Polarization and Rising Wage Inequality – Comparing the U.S. and Germany

Dirk Antonczyk*, Thomas DeLeire**, Bernd Fitzenberger***

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PRELIMINARY – PLEASE DO NOT QUOTE!

Abstract: In this paper, we estimate trends in wage inequality in the U.S. and in Germany. Building on the approach suggested by MaCurdy and Mroz (1995), we separately identify lifecycle wage profiles, macroeconomic shifts, and cohort wage effects. We find that between 1979 and 2004, there was widening wage dispersion in both the U.S. and Germany. However, there are many distinct patterns of this widening across the two countries. For example, in the U.S., since the 1990s, we see faster wage growth at the top (80th percentile) and bottom (20th percentile) than at the median of the wage distribution, which might be interpreted as evidence of polarization, but we see hardly any evidence of wage polarization in Germany after the mid-1980s. Moreover, we see a large role played by cohort effects in Germany - suggesting a role for supply-side effects - while we observe only small cohort effects in the U.S.. Because of these differences in the patterns of wage dispersion across the U.S. and Germany, an explanation that should be common across the two countries, such as skill-biased technological change (SBTC), cannot alone support the empirical findings. A more promising approach in order to explain changes in wage-inequality over time might thus be to consider to a larger extent the interaction between labor market institutions, supply-side effects, and SBTC.

Keywords: Wage Inequality, Polarization, International Comparison, Cohort Study, Quantile Regression

JEL-Classification: J30, J31

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* Albert-Ludwigs-University Freiburg.

Corresponding author: Dirk Antonczyk, Department of Economics, Albert-Ludwigs-University Freiburg, 79085 Freiburg, Germany, E-mail: dirk.antonczyk@vwl.uni-freiburg.de.

** University of Wisconsin - Madison, NBER, IZA. E-mail: deleire@wisc.edu.

*** Albert-Ludwigs-University Freiburg, IFS, IZA, ZEW. E-mail: bernd.fitzenberger@vwl.uni-freiburg.de.

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1 Introduction

A substantial body of research has documented increasing wage inequality in industrialized countries. Since the late 1970s and continuing through the mid-2000s, overall wage inequality has increased in the United States (e.g. Autor et al., 2008), Germany (e.g. Dustmann et al., 2009), the United Kingdom (e.g. Machin and Van Reenen, 2008), Canada (e.g. Boudarbat et al., 2006), and Australia (e.g., Atkinson and Leigh, 2007). As possible explanations of these trends, much of the research has focused on skill-biased technological change (SBTC), the supply of skilled workers, changes in institutions such as the rate of unionization and changes in the minimum wage, as well as changes in social norms.

The most prominent explanation in the literature for the increase in wage inequality in the U.S. and the U.K. is skill-biased technological change (SBTC), resulting in an increasing demand for more highly skilled labor, as better educated workers are complementaries to the new technologies (see the survey by Katz and Autor, 1999). The increase in demand is stronger than the simultaneous increase in the supply of skilled labor, leading to an overall increasing dispersion of wages. Several recent studies have argued that technological change can have a "polarizing" effect on the labor market rather than uniformly favoring more skilled groups (e.g. Autor et al., 2006). That is, technological change – for example computerization – can favor highly skilled groups at the expense of lesser skilled (routine-)service workers but to the advantage of lesser skilled (non-routine-)manual workers.

In this paper, we examine trends in wage inequality within and across cohorts of full-time working men in both Germany and the U.S. by describing the wage-distribution by a set of quantiles. Wage dispersion in both the U.S. and Germany has been rising since the end of the 1970s, as it is shown in figure 1, where cumulated real log wage growth at the median, the 20%-quantile, and the 80%-quantile is depicted for male workers for the period from 1979 to 2004. Despite strong evidence of rising wage inequality in both countries, we only find a pattern of wage polarization in the United States after 1985.[1] These patterns can be seen in that in Germany, the 80%-quantile increases faster than the 50%-quantile which in turn increases faster than the 20%-quantile, while in the U.S., the 80%-quantile outpaces both the 50%-quantile and the 20%-quantile. For the U.S. these two lower quantiles show an almost parallel trend since about 1985. This finding suggests one of two things: either polarization in the U.S. cannot be the result of a general phenomenon such as SBTC as polarization did not simultaneously occur in Germany, or

[1] For this study we use the term "polarization in wages" if the ratio of the upper quantile (e.g. the 80%-quantile) and the median increases, while the ratio of the median and the lower quantile (e.g. the 20%-quantile) is stable or even deceases.

changing institutional factors in Germany led to increased inequality among lesser skilled groups that more than offset their potential gains from technological change.

We employ an approach first proposed by MaCurdy and Mroz (1995), which allows us to separately identify cohort, age, and macroeconomic effects on wage profiles. We describe our version of their approach in Section 5, below.

Our main findings can be summarized as follows. We find that between 1979 and 2004, there was widening wage dispersion in both Germany and the U.S.. However, there are many distinct patterns of this widening across the two countries. For example, in the U.S., since the 1990s, we see faster wage growth at the top (80th percentile) and bottom (20th percentile) than at the median of the wage distribution, which might be interpreted as evidence of polarization, but we do not see any evidence of wage polarization in Germany after the mid-1980s. Moreover, we see a large role played by cohort effects in Germany – suggesting a role for supply-side effects – while we observe only small cohort effects in the U.S. Because of these differences in the patterns of wage dispersion across Germany and the U.S., an explanation that should be common across the two countries, such as SBTC, cannot alone support the empirical findings.

The remainder of the paper proceeds as follows: The next section reviews related studies in the literature. Section 3 describes the two data-sets. The following section presents the basic facts of wage growth and wage dispersion for the U.S. and Germany. Section 5 introduces our version of the MaCurdy and Mroz (1995)-approach. The corresponding empirical results are presented in section 6. Finally, section 7 provides some concluding remarks. The appendix contains graphical illustrations of our estimation results.

2 Literature

In this section we review some of the relevant literature on wage dispersion in the U.S. and Germany. We also review previous studies that have taken a cohort approach to examining trends in wage dispersion.

2.1 Development of wage dispersion in the U.S.

Between 1979 and 2004, overall cumulated wage growth of real hourly wage rates in the U.S. labor market was substantially faster at the top than at the middle and faster at the middle than at the bottom of the wage distribution. Thus, both dispersion in the top half of the distribution (as measured by the ratio of the 80th percentile of hourly wage rates to the median) and dispersion in the bottom half (as measured by the ratio of the median to the 20th percentile of hourly wage rates) increased.

However, the entire widening of the bottom half of the wage distribution occurred during the early 1980s. In 2004, the ratio of the median hourly wage to the 20th percentile of hourly wages was roughly 2. This ratio increased during the 1980s but declined slightly during the 1990s and 2000s. By contrast, the top half of the wage distribution widened in both the 1980s and thereafter.

The slight narrowing of the bottom half of the wage distribution after 1990 occurred during a period in which both the 20th percentile and the median wage outpaced inflation. By contrast, the widening in the bottom half of the wage distribution between 1979 and 1990 occurred in a period of slow wage growth, when the 20th percentile wage declined in real terms by 1.1 percent per year. Thus, factors that led to rapid growth in wages in the U.S. may also have led to polarization.

Autor et al. (2003) argue that technological change is the factor that led to wage growth and to polarization in the U.S., although their argument solely relies on employment trends. If so, we might expect to see similar patterns in wage growth and polarization in other industrialized countries. DiNardo et al. (1996), on the other hand, argue that increasing wage inequality in the 1980s and the early 1990s can be explained to an important part by changing labor market institutions, i.e. falling real minimum wages and deunionization. If this were the case, we would not necessarily expect to see similar patterns in wage growth and polarization in other industrialized countries.

Autor et al. (2003) propose a nuanced version of the SBTC hypothesis by operationalizing the way technology affects the labor market through the tasks performed at a job. Occupations are distinguished by the composition of the different tasks. This task–based approach argues that technological change results in a substitution of routine tasks by computers and other machines, as prices of the latter fall. Therefore, demand for workers performing non-routine tasks increases. For the U.S., Autor et al. (2003) analyze data at the occupational level and confirm that the employment in jobs involving routine tasks has fallen considerably.

In a recent study, Autor and Dorn (2009) argue that demand for low-skill service jobs, which pay low wages, has increased because these jobs involve mostly non-routine manual tasks requiring physical and interpersonal flexibility but little formal education. Hence, in contrast to the simple SBTC hypothesis, trends in wage inequality differ between the bottom and the top of the wage distribution. This has spurred interest in the so called polarization hypothesis both of wages and employment.

2.2 Development of wage dispersion in Germany

In Germany an increase in wage inequality in the lower half of the wage distribution began in the mid-1990s – a period in which real wages at the bottom were decreasing and wages at the median were growing. Between the early 1980s and the early 1990s, when wage inequality was astonishingly stable in the lower part of the distribution, wage growth at and below the median was substantially higher than in the decade to follow. These patterns for Germany are thus quite similar to those for the U.S. and suggest that at least to some extent the same factors are at work, though at different points in time.

In the U.S. a recession took place at the beginning of the 1980s, at the same points unions were weakened[2], the real value of the minimum wage fell, and the 50-20 difference increased. During generally increasing wages in the 1990s the 50-20 difference decreased somewhat. For Germany the 50-20 difference was constant during the 1980s, when wages were growing. After the recession in Germany in 1992/93 wages moved sideways, union-membership started to decline, and the 50-20 started to increase.

Even though wage inequality in West Germany started to rise at the top of the wage distribution in the 1980s, this rise was delayed for about ten years at the bottom. The developments in Germany[3] for the 1980s are consistent with the SBTC hypothesis (Fitzenberger, 1999), if one allows for the possibility that growing wage inequality in the lower part of the wage distribution was prevented by labor market institutions such as unions and implicit minimum wages implied by the welfare state. Based on administrative data from the IAB[4], Dustmann et al. (2009) confirm that wage inequality in West Germany has been rising since the 1980s. The study argues that wage inequality at the top of the wage distribution began to rise during the 1980s (see also Fitzenberger, 1999 and Fitzenberger and Kohn, 2006) whereas wage inequality at the bottom of the wage distribution only started to increase during the 1990s. The strong deunionization (see also Dustmann et al., 2009; Fitzenberger et al., 2010) is likely to have contributed to the increase in inequality at the bottom of the wage distribution. Gernandt and Pfeiffer (2007) find that the increase

[2]One may speculate that increasing unemployment has triggered the weakening of the unions and attitudes towards them. In the U.S. in the 1980s, in Germany in the 1990s.

[3]As the wage structure between West Germany and East Germany differ considerably and that the sample used here does not contain information for East Germany until the 1990s, we concentrate on West Germany. Frequently we will refer to it as Germany though.

[4]The German *Institute for Employment Research* of the Federal Employment Service in Nuremberg.

in wage inequality[5] between 1994 and 2005 has been much stronger for workers with low tenure compared to workers with high tenure. Thus, changes in wages over time seem to take place predominantly for new hirings whereas workers with higher tenure seem much less affected[6] – an indication that cohort-effects may play a role for the development of the German wage structure.

Spitz-Oener (2006) adapts a similar task-based approach as did Autor et al. (2003). She uses unique German survey data[7] which include information on the tasks individual workers perform. She documents similar changes in tasks for Germany until the end of the 1990s as in the U.S.. In particular, her analysis also shows a large increase in jobs involving non-routine manual tasks which tend to be low-wage jobs. As a big advantage, the German data allow to distinguish tasks from occupations. Even though the task approach is successful in explaining changes in the distribution of skill groups and the change in occupations, it is difficult to rationalize the fairly large stability of the lower part of the wage structure in Germany until the mid-1990s based on this hypothesis.[8]

Manning (2004), Goos and Manning (2007), and Autor and Dorn (2009) argue that the task-based approach may rationalize the empirical fact that the share of low wage jobs involving non-routine tasks with very low skill input has increased. These jobs traditionally paid less than many of the routine jobs requiring higher skill input. This is the basis for the polarization hypothesis stating that technological change may result in a reduction of jobs in the middle of the wage distribution implying a disproportionate growth of both high wage and low wage jobs. Based on the falling demand for workers in middle occupations, one might expect that wage inequality falls at the bottom of the wage distribution and increases at the top of the wage distribution. Even though Goos and Manning (2007) find evidence for the growth of employment of both low-wage and high-wage jobs, the polarization hypothesis can not rationalize that wage inequality did not fall at the bottom of the wage distribution. In fact, the most recent studies analyzing the German wage structure find increasing wage inequality at the bottom of the wage distribution (e.g. Kohn,

[5]The authors find that the increase in overall wage-inequality is mainly driven by an increase of dispersion in the lower part of the wage-distribution.

[6]These results relate in a sense to the study by (Card and Lemieux, 2001) considering the U.S., Canada, and the UK, in which the authors find that the increase in the educational wage differentials is mainly driven by larger skill-premia for younger cohorts in the labor market – the wage-premia for older workers change considerably less.

[7]Four waves of the "Qualification and Occupational Career" survey from the late 1970s until the late 1990s.

[8]In a recent study, Black and Spitz-Oener (2007) extend the task-based approach to analyze the change in the gender wage gap between 1979 and 1999. Their results confirm the polarization theory in the labor market regarding the growth of both low-skilled and high–skilled employment. The authors point out, that the pattern of polarization of employment is more pronounced for women compared to men.

2006; Gernandt and Pfeiffer, 2007; Dustmann et al., 2009). Autor and Dorn (2009) clarify that the polarization hypothesis may also be consistent with rising wage inequality at the bottom of the wage distribution, if the manual low-skill jobs at the bottom of the wage distribution exhibit very low productivity levels and the complementarities between goods produced by high-skilled workers and services in the low-skill jobs are not strong. For Germany, Dustmann et al. (2009) show that consistent with the polarization hypothesis for employment, occupations at the top of the wage distribution experienced the largest growth of employment shares, and growth of employment shares for the occupations in the middle of the wage distribution appears to be smaller than growth for occupations at the bottom of the wage distribution. They also find a positive statistical relationship between the change of the share in occupational employment and the change of daily wages for the region above the median, while this correlation is negative for the region below the median. The authors conclude that the development of rising wage dispersion in the lower part of the wage distribution is better explained by episodic changes, e.g. deunionization, than by technological change. Antonczyk et al. (2009), analyzing the very recent changes between 1999 and 2006 in the German wage structure of male workers likewise conclude that a task-based approach can not explain the rise in wage inequality and suspect institutional changes for the rise of the wage dispersion in the lower part of the distribution.

2.3 Cohort Studies on Wage Dispersion

MaCurdy and Mroz (1995) pioneered the methods we use in this paper in order to decompose changes in the wage distribution into cohort effects, time effects, and age effects. Their approach has been adopted by a number of studies, including Gosling et al. (2000), Fitzenberger et al. (2001), Fitzenberger and Wunderlich (2002)

Other cohort based approaches to the changing wage distribution have been adopted as well. For example, Card and Lemieux (2001) propose a model which allows for imperfect substitutability between younger and older workers to explain the fact that the increase of the educational gap between college- and high-school graduates is mainly driven by an increasing wage gap across skill-groups among younger workers. The authors argue that driving force of this phenomenon is the slowdown of the growth rate of skill-upgrading beginning with cohorts born in the 1950s, while relative demand for higher-skilled workers kept increasing steadily. The authors thus conclude that "the shifting structure of the returns to college in the United States, the United Kingdom, and Canada is a reflection of intercohort shifts in the relative supply of highly educated workers".

3 Data

In this section we describe the data we use for our analysis – the U.S. Current Population Survey (CPS) and the German IAB employment subsample (IABS). To the extent possible, we compile the data in a way so that the two data-sets are similar.

3.1 CPS

The first data-set used for this analysis come from the Current Population Survey, Outgoing Rotation Groups from 1979-2004. Wages are inflated to 2004 dollars using the CPI-U-RS. Workers' calculated hourly wage rates are either the reported hourly wage (for the 60 percent of workers paid on that basis) or weekly earnings divided by weekly hours (for the other 40 percent of workers). For the latter group, the usual earnings per week divided by the usual hours per week was generally used. When information on the usual hours per week was missing (in 2004, for example, the figures were missing for 5 percent of workers not paid on an hourly basis), the analysis used the number of actual hours worked in the previous week. While that procedure minimizes the number of workers excluded from the analysis, it introduces some noise into the calculated hourly rate of pay because the actual hours worked last week may differ from usual hours worked per week. For 14 percent to 19 percent of workers not paid on an hourly basis, the number of actual hours worked the previous week was different from the usual hours per week. Most often, those workers indicated that they worked part time in the previous week for various reasons but usually worked full time. Imputed data on hourly wage rates, usual weekly earnings, and usual hours worked per week were used in the analysis. Over the sample period, the percentage of workers with imputed wage data has increased and was 31 percent in 2004.

In this study we consider workers from the sample who are between 25 and 55 years old and (usually) work full time. Skill level in 1979 is measured as a categorical variable with three values: having completed 12 years or less of school, 13 to 15 years, and 16 years or more. Those categories are defined slightly differently after 1990 because of changes in the survey: having a high school diploma or less and not having attended college; having attended college but not having received a degree; and having at least a college degree. Age is measured continuously (in years). Observations are weighted by a person-weight variable and by the hours worked in the preceding week.

3.2 IABS

The second data-set used in the empirical analysis is the IABS (IAB employment subsample). Although the IABS has observations since 1975, we only use data starting from 1979, consistent with the time period available in the CPS[9], and we also inflate wages to 2004 euros. The IABS is micro-dataset consisting of a randomly drawn 2% sample of employees who participate in the German Social Security System and is provided by the *Institute for Employment Research.* [10] The IABS contains about 400,000 individuals in each annual cross-section. This data set or previous versions of it, has been used to carry out several studies on the German labor market (e.g. Fitzenberger, 1999; Dustmann et al., 2009)[11].

There are several advantages of using data from the IABS. First, the IABS is a very large sample. Second, the IABS contains precise information on earnings, since it is administrative data rather than survey data. Third, workers can be followed over time, while, to account for changing work force, a new random sample is added annually to the already existing, but diminishing sample. This ensures that the sample stays representative for the workers contributing to the social security system. Finally, workers can also be followed while unemployed.

