.09×10^{-3} *	2.2	0.09×10^{-3} *	2.2
potential experience^4 (years)	-0.08×10^{-5} +	-1.8	-0.08×10^{-5} +	-1.8
tenure (years)	0.07×10^{-1} **	2.8	0.07×10^{-1} **	2.8
tenure squared (years)	-0.01×10^{-2} +	-1.8	-0.01×10^{-2} +	-1.8
on-the-job training (*ojt*)	0.16 **	7.3	–	–
self-financed on-the-job training	–	–	0.16 **	4.7
employer-supported ojt	–	–	0.15 **	6.5
log of weekly work.hours (overt. i.)	0.32 **	4.3	0.32 **	4.3
male	0.26 **	16.2	0.26 **	16.2
foreigner	-0.06 **	-4.5	-0.06 **	-4.5
firm size: 20 - 199 employees	0.04 +	1.8	0.04 +	1.8
firm size: 200 - 1999 employees	0.06 **	3.1	0.06 **	3.1
firm size: $\geq$ 2000 employees	0.15 **	7.3	0.15 **	7.3
chemicals	0.02	0.7	0.02	0.7
construction, quarring	0.02	1.0	0.02	1.0
trade / bank / insurance	-0.06 *	-2.3	-0.05 *	-2.3
metal / electrical engineering	0.02	1.5	0.02	1.5
transport / traffic	0.06 +	1.9	0.06 *	2.0
starting wage in 1986	-0.11*	-2.1	-0.11*	-2.1
starting wage in 1987	-0.04	-0.9	-0.04	-0.9
N =	2518		2518	
$R^2_{adj.}$ =	0.42		0.42	
LM-Test =	498.2** (df=21)		498.6** (df=22)	
Wald-Test =	1671.1** (df=21)		1678.4** (df=22)	

Source: GSOEP, years 1986 - 1989.
Model: OLS with corrected covariance matrix (White).
N: Number of observations.
Significance level: ** (0.01), * (0.05), + (0.10).
LM-Test : Lagrange-multiplier-statistic; test for heteroscedasticity.
Wald-Test: Test of joint significance of the set of exogenous variables.

Hashimoto's (1981) formulation of Becker's sharing hypothesis implies an inverse relationship between the employers share in the cost of investment and subsequent wage growth. Hence, by means of wage regressions, we can provide an additional test on the importance of shared investment solutions.

Our used sample runs from 1986 to 1991. The individuals have to take part in the survey year 1989, since we need information on the incidence of on-the-job training. Given this selection rule, we include all observations of persons with valid information on the monthly gross wage / salary, who are full time employed at the date of the interview. The resulting 'unbalanced' panel consists of 1684 persons with 9145 observations. 230 (14%) persons participated in on-the-job training.

Appropriate econometric models for estimating wage functions are linear models of panel data. These models enable us to avoid any problems due to time invariant unobserved heterogeneity. We estimate one way fixed – and random effects models. To check for orthogonality of the random effects and the regressors, we use a Wald-Test-Version of the Hausman specification test suggested by Arellano (1993), which is robust to heteroscedasticity. Since the specification test rejects the hypothesis that the individual effects are uncorrelated with the regressors [χ^2 (19) = 924.1], we choose the fixed effects estimator. Heteroscedasticity is a problem in our fixed effects model [χ^2 (19) = 809.52][14]. Hence, we compute the appropriate covariance matrix according to Arellano (1987). Our dependent variable is the log of the monthly gross wage / salary. As exogenous variables we employ again quartics in tenure and potential experience to control for nonlinearities, the log of weekly working hours (overtime incl.)[15], a dummy, which indicates job mobility, the main effect *ojt* and a set of interactions of *ojt* and gender, *ojt* and the frequency of training, *ojt* and the duration of training, *ojt* and job mobility and of *ojt* and the finance of training. Table 2 reports our estimation results.

