ZEW
Zentrum für Europäische Wirtschaftsforschung GmbH

Centre for European Economic Research

Universität Konstanz

Rechts-, Wirtschafts- und Verwaltungswissenschaftliche Sektion
Fachbereich Wirtschaftswissenschaften

Diskussionspapiere der DFG-Forschergruppe (Nr.: 3468269275):

Heterogene Arbeit: Positive und Normative Aspekte der Qualifikationsstruktur der Arbeit

Michael Maier
Friedhelm Pfeiffer
Winfried Pohlmeier

Overeducation and Individual Heterogeneity

April 2003

Diskussionspapier Nr. 03/01
http://www.ub.uni-konstanz.de/kops/volltexte/2003/988/

Diskussionspapier der Forschergruppe (Nr.: 3468269275) “Heterogene Arbeit: Positive und Normative Aspekte der Qualifikationsstruktur der Arbeit“

Nr. 03/01, April 2003

Overeducation and Individual Heterogeneity

Michael Maier

Universität Konstanz / ZEW
Fach D124
78457 Konstanz
Germany

mail : maier@zew.de
phone : +49-7531-88-4242
fax : +49-7531-88-4450

Friedhelm Pfeiffer

Zentrum für Europäische Wirtschaftsforschung (ZEW)
Postfach 103443
68034 Mannheim
Germany

mail : pfeiffer@zew.de
phone : +49-621-1235-150
fax : +49-621-1235-225

Winfried Pohlmeier

Universität Konstanz /CoFE/ ZEW
Fach D124
78457 Konstanz
Germany

mail : winfried.pohlmeier@uni-konstanz.de
phone : +49-7531-88-2660
fax : +49-7531-88-4450

Abstract:

In this paper, the efficiency of human capital investments is evaluated in the light of inadequate educational careers and skill obsolescence. Assuming heterogeneous returns to schooling and overeducation we use the potential outcome approach to measure the causal effect of human capital investments on earnings as a continuous treatment effect.
Empirical evidence is based on a sample of West German full-time employed males from the "BIBB/IAB-Strukturerhebung 1998/99". Our estimate of the average treatment effect of an additional year of schooling (ATE) amounts to 8.7%, which does not differ much from conventional instrumental variable estimates. For skilled and high skilled workers, we find no evidence that the average returns to overeducation are lower than the average returns to required education, which differs from the evidence find in most traditional studies. There is evidence for considerable heterogeneity in the expected returns to overeducation. For 20 to 30% of the workers returns seem to be negative.

JEL Classification : C21, J24 , J31
Keywords : returns to schooling, overeducation, potential outcome approach, conditional mean independence, correlated random coefficient model
Download/Reference : http://www.ub.uni-konstanz.de/kops/volltexte/2003/947/

1 Introduction

For societies where a large proportion of education is controlled and financed by the public sector without a pricing mechanism, the optimal match between the supply of educational programs and their efficient use is of fundamental importance. In addition to unemployment caused by a mismatch of qualifications, overeducation can be regarded as another symptom for inefficient use of qualified labor[1]. In order to assess the market value of overeduction, empirical studies distinguish between the returns to required schooling and the returns to overschooling. However, they usually treat returns to education as being homogeneous across individuals and ignore that educational choices are endogenous outcomes of observable and unobservable determinants. In this paper, we stress this issue by analyzing the heterogeneous returns to overeducation within the potential outcome approach known from the econometric evaluation literature.

Since there is no clear-cut definition of overeducation there is an extensive methodological debate on the appropriate measurement for overschooling and whether objective or subjective measures are more adequate.[2] Based on the assumption of homogeneous returns to overeducation, Groot and van den Brink (2000) find in their meta-analysis of 25 econometric studies on overqualification that the estimated returns to overeducation lack robustness concerning the measurement of overeducation. Moreover, the returns to overeducation are significantly lower than the returns to required education only for an objective measure that depends on some difference measures between actual and required years of schooling in a job. The incidence and the earnings consequences of overschooling vary to a considerable degree between studies. Countries, gender, other socio-demographic factors and the definition of the overeducation measurement account for these differences. According to their meta-analysis, the returns to required education are roughly 8% in the USA and Europe.

[1]See Freeman (1976). Recent comprehensive reviews by Buechel (2001), Hartog (2000), Groot and van den Brink (2000) summarize the debate.

[2]Groot and van den Brink (2000) count two different definitions for each: The so called subjective measures rely either on a self-reported assessment of overqualification or on a comparison between a self-reported assessment of minimum educational requirements for the job and the educational attainment of the worker. The so-called objective measures rely either on the difference between average or modal educational attainment in an occupation and individual educational attainment or on a comparison between the actual educational attainment and job level requirements. Buechel and Weisshuhn (1997) develop a subjective indicator validated with objective information from occupational status and educational attainment. For more details and a comprehensive discussion of pros and cons, also compare Buechel (2001), Hartog (2000) and Sicherman (1991).

The returns to overeducation are 2.1% in Europe and 3.9% in the USA. Groot and van den Brink (2000) report that the percentage of the labor force that can be classified as overqualified amounts to 26.3% in the United States and 21.5% in Europe and that there is no incidence of a rise in overeducation in the last two decades (p. 153). Hartog (2000) also reports differences in overeducation between European countries. In this study measurement issues do not alter the general conclusion that the returns to overeducation are lower than the returns to required education. A more critical view of the framework of homogenous returns stems from Bauer (2002), who argues that most of the results for overeducation are based on cross-sectional evidence. According to his findings for Germany based on the GSOEP, the difference between returns to required education and overeducation vanishes when individual heterogeneity is controlled in the framework of a panel fixed effects estimator.