A major disadvantage of the IABS is censoring from above. In the case where the daily gross wage exceeds the upper social security threshold ("Beitragsbemessungsgrenze"), the daily social security threshold is reported instead. This censoring affects about the top 10%-14% of the workers in the wage distribution. Among university graduates, censoring from above can affect about half of the population. To get around the problems associated with censoring from above, we use quantile regressions, which are robust against this kind of right censoring. A second disadvantage of the data used is the existence of a structural break in 1984. Starting in 1984, one-time payments and other bonuses have been included in the data. This break leads to an increase in the observed inequality of wages at that time. A technique employed by Fitzenberger (1999) is used to correct for this.[12] Finally, no information is given on the hours of work except for whether the individuals worked

[9] Between 1975 and 1979 a slight increase of wage dispersion in the upper part of the distribution takes place and virtually no change in wage-dispersion in the lower part, as measured by the 80%-50% and 50%-20% difference of log-wages.

[10] It is mandatory for every employee in Germany to adhere to the German social security, given he works regularly and his wage passes a certain earnings threshold. Civil servants are the largest group of workers that do not participate in the German Social Security system. Taken into accounts further exceptions (e.g. students), about 80% of the German employees are covered.

[11] For a comprehensive overview of recent studies using either the IABS or the GSOEP for the analysis of wage inequality we refer to Gernandt and Pfeiffer (2007).

[12] For a detailed description (see also Fitzenberger and Wunderlich, 2002).

part-time[13] or full-time.[14] In this study, we concentrate on the group on male workers who are between 25 and 55 years old. This avoids interference with ongoing education and early retirement. Workers are grouped by their skills according to the following formal education levels given in the IABS:

(U) without a vocational training degree	(low-skilled)
(M) with a vocational training degree	(medium-skilled)
(H) with a technical college (”Fachhochschule”) or a university degree	(high-skilled)

3.3 Construction of Cohort-Year Cells

To construct cohort-year cells, we first define cells by skill-level, year of birth, and year of observation. For each of these cells we calculate different unconditional quantiles for the real wage. Applying the approach proposed by Fitzenberger (1999), this is done in the following way. The IABS contains information on the social security insurance spells comprising the starting point and the end point and the average daily gross wage (excluding employer's distribution) for this spell. As stated, in the case where the daily gross wage exceeds the upper social security threshold the daily social security threshold is reported instead. For the case where the wage is below the lower social security threshold, the employee is not obliged to pay social security contribution and is thus excluded. The daily gross wage is thus censored from above and truncated from below. The values of both thresholds change annually. Furthermore, the real wages are deflated by the price index for aggregate private consumption.

An annual wage observation for one individual is calculated as the weighted average of the wages he earned during his different spells within one year, where the spell lengths are used as the weights. The sum of the spell lengths for all individuals in one cell is used to calculate the number of employed workers within this cell. This variable is used as weight in the regressions.

The next step consists of calculating the 20%, 50%, and 80% quantile for the cells, where again the spell lengths are used as weights. This information will be sufficient for our empirical analysis, quantile regressions are carried out to analyze the data. The cohort year cells for the CPS are constructed in an analogous way, using the weights desribed above.

[13]The group of part-time workers is excluded from our analysis.

[14]Trends in wage inequality among German fulltime-working males are robust to either taking hourly wages (provided e.g. in the GSOEP), or taking monthly wages (for details see e.g. Dustmann et al., 2009).

4 The Basic Facts

4.1 Unconditional Wage Growth

Figure 1 depicts the unconditional wage growth jointly for all skill-groups between 1979 and 2004 for both the U.S. and Germany. For the U.S. wages at all considered quantiles fall until 1996, whereby declines are largest at the 20% quantile (-13 log pp). Wages at the median decline 10 log pp and those at the 80% quantile decline 4 log pp. This implies rising wage dispersion both in the upper and the lower part of the wage distribution in the U.S. Between 1996 and 2004, wages grow at all quantiles, whereby wages at the 20% quantile and at the 80% quantile rise about 9 log pp, which is 1-2 log pp more than the rise of the wages at the median. This widening of the wage distribution at the top and narrowing at the bottom is provides suggestive evidence of polarization of wages during the 1996 to 2004 period.

For Germany, wages throughout the distribution start to grow in the mid-1980s, and wages at the 80% quantile exhibit larger growth rates than those at the median and the 20% quantile. Wage inequality in the upper part of the wage distribution keeps rising steadily since the beginning of the 1980s, while wage dispersion in the lower part of the wage distribution only starts to increase in the mid-1990s. These results are in line with Dustmann et al. (2009).[15] Between 1979 and 2004 wages of workers at the 20% quantile, the median, and the 80% quantile increase by 9, 15, and 20 log pp, respectively – cumulative real wage growth between 1979 and 2004 is considerably higher in Germany compared to the U.S. Finally we point out that only during the early 1980s are German wages at the 20% quantile and the 80% quantile growing faster than wages at the median – thus only for a short period do we observe a weak pattern of polarization of wages.

Turning to skill-group specific trends, figure 2 shows the unconditional cross-sectional wage growth at different quantiles conditional on education and figure 3 summarizes overall wage dispersion (as measured by the 80-20 difference of log-wages), as well as dispersion in the lower and the upper part of the skill-specific wage distributions, as measured by the 50-20 and 80-50 differences, respectively.

In the U.S. only the group of high-skilled workers have higher real wages in 2004 than in 1979. Between 1979 and 1996 low-skilled workers lost about 32 to 34 log pp in terms of real wages. At the same time, the sharpest decline of wage inequality in the lower part of the distribution occurred among this group. Wages at the 20% quantile gained 12 log

[15] As Dustmann et al. (2009) use the 85% quantile instead of the 80% quantile and the 15% quantile instead of the 20% quantile their results differ slightly from ours.

pp during the eight following years. Workers at the median and the 80% quantile were also able to recover, but that recovery was less pronounced for these groups. The 80-50 difference stays rather stable over time, while the 50-20 difference starts to decline at the beginning of the 1990s. Wages of medium-skilled workers also increased after a low in 1996 and a clear pattern of polarization is observable since the early 1990s, as the 80-50 difference keeps increasing and the 50-20 difference starts to decrease. Finally, although only wages at the lowest quantile incurred real wage losses between 1979 and 1996 among the high-skilled workers, wage inequality in both parts of the distribution is slightly but steadily increasing since the late 1980s. Similar observations regarding the development of the wage structure have been made by e.g. Autor et al. (2006).

In Germany, only low-skilled workers at the 20% quantile had lower real wages in 2004 than in 1979 (a 10 log pp cumulative decline). This wage-loss stems from the period of a sharp decline beginning in the early 1990s. During the last twelve years of observation, the 20% quantile of wages fell by 20 log pp. Wages at the median also fell, but less strongly, while trends at the 80% quantile are flat since the early 1990s. Up until 1991/92, wages moved quite uniformly along the entire wage distribution. In 1992/93 a severe recession took place in Germany and, since then, wage dispersion was increasing in the lower as well in the upper part of the distribution.[16] Medium-skilled workers in Germany, making up the major part of the entire German workforce, experience quite similar movements as described for the overall wage distribution not conditioning on educational-level – rising wage dispersion in the upper part beginning in the 1980s and increasing wage inequality in the lower part of the distribution since the mid-1990s. Furthermore, similarly to the development of the entire wage-distribution, we observe a polarizing pattern of wages until 1984.

Figure 5 displays the skill premia (measured at the median) in both Germany and in the U.S. In Germany, the premium that high-skilled workers receive relative to medium-skilled workers grew substantially in the late-1980s and again in the late-1990s and early 2000s. The premium that medium-skilled German workers received relative to low-skilled workers fell during the early 1980s and grew slowly between the mid-1980s and 2004. By contrast in the U.S., the premia for high-skilled workers relative to medium-skilled workers and for medium-skilled workers relative to low-skilled workers both increased throughout the 1979 to 2004 period.

[16] Most low-skilled workers find themselves in the lower part of the total wage distribution. This result is thus in line with the facts we presented above.

4.2 Age Structure

We show below that changes in the age structure can imply changes in the wage structure, even when, conditional on skill-level, life-cycle wage-growth is constant across cohorts. To show this, figure 4 plots the mean age of the workers in the different skill-groups in our samples over time. The mean age of high-skilled workers rose continously and at a growing rate since the mid-1990s. The mean age of medium-skilled workers fell until the mid-1990s but grew strongly afterwards. The mean age of low-skilled workers fell until the middle of the 1990s and remained constant afterwards. The latter trend may be explained by the observation that older low-skilled workers tend to leave the workforce to a larger extent compared to younger ones.

At the beginning of the 1990s, the average age of U.S. medium-skilled workers started to rise as well and the mean age of high-skilled workers has been increasing since the mid-1980s. Similarly to Germany, the mean age of low-skilled workers in the U.S. decreased until the mid-1990s.

4.3 Employment Shares

Figure 4 further plots the employment shares of the different skill-groups for the U.S. and Germany. Interestingly, in both countries the share of low-skilled workers ceases to decline in the mid-1990s. For West Germany this might be due to a large inflow of ethnic Germans after the reunification as well as a wave of immigration of workers from East Germany. For the U.S., increased immigration might explain these trends as well. The share of high-skilled workers rises monotonically in both countries, while the relative rise is more pronounced in Germany, doubling from 8% in 1979 to 16% in 2004, during the same period the share in the U.S. rises from 16% to 22%. Medium-skilled workers in both countries make up for the largest share in educational groups. Their employment shares grew slightly until the mid-1990s and fell slightly afterwards in both countries.

5 Empirical Approach

This section presents the empirical framework to investigate the movement of the entire wage distribution for synthetic cohorts over time. A cohort is defined by the year of birth of the worker.

In order to decompose between– and within–group shifts in the wage distribution, we estimate various quantile regressions. We allow for the case that wage trends differ across cohorts indicating the presence of “cohort effects” and by quantiles indicating a trend towards increasing or decreasing within group wage dispersion. Under certain conditions, as will be made precise in the following, a cohort effect designates a movement of the entire life–cycle wage profile for a given cohort relative to other cohorts. In providing a parsimonious representation of trends in the entire wage distribution, we are able to pin down precisely the differences in wage trends across groups of workers defined by skill level. Basing the estimates on all years of observation, we are not restricted to a pointwise comparison of one–dimensional summary measures of average wage differences in two particular years, as it is often done in the literature. In light of the descriptive evidence presented in the previous section, we explicitly take into account the possibility that wage differences are sensitive to the business cycle as well as that they differ by age and by the position in the wage distribution.

Due to the inherent identification problem between age, cohort, and time effects on wages, see Heckman and Robb (1985), wage profiles based on cross–section relationships between age and wages over a sequence of years and movements of life–cycle wage profiles faced by successive cohorts are statistically indistinguishable. However, considering the wage growth experienced by a particular cohort over time or over age (of course both movements are the same), it can be tested whether apart from the differential age effect different cohorts exhibit the same time trend.

The initial version of the empirical framework described in this section was developed by MaCurdy and Mroz (1995) to estimate trends in median wages for male workers in the United States. Variants of this framework are developed and applied in Fitzenberger et al. (2001) and Fitzenberger and Wunderlich (2002) for West Germany and in Gosling et al. (2000) for the U.K..

5.1 Characterization of Wage Profiles

We denote the age of an employee by α and calendar time by t. A cohort c can be defined by the year of birth. The variables age, cohort and calendar year are linked by the relation $t = c+\alpha$. Studies of wage trends often investigate movements of “age–earnings profiles”[17]

$$(1) \quad ln[w(t, \alpha)] = f(t, \alpha) + u \quad .$$

[17] Alternatively, researchers often describe trends in “experience–earnings profiles”. Basically, the identification issue discussed in the following also applies to potential experience being constructed as “age – years of schooling – 6”.

The deterministic function f measures the systematic variation in wages and u reflects cyclical or transitory phenomena. For a fixed year t, the function $f(t, \alpha)$ yields the conventional cross–sectional wage profiles. Movements of f as a function of t describe how cross–sectional wage profiles shift over time. The cross–sectional relation f as a function of age does not describe "life–cycle" wage growth for any cohort or, put differently, the cross–section relation may very well be the result of "cohort effects". In fact, "cohort–earnings profiles" are statistically indistinguishable from "age–earnings profiles". Wage profiles can also be expressed as a function of cohort and age

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

where the deterministic function g describes how age–earnings profiles differ across cohorts. Holding age constant, $g(c, \alpha)$ describes the profiles of wages earned by different cohorts over time. Holding the cohort constant yields the profile experienced by a specific cohort over time and age. The latter is referred to as the "life–cycle profile", because it reflects the wage movements over the life–cycle of a given cohort. Again this profile reflects two effects such that life–cycle wage growth due to aging and intertemporal shifts in wages are indistinguishable.

The different parameterizations $g(c, \alpha)$ and $f(t, \alpha)$ are equivalent representations of the same wage profile. Without further assumptions, "pure life–cycle effects" due to aging or "pure cohort effects" cannot be identified. Focusing on wage trends for a given cohort over time, we use the cohort representation of wage profiles as the perspective of our analysis.

5.2 Testing for Uniform Wage Growth

Our analysis investigates whether wage trends are uniform across cohorts in the sense that every cohort experiences the same time trend in wages and the same age-specific wage growth. The latter can be attributed to labor market experience and is interpreted here as a life–cycle effect. Despite the identification issues discussed above, the existence of a uniform time trend across cohorts is a testable implication in the framework presented here. If such a uniform time trend is found, it is designated as the macroeconomic wage trend for the group of workers considered.[18] However, as will be seen from the empirical results reported in the following section, these uniform time trends differ by skill level.

One notion of wage growth proves useful: Wage growth for a given cohort in the labor

[18] If no uniform trend is found, the average across age groups combines age, time, and cohort effects.

market over time ("Insider Wage Growth"), given by

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

comprising the simultaneous change of time and age. Alternatively, holding age constant yields the change of wages earned by different cohorts at specific ages. For the age at labor market entry, α_e, entry wage growth is given by

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

again comprising two effects, namely a change of cohort and time.

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

$$(5) \quad g_\alpha = a(\alpha) + b(t) = a(\alpha) + b(c + \alpha),$$

then life–cycle wage growth $a(\alpha)$ is independent of the calendar year t. This condition is designated as the "uniform insider wage growth hypothesis" which we denote by H_{UI}. It implies that each cohort faces the same wage growth over the life–cycle due to aging $a(\alpha)$ and that economy wide shifts $b(t)$ are common to all cohorts in the same year but they occur at different points during the life–cycle of each cohort. If the separability condition (5) holds, we can construct a "life–cycle wage profile" independently of the calendar year and a macroeconomic time trend independently of age. Condition (5) is violated if interaction terms of α and t enter the specification of g_α.

Integrating back condition (5) on the derivative g_α with respect to α yields an additive form for the systematic component of the wage function $g(c, \alpha)$:

$$(6) \quad g(c, \alpha) = G + K(c) + A(\alpha) + B(c + \alpha)$$

where $G + K(c)$ is the cohort specific constant of integration. At a given point in time, the wages of cohorts differ only by the age–effect, given by $A(\alpha)$, and by a cohort–specific level, given by $K(c)$. The "uniform insider wage growth hypothesis" H_{UI} can be tested by investigating whether "interaction terms" $R(\alpha, t)$ enter specification (6) which are constructed as integrals of interaction terms of α and t in g_α.

5.3 Empirical Implementation

In order to describe wage profiles and to test the implications of uniform insider wage growth, we specify the wage function $g(c, \alpha)$ using a fairly flexible functional form, which nests the different hypotheses about uniform wage growth as special cases.

A general regression equation for the wage of individual i in the sample year t can be written as:

$$(7) \quad ln[w_{i,t}] = g(c_i, \alpha_{i,t}) + \overline{u}_t + u_{i,t}$$

where $\alpha_{i,t}$ and c_i denote the age of individual i at time t and the cohort of individual i, respectively. $g(c, \alpha)$ is specified as a smooth function of c and α. We further decompose the error term into a period specific fixed effect $\overline{u}_t$ (in addition to the function $g(c, \alpha)$) and a stochastic error term u_{it}. In the empirical analysis, we take age 25 years to be the age of entry into the labor market and we define $\alpha = (\text{age} - 25)/10$ and therefore $\alpha_e = 0$. Analogously, since the observation period starts in 1979, we define time $t = (\text{calendar year} - 1979)/10$. For each cohort, c corresponds to the time t at which α equals zero. For the cohort of age 25 in the year 1979, c equals zero and older cohorts have negative values for c.

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

$$(8) \qquad \begin{aligned} A(\alpha) &= A_1\alpha + A_{(2)}(\alpha) = A_1\alpha + A_2\alpha^2 + A_3\alpha^3 \\ B(t) &= B_1 t + B_{(2)}(t) = B_1 t + B_2 t^2 + B_3 t^3 + B_4 t^4 + B_5 t^5 \\ K(c) &= K_1 c + (1-\delta)K_b(c) + \delta K_a(c) \\ \text{with } \delta &= 1 \quad \text{for} \quad c \geq 0 \quad \text{and } \delta = 0 \qquad . \end{aligned}$$

The choice of polynomials is justified since the analysis does not intend to forecast wages outside the observed sample. For older cohorts entering before the sample period (i.e. before 1979), 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 1979), the cohort term is $K(c) = K_1 c + K_a(c)$, where:

$$K_b(c) = K_{b2}c^2 + K_{b3}c^3 \qquad \text{and} \qquad K_a(c) = K_{a2}c^2 \quad .$$

Since c takes the value zero for cohorts of age 25 in 1979, $K(c)$ is zero for this specific cohort and the cohort effects are centered around this cohort.