In contrast to the predictions of the shared investment hypothesis we do not observe a monotone, inverse relationship between wages and the employer's share in the cost of investment. Employer-financed training yields a significant smaller return on investment compared to the reference group of self-financed training, but there is no significant difference between self-financed training and the shared investment type of financing *ojt*. Furthermore, a test of the linear restriction $\beta_{ojt} + \beta_{finemp} = 0$ cannot reject the null hypothesis [χ^2 (1) = 0.74]. According to Macleod's and Malcomson's ap-

14 Breusch-Pagan's Lagrange-Multiplier Test is used.

15 Using the log of weekly working hours as an exogenous variable instead of the log of hourly wages as the dependent variable is based on the same line of arguments as before.

proach (1993a / b) our results seem to indicate that in West Germany employers are able to protect one-sided investment in *ojt* against opportunistic bargaining: Taken at face value, German employees with employer-financed *ojt* cannot bargain away any of the return on investment in *ojt*.

Table 2

Wages and On-The-Job Training

variable	coefficient	(*t*-value)
potential experience (years)	0.14 **	10.9
potential experience^2 (years)	-0.5×10^{-2} **	-5.9
potential experience^3 (years)	0.13×10^{-3} **	5.1
potential experience^4 (years)	-0.12×10^{-5} **	-4.8
tenure (years)	0.01 +	1.9
tenure^2 (years)	-0.02×10^{-1} **	-2.9
tenure^3 (years)	0.05×10^{-3} **	2.8
tenure^4 (years)	-0.06×10^{-5} *	-2.4
log of weekly work. hours (overt. incl.)	0.31 **	9.6
job mobility	0.07 **	2.7
on-the-job training (main effect)	0.09 **	2.9
*ojt**male	-0.02	-1.2
*ojt**multiple activity	-0.01	-0.2
*ojt**duration 2 days - 1 week	0.01	0.5
*ojt**duration 1 week - 1 month	-0.7×10^{-5}	-0.0
*ojt**duration > 1 month	-0.05 +	-1.9
*ojt**shared-financed	-0.05	-1.3
*ojt**employer-financed	-0.06 **	-3.1
*ojt**job mobility	-0.02	-1.2
N =	9145	
$R^2_{adj.}$ =	0.85	
LM-Test (df=19) =	809.5**	
Wald-Test (df=19) =	3340.5**	
Hausman-Test (df=19) =	924.1**	

Source: GSOEP, years 1986 - 1991.
Model: Fixed effects model with corrected covariance matrix.
N: Number of observations.
Significance level: ** (0.01), * (0.05), + (0.10).
$R^2_{adj.}$: adjusted R^2.
LM-Test : Lagrange-multiplier-statistic; test for heteroscedasticity.
Wald-Test: Test of joint significance of the set of exogenous variables.
Hausman-Test: Wald Version of Hausman specification test.

Table 3

Job Mobility and On-The-Job Training

variable	coefficient	(*t*-value)
constant	0.06	0.3
male	0.23 +	1.9
foreigner	-0.08	-0.6
union membership	-0.21	-1.5
handicapped	0.20	0.7
schooling level: 10th class	-0.02×10^{-2}	-0.0
schooling level: univ. entry qualification	0.21	0.8
occupat. qual.: apprenticeship	-0.10	-0.8
occupat. qual.: univesity degree	-0.62 *	-2.1
potential experience (years)	-0.04**	-5.7
tenure (years)	-0.19**	-8.6
tenure^2 (years)	0.03×10^{-1}**	4.1
firm size: 20 - 199 employees	0.06	0.5
firm size: 200 - 1999 employees	-0.45**	-2.8
firm size: $\geq$ 2000 employees	-0.78**	-4.1
chemicals	-0.24	-0.9
construction, quarring	0.16	1.1
trade / bank / insurance	0.12	0.7
metal / electrical engineering	-0.10	-0.7
transport / traffic	-0.14	-0.7
on-the-job training (main effect)	-0.27	-0.6
*ojt**multiple activity	0.06	0.2
*ojt**duration 2 days-1 week	0.36	0.9
*ojt**duration 1 week-1month	-0.23	-0.4
*ojt**duration > 1 month	0.48	1.1
*ojt**employer-supported finance	0.35	1.3
starting time in 1986	-0.48	-0.7
starting time in 1987	-0.03	-0.1
N =	2161	
Log-L =	-911.0	
LRS (df=27) =	506.2**	
LRS P / NB (df=1) =	0.6	

