

Fitzenberger, Bernd; Hujer, Reinhard; MaCurdy, Thomas E.; Schnabel, Reinhold

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The dynamic structure of wages in Germany 1976 - 1984: A cohort analysis

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Forschungsschwerpunkt
“Internationale Arbeitsmarktforschung”

Center for International Labor Economics
(CILE)

Fakultät für Wirtschaftswissenschaften und Statistik
Universität Konstanz

Bernd Fitzenberger
Reinhard Hujer
Thomas E. MaCurdy
Reinhold Schnabel

The Dynamic Structure of Wages
in Germany 1976-1984
A Cohort Analysis

12. APR. 1995 Weltwirtschaft
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Postfach 5560 D 139
78434 Konstanz
Deutschland / Germany

Diskussionspapier
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**The Dynamic Structure of Wages in Germany
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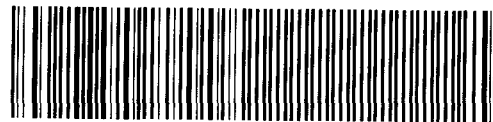
Bernd Fitzenberger

Reinhard Hujer

Thomas E. MaCurdy

Reinhold Schnabel

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Diskussionspapier

Nr. 22

März 1995

The Dynamic Structure of Wages in Germany 1976-1984

A Cohort Analysis

Bernd Fitzenberger*

Reinhard Hujer**

Thomas E. MaCurdy***

Reinhold Schnabel****

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ABSTRACT

Based on social security data, this paper analyzes wage trends for full employed males by estimating (censored) quantile regressions as functions of age, cohort, education, and year. We test whether a parsimonious specification separating life cycle effects from macroeconomic effects can describe the dynamics of wages. Our results indicate that insider wages are uniformly affected by a macroeconomic trend. For some education groups, this also holds for entry wages. Since within-inequality stays fairly constant, the estimated profiles characterize the entire wage distribution. After controlling for age and cohort, also wage differentials across education remain roughly stable.

Keywords: wage inequality, cohort analysis, decomposition of life cycle profile and time trend, quantile regressions, censoring.

This work originated at Stanford University in the years 1991 and 1992. The processing of the raw data and parts of the computation have been performed at the Institut für Arbeitsmarkt- und Berufsforschung (IAB) in Nürnberg. We thank the IAB for providing the data and we are particularly indebted to Lutz Bellmann for supporting this research.

* Universität Konstanz, ** Johann Wolfgang Goethe-Universität, Frankfurt am Main, *** Stanford University, and **** Universität Mannheim.

Mail concerning this paper should be sent to: Bernd Fitzenberger, Department of Economics and Statistics, University of Konstanz, P.O. Box 5560 <D139>, 78434 Konstanz, Germany. Email: fitzenbe@sonne.wiwi.uni-konstanz.de

1. INTRODUCTION

A widely discussed issue in Germany has been, whether in the face of negative supply shocks, the sharp increase in unemployment during the early 1980s was caused, or at least aggravated, by inflexible wages.¹ A common perception is that due to the wage bargaining process (union bargained wages apply to all workers in an industry, with only small regional variation) wages are more inflexible in Germany than in other countries, especially in contrast to the United States. To approach this issue, one can differentiate between flexibility of the aggregate (average) level of wages and flexibility of the structure of wages across industries, qualifications, or other socioeconomic variables.²

Aggregate wages seem to display procyclical behavior, but it is unclear to what extent this is an artefact due to labor force composition effects. During the cyclical recovery in the 1980s, Germany experienced moderate wage increases but the unemployment level remained fairly stable. This is often attributed to the stickiness of the *wage structure*.³ Supply or demand shocks having a different impact on different types of labor can generate unemployment, if relative wages are inflexible, even though they might not require an adjustment of the average wage level. This raises the question whether relative wages are in fact inflexible for Germany. In a recent study, Abraham and Houseman (1993a) find that education-specific wage differentials remained fairly constant in Germany during the period of 1976 to 1988. Bellmann and Buttler (1989, p. 210-212), on the contrary, find that the qualification structure of wages changed somewhat, namely that wage dispersion decreased in the period 1976 to 1984, corresponding to the concern of the policy debate at the time of the article that a compression of the wage structure had occurred in Germany during the 1970s and 1980s. However, the analysis by Bellmann and Buttler also suggests that wages of labor market entrants fell relative to older workers, thus the authors conclude that this supports the

¹ For a general description of Germany's unemployment experience in the 1970s and 80s, see Abraham and Houseman (1993b), chapter 3, and Franz (1994), chapter 9. The relationship between wage flexibility and unemployment has been discussed extensively in the economic policy debate, cf. among others Abraham and Houseman (1993b), pp. 49 - 52, OECD (1993), and Sachverständigenrat (1988, 1993, and 1994).

² Cf. Bellmann and Möller (1993) for a recent study on the interindustry wage structure in Germany.

³ Cf. for instance the analysis in Sachverständigenrat (1988, 1993, and 1994).

view of fixed insiders' versus flexible entrants' wages.

Various trends in labor supply could affect the wage structure. An important demographic factor lies in the baby boom generation consisting of cohorts born between 1950 and 1970 with a maximum number of births in 1964, i.e., later than in the United States. Other potential factors are the increased labor force participation of women, changes in immigration patterns, and the increase in the educational attainment of the labor force. In our empirical approach, we investigate, whether the cohorts entering the labor market in the period of 1976 to 1984 face depressed entry wages relative to previous cohorts and, whether wage growth is uniform over time across cohorts.

Our paper fits into a series of recent studies which have analyzed the trends in relative wages in various industrialized countries during the 1970s and 80s, documenting the growth of wage inequality in several dimensions.⁴ Katz and Murphy (1991) list the following stylized facts of wage trends in the United States: (i) the relative wages of more educated workers exhibit a decline during the 70s and a substantial increase in the 80s, (ii) the relative wages of older workers increase sharply among workers without a college degree during the 70s and 80s, but only during the 70s among workers with a college degree, (iii) the relative wages of females stayed more or less constant in the 70s and increased during the 80s, and (iv) wage inequality within gender, education, and age groups rises continuously during the 70s and 80s.⁵ Katz and Murphy discuss supply and demand factors which could potentially explain the observed trends. The baby boom and immigration may have increased the relative supply of unskilled labor. Skill biased technological change and an intensified international competition may have increased the relative demand for skilled labor. Further issues raised in the literature relate to institutional changes, namely the decline of unionism and the decline of real minimum wages in the United States during the 80s.

The inability to discriminate sharply between different hypotheses for the United States motivated recent cross-country studies⁶, since some but not all of the hypotheses are relevant to all industrialized countries. While Davis (1992) finds similar trends in wage

⁴ Cf. among others Borjas et al. (1991), Bound and Johnson (1992), Buchinsky (1994), Chamberlain (1994), Davis (1992), Katz and Murphy (1991), MaCurdy and Mroz (1991), Murphy and Welch (1992), and OECD (1993).

⁵ Finding (iv) is questioned in the study by MaCurdy and Mroz (1991), who do not find an increase in wage-inequality in a given age-education cell for male workers.

⁶ Cf. among others Davis (1992), Katz et al. (1993), and Katz and Revenga (1989).

inequality for almost all of the industrialized countries, which he rationalizes within a framework where relative factor prices converge across countries due to more intensive trade, Abraham and Houseman (1993a) find different patterns for Germany compared to the United States. Also Katz et al. (1993) and Katz and Revenga (1998) find country specific developments, e.g. in France and Japan, which they attribute to different institutions compared to the United States. Their analysis concludes that these institutional differences inhibited the supply and demand factors to operate the same way as they did in the United States.

In this study, we employ a framework developed by MaCurdy and Mroz (1991) in order to estimate dynamic age-earnings profiles from cohort specifications. We estimate the earnings profiles of different education groups as functions of age, cohort, and year, and test whether a parsimonious parameterization which implies additivity of age, cohort, and year effects is supported by the data. If so, year effects are common to all ages (and thereby cohorts) and may be interpreted as pure macroeconomic shifts in wages. Also, if age effects are common to all cohorts they may be interpreted as life cycle profiles that reflect pure individual aging. Based on the estimates, we can also construct time profiles that reflect macroeconomic wage growth and cyclical variation. Our empirical analysis uses wage data of male employees from a random sample of social security accounts (the German "Beschäftigtenstatistik") for the years 1976 to 1984. In order to handle the censoring of wages in our data we employ either quantile regressions based on data being grouped by education, year, and age, when the quantiles can be computed directly, or censored quantile regressions, when censoring is too severe.

Our empirical approach extends upon available studies for Germany in several dimensions. First, in using a cohort specification we are able to differentiate between changes in the "true" life cycle profile of wage from cohort effects when finding changes in the relative wage position of workers at different ages. Second, since we control for education, age, and cohort, we are able to decompose an observed trend in aggregate wage inequality in various "between-" and "within-"effects holding the other characteristics constant. Third, by testing whether a parsimonious specification describes the important features of the data, we are able to infer whether there are significant changes in the wage structure in different dimensions. And fourth, in those cases for which we can show that wage percentile differences within age-education classes do not change over time, our estimated profiles for

the median and the 25%-percentile describe the trends operating for the entire wage distribution.

Our empirical results show in fact that real wage profiles are separable into an age and a time component and that, as a consequence, the time (macro) trend uniformly affects the wage growth of insiders. Moreover, our results indicate that entry wages of young cohorts entering in our sample period grow at the same rate as insider wages. Nevertheless, we find some evidence for lower wages of younger workers relative to older workers for intermediate education levels. Apart from cyclical changes, the education differentials appear to be fairly constant over the sample period. Finally, we show that the inequality within cohorts of the same educational attainment is fairly constant so that the estimated wage profiles are for the most-part representative for the entire wage distribution.

The remainder of the paper is organized as follows: In the next section we present our empirical framework to analyze wage profiles. Section 3 describes the data set used. In section 4, we discuss the estimation and testing procedures and present the empirical results. Section 5 concludes.

2. EMPIRICAL FRAMEWORK

The empirical framework presented in this section was first developed in MaCurdy and Mroz (1991). We denote the age of an employee by α and the calendar time by t . A specific cohort can be defined by the year of birth or the year of labor market entry and it is denoted by c . If a cohort indicates the birth year the following identity links the three quantities age, cohort and calendar year:

$$(2-1) \quad t = c + \alpha$$

This linear relation between age, cohort and calendar year implies that separate linear effects of age, cohort, and time on wages can not be identified without arbitrary restrictions - a well known problem discussed in the literature (Heckman and Robb, 1985). Consequently, the profiles of wages may be expressed as a function of age and cohort-membership in the following way:

$$(2-2) \quad \ln[w(c, \alpha)] = g(c, \alpha) + u$$

where $g(c, \alpha)$ designates the systematic trend and u is a stochastic term, expressing deviations from this trend, as for cyclical shifts.

Holding the cohort constant yields the profile experienced by a specific cohort over time. This is often called a "life-cycle-profile", because it reflects the wage dynamics over the cohort's life-cycle. But as a cohort ages also the economy develops over time. Thus, this profile reflects two effects: life-cycle wage growth due to aging and macroeconomic (intertemporal) shifts in wages.

The wage growth of a given cohort c in year t (resp. at age α) is described by the partial derivative of g with respect to t (resp. α):

$$(2-3) \quad \frac{\partial g}{\partial t} \Big|_c = \frac{\partial g}{\partial \alpha} \Big|_c \equiv g_\alpha(c, \alpha) \equiv g_\alpha$$

Alternatively, holding age constant yields the change of wages earned by different cohorts at specific ages. For the age of labor market entry, α_e , this yields the growth rate of entry wages obtains. The corresponding profile of entry wages also comprises two effects: a cohort effect and a macroeconomic (time) effect.

$$(2-4) \quad \frac{\partial g}{\partial t} \Big|_{\alpha=\alpha_e} = \frac{\partial g}{\partial c} \Big|_{\alpha=\alpha_e} \equiv g_c(c, \alpha_e) = g_c(t - \alpha_e, \alpha_e) \equiv e(t)$$

Using the relation (2-1), the profiles of wages may also be described by the function

$$(2-5) \quad g(t - \alpha, \alpha) \equiv f(t, \alpha)$$

The different parameterizations $g()$ and $f()$ are equivalent representations of the same wage profiles. For a fixed year t , the function $f(t, \alpha)$ yields the cross-section profiles, in the literature often denoted as "age-earnings-profiles". Holding age constant gives the profiles of wages earned by different cohorts over time. Aggregating $f(t, \alpha)$ over ages yields an aggregate wage trend for the economy. Again note that this may also be "contaminated" by cohort effects (like the age composition of the labor force). For instance, a decreasing aggregate wage index may very well be compatible with increasing wages for each individual.

If the wage growth can be characterized as the sum of a pure aging effect and a pure time effect in the following way:

$$(2-6) \quad g_{\alpha} = a(\alpha) + b(t)$$

the life-cycle wage growth is independent of the calendar year t . This means that each cohort faces the same wage growth over the life-cycle due to aging. In addition, economy wide growth shifts are common to all cohorts in the same year but they occur at different points during the life-cycle of different cohorts. If the separability condition (2-6) holds, a life-cycle wage profile (a macro time trend) can be constructed independent of the calendar year (age). Obviously, this property does not exclude cohort-specific wage levels. A main point of our empirical analysis is to test this separability property which does not rely on arbitrary identification conditions.

Integrating back the derivative condition (2-6) with respect to α yields an additive form for the systematic component of the wage function $g(c, \alpha)$:

$$(2-7) \quad g(c, \alpha) = G + K(c) + A(\alpha) + B(c + \alpha)$$

where G is the constant of integration. At a given point in time, the wages of cohorts differ only due to the age-effect ($A(\alpha)$) and a cohort-specific level which is determined by $K(c)$ which stays the same for each cohort over the entire life-cycle. We call this property "uniform insider wage growth hypothesis" which we denote as H_{UI} . While condition (2-6) makes a statement on the uniformity of wage growth across cohorts it leaves the wage level unspecified.

If in addition to the uniform wage growth across cohorts, the growth of entry wages equals the macroeconomic wage growth

$$(2-8) \quad e(t) = b(t)$$

we obtain a stronger hypothesis which we call the "uniform wage growth hypothesis" denoted as H_U .

In order to test the implications of H_{UI} and H_U , we specify an estimable version of the wage function. In particular, this requires specifications of equation (2-2) such that it contains the two hypotheses as special cases. A general regression equation for the wage of individual i in the sample year t corresponding to equation (2-2) can be written as:

$$(2-9) \quad \ln w_{i,t} = g(c_i, \alpha_{i,t}) + \bar{u}_t + u_{i,t}$$

where α_{it} and c_i denote the age of individual i at time t , and the cohort of individual i , respectively. We further decompose the error term into a period specific effect u_t and a stochastic error term u_{it} . In the empirical analysis α equals (age - 25)/10 and the time t equals (calendar year - 1976)/10. Thus, c is the time at which α equals zero. For the cohort of age 25 in the year 1976, c equals zero and older cohorts have negative values for c .

As an empirical approximation of the wage profile imposing the hypothesis of uniform insider wage growth, we use polynomials in age, cohort and time of various degrees:

$$\begin{aligned}
 A(\alpha) &= A_1 \alpha + A_{(2)}(\alpha) \\
 &= A_1 \alpha + A_2 \alpha^2 + \dots \\
 B(t) &= B_1 t + B_{(2)}(t) \\
 &= B_1 t + B_2 t^2 + B_3 t^3 \\
 K(c) &= K_1 c + (1 - \delta) K_b(c) + \delta K_a(c) \\
 \text{with } \delta &= 1 \quad \text{for } c \geq 0 \\
 &= 0 \quad \text{else}
 \end{aligned}
 \tag{2-10}$$

For older cohorts, entering before the sample period (i.e. before 1976), the cohort term takes the form $K(c) = K_1 c + K_b(c)$ and for younger cohorts, entering during the sample period (i.e. after 1975), the cohort term is $K(c) = K_1 c + K_a(c)$, where:

$$\begin{aligned}
 K_b(c) &= K_{b2} c^2 + K_{b3} c^3 + \dots \\
 K_a(c) &= K_{a2} c^2 + K_{a3} c^3 + \dots
 \end{aligned}
 \tag{2-11}$$

Since c takes the value zero for cohorts of age 25 in 1976, $K(c)$ is zero for this specific cohort and thus, the cohort effects are centered around this cohort. We also include year dummies which are orthogonalized with respect to $B(t)$. Recognizing the problem of identification of the coefficients of the linear terms, the wage function (2-7) takes the form:

$$\begin{aligned}
 g(c, \alpha) &= G + [A_1 - K_1] \alpha + [B_1 + K_1] t + A_{(2)}(\alpha) + B_{(2)}(t) \\
 &+ (1 - \delta) K_b(c) + \delta K_a(c) + \sum_{i=1}^5 \kappa_i YD_i
 \end{aligned}
 \tag{2-12}$$

where G denotes the intercept and the κ_i 's are the coefficients of the year dummies YD_i .⁷ The hypothesis of uniform insider wage growth requires equation (2-12) to hold against some more general alternative, whereas the (stronger) uniform wage growth hypothesis additionally requires the coefficients K_a to be zero. Formally, it is also possible to test the hypothesis that the cohort effects K_b are zero. But, since we only observe entry wages for cohorts entering the labor market after 1975, our test of equation (2-8) for older cohorts is not directly based on the entry wages of these cohorts. Instead it relies on the implications of the hypothesis for the wages in later stages of the life-cycle.

In order to formulate a test of the hypothesis of uniform insider wage growth, we consider the following interaction terms of age and time in the *derivative* g_α :

$$(2-13) \quad \alpha t, \alpha t^2, \alpha^2 t, \alpha^2 t^2, \alpha^3 t, \alpha^3 t^2, \alpha^3 t^3, \alpha t^3, \alpha^2 t^3$$

Assuming that these quantities capture the potential interaction between α and t , the implied "nonseparable" variant of g expands (2-12) by further incorporating the variables $R_1 \dots R_9$ which are defined as follows:

$$(2-14) \quad \begin{aligned} R_1 &= \int \alpha(c+\alpha) d\alpha = c\alpha^2/2 + \alpha^3/3 \\ R_2 &= \int \alpha(c+\alpha)^2 d\alpha = c^2\alpha^2/2 + 2c\alpha^3/3 + \alpha^4/4 \\ R_3 &= \int \alpha^2(c+\alpha) d\alpha = c\alpha^3/3 + \alpha^4/4 \\ R_4 &= \int \alpha^2(c+\alpha)^2 d\alpha = c^2\alpha^3/3 + c\alpha^4 + \alpha^5/5 \\ R_5 &= \int \alpha^3(c+\alpha) d\alpha = c\alpha^4/4 + \alpha^5/5 \\ R_6 &= \int \alpha^3(c+\alpha)^2 d\alpha = c^2\alpha^4/4 + 2c\alpha^5/5 + \alpha^6/6 \\ R_7 &= \int \alpha^3(c+\alpha)^3 d\alpha = c^3\alpha^4/4 + 3c^2\alpha^5/5 + 3c\alpha^6/6 + \alpha^7/7 \\ R_8 &= \int \alpha(c+\alpha)^3 d\alpha = c^3\alpha^2/2 + c^2\alpha^3 + 3c\alpha^4/4 + \alpha^5/5 \\ R_9 &= \int \alpha^2(c+\alpha)^3 d\alpha = c^3\alpha^3/3 + 3c^2\alpha^4/4 + 3c\alpha^5/5 + \alpha^6/6 \end{aligned}$$

⁷ The orthogonalized year dummies YD_1, \dots, YD_5 are constructed as described in the following. Suppose equation (2-12) is estimated with $\sum_{i=1}^5 \kappa_i YD_i$ replaced by $\sum_{i=1}^9 \kappa_i \text{Dum}_{\text{year}(i)}$ under the orthogonality restrictions $\sum_{i=1}^9 i^j \kappa_i = 0$ for $j=0, 1, \dots, 3$, where $\text{Dum}_{\text{year}(i)}$ represents a dummy for year(i) and year(i) equals 1976, 1977, ..., 1984 for $i=1, 2, \dots, 9$. YD_1, \dots, YD_5 are derived by solving the restrictions for κ_i , $i=6, \dots, 9$, and replacing the resulting expressions in $\sum_{i=1}^9 \kappa_i \text{Dum}_{\text{year}(i)}$. Collecting terms for each remaining κ_i , $i=1, \dots, 5$, defines YD_1, \dots, YD_5 . Thus, the estimation under the four orthogonality restrictions is equivalent to a regression on YD_1, \dots, YD_5 without restrictions. In a subsequent step, estimates of κ_i , $i=6, \dots, 9$, are obtained by means of the orthogonality restrictions.

Consequently, as our most general formulation of the wage equation (2-7), we use

$$(2-15) \quad g(c, \alpha) = G + [A_1 - K_1]\alpha + [B_1 + K_1]t + A_{(2)}(\alpha) + B_{(2)}(t) \\ + (1-\delta)K_b(c) + \delta K_a(c) + \sum_{i=1}^9 \gamma_i R_i + \sum_{i=1}^5 \kappa_i YD_i$$

in order to test for H_U and H_{UI} . A formal test of the uniform insider wage growth hypothesis requires all coefficients of the interaction terms $R_1 \dots R_9$ to be jointly zero:

$$(2-16) \quad H_{UI}: R_1 - R_9 \text{ are not significant in } g(c, \alpha)$$

and the test on the stronger hypothesis of uniform wage growth is:

$$(2-17) \quad H_U: R_1 - R_9 \text{ are not significant in } g(c, \alpha) \text{ and } K_a = 0.$$

Only, if the separability condition holds it is meaningful to construct an index of a life-cycle wage profile as a function of pure aging. Otherwise, a different wage profile would apply for each cohort.

$$(2-18) \quad \ln w_L(\alpha) = k_L + (A_1 - K_1)\alpha + A_{(2)}(\alpha)$$

In interpreting this profile it is important to recognize that neither the level k_L nor the linear trend $(A_1 - K_1)$ are identified. The growth rates are identified up to a level $(A_1 - K_1)$.

Similarly, a macro-economic *trend* index can be constructed as a smooth function of time, provided that the separability of age and time effects is not rejected:

$$(2-19) \quad \ln w_m(t) = k_m + (B_1 + K_1)t + B_{(2)}(t)$$

In order to display the cyclical movements of wages it may be of interest to add the period-specific cyclical effects $\kappa_i YD_i$ to equation (2-19).

3. DESCRIPTION OF DATA

In the empirical analysis, we use the 0.5% sample drawn from the West-German "Beschäftigtenstatistik" of the Federal Employment Service⁸ (FES). This data set is based on the reporting system of the German social security system. The earnings data and other relevant information of each person paying contributions to the pension system are recorded over the entire life-cycle in order to calculate the individual pensions. The social security contributions are mandatory for employees which earn more than a minimum threshold and are working regularly. The main exemption are civil servants which do not pay social security taxes at all. Further exclusions from the mandatory contributions are students who work less than 20 hours a week on a regular basis or less than 6 weeks full-time. About 90 percent of the German employees are covered by this mandatory pension system.⁹ For unemployed persons who used to pay social security contributions in their previous employment, the FES continues reduced payments into the pension system. In addition to dependent employees, self-employed and other persons can choose to pay voluntary contributions.