We include year dummies that are orthogonalized with respect to $B(t)$ in order to estimate period specific fixed effects $\bar{u}_t$. The specification of the estimated wage function is augmented by orthogonalized time dummies $\sum_{i=1979}^{2004-N_b-1} \kappa_i YD_i$, where N_b is the order of the time polynomial $B(t)$, and the κ_i's are the coefficients of the orthogonalized year dummies YD_i. The time effects for the years $i = 2004 - N_b, \ldots, 2004$ are estimated implicitly by assuming that the sequence of estimated time effects $\kappa_i, i = 1979, \ldots, 2004$ is uncorrelated with $B(t) = B_1 + B_2(t)$ and therefore with each power of t up to N_b. These $N_b + 1$ restrictions are incorporated into the definition of the orthogonalized year dummies $YD_{1979}, \ldots, YD_{2004-N_b-1}$. The orthogonalization implies that $B(t)$ is estimated as if no cyclical effects were present in the regression. Thus, $B(t)$ can be interpreted as the trend component and the orthogonalized remaining time effects as the business cyclical component. In the empirical application, we choose a fifth order polynomial in time for $B(t)$ $(N_b = 5)$, which seems to yield a satisfactory decomposition of trend and cycle.

The hypothesis of uniform insider wage growth requires equation (6) to hold against a more general alternative. In order to formulate a test of the hypothesis of uniform insider wage growth, we consider in the derivative g_α the following interaction terms of age and time:

$$(9) \quad \alpha t, \alpha t^2, \alpha^2 t, \alpha^2 t^2 \quad .$$

The implied non–separable variant of $g(c, \alpha)$ expands (6) by incorporating the integrals of (9) which are denoted by $R_1, \ldots, R_4$. For instance, R_1 is defined as follows:

$$(10) \quad R_1 = \int \alpha(c + \alpha) d\alpha = (c\alpha^2/2) + (\alpha^3/3) \quad .$$

Consequently, the most general formulation of equation (7) becomes

$$(11) \quad \begin{aligned} g(c, \alpha) + \bar{u}_t \quad = \quad & G + (A_1 - K_1)\alpha + (B_1 + K_1)t + A_{(2)}(\alpha) + B_{(2)}(t) \\ & + (1 - \delta)K_b(c) + \delta K_a(c) + \sum_{i=1}^{4} \gamma_i R_i + \sum_{i=1979}^{2004-N_b-1} \kappa_i YD_i \ . \end{aligned}$$

A formal test of the uniform insider wage growth hypothesis is:

$$(12) \quad \mathbf{H_{UI}}: \quad R_1, \ldots, R_4 \quad \text{do not appear in} \quad g(c, \alpha)$$

Only if the separability condition H_{UI} holds, is it meaningful to construct an index of a life–cycle wage profile as a function of pure aging *and* a macroeconomic trend index. Otherwise, a different wage profile would apply for each cohort. Thus, provided H_{UI} holds, the life–cycle (L) is given by

$$(13) \quad ln[w_L(\alpha)] = (A_1 - K_1)\alpha + A_{(2)}(\alpha)$$

and the macroeconomic (m) wage trend index is given by

$$(14) \quad ln[w_m(t)] = (B_1 + K_1)t + B_{(2)}(t) \quad .$$

When interpreting these indices, it is important to recognize that neither the level nor the coefficient on the linear term are identified in a strict econometric sense. In fact, identification relies on the assumption that the coefficient on the linear cohort term is equal to zero.

This assumption is motivated by equation (5) – provided it is justified in light of the data – which allows to decompose wage growth into a pure age and a pure time effect which are both common to all cohorts in the labor market. In light of this condition, setting the linear cohort term to zero is quite natural. If, for instance, also entry wages grow at the same rate as the time effect $b(t)$ before and during the sample period, the entire cross–section profile $f(\alpha, t)$ exhibits purely parallel shifts over time, a situation, one would not naturally characterize by "cohort effects". When uniform insider–wage growth is accepted, our notion of a cohort effect requires a situation where the differences in starting points of the common life–cycle profile differ from the macroeconomic wage growth experienced by the cohorts in the labor market. For this reason, we also orthogonalize our polynomial sprecifications for $K_a c$ and $K_b c$ with respect toa linear cohort effect.

5.4 Quantile Regression Approach

The literature typically investigates movements in mean log wages based on least squares (or tobit for the case of censoring) estimation procedures. This allows one to measure how the mean of the conditional wage distribution differs across workers with different socio–economic characteristics and how that mean changes over time. However, it is also of great interest to measure within–group differences and their movement over time. Another group of more descriptive studies, see among others OECD (1996), describes the time trends in quantile differences of wages for some broadly defined groups of workers in order to analyze trends in wage dispersion on a fairly aggregated level. However, it is rarely analyzed whether within–group wage dispersion differs across workers with different characteristics.

Quantile regressions, developed by Koenker and Bassett (1978), provide a very useful tool to study wage differences across and within groups of workers with different socio–economic characteristics and how they evolve over time. In this respect, quantile regressions combine the two approaches outlined in the previous paragraph. In addition, quantile regressions exhibit certain robustness properties due to the insensitivity of empirical quantiles to outliers in wages and the fact that they can be extended to the censored case without losing their robustness properties, see Powell (1986). Since the data used in this study are topcoded, i.e. wages are censored from above, we now introduce the notation for censored quantile regressions.

For general $\theta \in (0,1)$, we estimate conditional quantiles of wages

$$(15) \quad q_\theta(ln[w_{i,t}]|c,\alpha,\beta^\theta) = g^\theta(c,\alpha,\beta^\theta) \ + \ \bar{u}_t^\theta \ ,$$

where $q_{\theta,t}(ln[w_{i,t}]|c,\alpha,\beta^\theta)$ denotes the θ–quantile of the wage in cohort–age–cell (c,α) ($\equiv$ cohort–year–cell (c,t) where $t = c+\alpha$). The vector β^θ comprises the coefficients in equation (11) relating to the set of regressors $x_{i,t}$ ($\equiv$ powers of c,α and t; year dummies). In the empirical analysis, we model the following quantiles: $\theta = 0.2, 0.5, 0.8$ (20%–, 50%–, and 80%–quantile).

We use a minimum–distance approach suggested by Chamberlain (1994) or MaCurdy and Mroz (1995),[19] for the estimation of quantile regressions when the data on the regressors can be grouped into cells and censoring is not too severe. The approach consists of calculating the respective cell quantiles in a first stage and regressing (by weighted least squares) those empirical quantiles, which are not censored, on the set of regressors in the second stage. For the dataset used in this study, the cell sizes are large enough for making this a fruitful approach (Chamberlain suggests cell sizes of at least 30). However, we do not estimate the 80%–quantile for males in skill group (H) since censoring is too severe in this case. When applying the minimum–distance approach, we use the cell sizes as weights, but we do not attempt to weight the cells efficiently using an estimate of the variance of the empirical quantile. Available estimators of the variance within cells typically require an i.i.d. assumption within the cell and an estimate of the density at the quantile under investigation. The standard error estimates are robust with respect to the weighting procedure (see the next subsection).

[19]See Fitzenberger et al. (2001), and Fitzenberger and Wunderlich (2002) for studies using this approach.

5.5 Block Bootstrap Procedure for Inference

In the context of this study, we allow for the error terms being dependent across individuals within cohort–year–cells and across adjacent cohort–year–cells. The dependence is assumed to take the form of rectangular m–dependence across time and across cohorts. We use a flexible moving block bootstrap approach allowing for standard error estimates which are robust against fairly arbitrary heteroscedasticity and autocorrelation of the error term (see Fitzenberger and MaCurdy, 1996). The block bootstrap approach employed here extends the standard bootstrap procedure in that it draws blocks of observations to form the resamples. For each observation in a block, the entire vector comprising the endogenous variable and the regressors is used, i.e., we do not draw from the estimated residuals. We draw a two–dimensional block of observations of block length eight in the cohort and in the time dimension with replacement until the resample has become at least as large as the resample size.[20] Accordingly, standard error estimation takes account of error correlation both within a cohort–year–cell and across pairs of cohorts and time periods which are at most seven years in the cohort dimension and five years in the time dimension apart.

For the weighted least squares estimation based on cell quantiles, we simply draw the blocks of at most 64 cohort–year–cells to form the resample. In addition to the cell quantile and the regressor vector, each cell also has a weight attached (employment in year equivalent) which is used in the weighted least squares regression on the resample. When the design matrix for a resample becomes rank deficient (this happens frequently with dummy specifications) the resample is dismissed. Contrasting the results presented in section 6 with conventional standard error estimates (not reported) indicates that allowing for correlation between the error terms within and across cohort–year–cells (when forming the blocks) changes the estimated standard errors considerably. Thus, it is very likely that such correlation is present and important for inference. In the absence of a clear cut decision rule about the choice of blocksize, we experimented somewhat with slightly smaller or larger blocks without changes in the substance of the results.

6 Results

Based on the empirical framework introduced above, this section discusses the estimated specifications and then presents the empirical results.

[20]When resampling, we draw new blocks until the size of the resample is equal to or larger than the respective sample.

6.1 Estimated Specifications for Wage Equations

We estimate two specifications (model 1 and 2) of equation (12) for the 20%–, 50%–, and 80%–quantile for males by skill groups (U), (M), and (H). The high degree of censoring allows only estimation for the 20%– and the 50%–quantile in the case of high–skilled (H) males in Germany. The standard error estimates are obtained by a block bootstrap procedure as described in section 5.5.

The most general specification (model 1) is given by

$$\begin{aligned} g(c,\alpha) &= G + a_1\alpha + a_2\alpha^2 + a_3\alpha^3 + b_1 t + b_2 t^2 + b_3 t^3 + b_4 t^4 + b_5 t^5 \\ &\quad + \gamma_{b2} c_b^2 + \gamma_{b3} c_b^3 + \gamma_{a2} c_a^2 + \sum_{j=1}^{4} \rho_j R_j \ , \end{aligned} \tag{16}$$

where the age polynomial is of order 3, the time polynomial of order 5, and $c_b = (1-\delta)c$ and $c_a = \delta c$ are the cohort terms before and after 1979, orthogonalized with respect to the linear cohort term. All specifications include the cyclical year dummies YD_i which are orthogonalized with respect to the time trend. Model 2 is a restricted versions of model 1:

(17) Model 2: $\rho_j = 0$ for $j = 1, ..., 4$ H_{UI} imposed

Model 2 imposes separability of wage growth into age and time effects. Statistical tests using the available data imply that conditional on cohort-effects and education, macro-shifts and life-cycle profiles are the same across cohorts, i.e. we cannot reject the hypothesis that interaction effects between age and time are zero. The decomposition which we apply is thus meaningful.

6.2 Life-Cycle Profiles

Figure 6 summarizes graphically the estimated life-cycle profiles for workers in the U.S. and Germany, normalized to zero at age 25. Note that wage growth over the life-cycle at the median wage, which closely relates to a standard human capital wage equation (Gosling et al., 2000), is positively correlated with educational level – i.e., the returns to experience are increasing with education.[21]

For the group of low-skilled workers, the pattern of wage growth over the life-cycle differs across the two countries. While in the U.S., workers experience monotonically

[21] For high-skilled workers in Germany we only estimate wages at the 20% and 50% quantiles, due to censoring.

rising wage growth over their entire life-cycle as well as increasing wage dispersion within cohorts as the cohorts age, wages at the median and above of their German counterparts experience considerably lower wage growth. Wage-growth at the 20% quantile is quite similar to that in the U.S. On the other hand, workers in the U.S. experience faster wage-growth at the median and at the 80% quantile, while German workers experience slower wage growth at the median and the 80% quantile, leading to a decreasing within-cohort wage-dispersion in Germany, but rising within-cohort wage-dispersion in the U.S.

What are possible causes of these cross-national differences? The decreasing within–cohort wage dispersion over time for German low-skilled workers may be due to a selection-process. Older German low-skilled workers at the bottom of the skill-specific wage distribution might drop out of the labor-market as they get older, e.g. due to layoffs, if their productivity lies below the wages set by labor agreements. This seems reasonable, as German unions try especially to compress wages in the low-wage sectors. Another reason might be that U.S. low-skilled workers are more heterogeneous than German low-skilled workers, as in the U.S. on-the-job training or internal education after entering the workforce is more widespread among low-skilled workers than it is in Germany, where the educational and training systems tend to be more formal.

The group of medium-skilled workers in Germany is the largest group of employees, making up 75% to 80% of the workforce during the observation period. Workers in this group typically receive vocational training after finishing between nine and ten years of secondary schooling, resulting in a total of twelve to thirteen years of formal education. For the U.S., the group of medium-skilled workers is defined as those who finished high-school and those who subsequently received between one and three years of college education – 55% to 60% of the U.S. workforce falls within this category. Interestingly, wages at and above the median change quite similarly in the U.S., exhibiting cumulated growth over the life-cycle of about 40 log pp, just as wages at the 80% quantile in Germany do. Wages at the median in Germany rise only about 28 log pp though. Wages at the lower end of the distribution in the U.S. see higher cumulated wage growth (32 log pp) over their life-cycle as well, compared to their German counterparts (23 log pp). Thus, contrary to the low-skilled, the increase of within-cohort wage dispersion associated with aging is twice as strong for German medium-skilled workers compared to U.S. medium-skilled workers.

Due to the severe censoring of the German data, we restrict ourselves to statements regarding the 20% quantile and the median for the group of high-skilled workers in Germany. Life-cycle wage growth for workers at the 20% quantile results in a cumulated gain of 56 log pp over the life-cycle. Examining the life-cycle profile at the median wage for high-skilled workers based on the conditional quantile models, described above, shows stronger life-cycle wage growth than for other skill-groups, resulting in a cumulated gain of 55-60 log pp over the life-cycle. The increase until age 50 is about 10 log pp higher at the median compared to the 20% quantile. For the group of high-skilled workers in the U.S., wages increase 48, 55, and 56 log pp over the life-cycle at the 20%, 50%, and 80% quantile, respectively – resulting once again in an increasing within-cohort wage-dispersion for this skill group.

The results regarding the development of wage dispersion over the life-cycle for the U.S. are in line with Gosling et al. (2000) findings for the U.K. The growth of wage-dispersion over the life-cycle conditional on education is negatively correlated with skill-level, i.e. in the U.S. low-skilled workers experience the highest increase in wage-dispersion over the life-cycle. For Germany the finding is similar but the dispersion seems to increase more strongly above the median for medium-skilled workers.

6.3 Time-Trends

Figure 7 depicts trends in real wages due to macroeconomic-shifts, normalized to zero for the year 1979, in the U.S. and Germany. The macroeconomic-shifts affect all cohorts uniformly within the same skill-group at the same point in time (but at different points in their life-cycle). These macro-shifts are purged of cohort effects and of life-cycle effects. At first glance we see that time-trends in the U.S. were more positive for workers with higher educational attainment than for low- and medium-skilled U.S. workers. Comparing low- and medium-skilled workers in Germany at the different quantiles, we see that the time-trends in wages were roughly the same across skill-groups. Time-trends for German high-skilled workers were about the same as for less skilled workers until the early 1990s but wage grwoth was stronger thereafter. The time-trends in wages were more positive for German workers than for U.S. workers, as the former exhibit higher cumulated growth.

For low-skilled workers in Germany, the 20%, 50%, and 80% quantiles of the wage distribution move in a parallel manner between 1979 and 1992, resulting in an uniform gain of about 8 log pp along the entire distribution. Thereafter, wages at the 80% quantile exhibit small gains, while the wages at the 20% quantile decrease, resulting in real wage losses of 5 log pp between 1992 and 2004. Wages at the median remain flat during this period. One possible cause for the declines in wages among low-skilled workers at the lower end of this wage distribution (and therefore at the lower end in the overall wage distribution) may be the large inflow (immigration) of low-skilled workers into West-Germany after the reunification, resulting in an higher supply of low-skilled workers, in combination with the recession that took place in Germany in 1992/93.

Medium-skilled workers in Germany do slightly better than low-skilled workers, in terms of time-trends at the lower end of the skill-specific wage-distribution. Time-trends for wages at and above the median are fairly similar. Cumulated wage growth at the 20% quantile for German medium-skilled workers is slightly above zero, compared to real wage losses of about 2 log pp in the group of the low-skilled. However, this masks the fact that since the beginning of the 1990s, real wage losses are more pronounced among low-skilled workers in the lower part of the distribution. Wages at the 20% quantile of German high-skilled workers were staying flat since the beginning of the 1990s. Over the entire period, cumulated wage growth is about 1 log pp for this group.

The time-trend for German high-skilled workers at the median starts to increase monotonically in the early 1980s, at an annual rate of about 0.5 log pp. Wages at the 20% quantile were rising between the early 1980s and the early 1990s, but then started to flatten out.

The mid-1990s mark a turning point in the development of the macro wage indices of both low-skilled and medium-skilled worker in the U.S.. Until that point in time, workers in both subgroups experienced real wage losses throughout the entire wage distribution, being stronger for the low-skilled (-30 log pp at the 80% and 20% quantile and -32 log pp at the median). Medium-skilled workers incurred losses of -11, -20, and -22 log pp with at the 80%, 50%, and 20% quantile, respectively. Between 1996 and 2004 wages grew considerably though at all considered quantiles of both low- and medium-skilled workers. Wages of the low-skilled at the 20% quantile grew about 10 log pp, wages at the median and at the 80% quantile experienced a gain of 5 log pp. In the group of the medium-skilled, the wage growth starting in the mid-1990s was less pronounced. Wage growth was about 4 log pp at both the 20% and the 80% quantile and about 3 log pp at the median. The estimated time-trends developed most positively for the group of high-skilled workers in the U.S.. The data reveal a cumulated wage growth of -1, 8, and 17 log pp at the 20%, 50%, and 80% quantile, respectively between 1979 and 2004.

6.4 Cohort-effects and Entry Wage Growth

Cohort-effects can occur for at least two reasons.[22] The first is supply-side effects, in the spirit of Card and Lemieux (2001), who argue that the increasing wage-premium between college graduates and high-school graduates is due to a slowdown in the growth of supply of higher-skilled workers. The second is an interaction between tenure and wage-dispersion, as put forward in the study by Gernandt and Pfeiffer (2007), which makes the point that wage-dispersion is especially increasing among workers with low tenure in Germany. Related to that argument, cohort-effects may also indicate that wage adjustments are mainly carried out among younger workers and that these effects are of a permanent nature. Of course, these two interpretations are not necessarily inconsistent with one another.

