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ABSTRACT

Employer Learning and the Returns to Schooling*

We examine the dynamic role of education and experience as determinants of wages. It is hypothesized that an employee's education is an important signal to the employer initially. Over time, the returns to schooling should decrease with labor market experience and increase with initially unobserved ability, since the employer gradually obtains better information on the productivity of an employee. Replicating US studies using data from a large German panel data set (GSOEP), we find no evidence for the employer learning hypothesis for Germany. Differentiating blue-collar and white-collar workers and estimating quantile regressions, however, leads to the conclusion that employer learning takes place for blue-collar workers at the lower end of the wage distribution. We further show, that information on the productivity of an employee is to a large extend private.

JEL Classification: J21, J24, J31

Keywords: Employer learning, returns to education, tenure, experience, on-the-job training

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I. Introduction

The dynamic relationship between the returns to schooling and labor market experience has often been used to test the signaling model against the human capital model (Willis, 1986; Weiss, 1995). This test relies on the hypothesis that if education acts as a signal, the partial effect of schooling on earnings will decline with increasing labor market experience of an individual, since employers gradually obtain better information on the true productivity of a worker. In recent articles, Farber and Gibbons (1996) and Altonji and Pierret (1998, 1999) investigate the dynamic relationship between the returns to schooling and labor market experience in a model of employer learning. According to this model, the returns to formal education, as measured by years of education, is independent or even decreases with labor market experience, whereas the returns to natural ability, as measured by a standardized aptitude test, parents' education or the wages of siblings, increase with labor market experience when estimating a standard Mincer-type wage equation. Formal education provides some information to the employer as to the general productivity of an employee. However, the more an employer learns first-hand about the employee's true productivity on the job, the faster the measured effect of schooling on wages should decline and the measured effect of natural, initially unobserved ability should increase with labor market experience.

This paper takes the standard models of Farber and Gibbons (1996) and Altonji and Pierret (1998, 1999) to test the hypotheses of employer learning for Germany. We use a large panel data set, the German Socio-Economic Panel, from 1984 to 1996 with detailed information on job histories, formal education, the presence of explicit on-the-job training (after completion of formal education), human capital, wages and job characteristics. Replicating the US studies using a sample of West German prime-aged males, we find strong evidence to support the hypothesis that in fact the relationship between the reward to education and experience is positive for Germany and some evidence that the relationship between natural ability and experience is also positive. Hence, there seems to be no employer learning in Germany. Relaxing the assumption that information on the productivity of a worker is public, we find experience effects on the returns to schooling and unobserved ability are mainly driven by tenure at the current job and not through *previous* job experience indicating that information on a workers productivity is private rather than public.

Economic theory and existing empirical evidence indicate that employer learning should differ for different types of jobs. For employer learning to take place, the employer must be able to observe the productivity of workers. The performance of blue-collar workers should be easier to observe compared to white-collar workers, since the former in general perform tasks where they use physical work to produce tangible goods, whereas the latter perform tasks with "mental" inputs and largely intangible outputs. Furthermore, the theory and empirical evidence on firms' hiring strategy suggest that employers invest more in the screening of applicants for positions which require a higher schooling level and more training. Hence, at the time of hiring employers should have more information and therefore lower learning rates on high-skilled and high paid workers than on low-skilled and low-paid workers. Differentiating between blue-collar and white-collar workers and estimating quantile regressions we find that employer learning in Germany takes place only for blue-collar at the lower end of the earnings distribution.

The paper proceeds as follows. In Section II we present the basic intuition behind the idea of employer learning by briefly discussing the models developed by Farber and Gibbons (1996) and Altonji and Pierret (1998, 1999). Section III describes the data set. In Section IV we first replicate the estimations of Farber and Gibbons (1996) and Altonji and Pierret (1998, 1999) using German data. We then relax the assumption that information on the productivity of workers is known to all possible employers by splitting total labor experience into experience in the current job and previous labor market experience. We further present estimation results when differentiating between blue-collar and white-collar workers and discuss the findings of the quantile regressions. Section V contains concluding remarks and possible extensions for future research.

II. Background

Several empirical studies use the dynamic relationship between the returns to schooling and labor market experience to test the signaling model against the human capital model.[1] According to Layard and Psacharopoulos (1974) and Psacharopoulos (1979), one prediction of the signaling model is that the partial effect of education on earnings decline with the labor market experience of a worker, since over time employers gradually obtain better information about the worker's real productivity. Riley (1979), however, states that it is a necessary condition of the screening hypothesis that the employers make correct predictions of the productivity of workers on the average, when these predictions are based on educational attainment. The relationship between the returns to education and labor market experienced also received some attention within the literature on employer learning.

In their seminal paper on this issue, Farber and Gibbons (1996) argue along the lines of Riley (1979) using a dynamic model of employer learning and wage determination. Consider a wage equation of the form:

$$W_{it} = F(T_i) + \beta_S S_i + \beta_{S,T}(S_i \cdot T_i) + \beta_Z Z_i^* + \beta_{Z,T}(Z_i^* \cdot T_i) + u_{i,T}, \qquad (1)$$

[1] Surveys are given by Willis (1986) and Weiss (1995).

where W_{it} is the wage level of worker i with T years of work experience, $F(T_i)$ is the experience profile of the worker, S_i refers to years of schooling, and Z_i^* is an indicator of the natural ability of an individual which is only observed by the econometrician, but not by the employer. The variable Z_i^* is assumed to be orthogonal to an employers information set on the productivity of a worker at the beginning of his working-life. $u_{i,T}$ is an error term which is assumed to be unrelated to the other variables in the model.

The theoretical model of FARBER AND GIBBONS (1996) shows that the estimated effect of schooling on the level of wages should be independent of the labor market experience of a worker, i.e. $\beta_{S,T} = 0$. The reason is that future observations of the employers confirm on average their initial perceptions of the relationship between expected productivity and the educational attainment of new labor market entrants. They further show that $\beta_{Z,T}$ is positive as long as Z_i^* and the output is correlated with the ability of a worker, because wages progressively take output signals into account. Hence, regardless of the nature of the relationship between the education and the productivity of a worker, the returns to education will not change with labor market experience as long as the relationship between education and productivity does not change.

Using the National Longitudinal Survey of Youth (NLSY), FARBER AND GIBBONS (1996) present empirical evidence, which is in general supportive of the predictions of their theoretical model. In their empirical approach, they use the Armed Forces Qualifying Test (AFQT) score and the possession of a library card when the individual was fourteen as measures for Z_i^*. Consistent with their theory of employer learning, estimations of equation (1) provides no evidence that the returns to schooling are affected by the labor market experience of a worker. They note that the result of an insignificant $\beta_{S,T}$ in a regression where the wage is measured in levels is consistent with a negative coefficient on the education-experience interaction, when estimating the more common wage equation where the dependent variable is measured in logs. Finally, $\beta_{Z,T}$ is estimated to be significantly positive for both measures of Z_i^* they use, which further validates their learning model.

In two related papers, ALTONJI AND PIERRET (1998, 1999) use a model, which is slightly different to that of FARBER AND GIBBONS (1996). Specifically, ALTONJI AND PIERRET (1998, 1999) consider a wage equation of the following form:

$$log(W_{it}) = F(T_i) + \beta_S S_i + \beta_{S,T}(S_i \cdot T_i) + \beta_Z Z_i + \beta_{Z,T}(Z_i \cdot T_i) + u_{i,T}. \tag{2}$$

In contrast with FARBER AND GIBBONS (1996), ALTONJI AND PIERRET (1998, 1999) use log wages instead of wage levels as independent variable. But more importantly, they explicitly allow S_i and Z_i to be correlated with each other. In the model of ALTONJI AND PIERRET (1998, 1999) this change leads to the proposition that *(i)* $\beta_{S,T}$ is non-increasing and $\beta_{Z,T}$ is non-decreasing in t and that *(ii)* $\beta_{S,T} = \beta_{Z,T} = 0$ if employers have full information about the productivity of new workers or do not learn over time. The intuition behind these propositions is that, as long as Z_i is positively correlated with the unobserved ability of individual i, the effect of Z_i is likely to increase with the labor market experience of the individual as more information about his true productivity is revealed to the employers. Since Z_i is correlated with S_i, the measured effect of schooling on wages is likely to decline with increasing labor market experience T_i. Using the AFQT test score, the education of the father and the wage of siblings as measures for Z_i, the empirical analysis of ALTONJI AND PIERRET (1998, 1999) in general support the above hypotheses, i.e. the estimated coefficient on years of schooling falls and the estimated coefficient on Z_i rise with the labor market experience of an individual.