The 0.5% sample of the Beschäftigtenstatistik of the FES covers the years 1976 to 1984.¹⁰ The sample has been drawn from the population of all individual social security accounts. Thus, each person on the file had the same selection probability irrespective of the number or the length of employment spells. From this existing sample, we selected spells of male persons with German citizenship. In a second step, the spells of full-time, dependent employment were chosen (i.e. either white- or blue-collar workers, excluding e.g. civil servants and apprentices). Since the Beschäftigtenstatistik does not contain information about hours worked, we had to concentrate on full-time employment. Using the employment spells and the corresponding gross earnings, daily wages were computed for each employee in our

⁸ Bundesanstalt für Arbeit, Nürnberg.

⁹ Well educated workers are underrepresented since they are more often than others employed in the civil service or self-employed or self-employed.

¹⁰ This data set is usually not available to researchers outside the FES. The data has been used extensively by researcher in the FES, e.g. Bellmann and Buttler (1989 and 1990). However, aggregate numbers calculated from the data set were given out occasionally to researchers, e.g. Abraham and Houseman (1993) and OECD (1993). In our case the processing of the raw data had to be done at the FES in Nürnberg.

sample. As additional variables, we could use age and schooling. For our working sample we finally selected persons of age 25 to 55 for each sample year separately. Thus, the oldest cohort was born in the year 1921, and the youngest cohort was born in 1959.

Six different categories of schooling are available: ranging from persons without any vocational training and without a highschool degree up to college graduates. The German educational system is very different from the American (or anglo-american). Thus, we briefly comment on it. Primary school starts at the age of six and comprises four years. Nine years of schooling are compulsory. After the fourth year, children choose between three types of secondary school: Hauptschule (5 years), Realschule (6 years) or Gymnasium (9 years).¹¹ Successful graduation from Gymnasium is a necessary qualification for attending a university and might be compared to a highschool degree. To enter the Fachhochschule, a student had to successfully pass 12th grade in Gymnasium. The Realschule prepares either for further schooling (e.g. Gymnasium) or for apprenticeships (e.g. banking, insurance). The Hauptschule usually qualifies for apprenticeships in trades and industry. In the 1950s and still in the 60s the Hauptschule was the main part of the schooling system and was chosen by the majority of children. Since then, an increasing fraction of children engaged in higher education.¹²

Apprenticeship combined with part-time vocational schooling is still the most important institution of the German system of vocational training and is the typical route for those who have completed the Hauptschule and the Realschule. Even a considerable fraction of highschool graduates choose an apprenticeship, mostly in the industry and in the service sector. A second route of vocational training which is feasible for graduates of the Realschule is a full-time vocational school. It usually qualifies for the Fachhochschule without requiring a highschool degree. The Fachhochschule, being mostly an engineering school, is a second line of college besides the regular universities having a more applied curriculum. It requires a minimum of 3 years of course work, while universities require 4 to 5 years.

In order to study the wage structure across different levels of schooling, we stratify

¹¹ In some German states, there exists also a parallel system of comprehensive schools (Gesamtschule) where students go to the same school for the first 10 years. However, this system leads to the same schooling degrees as the regular three tracks described here.

¹² The schooling boom was additionally intensified by the baby boom. In Germany, the baby boom started in the early fifties, reached its maximum in the year 1964, and declined rapidly afterwards.

the sample by education. Out of the six available categories, we have constructed the following four:

- (A) Neither highschool nor formal vocational education
- (B) Formal vocational training degree without highschool degree
- (C) Highschool degree without college (with or without vocational training degree)
- (D) College (Either university or Fachhochschule)

Group (C) merges highschool graduates with and without vocational training degree but still remains the smallest group. Group (D) merges both graduates from university and from Fachhochschule who undertook a similar kind of higher education.¹³

A major problem of the Beschäftigtenstatistik is that earnings are censored from above.¹⁴ The censoring points are identical to the thresholds of social security taxation (Beitragsbemessungsgrenze der Rentenversicherung). Contributions are proportional to earnings up to the threshold and zero for the amount above. Thus, earnings exceeding the threshold are recorded but truncated.

The censoring points are changing every year according to an index of gross earnings and are legislated by the federal authorities. Table 1 in appendix 1 provides the numbers for the two main pension systems, the first of which is by far the most important. The second one is only relevant for the mining sector.

In appendix 1, we display median wages by age, year, and schooling for all four education groups and additionally 25%-percentiles for education group (D), since the censoring problem is most severe for education (D), see figures 1 to 9. In any year, for college graduates, medians can only be calculated for those below age 35. Between 75% and 90% of the experienced college graduates (age 40 and above) earn more than the threshold value in any given year. Censoring is somewhat less severe for the 25%-percentiles, e.g. for 1983 almost the entire cross-section is uncensored. For the lower education classes the censoring is not that severe. For (C), the median wages can be calculated except for a few age-year cells, and for (A) and (B), for all age-year cells.

¹³ Our sample consists of 371390 wage observations with 51596 in education group (A), 279760 in (B), 9142 in (C), and 30892 in (D).

¹⁴ The percentages of censored observations are 0.7% for education group (A), 5.6% for (B), 22.3% for (C), and 44.6% for (D). Within (D), censoring is more severe for university grads than for the grads from "Fachhochschule". For the latter ones, the number of observations for older workers are quite small.

4. ESTIMATION RESULTS

In this section, we estimate profiles for median wages for education groups (A)-(C) and for 25%-percentiles of wages for (A)-(D). Subsequently, we analyze to what extent the wage distribution in a given age-education cell has changed over time. If the latter within-wage-inequality measured as percentile differences remains constant over time, it is sufficient to describe medians or 25%-percentiles in order to analyze shifts in the entire wage distribution of an age-education cell. In section 4.1. we present the estimated profiles for medians and 25%-percentiles. Section 4.2. is concerned with shifts in percentile differences of wages over time.

4.1. Trends in Medians and 25%-Percentiles

This section presents the results of estimating wage profiles as described in section 2. Various specifications given by equation (2-15) are estimated separately for each education group, with and without the imposition of the separability and uniform growth hypotheses formulated in section 2. In what follows, we first comment on the estimation specifics. Second, we discuss the actual parameter estimates and the test results, and we finally summarize the main features of the data by a series of graphical illustrations based on the preferred specifications of the fitted wage profiles.

Estimation Approach

To begin with the details of the estimation, the wage data, daily wages deflated by the annual consumer price index, are grouped in 279 age-year-cells (31 ages * 9 periods) for each education group. For each cell, the median of the real wage is calculated. Figures 1 to 9 in appendix 1 depict the cross-sections of the medians for each year and education group. While for education groups (A) and (B) all 279 cell medians are uncensored and for (C) the number is still 264, for (D) there are only 101 uncensored cell medians available. Therefore, we chose to estimate the wage profiles for education groups (A),(B), and (C) by means of weighted least squared regressions as done in MaCurdy and Mroz (1991), where the number of observations in a cell is used as the weight. For education group (C), the estimation was

based only on the 264 uncensored cells.¹⁵ For education group (D), because of the severe censoring problem, the method of censored quantile regression is used, with the 25%-percentile being estimated.¹⁶ Censored quantile regressions were introduced by Powell (1984) and (1986). The method amounts to minimize the objective function

$$(4-1) \quad \sum_j \text{sgn}_\theta \{ \ln w_j - \min[g(c_j), \alpha_j], \ln w_{\text{cens},j} \} (\ln w_j - \min[g(c_j), \alpha_j], \ln w_{\text{cens},j})$$

where the θ -weighted sign function is defined as $\text{sgn}_\theta(x) = \theta$ for $x \geq 0$ and $(1-\theta)$ for $x < 0$ and $\ln w_{\text{cens},j}$ represents the individual censoring point for observation j . For the median, $\theta=0.5$ and for the 25%-percentile, $\theta=0.25$. The fitted values in this regression provide an estimate of the θ -percentile of wages in an age-year cell, since age and time are the only regressors. For our estimation, we apply the algorithm BRCENS developed in Fitzenberger (1994).¹⁷ BRCENS recognizes that there are individual censoring points for each observation as described in section 3. Only if the conditional wage distribution does not move over time, then trends in median wages and in 25%-percentiles coincide. The results in section 4.2 indicate that there were no major shifts in the lower half of the conditional wage distribution as far as it is observed. The discussion of estimation results in this section takes median wages for education groups (A) to (C) and 25%-percentiles for (D) as being representative for the entire wage distribution. In order to evaluate how much we can rely on our comparison of medians (A)-(C) and 25%-percentiles (D), we estimated both the most general and the final specification used for medians for education groups (A)-(C) also for 25%-percentiles for (A)-(C). For the latter estimate, we test whether the final specification differs significantly from the most general and we juxtapose the estimated age profiles and time

¹⁵ The omission of 15 censored cells seems innocuous. Chamberlain (1991) states that even in the case with censoring, a least squares regression based on the uncensored cell medians is asymptotically equivalent to a least absolute deviation (median) regression on the raw data.

¹⁶ The estimation for education group (D) was first performed for medians but the results proved to be unsatisfactory. Since censoring is so severe in this case, we were only able to estimate a significant linear age profile which obviously did not fit very well for older workers.

¹⁷ Fitzenberger (1994) extends the standard Barrodale and Roberts (1974) algorithm to the censored quantile regression case. In a recent study, Buchinsky (1994) developed a different algorithm for censored quantile regressions, which he applied to US wage data. Our preference for the first algorithm is based upon the juxtaposition of the two algorithms in Fitzenberger (1994).

(macro) trend in the final specification for medians and 25%-percentiles for (A)-(C).

For the estimation of standard errors, the Moving Blocks Bootstrap (MBB) procedure is applied. This method allows for estimates which are robust against fairly arbitrary correlation of the error term across time and cohorts.¹⁸ The MBB is an extension of the standard bootstrap procedure. Here blocks of observations are drawn to form the resamples, whereby for one observation the entire vector of endogenous variable and regressors is used.¹⁹ To build up a block in our estimation problem, we first draw one sample observation at random and then add all observations for the same cohort as the initially drawn observation, which are at most three years apart from the year of the initially drawn observation, and those observations for the adjacent cohorts which are at most two years apart from the initially drawn observation in the cohort dimension and at most one year in the time dimension. By drawing such blocks to form the resamples, the MBB standard error estimates take account of weak dependence in the data both across time for a given cohort and across cohorts in the same and adjacent time periods.²⁰

Estimation Results

Having specified the estimation approach, we can now comment on the results. We first

¹⁸ The method was first applied in this context by MaCurdy and Mroz (1991). Fitzenberger (1993) provides a theoretical analysis and a simulation study in the time series dimension within the linear regression context, both for least squares and quantile regression estimation problems.

¹⁹ I.e., we do not draw from the estimated residuals.

²⁰ While in the case of education groups (A),(B) and (C), the MBB estimates are based on 5000 resamples, we can only form 100 resamples for education group (D), due to the much higher computational costs involved with the censored quantile regressions. For the least squares regressions, blocks of cell observations are drawn to form the resamples including their respective cell weights, and then using those weights a weighted least squares regression is performed to obtain the resample estimate. For the censored quantile regression, blocks of all observations in the respective cells are included in the resample and then a censored quantile regression is performed on the resample. The choice of blocksize is somewhat arbitrary, and we experimented with various blocksizes. While in general the variance estimates increased considerably, when switching from the standard bootstrap approach to the blocks bootstrap, the estimates varied only slightly and none of the qualitative results changed when the chosen blocksize was modified marginally. We take this as an indication for the need of standard error estimates which are robust against both correlation in the time and cohort dimension.

discuss shortly the parameter estimates for various wage specifications and the results of the hypothesis tests. Based on our preferred specification for each education group, we continue by evaluating graphically the estimated profiles of medians and 25%-percentiles, respectively. Table 2 in appendix 2 contains the parameter estimates for different specifications of equation (2-15) with various exclusion restrictions imposed - medians for education groups (A)-(C) and 25%-percentiles for (D). We allow age polynomials up to order three and, in all specifications, we fully span the time dimension with a cubic polynomial time trend and the five orthogonalized year dummies, YD_1, \dots, YD_5 , as described in section 2. The latter dummies are supposed to capture cyclical effects. In total, twelve different specifications were estimated over the four education groups, but not every specification for every group.

In order to evaluate the differences across specifications in table 2, it is more illustrative to turn to the test results in table 3, appendix 2. For all four education groups, the tests reveal that the hypotheses of separability and uniform wage growth are decisively not rejected by the data (rows one to four in table 3). The results of tests (rows five to seven) whether cohorts entering the labor market before 1976 had different initial conditions for their wage profiles indicate that for education groups (A) and (D) no cohort effects can be found, whereas for education groups (B) and (C) cohort terms before 1976 are significant. Judging from these results and from significance tests for individual regressors in table 2, our preferred (final) specifications for the four education groups are indicated in the table. Before continuing with a detailed graphical illustration of the final specifications, we should reiterate the important result, that the data clearly support the notion of a macroeconomic time trend for each education group. In the following, this result allows us to infer the trends in relative wages between education groups, i.e., the returns to education, by a simple comparison of the estimated macroeconomic time trends. The last row in table 3 is based on estimating the most general specification (1) and the final specification for medians in (A)-(C) and 25%-percentiles in (D) for 25%-percentiles in all four education groups. We test in particular whether moving from the most general specification to our preferred (final) specifications for medians in (A)-(C) is rejected for the 25%-percentiles in (A)-(C) based on estimating the same specifications. The results indicate that for (A)-(C) we can restrict the wage profiles for the 25%-percentiles to the same specification as for medians which is comforting since in this subsection we mainly contrast the results for medians in (A)-(C) to the results for 25%-percentiles in (D).

Figures 10 to 28 in appendix 2 represent the graphical illustrations of the final specifications of the estimated wage profiles for medians in (A)-(C) and 25%-percentiles in (D), except for figures 12 and 13 where we contrast for (A)-(C) the estimated life cycle profiles and macro wage indices for medians and 25%-percentiles based on the estimated final specifications for both percentiles. Since wages for all four education groups pass the separability test, a life cycle index of wages depicting growth due to pure aging can be identified. These estimated life cycle profiles normalized to zero at age 25 are displayed in figure 10 (cf. equation 2-18). The estimated profiles appear quite reasonable, since they are the steeper the higher the education group, except for (D) after age 40. Only for the lowest education group (A) and the highest education group (D), one finds a maximum of the life cycle wage around the age 40 for (A) and 50 for (D), whereas wage growth due to pure aging continues for the other education groups until age 55.²¹ Figure 12 depicts the estimated age profiles in (A)-(C) both for medians and 25%-percentiles. Wage growth related to age is smaller for 25%-percentiles than for medians and the difference is higher for the higher education levels, i.e. within-wage-inequality is an increasing function of age and education. The age effect can be rationalized, for instance, considering that workers at older age had a longer time to signal their true individual ability and that something like Gibrat's law could be operating over the life cycle of different workers.

Figure 11 exhibits the estimated macroeconomic wage trend polynomials of order three, which are normalized to zero in 1976 (cf. equation 2-19). Both the lowest and the highest education group, (A) and (D), experience trend wage growth of about 9 log-percentage points from 1976 to 1984, albeit with a different growth pattern. Whereas (A) experiences the steepest growth of all education groups until 1980, it shows an almost flat profile in the second half of the sample period. For (D), wages grow at a decreasing rate from 1976 to 1980 and at an increasing rate from 1982 to 1984. From 1980 to 1982, they stay more or less constant. For the entire period, wages in both education groups (B) and (C)

²¹ When estimating medians for education group (D), we obtain a linear age profile, which is steeper than the profiles for the three other groups. However, the profile is implausible for the age interval above 40 years where wage growth is too high. The estimated age profiles for medians mainly reflect wage growth for the younger workers in this group despite the fact that the estimation approach adopted takes account of all observations. In contrast to the results on the age profiles, however, the estimated time effects are quite similar both for the median and the 25%-quantile case.

exhibit an overall growth of around 4 log-percentage points, but the patterns are somewhat distinct. Also for these groups wages rise in the beginning, but then start to fall again. (B) reaches its maximum in 1979/80 and wages keep falling afterwards until 1984. For (C), wages already start falling after 1978 but after 1983 they begin to recover again. The estimated residual period specific components of wages are depicted in figure 14 as cyclical effects. The estimates are fairly similar across education groups and amazingly so for the first half of the sample period. The estimated effects appear to be procyclical with respect to the business cycle, maybe lagging somewhat behind. Figure 13 contrasts the estimated macro wage indices for medians and 25%-percentiles in (A)-(C) based on the estimated final specifications for both percentiles. Except for the strong cyclical pattern in percentile differences, which we observe also in section 4.2., the estimated trends appear fairly close.

For comparison, figure 15 provides three aggregate measures of male wages from the official statistics over our sample period, which are normalized to zero in 1976.²² All the three measures exhibit steep growth of male wages from 1976 to 1979 similar to the combined estimated trend and cyclical effects in figures 11 and 14, but the patterns diverge somewhat afterwards. Wages for white-collar-workers²³ continue to rise until 1980 at about the same rate as before, then decline until 1982 and return to their 1980 level in 1984. The index for weekly wages for blue-collar-workers²⁴ grows until 1980 but remains below the index for white-collar-workers after 1977. From 1980 to 1982 blue-collar-workers experience a decline which erodes half of the wage gains during the previous years.²⁵ Although white-collar-workers typically have higher educational levels, compared to blue-collar-workers, it is not straight forward to relate the patterns in figure 15 to the estimated time effects in figures 11 and 14. The pattern for blue-collar-workers corresponds fairly closely to the case of education group (B), whereas it differs considerably from the estimated trend for education group (A). The wage index for white-collar-workers, on the other hand, differs considerably from the estimated trends for education groups (C) and (D). We conclude, that especially

²² These numbers are for the industrial sector only. Source: "Statistisches Taschenbuch 1990 - Arbeits- und Sozialstatistik", Der Bundesminister für Arbeit und Sozialordnung, Bonn.

²³ "Angestellte" in German, i.e. workers who receive a salary.

²⁴ "Arbeiter" in German, i.e. workers who receive an hourly wage.

²⁵ The index for hourly wages of "Arbeiter" does not exhibit the same decline from 1980 to 1982. The major reason for the corresponding reductions in hours probably was the increase in shorttime work in the early 1980's.

after 1980 wage growth across education groups was very distinct, so that aggregate measures for blue-collar-workers and white-collar-workers do not represent common wage growth among the workers in these two groups.

Figures 16 to 19 describe the predicted time series of wages at ages 30, 40, and 50 for the four education groups. Since for education groups (A) and (D) no cohort effects are significant, the profiles follow the same macro trend as depicted in figure 11 with the returns to age remaining constant over time. For education groups (B) and (C), however, the age differentials increase over time. Especially, the relative position of the 30 years old workers deteriorates. It should be noted that for (B) the predicted wages at age 50 are below the predicted wages at age 40 even though the pure age profile in figure 10 is sloping upwards for all ages. In order to explore how the entire cross-section of wages has moved over time, figures 20 to 23 present the predicted cross-sections in the two years 1978 and 1983. As stated before, for (A) and (D), the entire cross-sections move by the estimated macro trend. For (B) and (C), the age structure of wages changed significantly between those two years. Actually, for (B) and (C), workers below age 37 and 42, respectively, experienced a reduction of real wages up to two log-percentage points. The wages of young workers relative to old workers deteriorate considerably for both education groups. Due to the censoring problem, we could not identify whether this was also true for (D).

Finally, in order to combine cross-sectional and time series information, figures 24 to 27 juxtapose the estimated cross-sections in 1978 to the estimated time series of the cohorts, who were 30, 40, and 50 years old in the year 1978. The estimated time series for the cohorts comprise age and time effects. In almost all cases, the time series intersect the cross-sections from below and the graphs show for some cases how drastically the profiles experienced by a given cohort over age and time differ from the estimated cross-sectional profiles. It should also be noted, that the cohorts in (B) and (C) being 30 years old in 1978 do not experience a real wage decline in the sample period.

Figure 28 provides the time patterns of estimated premia of education group (D) relative to the other education groups. The premia are defined as the ratios of the estimated trend-macro indices in figure 11. While the position of education group (D) improves by around 3 log-percentage points relative to (B) and (C) from 1976 to 1984, the premium relative to (A) deteriorates until 1980 and recovers somewhat afterwards. The relative position of workers with low and with high education levels rose over the sample period

relative to the workers with intermediate education levels.

It is clear from the figures presented in the appendix, that for a given age the wage structure across education groups changed only marginally over the sample period, the most notable changes being the deterioration for 30 years old workers of education groups (B) and (C) relative to (A) and (D) and the improvement for 40 and 50 years old workers in (C) relative to the other education groups. These results extend upon findings by Abraham and Houseman (1993a) who tabulate earnings ratios by age groups and by education groups separately. Their analysis did not reveal considerable trends in gross earnings ratios neither across education groups nor across age groups.

Summary for Trends in Medians and 25%-Percentiles

Summarizing the analysis in this section, we note the following points: First, a macroeconomic wage index and a pure life cycle wage index can be identified for all four education groups. The estimated life-cycle profile exhibit plausible shapes, especially when compared across education groups. While showing strong real wage growth until 1980 for all education groups, the predicted trend macro wage indices differ considerably for the period after 1980. The wage position of education groups (B) and (C) deteriorates relative to both (A) and (D), however, the estimated changes are miniscule in international comparison. Second, while age differentials are predicted to remain constant over time for education groups (A) and (D), the wages of young workers deteriorate relative to old workers in education groups (B) and (C). Third, the overall predicted wage structure for a given age across education groups remains fairly constant over time. Fourth, given the comparison between the results for medians and 25%-percentiles in education groups (A)-(C), it does not appear harmful that we focus our analysis on contrasting results for medians in (A)-(C) and 25%-percentiles in (D). Finally, our findings show the importance of combining cross-sectional and time-series information when estimating wage profiles.

4.2. Analysis of Percentile Differences

After estimating wage trends in medians and 25%-percentiles, respectively, in the previous section, we continue by analyzing the movements in the percentile differences in wages over

time given age and education of the workers. The idea behind this approach is the following: If we do not find considerable trends in percentile differences in an age-education cell (within-distribution), then estimating the trends in medians or 25%-percentiles of wages appears to be sufficient for describing trends of the entire wage distribution. In the following, we can show that this argument applies in most cases. Figures 29 to 40 in appendix 3 provide a graphical analysis of percentile differences in log wages over time. Because of the censoring problem, only those percentile differences are used for which the upper percentile is uncensored. The fact, that some percentiles are censored, limits the scope of our analysis.