Source: GSOEP, years 1986 - 1991.
Model: Poisson model.
N: Number of observations.
Significance level: ** (0.01), * (0.05), + (0.10).
Log-L: Log-Likelihood.
LRS: Likelihood-ratio-statistics.
LRS P / NB: LRS of negativ binomial against Poisson model.

As mentioned before the underlying story of the shared investment hypothesis is the idea to tie workers to the firm by generating mobility costs. Since standard human capital theory under symmetric information implies that investment and mobility decisions can be analyzed separately (Chang / Wang 1996), we can provide additional evidence on Becker's finance hypothesis by assessing the impact of financing on-the-job training on subsequent job mobility. Therefore, we analyze the effect of financing on-the-job training on subsequent mobility of workers between firms. Based on our subsample we examine job changes within three years after the beginning of the training spell; respectively for respondents with no training spell for the period 1988 to 1991. The observed individuals have to be employed (full-time) at the end of the observed period. This condition applies to 2161 persons including 306 (14%), who had undergone on-the-job training. 320 respondents (15%) have changed job once or more often.

The appropriate econometric specification for the dependent variable 'number of job changes' is a count data model (Greene 1993, Winkelmann / Zimmermann 1995). We employ models with Poisson and with negative binomial distributions and test the hypothesis of equi-dispersion in the Poisson model. Since we find no evidence for rejecting equi-dispersion [$\chi^2(1) = 0.9$], we present the estimates of the Poisson model. As exogenous variables we use our 'standard' set of control variables and interactions of *ojt* and the duration of training, *ojt* and the frequency of training and of *ojt* and financial support from the employer[16]. The estimated interaction coefficients provide additional information on the characteristics of *ojt*. In Table 3 our results of the Poisson model are reported.

Employer-supported on-the-job training has no significant effect on subsequent job mobility though Becker's sharing hypothesis suggests that there should be a negative one. Therefore, our result is again not in accordance with the standard sharing hypothesis.

5. Career Concerns and the Finance of On-The-Job Training

Taking the results at face value, there is no evidence for the shared investment hypothesis in our data. An explanation given in the literature (for example MacLeod / Malcomson 1993a/b) is that in standard human capital theory the bargaining situation is not described in a sufficient manner. Related to this issue, other incentive schemes are discussed, in particular career schemes (Gibbons 1996). The latter seem to be an efficient incentive

[16] Again, we aggregate the information on shared investment and employer-financed training to employer-supported training.

system to induce firm specific human capital, since by means of career schemes, opportunity costs of career and income prospects are imposed on the employees. However, the evidence for these issues is still very scarce (Gibbons 1996)[17]. Using our information on financing on-the-job training, we are able to shed some light on the joint determinants of on-the-job training and promotions within the firm for a subsample of employees who stayed in the firm over the whole observation period. Restricting the analysis to this subgroup implies that we separate the decision of layoffs and quits. However, conditional on the group of 'stayers', our analysis provide some information on the correlation of financing *ojt* and promotions within the firm and indicates whether German employers try to link *ojt* and career concerns of their workers.