FARBER AND GIBBONS (1996) and ALTONJI AND PIERRET (1998, 1999) note that their propositions about the signs of $\beta_{S,T}$ and $\beta_{Z,T}$ relies on the assumption that the effects of on-the-job training is fully captured by $F(T_i)$, i.e. that on-the-job training has no effect on the time paths of S_i and Z_i. If, however, education and ability make workers more trainable and if more educated and more able workers receive more training, it is possible that both coefficients, $\beta_{S,T}$ and $\beta_{Z,T}$, are positive. Empirical evidence, suggest that education and ability are positively related to the probability to receive and the amount of on-the-job training.[2] PANNENBERG (1998) shows that the probability to receive on-the-job training in Germany is positively related to the schooling level of an individual. His empirical analysis further indicates, that the timing of on-the-job training is very important for the returns a worker could expect from the training measure. According to the results of PANNENBERG (1998) the highest partial wage effects of on-the-job training can be observed when training takes place after two to three years of firm tenure. These results indicate that on-the-job training will mainly take place when the employer has sufficient information about the true productivity of a worker.

In section IV of this paper we replicate the estimations of FARBER AND GIBBONS (1996) and ALTONJI AND PIERRET (1998,1999) using the German Socio-Economic Panel (GSOEP). We will estimate equation (2) using the education of the parents of individual i as a measure of Z_i. Unfortunately the GSOEP provides no information on test scores such as the AFQT test scores used by FARBER AND GIBBONS (1996) and ALTONJI AND PIERRET (1998, 1999). Using the income of the siblings of an individual like ALTONJI AND PIERRET (1999) is not possible either, even though this information is in principle available in the the GSOEP. However, using this variable would reduce the sample to an unusable size. Following ALTONJI AND PIERRET (1999), we try to mitigate the problem of on-the-job training for estimating $\beta_{S,T}$

[2]See for example ALTONJI AND SPLETZER (1991) and LYNCH (1992) for the US, and BOOTH (1991), GREENHALGH AND STEWART (1987) and GREENHALGH AND MAVROTAS (1994) for the UK. Related evidence for Germany is given by PANNENBERG (1995) and PISCHKE (1996).

and $\beta_{Z,T}$ by including a dummy variable which indicates, whether a worker received on-the-job training.

III. Data

The German Socio-Economic Panel (GSOEP) is a panel dataset from 1984 to 1996 of some 12,700 individuals and roughly 6,600 households living in West Germany (the "old" states) and East Germany (the "new" states). Foreigners and recent migrants are also included in the panel. The German version of the GSOEP data is used here, although the same analysis can be made with the international "scientific use" version, albeit with approximately 5% fewer observations.[3] The analysis in this paper is restricted to full time West German males up to age 60, having worked up to 80 hours per week. Only private sector, non-agricultural regular wage and salary workers in dependent employment are included here (white and blue collar workers).[4]

We estimate equation (2) using pooled OLS. As dependent variable we use log real hourly wages.[5] The GSOEP differentiates between actual and contractual hours worked per week. In this analysis, the maximum of the two is used. This avoids undercounting the nominal 40-hour manager/salaried jobs on the top end, and on the bottom end, where a full time employed person actually only worked say 10 hours that interview week due to sickness, but would normally work 40. As the data span more than a decade, all wage information has been deflated by the OECD main economic indicators consumer price index (base year 1990).

Education of the individuals enters into the estimation as a quasi-continuous variable.[6] Using information on achieved educational degrees, diplomas, certificates and apprenticeship, a year-mapping is generated. The calculation of parents' education is done in a similar manner. Note, that we use the larger of fathers' and mothers' years of schooling as a proxy for a person's own "natural ability", which we assume is not observed by the employers.

We calculate two different measures of job experience: (a) potential work experience, defined

[3] See Haisken-DeNew and Frick (1997) for extensive documentation on the GSOEP and Wagner, Burkhauser and Behringer (1991) for more details on the international "scientific use" version.

[4] The data were processed using the TDA and Stata distribution of the GSOEP. The data are available in ready-made Windows binary datafiles in Stata, SAS, SPSS and TDA format as well as in ASCII format. Retrieval/match files can be automatically generated using the bilingual (German/English) SOEPINFO-WWW on the SOEP Homepage `http://www.diw.de/soep`. This feature is available for *all* supported statistical packages.

[5] The GSOEP asks very detailed income information of *all adult respondents directly*, including gross and net monthly income (uncensored), and various other components. For more detailed information see the GSOEP-PSID Equivalent documentation in Burkhauser, Butrica and Daly (1997).

[6] This information is taken from the ready-made generated variables file of the regular GSOEP distribution.

as current age - years of education - 6, and (b) actual work experience, defined as the number of years actually working in full and part time employment taken from the life history calendar. Apart from the interaction terms with years of schooling and parents' education, our estimations control for a cubic in the different experience measures, respectively. A dummy variable is created for the presence of on-the-job training (OJT), to control for increases in human capital not captured by the formal education variable, using retrospective information asked in detail at two time periods. Although the length of OJT is also asked, the variable used is coded to be simply the presence of OJT in that year regardless of length (under 1 year). Many OJT courses last several years, and as such get carried forth into the coding for the appropriate following years.[7]

In addition to these variables, which are the focus of our analysis, our basic specification includes the following control variables: 12 year dummies, 13 industry dummies[8], 3 firm size dummies, a white/blue collar dummy, and a dummy variable indicating marital status. After eliminating all observations with missing values for the variables of interest, a final sample of 13,499 person-year observations for 2,503 individuals remained. Descriptive statistics are reported in Appendix-Table 1.

IV. Application

A. Replication of US studies

In Table (1) we report the estimates of equation (2) using potential and actual experience, respectively. We present only the estimation results on variables which are of interest for the question at hand.[9] Column (1) present a basic specification which includes years of schooling, the education of the parents, and an interaction term between years of schooling and experience. In column (2) we add to this basic specification a linear interaction term between experience and parents' education.

[7]There is likely to be a substantial amount of measurement error is this variable, as the upper category for length of time in OJT is "more than two years", which we code as 3 years. The question was explicitly asked only in 1989 and 1993. The next scheduled detailed questioning of OJT in the GSOEP is in 2000. Also in an effort to include as many observations as possible, forward looking information is used as well. For example, those who said that they had started an OJT course in 1993 and that the course *would last into the future* "more than two years" had "valid" codings for up to three following years.

[8]The GSOEP uses a quasi 2-digit industry classification scheme modeled after the macro-level official statistics from the German Statistical Office. Due to cell-size considerations and keeping in mind the wage-bargaining mechanisms in Germany, those industries that "collectively bargain together" are more or less also grouped together in the analysis.

[9]A full set of the estimation results is available on request.

The results reveal the usual positive relationship between education and wages. The estimated rates of return to an additional year of schooling at the time individuals enter the labor market of 3.1% to 3.6% are consistent with existent evidence for Germany (Haisken-DeNew and Schmidt, 1999). For the basic specification, the coefficient on the education of the parents is significant positive. The estimated coefficient indicate, that a one year increase of the years of schooling of the highest educated parent increases wages by about 0.7%.

All estimated coefficients of the interaction variable between education and experience in columns (1) of Table (1) are positively significant, suggesting that the effect of education on wages increases with experience. The size of the coefficients, which is not significantly affected by changing the definition of labor market experience, indicates that the returns to schooling increase by about 0.1% for every additional year of potential labor market experience. Adding the interaction variable between parents' education and experience to the specification (see columns (2) in Table (1)) slightly reduces the positive interaction between education and experience and makes the coefficient on parents' education insignificant. The estimated coefficients on the interaction term between parents' education and experience are statistically significant positive (one-sided test) for both experience measures and indicate that the effect of unobserved ability on wages increase with the labor market experience of an individual. Even though the interaction terms between parents' education and experience are significant positive (i.e. $\beta_{Z,T} > 0$), the results do not confirm the hypotheses of the employer learning model because the interaction term between education and experience is also significant positive (i.e. $\beta_{S,T} > 0$).