Figures 29 to 36 show the development of raw percentile differences over time for a given age-education cell. For this analysis the age variable is grouped in six five-year-intervals. We examine the 90%-10%, 90%-50%, and 50%-10% differences, to the extent that the upper percentile is uncensored. Basically no information on the 90%-10% and 90%-50% differences is available for education groups (C) and (D), and only limited information is available on the 50%-10% difference for (D). Figures 29 to 34 indicate that the within distribution for (A) and the bottom of the within distribution for (B) remained constant over time, while the dispersion in the upper part for (B) increased somewhat. Figures 35 and 36 show that also for (C) and (D) no discernable trend in the dispersion of the lower part of the distribution can be detected.

In the graphical analysis above, the figures exhibit a lot of noise in the percentile differences. Therefore, we turn next to a more formal description of the trends. We estimated weighted least squares regressions of the percentile differences on a set of dummies for the age-education cells and a set of year dummies. The weights used are the numbers of observation in the respective age-education cell.

$$(4-2) \quad \begin{array}{l} \text{Percentile Difference of log real wages} \\ \text{in age-education-cell } k \text{ in year } t \end{array} = \sum_k \beta_k Dum_{\text{age-education-cell},k} + \sum_{i=1}^9 \kappa_i Dum_{\text{year}(i)}$$

$Dum_{\text{year}(i)}$ represents a dummy for year(i) and year(i) equals 1976, 1977, ..., 1984 for $i=1, 2, \dots, 9$ and the coefficient for year 1976, κ_1 , is set to zero. $Dum_{\text{age-education-cell},k}$ is a dummy variable for age-education-cell k. For these regressions, available data from all the education groups are pooled thus enabling us to estimate common year effects, κ_i , across age-education-cells. The estimation is performed for the 90%-10%, 90%-50%, 50%-10%, and 75%-25%

5. CONCLUSIONS

Our study analyzes wage trends for male employees in West Germany from 1976 to 1984. This is the period of major changes in wage trends in the United States and other industrialized countries. Our results indicate that a macroeconomic wage index and a pure life cycle wage index can be identified for all education groups. We find macroeconomic wage trends to be different depending on education levels showing a minor deterioration of the relative wage position of workers with intermediate skill levels ("Formal vocational training degree" and "Highschool degree") relative to unskilled workers and college grads. In addition, we do find a decline of relative wages of young worker for intermediate education levels, but not for the lowest education group. Within-inequality of wages seems to have increased in the upper part of the distribution for intermediate education levels, but remained constant for the lower part of the distribution. The increase in the upper part is quite substantial for 1984, thus, it is important to extend this analysis to more recent years. The latter findings remained unnoticed in the study of Abraham and Houseman (1993a) who only had access to more aggregated data.

The results on the within-inequality and the relative wages of young to old workers within an education group and on the differences in wage trends depending on the education group point to some flexibility in the structure of wages in Germany, however, the observed changes are very small compared to the United States and other industrialized countries. However, it should be emphasized as well that we did not find a trend of wage compression which had been a point of discussion in the German literature on wage structure. The result of constant within-wage-inequality for the lower part of the distribution as well as the finding that the relative wage position of unskilled labor improved slightly relative to the intermediate groups are consistent with a view that there are minimum wage effects operating in Germany - similar to the discussion of Katz et al. (1993) for France. This may be due to union bargained wages which did not decline to the extent as in the United States during the sample period. This view is not contradicted by the decline of relative wages of young workers in the intermediate education groups, since union wages are typically not binding in Germany due to significant wage drift. However, this finding could also be rationalized by baby-boom effects increasing the supply of labor market entrants during the sample period.

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APPENDIX 1: DESCRIPTION OF THE DATA

Description of Education Groups:

- (A) : Without formal vocational training degree - Ohne abgeschlossene Berufsausbildung
- (B) : With formal vocational training degree - Mit abgeschlossener Berufsausbildung
- (C) : With high school degree allowing for university - Abitur mit oder ohne abgeschlossene Berufsausbildung
- (D) : College / University degree - Abschluß von Fachhochschule oder Universität

Table 1: Social Security Taxation Thresholds 1976-1984 in DM

	Rentenversicherung der Arbeiter und Angestellten			Knappschaftliche Rentenversicherung		
	yearly	monthly	daily	yearly	monthly	daily
1976	37200	3100	142.53	45600	3800	174.71
1977	40800	3400	156.32	50400	4200	193.10
1978	44400	3700	170.11	55200	4600	211.49
1979	48000	4000	183.91	57600	4800	220.69
1980	50400	4200	193.10	61200	5100	234.48
1981	52800	4400	202.30	64800	5400	248.28
1982	56400	4700	216.09	69600	5800	266.67
1983	60000	5000	229.89	73200	6100	280.46
1984	62400	5200	239.08	76800	6400	294.25

Source: Statistisches Taschenbuch 1991, Arbeits- und Sozialstatistik

Figures 1-9: Cross-Sections of Median Real Daily Wages for all education groups (A) - (D) and 25%-Percentile for (D) - 1980 = 100