We analyze employment histories of full time employed individuals who stay in their firm over the whole observation period (1984 to 1991). To find out whether a person climbed on the internal career ladder, we use upward changes in the occupational position between 1984 and 1991 as a proxy for promotion. We have ordinal information for blue collar workers (unskilled worker, trained worker, semi-skilled and skilled worker, foreman, master craftsmen) and for white collar workers (employee with simple duties and no degree, employee with simple duties and degree, employee with qualified duties, employee with highly qualified duties or managerial function, employee with extensive managerial duties). We generate a promotion dummy with '1' for upward mobility and '0' otherwise. Since respondents with the highest occupational status in 1984 (2% of our subsample) have a zero probability of promotion, they are excluded from our analysis. In addition we use as endogenous variable the dummy on-the-job training (*ojt*) with '1' for investment in *ojt* and '0' otherwise. Given these restrictions, the remaining subsample consists of 984 individuals. 122 respondents (12%) are participants in on-the-job training.

An appropriate econometric model for analyzing the simultaneity of on-the-job training and promotion within the firm is the bivariate probit model (Greene 1993). As we are interested in both, a correlation of the disturbances and the impact of on-the-job training on promotion, we use a 'mixed structure' model (Maddala 1985). Table 4 presents the estimation results for the determinants of promotion.

[17] Since theory still seems to be far away from explaining broad patterns of stylized facts on incentives and careers in organizations (Gibbons 1996), we do not try to provide a structural test of one of these suggested models against Becker's standard model.

Table 4

Internal Career Ladders and On-The-Job Training

		promotion	
variable		coefficient	(*t*-value)
constant		0.98**	2.7
male		0.43**	3.0
foreigner		-0.34*	-2.5
union membership		-0.15	-1.3
handicapped		-0.46	-1.1
schooling level: 10th class		0.13	0.8
schooling level: univ.entry qualification		0.80**	2.6
occupat. qual.: apprenticeship		0.04	0.3
occupat. qual.: univesity degree		-0.15	-0.4
potential experience (years)		-0.00	-0.4
tenure (years)		0.00	0.1
worker		-0.48 *	-2.5
occupational starting position 2		-1.13**	-8.2
occupational starting position 3		-1.87**	-9.6
occupational starting position 4		-2.22**	-9.3
firm size: 20 - 199 employees		-0.17	-1.0
firm size: 200 - 1999 employees		-0.29	-1.5
firm size: $\geq$ 2000 employees		-0.10	-0.5
on-the-job training (main effect)		-0.91	-0.9
*ojt**occupat. starting position 4		-0.84*	-2.1
*ojt**blue collar worker		-0.45	-1.3
*ojt**multiple activity		0.12	0.4
*ojt**duration 2 days - 1 week		0.50	1.1
*ojt**duration 1 week - 1 month		0.51	2.0
*ojt**duration > 1 month		0.68	1.1
*ojt**employer-supported finance		0.62*	2.0
correlation coefficient ρ		0.35	0.7
N	=	984	
Log-L	=	-752.0	
LRS (df=45)	=	370.8**	

Source: GSOEP, years 1984 - 1991.
Model: Bivariate probit with mixed structure. 'OJT-equation' in Appendix 3.
N: Number of observations.
Significance level: ** (0.01), * (0.05), + (0.10).
Log-L: Log-Likelihood.
LRS: Likelihood-ratio-statistics.

The probability of promotion rises (at the 5% level) for individuals who received employer-supported on-the-job training[18]. However, a test of the linear restriction $\beta_{ojt} + \beta_{emp.-sup.} = 0$ cannot reject the null hypothesis [$\chi^2(1) = 0.08$]. Thus, there is some evidence for the incidence of promotion-based incentive systems to induce efficient investment in firm-specific human capital.

6. Conclusions

Though the shared investment hypothesis of human capital theory that employers and employees share the costs of and the return on investment in firm-specific human capital is widely accepted in economics, we know little about the empirical evidence. This paper shows that there is no evidence for the shared investment hypothesis for the former West Germany. Neither the 'standard' analysis of starting wages, nor the analysis of the impact of different forms of financing on-the-job training on wage profiles and on subsequent job mobility seems to support the shared investment hypothesis. Rather we observe that employers seem to be able to protect their one-sided investments in firm specific human capital against opportunistic bargaining.