As we have noted in section II, $\beta_{S,T}$ and $\beta_{Z,T}$ can be both positive if on-the-job training is complementary to education and ability. Columns (1') and (2') shows the respective estimation results for the specifications in columns (1) and (2) when on-the-job training is controlled for. The estimated effects of on-the-job training on wages are all statistically significant and indicate that those who received on-the-job training earn about 3% more than those who did not. The estimated coefficients on the interaction terms between education and experience and parents' education and experience, however, are not affected by controlling for on-the-job training.

Overall, these results are not consistent with the model of employer learning as proposed by Farber and Gibbons (1996) and Altonji and Pierret (1998,1999) and are in contrast to their empirical results for the United States, which generally confirm the employer learning hypothesis. Within the employer learning framework our results rather suggest that there is a complementary relationship between education and human capital accumulation on the job, as it is also found in studies on the determinants of on-the-job training.

B. *Private versus Public Information*

The models of Farber and Gibbons (1996) and Altonji and Pierret (1998, 1999) assume that information about the productivity of a workers is public, i.e. that all possible employers have the same information. There is, however, some empirical evidence that part of an employers' information on the productivity of a worker is private. Using data from the Displaced Worker Survey (DWS), Gibbons and Katz (1991) show for the US that laid off workers are stigmatized, since the dismissal acts as a signal of below average productivity. Their estimation results suggest that laid off white-collar workers have 5.5% lower post-displacement wages than white-collar workers displaced by plant closings. This stigma effect is insignificant for blue collar workers.[10] If information about a workers' productivity is public and if wages are flexible, layoffs should not give additional information to employers and the above wage effects should not occur (see Gibbons and Katz (1991), p. 376).

Within the framework of employer learning, the issue of private versus public information could be addressed by splitting total labor market experience of a worker into tenure with the current firm and the sum of labor market experience of a worker before he started working for his current firm. Consider the following wage equation:

$$\begin{aligned} log(W_{it}) \; = \; & F(T_i) + \beta_S S_i + \beta_{S,t}(S_i \cdot t_i) + \beta_{S,T-t}(S_i \cdot (T_i - t_i)) + \\ & \beta_Z Z_i + \beta_{Z,t}(Z_i \cdot t_i) + \beta_{Z,T-t}(Z_i \cdot (T_i - t_i)) + u_{i,t}, \end{aligned} \tag{3}$$

where T_i indicates the total labor market experience of worker i and t_i his tenure with the current firm. If information is public, one would expect that the experience paths of S_i and Z_i are independent of whether one measures experience in the current firm or experience in previous firms, i.e., $\beta_{S,t} = \beta_{S,T-t}$ and $\beta_{Z,t} = \beta_{Z,T-t}$. If information is exclusively private, one should expect that the returns to S_i and Z_i are only affected by the experience in the current firm and not by previous labor market experience, i.e., $\beta_{S,T-t} = \beta_{Z,T-t} = 0$. To estimate equation (3) we split the two overall job experience variables used in the last section into tenure at the current job and previous job experience, where the latter is defined as potential or actual labor experience minus current job tenure.

The estimation results for both experience measures are depicted in Table (2). The basic specification is shown in columns (1) and (2). Columns (1') and (2') show the respective estimation results when controlling for on-the-job training. The estimated returns to schooling of 3.6% to 3.7% at the time individuals enter the labor market are similar to those reported in

[10] In general, the findings of Gibbons and Katz (1991) for the US have been confirmed by Stevens (1997), who uses the Panel Study of Income Dynamics (PSID), and by Doiron (1995) for the Canadian labor market. Using the German Socio-Economic Panel (GSOEP), Grund (1999) shows that there is no evidence that stigma effects of layoffs are present in the German labor market.

Table (1). On-the-job training has a positive effect on wages. Independent of the experience measure used, the education of the parents has no significant effect.

The estimated coefficients on the different interaction terms between education and parents' education and tenure on the current job and previous labor market experience indicate that information on the productivity of workers is private. The interaction terms between education and previous experience and parents' education and previous experience are not significant different from zero (i.e. $\beta_{S,T-t} = 0$ and $\beta_{Z,T-t} = 0$) for all specifications. The interaction term between education and tenure in the current firm ($\beta_{S,t}$) is highly significant for both experience measures. The estimated coefficients indicate that the returns to schooling increase by 0.15% for every additional year in a particular firm. The interaction term between parents' education and tenure ($\beta_{Z,t}$) has no significant effect on wages for all specification in Table (2). Hence, even if we allow information on a workers' productivity to be private, the employer learning hypotheses can be rejected. The returns to schooling are increasing with tenure in a firm (i.e. $\beta_{S,t} > 0$) and unobserved ability, measured by the education of the parents, does not gain importance with increasing tenure (i.e. $\beta_{Z,t} = 0$).

C. The Role of Occupational Status

Two arguments can be put forward to expect that employer learning differs for blue-collar and white-collar workers. For employer learning about the productivity of a worker to take place, it is necessary that the employer is able to measure the performance of the worker. Given the specific task that a worker is performing, the quality of the available information of the input and output of workers differ. In general, blue-collar workers perform tasks where the input is physical work and the outputs are tangible goods and services. The tasks of white-collar workers require more mental inputs and the outputs are intangible "ideas" or organisation. The information flow about the output of white-collar workers is therefore more noisier than that of blue-collar workers (Fama, 1991). Due to the differences in the information flow about the input and the output, it is reasonable to hypothesize that employer learning plays a more important role for blue-collar workers if compared to white-collar workers.

Another argument to differentiate between different types of workers could be found in the hiring process itself. The hiring decision of a firm can be interpreted as an investment decision under uncertainty. Hence, hiring can be modeled as an optimal control problem, where the rate at which individuals are hired and the productivity of new hires are chosen to maximize the expected present value of profits. In the literature, search models are used to analyze the hiring process of firms.[11] In these models it is typically assumed that an employer who wants

[11]See, for example, Lippman and McCall (1976), Barron, Bishop and Dunkelberg (1985), and van

to fill a position is contacted by job seekers. The applicants differ in their ability to perform the particular position the employer wants to fill. The employer has imperfect information on the productivity and ability of an applicant and obtains signals on the productivity of an applicant through interviews. According to BARRON, BISHOP AND DUNKELBERG (1985) an employer is confronted with two search decisions: (*i*) the determination of the accuracy of the signals he obtains from the applicants (*intensive search*) and (*ii*) which individual out of the applicant pool to hire (*extensive search*). Among others, such as firm size and the general labor market situation, the education and training requirements of the position to fill is an important factor that influence employer search. In their theoretical model BARRON, BISHOP AND DUNKELBERG (1985) show that both, intensive and extensive search increase with the educational and training requirements of a job.

Direct estimates of hiring costs indicate that the costs of hiring and training a salaried worker are about three times higher than those of a production worker (HAMERMESH,1993, p. 208). Investigating vacancy durations in the Netherlands, VAN OURS AND RIDDER (1992) show that if a job requires a higher level of education, a vacancy is filled at a significant lower rate. Using US data, BARRON, BISHOP AND DUNKELBERG (1985) show, that the level of required training for a position influence the number of applicants interviewed and the time spend per interview. If an employer wants to fill a position requiring a higher level of education, they spend more time for recruiting, screening, and interviewing applicants. Overall, the theory and the empirical evidence on the hiring strategy of employers indicate that they invest more in screening applicants for positions which require higher education and more training. It seems therefore reasonable to assume that at the time of hiring employers have more information on higher skilled and high paid workers than on low-skilled and low-paid workers.