Figure 8 plots the estimated cohort effects for the different groups in both Germany and the U.S. These are quadratic and cubic terms for cohorts that enter the labor market before and after 1979, orthogonalized to the linear cohort term. For both medium- and high-skilled workers in the U.S., negative cohort effects are observed for the oldest cohorts and positive effects for the youngest cohorts. For low-skilled workers we find positive cohort-effects for the youngest cohorts and only negative ones for the oldest cohorts at the 80%-quantile. Interestingly, we find that roughly during the 1980s cohort-effects had a positive effect on medium-skilled and high-skilled workers[23] – this is the period for which Card and Lemieux (2001) observed increasing skill-premia among younger workers for the U.S..

For Germany, for all skill groups, both the youngest and the oldest cohorts exhibit negative cohort-effects, relative to the cohorts entering the labor market roughly between the mid-1960s and mid-1980.[24] Furthermore, the youngest cohorts experience higher within-cohort wage dispersion due to these effects. The results regarding Germany confirm the results by Gernandt and Pfeiffer (2007).

Cohort effects and time-trends additively define entry wage growth. To see the interaction between the macroeconomic-shifts and the cohort-specific effects, figure 14 plots the development of entry wages conditional on educational achievement. During 1979 and

[22] Changes in educational policy, or more generally, any pre-labor market conditions, may also be captured by cohort-effects in our specification.

[23] Increasing wage dispersion due to cohort effects across skill-groups may also indicate selection effects, i.e. the "ability" of workers within skill-groups can change over time.

[24] Due to the severe censoring we only observe cohort effects for the younger German high-skilled workers. The youngest high-skilled workers also seem to be negatively affected by those, compared to the cohorts entering the labor market until the mid-1990s.

2004 entry-wages in the U.S. become more dispersed among medium- and high-skilled workers, entry wages for U.S. low-skilled workers become less dispersed during this period, but the decline of entry wages for this group is severe throughout the skill specific distribution. Entry wages decline for medium-skilled workers, while they rise for high-skilled U.S. workers. The overall within skill-group wage dispersion increases by 10 log pp for the medium-skilled and 15 log pp for the high-skilled. The difference between the medians across skill-groups increases by 22 log pp. However, this is primarily due to time-effects across skill-groups. Cohort-effects across skill-groups seem to play a minor role.

Entry wages for German workers across skill-groups begin to disperse in the early 1990s. Strong negative cohort effects – being larger in size for the lesser skilled workers – for the youngest cohorts complement the dispersion stemming from the time-trends. For low- and medium-skilled workers, wages at the median in 2004 lie below their level from 1979, whereby losses are more pronounced for low-skilled workers at all observed quantiles. Furthermore, wage-dispersion among low-skilled workers is more pronounced than for medium-skilled workers. Entry-wages of high-skilled workers at the median are about 10 log pp higher in 2004 than in 1979, while the difference to wages at the 20% quantile in this group increased by 20 log pp.

6.5 Rising Wage Dispersion or Polarization of Wages?

6.5.1 Development of Skill-Premia due to Macroeconomic-Shifts

How much of the increase in wage dispersion in the U.S. and Germany are due to rising skill-premia across educational groups? Some studies have suggested that this part is substantial. For example Lemieux (2006) finds that almost half of the increase in wage inequality in the U.S. can be explained by changes in skill-premia. For Germany our descriptive results in section 4 show that the rise of the skill-premium between medium- and low-skilled workers and the increase in dispersion in the lower part of the German wage distribution in the 1990s take place during the same period. The main part of the rise of the skill-premium between high- and medium-skilled workers also seems to take place during the second half of our observed period. Dustmann et al. (2009) find that price effects seem to play a major role in explaining the increase in lower-tail inequality in Germany, without quantifying the exact impact of the rising skill-premium on wage-inequality though.

To answer this, Figure 9 depicts the development of the time-trends of median wages across skill groups and the difference between skill-groups. Cumulated wage growth over time in the U.S. at the median is positively correlated with skill-level, which we interpret as an increasing skill-premium. This steady rise in relative productivity of higher skilled workers in the U.S. may be explained by SBTC.[25] In contrast to the U.S. experience, until the mid-1990s median-wages of German workers across skill-groups move in a parallel manner. Since then, wages of the high-skilled exhibit higher growth rates than those of low- and medium-skilled workers while the skill-premium across medium- and low-skilled German workers does not change over time. The latter observation is somewhat surprising, as the unconditional dispersion between those two groups at the median is clearly increasing since the end of the 1980s (see Figure 5). What can explain these differences between the unconditional development of the skill-premium and the time-trends? Below we provide evidence that negative cohort-effects for young low-skilled workers have contributed to the increasing skill-premium observed unconditionally – which can be very well in line with the immigration story, that is an inflow of lower skilled workers into West Germany after the fall of the iron curtain.[26] Moreover, and at least as important, we find that the decline in average age of low-skilled workers and changes in the age-structure of the group of the medium-skilled (figure 4) contributed to the rising skill-premium in Germany, as Figure 11 reveals. Mechanically this happens because the median wage of the medium-skilled (low-skilled) workers increases (decreases) as medium-skilled (low-skilled) workers become older (younger). Finally unions may have successfully counteracted an increasing skill-premium between medium- and low-skilled workers, which otherwise would have prevailed due to technological change. The same mechanical compositional effects account for roughly 40% of the sharp increase of 17 log pp in the skill-premium between medium- and high-skilled workers in Germany during the early 1990s and 2004, which is observed unconditionally, the remainder is explained by diverging time-trends. Note that dispersion due to time-trends only starts increasing at the beginning of the 1990s, whereas the skill-premium in the U.S. had already been sharply rising. In the early 1980s time-trends seem to play no substantial role in explaining the somewhat increasing skill-premium between medium- and high-skilled German workers in the 1980s. The altering of the age-structure accounts for some of the increase, so might changes in the cohort-structure.[27]

For the U.S., we find that the time-trends describe the same pattern for the skill-

[25]Note that the wage-premium of U.S. medium-skilled to low-skilled workers due to macroeconomic-shifts stopped to increase entirely since the mid-1990s, it even started to slightly decrease – it also did so unconditionally, i.e. in the cross-section. This indicates that – possibly due to a more nuanced version of SBTC – wages at the median across skill-groups polarize since the mid-1990s in the U.S.

[26]Section 6.5.3 summarizes compositional effects on wage growth and wage dispersion both across and within skill-groups.

[27]Due to the severe censoring of the IABS we cannot satisfyingly determine the effect of the changing cohort structure on the skill-premium between high- and medium-skilled workers during the 1980s.

premia as are observed unconditionally – but not to the full extent. During the 1980s, when the skill-premium between medium- and low-skilled U.S. workers increased, negative cohort effects for the low-skilled were at work, perhaps also the effect of immigration. The declining age of low-skilled workers also contributed to the rising wage-premium – while the age-structure of medium-skilled workers was quite stable during the 1980s. Regarding the wage-premium between high-skilled and medium-skilled in the U.S., we see that the aging of the high-skilled contributed to an increasing premium during the 1980s. Overall, we thus observe somewhat similar patterns regarding the compositional effects on the wage-premia for the U.S. and Germany.

Macroeconomic shifts are smooth functions of SBTC, institutional factors,[28] and supply-side factors, whereby the ways in which these functional arguments interact are a priori not clear. Given that we observe two industrialized countries over the same period in time, it is likely that they had access to the same technologies. Hence our results provide evidence that technological change alone is not able to explain rising wage inequality as the wage-premium due to macro-economic shifts between German low- and medium-skilled workers does not change over the entire period and comparing high- to medium-skilled workers it only starts rising at the beginning of the 1990s. In fact, supply-side and institutional factors seem to play a key role in explaining the widening of the between skill-group wage-dispersion for Germany. A more promising approach in order to explain changes in wage-inequality over time might thus be to consider to a larger extent the interaction between labor market institutions, supply-side effects, and SBTC.[29] Note that trends in relative labor-supply across skill-groups as well as the age-pattern within skill-groups are showing very similar trends in both countries. This indicates that institutional factors – and their interaction with SBTC – may be more important than supply-side factors in explaining the cross-national differences.

6.5.2 Wage Dispersion within Skill-Groups

As the skill-premium due to time-trends did only change to a small extent in Germany, most of the increase of wage-dispersion in Germany is therefore likely to be due to diverging time-trends within skill-groups. Figure 10 depicts for each skill-group in the U.S. and Germany the development of overall wage inequality due to macroeconomic shifts within skill-groups, as measured by the difference of the time trends at the 80% quantile and the 20% quantile, as well as the wage dispersion in the upper and the lower part of

[28] Besides deunionization and the minimum wage, institutional factors can reflect social norms and incentives set by tax-systems.

[29] This point has also been made by Lemieux (2008).

the wage distribution, as measured by the 80%-50% and 50%-20% difference, respectively.

After a short period of decreasing overall wage inequality in Germany between 1979 and 1982, low-skilled workers experience a large increase in wage dispersion, whereby the increasing 50%-20% difference is the main cause of the rise in overall wage dispersion, starting in the mid-1990s. Again, a large inflow of ethnic Germans and immigration from East to West Germany after the reunification may be one driving force behind this phenomenon, assuming that these workers find themselves in the lower end of the wage distribution. Furthermore, unemployment rates in Germany are high among those workers, hence there might also be selection processes going on – thus another supply-side factor – driving these developments.

Until the mid-1990s the 50%-20% difference of medium-skilled workers in Germany remained almost unchanged, compared to 1979. Overall wage inequality rose to about 4 log pp until then, purely driven by an increasing dispersion in the upper part of the wage distribution. Since the mid-1990s wage dispersion is increasing monotonically both in the lower- and upper part of the distribution, resulting in a cumulated increase in wage dispersion of 3 log pp in the lower part and 7 log pp in the upper part, aggregating to a 10 log pp increase in accumulated overall wage dispersion between 1979 and 2004. These results are qualitatively similar to those in Dustmann et al. (2009), who observe that wage inequality in the lower part of the entire wage distribution did not start to rise until the mid-1990s.

The 50%-20% difference of high-skilled workers is quite flat until the early 1990s, when it starts increasing monotonically until the end of our observed period at an annual rate of about .8 log pp. The late increase in wage-dispersion among German high-skilled workers is interesting considering that unconditional wage-dispersion in Germany at the top started to increase already during the 1980s. Apparently this was not caused by an increasing within-wage dispersion among high-skilled workers below the median. Unfortunately, we cannot pin down the trends above the median.

Low-skilled workers in the U.S. experienced an astonishing decline in wage dispersion in the lower part of the wage distribution starting in the mid-1980s. After a short period of a rising 50%-20% difference of 2 log pp, wages at the median dropped more sharply then wages at the 20% quantile until 1996 (and thereafter increased more slowly), resulting in a decreasing dispersion of the lower part of the wage-distribution. Moreover, this decrease is the driving force behind the decline of overall decreasing wage inequality, as measured by the 80%-20% difference, as the inequality in the upper part was quite stable between

1980 and the end of the 1990s[30] (thereafter wage inequality in the upper part decreased by about 2 log pp).

Increasing wage inequality among U.S. medium-skilled workers since the early 1990s masks a polarization pattern which starts as early as the end of the 1980s. Up until then, wage inequality in the upper as well as the lower end of the wage distribution of this group increased in a parallel way. Afterwards, the 80%-50% difference kept increasing monotonically, while the 50%-20% difference started to decrease. Mechanically, this results in a small increase of the 80%-20% difference since the beginning of the 1990s.

Our results regarding wage inequality of U.S. low-skilled workers and the lower part of U.S. medium-skilled workers for the 1980s may reflect "episodic events", such as the declining real minimum wage and deunionization, and are thus in line with the study by Card and DiNardo (2002).[31]. The polarization of wages, beginning at the end of the 1980s, has also been documented in a study by Autor and Dorn (2009), who suspect the low-skill service sector to be the driving force behind this phenomenon. Chernozhukov et al. (2009) further argue that the decline of the minimum wage during the 1980s counteracted a polarization of wages during this period, as it led to a decline of wages at the lower end of the wage distribution. What is also interesting is the fact that the polarizing pattern – purely due to macroeconomic shifts – sets in at least five years before the general recovery of wages in the U.S. in the mid-1990s.

The highest increase of overall wage dispersion as well as dispersion in the lower part of the distribution is observed for the group of high-skilled workers in the U.S. In 1986, the 80%-20% difference was at the same level as in 1979, then it started increasing monotonically to reach a cumulated grwoth of 17 log pp in 2004, an increase of about 1 log pp per year. Since 1986 we also observe a steep increase of the 80%-50% difference, after it had dropped down to -2 log pp before. Accumulated wage dispersion over the entire period is a little stronger for the 50%-20% difference (9 log pp), compared to 8 log pp for the 80%-50% difference.[32] Neither unions nor minimum wages are likely to have a large impact on the developments of wages in this group. It is rather likely that technologi-

[30] During the first half of the 1990s we find some support for within-skill group polarization of wages, as the 80%-50% difference slightly increases while the 50%-20% difference sharply drops during that period.

[31] A recent study by Chernozhukov et al. (2009), building upon DiNardo et al. (1996) shows that minimum wage seems to play a larger role in 50-10 increase than deunioninzation. Autor et al. (2008), in the same line, concur that the decline of the minimum wage contributed to the rising lower tail wage-inequality.

[32] Note though that the 50%-20% difference plateaued during the second half of the 1990s, while the 80%-50% difference kept increasing. For this period we find evidence of polarization within the group of U.S. high-skilled workers.

cal change had heterogeneous effects among the group of college-graduates (see Lemieux, 2006). Moreover, changes in social norms might have played a role especially for this group (see Piketty and Saez, 2003).

What explains these differences in the development of polarization between the U.S. and Germany? For the U.S., we see patterns of polarizations due to macroeconomic shifts both within and across skill-groups.[33] For Germany, we find little evidence for any polarizing pattern of wages.[34]

As Fitzenberger (1999) and Dustmann et al. (2009) point out, the development of the German wage structure is consistent with the SBTC story, if one allows for institutional factors, such as unions and implicit minimum wages implied by the welfare state, which, in comparison to the U.S., delayed the widening of the German wage-dispersion in the lower part for about ten years. A further explanation might be that social norms in Germany have been different, an explanation which is put forward by Piketty and Saez (2003) for other continental European countries as well. Along the line of the argument brought forward by Chernozhukov et al. (2009), that is the decline of the minimum wage in the 1980s in the U.S. counteracted the polarization of wages during that period, it is also possible that the deunionization in Germany during the 1990s and the early 2000s counteracted a polarization of wages.

6.5.3 Compositional Effects on Wage-Growth and Inequality

From figure 6, which depicts the life-cycle profiles of wage-growth conditional on education, it is clear that inequality varies by age. To show this, figure 11 plots the effect of the changing age structure on wage growth and (implicitly) on wage-dispersion. This is done by using the estimates of the life-cycle profile of wages and the changing distribution of ages to calculate the implied change in wages. The increase of the mean ages both of medium- and high-skilled workers in the U.S. reflect the changes of the age structure which result in increasing wages in these two subgroups. Wage inequality only slightly increases due to the changing age structure though. The picture for low-skilled workers in the U.S. is reversed: The mean age decreases between 1979 and 2004, and changes in the age-structure lead to decreasing wages as well as less wage-inequality over time, mainly driven by declining wage dispersion in the lower part of the wage distribution. Comparing the development of the wages at the medians across skill groups it is clear that, first, throughout the entire period the changing age structure among low- and medium-skilled

[33] Autor et al. (2008) also document this pattern of polarization both within and between skill-groups.
[34] Note that employment has polarized in Germany since the 1980s (see e.g. Spitz-Oener, 2006; Dustmann et al., 2009).

U.S. workers led to an increasing skill-premium between medium and low, second, that during the 1980s the aging of high-skilled workers led to an increasing skill-premium between high and medium.

For Germany the results differ for the low-skilled. Although the age-pattern is qualitatively the same between 1979 and 2004 compared to the U.S., the rejuvenation of this skill-group, indicated by a decrease of the mean age, leads to an increasing wage dispersion over time, as the 20% quantile in this group experiences the largest life-cycle wage growth. The changing age-structure of medium-skilled workers in Germany, indicated by the rise of the mean age starting in the late 1990s, mechanically leads to an increasing wage dispersion in the upper part of the wage-distribution. The changes in the age structure only account for up to 2 log pp of the altering within-skill group changes of wage dispersion. The age-decomposition effect thus seems to play a minor role in explaining changes of wage dispersion conditional on education. The aging of German medium skilled workers since the early 1990s led to an increasing skill-premium between low- and medium-skilled workers, which, as we have shown above, is not due to macro-economic shifts. Similarly, differences in the pattern of aging between medium- and high-skilled workers led to an increasing skill-premium between those two groups.

Figure 12 and figure 13 depict the impact of the inflow and outflow of the cohorts on skill-specific wage-growth and -dispersion, respectively. The latter graphs show that starting in the early 1990s, the change in the cohort structure supports the catching-up process of both wages at the median and the 20% quantile to wages at the 80% quantile in the group of low-skilled workers in the U.S.. The 80-50 and 80-20 difference of wages had increased though before due to cohort-effects. Contrary to that, cohort-effects in Germany for the group of low-skilled led to an increasing wage-dispersion of about 5 log pp throughout the entire wage-distribution between 1992 and 2004, while before the early 1990s cohort effects led to a decreasing wage dispersion, whereby the movements of the 80-20 difference are mainly driven by changes of the wage dispersion in the lower part. Cohort effects for medium- and high-skilled workers affect wage dispersion somewhat less in both countries. Relatively to the oldest and the youngest cohorts, those in the middle seem to exhibit higher cohort-specific wage-dispersion, driven mostly by positive cohort-effects at the median and the 80%-quantile. When the presence of those cohorts in the middle is strongest– during the middle of the observed period – the increasing effect on wage dispersion within skill-groups is thus strongest. What can be inferred from figure 12 is that the sharp drop of cohort effects among low-skilled German workers mechanically increases the wage-premium between low- and medium-skilled workers in Germany. Compositional effects regarding the cohort structure also seem to increase the skill-premium between high-and medium-skilled workers in Germany since the early 1990s. For the U.S., those kind of compositional effects seem to play only a minor role.

