DIW Diskussionspapiere
Discussion Papers

Discussion Paper No. 135

# Financing On-The-Job Training: Shared Investment or Promotion Based System?

Evidence from Germany

by
Markus Pannenberg

Deutsches Institut für Wirtschaftsforschung, Berlin
German Institute for Economic Research, Berlin

Die in diesem Papier vertretenen Auffassungen liegen ausschließlich in der Verantwortung des Verfassers und nicht in der des Instituts.

Opinions expressed in this paper are those of the author and do not necessarily reflect views of the Institute.

**Deutsches Institut für Wirtschaftsforschung**

Discussion Paper No. 135

# Financing On-The-Job Training: Shared Investment or Promotion Based System?

Evidence from Germany

by
Markus Pannenberg

- revised Version -

Berlin, April 1996

Deutsches Institut für Wirtschaftsforschung, Berlin
Königin-Luise-Str. 5, D-14191 Berlin
Telefon: 49-30 - 89 7 89-0
Telefax: 49-30 - 89 7 89-200

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

Markus Pannenberg *
*Deutsches Institut für Wirtschaftsforschung (DIW)*

(revised Version)

## 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 use career ladders to protect one-sided investments against opportunistic bargaining. In contrast to these shortcomings we find convincing evidence for human capital theory, analysing the effects of on-the-job training itself on subsequent job mobility, career ladders and wage growth.

JEL-Classification: J24, J31, J62, J63.

* *I am grateful to John Haisken-DeNew, Johannes Schwarze, Gert Wagner and participants at the EEA Congress 1995 in Prague for helpful comments. All remaining errors are mine.* *Mailing address: German Institute for Economic Research (DIW), German Socio Economic Panel Study (GSOEP), Königin-Luise-Straße 5, 14195 Berlin/Germany, Phone: (030) 89789-678, Fax: (030) 89789-200, e-mail: mpannenberg@diw-berlin.de.*

## 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 economist's 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 gets its inspiration from the proposition of the Clinton administration to establish an nation-wide apprenticeship system after the German model. A lot of theoretical and empirical work has been done in this field (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 labour 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, Büchel/Pannenberg 1994, Groot 1995, Lynch 1992, Lynch 1994, Lynch/Black 1995). Particulary we know nearly nothing about the contractual arrangements of financing on-the-job training to protect against opportunistic bargaining and the consequences these arrangements have on job mobility, career ladders and wage growth. 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 against other contractual arrangements used to overcome opportunistic bargaining.

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 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 labour 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' (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 steeper wage profiles over time. Therefore, if we have a measure for on-the-job training with firm-specific human capital, we can test the

sharing hypothesis by running appropriate regressions of starting wages and wage growth on the on-the-job training variables.

Some authors doubt the empirical importance 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 the investment. Prendergast (1993) stresses, since much investments in firm-specific human capital are difficult to quantify, 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 supports 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.

To discriminate between these models and the traditional human capital sharing hypothesis, we assess the impact of different forms of financing on-the-job training on starting wages, job mobility, career ladders and wage growth.

## 3. Data and Sample Design

As mentioned in the introduction, the data set used for the empirical analysis is drawn from the Public Use File of the German Socio-Economic Panel (GSOEP). This data base consists of representative longitudinal data from West Germany households and persons[1]. We use panel data for the survey years from 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. Based on this information, we select a subsample of all persons in the GSOEP, who were employed (full-time) during the 'investment period' 1986 - 1989, who did not change their employer during the 'investment period', who did not work in public service and who were not self-employed. Given these

[1] For details see Wagner/Burkhauser/Behringer (1993).

restrictions, the remaining subsample consists of 1965 individuals including 308 (16 %) who had undergone on-the-job training between 1986 and 1989.

Information concerning the finance on-the-job training is based on two questions about financial assistance and 'out-of- pocket' expenses for training[2]. We create our variable 'finance' as follows:

- *self-financed training* (value 0): no financial assistance from the employer, from employment office or from somewhere else,
- *shared-financed training* (value 1): financial assistance from employer and out-of-pocket expenses > 0,
- *employer-financed training* (value 2): financial assistance from employer and incurred no cost.

Other (dummy-) information concerning on-the-job training (*ojt*) that we use in our econometric analysis as exogenous variables are *multiple ojt, duration of ojt, financial support employer* and interaction terms of *ojt* and *other characteristics*[3].