Based on a comparison of educational attainment and job level requirement in Germany, Velling and Pfeiffer (1997) find that the incidence of overeducation is inversely related to the level of educational attainment. Among university graduates, 11% were found to be overqualified. This is compared to 23% of graduates from dual vocational training. Moreover, they show that overeducation varies between academic fields and that the incidence of overeducation is higher among students from the social sciences than it is for students from natural sciences and economics. Women and workers with less experience have a higher incidence of overeducation, which seems to be in line with the international evidence (Buechel (2001), Groot and van den Brink (2000)). Blechinger and Pfeiffer (2000) find that skill obsolescence has risen significantly among German apprentices between 1979 and 1992. According to their analysis this is due to rapid technical and organizational changes in this period and correspondingly, a slow response from the officials responsible for the curricula. In addition, the study by Groot and van den Brink (2000) indicates a concentration of overeducation among low ability workers for whom the returns to overeducation are low.

The literature notes similarities between overeducation and unemployment in the sense of underutilization of skills acquired in the educational system (see Buechel (2001), Groot and van den Brink (2000), Velling and Pfeiffer (1997)). Buechel (2001) observes that overeducation exceeds unemployment rates in each industrialized country. Velling and Pfeiffer's (1997) findings suggest a positive correlation between the incidence of overeducation and unemployment. Groot and van den

Brink (2000) report from OLS estimates that unemployment lowers the returns to required schooling, but has no effect on the returns to overschooling. The causality issues between rising unemployment and prolonged education due to inflexible labor markets has, to the best of our knowledge, not been addressed in the literature so far.

Two major issues that have been raised in the recent empirical literature on human capital investment have been neglected in the context of overeducation. First, education, as well as overeducation as the individual's choice parameter are endogenous regressors in the standard earnings function. Since coefficient estimates on schooling variables can only be interpreted as causal effects of schooling on earnings if individuals had been randomly assigned to different schooling levels, standard least squares estimates are of a purely explorative nature. Therefore, their usefulness with respect to policy recommendations is limited. In order to assess the causal effect of (over-)education on earnings we therefore adopt the concept of the average treatment effect (ATE) of the earnings function developed in the econometric evaluation literature. This is used to quantify the expected earnings difference between two otherwise identical individuals if they had been assigned randomly to S and $S+1$ years of schooling, respectively. Contrary to previous studies on the ATE in standard earnings functions which rest on a control function approach we apply the conditional mean independence (CMI) approach to identify the ATE of schooling and overeducation.

Second, as a choice parameter the individual's schooling level is determined by the individual's observed and unobserved marginal benefits and costs of schooling. Thus, the return of an additional year of schooling presumably varies across individuals. The same argument also holds for the case of overeducation. In fact, one could argue that selection issues are particularly severe for overeducation since the population of the overeducated is not likely to be a randomly selected subgroup of the total population.

Our paper is organized as follows: In Section 2, we develop the idea of random returns to education based on Card's schooling model (Card, 1999). Following Wooldridge (2002), we identify the average treatment effect via conditional mean independence assumptions and show that the ATE for the continuous treatment variable schooling can be estimated by means of auxiliary regressions. Section 3 describes the data and provides information on the institutional settings in Germany. Our empirical findings are presented in Section 4, while Section 5 concludes and gives an outlook on future research.

2 The CMI Approach

Numerous studies on the returns to education emphasize that schooling is a choice variable depending on observable and unobservable factors that determine the individual's marginal costs and benefits of schooling. For the econometrician, this implies that returns to schooling is a random variable correlated with the determinants; i.e., the returns to schooling vary across individuals. These basic features are captured in Card's (1999, 2001) model of schooling and earnings which we will use in the sequel as a specification device.

The individual is assumed to choose the optimal amount of schooling, S and earnings, Y that maximize his lifetime utility depending on earnings and the disutility of schooling, $\varphi(S)$:

$$\max_{S,Y} U(S,Y) = \ln Y - \varphi(S) \text{ with } \varphi'(S) > 0 \text{ and } \varphi''(S) > 0. \tag{2.1}$$

Let the benefits of schooling (schooling-earnings relationship) be $Y = Y(S)$ with $Y'(S) > 0$. This yields the first order conditions

$$\frac{Y'(S)}{Y(S)} = \varphi'(S). \tag{2.2}$$

A linear log earnings function for schooling arises if marginal benefits are constant[3]:

$$MB \equiv \frac{Y'(S)}{Y(S)} = \beta. \tag{2.3}$$

If marginal costs are linear in schooling, then:

$$MC \equiv \frac{\varphi'(S)}{\varphi(S)} = \gamma + \kappa S, \quad \kappa > 0. \tag{2.4}$$

Optimal schooling is given by

$$S = \frac{\beta - \gamma}{\kappa}. \tag{2.5}$$

[3]Assuming a linear marginal benefit function results in a log earnings function that contains an additional quadratic schooling term.

Integration of the marginal benefit function (2.3) yields a log linear earnings function with random coefficients, an individual specific intercept and an individual specific slope coefficient:

$$\ln Y = \alpha + \beta S. \tag{2.6}$$

Intercept coefficient α captures the absolute productivity (ability) advantages of the agent. Observable factors and unobserved heterogeneity in the absolute and marginal benefits of schooling as well as factors driving the marginal costs of schooling enter the earnings function through the coefficients α, β and γ, respectively. Let α be presented by the linear predictor function

$$\alpha = \alpha_0 + X_1'\alpha_1 + \eta_\alpha, \tag{2.7}$$

where X_1 is a vector of observables and the random variate η_α captures unobserved heterogeneity in the absolute productivity term. Likewise, marginal productivity may depend on the same set of factors:

$$\beta = \beta_0 + X_1'\beta_1 + \eta_\beta, \tag{2.8}$$

while marginal cost depends on the X_1 variables as well as on additional cost driving factors X_2:

$$\gamma = \gamma_0 + X_1'\gamma_1 + X_2'\gamma_2 + \eta_\gamma. \tag{2.9}$$

Inserting (2.7) - (2.9) in the schooling equation (2.5) yields a reduced form of the schooling equation:

$$\begin{aligned} S &= \frac{1}{\kappa}\left[(\beta_0 - \gamma_0) + X_1'(\beta_1 - \gamma_1) - X_2'\gamma_2 + \eta_\beta - \eta_\gamma\right] \\ &= \pi_0 + X_1'\pi_1 + X_2'\pi_2 + \xi \end{aligned} \tag{2.10}$$