6.6 Employment Growth

In order to describe employment growth along the wage distribution and to detect possible polarization of employment we use a method similar to that proposed by Card et al. (1999). We rank the age-education cells across skill-groups for a base year according to the cells unconditional median wages, normalized by the estimated age-specific life-cycle wage growth of the specific cells.[35] Then we calculate the cumulated relative employment growth of each cell over the next ten years.[36] Our age variable is discrete, ranging between 25 and 55, and we distinguish three educational levels, which yields 93 cells for this analysis, which Card et al. (1999) interpret as "skill-groups". The base years we choose are 1979, 1984, 1989, and 1999. The results are depicted in figure 15.

For the base years 1979 and 1984 relative changes in employment is a monotonically increasing function of the rank of wages in the base year. We find evidence of employment polarization in Germany starting with the base year 1989, which becomes more pronounced for the base year 1994. That means that for the latter two base years age-education cells which are ranked at the bottom exhibit higher growth rates than those at the middle, the highest ranked age-education exhibit the largest growth rates. For the U.S. we observe a similar pattern of polarization starting in the second half of the 1990s. The general pattern of the four graphs for the U.S. and Germany look strikingly similar for across countries.

This simple analysis helps us to separate demand-side vs. supply-side stories. In the U.S. we observe polarization in wages and employment, as a nuanced version of the SBTC-story would suggest, while in Germany we only observe polarization in employment. The latter observation might also be caused by immigration into West Germany for example. Hence only in the U.S. is this consistent with a pure demand-side story.

[35]Cells whose median wages are top-coded – this happens frequently for the group of high-skilled German workers – are given the highest ranks, whereby the general pattern of the graphs is not affected by the chosen order. We thus draw random numbers to determine the order of the ranks at the top-end.

[36]Note that in the latter period different workers are in those cells, as the age is held constant for each cell.

7 Conclusion

In this paper, we estimate trends in wage inequality in the U.S. and in Germany. A cross-national comparison of these trends is important because many stories for the widening gap in wages between highly skilled workers and less skilled workers, for example, should apply to both economies. The methods we employ enable us to separately identify life-cycle wage profiles, trends in wages (due to macroeconomic shifts), and cohort wage effects.

We find that, among low-skilled workers in Germany, there is decreasing wage inequality over the life cycle. However, for higher skilled workers in Germany and for workers of all skill levels in the U.S., there is increasing wage inequality over the life cycle.

The time trends in wages tend to favor highly skilled workers in both the U.S. and in Germany. In the U.S. for low- and medium-skilled workers, there were secular declines in wages until the mid-1990s when these trends reversed. In Germany we see the opposite pattern – rising secular trends in wages until the mid-1990s when we see a flattening (at the median) or a decline (at the 20th percentile) in wages. The result of these trends is that in recent years we have seen a increase in wage inequality among low-skilled workers in Germany and a decline in wage inequality among low-skilled workers in the U.S.

We also see a rising skill premium in both the U.S. and in Germany. In Germany, however, this rising skill premium is non-existent once we purge the time trends of cohort and life-cycle effects. That is, in Germany, the rising skill premium between medium- and low-skilled workers is entirely the result of cohort effects and aging effects. The rise for high-skilled compared to medium-skilled workers is mostly restricted to the period after the mid-1990s.

In the U.S., we see faster wage growth at the top (80th percentile) and bottom (20th percentile) of the wage distribution. This has been interpreted as evidence of polarization in previous studies (e.g. Autor et al., 2008). We see only little evidence of wage polarization in Germany.

There are important cohort effects evident in the German data. In Germany, both the old and the young cohorts of workers have sizable negative cohort effects. These effects could be the result of supply-side factors such as immigration, cohort size, or selection into skill group. In the U.S., by contrast, the size of the cohort effects is substantially smaller.

The changing age structure of the workforce has important implications for trends in wage inequality in both the U.S. and in Germany. Aging among higher skilled workers tends to lead to increase both wage levels and wage inequality in both counties. However, the declines in age among lower skilled workers has different effects in the U.S. than in Germany. In the U.S., these declines in age have the effect of lowering wages and lowering wage inequality. However, in Germany declines in age tend to lower wages and thereby increase wage inequality.

Because we observe different trends in wage inequality in the U.S. and in Germany once we account for cohort effects and the impact of the changing age structure, we find it unlikely that simple skill-biased technical change stories can account for polarization in wages and employment in the U.S. and Germany. This is because, under this simple story, we would expect to see a similar impact of SBTC in both countries. A more likely possibility is that episodic changes resulting from changes in institutional factors such as unionization or the minimum wage are responsible. Another possibility is that SBTC interacts in important ways with institutional factors and that differences in institutions across economies is the reason why we observe different trends in inequality across Germany and the U.S.

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Appendix

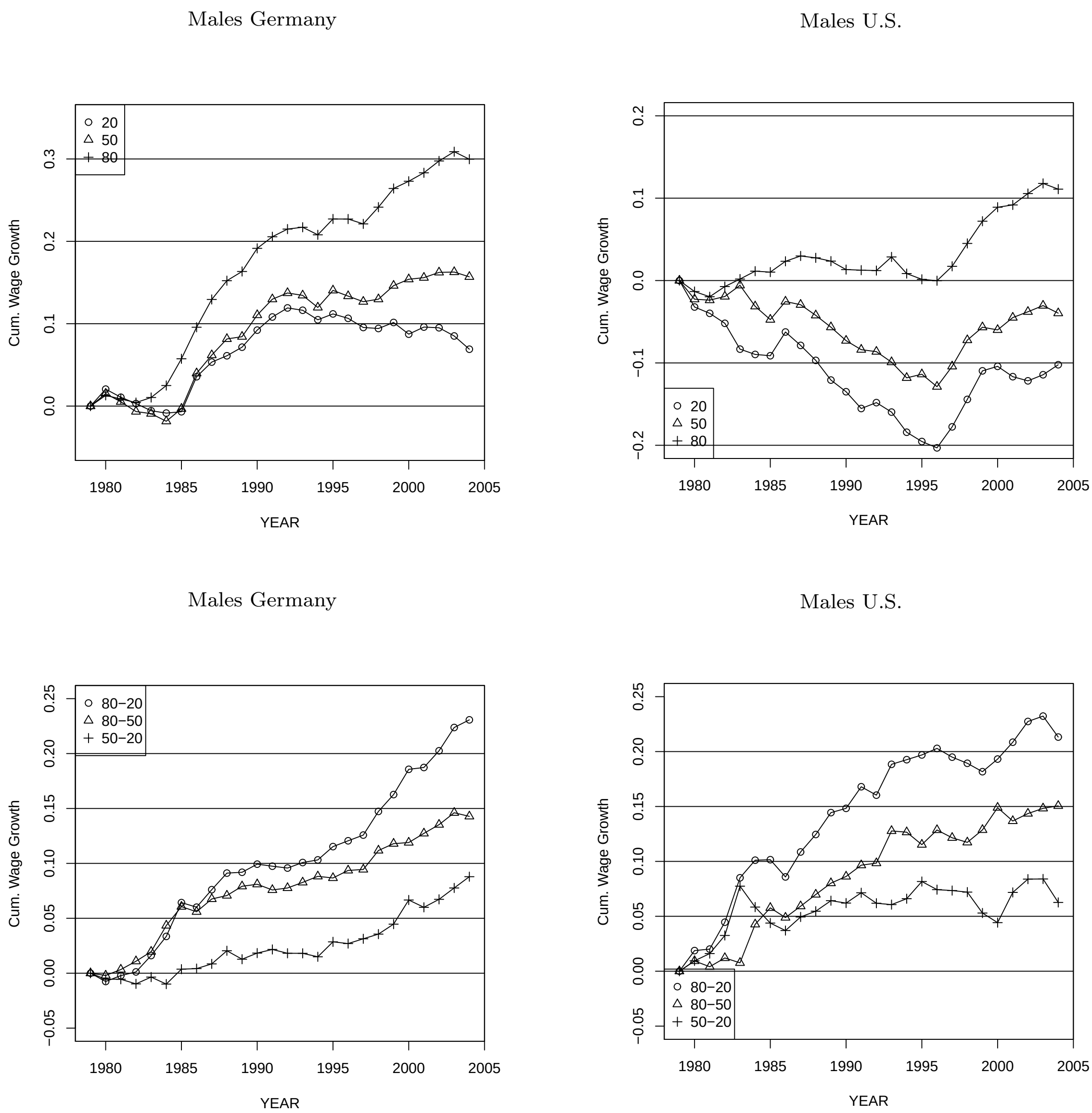


Figure 1: Total Unconditional Cumulated Wage-growth at 20%, 50%, 80% quantiles and quantile differences, 1979-2004 for males, left: Germany, right: U.S.

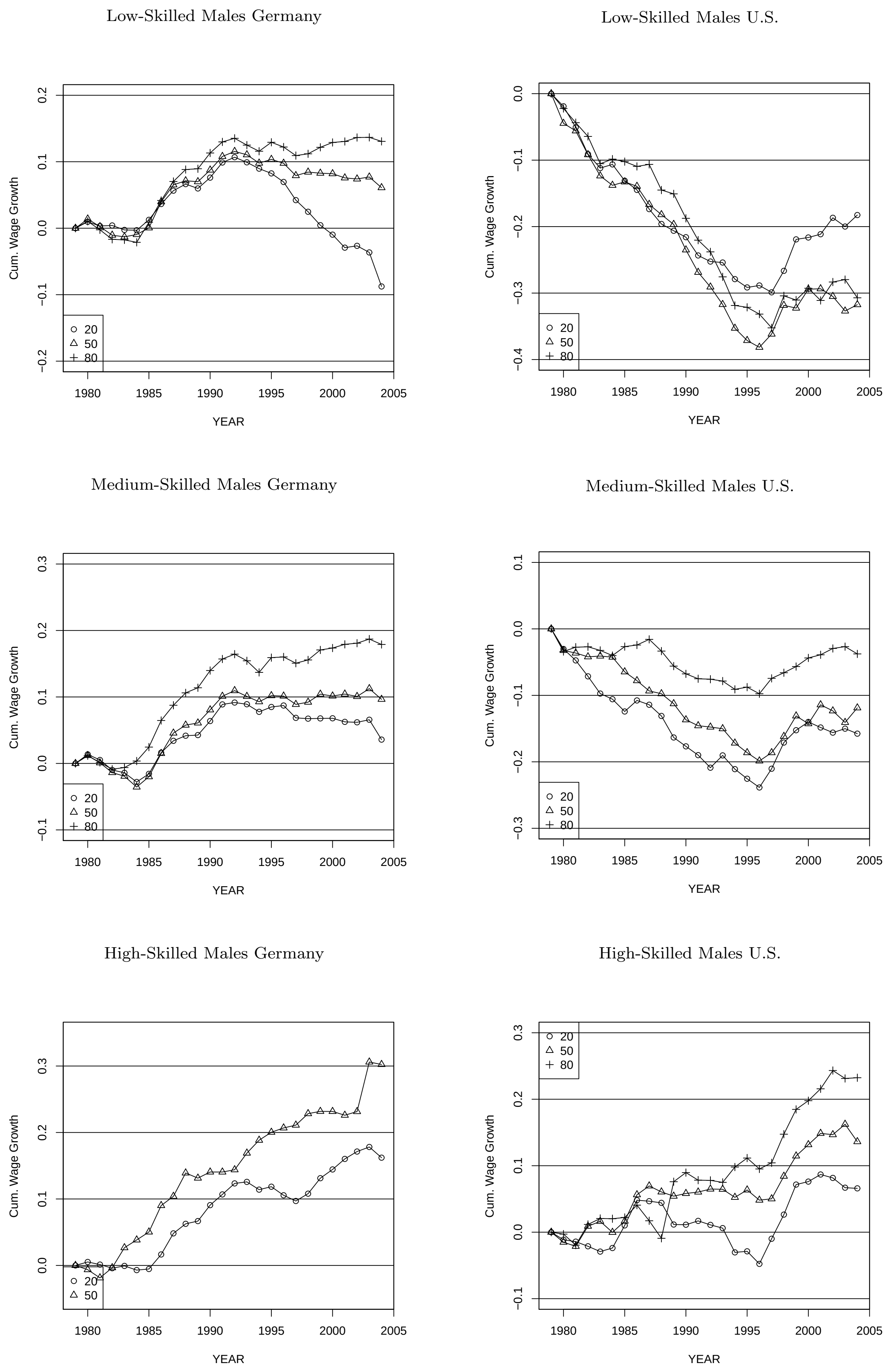


Figure 2: Unconditional Cumulated Wage-growth 1979-2004 for males, left: Germany, right: U.S.

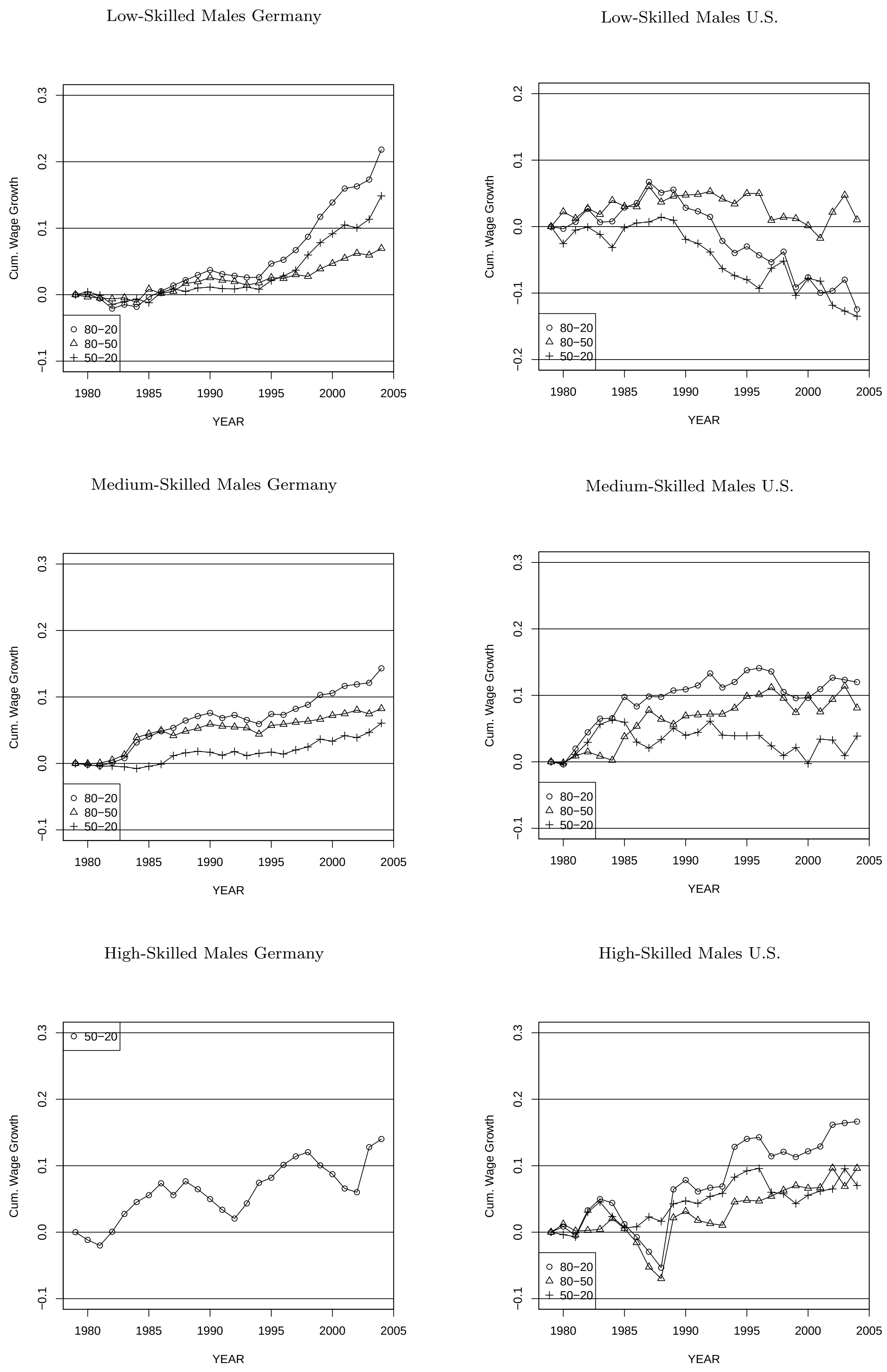


Figure 3: Unconditional Cumulated Wage-Dispersion 1979-2004 for males, left: Germany, right: U.S.