Figure 1: Year = 1976

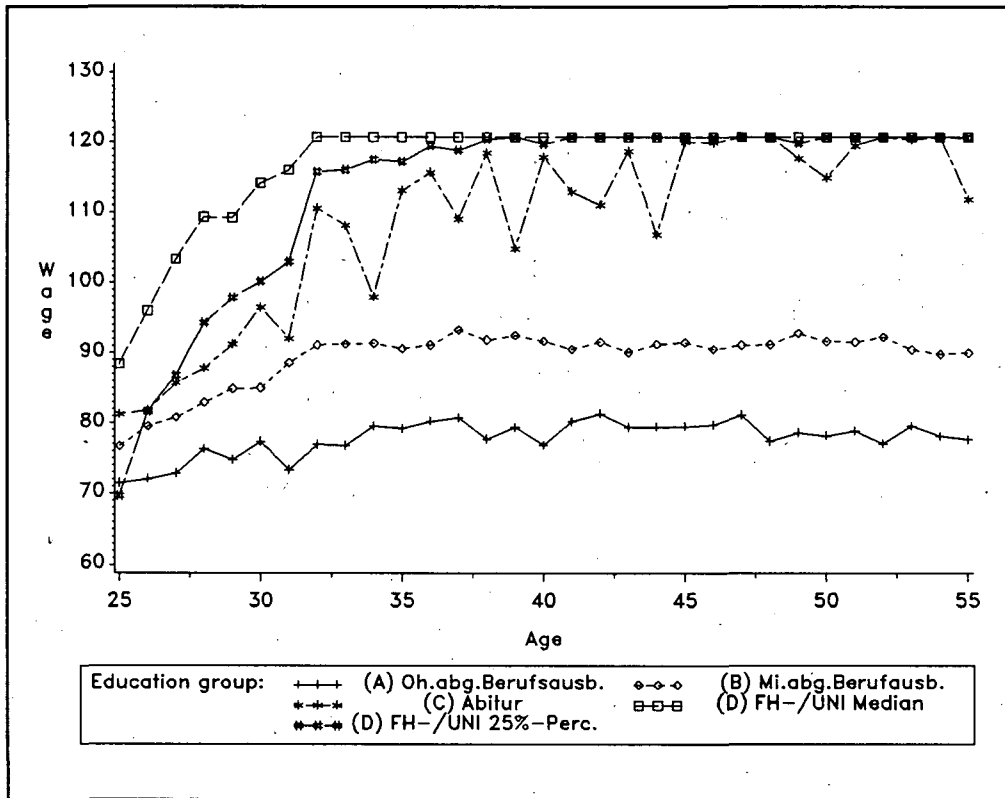


Figure 2: Year = 1977

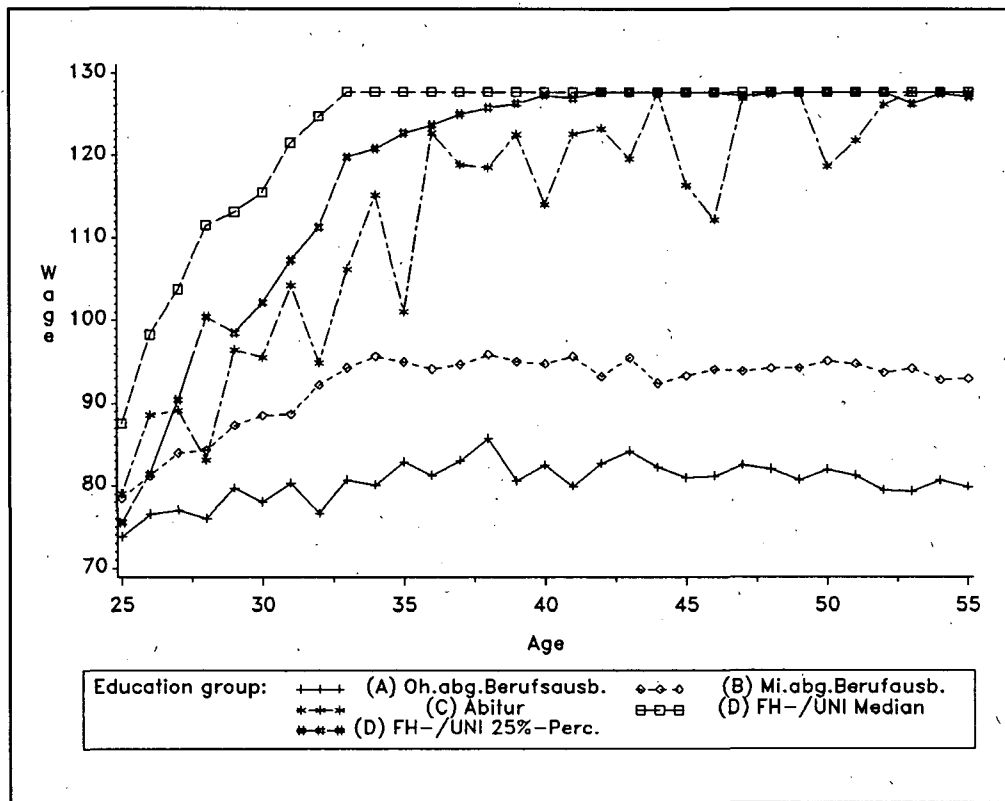


Figure 3: Year = 1978

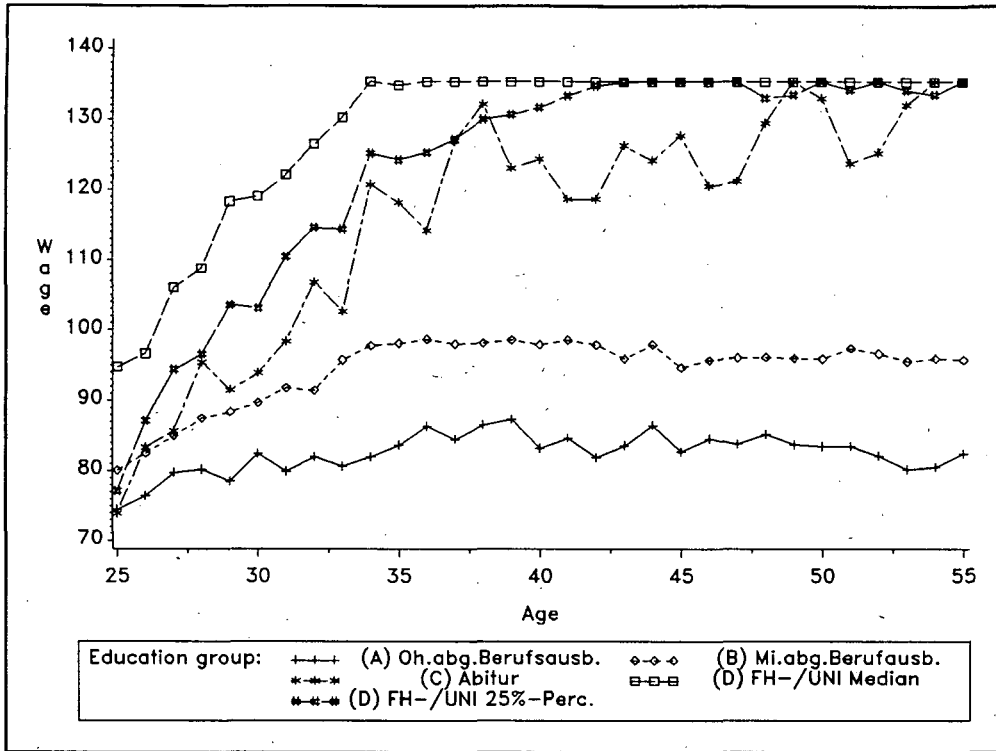


Figure 4: Year = 1979

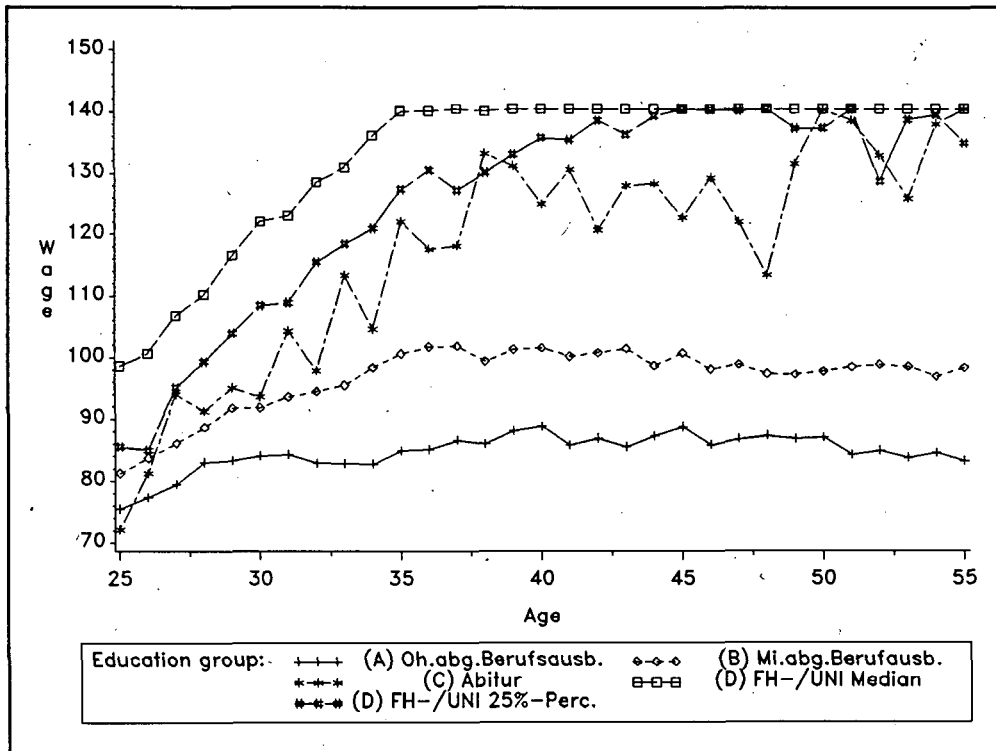


Figure 5: Year = 1980

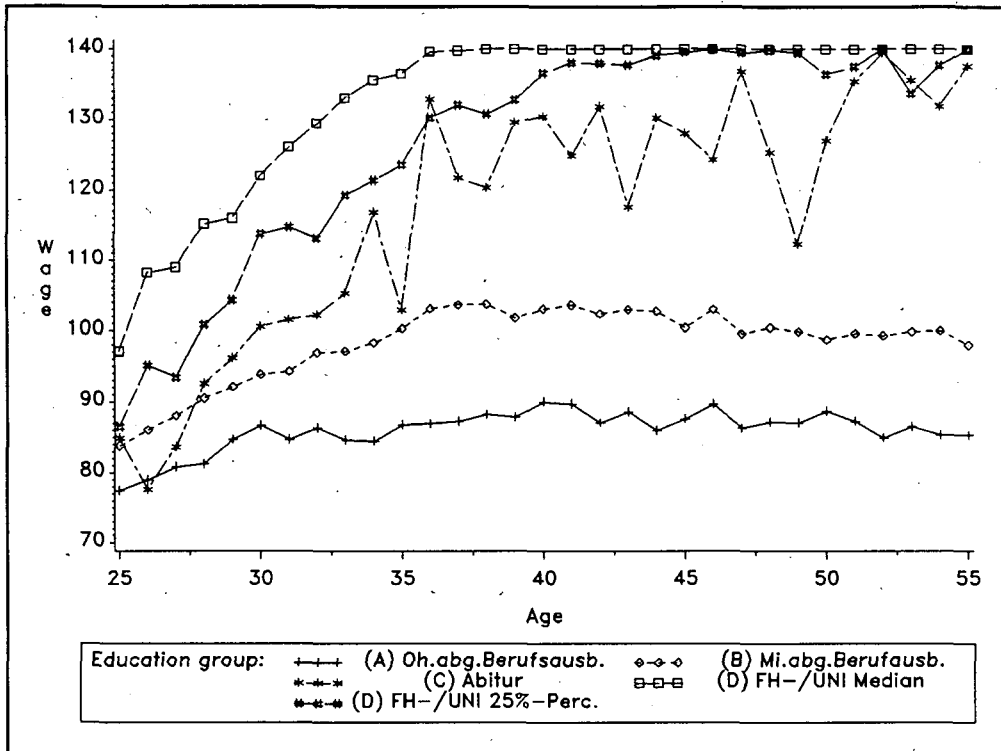


Figure 6: Year = 1981

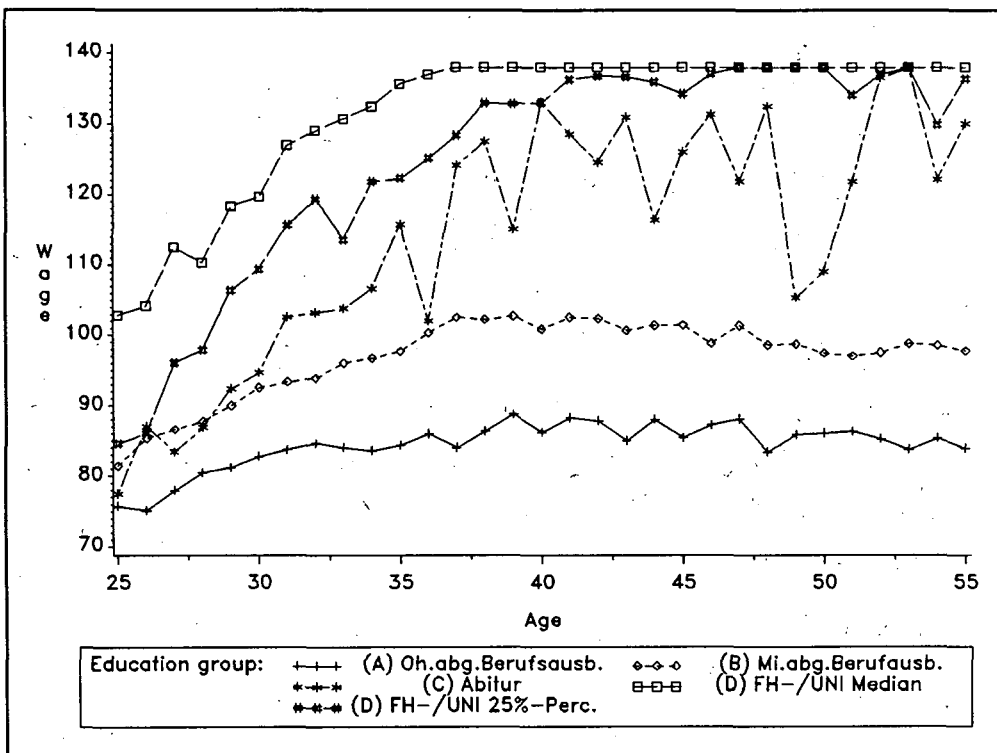


Figure 7: Year = 1982

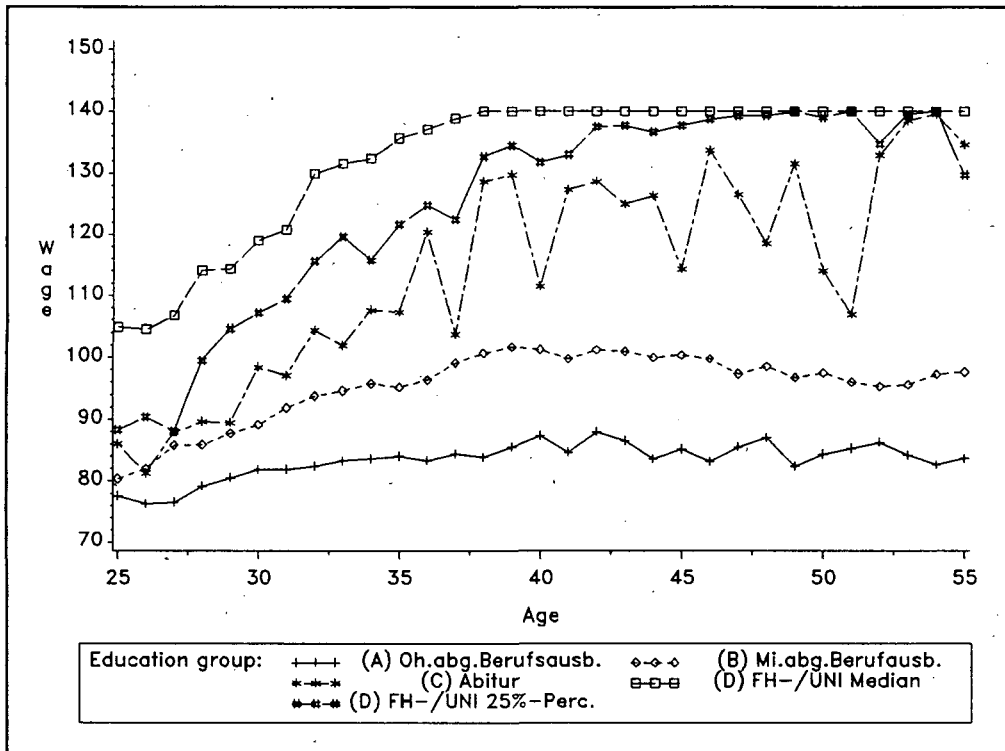


Figure 8: Year = 1983

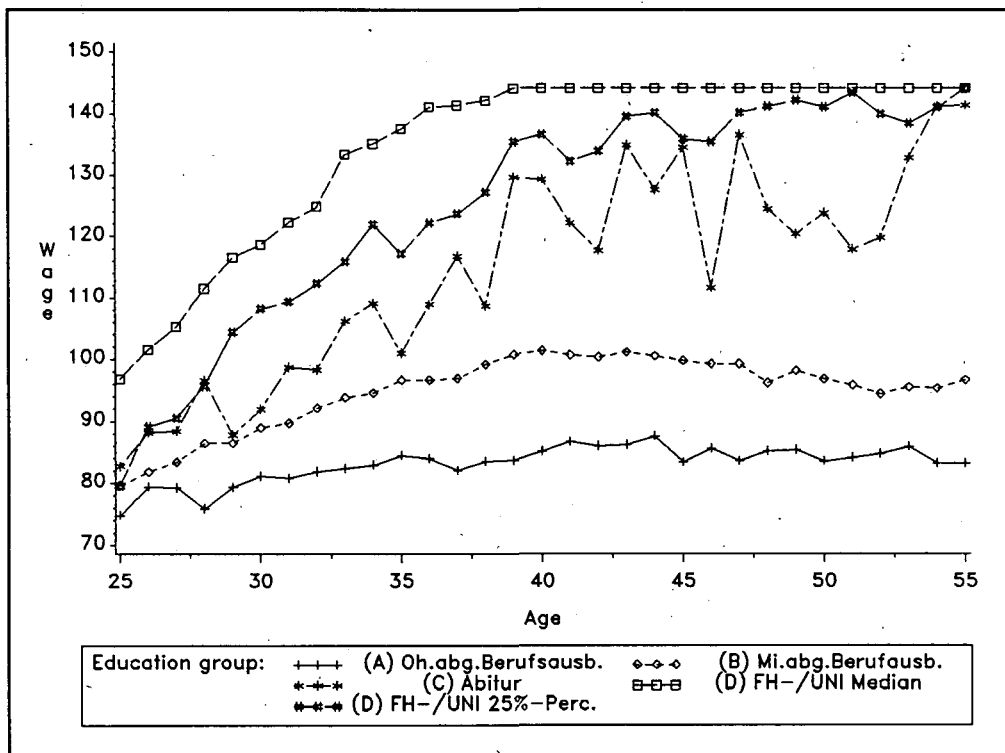
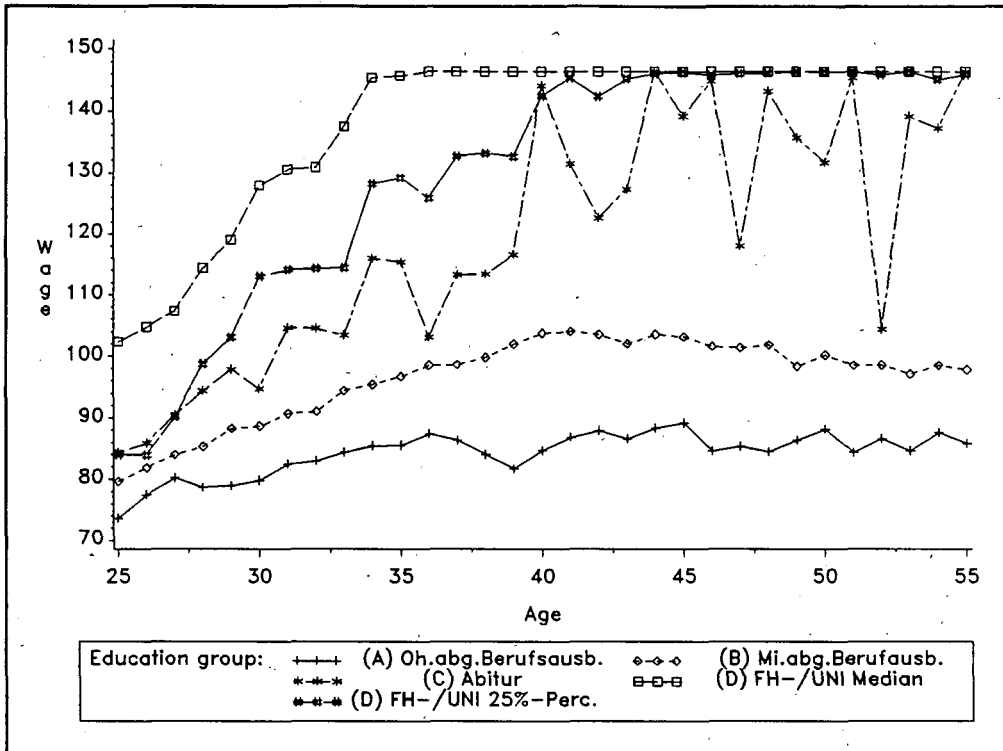


Figure 9: Year = 1984



APPENDIX 2: RESULTS OF MEDIAN REGRESSIONS FOR EDUCATION GROUPS (A) - (C) AND OF 25%-QUANTILE REGRESSIONS FOR (D)

Table 2

Parameter Estimates For Wage Specifications
(standard errors in parentheses - final specification denoted by *)

Education Group	(A) - Ohne abgeschlossene Berufsausbildung und ohne Abitur (Median Regression)					(B) - Mit abgeschlossener Berufsausbildung und ohne Abitur (Median Regression)				
	(1)	(2)	(3)	(4)	(5) *	(1)	(2)	(3)	(4) *	(5)
Intercept	4.2592 (0.032)	4.2665 (0.022)	4.2651 (0.012)	4.2656 (0.010)	4.2500 (0.009)	4.3365 (0.018)	4.3418 (0.013)	4.3414 (0.007)	4.3404 (0.006)	4.3139 (0.012)
α	0.2585 (0.118)	0.1672 (0.073)	0.1827 (0.068)	0.1761 (0.027)	0.1766 (0.021)	0.2919 (0.074)	0.2260 (0.041)	0.2309 (0.036)	0.2478 (0.015)	0.3206 (0.026)
α^2	-0.0410 (0.166)	-0.0024 (0.123)	-0.0639 (0.020)	-0.0642 (0.020)	-0.0771 (0.015)	0.0059 (0.087)	-0.0114 (0.072)	-0.0739 (0.014)	-0.0739 (0.013)	-0.1489 (0.021)
α^3	-0.0098 (0.040)	-0.0079 (0.027)	0.0088 (0.004)	0.0088 (0.004)	0.0096 (0.003)	-0.0120 (0.023)	-0.0051 (0.016)	0.0081 (0.003)	0.0081 (0.003)	0.0207 (0.005)
t	0.5477 (0.218)	0.5011 (0.176)	0.5167 (0.081)	0.5229 (0.040)	0.5601 (0.031)	0.4372 (0.109)	0.4277 (0.091)	0.4910 (0.040)	0.4752 (0.023)	0.5234 (0.045)
t ²	-1.3823 (0.698)	-1.0080 (0.453)	-1.1013 (0.097)	-1.0984 (0.098)	-1.0917 (0.098)	-0.8204 (0.362)	-0.6667 (0.243)	-0.9853 (0.060)	-0.9852 (0.061)	-0.9997 (0.124)
t ³	0.8894 (0.615)	0.6029 (0.348)	0.6656 (0.079)	0.6633 (0.080)	0.6505 (0.085)	0.3712 (0.331)	0.2641 (0.187)	0.5742 (0.054)	0.5715 (0.056)	0.5775 (0.110)
c _b ²	-0.5416 (0.567)	-0.1118 (0.214)	-0.0777 (0.179)	-0.0630 (0.092)		-0.2164 (0.334)	0.1114 (0.107)	0.1650 (0.089)	0.1233 (0.048)	
c _b ³	-0.5756 (0.611)	0.0301 (0.272)	-0.0722 (0.193)	-0.0603 (0.121)		0.2035 (0.349)	0.4156 (0.152)	0.2602 (0.098)	0.2226 (0.066)	
c _b ⁴	-1.7414 (2.216)	-0.0373 (0.133)	-0.0300 (0.095)	-0.0258 (0.067)		-1.2039 (1.271)	0.0395 (0.071)	0.1194 (0.053)	0.1052 (0.039)	
c _b ⁵	-0.2587 (0.190)	-0.0075 (0.024)	-0.0043 (0.018)	-0.0038 (0.014)		-0.0944 (0.109)	0.0074 (0.015)	0.0174 (0.012)	0.0155 (0.009)	
c _a ²	0.2688 (1.086)	-0.0254 (1.277)	0.0416 (1.238)			0.0558 (0.830)	-0.1157 (0.793)	-0.0414 (0.786)		
c _a ³	-0.2400 (3.398)	0.0092 (4.553)	-0.0429 (4.364)			-0.0275 (2.979)	0.1104 (2.946)	0.0064 (2.928)		
R ₁	-2.8307 (5.005)	-0.5508 (1.281)				-3.4940 (2.844)	-0.9573 (0.707)			
R ₂	11.4548 (17.973)	0.4445 (1.524)				10.5839 (10.183)	1.2739 (0.821)			
R ₃	2.5966 (3.298)	0.2071 (0.416)				2.1186 (2.025)	0.2625 (0.234)			
R ₄	-10.0422 (12.661)	-0.1551 (0.497)				-7.0266 (7.545)	-0.3228 (0.269)			
R ₅	-0.4555 (0.666)					-0.3378 (0.401)				
R ₆	1.8550 (2.682)					1.2261 (1.569)				
R ₇	-1.7564 (2.600)					-1.0910 (1.492)				
R ₈	-11.1910 (16.904)					-8.4272 (9.493)				
R ₉	9.4802 (12.143)					5.9930 (7.076)				

YD ₁	0.0052 (0.005)	0.0057 (0.001)	0.0057 (0.001)	0.0057 (0.001)	0.0057 (0.001)	0.0073 (0.002)	0.0060 (0.000)	0.0060 (0.000)	0.0060 (0.000)	0.0060 (0.001)
YD ₂	-0.0057 (0.007)	-0.0065 (0.002)	-0.0065 (0.002)	-0.0065 (0.002)	-0.0065 (0.002)	-0.0086 (0.003)	-0.0067 (0.001)	-0.0067 (0.001)	-0.0067 (0.001)	-0.0066 (0.002)
YD ₃	-0.0091 (0.004)	-0.0095 (0.002)	-0.0095 (0.002)	-0.0095 (0.002)	-0.0095 (0.002)	-0.0099 (0.002)	-0.0090 (0.001)	-0.0090 (0.001)	-0.0090 (0.001)	-0.0089 (0.001)
YD ₄	0.0033 (0.003)	0.0037 (0.002)	0.0037 (0.002)	0.0037 (0.002)	0.0038 (0.002)	0.0019 (0.002)	0.0011 (0.001)	0.0011 (0.001)	0.0011 (0.001)	0.0011 (0.001)
YD ₅	0.0143 (0.006)	0.0150 (0.002)	0.0149 (0.002)	0.0149 (0.002)	0.0149 (0.002)	0.0171 (0.003)	0.0156 (0.001)	0.0155 (0.001)	0.0155 (0.001)	0.0155 (0.001)
R ²	.88	.88	.87	.87	.87	.98	.98	.98	.98	.95

◦ Standard errors are computed by 5000 Moving Blocks Bootstrap replications with Blocks containing adjacent 3 time periods for any particular cohort, with 2 adjacent cohorts within a particular year and 1 adjacent year.

- Final Specification for Education Group (A) is Specification (5)
- Final Specification for Education Group (B) is Specification (4)

Table 2

Parameter Estimates For Wage Specifications
(Continued)

Education Group	(C) - Abitur Mit und Ohne abgeschlossene Berufsausbildung - Ohne FH-/UNI-Abschluß (Median Regression)								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9) *
Intercept	4.3809 (0.098)	4.3738 (0.069)	4.3271 (0.040)	4.3251 (0.037)	4.3239 (0.034)	4.3394 (0.031)	4.3268 (0.033)	4.3450 (0.031)	4.3663 (0.027)
α	0.4212 (0.304)	0.2900 (0.192)	0.3882 (0.172)	0.4051 (0.074)	0.5045 (0.084)	0.5073 (0.080)	0.4803 (0.077)	0.4964 (0.086)	.3870 (0.041)
α^2	0.5343 (0.555)	0.3548 (0.390)	-0.1807 (0.066)	-0.1775 (0.068)	-0.1789 (0.069)	-0.1851 (0.072)	-0.2111 (0.070)	-0.1613 (0.069)	-.0633 (0.021)
α^3	-0.1335 (0.148)	-0.0687 (0.100)	0.0303 (0.015)	0.0296 (0.016)	0.0218 (0.017)	0.0290 (0.018)	0.0375 (0.017)	0.0235 (0.017)	
t	0.0264 (0.654)	0.0250 (0.424)	0.5932 (0.210)	0.5794 (0.152)	0.5427 (0.151)	0.4949 (0.140)	0.5794 (0.149)	0.4860 (0.134)	.4786 (.141)
t ²	-0.3662 (2.155)	0.4803 (1.123)	-1.3724 (0.352)	-1.4071 (0.346)	-1.4133 (0.397)	-1.3970 (0.379)	-1.5059 (0.364)	-1.4057 (0.377)	-1.3615 (.390)
t ³	0.5151 (1.919)	-0.3318 (0.890)	1.0183 (0.280)	1.0535 (0.272)	1.0560 (0.309)	1.0573 (0.297)	1.1245 (0.281)	1.0645 (0.296)	1.0260 (.308)
c_b^2	-1.2716 (1.324)	0.1440 (0.632)	0.6064 (0.485)	0.5681 (0.279)		-0.0023 (0.076)	0.1755 (0.133)	-0.0269 (0.019)	-.0242 (.018)
c_b^3	-0.3363 (1.393)	1.6268 (0.824)	0.7296 (0.606)	0.7007 (0.425)		0.0076 (0.026)	0.1440 (0.112)		
c_b^4	-4.7776 (6.144)	-0.0473 (0.428)	0.3099 (0.329)	0.3003 (0.255)			0.0283 (0.029)		
c_b^5	-0.5526 (0.593)	-0.0056 (0.090)	0.0446 (0.065)	0.0434 (0.053)					
c_a^2	0.1050 (2.257)	-0.7407 (2.189)	-0.2806 (2.188)						
c_a^3	-0.0962 (7.182)	0.7975 (5.112)	0.3916 (5.115)						
R ₁	-11.0941 (14.595)	-5.6856 (3.918)							
R ₂	33.0257 (53.367)	6.0551 (4.735)							
R ₃	5.2910 (10.859)	1.5278 (1.498)							
R ₄	-22.5495 (42.349)	-1.5945 (1.791)							
R ₅	-0.4429 (2.443)								
R ₆	3.6747 (9.903)								
R ₇	-4.7009 (9.659)								
R ₈	-30.6726 (51.344)								
R ₉	24.5011 (41.058)								
YD ₁	0.0080 (0.012)	0.0044 (0.003)	0.0042 (0.003)	0.0043 (0.003)	0.0034 (0.003)	0.0042 (0.003)	0.0037 (0.003)	0.0040 (0.003)	.0042 (.003)

YD ₂	-0.0118 (0.019)	-0.0061 (0.007)	-0.0059 (0.007)	-0.0061 (0.007)	-0.0041 (0.007)	-0.0057 (0.007)	-0.0048 (0.008)	-0.0054 (0.007)	-.0058 (0.007)
YD ₃	-0.0079 (0.011)	-0.0055 (0.005)	-0.0052 (0.005)	-0.0053 (0.005)	-0.0056 (0.006)	-0.0055 (0.006)	-0.0054 (0.006)	-0.0055 (0.006)	-.0054 (0.006)
YD ₄	0.0067 (0.008)	0.0040 (0.004)	0.0039 (0.004)	0.0040 (0.004)	0.0031 (0.004)	0.0038 (0.004)	0.0035 (0.004)	0.0036 (0.005)	.0036 (0.005)
YD ₅	0.0154 (0.016)	0.0112 (0.005)	0.0109 (0.005)	0.0110 (0.005)	0.0108 (0.005)	0.0113 (0.005)	0.0106 (0.005)	0.0112 (0.005)	.0116 (0.006)
R ²	.91	.90	.90	.90	.88	.88	.89	.88	.88

◦ Standard errors are computed by 5000 Moving Blocks Bootstrap replications with Blocks containing adjacent 3 time periods for any particular cohort, with 2 adjacent cohorts within a particular year and 1 adjacent year.

◦ Final Specification for Education Group (C) is Specification (9)

Table 2

Parameter Estimates For Wage Specifications
(Continued)

Education Group	(D) - FH-/UNI-Abschluß (25%-Quantile Regression)					
Specification	(1)	(2)	(3)	(4)	(5)	(10) *
Intercept	4.2302 (.159)	4.2657 (.616)	4.3461 (.058)	4.3290 (.104)	4.3633 (.112)	4.3991 (.085)
α	1.9734 (1.026)	1.3808 (.818)	1.0427 (.250)	.7724 (.151)	.6373 (.150)	.4687 (.056)
α^2	-3.2729 (4.144)	-2.8538 (3.172)	-.5154 (.216)	-.5056 (.215)	-.2705 (.233)	-.0997 (.038)
α^3	1.6600 (2.326)	1.8997 (2.197)	.1371 (.113)	.1316 (.108)	.0406 (.102)	
t	1.0845 (1.167)	.7269 (.903)	.1779 (.425)	.5051 (.833)	.4492 (1.010)	.3996 (.658)
t ²	-4.8101 (5.024)	-2.4314 (3.372)	-.9072 (1.052)	-1.0879 (1.913)	-1.1019 (2.587)	-.8325 (1.570)
t ³	2.9250 (4.488)	1.1912 (2.542)	.6134 (.822)	.7494 (1.325)	.8293 (1.872)	.5404 (1.161)
c _b ²	-1.8814 (3.185)	1.2484 (2.934)	-3.1780 (2.802)	.1439 (1.196)		
c _b ³	-.0176 (5.627)	-4.3883 (11.304)	-10.1517 (11.742)	.1347 (4.491)		
c _b ⁴	-9.6818 (16.347)	-18.3167 (30.842)	-12.2353 (17.904)	.0369 (6.506)		
c _b ⁵	-3.8444 (4.901)	-23.6196 (31.018)	-5.0763 (7.470)	.0062 (2.519)		
c _a ²	3.0980 (2.675)	1.6753 (2.185)	.9126 (1.085)			
c _a ³	-2.1524 (5.072)	-1.1481 (2.658)	-.8491 (2.558)			
R ₁	-32.8140 (42.628)	17.4975 (24.528)				
R ₂	196.355 (168.92)	-13.795 (24.248)				
R ₃	124.667 (106.86)	-20.4046 (24.994)				
R ₄	-522.903 (443.50)	17.6473 (23.682)				
R ₅	-94.4356 (88.069)					
R ₆	346.243 (319.24)					
R ₇	-300.37 (276.60)					
R ₈	-196.859 (175.68)					
R ₉	478.122 (409.01)					
YD ₁	.0149 (.024)	.0058 (.029)	.0067 (.026)	.0085 (.016)	.0052 (.029)	.0065 (.015)

YD ₂	-0.196 (.036)	-0.077 (.062)	-0.050 (.061)	-0.0107 (.031)	-0.0049 (.065)	-0.0058 (.029)
YD ₃	-0.0168 (.020)	-0.0061 (.030)	-0.0179 (.026)	-0.0099 (.009)	-0.0083 (.027)	-0.0124 (.008)
YD ₄	.0087 (.014)	.0022 (.017)	.0103 (.020)	.0014 (.014)	-.0015 (.023)	-.0003 (.012)
YD ₅	.0219 (.033)	.0107 (.020)	.0135 (.008)	.0208 (.013)	.0142 (.012)	.0206 (.012)

◦ Standard errors are computed by 100 Moving Blocks Bootstrap replications with Blocks containing 3 adjacent time periods for any particular cohort and 2 adjacent cohorts within a particular year and 1 adjacent year.

◦ Final Specification for Education Group (D) is Specification (10)

Table 3

Tests of Wage Growth Hypothesis
Chi-Square Statistics obtained using the MBB procedure

Hypothesis	ED = (A) O.abg.Ber. (Med.Reg)	ED = (B) M.abg.Ber. (Med.Reg)	ED = (C) Abitur (Med.Reg)	ED = (D) FH/UNI-Ab. (25%-QReg)	Critical Value 0.95
R1-R9=0, H_{UI} Specification (1)	2.23	4.46	4.80	2.81	$\chi^2(9)=16.9$
R1-R9=0, $K_x(c)=0$ H_U Specification (1)	2.28	4.56	4.84	4.63	$\chi^2(11)=19.7$
H_{UI} given R5-R9=0 Specification (2)	1.06	6.23	4.07	1.59	$\chi^2(4)= 9.5$
$K_x(c)=0$, H_U given H_{UI} Specification (3)	0.01	0.05	0.03	1.64	$\chi^2(2)= 6.0$
$K_b(c)=0$ given H_U Specification (4)	1.71	108.58	20.60	0.23	$\chi^2(4)= 9.5$
4th and 5th power of $K_b(c)$ =0 given H_U - Specification (4)	0.31	14.96	4.95	0.30	$\chi^2(2)= 6.0$
3rd, 4th, and 5th power of $K_b(c)=0$ given H_U - Specification (4)	-	-	4.96	0.01	$\chi^2(3)= 7.8$
YD's = 0 given H_U and $K_b=0$ - Final Specification	98.90	128.96	7.93	3.87	$\chi^2(5)=11.1$
Test of final specification for 25%-Quantile Regression against Specification (1) (Degrees of Freedom in Parentheses)	8.37 (15)	5.90 (11)	20.79 (15)	7.15 (16)	$\chi^2(15)=25.0$ $\chi^2(11)=19.7$ $\chi^2(16)=26.3$

◦ The test statistics are Wald statistics based on the specifications presented in table 1. They are calculated using the variance-covariance matrix computed by 5000/100 (A-C/D) Moving Blocks Bootstrap replications as reported in table 1. The Blocks drawn for the resamples contain for any particular cohort 3 adjacent time periods and 2 adjacent cohorts within a particular year and 1 adjacent year.