Note that the returns of an additional year of schooling is now a random variable depending on the level of schooling and the marginal costs of schooling; i.e., the returns to schooling vary across the population. The average treatment effect, ATE of an additional year of schooling is the mean across all individual returns of an additional year of schooling:

$$ATE = E\left[E[\ln Y|S = s+1, \alpha, \beta] - E[\ln Y|S = s, \alpha, \beta]\right] = E[\beta]. \tag{2.11}$$

For example, in the context of the German debate on the effects of shorter secondary schooling, it is interesting to know how much a reduction of schooling changes earnings for those with a given schooling level $S = s$. This effect is the average treatment on the treated effect (ATET) in the continuous treatment effect framework:

$$ATET = E[\beta|\beta = \kappa \cdot s + \gamma] = \frac{\int_{\beta \geq \gamma} \beta \mathrm{f}_{\beta,\gamma}(\beta, \beta - \kappa \cdot s)\, d\beta}{\mathrm{f}_{\beta-\gamma}(\kappa \cdot s)},$$

which evaluates the expected returns across all the combinations of marginal benefits and costs of schooling that imply the same optimal schooling level $S = s$.

Similar to the binary treatment effect literature for the case of a continuous treatment, one can distinguish between two approaches to the evaluation problem . Garen (1984), Heckman and Vytlacil (1998) and Wooldridge (1997) propose an IV or control function approach that makes use of control functions such as (2.7) and (2.8) to estimate the ATE from the reduced forms for earnings and schooling. The major drawback of this approach is the limited availability of reasonable exclusion restrictions (instruments) that differentiate the causal treatment effect from the selection effect.

Here, we follow a suggestion found in Wooldridge(2002, Chapter 18.5) . We estimate the average treatment effect in a random coefficient framework by assuming conditional mean independence. In this case, treatment can be ignored when conditional on a set of covariates. The ATE can be identified under these ignorability conditions if the following assumptions hold.

Identifying Assumptions for the ATE (Wooldridge (2002), p.639):

(i) Equation (2.6) holds.

(ii) For a set of covariates X, the following redundancy assumption holds:
$\mathrm{E}[\ln Y|S, \alpha, \beta, X] = \mathrm{E}[\ln Y|S, \alpha, \beta]$

(iii) Conditional on X, α and β are redundant in the first two conditional moments of S:
$\mathrm{E}[S|X, \alpha, \beta] = \mathrm{E}[S|X]$ and $\mathrm{V}[S|X, \alpha, \beta] = \mathrm{V}[S|X] > 0$

Identification condition (ii) obviously holds since the control variable X enters the earnings function through α, β and S only. The linear predictor specification used for illustrative purposes in (2.7) and (2.8) is not required to identify the ATE. In fact, the conditional mean independence approach uses identification conditions different from the control function approaches in correlated random coefficient models. Identification condition (iii) denotes that conditional on the controls, expected schooling is mean independent of α and β. Thus no new information is gained in projecting schooling if there are sufficient controls. This is the crucial identification condition (ignorability condition) needed to identify the ATE.

Proposition 2.1 (ATE)
Under the identifying assumptions the average treatment effect for all X in the relevant population is given by

$$\mathrm{E}\left[\beta\right] = \mathrm{E}\left[\frac{\mathrm{Cov}[S, \ln Y|X]}{\mathrm{V}[S|X]}\right].$$

In the following analysis, we estimate $\mathrm{V}[S|X]$ and $\mathrm{Cov}[S, \ln Y|X]$ by means of linear regression. Replacing the population parameters with the regression estimates yields a consistent estimate of the average treatment effect under the assumption of iid distributed observations:

$$\hat{\mathrm{E}}[\beta] = \frac{1}{n}\sum_{i=1}^{n}\frac{\hat{\mathrm{Cov}}[S_i, \ln Y_i|X_i]}{\hat{\mathrm{V}}[S_i|X_i]}.$$

Note that contrary to the IV or control function approach the CMI approach does not require exclusion restrictions for instrumental variables in such a way that the instruments drive the selection process (choice of the optimal years of schooling). Rather, they are uncorrelated with the error term of the structural equation. Since the ATE is nothing but the mean of the ratio of second moments and cross-moments of schooling and earnings conditional on X, more insights into the causal effects of schooling can be obtained by analyzing other distributional properties of this ratio rather than the mean.

3 Data

Our empirical study is based on a sample of full-time employed male workers from the so-called BIBB/IAB survey on educational and vocational attainment and career (BIBB/IAB (1999)).[4] The BIBB/IAB survey is a 0.1 % representative survey of German workers which has been conducted every five to six years since 1979. The last survey dates from 1998/99. The objective of the survey is to supply "differentiated, actual data on workers in Germany, their qualifications and working conditions" (Jansen and Stooss (1993)).

For our analysis, we select a sample of German male workers from the most recent survey. One advantage of the most current survey is that it contains comprehensive information on the number of years spent in the educational and vocational education system in Germany. In particular, our data contain extensive information on the successful completion of schooling levels (basic schooling, vocational and university education) and the actual years spent in the educational system to obtain the degree. Hence, our definition of the schooling variable is more closely related to the definition of an input variable than the standard definitions using either the minimum years required by the individual to receive his/her highest educational attainment or the average years of schooling necessary to attain a degree. In Germany, three major types of education systems have to be recognized: 1. The general schooling system with compulsory school attendance until the age of eighteen. This means that youths who do not find a job in the German apprenticeship system (dual vocational training system, DVTS) have to stay in the general schooling system until age 18. 2. The second system, the DVTS, provides apprentices with a mixture of theoretical schooling and practical skill-specific training (see Blechinger and Pfeiffer (2000)). 3. The university system.