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 during the 'investment period' and did not change their job, we assume that most training has both, a significant firm specific and a general component. Nevertheless, using additional information about the investment in on-the-job training, we are able to classify on-the-job training by different degrees of firm specific human capital. 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 during the whole 'investment period' and did not change his job, 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 precisely. Therefore we define - according to the question in the survey - the wage at the beginning of the 'investment period' as the 'starting wage'.

---

[2] (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.

[3] All variables employed in the empirical analysis are described in Appendix 1.

## 4. Financing On-The-Job Training and Starting Wages

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 56% most on-the-job training is financed by employers, a considerable part is born by the employees (35%), but shared-investment plays only a minor role (9%).

The 'standard' test applied to Becker's shared investment hypothesis is a regression of starting wages on an on-the-job training variable[4] and on other relevant factors. In such a regression, the training coefficient should be negative. We estimate a starting wage equation with on-the-job training and various control variables, such as sex, education, experience, weekly hours worked (including overtime), nationality, firm size and industrial classification of the employer[5]. As dependent variable we use the log of monthly gross wage/salary at the beginning of the 'investment period'.

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. Thus, we estimate a model with multiplicative heteroscedasticity (Judge/Griffiths /Hill/Lütkepohl/Lee 1985). The used variance function is $Var(\varepsilon_i) = \sigma^2 \times z_i^{\alpha'}$ with $\sigma^2$ the variance of the normal distribution, $z_i$ a vector of variables and $\alpha'$ the estimated coefficients. Table 1 reports the maximum likelihood estimates.

---

[4] See for example: Barron/Black/Loewenstein (1989).

[5] See for a detailed description of the variables Appendix 1.

Table 1: Starting Wages and On-The-Job Training

| variable | coefficient | (t-value) |
|---|---|---|
| constant | 5.3780** | 18.480 |
| schooling education (in years) | 0.0635** | 12.682 |
| experience (years) | 0.0409** | 11.513 |
| experience squared (years) | -0.0007** | -9.798 |
| tenure (years) | 0.0014 | 1.298 |
| on-the-job training | 0.1070** | 4.275 |
| weekly work. hours (overt. incl.) | 0.3099** | 4.009 |
| male | 0.2781** | 14.636 |
| foreigner | -0.0235 | -1.217 |
| firm size: 20 - 199 employees | 0.0141 | 0.627 |
| firm size: 200 - 1999 employees | 0.0596 * | 2.506 |
| firm size: ≥ 2000 employees | 0.1469** | 5.952 |
| chemicals | 0.0330 | 1.056 |
| construction, quarring | 0.0888 + | 1.702 |
| trade/bank/insurance | 0.0155 | 0.517 |
| metal/electrical engineering | 0.0290 | 1.387 |
| transport/traffic | 0.0657 * | 2.429 |
| *parameters of variance function* | | |
| $\sigma^2$ | 0.0047 * | 2.020 |
| schooling education (in years) | 1.5059** | 8.143 |
| experience | -0.1873** | -2.976 |
| N = | 1472 | |
| LM = | 59.79** | |
| Log-L = | -294.54 | |
| LRS = | 905.18** | |
| LRS Vf. = | 69.06** | |

Source: GSOEP, years1986 - 1989.
Model: ML-estimates with multiplicative heteroscedasticity.
N: Number of observations.
$R^2_{adj.}$: adjusted $R^2$.
Significance level: ** (0.01), * (0.05), + (0.10).
LM: Lagrange-multiplier-statistic;test for heteroscedasticity.
Log-L:Log-likelihood.
LRS: Likelihood-ratio-statistic full model.
LRS Vf. : Likelihood-ratio-statistic Variancefunction ($\alpha' = 0$).

Investment in on-the-job training affects the starting wage positively and significantly. 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*: Both estimates are significantly positive, but a test with the null hypothesis that the coefficients are identical cannot reject the null hypothesis. Hence, in view of the predictions of human

capital theory that workers share training costs through lower starting wages we find no support for Becker's sharing hypothesis. Our result indicates rather that German employers seem to use other incentive mechanisms than generating sunk costs for employees. For example, in models with career ladders the employer has to find an efficient assignment rule to sort workers to jobs and on-the-job training simultaneously. Promotion choice hinges on workers ability, because training and abilities are complements in production, and on the individual propensity to remain on the job. Consistently more able workers will *c.p.* be matched to positions requiring a greater amount of on-the-job training. Since we cannot control perfectly for this type of sample selection in our starting wage equation, these selection patterns may be also captured by the training variable[6]. We have tried to control for sample selection explicitly by means of sample selection models though there is an ongoing controversial discussion about these procedures (Greene 1995, Rendtel 1992). The results of this exercise indicate that there is no significant positive sample selection at work ( $\rho = 0.007, t = 0.66$ ).