To test the hypothesis that employer learning differs for different jobs, we estimate equations (2) and (3) separately for blue and white-collar workers. The estimation results for the different experience measures, potential and actual experience, are reported in Table (3). Columns (1) and (3) of the Table shows the results of the basic specification with the interaction terms between education and experience and parents' education and experience for blue-collar and white-collar workers, respectively. Columns (2) and (4) show the respective results when differentiating between tenure in the current firm and previous labor market experience by estimating equation (3). Similar to Table (1), columns (1'), (2'), (3') and (4') report the results when controlling for on-the-job training.

Table (3) shows that the estimated returns to schooling are significantly lower for blue-collar workers. In the basic specification, at the time an individual enters the labor market the returns

OURS AND RIDDER (1992).

to an additional year of schooling are approximately 4% for blue-collar workers and 6% for white-collar workers. These returns decrease to 3% and 5%, respectively, when differentiating between tenure in the current firm and previous labor market experience. When using the basic specification shown in columns (1) and (3) of Table (3), the education of the parents is statistically insignificant for both, blue-collar and white-collar workers, irrespective which experience measure is used. Differentiating between experience in the current firm and previous labor market experience, the estimated coefficient on parents' education stays insignificant for white-collar workers, but becomes significant negative for blue-collar workers (see columns (2), (2'), (4) and (4')). Having on-the-job training increases the wages of blue-collar workers by about 5%, and those of white-collar workers by about 3%.

Referring to the basic specification reported in columns (1), (1'), (3) and (3') of Table (3), the estimated coefficient on the interaction term between education and experience is negative but not significantly different from zero for blue-collar and white-collar workers. This result is not affected by using different experience measures or by controlling for on-the-job training. The coefficient of the interaction term between the education of the parents and experience is statistically significant and positive at the 10%-level for blue-collar workers and insignificant for white-collar workers. Again, these results do not depend on the experience measure used and do not change when controlling for on-the-job training. According to these results, we find evidence for the presence of employer learning for blue-collar workers, whereas it is not of importance for white-collar workers.

Similar to Table (2), the estimation results in Table (3) indicate that information on the productivity of workers is private rather than public. The interaction terms between education and previous experience and parents' education and previous experience are not significant different from zero for all specifications ($\beta_{S,T-t} = 0$ and $\beta_{Z,T-t} = 0$). Similar to the basic specification, the estimation results in columns (2), (2'), (4) and (4') show that employer learning takes place for blue-collar workers but not for white-collar workers. For blue-collar workers the estimated coefficient for the interaction term between education and tenure is not significant different from zero (i.e. $\beta_{S,t} = 0$), whereas the estimated coefficient for the interaction term between parents' education and tenure is significant positive (i.e. $\beta_{Z,t} > 0$). For white-collar workers the estimated increase in the returns to schooling with experience is solely due to the experience in the current firm (i.e. $\beta_{S,t} > 0$). Unobserved ability, measured by parents' education, do not effect their wages at all (i.e. $\beta_{Z,t}$=0). These results hold for both experience measures and are not affected when controlling for on-the-job training.

As outlined above, two reasons might be responsible for the differences of employer learning for workers with a different occupational status. First, the measurement of the input and the output of white-collar workers might be too noisy to allow employers to learn about their true productivity. Second, firms put more resources in the screening of white-collar workers when hiring them and therefore already have sufficient information on their productivity at the time they start working.

D. *Quantile Regressions*

Ordinary least squares (OLS) regression is based on the *mean* of the conditional distribution of the dependent variable. Hence, OLS implicitly assumes that possible differences of the impact of the exogenous variables on the independent variable along the conditional distribution are unimportant. If the independent variables influence parameters of the conditional distribution of the dependent variable other than the mean, then an analysis which disregards this possibility will be weakened (Koenker and Basset, 1978). In contrast to OLS, quantile regression models allow to analyze the conditional distribution of the dependent variable.

As we have outlined above, employer learning seems to be important only for blue collar workers. Two reasons can put forward to explain this finding. First, employers are unable to observe the performance of white-collar workers and therefore cannot learn about their true productivity. Second, due to the nature of the hiring process, employers have sufficient information on the productivity of white-collar workers because they invest more in screening them before hiring. If the latter argument is true, one would expect that for both, blue-collar and white-collar workers, employer learning will take place for low-paid jobs and not for high-paid jobs. The reason is that employers will invest more in the screening of applicants for high-paid jobs than for low-paid jobs and therefore have a higher level of information at the time of hiring on the former. If difficulties in observing the performance of workers is the main reason for the observed differences in employer learning between blue-collar and white-collar workers, then one would expect that the extent of employer learning does not vary for different percentiles of the wage distribution. Using quantile regression we can investigate whether the importance of employer learning for the returns to schooling is different at different quantiles of the wage distribution, i.e. we hypothesize that employer learning is only important for jobs at the lower end of the earnings distribution.

The quantile regression model can be written as (see Koenker and Basset, 1978; Buchinsky, 1994, 1995)

$$w_i = X_i\beta_\theta + u_{\theta,i} \;\; with \;\; Quant_\theta(w_i|X_i) = X_i\beta_\theta, \tag{4}$$

where X_i is a vector of exogenous variables and β_θ is the vector of parameters to be estimated. $Quant_\theta(w_i|X_i)$ denotes the θth conditional quantile of w_i given X_i. The θth regression quantile,

$0 < \theta < 1$, is defined as the solution to the problem

$$min_{\beta e R^k}\{\sum_{i:y_i \geq X_i\beta} \theta|w_i - X_i\beta| + \sum_{i:y_i < X_i\beta} (1-\theta)|w_i - X_i\beta|\}. \tag{5}$$

The least absolute deviation (LAD) estimator of β is a special case within this framework, which is obtained by setting θ=0.5 (the median regression). In general, by variation of θ, any quantile of the conditional distribution can be obtained. Since the minimization problem of equation (5) has no explicit form, linear programming techniques are used to solve the problem. The standard errors of the estimates are obtained by bootstrapping with 100 repetitions. The estimated coefficients of the quantile regression can be interpreted similar to OLS regression estimates; i.e. they show the marginal change in the θth conditional quantile due to a marginal change in a exogenous variable.

The results of the quantile regressions are shown in Table (4) for the basic specification and in Table (5) for the extended specification, which differentiates between tenure in the current firm and previous labor market experience, for both measures of labor market experience. For both specifications, the returns to education at the time an individuals enters the labor market are lower, the higher an individual stands in the earnings distribution. For the basic specification, the education of the parents has a significant negative effect on wages for the 50 percentile; for all other specifications parents' education does not have a significant effect on wages. The coefficients for on-the-job training are significant positive for all quantiles and in all specifications. They further show that the returns to on-the-job training are increasing the higher a person stands in the earnings distribution.

Irrespective of the experience measure used, the employer learning hypothesis can be rejected for all quantiles (see Table (4)) when using the basic specification. Even though the coefficient on the interaction term between parents' education and labor market experience is significant and positive ($\beta_{Z,T} > 0$), the estimated coefficient on the interaction term between education and experience is also significant and positive ($\beta_{S,T} > 0$). Note, that the experience path of the returns to schooling is flatter for individuals in the lower part of the earnings distribution.

Concerning the question of whether information on workers' productivity is public or private, Table (5) gives a slightly different picture to the one of the last two sections. For both experience measures, the interaction term between parents' education and previous labor market experience ($\beta_{Z,T-t}$) is insignificant. The interaction between education and previous labor market experience ($\beta_{S,T-t}$) is significant positive for all precentiles when using potential experience and significant positive for the 50 and 75 percentile when using actual experience. Comparing the size of ($\beta_{S,T-t}$) with the interaction terms between education and tenure in the current firm ($\beta_{S,t}$), however, indicates that private information is more important. Finally, the hypotheses of employer learning can also be rejected when differentiating between tenure in the current firm and previous labor market experience. Either the returns to schooling are significantly increasing with both, labor market experience and unobserved ability (see the 25 and 50 percentiles), or the returns to schooling are increasing only with labor market experience (see the 75 percentile).