As of 1995, about 70% of all German workers had been trained in the DVTS. Although the number of young people entering vocational training is declining, the DVTS remains quantitatively the most important form of training system. Note that despite considerable compulsory school attendance 15% of the workers have not received a formal vocational degree.

[4]BIBB: Federal Institute for Vocational Training, or Bundesinstitut für Berufsbildung, IAB: Institute for Labor Market and Occupational Research of the Federal Labour Office, or Institut für Arbeitsmarkt- und Berufsforschung der Bundesanstalt für Arbeit. Data collection is organized jointly by the two organisations: BIBB and IAB. The data are processed and documented by the Central Archive for Empirical Social Research, or Zentralarchiv für empirische Sozialforschung (ZA), Cologne. The BIBB, the IAB nor the ZA take any responsibility for the analysis or the interpretation of the data presented here. For more details, aims and descriptions of the four available surveys, see Dostal and Jansen (2002).

We concentrate on full-time male workers (that is, we exclude women, self-employed and part-time employed males) because we assume that men by and large, have an inelastic labor supply. With this assumption, we can disregard selection into the labor force. Furthermore, we select only workers born after 1945 who were living in West Germany at the time of the survey and had no more than two degrees from either the compulsory educational or the vocational systems. The latter selection criterion excludes roughly 5% of the workers from our analysis. In addition, we trimmed the number of schooling years variable in order to exclude the one percent of observations with the lowest and the one percent with the highest number of years spent in the compulsory educational and vocational systems.

Our earnings variable refers to the natural logarithm of monthly earnings before taxes. In the BIBB/IAB surveys, earnings is devided into 18 categories. We use the mean of each of the categories (for example, one category is from DEM 3,000 to 3,500, and we use the mean value – ln (3,250)). After a listwise deletion of incomplete observations in the explanatory variables, the sample consists of 7,722 observations. Table 1 and Table 6 of the Appendix present the summary statistics on earnings by skill group and the covariates, respectively.

Table 1: Summary Statistics of Schooling and Earnings by Skill Group

Sample	Observations		Earnings [DM]		Schooling [years]	
	Freq.	Percent	mean	std. dev.	mean	std. dev.
Overall sample	7,722	100	4,697	1,986.4	14.3	3.5
Unskilled	762	9.9	3,689	1,667.7	10.6	2.4
Vocational training	4,988	64.6	4,302	1,572.0	13.7	2.5
Foreman, senior craftsman	1,330	17.2	5,627	2,017.5	16.5	3.6
University graduate	642	8.3	7,028	2,628.3	19.7	2.7

In order to account for the institutional structure of the German educational and occupational system, we construct four groups of workers (see Table 1): workers without any formal occupational degree, workers with an apprenticeship degree (Geselle), workers with senior craftsmen qualifications (Meister) or a degree from a university of applied sciences (Fachhochschule) and workers with at least a university degree. As a standard, the years of occupational schooling for the four groups are zero, three, four and five. The overall years of standard schooling for these groups are 10, 13, 15-16 and 18.

4 Empirical Findings

As a benchmark for our estimates of the ATE based on the earnings function with correlated random coefficients, we first present two-stage least squares estimates of the earnings function with homogenous returns to schooling. The instruments used are the unemployment rate at graduation and its interaction terms with age and the squared age variable. This gives us three overidentifying restrictions. The reasoning behind the use of these instruments lies in specific institutional features of the German vocational system. By opting for the elementary vocational year (Berufsgrundbildungsjahr), youths, especially those without an apprenticeship training position, have the opportunity to prepare for vocational training by attending a full-time school year (optional as part-time school). The preparation year for vocational training (Berufsvorbereitungsjahr) basically serves the same purpose as the elementary vocational year, but in a somewhat broader sense. It prepares youths without an apprenticeship position for vocational training.[5] If unemployment reflects opportunity costs, an individual is more likely to stay in the educational system if employment prospects are low. This argument seems particularly relevant for the case of Germany where tuition and fees for general schooling and vocational training are rare exceptions or negligible.

Table 2 presents the reduced form estimates for the schooling equation. Given the large value of the F-Test (195.84) we can reject the null of weak instruments in terms of the relative 2SLS bias ($> 10\%$) and the actual size of the 2SLS t-test ($> 15\%$) according to the critical values presented in Stock, Wright, and Yogo (2002). The unemployment rate at graduation has a significant impact on the schooling level, and its impact varies across cohorts. Our specification explains 36% of the variation in schooling in the sample. Using the Hausman test (auxiliary regression specification), we have to reject the hypothesis that schooling can be treated as an exogenous explanatory variable.

[5] Also see Franz, Inkmann, Pohlmeier, and Zimmermann (2000) for a study on the impact of vocational training on youth unemployment duration.

Table 2: Reduced Form Estimates of the Schooling Equation

Variable*	β	t value
Experience	-.330	-16.65
Experience squared	-.003	-4.96
Handicapped	-.300	-1.78
Age	.267	2.43
Age squared	.003	2.12
Unemployment ratio at graduation	-.331	-1.10
Unemployment ratio at graduation $*$ Age	.028	1.79
Unemployment ratio at graduation $*$ Age squared	.000	-1.41
Sector (Manufacturing)		
Craft	-.354	-3.45
Trade	-.136	-1.14
Public Service	.951	10.62
Agriculture	-.038	-0.11
Others	.375	3.32
Firm size (large)		
small (<49)	-.400	-4.28
medium (50 - 499)	-.285	-3.31
City size (large)		
small (<20,000)	-.119	-1.37
medium (20,000 - 100,000)	.083	0.98
Federal state (NRW)		
Schleswig Holstein and Lower Saxony	.028	0.27
Hamburg and Bremen	.290	1.54
Rhineland-Palatinate, Hesse and Saarland	-.027	-0.26
Baden Wuerttemberg and Bavaria	-.047	-0.53
West Berlin	-.831	-4.45
Constant	6.685	2.94
N = 7,722		
F(22, 7,699) = 195.84		
$R^2 = 0.36$		

*Base categories for the dummy variables in brackets.