The estimated coefficients of schooling education and experience correspond to other studies with cross-section estimates of earning functions (Lorenz/Wagner 1993). The same is true for firm size (Gerlach/Schmidt 1990). The estimation results for the variance function have to be emphasized: The variance of income rises with schooling and declines with experience. This confirms matching theory which states that at the beginning of a working life, the variance of income is greater than after sorting processes have been undertaken and that the 'starting level' of variance rises with education.

More insights into the financial structure of on-the-job training are gained by analysing the determinants of the employers' financial share. Therefore, we run a regression of our variable 'finance' on a set of control variables including sex, education, nationality, union membership, experience, tenure, firm size, and some industry dummies[7]. The appropriate econometric model is the ordinal probit (Greene 1993). Unfortunately the maximum likelihood estimators of this model are inconsistent and the estimated variance matrix is inappropriate if the disturbances are heteroscedastic (Yatchew/Griliches 1985). This is true for our data, which is shown by a Lagrange multiplier test with an LM statistic of

---

[6] In contrast to our result Barron/Black/Loewenstein (1989) find a negative, non significant effect of on-the-job training on starting wages for the US. They conclude that the „two effects of training on starting wages are essential offsetting" (p. 6).

[7] For a detailed description see appendix 1.

16.14 ($\alpha$=0.01). Therefore, we employ an ordinal probit model with multiplicative heteroscedasticity of the form $Var(\varepsilon_i) = \sigma^2 \exp(2\ \gamma' z_i)$ (Davidson/MacKinnon 1984). Table 2 reports the results of our estimation.

Table 2: Determinants of Finance of On-The-Job Training

| variable | coefficient | (t-value) |
|---|---|---|
| constant | 1.2257 * | 2.125 |
| male | -0.6415 | -1.270 |
| handicapped | 2.1941 + | 1.762 |
| foreigner | 1.5814 | 1.405 |
| union membership | 1.6396 * | 2.009 |
| occupat. qual.: apprenticeship | 1.5173 * | 2.218 |
| univesity degree | 1.2501 * | 2.163 |
| blue collar worker | -1.0973 + | -1.669 |
| experience (years) | -0.0661 + | -1.728 |
| tenure (years) | 0.0182 | 0.530 |
| firm size: 20 - 199 employees | 0.6279 | 1.081 |
| firm size: 200 - 1999 employees | 3.6824 * | 2.520 |
| firm size: ≥ 2000 employees | 1.6187** | 2.640 |
| chemicals | -2.1245 * | -1.982 |
| construction, quarring | -1.7180 | -1.451 |
| trade/bank/insurance | -0.9931 | -1.435 |
| metal/electrical engineering | -1.4169 * | -2.074 |
| transport/traffic | -1.4796 * | -2.431 |
| (threshold) $\mu_2$ | 0.6948** | 3.392 |
| *parameters of variance function* | | |
| occupat. qual.: Apprenticeship | 1.7827** | 5.293 |
| firm size: 20 - 199 employee | -0.9318** | -2.663 |
| N = 304 | | |
| Log-L = -239.75 | | |
| LRS = 58.89 | | |
| LM = 16.14** | | |
| $R^2_{MZ}$ = 0.73 | | |

Source: GSOEP, years 1986 - 1989.
Model: Ordinal probit with multiplicative heteroscedasticity.
Dependent variable: 0 self-financed, 1 shared-financed, 2 employer-fin.
N: Number of observations.
Significance level: ** (0.01), * (0.05), + (0.10).
Log-L: Log-Likelihood.
LRS: Likelihood-ratio-statistic.
LM: Lagrange-multiplier-statistic; test for heteroscedasticity.
$R^2_{MZ}$ : Pseudo-$R^2$ McKelvey/Zavoina.

Considering the effects of occupational qualification on the structure of financing on-the-job training, we observe that the probability of employer-financed training rises with the degree of formal qualification. This supports the prediction of human capital theory of persistence in human capital investment as well as complementarity of formal education and on-the-job training (Mincer 1992). Furthermore, the negative influence of

years of experience on the probability of getting employer-financed training is also in accordance with human capital theory. This negative correlation is explained by declining phases of receiving a return on investment.