The extent of employer learning changes again when differentiating between blue-collar and white-collar workers. Table (6) shows the results of the quantile regressions for the basic specification when splitting the sample into blue-collar and white-collar workers, Table (7) shows the respective results for the extended specification. Consistent with the results reported in Tables (3), (4) and (5), the returns to schooling at the time of labor market entrance are higher for white-collar workers and the lower the higher an individuals' position in the wage distribution. Parents' education has a negative effect on the wages of blue-collar workers, in particular for those in the lower percentiles, whereas it has overall no significant effect on the wages of white-collar workers. Overall, OJT is more important for blue-collar workers, however, white-collar workers in the 75 percentile have the highest returns to OJT.

The results for the basic specification in Table (6) show that employer learning could not be rejected for blue-collar workers at the 25 and 50 percentile. For both experience measures, the estimated $\beta_{Z,T}$ is positive and significant and the estimated $\beta_{S,T}$ either insignificant or marginally significant and negative. For blue-collar workers at the 75 percentile both, $\beta_{Z,T}$ and $\beta_{S,T}$ are significant and positive. For white-collar workers the employer learning hypotheses can be rejected for those at the 25 and 75 percentile, but not for those at the 50 percentile.

Table (7) shows the results when splitting total labor market experience into tenure with the current firm and previous labor market experience. For most specifications depicted in Table (7), the interaction term between parents' education and previous labor market experience is insignificant, whereas the interaction term between parents' education and tenure in the current firm is highly significant for blue-collar workers and insignificant for white-collar workers. The returns to schooling rise significantly with previous labor market experience only for white-collar workers in the 50 and 75 percentile. The interaction between education and tenure is significant and positive for all groups but for blue-collar workers at the 25 percentile. These results imply the following conclusions. First, information concerning a workers' productivity is private for blue-collar workers and for white-collar workers in the lowest percentile. For white-collar in the 50 and 75 percentile the returns to schooling are increasing with previous labor market experience. This effect is, however, only half of the effect of tenure in the current firm. Second, employer learning seems to be important only for blue-collar workers at the lower end of the wage distribution. For all other groups the returns to schooling are either increasing in both, labor experience and unobserved ability (blue-collar workers in the 50 and 75 percentile), or only increasing with labor market experience (white-collar workers). Concerning the two explanations for the observed differences on employer learning stated above, this results means that both, difficulties in observing the performance of workers and differences in the hiring process, have some content.

V. Conclusions

This paper investigates the hypothesis of employer learning recently proposed by Farber and Gibbons (1996) and Altonji and Pierret (1998, 1999) using a large German panel data set. According to their theoretical models, the returns to formal education as measured by years of education should decrease and the effect of variables correlated with ability but not observed by the employer should increase with the labor experience of employees as more information about the true productivity of the employee is revealed to the employer over time. In general, their empirical results confirm the hypothesis on employer learning for the United States.

In contrast to the empirical results for the United States, the empirical evidence of this study suggest that the hypothesis of employer learning could not be confirmed for Germany when just replicating the US studies. When differentiating between blue-collar and white-collar workers and by estimating quantile regression, however, we find that employer learning takes place for blue-collar workers at the lower end of the wage distribution. We further show that information on the productivity of blue-collar workers is mainly private. For white-collar workers, the returns to schooling are increasing with tenure in the current firm and previous labor market experience. The positive effect of tenure on the returns to schooling, however, is much more important. These results suggest that information on the productivity of workers is to a large part private.

Some potential problems of the above empirical analysis should be mentioned. First, we can use only parents' education as a measure of natural ability which is unobserved by the employers when an individual enters the labor market. Our data set does not allow one to use other measures such as test scores or wages of siblings. It might be the case that our measure of Z_i is not adequate to identify fully employer learning. Second, it might be that introducing just a dummy variable for the presence of on-the-job training is not sufficient to sort out the effects of human capital accumulation on the time paths of the returns to schooling and natural ability.

Several reasons could be put forward why employer learning in Germany is less important than in the US. First, the quality variability of schools and universities in Germany is much lower than in the United States. Furthermore, the German apprenticeship system provides standardized occupational training. Therefore, schooling degress and grades provide more direct information on the true productivity of an individual. This hypothesis could be tested by comparing individuals who received their education in Germany to migrants, who received their education abroad. In the case that the homogeneous German schooling system is responsible for the different results in Germany and the US, one would expect that employer learning is more important for migrants. Second, there are much lower restrictions in Germany on the amount and type of information generally asked for and expected, when prospective employees apply for a job. For example, it is common in Germany to include a photo with the application forms, which is generally not the case in the US. Furthermore, on applying for any job, employers require from prospective employees an official statement from the local administration regarding any previous criminal record (*polizeiliches Führungszeugnis*). Given these differences in the amount of information on employees at the time of hiring it might be interesting to compare employer learning for individuals who received their job through the normal application procedure to individuals who received their job through old boys networks.

Finally, an important influence may come from the fact that Germany's centralized collective bargaining system (see Haisken-DeNew and Schmidt, 1998) does not really allow employers to differentiate in pay between productive and non-productive employees, even if employers can actually identify productivity. For example, the common German *Bundesangestelltentarif* (BAT) pay scale system for white-collar workers uses three pieces of information: position level (typically defined by formal education requirements), employee's age and employees' marital status/number of children in determining pay levels. Measured productivity does not enter into the equation directly. For private sector industries, there are very similar pay scales defined by that industry's particular trade union agreement. If the German collective bargaining system is an important explanation of the lack of employer learning, one might look at differences in employer learning in different industries. It would then be expected that employer learning is more important in industries with a higher wage drift.

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Table 1: Regression Analysis of Earnings Function: Total Sample

	Potential Experience				Actual Experience			
	(1)	(1')	(2)	(2')	(1)	(1')	(2)	(2')
Education	0.033 (7.83)	0.033 (7.77)	0.036 (8.40)	0.036 (8.34)	0.031 (8.94)	0.031 (8.88)	0.033 (9.19)	0.033 (9.14)
Parents' Education $\times 10^{-2}$	0.660 (2.34)	0.655 (2.32)	-0.284 (0.49)	-0.286 (0.49)	0.754 (2.66)	0.749 (2.65)	0.037 (0.08)	0.029 (0.06)
Education $\times$ Experience $\times 10^{-2}$	0.110 (5.01)	0.110 (5.03)	0.095 (4.11)	0.095 (4.13)	0.126 (5.42)	0.126 (5.43)	0.112 (4.48)	0.113 (4.50)
Parents' Education $\times$ Experience $\times 10^{-2}$	-	-	0.045 (1.80)	0.045 (1.80)	-	-	0.043 (1.77)	0.043 (1.78)
On-The-Job Training	-	0.034 (3.50)	-	0.033 (3.50)	-	0.031 (3.17)	-	0.031 (3.20)
R^2	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51

Note: The dependent variable is log real hourly wages. The number in parentheses are absolute t-values, which have been calculated using White/Huber standard errors accounting for the fact that there are multiple observations for each individual. There are 13,499 person-year observations for 2,503 individuals. All equations include as additional explanatory variables 12 year dummies, 13 industry dummies, 3 firm size dummies, a white/blue collar dummy, and a dummy variable indicating marital status. Actual experience is modeled with a cubic polynomial. Estimations of equation (3) include a cubic in tenure.

Table 2: Earnings Function and the Role of Job Tenure and Previous Experience

	Potential Experience		Actual Experience	
	(1)	(1')	(2)	(2')
Education	0.036 (9.35)	0.035 (9.28)	0.037 (11.23)	0.037 (11.18)
Parents' Education $\times 10^{-2}$	0.382 (0.78)	0.377 (0.77)	0.309 (0.72)	0.304 (0.71)
Education $\times$ Tenure $\times 10^{-2}$	0.147 (5.95)	0.147 (5.98)	0.147 (5.97)	0.147 (5.99)
Education $\times$ (Experience-Tenure) $\times 10^{-2}$	0.044 (1.58)	0.045 (1.60)	0.031 (0.98)	0.031 (0.99)
Parents' Education $\times$ Tenure $\times 10^{-2}$	0.038 (1.27)	0.038 (1.27)	0.040 (1.34)	0.040 (1.33)
Parents' Education $\times$ (Experience-Tenure) $\times 10^{-2}$	-0.008 (0.29)	-0.008 (0.28)	-0.000 (0.00)	-0.000 (0.01)
On-The-Job Training	-	0.038 (3.91)	-	0.037 (3.71)
R^2	0.50	0.51	0.50	0.50

Note: See Table (1).