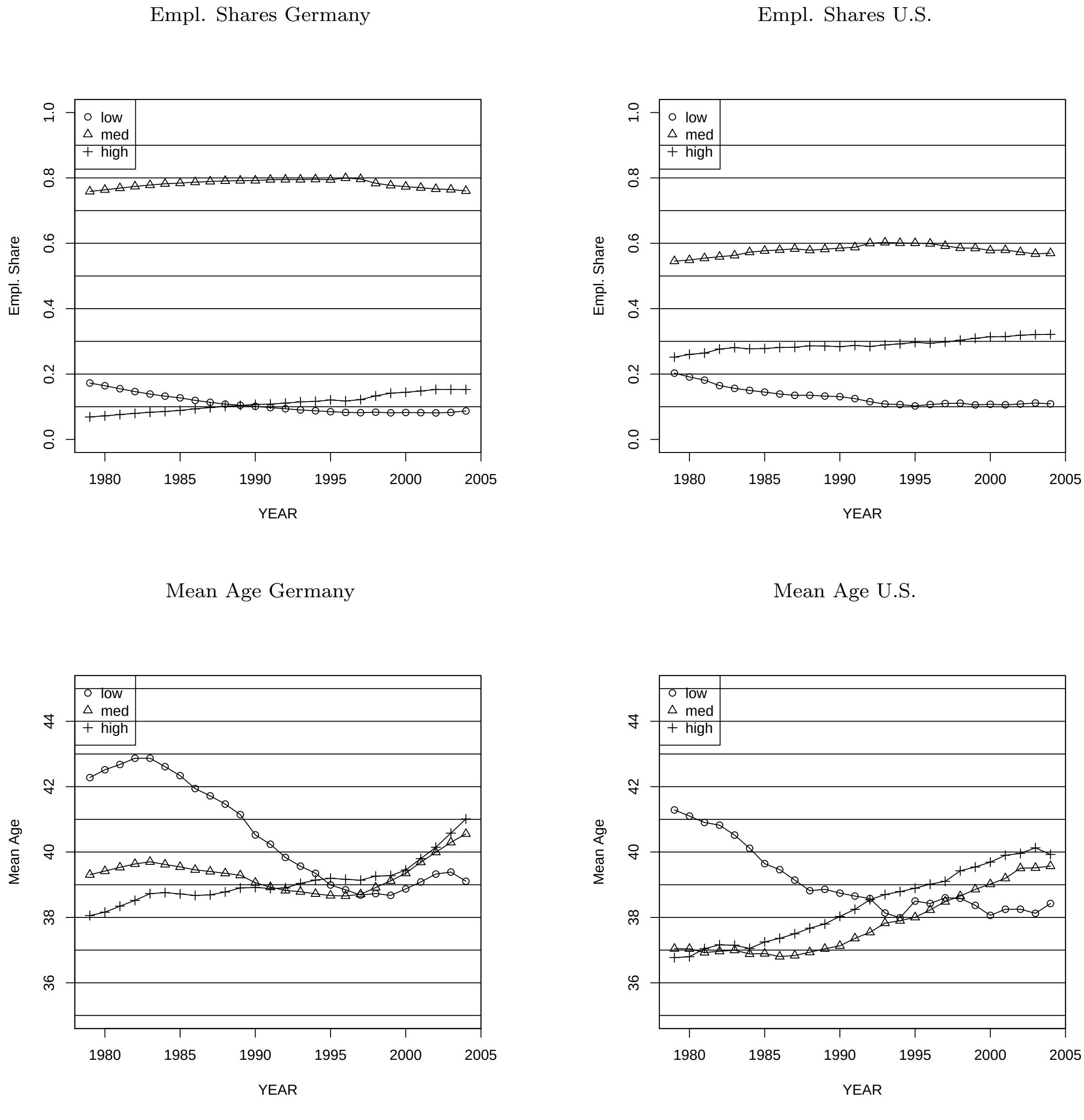


Figure 4: Employment Shares and Mean Age 1979-2004 for males, left: Germany, right: U.S.

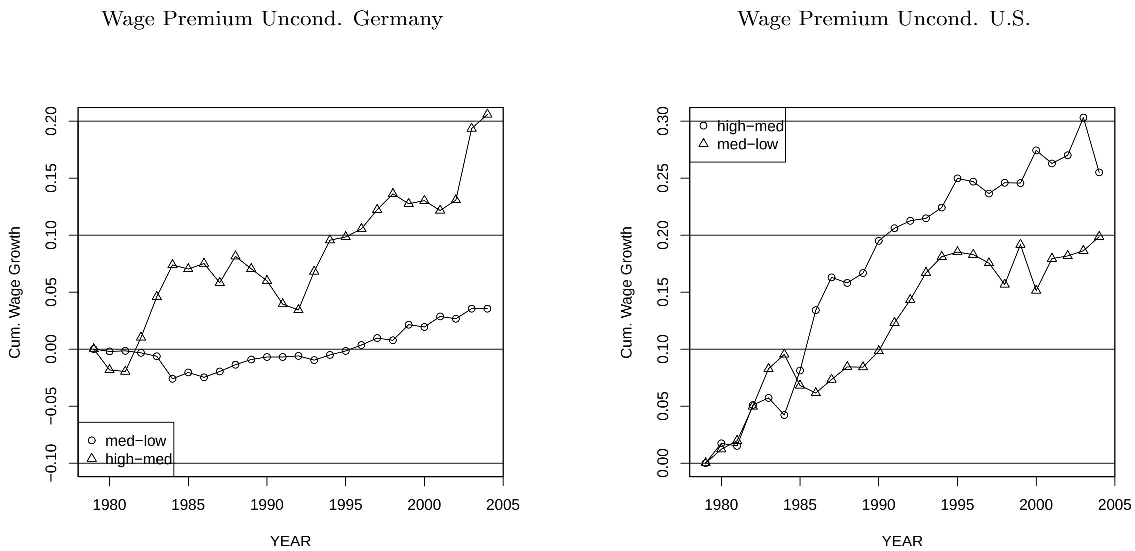
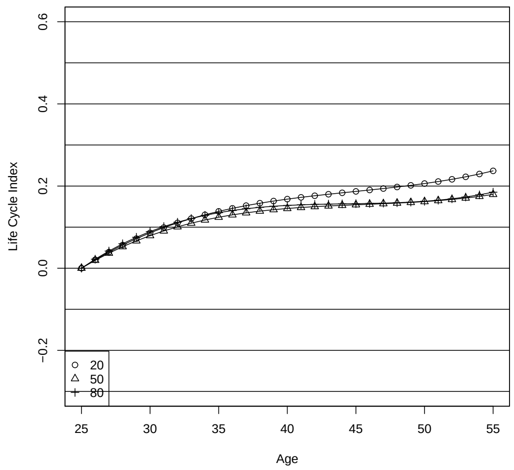
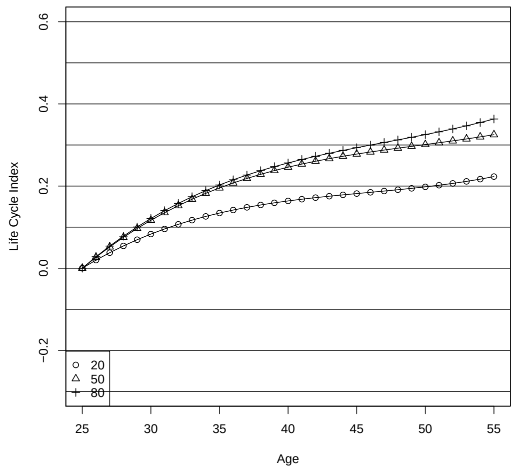


Figure 5: Unconditional Wage Premia, left: Germany, right: U.S.

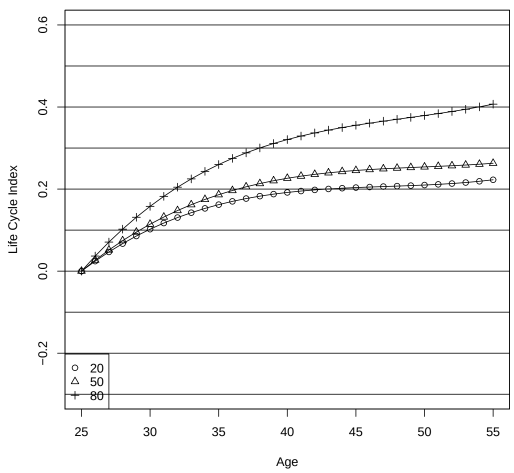
Estimated Lifecycle Index, Low-Skilled Males Germany



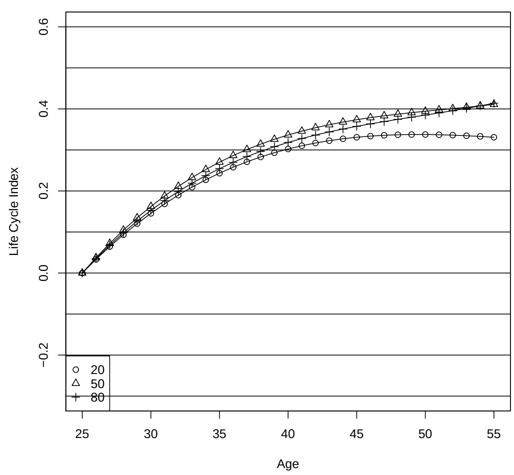
Estimated Lifecycle Index, Low-Skilled Males U.S.



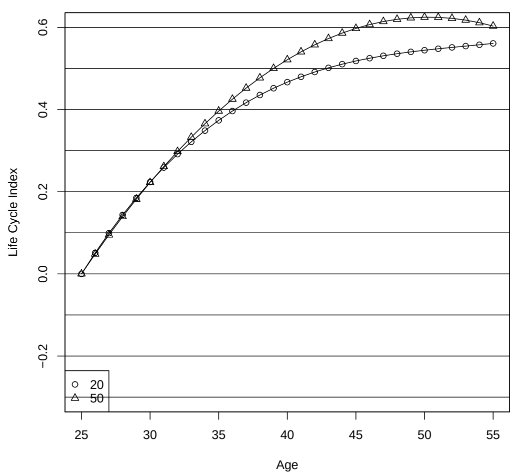
Estimated Lifecycle Index, Medium-Skilled Males Germany



Estimated Lifecycle Index, Medium-Skilled Males U.S.



Estimated Lifecycle Index, High-Skilled Males Germany



Estimated Lifecycle Index, High-Skilled Males U.S.

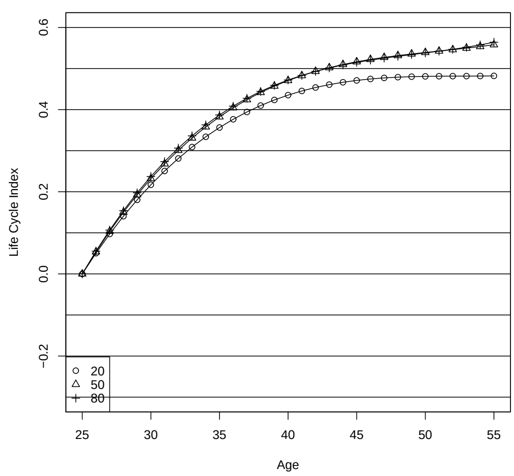


Figure 6: Lifecycle indicies 1979-2004 for males, left: Germany, right: U.S.

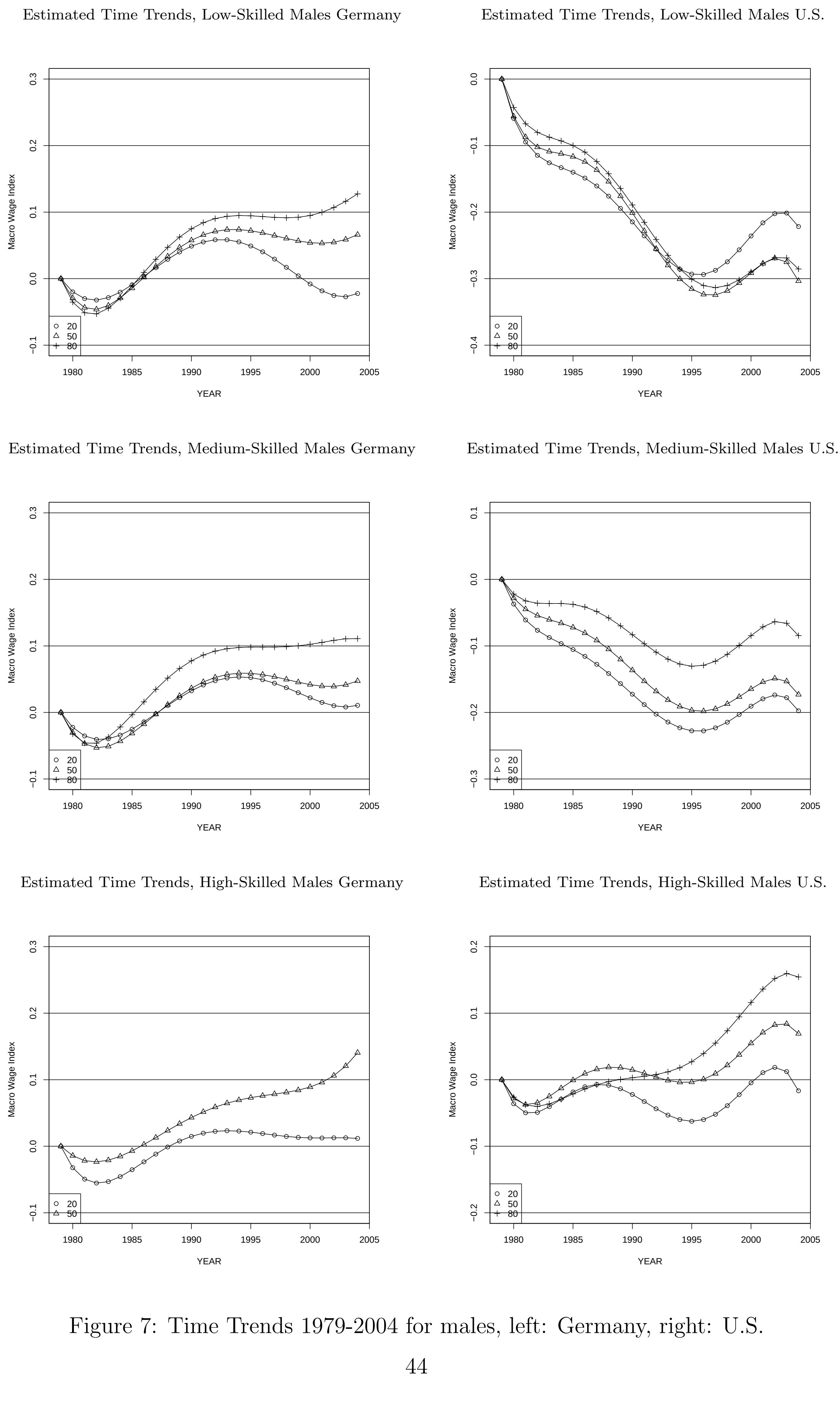


Figure 7: Time Trends 1979-2004 for males, left: Germany, right: U.S.

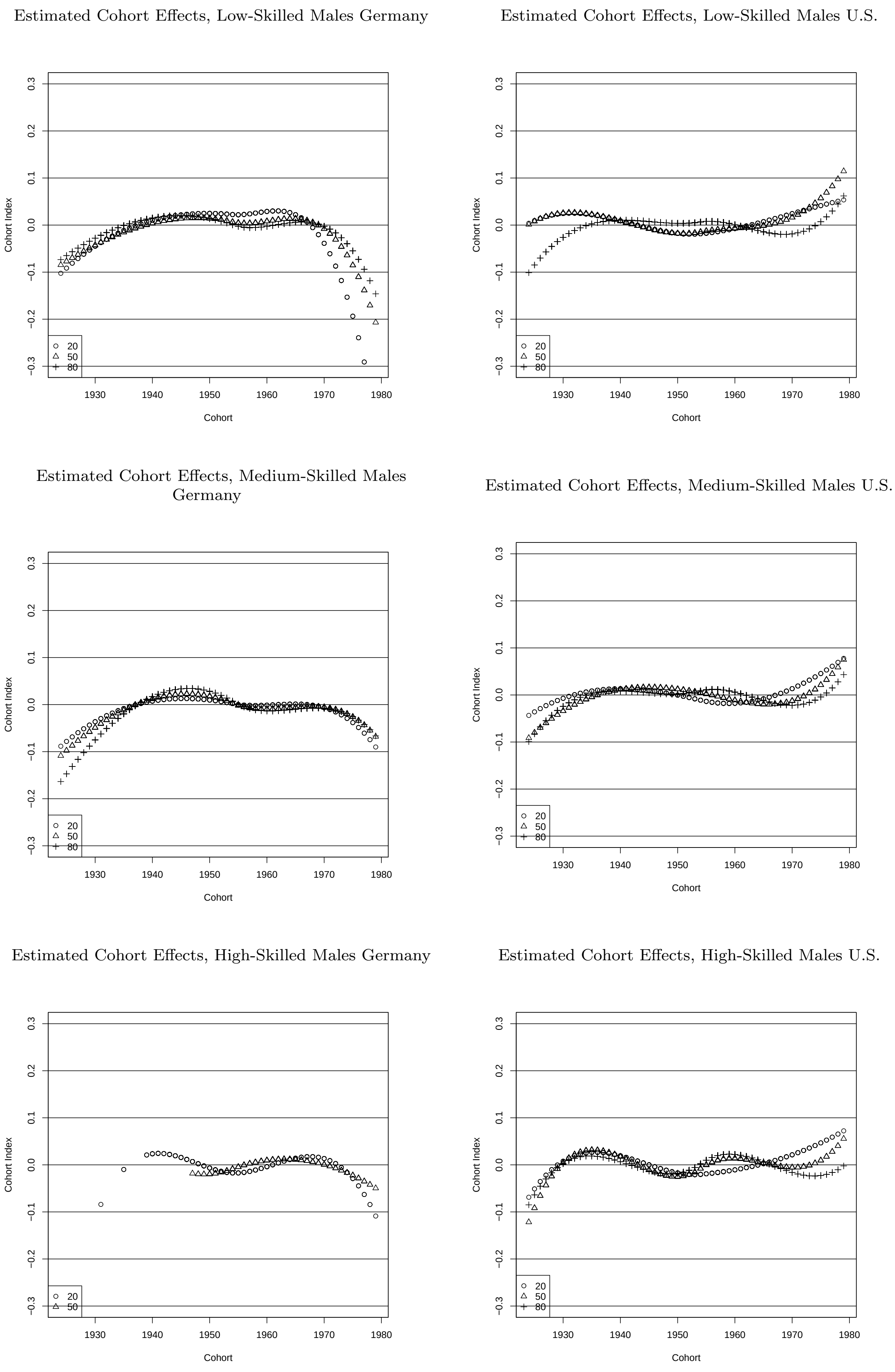


Figure 8: Cohort Effects 1979-2004 for males, left: Germany, right: U.S.