Dependent variable: Years of schooling

Data source: BIBB/IAB survey on educational and vocational attainment and career 1999

The 2SLS estimates of the fixed coefficient earnings function are given in Table 3. In addition to the typical covariates schooling, experience and experience squared, we use sectoral dummies, regional dummies, firm size and a dummy variable for handicapped workers as additional controls. The return to an additional school year is 8.3%, which is in line with the international evidence reported by Groot and van den Brink (2000) and Pfeiffer (2000). Ignoring the endogeneity of schooling by estimating the equation using ordinary least squares results in a lower estimate of 4.2% (see Table 7 in the Appendix). These differences confirm the international evidence that the return rates obtained from instrumental variable estimators are above the ones from ordinary least squares.[6]

[6] See Card (2001) for a comparison of recent empirical studies.

Table 3: 2SLS Estimates of the Earnings Equation

Variable*	β	t value
Schooling	.083	33.57
Experience	.030	18.09
Experience squared	.000	-9.48
Handicapped	-.039	-1.88
Sector (Manufacturing)		
Craft	-.050	-3.86
Trade	-.028	-1.86
Pubilc Service	-.094	-8.01
Agriculture	-.244	-5.67
Others	.012	.85
Firm size (large)		
small (<49)	-.110	-9.49
medium (50 - 499)	-.031	-2.89
City size (large)		
small (<20,000)	.019	1.81
medium (20,000 - 100,000)	-.015	-1.46
Federal state (NRW)		
Schleswig Holstein and Lower Saxony	-.049	-3.81
Hamburg and Bremen	-.095	-4.06
Rhineland-Palatinate, Hesse and Saarland	-.025	-1.94
Baden Wuerttemberg and Bavaria	-.020	-1.80
West Berlin	-.068	-2.93
Constant	6.92	159.9
N = 7722		
F(18, 7703) = 132.19		
$R^2 = 0.2360$		
Hausman test ($N(0,1)$) = 20.76		

*Base categories for the dummy variables in brackets.

Dependent variable: Logarithm of wage

Data source: BIBB/IAB survey on educational and vocational attainment and career 1999

The estimates of the expected rate of return to an additional year of schooling based on the random coefficient model are reported in Table 4. In the first line of Table 4, we report the ATE using all observations. Outliers turn out to have a strong effect on the estimates of the ATE. Therefore, we also present estimates based on a trimmed sample, where we drop observations below the 1% and above the 99% quantiles of overall sample. Since trimming obviously leads to more plausible estimation results, we discuss the estimation results in the sequel based on the trimmed sample only. The potential outcome approach reveals an average treatment effect of an additional year of schooling (ATE) at 8.7% which is significantly different from zero. This estimate does not differ much from the 2SLS results reported above. Angrist and Imbens (1995) show that for models with variable treatment intensity, the 2SLS estimator identifies a weighted average of the treatment effect in the population whose educational attainment was changed by the instrument. Hence, there is no reason to expect *ex ante* quantitatively similar estimates. Using a control function approach, Deschenes (2002) also estimates the ATE within a correlated random coefficient framework for the US. He obtains a value of 16.2%, which is slightly lower than his 2SLS estimate.

Table 4: Estimates of the ATE

$\hat{\mathrm{E}}[\beta]$	t value	Quantiles					
		10%	25%	50%	75%	90%	
1.060	1.22	-.103	.005	.076	.158	.294	without trimming
.087	29.94	-.091	.007	.076	.156	.283	trimmed

The quantiles of the individual return rates reported in Table 4 reveal that the impact of educational attainment on earnings is far from being homogeneous. For a quarter of the individuals, the causal return rate is more than 15.6%, and for the 90% quantile, it is 28.3%. On the other hand, for a quarter of the individuals there are very low or even negative causal return rates. For example, negative return rates may result from a restricted entry into the labor market, in which case education serves as means of bridging over waiting queues in times of unemployment. They can be the result of a suboptimal matching between heterogenous students and teaching institutions as well. More descriptive evidence on the distribution of the heterogenous returns is given by the kernel density estimate depicted in Figure 1. The estimated distribution of β turns out to be slightly skewed to the right.

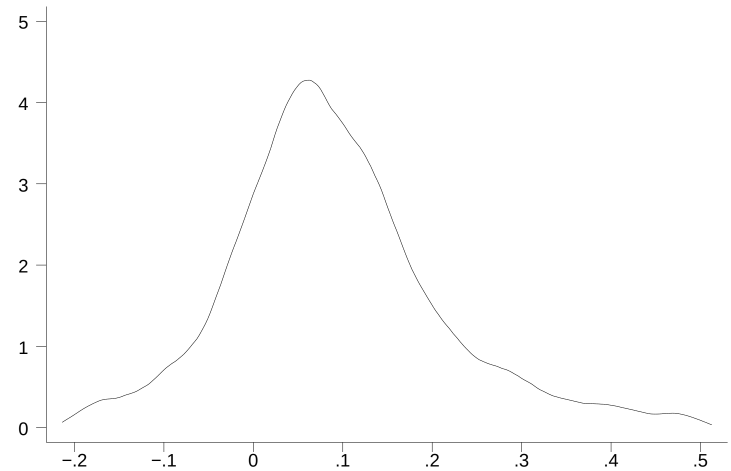

Figure 1: Kernel density estimates of the random return rate β

In our analysis of the rates of return to overeducation, we assume that the returns to required schooling, i.e., the return to the minimum educational attainment legally required to work in the individual's actual profession, may differ from the returns that an individual obtains from educational attainment beyond the required level. Let S denote actual schooling and S_r be required schooling. Then, $S_o = S - S_r \geq 0$ defines overeducation. Distinguishing between the two rates of return yields the following correlated random coefficient earnings function:

$$E[\ln Y|S_r, S, \alpha, \beta_r, \beta_o] = \alpha + \beta_r S_r + \beta_o(S - S_r), \tag{4.1}$$

where β_r is the return to required schooling and β_o is the rate of return to overeducation. Considering (4.1) for a given level of required schooling s_r results in a standard correlated random coefficient specification for the subgroup of individuals with schooling level s_r:

$$E[\ln Y|S_r = s_r, S, \alpha, \beta_r, \beta_o] = \alpha_o + \beta_o S, \tag{4.2}$$

where $\alpha_o = \alpha + (\beta_r - \beta_o)S_r$. Hence $E[\beta_o]$ is the average treatment effect of an additional year of overeducation for individuals with required schooling level s_r. Moreover, our approach does not require an explicit definition of required schooling which may otherwise be a source of an errors in variables problem. On the other hand no explicit parameter for the returns of overeducation can be obtained. Since required schooling is treated as given, our approach to estimating the ATE of overeducation neglects the process of selection determining the required schooling level.

The estimation results for the returns of overeducation for four different employment groups are given in Table 5. The estimates of the expected returns to overeducation by and large seem to be inversely related to skill level. The higher the educational skills in the employment group under study, the higher the returns to overeducation. The estimates of the expected returns to overeducation are not statistically different from zero for the low skilled workers. This is in line with findings based on traditional returns estimates (see Groot and van den Brink (2000)). In fact, for the largest group of workers with vocational training, our findings suggest that the average returns to required education and overeducation are rather similar.

Table 5: Estimates of the ATE to Overeducation

	without trimming		trimmed	
Group	$\hat{E}[\beta]$	t value	$\hat{E}[\beta]$	t value
Unskilled	.093	0.83	.049	1.18
Vocational training	.069	1.29	.082	23.25
Foreman, sen. craftsman	.054	2.94	.061	12.58
University graduates	.384	2.34	.237	7.66

There is no evidence that the average returns to overeducation are lower than the returns to required education for university graduates. Since we are not able to control for the required length of academic programs, the high returns to overeducation for the university graduates pick up fixed effects. Provided that the length of academic programs is positively related to earnings, our estimates of the return to an additional year of academic education also capture the potential effect of a change of the academic program rather than the pure effect of extending the study in the same program.

In summary, our findings for German males suggest that the returns to overeducation are similar to returns to required education and therefore, "overeducation" seems to be a rational investment strategy used by the skilled. Only in the unskilled group are the returns to overeducation indeed very low on average. Equally important is the finding that there is considerable individual heterogeneity in the returns to education and to overeducation. The assumption on heterogeneous effects of overeducation on earnings provides a richer, more realistic picture than an analysis under the traditional homogeneity assumption. In particular, it provides valuable insights into efficiency aspects of various institutions of the education system. For a considerable share of workers in all skill groups (20 - 30%) the expected return to an additional year of overeducation seems to be negative and for a share of 20% or more, returns are very high. Additional educational attainment seems to be particularly rewarding in terms of an earnings increase for the university graduates.

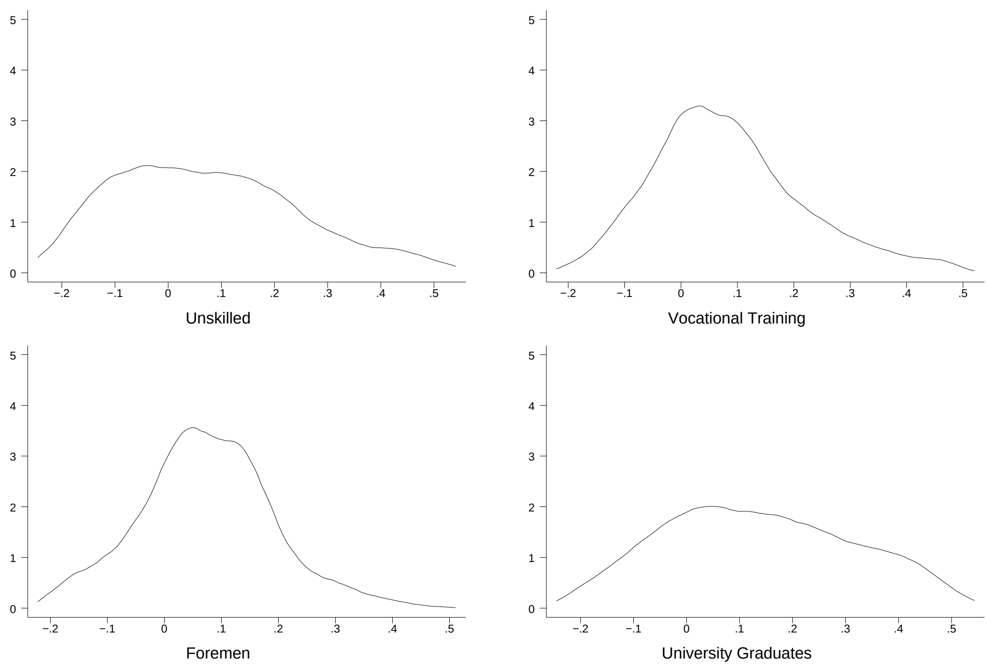

Figure 2: Kernel density estimates of the random return rate to overeducation by skill group

Figure 2 depicts the distribution of the returns to overeducation for the four skill groups. Visual inspection suggests that the distributions are not that different for the two medium skill groups. In these two groups, skill-specific education dominates with standardized curricula in firms and in school-related education. For the unskilled and the high skilled, however, the distribution is less compressed. That either reflects the higher degree of heterogeneity in the effectiveness of education for these groups or the higher degree of heterogeneity of the education acquired by these groups. Since the data provide no information of institutional diversity we cannot distinguish these two reasons for heterogeneity empirically.