Table 3: Earnings Regression by Occupational Status

	Potential Experience							
	Blue Collar				White Collar			
	(1)	(1')	(2)	(2')	(3)	(3')	(4)	(4')
Education	0.043 (4.82)	0.042 (4.70)	0.027 (3.79)	0.027 (3.68)	0.063 (11.18)	0.063 (11.16)	0.048 (10.34)	0.048 (10.37)
Parents' Education $\times 10^{-2}$	-0.743 (1.05)	-0.705 (1.00)	-1.212 (1.91)	-1.169 (1.85)	0.350 (0.45)	0.333 (0.43)	0.388 (0.61)	0.358 (0.56)
Education $\times$ Experience $\times 10^{-2}$	-0.019 (0.39)	-0.018 (0.35)	-	-	-0.009 (0.31)	-0.009 (0.32)	-	-
Parents' Education $\times$ Experience $\times 10^{-2}$	0.055 (1.48)	0.053 (1.42)	-	-	0.011 (0.36)	0.011 (0.38)	-	-
Education $\times$ Tenure $\times 10^{-2}$	-	-	0.109 (1.56)	0.108 (1.54)	-	-	0.100 (3.33)	0.099 (3.31)
Education $\times$ (Experience-Tenure) $\times 10^{-2}$	-	-	-0.010 (0.23)	-0.006 (0.15)	-	-	0.027 (0.81)	0.026 (0.80)
Parents' Education $\times$ Tenure $\times 10^{-2}$	-	-	0.152 (3.42)	0.149 (3.38)	-	-	-0.029 (0.83)	-0.029 (0.83)
Parents' Education $\times$ (Experience-Tenure) $\times 10^{-2}$	-	-	0.023 (0.55)	0.021 (0.50)	-	-	0.042 (1.19)	0.043 (1.24)
On-The-Job Training	-	0.047 (3.59)	-	0.045 (3.54)	-	0.027 (2.11)	-	0.035 (2.68)
R^2	0.31	0.31	0.30	0.31	0.51	0.51	0.49	0.49
	Actual Experience							
	Blue Collar				White Collar			
	(1)	(1')	(2)	(2')	(3)	(3')	(4)	(4')
Education	0.032 (4.67)	0.032 (4.60)	0.027 (4.43)	0.026 (4.34)	0.050 (10.78)	0.050 (10.77)	0.048 (11.22)	0.048 (11.25)
Parents' Education $\times 10^{-2}$	-0.336 (0.61)	-0.327 (0.60)	-1.120 (2.25)	-1.103 (2.24)	0.490 (0.74)	0.475 (0.71)	0.609 (1.05)	0.591 (1.01)
Education $\times$ Experience $\times 10^{-2}$	0.022 (0.46)	0.021 (0.45)	-	-	0.034 (1.10)	0.034 (1.10)	-	-
Parents' Education $\times$ Experience $\times 10^{-2}$	0.053 (1.59)	0.052 (1.57)	-	-	0.012 (0.38)	0.013 (0.39)	-	-
Education $\times$ Tenure $\times 10^{-2}$	-	-	0.111 (1.57)	0.109 (1.54)	-	-	0.103 (3.44)	0.102 (3.42)
Education $\times$ (Experience-Tenure) $\times 10^{-2}$	-	-	-0.017 (0.43)	-0.016 (0.40)	-	-	0.013 (0.33)	0.013 (0.32)
Parents' Education $\times$ Tenure $\times 10^{-2}$	-	-	0.149 (3.37)	0.146 (3.33)	-	-	-0.027 (0.78)	-0.027 (0.77)
Parents' Education $\times$ (Experience-Tenure) $\times 10^{-2}$	-	-	0.029 (0.76)	0.029 (0.76)	-	-	0.044 (1.05)	0.045 (1.08)
On-The-Job Training	-	0.044 (3.30)	-	0.045 (3.47)	-	0.023 (1.84)	-	0.032 (2.48)
R^2	0.31	0.31	0.30	0.31	0.50	0.50	0.49	0.49

Note: The dependent variable is real hourly wages on the current job in levels and logs respectively. The number in parentheses are absolute t-values, which have been calculated using White/Huber standard errors accounting for the fact that there are multiple observations for each individual. There are 7,278 person-year observations for 1,527 blue collar workers and 6,089 person-year observations for 1,269 white collar workers. All equations include as additional explanatory variables 12 year dummies, 13 industry dummies, 3 firm size dummies, a white/blue collar dummy, and a dummy variable indicating marital status. Actual experience is modeled with a cubic polynomial. Estimations of equation (3) include a cubic in tenure.

Table 4: Quantile Regressions of Earnings Function: Basic Specification

	Potential Experience					
Quantile	0.25	0.5	0.75	0.25	0.5	0.75
Education	0.039 (11.89)	0.035 (11.43)	0.030 (10.68)	0.038 (12.00)	0.034 (12.44)	0.029 (10.20)
Parents' Education $\times 10^{-2}$	-0.622 (1.60)	-0.067 (2.16)	-0.179 (0.46)	-0.602 (1.77)	-0.067 (2.15)	0.075 (0.17)
Education $\times$ Experience $\times 10^{-2}$	0.086 (5.91)	0.101 (5.81)	0.129 (9.24)	0.088 (5.62)	0.101 (6.71)	0.128 (8.88)
Parents' Education $\times$ Experience $\times 10^{-2}$	0.047 (2.63)	0.054 (4.24)	0.039 (2.34)	0.047 (2.97)	0.056 (4.22)	0.034 (1.82)
On-The-Job Training	-	-	-	0.030 (2.96)	0.029 (3.22)	0.033 (4.10)
R^2	0.28	0.32	0.35	0.29	0.32	0.35
	Actual Experience					
Quantile	0.25	0.5	0.75	0.25	0.5	0.75
Education	0.036 (11.89)	0.034 (15.18)	0.025 (10.38)	0.036 (15.49)	0.034 (15.73)	0.026 (11.16)
Parents' Education $\times 10^{-2}$	-0.058 (0.18)	-0.287 (1.13)	0.320 (1.14)	-0.006 (0.02)	-0.308 (1.17)	0.226 (0.73)
Education $\times$ Experience $\times 10^{-2}$	0.110 (6.58)	0.114 (7.91)	0.158 (10.54)	0.112 (8.99)	0.117 (8.73)	0.151 (11.36)
Parents' Education $\times$ Experience $\times 10^{-2}$	0.034 (2.17)	0.044 (3.19)	0.027 (2.04)	0.031 (1.70)	0.045 (3.60)	0.029 (2.01)
On-The-Job Training	-	-	-	0.023 (2.44)	0.024 (2.65)	0.035 (3.80)
R^2	0.28	0.32	0.35	0.28	0.32	0.35

Note: The dependent variable is log of real hourly wages. The number in parentheses are absolute t-values, which have been obtained by bootstrapping with 100 repetitions. There are 13,499 person-year observations for 2,503 individuals. All equations include as additional explanatory variables 12 year dummies, 13 industry dummies, 3 firm size dummies, a white/blue collar dummy, and a dummy variable indicating marital status. Actual experience is modeled with a cubic polynomial. Estimations of equation (3) include a cubic in tenure.