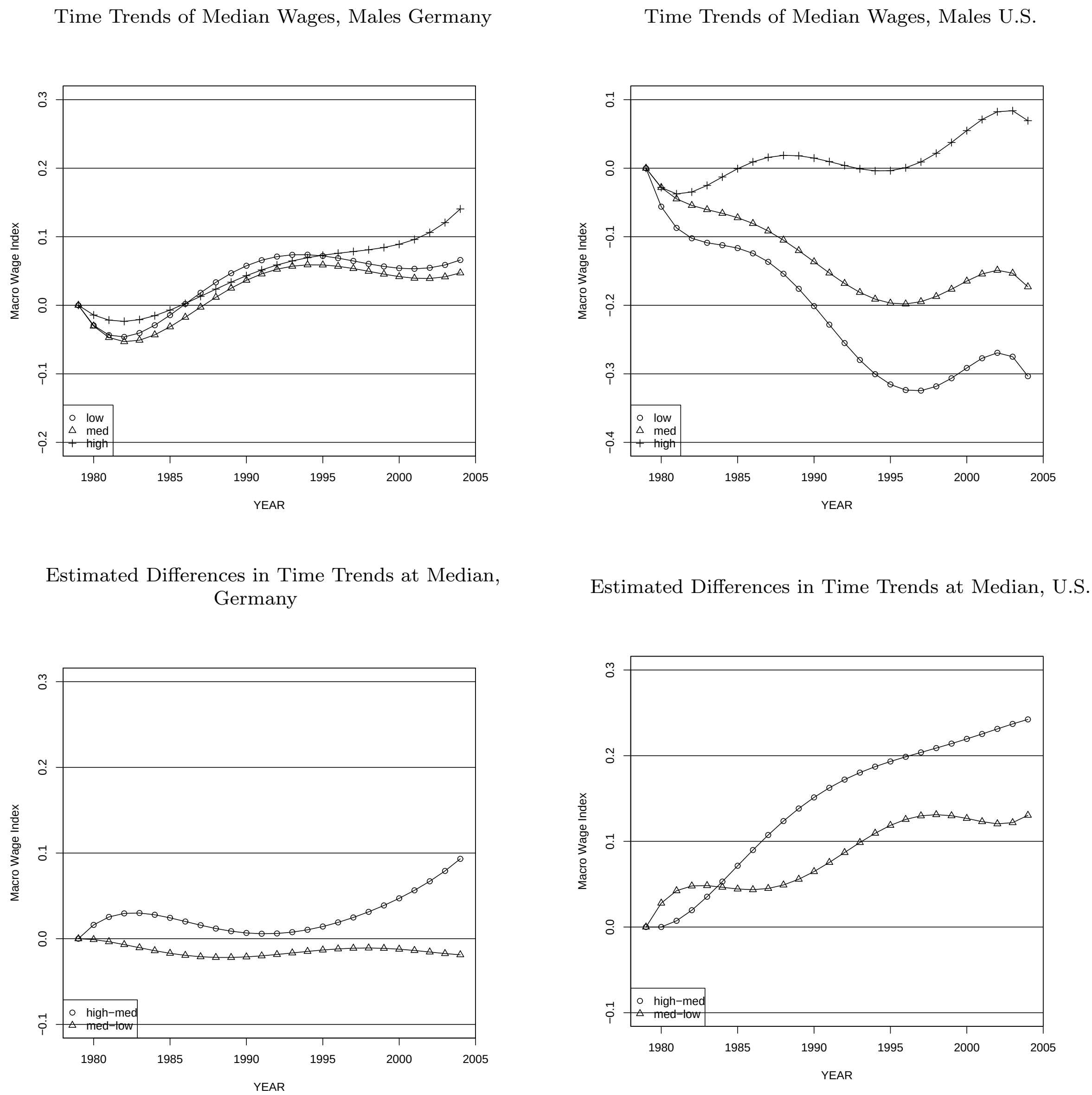
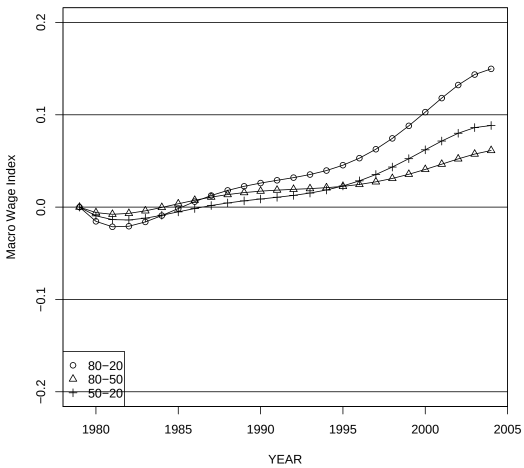
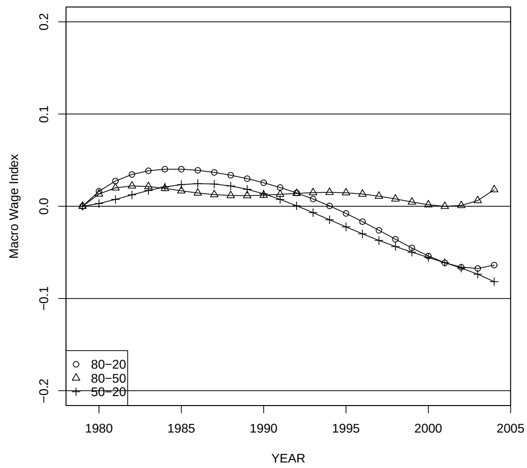


Figure 9: Medians of Educational Groups 1979-2004 for males, left: Germany, right: U.S.

Estimated Differences in Time Trends, Low-Skilled Males Germany

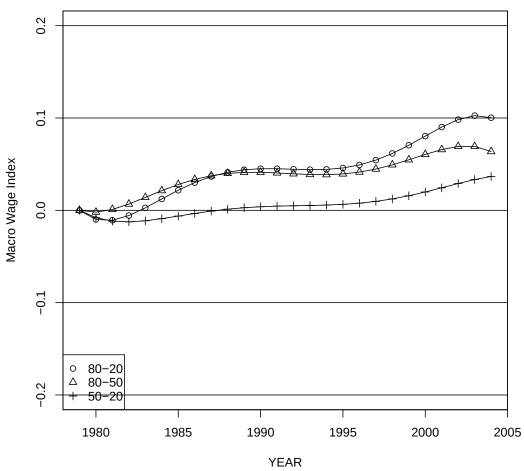


Estimated Differences in Time Trends, Low-Skilled Males

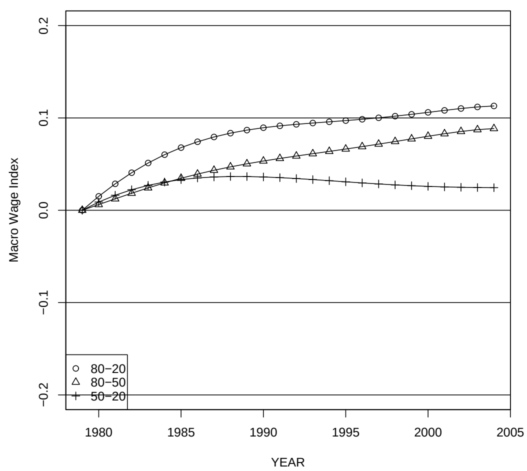


U.S.

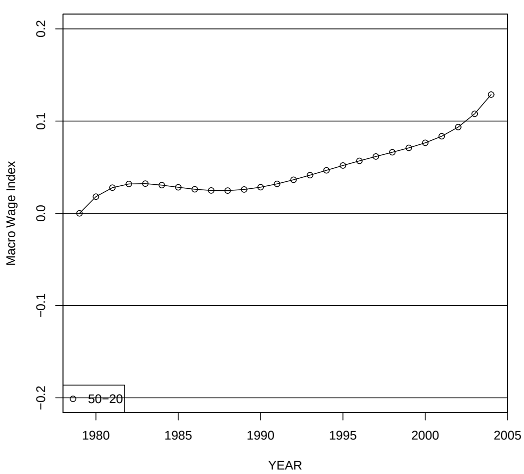
Estimated Differences in Time Trends, Medium-Skilled Males Germany



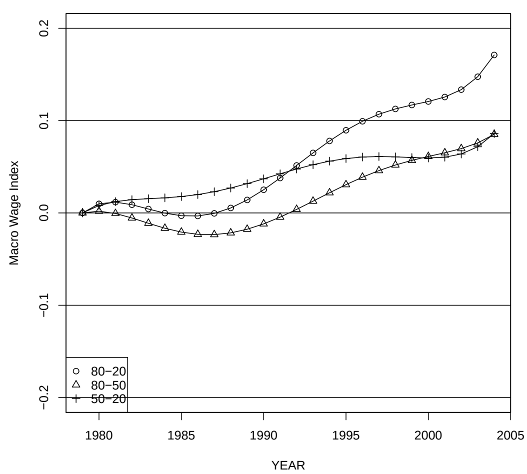
Estimated Differences in Time Trends, Medium-Skilled Males U.S.



Estimated Differences in Time Trends, High-Skilled Males Germany



Estimated Differences in Time Trends, High-Skilled Males



U.S.

Figure 10: Differences in Time Trends 1979-2004 for males, left: Germany, right: U.S.

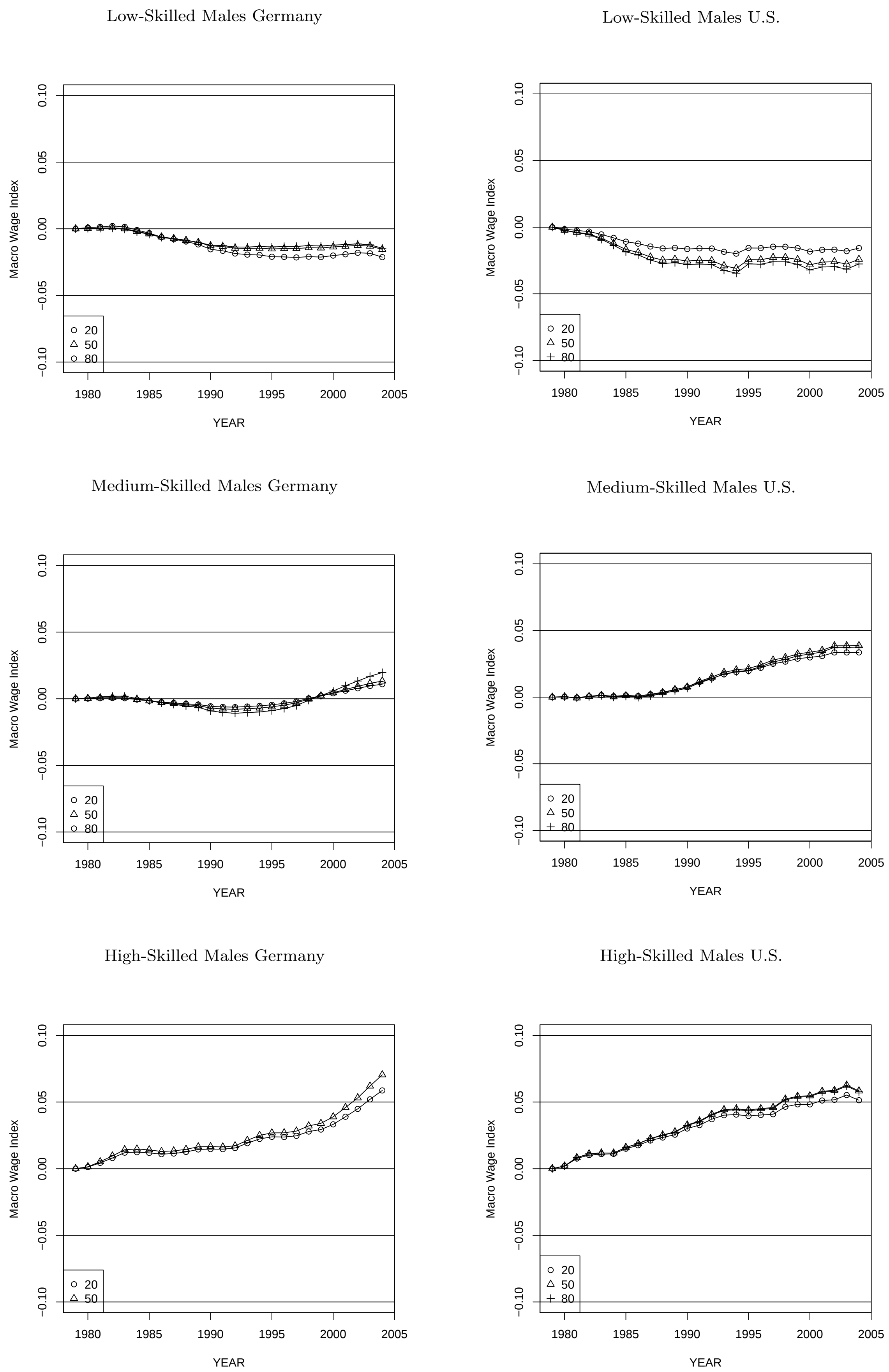


Figure 11: Effect of change in the age structure on wage growth: 1979-2004 for males, left: Germany, right: U.S.

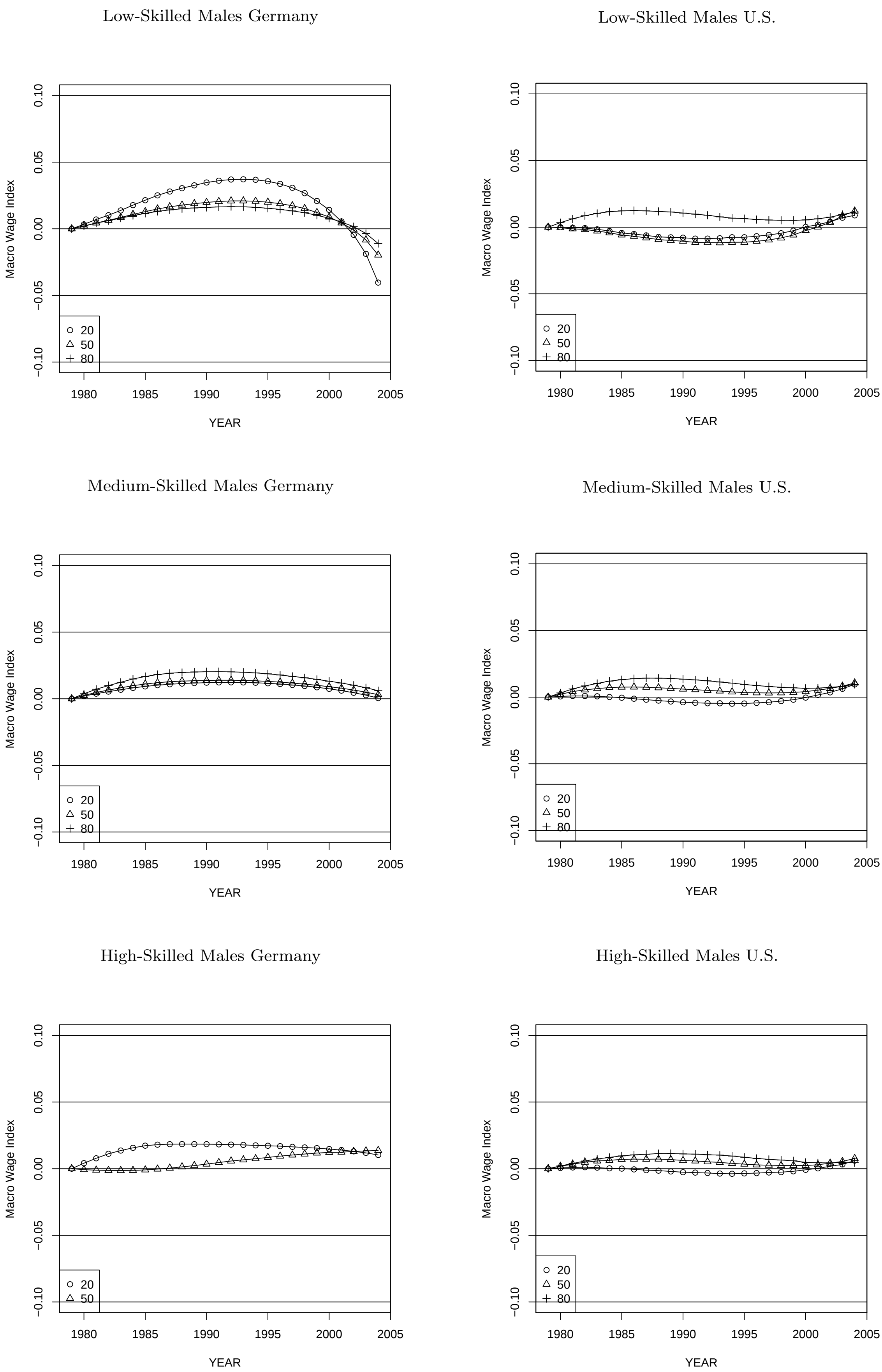


Figure 12: Effect of change in the cohort structure on wage growth: 1979-2004 for males, left: Germany, right: U.S.

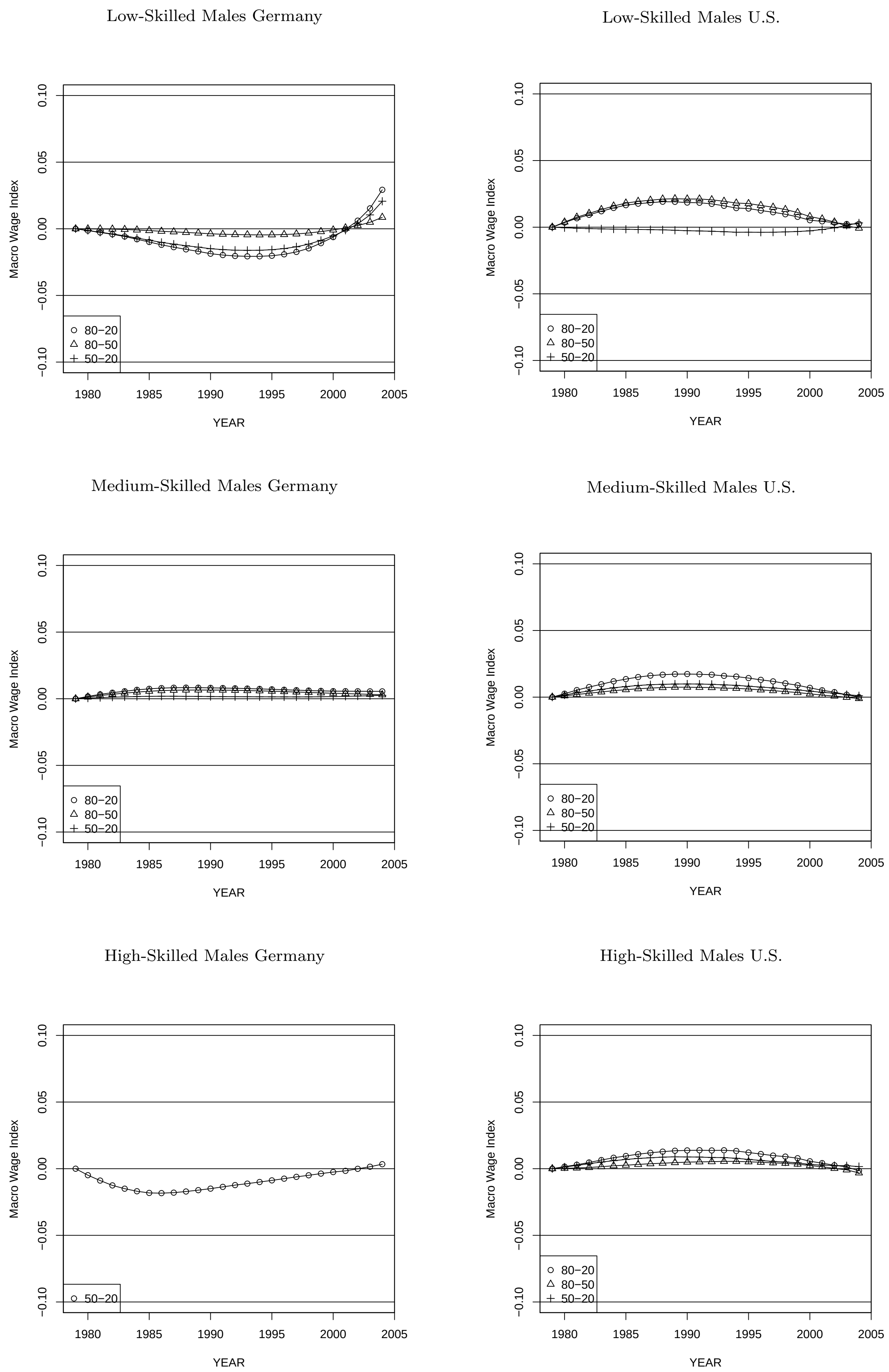


Figure 13: Effect of change in the cohort structure on wage dispersion: 1979-2004 for males, left: Germany, right: U.S.