Further results indicate a positive correlation between employer-supported investment in on-the-job training and promotion within firms. Hence, we find evidence that indeed career concerns are a key ingredient in modelling the bargaining process between employers and employees if on-the-job training is considered. Within such a theoretical framework we have to analyze the determinants of on-the-job training, promotions, turnover and wages jointly while estimates in a traditional human capital setting like the one presented here are reduced form estimates.

[18] Analogous to the previous step we have to recode the variable 'finance'.

Appendix

Table 1

Description of Variables

variable name	description
male	1; 0 else
handicapped	1; 0 else
foreigner	1; 0 else
union membership	1; 0 else
schooling education	in years
schooling level	10th class grade 1; 0 else; university entry qualification 1; 0 else; (8th class grade, no degree)
occupational qualification	apprenticeship 1; 0 else; university degree 1; 0 else; (no degree)
blue collar worker	1; 0 else
potential experience	in years; (age – period of time qualification -6)
tenure	in years
firm size	(fs1: $\leq$ 20 employees); fs2: 20 - 199 empl.; fs3: 200 - 1999 empl.; fs4: $\geq$ 2000 empl.
industry	chemicals; construction / quarring; trade / bank / insur-ance; metal / electrical / engineering; transport / traffic; (agricult., forestry, mining, energy)
occupational starting position *	blue collar workers: (unskilled worker) (1), trained worker (2), semi-skilled and skilled worker (3), foreman (4). white collar workers: (employee with simple duties and no occupational degree) (1), employee with simple duties and occupational degree (2), employee with qualified duties (3), employee with highly qualified duties or managerial function (4).
log of weekly working hours (overtime incl.)	log of hours
job mobility	1; 0 else
starting wage / time in 198*	(first) information from 1986 or 1987 instead of 1988
on-the-job training (ojt)	1; 0 else
ojt * multiple activity	1 for persons with more than 1 training spell
*ojt**duration**	(1 day), 2 days-1 week, 1 w.- 1 month, > 1 month
*ojt**self-financed	1 for (ojt=1 and finance=0); 0 else
*ojt**shared-financed	1 for (ojt=1 and finance=1); 0 else
*ojt**employer-financed	1 for (ojt=1 and finance=2) ; 0 else
*ojt**financial support employer	1 for (ojt=1 and finance 1) ; 0 else
ojt interaction effects*	1 for (ojt=1 and interaction term=1); 0 else

(1) for dummy variables the base category is given in parentheses.

Table 2

Means of variables employed in the estimations

variable	equation Ia,b	equation II	equation III	equation IV[1]
dependent variable	8.01	8.10	0.19	0.27
male	0.73	–	0.76	0.80
foreigner	0.36	–	0.37	0.44
union membership	–	–	0.31	0.33
handicapped	–	–	0.05	0.02
schooling level: 10th class	–	–	0.80	0.79
schooling level: univ. entry qualification	–	–	0.10	0.06
schooling education (in years)	10.72	–	–	–
occupat. qual.: apprenticeship	–	–	0.63	0.60
occupat. qual.: univesity degree	–	–	0.05	0.04
blue collar worker	–	–	–	0.72
occupational starting position 2	–	–	–	0.38
occupational starting position 3	–	–	–	0.35
occupational starting position 4	–	–	–	0.14
potential experience (years)	22.35	23.98	22.12	22.58
tenure (years)	11.03	12.60	11.12	11.69
log of weekly working hours (overt. incl.)	3.66	3.70	–	–
job mobility	–	0.09	–	–
firm size: 20 - 199 employees	0.30	–	0.29	0.28
firm size: 200 - 1999 employees	0.22	–	0.24	0.29
firm size: $\geq$ 2000 employees	0.24	–	0.24	0.32
chemicals	0.07	–	0.07	0.09
construction, quarring	0.11	–	0.12	0.11
trade / bank / insurance	0.10	–	0.10	0.09
metal / electrical engineering	0.31	–	0.32	0.41
transport / traffic	0.06	–	0.05	0.02
on-the-job training (main effect)	0.14[2]	0.08	0.14	0.12
*ojt**multiple activity	–	0.06	0.10	0.09
*ojt**duration 2 days-1 week	–	0.05	0.09	0.08
*ojt**duration 1 week-1month	–	0.01	0.02	0.01
*ojt**duration > 1 month	–	0.01	0.02	0.02
*ojt**self-financed	*0.04*[3]	–	–	–
*ojt**employer-supported	*0.10*[3]	–	0.10	0.09
*ojt**shared finance	–	0.01	–	–
*ojt**employer-financed	–	0.05	–	–
*ojt**sex	–	0.06	–	–
*ojt**job mobility	–	0.02	–	–
*ojt**blue collar worker	–	–	–	0.04
*ojt**occupational starting position 4	–	–	–	0.04
starting wage / time 1986	0.004	–	0.006	–
starting wage / time 1987	0.03	–	0.03	–
number of observations	2518	9145	2161	984