5 Conclusions

In this paper, we analyzed the efficiency of human capital investments in the light of inadequate educational careers and skill obsolescence based on the potential outcome for continuous treatments. Empirical studies on the returns to overeducation usually treat schooling and overeducation as exogenously given rather than as the outcome of an individual's investment decision. Moreover, the return of an additional year of schooling is taken to be the same across individuals. This neglects the fact that unobserved heterogeneity in the benefits and the costs of schooling may generate individually different return rates. Here, we analyze the causal effect of schooling on earnings taking into account the heterogeneity of individual returns using a correlated random coefficient earnings function. Our estimate of the average causal effect of an additional year of schooling is 8.7%, which is close to the two stage least square estimate of the rate of return in a traditional fixed coefficient earnings function, but considerably higher than the least squares estimate.

We find that heterogeneity in the returns does matter and that the monetary benefits of an additional year of schooling vary largely across the population. For 20 to 30% of the male workers in our sample, an additional year of schooling yields negative returns. For more than 25%, the returns are above 15%. Negative return rates may result from restricted entry into the labor market in which case education is a means of bridging over waiting queues in times of unemployment, for example. The large positive returns may result from individual differences in learning abilities, educational costs and educational quality, for example. More research is needed to disentangle the sources of individual heterogeneity.

From our samples of skilled and high skilled German male workers there is no evidence that the average returns to overeducation are lower than the average returns to required education. As summarized in the introduction, this seems to differ from the evidence found in most traditional studies. "Overeducation" should be viewed as a rational investment strategy, especially by a large part of the group of skilled workers. Only in the group of unskilled are the average returns to overeducation very low indeed. This seems to confirm international findings. However, there is evidence for considerable heterogeneity in the expected returns to overeducation as well as to required education. For 20 to 30% of the workers returns seem to be negative and investments seem to be wasted.

Since there is little practical experience with the CMI approach applied to correlated random coefficient models, our results, although plausible, should be treated with caution. More evidence based on other data is clearly needed to evaluate the robustness of the results and the virtues of the new econometric technique. Our findings should also be confronted with results obtained by alternative estimation approaches (e.g. control function approaches to the correlated random coefficient model). For policy analysis, other treatment effects such as the effect of treatment on the treated, the treatment on the nontreated and the local average treatment effect should also be evaluated.

References

Angrist, J. D., and G. W. Imbens (1995): "Two-Stage Least Squares Estimation of Average Causal Effects in Models with Variable Treatment Intensity," *Journal of the American Statistival Association*, 90, 431 – 442.

Bauer, T. (2002): "Educational Mismatch and Wages: A Panel Analysis," *Economics of Education Review*, 21, 221 – 229.

BIBB/IAB (1999): *Erwerb und Verwertung beruflicher Qualifikationen von Erwerbstaetigen. BIBB/IAB Strukturerhebung 1998/99. Erhebungsmaterialien zur Hauptstudie.* BIBB, Berlin.

Blechinger, D., and F. Pfeiffer (2000): "Technological Change and Skill Obsolescence: the Case of German Apprenticeship Training," in *Education and Training in a Knowledge-Based Economy*, ed. by H. Heijke, and J. Muysken, pp. 243–276. St. Martin's Press, New York.

Buechel, F. (2001): "Overqualification: Reasons, Measurement Issues and Topological Affinity to Unemployment," in *Training in Europe. Second Report on Vocational Training Research in Europe 2000: Background Report*, ed. by P. Descy, and M. Tessaring, pp. 453 – 560, Luxembourg. CEDEPFOP Reference Series.

Buechel, F., and G. Weisshuhn (1997): *Ausbildungsinadaequate Beschaeftigung der Absolventen des Bildungssystems. Berichterstattung zu Struktur und Entwicklung unterwertiger Beschaeftigung in West- und Ostdeutschland*, Volkswirtschaftliche Schriftenreihe, 471. Duncker & Humblot, Berlin.

Card, D. (1999): "The Causal Effect of Education and Earnings," *Handbook of Labour Economics*, 3, 1801–1863.

——— (2001): "Estimating the Returns to Schooling: Progress on Some Persistent Econometric Problems," *Econometrica*, 69 (5), 1127–1160.

Deschenes, O. (2002): "Estimating the Effects of Family Background on the Return to Schooling," paper presented at the Econometric Society European Meeting (ESEM), Venice, August 2002.

Dostal, W., and R. Jansen (2002): "Qualifikation und Erwerbssituation in Deutschland - 20 Jahre BIBB/IAB Erhebungen," *Mitteilungen aus der Arbeitsmarkt- und Berufsforschung (MittAB), 35(2)*, pp. 232–253.

Franz, W., J. Inkmann, W. Pohlmeier, and V. Zimmermann (2000): "Young and Out in Germany: On Youths' Chances of Labor Market Entrance in Germany," in *Youth Employment and Joblessness in Advanced Countries*, ed. by D. G. Blanchflower, and R. B. Freeman, chap. 10, pp. 381–425. The University of Chicago Press.

FREEMAN, R. (1976): *The overeducated American*. Academic Press, New York.

GAREN, J. (1984): "The Returns to Schooling: A Selectivity Bias Approach with a Continous Choice Variable," *Econometrica*, 52, 1199 – 1218.