Figures 10-28: Illustration of Estimated Wage Profiles for Median and 25%-Percentile - Final Specifications for each education group

Figure 10: Pure Life Cycle Wage Profiles - (A-C) Median, (D) 25%-Percentile

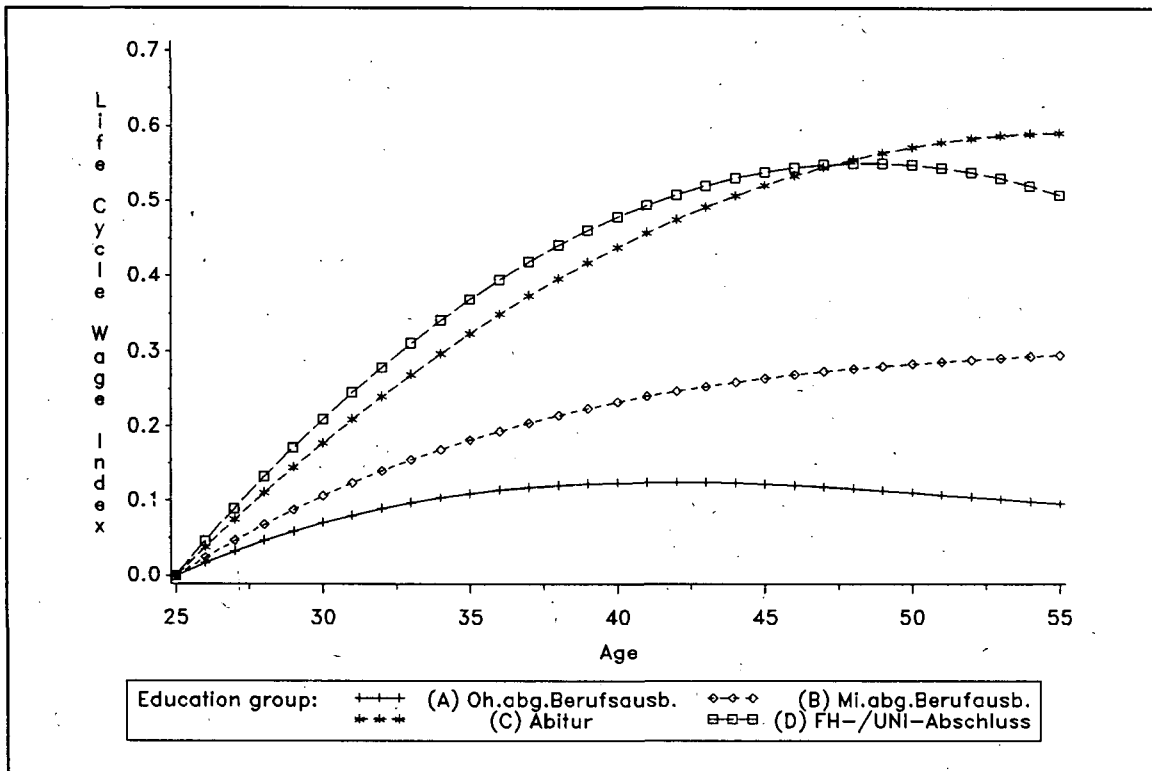


Figure 11: Trend-Macro Wage Indices - (A-C) Median, (D) 25%-Percentile

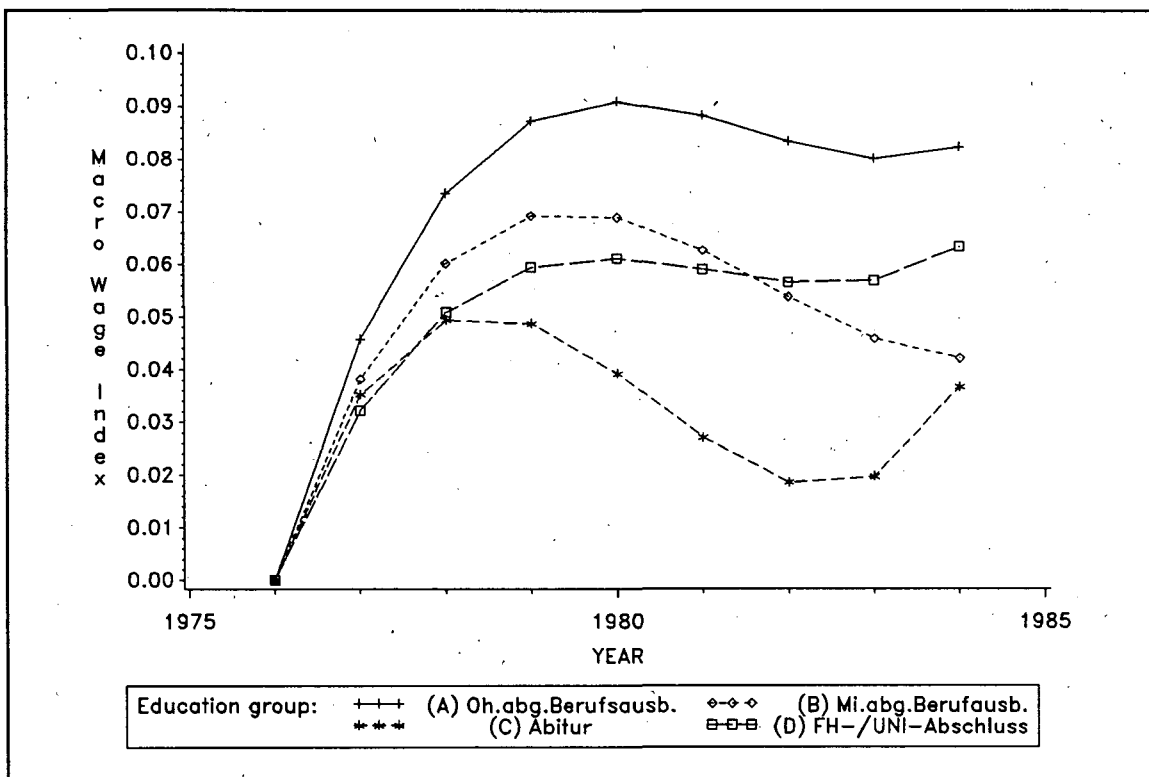


Figure 12: Pure Life Cycle Wage Profiles - (A-C) Median and 25%-Percentile

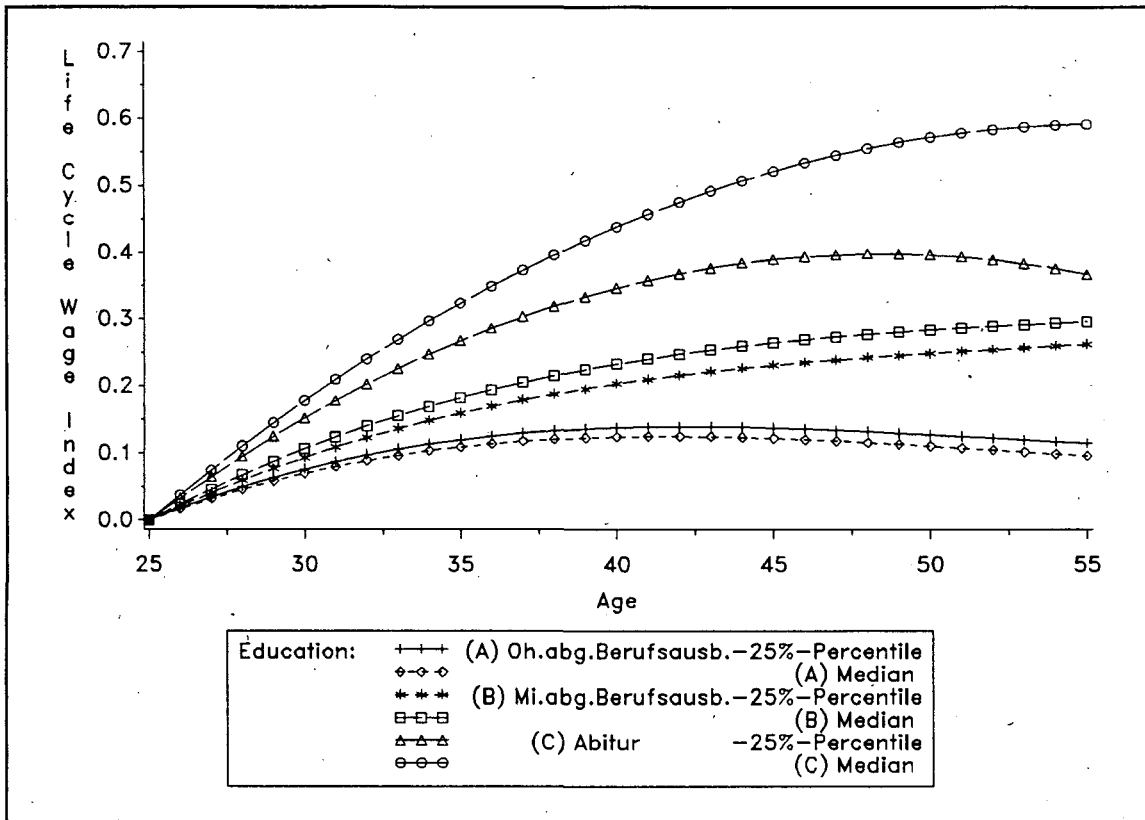


Figure 13: Trend-Macro Wage Indices - (A-C) Median and 25%-Percentile

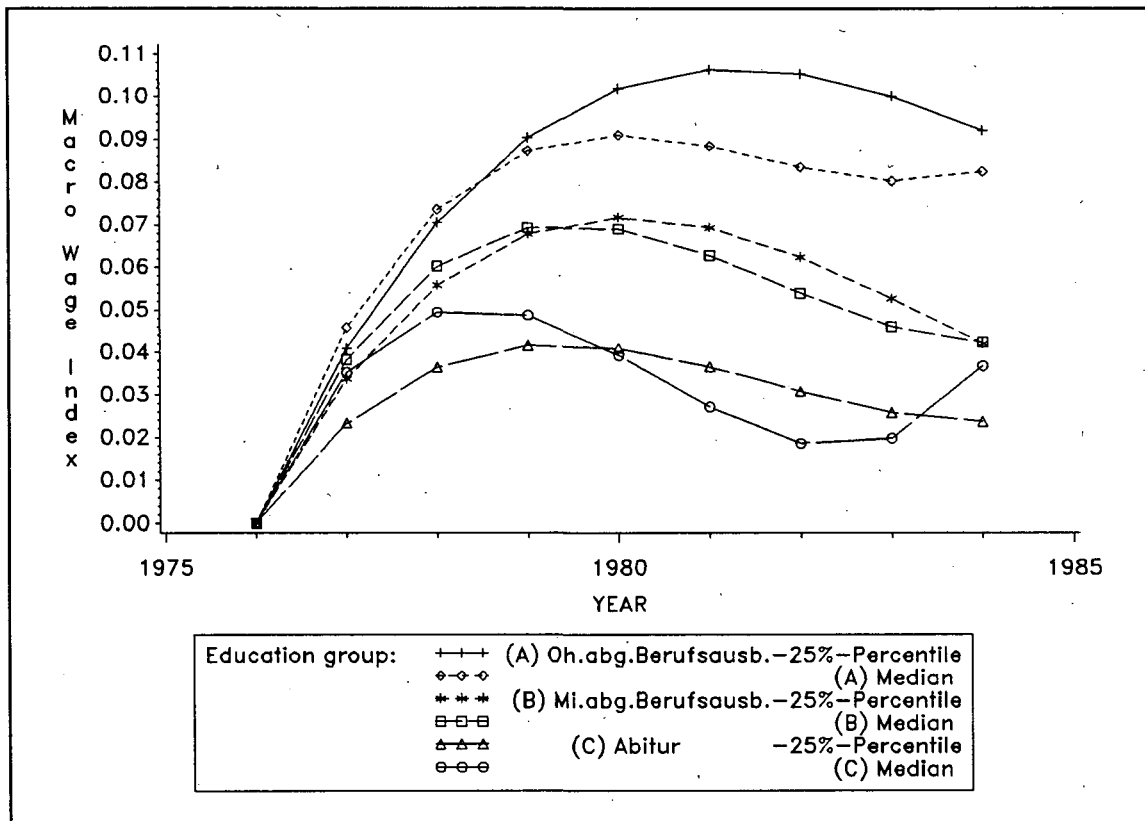


Figure 14: Cyclical Time Effects - (A-C) Median, (D) 25%-Percentile

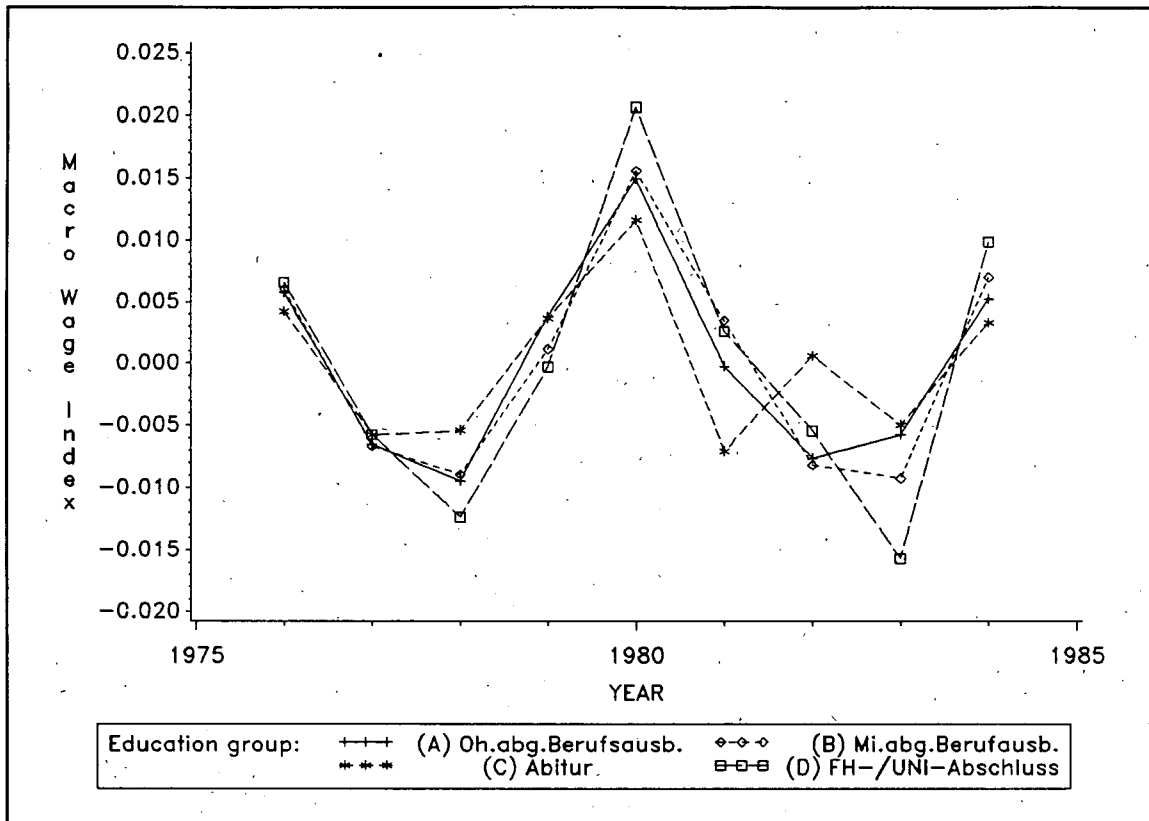


Figure 15: Aggregate Macro Wage Indices for Comparison - 1976=0

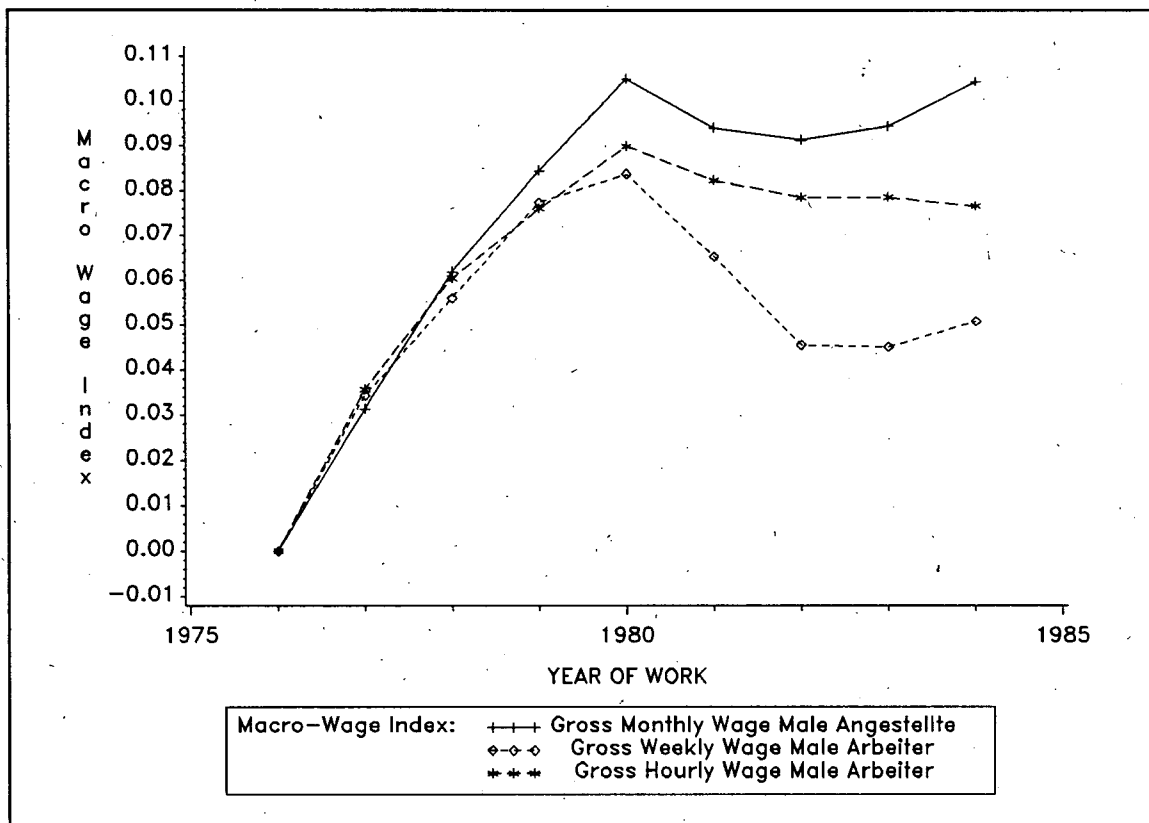


Figure 16: Wage Rates at Ages 30, 40, and 50 - Educ = (A) Ohne abgeschl. Berufsausb. - Median

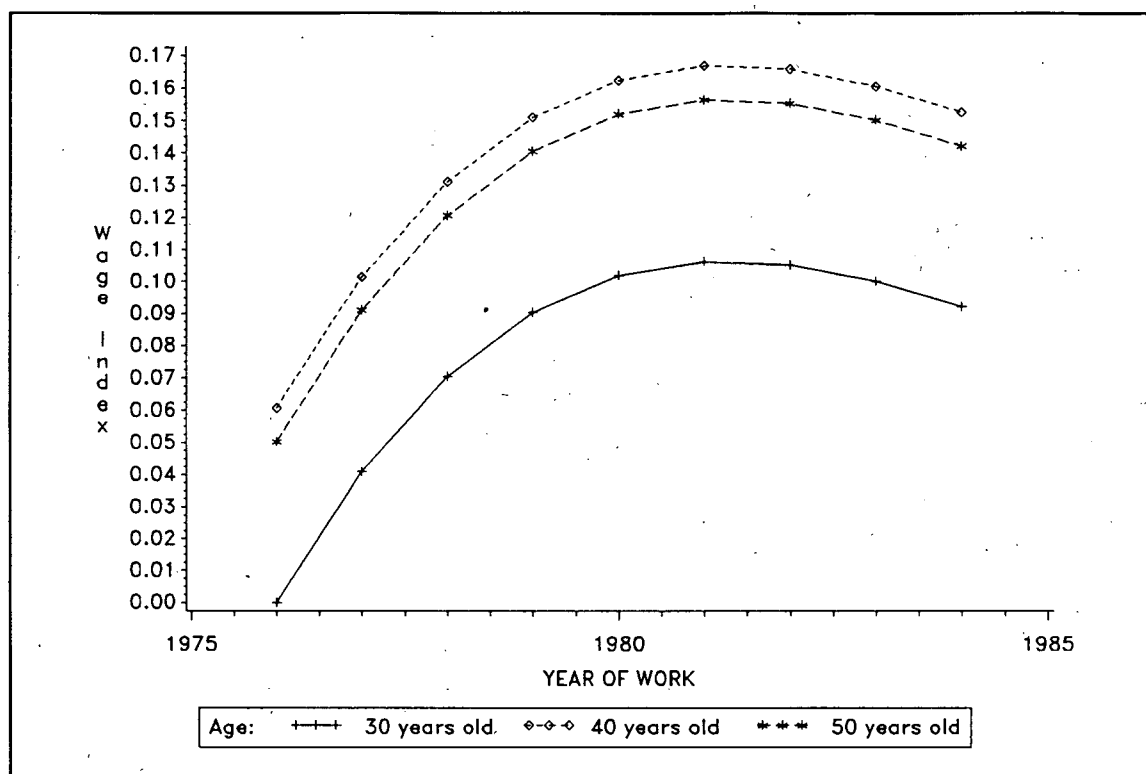


Figure 17: Wage Rates at Ages 30, 40, and 50 - Educ = (B) Mit abg. Berufsausbildung - Median