Table 5: Quantile Regressions of Earnings Function: Extended Specification

	Potential Experience					
Quantile	0.25	0.5	0.75	0.25	0.5	0.75
Education	0.037 (12.68)	0.035 (13.46)	0.032 (11.73)	0.037 (13.87)	0.035 (13.69)	0.031 (11.15)
Parents' Education $\times 10^{-2}$	-0.032 (0.10)	0.234 (0.82)	0.577 (1.50)	0.023 (0.07)	0.301 (0.96)	0.604 (1.61)
Education $\times$ Tenure $\times 10^{-2}$	0.140 (9.12)	0.157 (11.44)	0.163 (6.92)	0.141 (10.89)	0.158 (11.57)	0.161 (9.14)
Education $\times$ (Experience-Tenure) $\times 10^{-2}$	0.038 (1.76)	0.044 (2.72)	0.041 (2.21)	0.039 (1.86)	0.049 (2.90)	0.042 (2.33)
Parents' Education $\times$ Tenure $\times 10^{-2}$	0.062 (3.53)	0.028 (1.62)	0.025 (0.91)	0.056 (3.38)	0.026 (1.51)	0.023 (1.01)
Parents' Education $\times$ (Experience-Tenure) $\times 10^{-2}$	-0.013 (0.60)	-0.010 (0.64)	-0.004 (0.20)	-0.013 (0.65)	-0.014 (0.85)	-0.005 (0.26)
On-The-Job Training	-	-	-	0.026 (2.99)	0.032 (3.36)	0.041 (3.67)
R^2	0.28	0.31	0.34	0.28	0.31	0.34
	Actual Experience					
Quantile	0.25	0.5	0.75	0.25	0.5	0.75
Education	0.038 (16.96)	0.037 (16.55)	0.031 (13.41)	0.038 (16.73)	0.036 (16.35)	0.031 (14.38)
Parents' Education $\times 10^{-2}$	-0.091 (0.36)	0.239 (1.01)	0.931 (3.97)	-0.049 (0.18)	0.301 (1.07)	0.841 (2.67)
Education $\times$ Tenure $\times 10^{-2}$	0.141 (10.19)	0.155 (9.18)	0.168 (8.94)	0.141 (11.67)	0.161 (11.86)	0.163 (10.32)
Education $\times$ (Experience-Tenure) $\times 10^{-2}$	0.028 (1.31)	0.041 (2.41)	0.048 (2.67)	0.024 (1.16)	0.044 (2.51)	0.048 (2.72)
Parents' Education $\times$ Tenure $\times 10^{-2}$	0.059 (3.64)	0.031 (1.85)	0.017 (0.70)	0.054 (3.57)	0.027 (1.56)	0.022 (0.91)
Parents' Education $\times$ (Experience-Tenure) $\times 10^{-2}$	-0.007 (0.31)	-0.011 (0.66)	-0.020 (1.06)	-0.002 (0.11)	-0.015 (0.81)	-0.019 (1.09)
On-The-Job Training	-	-	-	0.026 (3.10)	0.027 (2.92)	0.038 (3.36)
R^2	0.28	0.31	0.34	0.28	0.31	0.34

Note: See Table (4)

Table 6: Quantile Regressions of Earnings Function by Occupational Status: Basic Specification

	Potential Experience											
	Blue-Collar						White-Collar					
Quantile	0.25	0.5	0.75	0.25	0.5	0.75	0.25	0.5	0.75	0.25	0.5	0.75
Education	0.045 (5.23)	0.035 (5.84)	0.023 (3.25)	0.047 (5.51)	0.035 (5.28)	0.023 (3.29)	0.060 (13.83)	0.063 (15.54)	0.063 (14.39)	0.060 (16.67)	0.063 (18.42)	0.065 (17.32)
Parents' Education $\times 10^{-2}$	-0.366 (0.65)	-1.157 (2.33)	-0.555 (0.87)	-0.549 (0.84)	-1.188 (2.91)	-0.353 (0.62)	-0.234 (0.46)	-0.532 (1.17)	0.604 (1.27)	-0.301 (0.70)	-0.476 (1.04)	0.567 (1.15)
Education $\times$ Experience $\times 10^{-2}$	-0.057 (1.43)	-0.009 (0.29)	0.092 (2.55)	-0.065 (1.67)	-0.014 (0.42)	0.083 (2.34)	0.000 (0.03)	-0.014 (0.78)	-0.003 (0.13)	0.004 (0.22)	-0.012 (0.73)	-0.010 (0.57)
Parents' Education $\times$ Experience $\times 10^{-2}$	0.047 (1.62)	0.082 (3.60)	0.064 (2.58)	0.050 (1.61)	0.083 (4.24)	0.059 (2.63)	0.016 (0.71)	0.040 (2.17)	-0.004 (0.23)	0.019 (0.89)	0.037 (1.97)	-0.003 (0.15)
On-The-Job Training	-	-	-	0.053 (4.23)	0.036 (2.26)	0.036 (2.05)	-	-	-	0.023 (1.70)	0.021 (1.72)	0.049 (3.80)
R^2	0.19	0.18	0.17	0.19	0.18	0.17	0.33	0.33	0.31	0.33	0.33	0.32
	Actual Experience											
	Blue-Collar						White-Collar					
Quantile	0.25	0.5	0.75	0.25	0.5	0.75	0.25	0.5	0.75	0.25	0.5	0.75
Education	0.032 (5.68)	0.027 (4.83)	0.015 (2.82)	0.033 (5.74)	0.029 (4.33)	0.015 (2.91)	0.053 (14.37)	0.053 (21.73)	0.045 (14.34)	0.052 (16.11)	0.052 (19.84)	0.045 (12.74)
Parents' Education $\times 10^{-2}$	-0.070 (0.18)	-0.555 (1.84)	-0.024 (0.04)	-0.090 (0.20)	-0.512 (1.70)	0.021 (0.04)	0.162 (0.39)	-0.193 (0.56)	0.908 (2.15)	0.225 (0.58)	-0.123 (0.33)	0.955 (2.11)
Education $\times$ Experience $\times 10^{-2}$	-0.016 (0.42)	0.018 (0.57)	0.136 (3.72)	-0.027 (0.69)	0.018 (0.49)	0.136 (4.05)	0.027 (1.33)	0.023 (1.45)	0.069 (3.81)	0.033 (1.85)	0.026 (1.50)	0.068 (3.27)
Parents' Education $\times$ Experience $\times 10^{-2}$	0.044 (1.88)	0.073 (3.53)	0.047 (1.98)	0.042 (1.62)	0.075 (3.43)	0.048 (2.19)	0.009 (0.38)	0.031 (1.81)	-0.005 (0.26)	0.006 (0.31)	0.027 (1.55)	-0.012 (0.65)
On-The-Job Training	-	-	-	0.046 (3.75)	0.039 (2.72)	0.039 (2.57)	-	-	-	0.021 (1.40)	0.015 (1.10)	0.040 (3.38)
R^2	0.19	0.18	0.17	0.19	0.18	0.17	0.33	0.33	0.31	0.33	0.33	0.31

Note: The dependent variable is log of real hourly wages. The number in parentheses are absolute t-values, which have been obtained by bootstrapping with 100 repetitions. There are 7,278 person-year observations for 1,527 blue collar workers and 6,089 person-year observations for 1,269 white collar workers. All equations include as additional explanatory variables 12 year dummies, 13 industry dummies, 3 firm size dummies, a white/blue collar dummy, and a dummy variable indicating marital status. Actual experience is modeled with a cubic polynomial. Estimations of equation (3) include a cubic in tenure.

Table 7: Quantile Regressions of Earnings Function by Occupational Status: Extended Specification