[1] Dependent variable is career. [2] Equation Ia. [3] Equation Ib.

Table 3

Determinants of On-The-Job Training
(second equation bivariate probit)

		on-the-job training	
variable		coefficient	(*t*-value)
constant		-1.40**	-2.7
male		0.12	0.6
foreigner		-0.48 *	-2.4
union membership		-0.18	-1.1
handicapped		0.26	0.5
schooling level: 10th class		0.15	0.3
schooling level: univ.entry qualification		0.40	0.8
occupat. qual.: apprenticeship		0.69*	2.3
occupat. qual.: univesity degree		0.61	1.5
potential experience (years)		-0.03**	-2.6
tenure (years)		0.04	1.5
tenure squared (years)		-0.00	-1.3
worker		-0.75 *	-4.2
firm size: 20 - 199 employees		0.12	0.5
firm size: 200 - 1999 employees		0.18	0.7
firm size: $\geq$ 2000 employees		0.53 *	2.2
chemicals		0.26	1.1
construction, quarring		-0.18	-0.6
trade / bank / insurance		0.13	0.6
metal / electrical engineering		0.06	0.3
transport / traffic		-0.18	-0.4
correlation coefficient		0.35	0.7
N	=	984	
Log-L	=	-752.0	
LRS (df=45)	=	370.8**	

Source: GSOEP, years 1984 - 1991.
Model: Bivariate probit with mixed structure.
Estimates of career-equation in the main text.
N: Numbers of observation.
Significance level: ** (0.01), * (0.05), + (0.10).
Log-L: Log-Likelihood.
LRS: Likelihood-ratio-statistics.

References

Acemoglu, D. and J.-S. *Pischke* (1996), Why Do Firms Train? Theory and Evidence, NBER Working Paper 5605.

Arellano, M. (1987), Computing Robust Standard Errors for Within-Groups Estimators, Oxford Bulletin of Economics and Statistics 49, 431 - 434.

– (1993), On the Testing of Correlated Effects with Panel Data, Journal of Econometrics 59, 87 - 97.

Barron, J. M., D. A. *Black* and M. A. *Loewenstein* (1989), Job Matching and On-the-Job Training, Journal of Labor Economics 7, 1 - 19.

Becker, G. S. (1975), Human Capital, New York-London.

Chang, C. and Y. *Wang* (1996), Human Capital under Asymmetric Information: The Pigovian Conjecture Revisited, Journal of Labor Economics 14, S. 505 - 519.

Gibbons, R. (1996), Incentives and Careers in Organizations, NBER Working Paper 5705.

Greene, W. H. (1993), Econometric Analysis, New York-London.

Groot, W. (1995), The Wage Effects of Investment in Enterprise-Related Training, Empirical Economics 20, 133 - 147.