Concerning the effects of firm size on the probability of receiving employer-financed training, we observe that in firms with more than 200 employees, employers are more likely to finance on-the-job training on their own. This result confirms portfolio-models of on-the-job training (Holtmann/Idson 1991a/b). In these models, a positive relationship between the probability of employer-financed on-the-job training and firm size is derived from the idea that larger firms are able to tie workers closer to firms by using internal career ladders. This effect reduces the risk of employer-sided investment in human capital.

## 5. Job Mobility, Career Concerns, Income Dynamics and On-The-Job Training

Considering the effects that different forms of financing on-the-job training have on job mobility, climbing career ladders and on income dynamics, we provide another test for Becker's sharing hypothesis. Since linking our training informations to individual employment histories decreases the total amount of on-the-job training spells, we have to recode our variable 'finance'. Hence, we employ an interaction term of on-the-job training with financial support from the employer[8].

### *Job Mobility*

Starting with job mobility we analyse the effect of financing on-the-job training on subsequent mobility of workers between firms. Based on our subsample we examine job changes within two years after the 'investment period'. The observed individuals have to be employed (fulltime) in 1991. This condition applies to 1601 persons. 130 respondents (8 %) have changed job once or more often.

The appropriate econometric specification for the dependent variable 'number of job changes' is the count data model (Greene 1993, Winkelmann/Zimmermann 1995). We use models with Poisson and with negative binomial distributions and test the hypothesis

[8] For reasons of clarity in all subsequent tables the coefficients of the control variables (sex, union membership, handicapped, foreigner, experience, tenure, schooling, occupational level, firm size, industries and the log of weekly working hours ) are excluded. The results are available from the author on request.

of equi-dispersion in the Poisson model. We find no evidence for rejecting equi-dispersion (LRS = 1.17). Thus, in Table 3 our results of the Poisson model are reported.

Table 3: Job Mobility and On-The-Job Training

| variable | coefficient | (t-value) |
|---|---|---|
| on-the-job training (main effect) | -0.0423 | 0.064 |
| ojt * multiple activity | -0.5867 + | 1.728 |
| ojt * duration 2 days-1 week | 0.7844 | 1256 |
| ojt * duration 1 week-1month | 0.5309 | 1.636 |
| ojt * duration > 1 month | 1.2450 + | 1.847 |
| ojt * financial support employer | 0.2902 | 1.776 |
| N = 1601 | | |
| Log-L = -432.69 | | |
| LRS = 185.7** | | |
| LRS P/NB = 1.2 | | |

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-statistic.
LRS P/NB: LRS test negativbinomial against poisson model.

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 sharing hypothesis.

Multiple on-the-job training reduces (at the 10% level) the expected number of job changes. Repeated on-the-job training in a period of three years indicates that the amount of firm specific human capital acquired may be greater than in the reference group. This supports human capital theory which states that there is a negative relationship between job mobility and firm specific human capital (Mincer 1992). On-the-job training with a duration greater than one month raises (at the 10% level) the expected number of job switches between firms. These training presumably impart more general human capital than the reference traning with a duration of 1 day. Thus, corresponding to the results of multiple on-the-job training, this result is in line with human capital models (Pichler 1992).

*Career Ladders*

Career ladders seem to be an efficient incentive 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. Hence, to protect their investments in on-the-job training, employers have to design an assignment rule to sort workers to jobs and on-the-job training simultaneously.

We have to take this simultanity into account when analysing employment histories of individuals who stay in their firm over the whole observation period. To find out whether a person climbed on the internal career ladder, we use upward changes in the occupational position 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/foreman) 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. In addition we use as endogenous variable the dummy on-the-job training (*ojt*) with '1' for investment in *ojt* and '0' otherwise.

An appropriate econometric model for analysing the simultaneous decision of employers who gets on-the-job training and who gets promotion is the bivariate probit model (Greene 1993). As we are interested in both, a correlation of the disturbances and the causality between promotion and on-the-job training, we use a 'mixed structure' model (Maddala 1985). Table 4 presents the estimation results for the determinants of promotion.