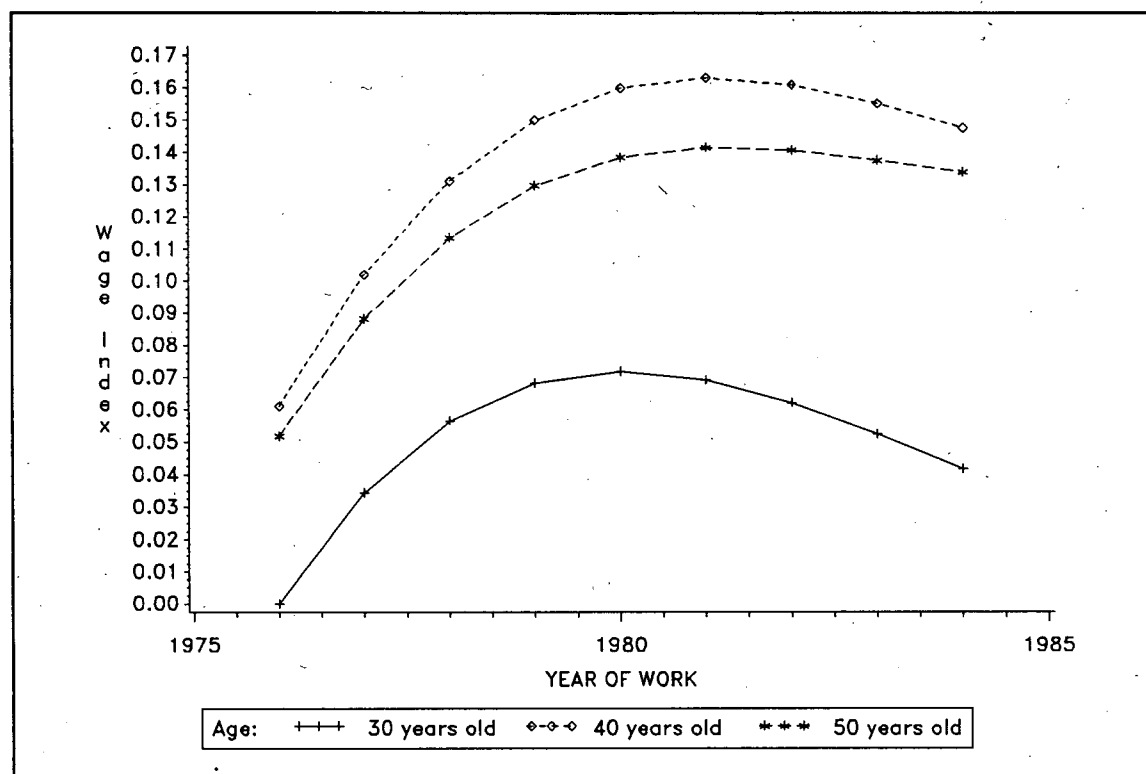


Figure 18: Wage Rates at Ages 30, 40, and 50 - Educ = (C) Abitur - Median

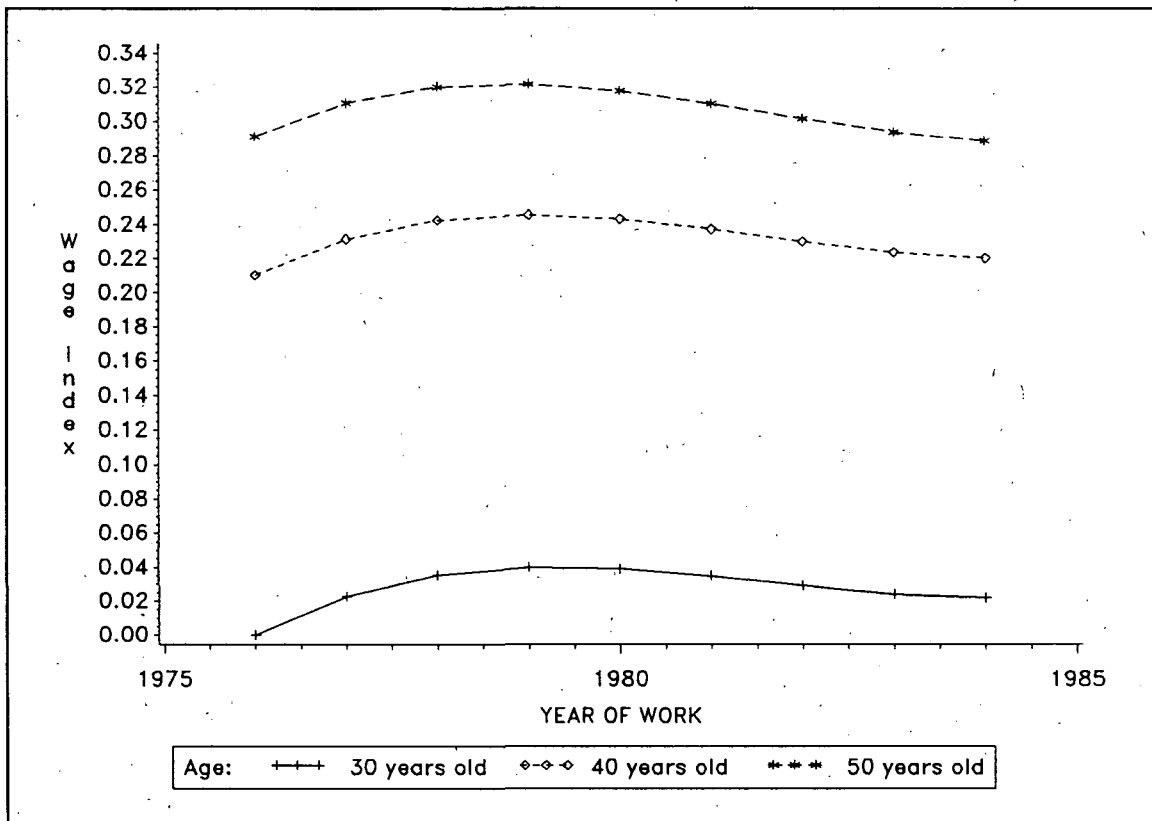


Figure 19: Wage Rates at Ages 30, 40, and 50 - Educ = (D) FH-/UNI-Abschluß - 25%-Percentile

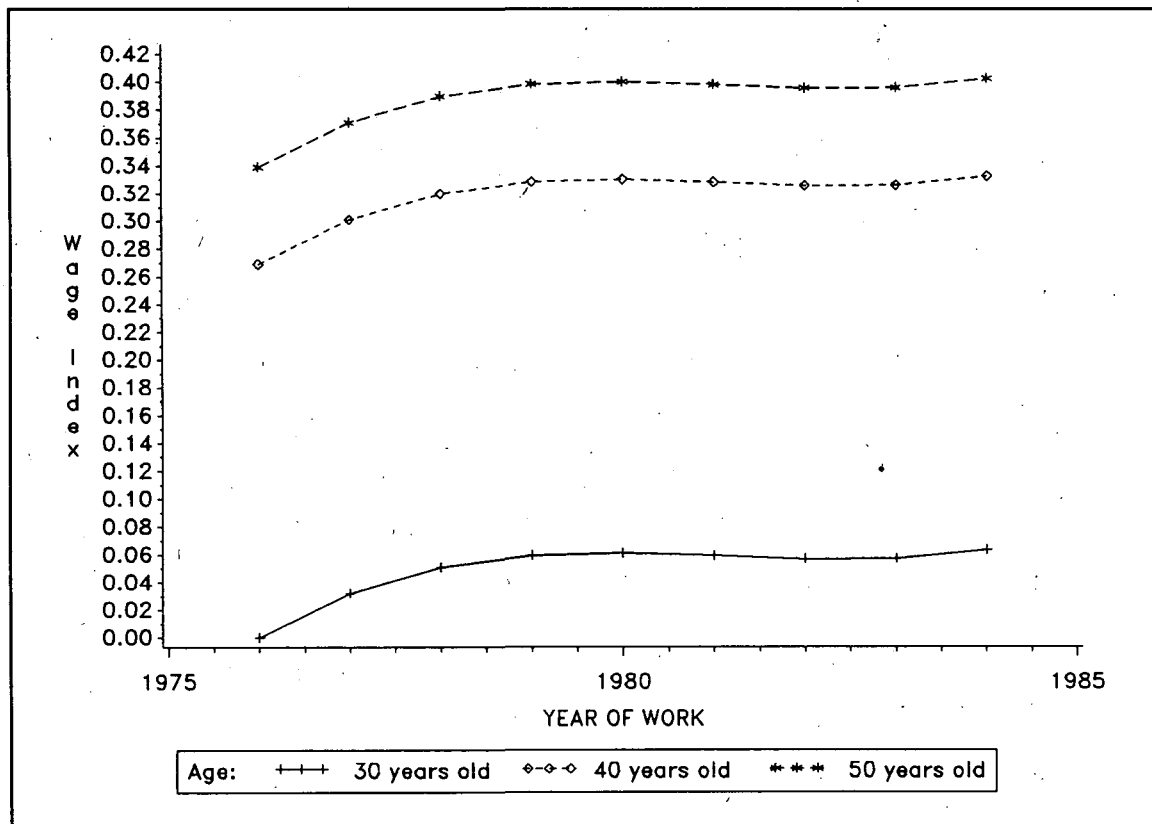


Figure 20: Cross-Sections of Predicted Wages 1978 and 1983 - Educ = (A) Ohne abgeschl. Berufsausb. - Median

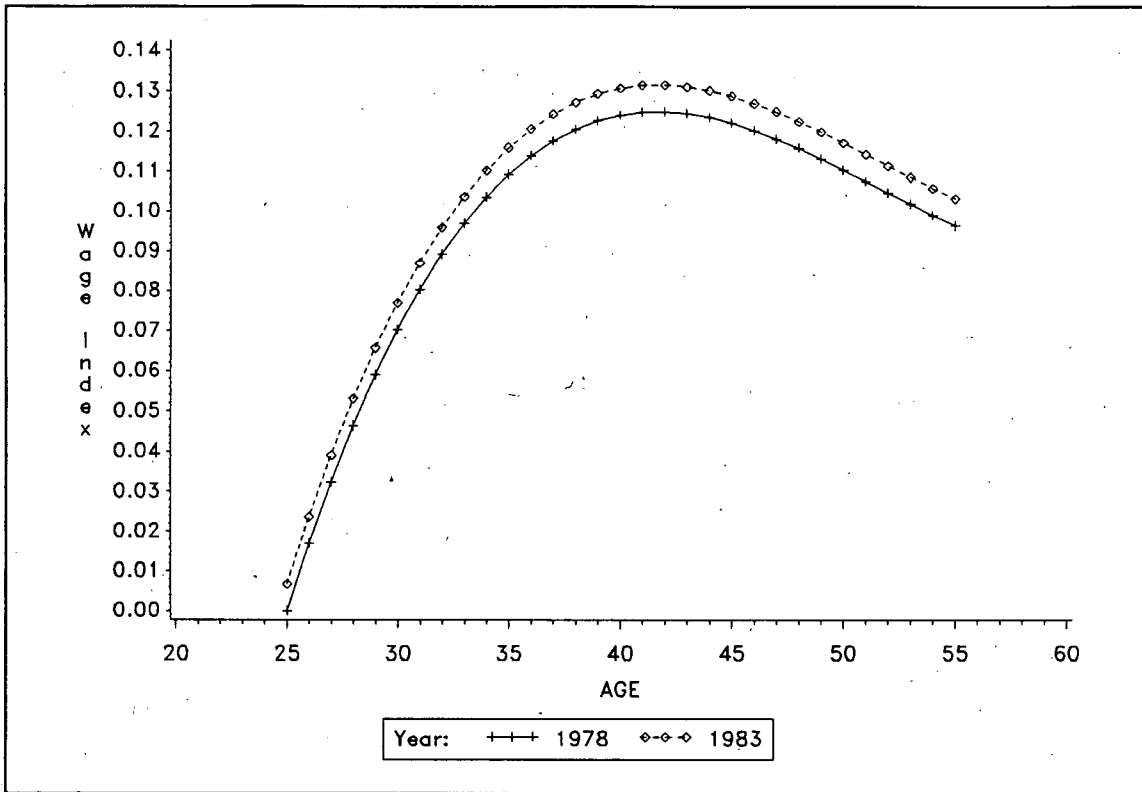


Figure 21: Cross-Section of Predicted Wage 1978 and 1983 - Educ = (B) Mit abg. Berufsausbildung - Median

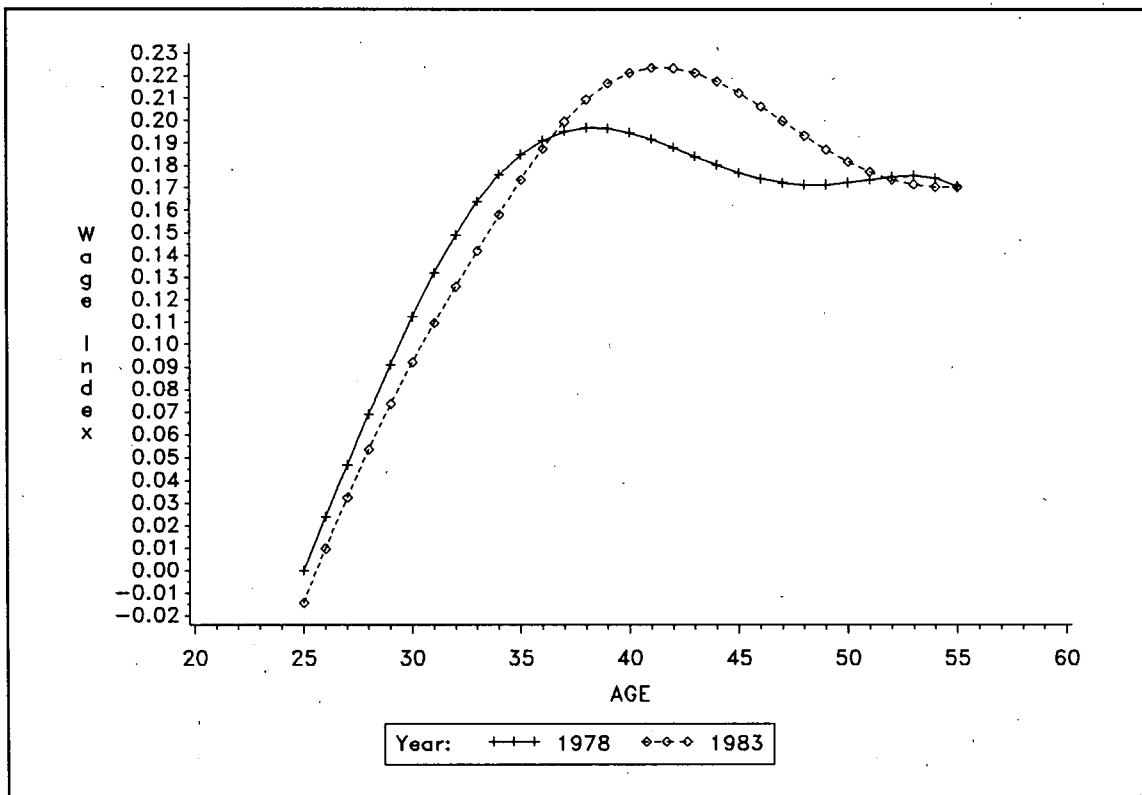


Figure 22: Cross-Section of Predicted Wages 1978 and 1983 - Educ = (C) Abitur - Median

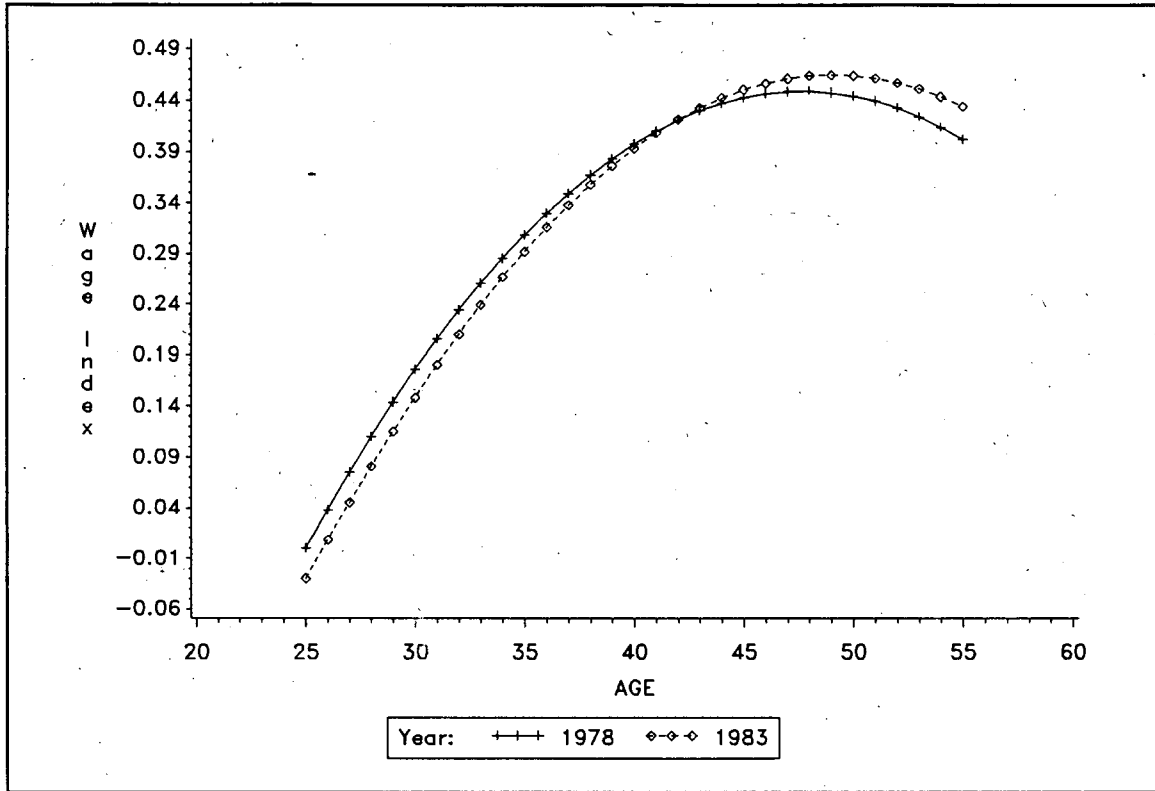


Figure 23: Cross-Section of Predicted Wages 1978 and 1983 - Educ = (D) FH-/UNI-Abschluß - 25%-Percentile

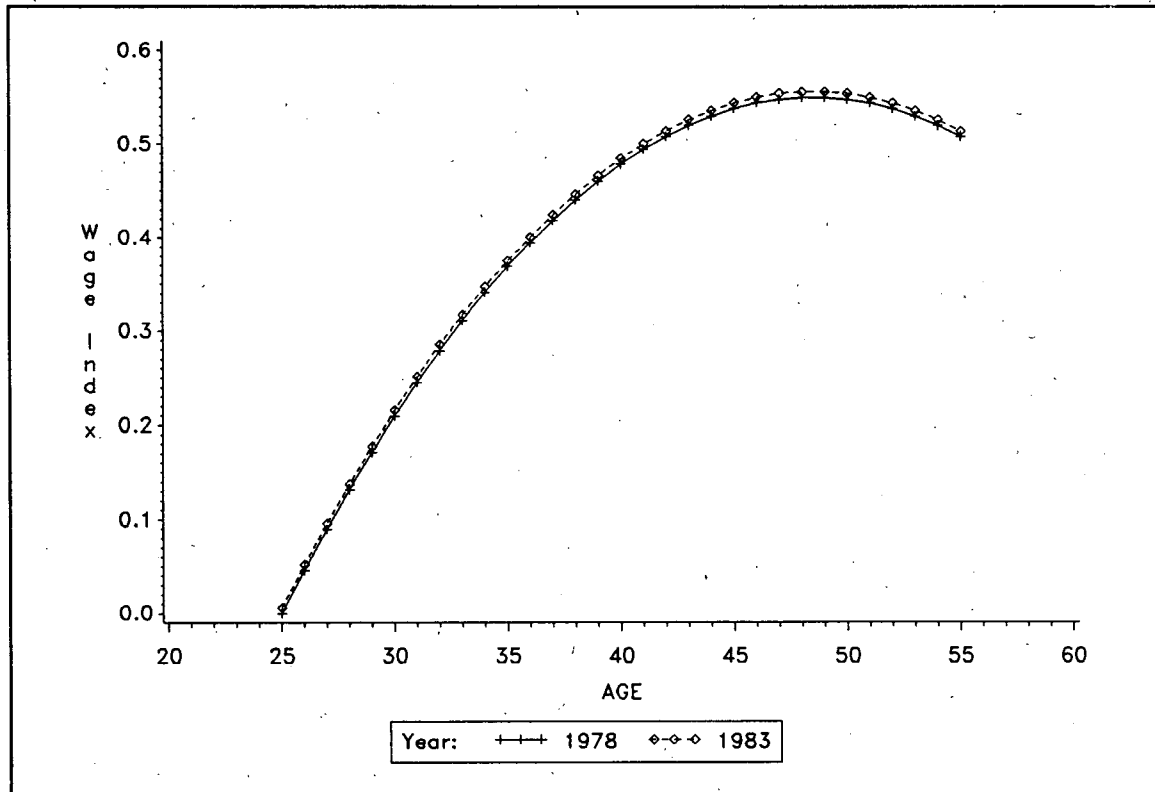


Figure 24: Cross-Sections of Predicted Wages 1978 and Cohort Profiles - Educ = (A)
Ohne abgeschl. Berufsausb. - Median

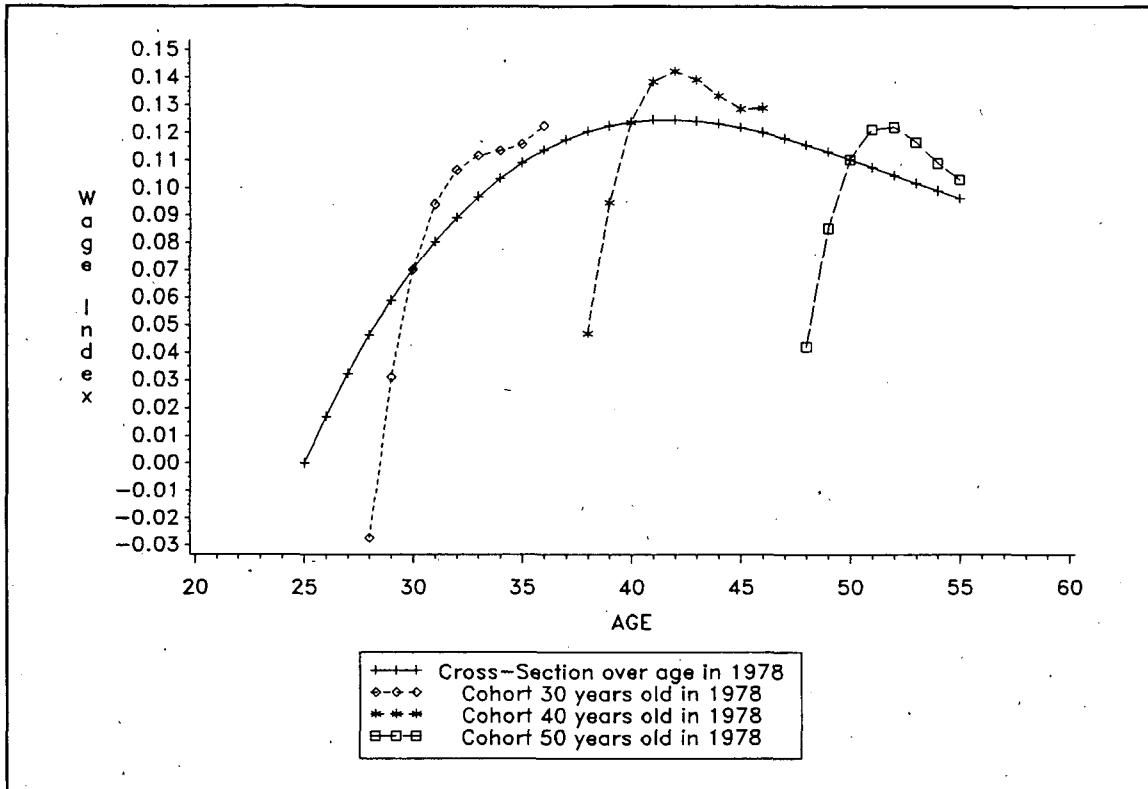


Figure 25: Cross-Section of Predicted Wage 1978 and Cohort Profiles - Educ = (B)
Mit abg. Berufsausbildung - Median