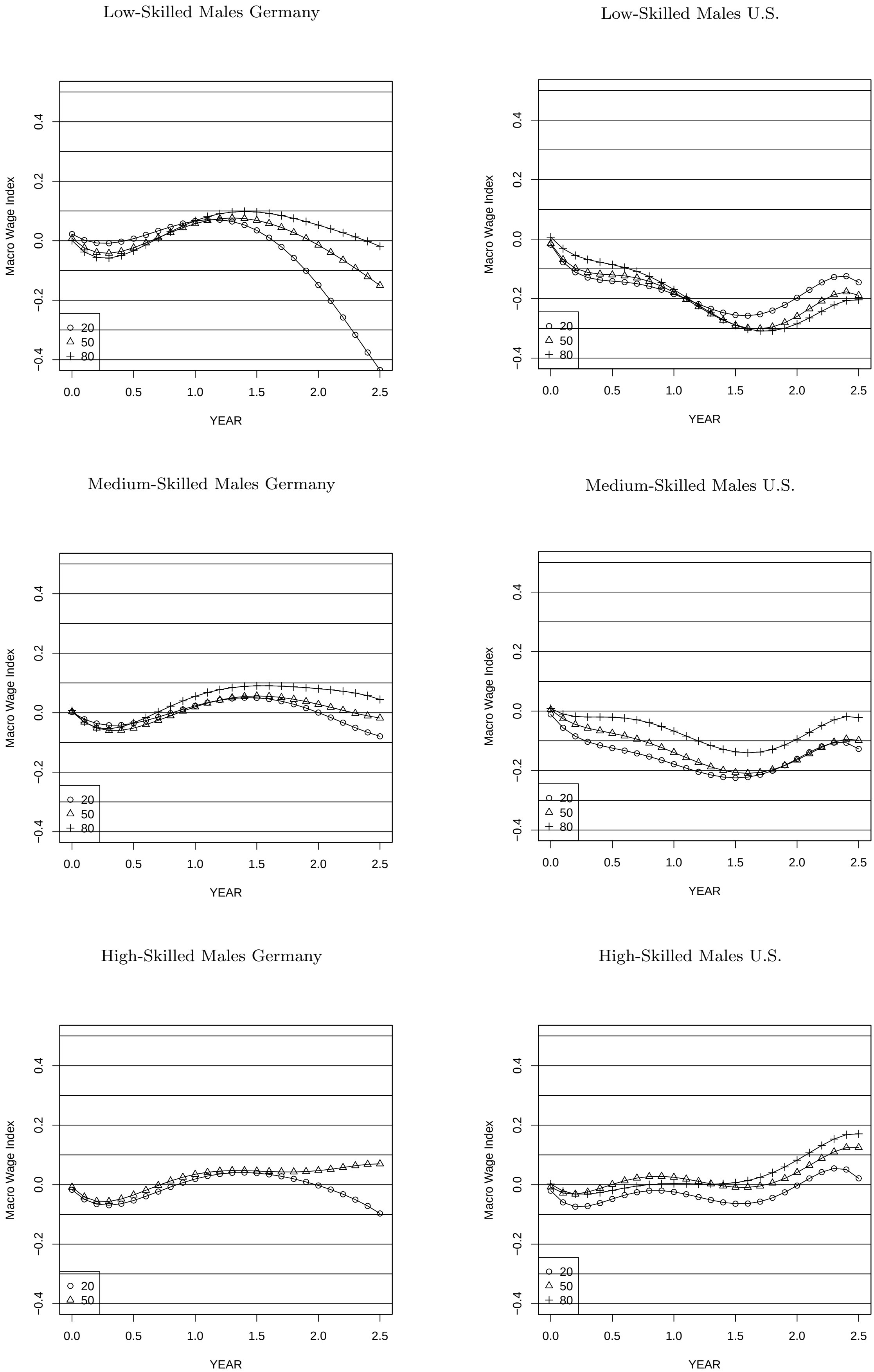
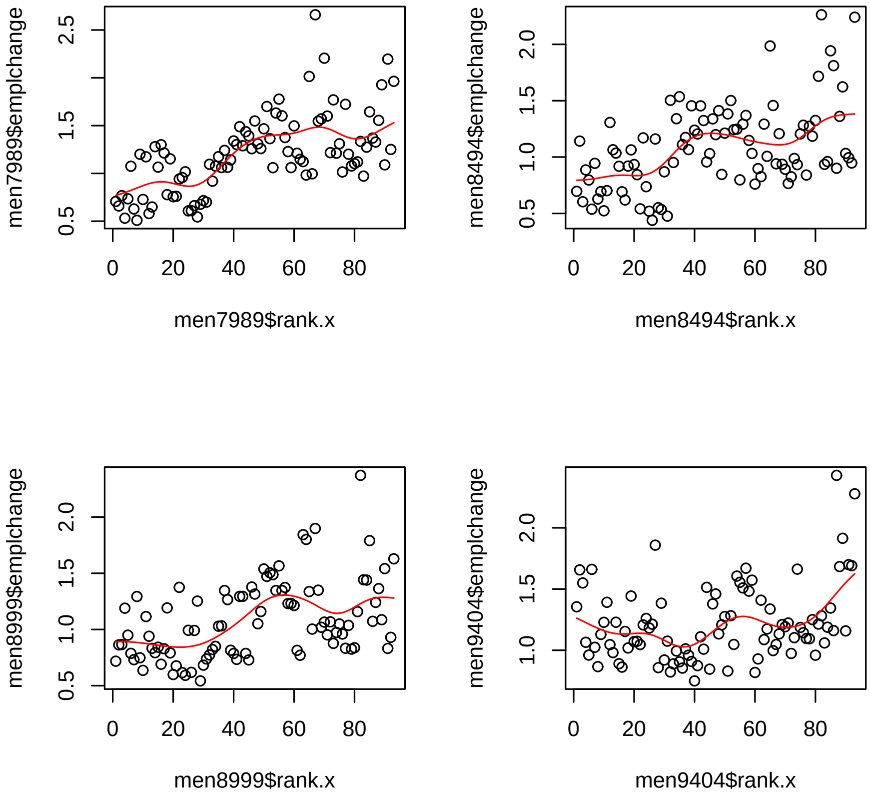


Figure 14: Cumulated growth of Entry Wages (x-scale normalized to 0 at 1979), left: Germany, right: U.S.

U.S.



Germany

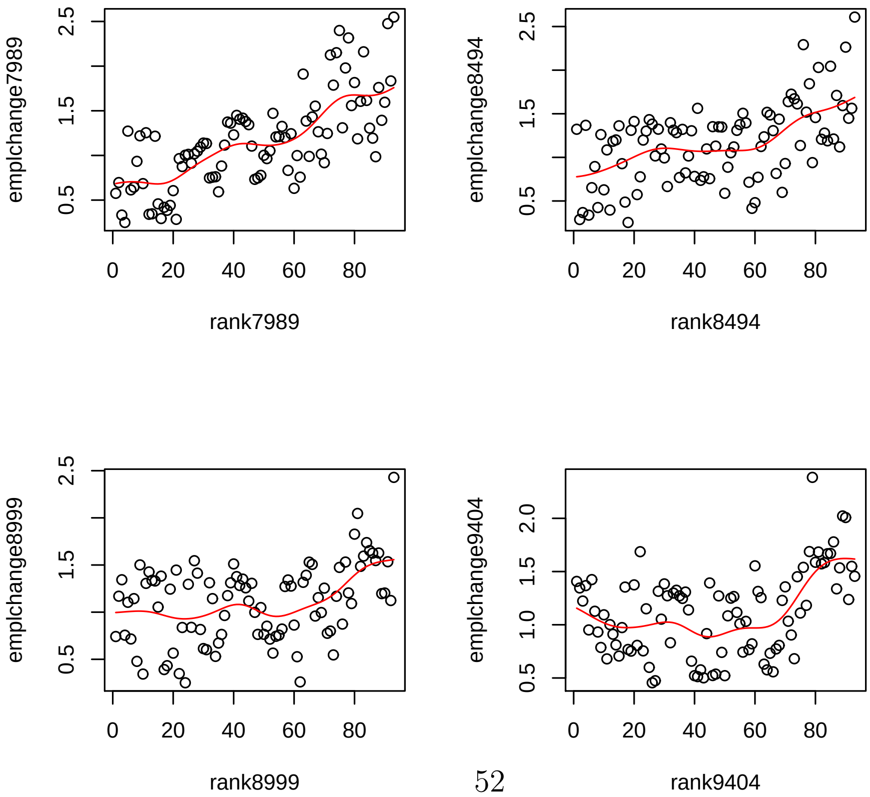


Figure 15: Pattern of changes in Employment, upper graphs: U.S., lower graphs: Germany

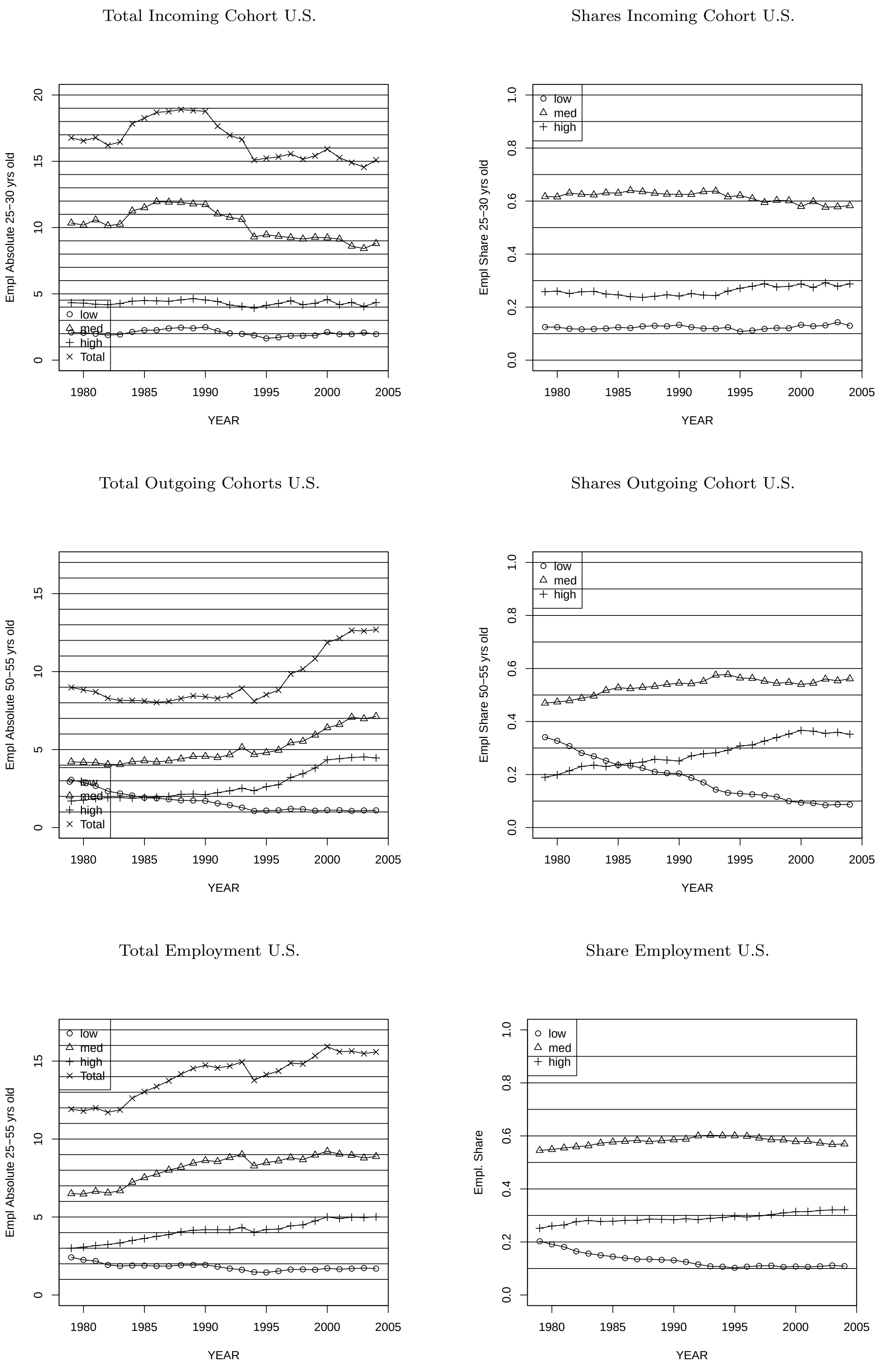


Figure 16: U.S. Cohort Sizes and Shares

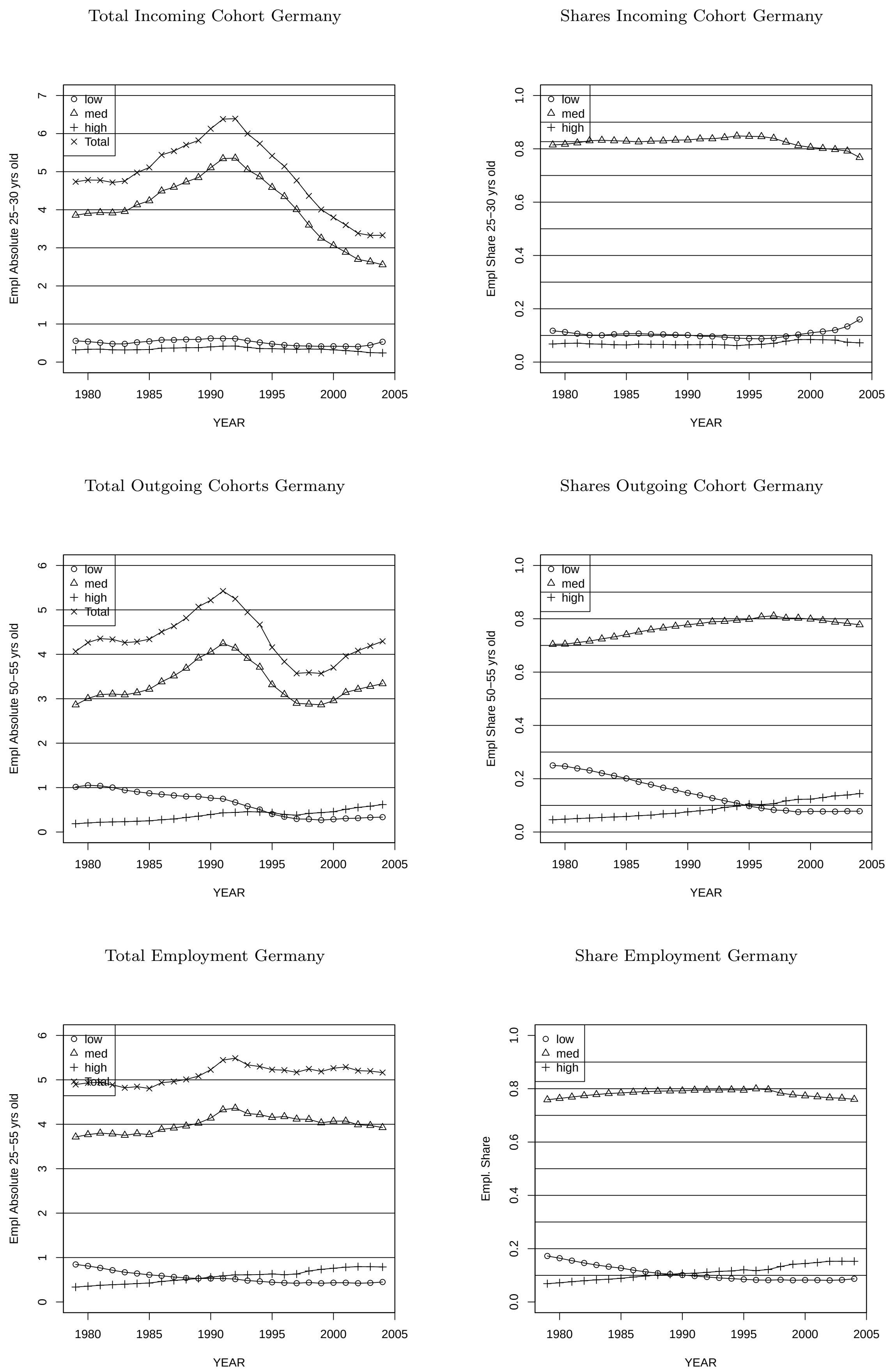


Figure 17: Germany Cohort Sizes and Shares