Table 4: Internal Career Ladders and On-The-Job Training

| variable | promotion | |
|---|---|---|
| | coefficient | (t-value) |
| on-the-job training (main effect) | -0.4500 | - 0.257 |
| ojt * occupat. start. pos. | -0.3495 | - 0.940 |
| ojt * blue collar worker | -0.9813 | - 0.932 |
| ojt * multiple activity | 0.3704 | 0.817 |
| ojt * duration 2 days-1 week | 0.9535 + | 1.875 |
| ojt * duration 1 week-1month | 1.2711 * | 2.025 |
| ojt * duration > 1 month | 0.5507 | 0.898 |
| ojt * fin. support employer | 0.6569 + | 1.723 |
| correlation coefficient ρ | 0.4159 | 0.950 |
| N = 948 | | |
| Log-L = 708.80 | | |
| LRS = 427.54 ** | | |

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

The probability of promotion rises significantly (at the 10% level) for individuals who get employer-financed or employer-supported on-the-job training. Thus, we have some evidence for the hypothesis that German employers use promotion-based incentive systems to induce efficient investment in firm-specific human capital instead of shared investment contracts. This result holds if we control for the simultaneity of employer-sided assignment to on-the-job training and changes on the internal career ladder.

Investments in on-the-job training with a duration of two days to one week, or one week to one month significantly influence the promotion probability in a positive way. Employers presumably use these courses to provide workers within the firm with firm-specific knowledge needed in the production operation or commercial services. To tie the skilled workers to the firm, employers seem to design career ladders. The result corresponds to the estimation of the determinants of job mobility: In this case, on-the-job training which lasts more than one month raises the expected number of job changes.

*Income Dynamics*

Hashimotos (1981) formulation of Becker's sharing hypothesis implies an inverse relationship between the employers share in the cost of investment and the growth rate of income after the investment has been made. Moreover, by means of wage growth regression, we can get more evidence on the existence of shared investment solutions.

Appropriate econometric models for estimating wage growth functions are linear models of panel data. Therefore, we estimate fixed- and random effects models and use Hausman's specification test to check for orthogonality of the random effects and the regressors (Greene 1993). As the Hausman test rejects the hypothesis that the individual effects are uncorrelated with the regressors, we use the fixed effects model. Again, as in the starting wage regression, the dependent variable is the log of the monthly gross wage or salary. We observe wage growth for a pooled regression of job stayers and job movers for the period 1986 to 1991. Table 5 reports our estimation results.

Table 5: Income Dynamics and On-The-Job Training: 1986 - 1991

| variable | coefficient | (t-value) |
|---|---|---|
| on-the-job training (main effect) | 0.1571** | 2.594 |
| ojt*blue collar worker | -0.0287 | -0.778 |
| ojt*male | -0.0257 | -0.603 |
| ojt*multiple activity | 0.0066 | 0.176 |
| ojt*duration 2 days-1 week | 0.0183 | 0.408 |
| ojt*duration 1 week-1 month | 0.0225 | 0.360 |
| ojt*duration > 1 month | 0.0651 | 1.141 |
| ojt*fin. support employer | 0.0073 | 0.214 |
| ojt*job mobility | -0.1660** | 3.169 |
| job mobility | 0.1653** | 6.659 |
| N: | 1323 | |
| $R^2_{adj.}$ : | 0.81 | |
| F test : | 9.54** | |
| F test panel model: | 8.55** | |
| Hausman specification test: | 170.33** | |

Source: GSOEP, years 1984 - 1991.
Model: Fixed effects model.
N: Numbers of observation.
t-values in brackets.
Significance level: ** (0.01), * (0.05), + (0.10).
$R^2_{adj.}$: adjusted $R^2$.
F test: Test of joint significance of the set of exogenous variables.
F test panel model: Test of joint significance of group effects.
Hausman specification test.

In contrast to the predictions of the shared investment hypothesis we do not observe a negative relationship between income dynamics and employer supported investment in human capital in our data. Thus again, there is no evidence in favor of the shared investment hypothesis for Germany.

Considering the income effects of on-the-job training we observe a significant and positive effect of on-the-job training itself, a significantly negative effect of the interaction term *ojt*job mobility* and a significantly positive one of job mobility itself. A

test with the hypothesis that the three coefficients are identical cannot reject the null. On-the-job training solely raises income growth if the employee remains in the firm. Furthermore, there is no difference in income growth between job stayers with on-the-job training and job movers with or without on-the-job training. Hence, our findings provide an important confirmation of basic human capital theory and we are able to reject the matching theory hypothesis that age-earnings profiles primarily reflect the increasing quality of matches during the life cycle. Also, this result is in accordance with our hypothesis that German Employers use career ladders instead of shared investment contracts to tie their workers closer to the firm.