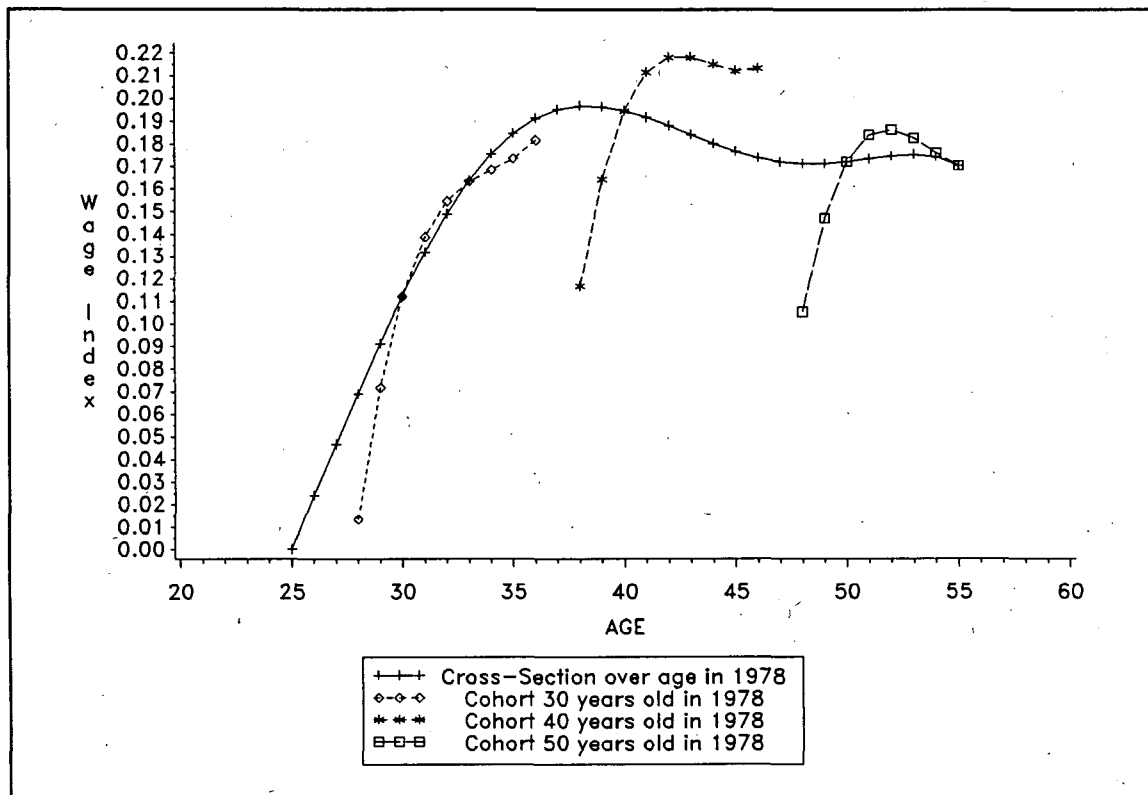


Figure 26: Cross-Section of Predicted Wages 1978 and Cohort Profiles - Educ = (C) Abitur - Median

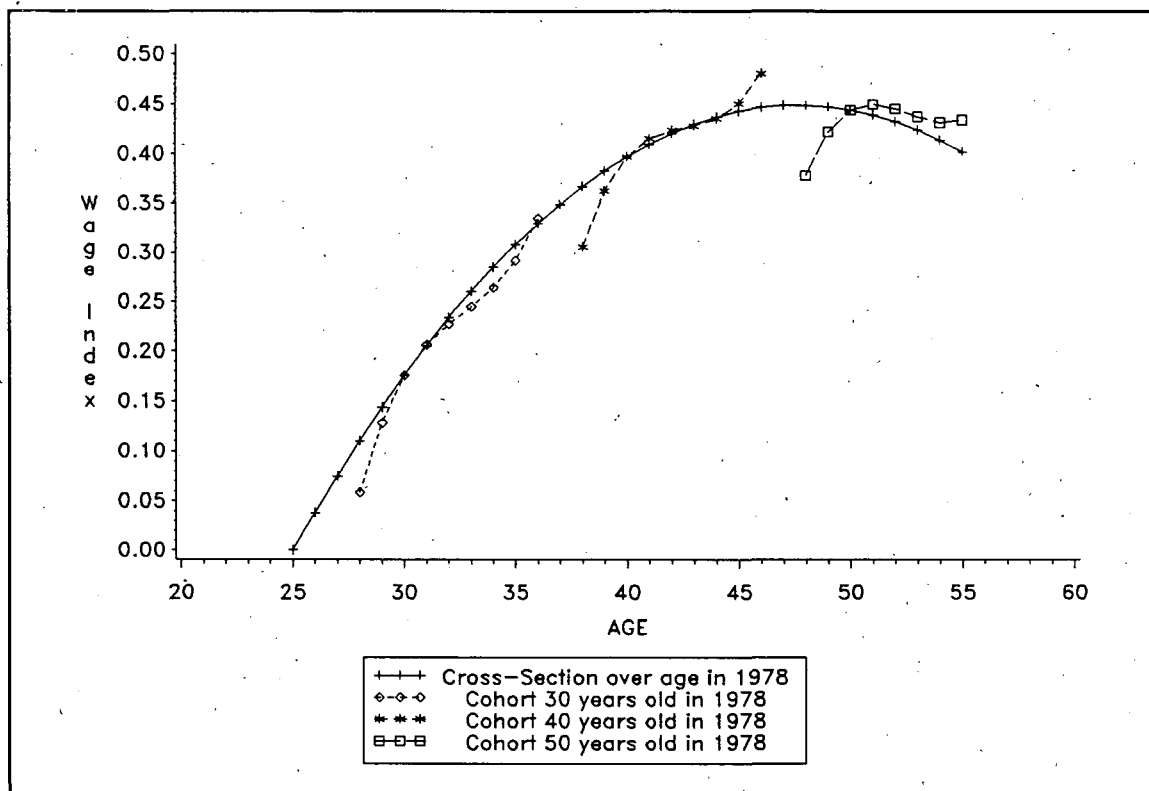


Figure 27: Cross-Section of Predicted Wages 1978 and Cohort Profiles - Educ = (D) FH-/UNI-Abschluß - 25%-Percentile

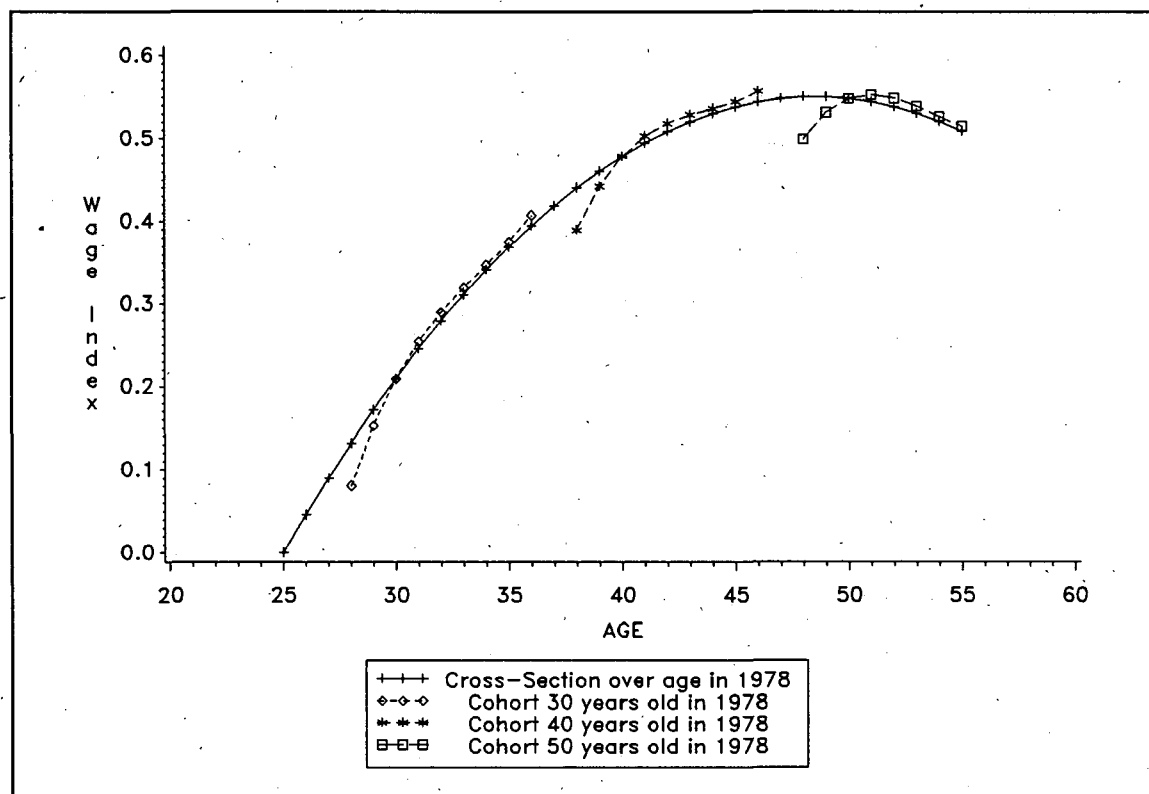
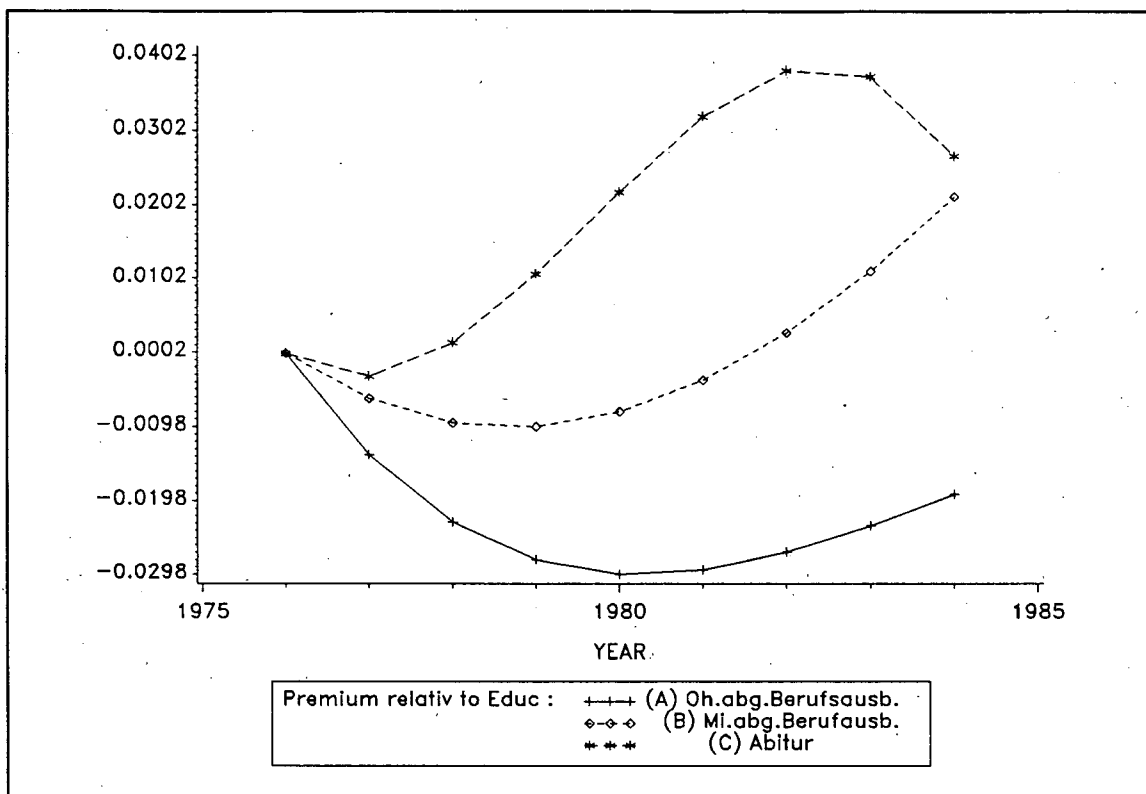


Figure 28: Change in Premium for (D) FH-/UNI-Abschluß 25%-Perzentile relative to other Education Groups Median - 1976=0



APPENDIX 3: ANALYSIS OF PERCENTILE DIFFERENCES

Figures 29-36: Percentile Differences of Log Real Wages over Time

Figure 29: Percentile Differences 90%-10% - Educ = (A) Ohne abgeschl. Berufsausbildung

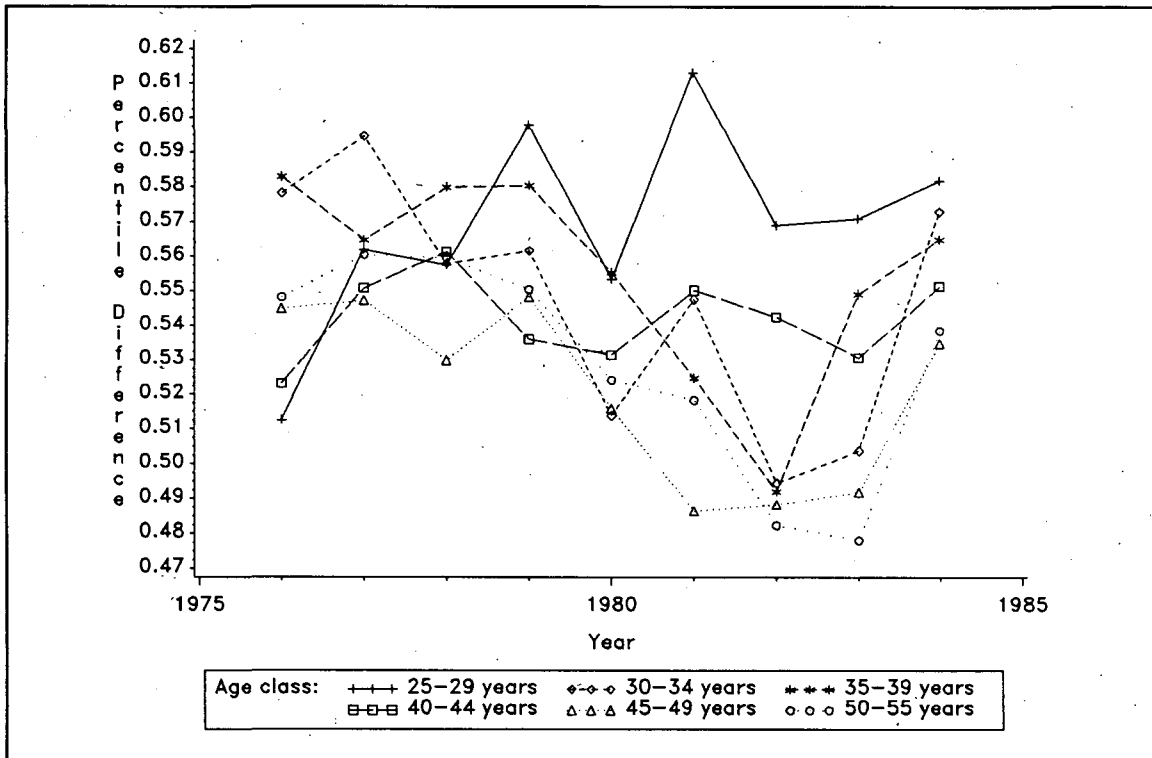


Figure 30: Percentile Differences 90%-10% - Educ = (B) Mit abgeschl. Berufsausbildung

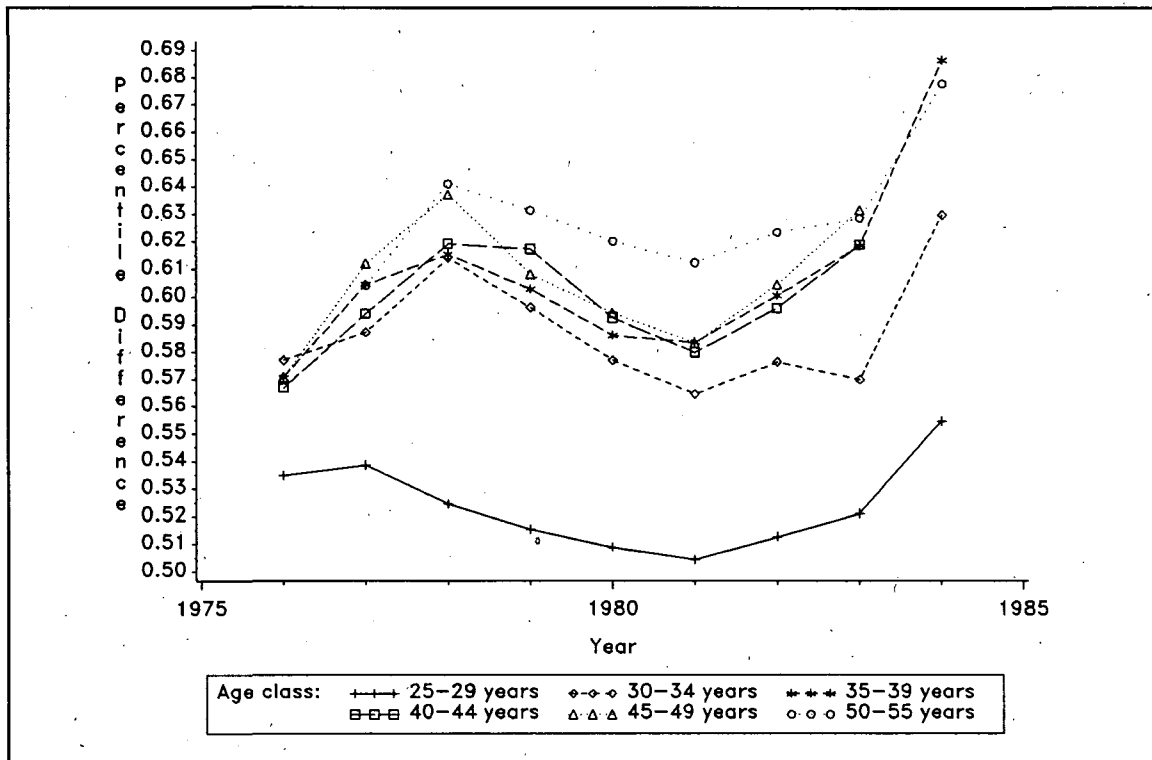


Figure 31: Percentile Differences 90%-50% - Educ = (A) Ohne abgeschl. Berufsausbildung

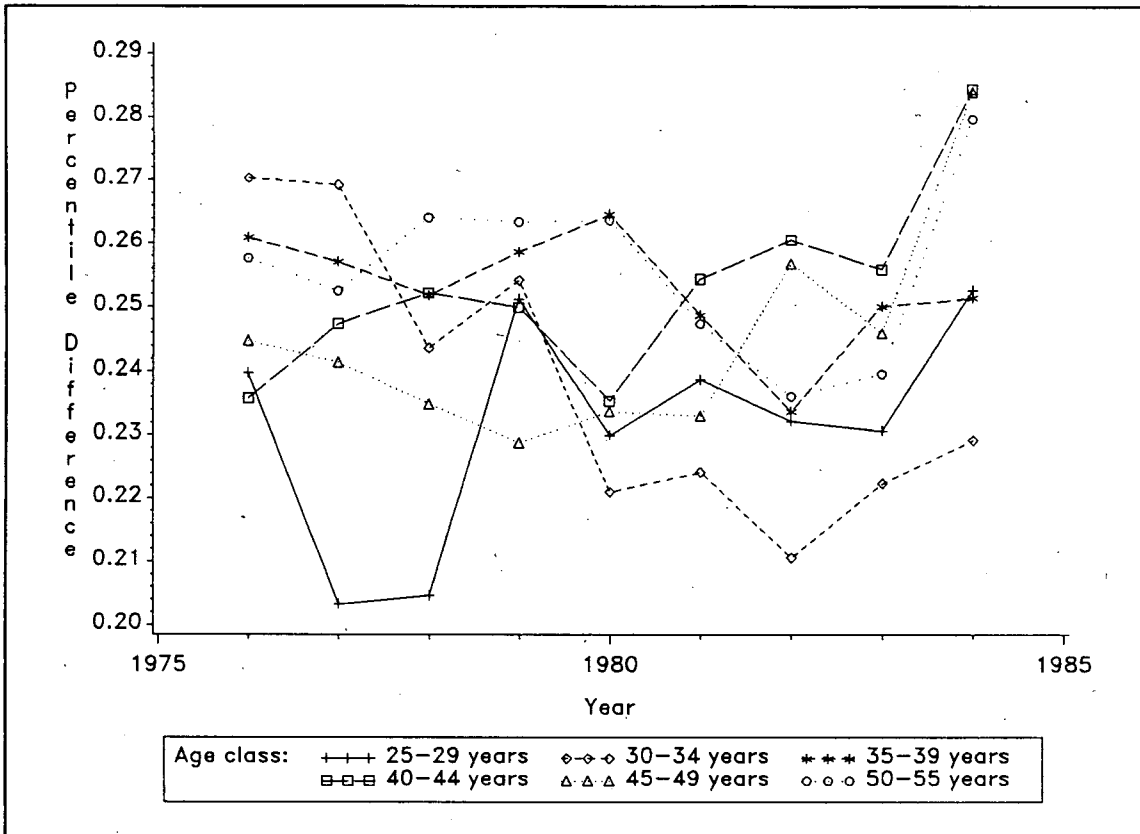


Figure 32: Percentile Differences 90%-50% - Educ = (B) Mit abgeschl. Berufsausbildung

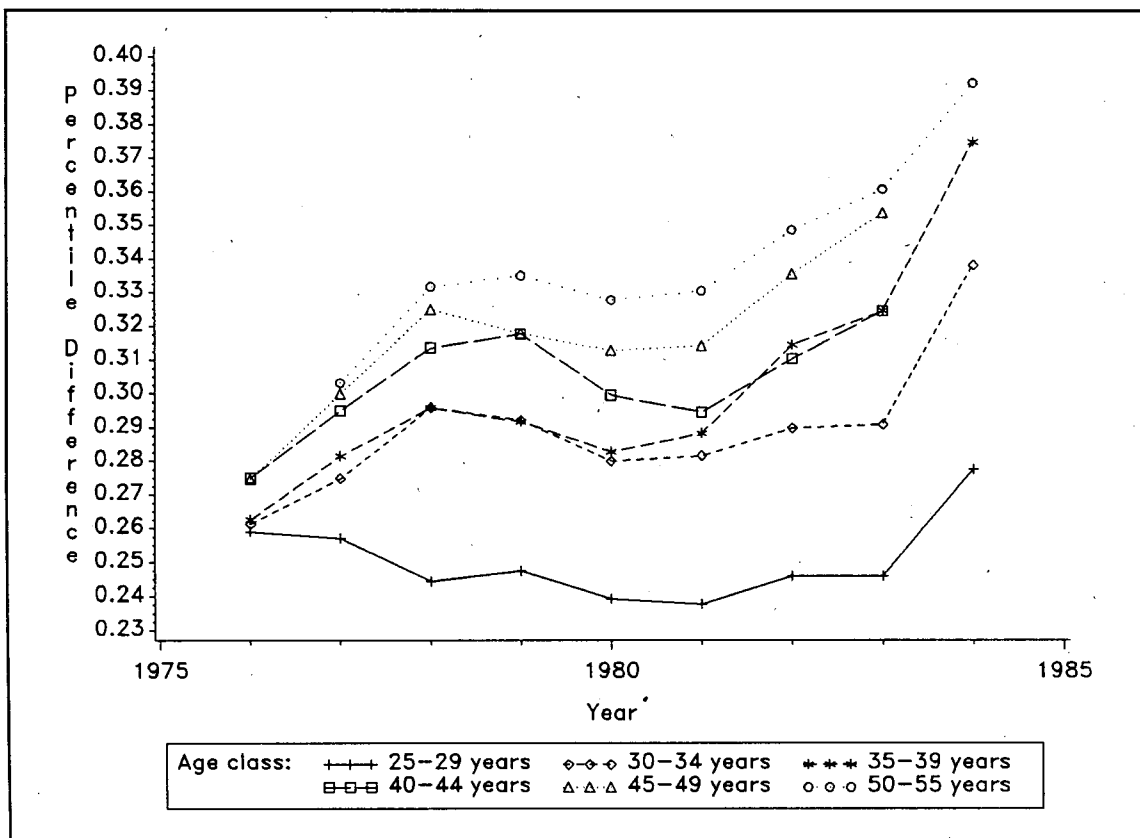


Figure 33: Percentile Differences 50%-10% - Educ = (A) Ohne abgeschl. Berufsausbildung