	Potential Experience											
	Blue-Collar						White-Collar					
Quantile	0.25	0.5	0.75	0.25	0.5	0.75	0.25	0.5	0.75	0.25	0.5	0.75
Education	0.031 (5.54)	0.021 (3.74)	0.015 (3.54)	0.031 (5.01)	0.019 (3.79)	0.014 (3.09)	0.052 (14.86)	0.048 (14.89)	0.043 (15.24)	0.052 (13.37)	0.048 (12.50)	0.044 (13.99)
Parents' Education $\times 10^{-2}$	-0.983 (1.86)	-1.434 (3.35)	-0.970 (1.71)	-1.031 (1.96)	-1.257 (2.94)	-0.813 (1.63)	-0.110 (0.29)	0.200 (0.51)	0.781 (1.58)	-0.147 (0.36)	0.256 (0.58)	0.553 (1.34)
Education $\times$ Tenure $\times 10^{-2}$	0.043 (0.94)	0.167 (4.59)	0.246 (6.50)	0.026 (0.52)	0.171 (4.14)	0.250 (7.03)	0.082 (4.50)	0.097 (5.01)	0.114 (5.84)	0.086 (4.37)	0.095 (4.60)	0.102 (4.72)
Education $\times$ (Experience-Tenure) $\times 10^{-2}$	-0.020 (0.62)	-0.044 (1.53)	-0.027 (0.97)	-0.011 (0.32)	-0.033 (1.20)	-0.021 (0.69)	0.013 (0.51)	0.047 (2.33)	0.062 (2.68)	0.013 (0.56)	0.052 (2.22)	0.059 (2.59)
Parents' Education $\times$ Tenure $\times 10^{-2}$	0.139 (3.94)	0.159 (6.19)	0.130 (4.56)	0.145 (4.56)	0.156 (6.29)	0.125 (5.45)	-0.021 (0.95)	-0.026 (1.47)	-0.037 (1.55)	-0.023 (0.94)	-0.024 (1.07)	-0.025 (1.15)
Parents' Education $\times$ (Experience-Tenure) $\times 10^{-2}$	0.028 (0.85)	0.054 (1.93)	0.038 (1.42)	0.018 (0.54)	0.044 (1.65)	0.032 (1.09)	0.042 (1.57)	0.021 (0.92)	0.021 (0.92)	0.042 (1.66)	0.016 (0.63)	0.025 (1.13)
On-The-Job Training	-	-	-	0.032 (2.47)	0.033 (2.67)	0.033 (1.09)	-	-	-	0.026 (2.22)	0.022 (1.96)	0.047 (3.69)
R^2	0.19	0.18	0.17	0.19	0.18	0.17	0.33	0.32	0.30	0.33	0.32	0.30
	Actual Experience											
	Blue-Collar						White-Collar					
Quantile	0.25	0.5	0.75	0.25	0.5	0.75	0.25	0.5	0.75	0.25	0.5	0.75
Education	0.029 (5.26)	0.018 (3.87)	0.012 (2.87)	0.029 (5.31)	0.017 (3.42)	0.012 (2.81)	0.050 (16.16)	0.049 (19.63)	0.041 (12.74)	0.050 (14.23)	0.049 (17.56)	0.042 (13.69)
Parents' Education $\times 10^{-2}$	-0.880 (2.08)	-1.065 (2.78)	-0.490 (0.86)	-0.855 (2.13)	-1.007 (2.68)	-0.562 (1.03)	0.177 (0.52)	0.338 (0.97)	1.203 (2.64)	0.173 (0.48)	0.377 (0.96)	1.220 (2.90)
Education $\times$ Tenure $\times 10^{-2}$	0.047 (1.03)	0.170 (4.13)	0.256 (5.84)	0.042 (0.95)	0.178 (4.23)	0.250 (5.81)	0.099 (5.25)	0.098 (5.42)	0.126 (5.94)	0.101 (5.02)	0.094 (4.97)	0.122 (5.62)
Education $\times$ (Experience-Tenure) $\times 10^{-2}$	-0.021 (0.62)	-0.039 (1.52)	-0.006 (0.19)	-0.020 (0.57)	-0.036 (1.36)	-0.002 (0.09)	0.006 (0.24)	0.039 (2.30)	0.058 (2.24)	0.009 (0.30)	0.037 (1.92)	0.061 (2.42)
Parents' Education $\times$ Tenure $\times 10^{-2}$	0.139 (4.32)	0.147 (5.48)	0.122 (3.96)	0.139 (4.92)	0.147 (6.46)	0.123 (4.29)	-0.029 (1.06)	-0.020 (0.95)	-0.043 (1.58)	-0.023 (1.01)	-0.022 (1.10)	-0.041 (2.07)
Parents' Education $\times$ (Experience-Tenure) $\times 10^{-2}$	0.027 (0.81)	0.048 (1.92)	0.015 (0.53)	0.026 (0.77)	0.047 (1.76)	0.012 (0.49)	0.039 (1.63)	0.018 (0.90)	0.007 (0.27)	0.036 (1.15)	-0.020 (0.97)	0.004 (0.17)
On-The-Job Training	-	-	-	0.031 (2.30)	0.034 (3.15)	0.034 (2.20)	-	-	-	0.018 (1.59)	0.021 (1.48)	0.053 (4.19)
R^2	0.19	0.18	0.17	0.19	0.18	0.17	0.32	0.32	0.29	0.32	0.32	0.29

Note: See Table (6)

Appendix

Table 1: Weighted Descriptive Statistics

	Total Sample		Blue-Collar		White-Collar	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Real Hourly Wage (Log DM)	3.0134	0.3355	2.8823	0.2533	3.1602	0.3435
Year 1985	0.0680	0.2518	0.0790	0.2698	0.0750	0.2635
Year 1986	0.0725	0.2593	0.0856	0.2798	0.0732	0.2606
Year 1987	0.0747	0.2630	0.0834	0.2765	0.0749	0.2632
Year 1988	0.0751	0.2636	0.0772	0.2670	0.0737	0.2614
Year 1989	0.0889	0.2846	0.0852	0.2792	0.0854	0.2795
Year 1990	0.0854	0.2796	0.0833	0.2763	0.0803	0.2718
Year 1991	0.0773	0.2672	0.0712	0.2571	0.0759	0.2648
Year 1992	0.0782	0.2685	0.0701	0.2553	0.0728	0.2598
Year 1993	0.0847	0.2784	0.0776	0.2676	0.0777	0.2677
Year 1994	0.0797	0.2709	0.0675	0.2508	0.0751	0.2635
Year 1995	0.0763	0.2656	0.0687	0.2530	0.0831	0.2761
Year 1996	0.0708	0.2566	0.0636	0.2441	0.0785	0.2690
II-Energy	0.0283	0.1660	0.0262	0.1599	0.0407	0.1977
III.1-Chemicals	0.0681	0.2520	0.0743	0.2623	0.0572	0.2322
III.2-Plastics	0.0128	0.1125	0.0221	0.1471	0.0062	0.0788
III.3-Stone/Ceramics	0.0132	0.1144	0.0154	0.1231	0.0184	0.1344
III.4-Metal	0.3442	0.4751	0.3802	0.4855	0.3101	0.4626
III.5-Wood	0.0438	0.2047	0.0628	0.2426	0.0232	0.1504
III.6-Textiles	0.0176	0.1316	0.0207	0.1425	0.0158	0.1246
III.7-Food	0.0388	0.1932	0.0415	0.1994	0.0296	0.1694
IV-Construction	0.1339	0.3405	0.2054	0.4040	0.0481	0.2140
V-Wholesale/Retail	0.0860	0.2804	0.0460	0.2096	0.1224	0.3277
VI-Transport	0.0510	0.2201	0.0650	0.2465	0.0443	0.2059
VII-Banking	0.0436	0.2043	0.0008	0.0287	0.1053	0.3069
VIII-Other Services	0.0919	0.2890	0.0352	0.1842	0.1430	0.3501
IX-Nonprofit	0.0260	0.1592	0.0043	0.0651	0.0358	0.1858
Firm Size (1-20)	0.1676	0.3735	0.2148	0.4107	0.1064	0.3084
Firm Size (21-200)	0.2655	0.4416	0.2656	0.4417	0.2511	0.4337
Firm Size (201-2000)	0.2580	0.4375	0.2396	0.4269	0.2910	0.4543
Firm Size (2001-)	0.3087	0.4620	0.2800	0.4490	0.3515	0.4775
Married	0.6525	0.4761	0.6696	0.4704	0.7251	0.4465
White Collar Worker	0.4706	0.4991	-	-	-	-
Years Education	11.3268	2.4093	10.1277	0.9942	12.5058	2.7834
On-The-Job Training	0.0775	0.2675	0.0458	0.2090	0.1261	0.3320
Max Parents' Education	10.8309	1.9773	10.2642	1.3208	11.2386	2.1975
Potential Work Experience	22.5740	11.0654	22.5759	11.3842	22.4130	10.4456
Actual Experience	19.0609	11.5604	19.1353	11.9669	18.8396	10.8274
Job Tenure	11.1069	9.6735	11.0146	9.7485	11.5232	9.8517
Person-Year Observations	13,499		7,278		6,089	
Individuals	2,503		1,527		1,269	

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