## 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 subsequent job mobility, on career ladders and on income dynamics supports the shared investment hypothesis. Rather we observe that game theoretic approaches, which use career ladders to protect one-sided investments against opportunistic bargaining, seem to be a fruitful way to describe the results of bargaining between employers and employees. Our analysis suggests that German employers prefer creating opportunity costs of job mobility by generating career and income prospects in the future instead of using sunk costs of human capital investment by workers.

In contrast to the shortcomings of the shared investment hypothesis, we find convincing evidence for human capital theory in analysing the effects of on-the-job training itself on subsequent job mobility, career ladders and wage growth: Investment in firm-specific human capital reduces job mobility, raises individual promotion chances and increases wage growth. Particulary, we are able to refute the prediction, based on matching theory, that on-the-job training does not affect income growth in an important way.

Hence, we can summarize that human capital theory is powerful for explaining the 'investment core' of on-the-job training and its consequences on working careers, but is

not suited well to describe the bargaining situation if investment in firm-specific human capital is considered.

Appendix 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 |
| experience | in years; (age - period of time qualification -6) |
| tenure | in years |
| firm size | (fs1: ≤ 20 employees); fs2: 20-199 empl.; fs3: 200-1999 empl.; fs4: ≥ 2000 empl. |
| industry | chemicals; construction/quarring; trade/bank/ insurance; metal/electrical/engineering; trans-port/traffic;(agricult., forestry, mining, energy) |
| occupation starting position (ordinal) | blue collar workers: unskilled worker (1), trained worker (2), semi-skilled and skilled worker (3), foreman (4), master craftsmen/foreman (5)<br>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), employee with extensive managerial duties(5). |
| weekly working hours (overtime incl.) | in hours |
| job mobility | 1; 0 else |
| multiple ojt | 1 for persons with more than 1 training spell |
| duration of ojt | 1 day, 2 days-1 week, 1 w.- 1 month, (> 1 m.) |
| financial support employer | 1 for ojt with 'finance' ≥ 1 |
| ojt * *interaction term* | 1 for (ojt=1 and interaction term=1); 0 else |

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

*References*


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.

Brown, J.N. (1989), Why Do Wages Increase with tenure? On-the-job Training and Life-Cycle Wage Growth Observed Within Firms, American Economic Review 79, 971-991.

Büchel, F., M. Pannenberg (1994), On-the-Job Training, innerbetriebliche Karrierepfade und Einkommensentwicklung, Jahrbücher für Nationalökonomie und Statistik 213, 278-291.

Davidson, R. and J.G. MacKinnon (1984), Convenient Specification Tests for Logit and Probit Models, Journal of Econometrics 25, 241-262.

Gerlach, K. and E.M. Schmidt (1990), Firm size and wages, in: Labour 4, 27-49.

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

Holtmann, A.G. and T.L. Idson (1991a), Employer Size and On-the-Job Training Decisions, Southern Economic Journal 58, 339-354.

Holtmann, A.G. and T.L. Idson (1991b), Employer Size, Training and Wage Growth, Discussion Paper Series No. 513 Columbia University, New York.

Judge, G., W. Griffiths, R. Hill, H. Lütkepohl and T. Lee (1985), The Theory and Practice of Econometrics, NewYork.

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

Lorenz, W. and J. Wagner (1993), A Note on Returns to Human Capital in the Eighties: Evidence from Twelve Countries, Jahrbücher für Nationalökonomie und Statistik 211, 60-72.

Lynch, L.M. (1992), Private-Sector Training and the Earnings of Young Workers, American Economic Review 82, 299-312.

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.

MacLeod, W.B. and J.M. Malcomson (1993b), Specific Investment and Wage Profiles in Labour 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, Discussion Paper Series No. 591 Columbia University, New York.

Pichler, E. (1992), Investment in General and Job-Specific Training with Occupational Mobility, Jahrbücher für Nationalökonomie und Statistik 210, 35-46.

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

Rendtel, U. (1992), On the Choice of a Selection Model when Estimating Regression Models with Selectivity, DIW-Discussion Paper No. 53, Berlin.

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.

Yatchew, A. and Z. Griliches (1985), Specification Error in Probit Models, Review of Economics and Statistics 67, 134-139.