GROOT, W., AND H. M. VAN DEN BRINK (2000): "Overeducation in the labor market: a meta-analysis," *Economics of Education Review*, 19(2), 149–158.

HARTOG, J. (2000): "Over-education and earnings: where are we, where should we go?," *Economics of Education Review*, 19(2), 131–147.

HECKMAN, J. J., AND E. VYTLACIL (1998): "Instrumental Variables Methods for the Correlated Random Coefficient Model: Estimating the Rate of Return to Schooling When the return is Corelated with Schooling," *Journal of Human Resources*, 23, 974–987.

JANSEN, R., AND F. STOOSS (1993): *Qualifikation und Erwerbssituation im geeinten Deutschland: BIBB/IAB Erhebung 1991/92*. Bundesinstitut fuer Berufsbildung, Berlin.

PFEIFFER, F. (2000): "Aufwand und Ertrag: Daten und Fakten zur Bildung in Deutschland und in Europa," in *Rohstoff Bildung*, ed. by K. Morath, pp. 11 – 26. Frankfurter Institut - Stiftung Marktwirtschaft und Politik.

SICHERMAN, N. (1991): "Overeducation in the Labor Market," *Journal of Labor Economics*, 9, 101 – 122.

STOCK, J. H., J. H. WRIGHT, AND M. YOGO (2002): "A Survey of Weak Instruments and Weak Identification in Generalized Method of Moments," *Journal of Business and Economic Statistics*, 20, 518 – 529.

VELLING, J., AND F. PFEIFFER (1997): *Arbeitslosigkeit, inadaequate Beschaeftigung, Berufswechsel und Erwerbsbeteiligung*. ZEW Dokumentation Nr. 97-02, Mannheim.

WOOLDRIDGE, J. M. (1997): "On Two Stage Least Squares Estimation of the Average Treatment Effect in a Random Coefficient Model," *Economics Letters*, 56, 129 – 133.

——— (2002): *Econometric Analysis of Cross Section and Panel Data*. MIT Press, Cambridge, MA.

A Appendix

Table 6: Summary Statistics of the Covariates

	Sample									
Variable	Overall		Unskilled		Voc. training		Foremen		Univ. Grad.	
	mean	std. dev.	mean	std. dev.	mean	std. dev.	mean	std. dev.	mean	std. dev.
Age	37.47	8.352	36.72	9.017	36.72	8.438	39.762	7.565	39.422	7.168
Age squared	1474	629.5	1430	662	1420	629.1	1638	600.4	1605	573
Experience	18.68	9.46	18.55	10.16	19.00	9.38	20.32	8.93	12.94	8.09
Experience squared	438.4	374.0	447.2	395	449.1	377.4	492.7	369.5	232.7	242.5
Handicapped	.038	.191	.050	.218	.038	.192	.038	.192	.017	.130
Sector										
Manufacturing	.318	.466	.357	.479	.333	.471	.283	.450	.226	.418
Craft	.213	.409	.234	.423	.265	.441	.103	.304	.009	.096
Trade	.103	.303	.115	.320	.121	.327	.045	.208	.059	.236
Public Service	.232	.422	.126	.332	.160	.363	.450	.498	.494	.500
Agriculture	.009	.094	.022	.148	.008	.090	.006	.077	.005	.068
Others	.120	.325	.134	.341	.110	.313	.110	.313	.201	.401
Firm size										
small	.414	.493	.460	.499	.450	.498	.298	.457	.321	.467
medium	.341	.474	.331	.471	.318	.466	.409	.492	.399	.490
big	.229	.420	.188	.391	.216	.411	.285	.452	.271	.445
City size										
small	.360	.480	.297	.457	.383	.486	.334	.472	.305	.461
medium	.276	.447	.280	.449	.275	.447	.295	.456	.234	.423
big	.365	.481	.424	.494	.341	.474	.371	.483	.461	.499
Federal state										
Schleswig Holstein and Lower Saxony	.160	.367	.150	.357	.170	.375	.130	.337	.162	.369
Hamburg and Bremen	.033	.180	.034	.182	.032	.178	.032	.177	.040	.197
North-Rhine Westphalia	.286	.452	.311	.463	.276	.447	.308	.462	.293	.455
Rhineland-Palatinate, Hesse and Saarland	.166	.372	.138	.345	.161	.367	.189	.391	.190	.393
Baden Wuerttemberg and Bavaria	.320	.467	.302	.459	.326	.469	.320	.467	.294	.456
West Berlin	.034	.182	.066	.248	.035	.184	.021	.144	.020	.141
Unemployment ratio	4.16	2.83	4.26	2.97	4.24	2.83	3.76	2.76	4.28	2.71
Number of observations	7,722		762		4,988		1,330		642	

Table 7: LSE of the Earnings Function: Fixed Coefficient Model

Variable*	β	t-Value
Schooling	.042	34.32
Experience	.028	17.05
Experience squared	.000	-10.83
Handicapped	-.054	-2.60
Sector (manufacturing)		
craft	-.085	-6.73
trade	-.036	-2.43
service	-.025	-2.25
agriculture	-.248	-5.79
others	.053	3.76
Firm size (large)		
small	-.124	-10.71
medium	-.039	-3.65
City size (large)		
small	.004	0.40
medium	-.020	-1.91
Federal state (NRW)		
Schleswig Holstein and Lower Saxony	-.046	-3.55
Hamburg and Bremen	-.086	-3.66
Rhineland-Palatinate, Hesse and Saarland	-.023	-1.81
Baden Wuerttemberg and Bavaria	-.028	-2.52
West Berlin	-.110	-4.77
Constant	7.57	284.60
N = 7,722		
F(18, 7703) = 135.44		
$R^2 = 0.24$		

*Base categories for the dummy variables in brackets.
Dependent variable: Logarithm of wage
Data source: BIBB/IAB survey on educational and vocational attainment and career 1999