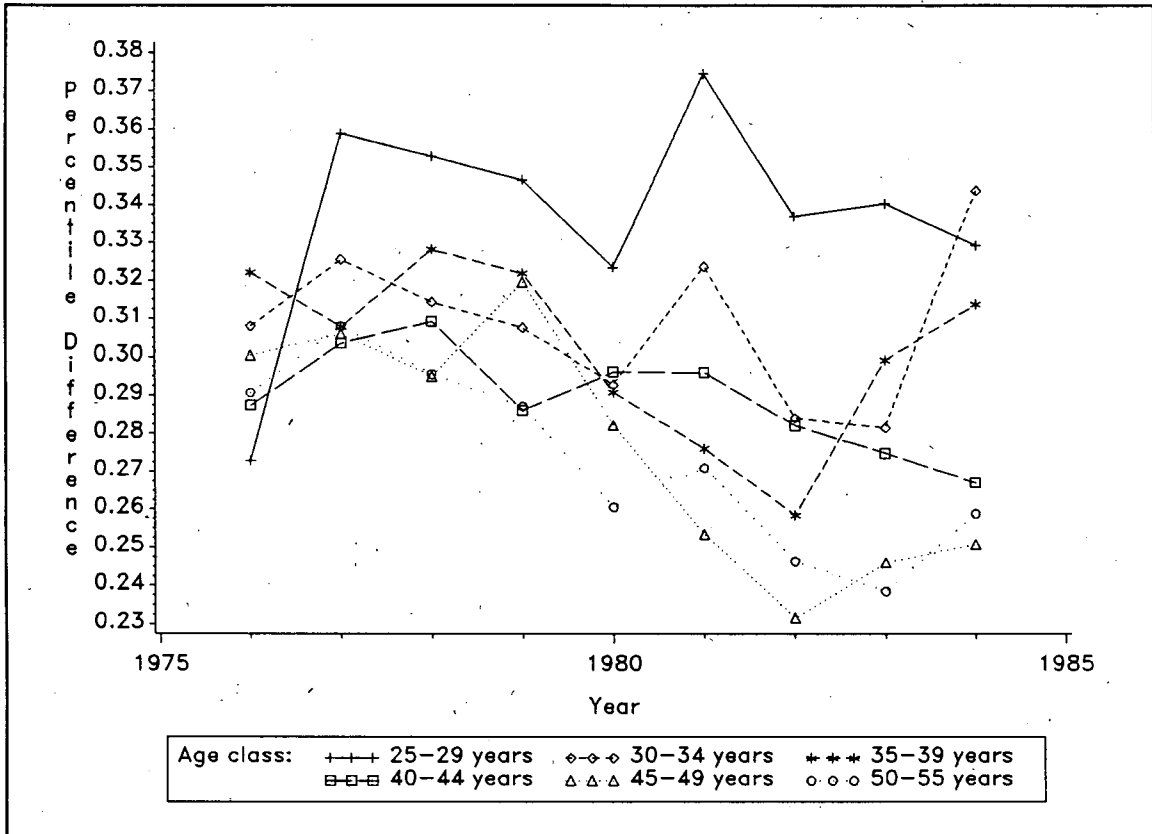


Figure 34: Percentile Differences 50%-10% - Educ = (B) Mit abgeschl. Berufsausbildung

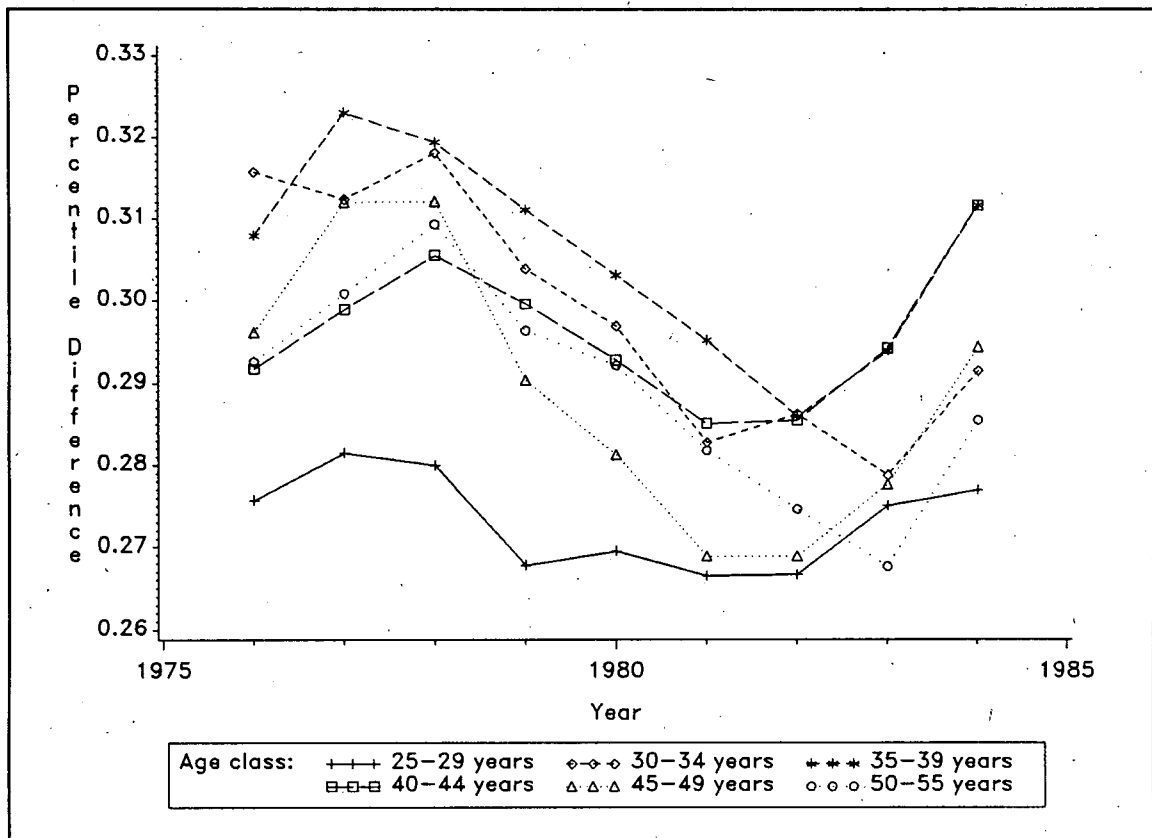


Figure 35: Percentile Differences 50%-10% - Educ=(C) Abitur

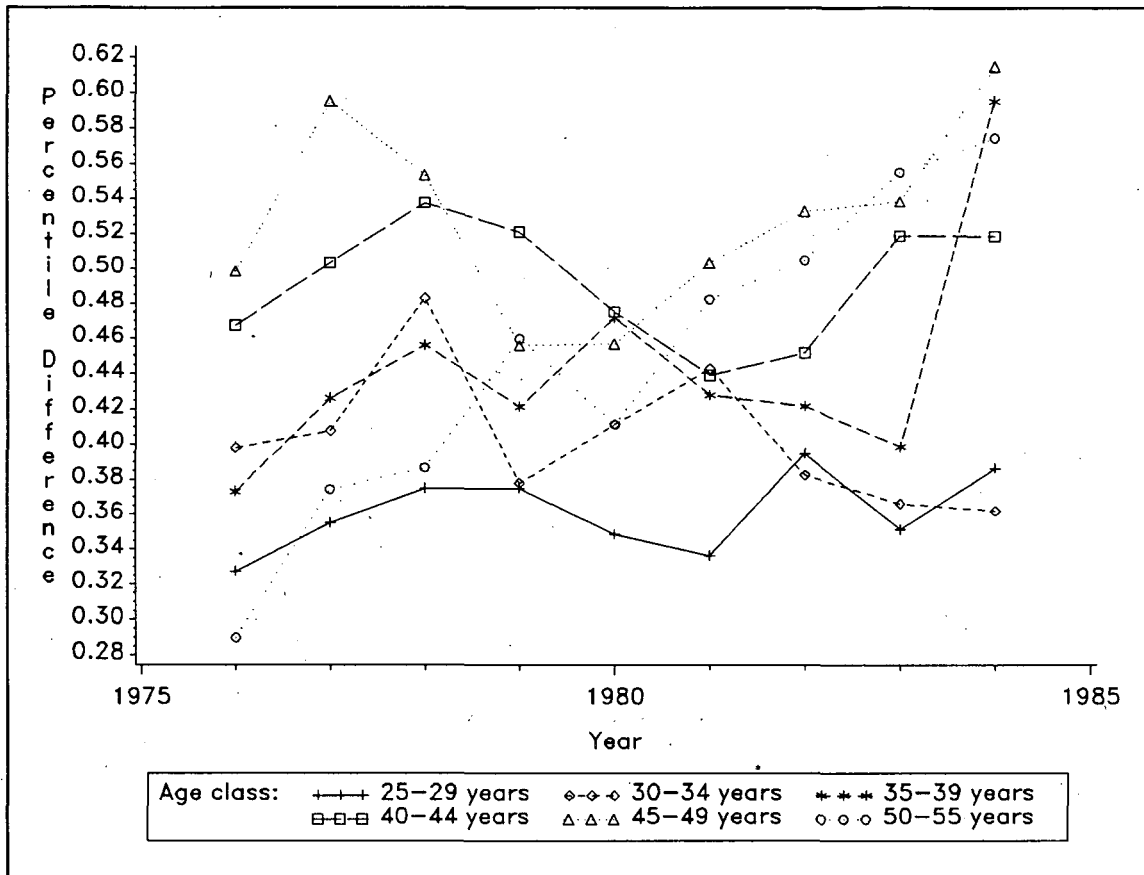
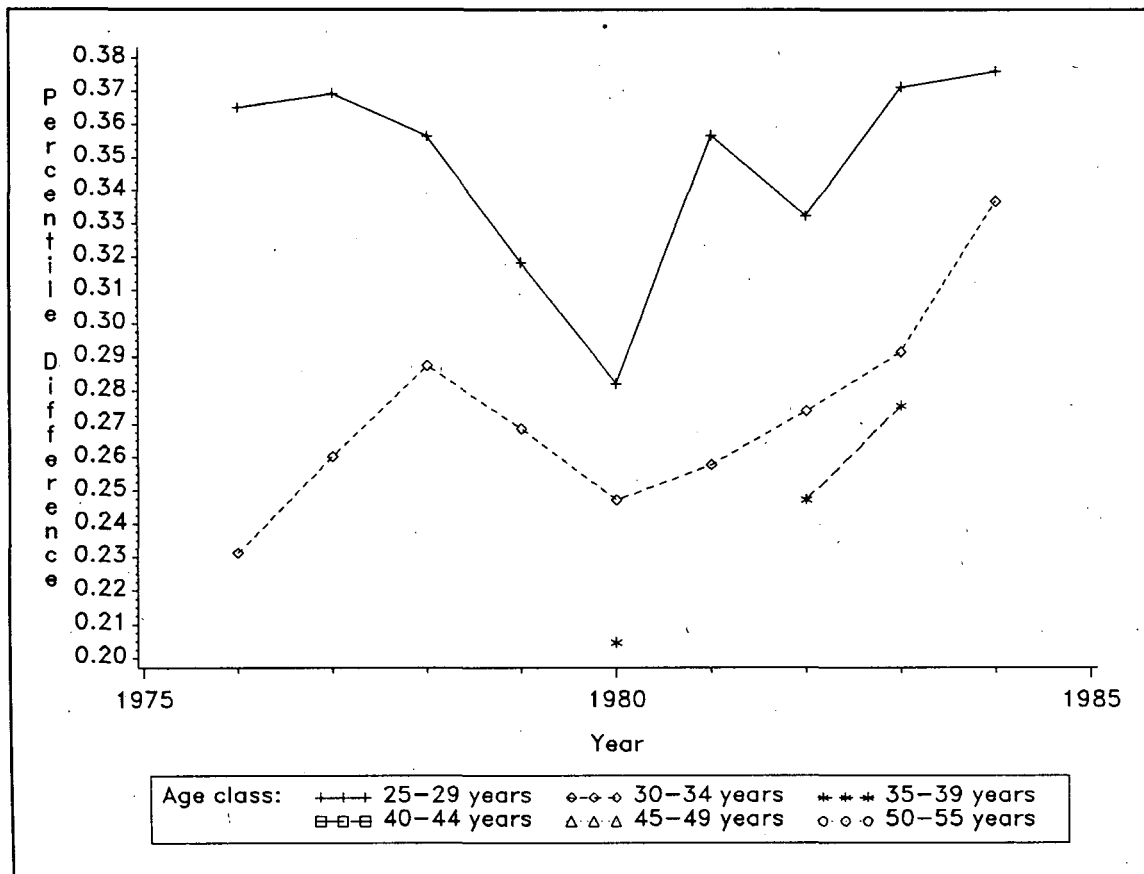


Figure 36: Percentile Differences 50%-10% - Educ. = (D) FH-/UNI-Abschluß



Figures 37-40: Estimated Year Dummies in Regressions of Percentile Differences of Log Real Wages on Age-Education-Dummies and Year-Dummies

Figure 37: Percentile Differences 90%-10%

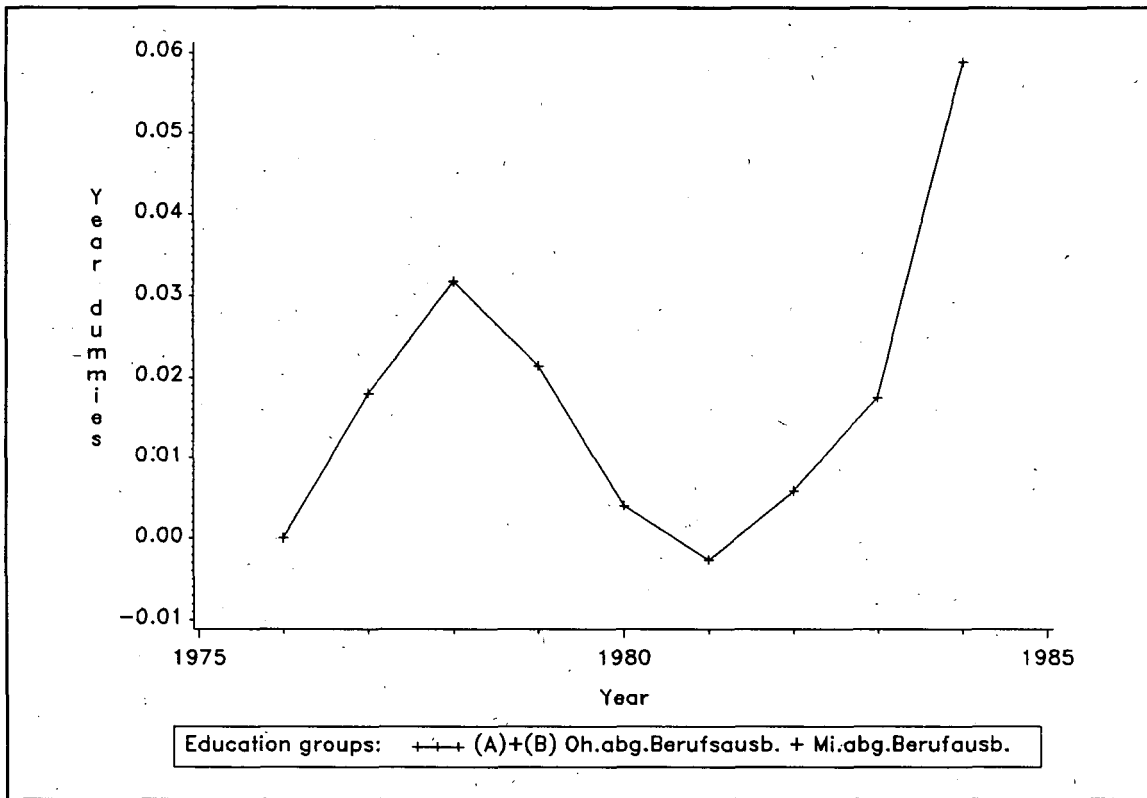


Figure 38: Percentile Differences 90%-50%

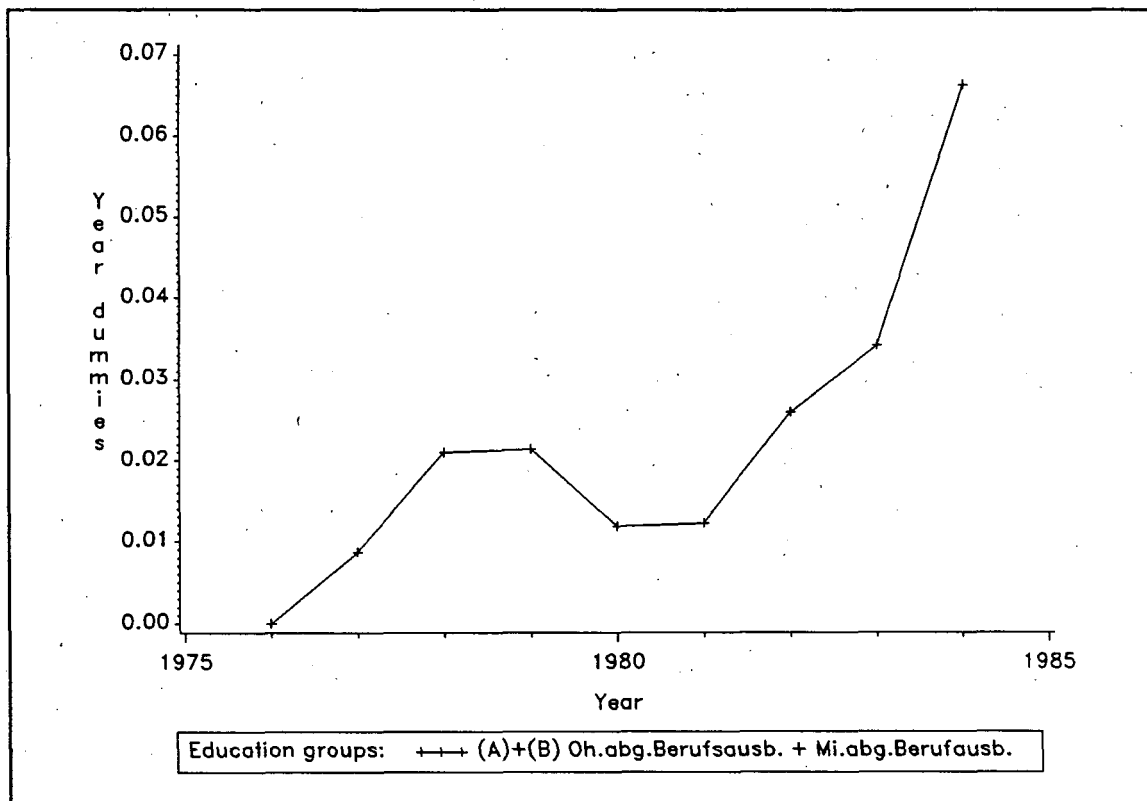


Figure 39: Percentile Differences 50%-10%

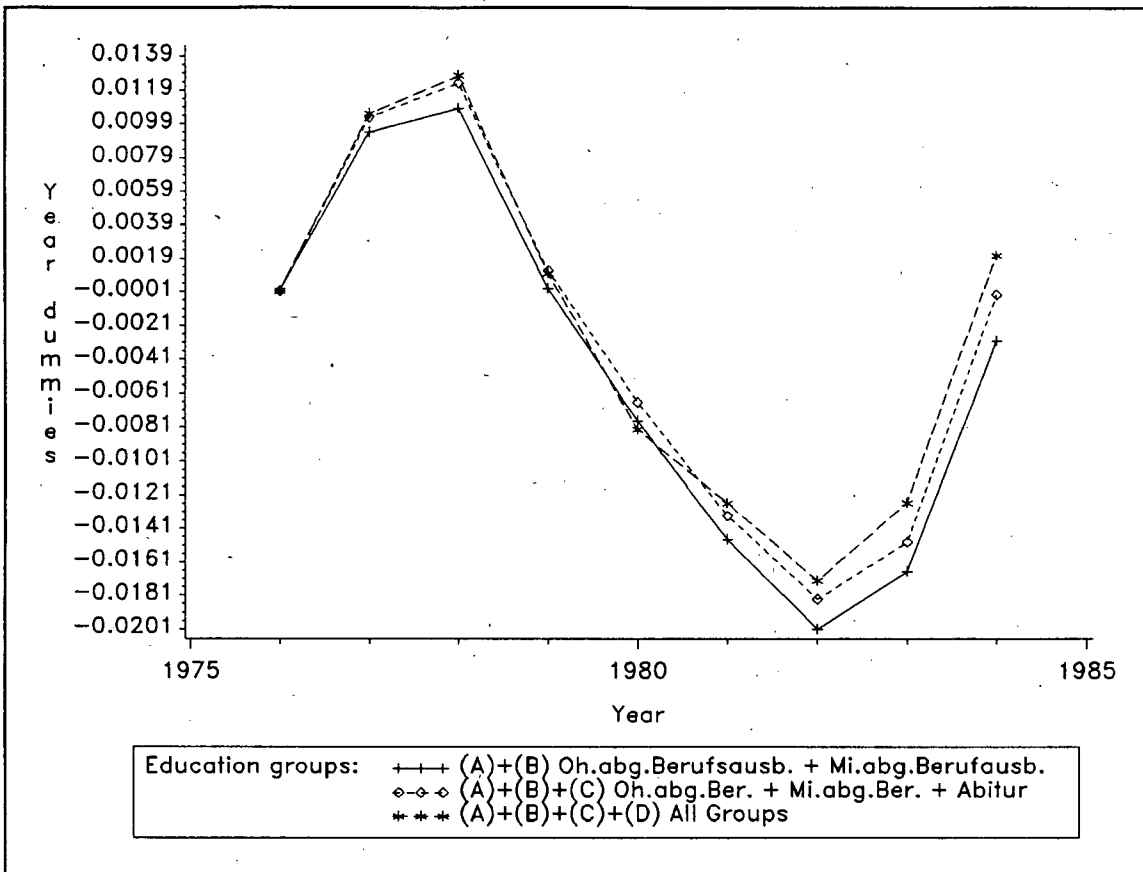


Figure 40: Percentile Differences 75%-25%