Harhoff, D. and Th. J. *Kane* (1994), Financing Apprenticeship Training – Evidence from Germany, revised version of NBER Working Paper No. 3557.

Hart, O. and B. *Holmström* (1987), The Theory of Contracts, in: T. Bewley, (ed.), Advances in Economic Theory: Fifth World Congress, Cambridge, 71 - 155.

Hashimoto, M. (1981), Firm-Specific Human Capital as a Shared Investment, American Economic Review 71, 475 - 482.

Kahn, C. and G. *Huberman* (1988), Two-Sided Uncertainty and "Up-or-Out" Contracts, Journal of Labor Economics 6, 423 - 444.

Lynch, L. M. (ed.) (1994), Training and the Private Sector, International Comparisons, Chicago.

Lynch, L. M. and S. E. *Black* (1995), Beyond the Incidence of Training: Evidence from a National Employers Survey, NBER Working Paper No. 5231.

MacLeod, W. B. and J. M. *Malcomson* (1993a), Investments, Holdup, and the Form of Market Contracts, American Economic Review 83, 811 - 837.

– (1993b), Specific Investment and Wage Profiles in Labor Markets, European Economic Review 37, 343 - 354.

Maddala, G. S. (1985), Limited-Dependent and Qualitative Variables in Econometrics, Cambridge.

Mincer, J. (1992), Human Capital. A Review, Working Paper No. 591 Columbia University, New York.

Murphy, K. M. and F. *Welch* (1990), Empirical Age-Earnings Profiles, Journal of Labor Economics 8, 202 - 229.

Pannenberg, M. (1995), Weiterbildungsaktivitäten und Erwerbsbiographie. Eine empirische Analyse für Deutschland, 'Studies in Labor Economics', Frankfurt / New York.

Pfeiffer, F. and *Brade,* J. (1995), Weiterbildung, Arbeitszeit und Lohneinkommen, in: Steiner, V. / Bellmann, L. (eds.), Mikroökonomik des Arbeitsmarktes, Nürnberg.

Pischke, J.-S. (1996), Continuous Training in Germany, Manuscript MIT, Cambridge (Mass.).

Prendergast, C. J. (1993), The Role of Promotion in Inducing Specific Human Capital Acquisition, Quarterly Journal of Economics 108, 523 - 534.

Wagner, G., R. *Burkhauser* and F. *Behringer* (1993), The English Language Public Use File of the German Socio-Economic Panel, The Journal of Human Ressources 28, 429 - 433.

Winkelmann, R. and K. F. *Zimmermann* (1995), Recent Developments in Count Data Modeling: Theory and Applications, Journal of Economic Surveys 9, 1 - 24.

Zusammenfassung

Obwohl Beckers "shared investment" Hypothese der Teilung der Kosten und der Quasi-Rente von Investitionen in firmenspezifisches Humankapital arbeitsmarktökonomisches Allgemeingut ist, wissen wir wenig über ihre empirische Evidenz. Die Arbeit zeigt mit Daten des Sozio-ökonomischen Panels (1984 - 91), daß Beckers Hypothese für die Bundesrepublik keine Bedeutung besitzt. Vielmehr ist die betriebliche Personalpolitik bei einseitiger Finanzierung in der Lage, die Investition gegen opportunistisches Verhandeln zu sichern. Darüber hinaus findet sich ein positiver Zusammenhang von arbeitgeberseitig (mit-)finanzierten Weiterbildungsinvestitionen und Beförderungen in der jeweiligen Firma.

Abstract

Though the shared investment hypothesis of human capital theory, i.e. that employers and employees share the costs of and the return on investment in firm-specific human capital, is widely accepted, we know little about the empirical evidence. The paper shows that in German data (1984 - 1991) there is no empirical evidence for the shared investment hypothesis. Rather we observe that employers are able to protect one-sided investments against opportunistic bargaining. Moreover there is a positive correlation between the incidence of employer-supported on-the-job training and promotions within firms.

JEL-Klassifikation: J24, J31, J41