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Revisiting the German Wage Structure

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ABSTRACT

Revisiting the German Wage Structure*

This paper challenges the view that the wage structure in West-Germany has remained stable throughout the 80s and 90s. Based on a 2 % sample of social security records, we show that wage inequality has increased in the 1980s, but only at the top of the distribution. In the early 1990s, wage inequality started to rise also at the bottom of the distribution. Hence, while the US and Germany experienced similar changes at the top of the distribution throughout the 80s and 90s, the patterns at the bottom of the distribution are reversed. We show that changes in the education and age structure can explain a substantial part of the increase in inequality, in particular at the top of the distribution. We further argue that selection into unemployment cannot account for the stable wage structure at the bottom in the 80s. In contrast, about one third of the increase in lower tail inequality in the 90s can be related to de-unionization. Finally, fluctuations in relative supply play an important role in explaining trends in the skill premium. These findings are consistent with the view that technological change is responsible for the widening of the wage distribution at the top. The widening of the wage distribution at the bottom, however, may be better explained by episodic events, such as changes in labour market institutions and supply shocks.

JEL Classification: J3, D3, O3

Keywords: inequality, polarization, institutions

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1. Introduction

Starting in the mid to late 70s, the US and UK witnessed a sharp increase in wage- and earnings inequality (see e.g. Bound and Johnson 1992, Katz and Murphy 1992, Levy and Murnane 1992 for the US and Gosling, Machin and Meghir 2000 for the UK). Skill-biased technological change emerged as one of the leading explanations for these changes (see e.g. Acemoglu 2002 for a literature review).

However, the hypothesis of skill-biased technological change faces an important challenge: The increase in wage inequality appears to be confined to a handful of countries, like the US, UK, and Canada. Most countries in Continental Europe seem to have witnessed much smaller increases in inequality in the 80s, or no increases at all (see e.g. Freeman and Katz 1996 for a summary of inequality in European countries). In particular, West-Germany, the third largest economy in the world, has been singled out as a country characterized by a stable wage distribution throughout the 80s (see Steiner and Wagner 1998 and Prasad 2004, among others)[6]. Yet, firms in these countries had access to the same technologies as firms in the US or UK[7].

The hypothesis of skill-biased technological change has come under attack also for other reasons. For instance, Card and DiNardo (2002) argue that the slowdown in inequality in the 90s in the US provides a major puzzle for this hypothesis, as technological change –in particular the diffusion of information and communication

[6] Some recent papers argue that wage inequality started to increase in Germany in the 90s; see for instance Kohn (2006), Gernandt and Pfeiffer (2006), Riphahn (2003), and Möller (2005).
[7] Among others, Card, Kramarz, and Lemieux (1999), Piketty and Saez, (2003), and Saez and Veall, (2005) discuss the puzzle of different inequality trends in Continental Europe and the US/UK.

technology- continued throughout the 90s. Lemieux (2006a) further shows that a large fraction of the rise in residual wage inequality between 1973 and 2003 –all since 1988– is due to mechanical changes in the workforce composition. These papers view the rise in inequality in the US as an 'episodic' event that is best explained by institutional changes, such as the decline in unionization and minimum wages, and changes in the composition of the US labor force.

This paper revisits the changes in the wage structure in West-Germany (which we often refer to simply as Germany). We show that the common perception that Germany's wage structure has remained largely stable throughout the 80s is inaccurate. Based on a 2% sample of social security records, we find that wage inequality has increased in the 80s, but only at the top half of the distribution[8]. In the early 90s, wage inequality started to rise also at the bottom half of the distribution. Hence, while the US and Germany experienced similar changes at the top of the distribution throughout the 80s and 90s, the two countries markedly differ with respect to the lower end of the wage distribution: The rise in lower tail inequality happened in the 80s in the US, but in the 90s in Germany.

We investigate several explanations for the changes in wage inequality in Germany. First, we use a new decomposition technique recently developed by Melly (2006) to analyze whether the changes in inequality are explained by mechanical changes in the workforce composition, or whether they reflect changes in skill prices. In line with Lemieux (2006a), we show that it is important to account for changes in workforce composition, in particular at the upper end of the wage distribution. However, these changes cannot fully account for the divergent path of upper and lower tail inequality in the 80s, or for the divergent path of lower tail inequality in the 80s and 90s.

[8] This observation has also been made by Fitzenberger (1999).

We then investigate whether the rising unemployment and the corresponding selection into work can explain why lower tail inequality did not increase in the 80s, although upper tail inequality did. Here, we exploit the panel nature of our data in order to impute a wage for the unemployed. We then compare trends in latent wage inequality (including the unemployed) with trends in measured inequality (excluding the unemployed). We find that selection into unemployment is not responsible for why lower tail inequality did not increase in the 80s.

Third, we evaluate whether the decline in unionization Germany experienced in the 90s is responsible for the rise in lower tail inequality over that period. We find that between 1995 and 2004, de-unionization can account for one third of the rise in inequality at the lower end of the wage distribution.

Fourth, we provide evidence that is consistent with a polarization of work. We show that occupations with high median wages in 1979 experienced the largest growth rate, while occupations in the middle of the 1979 wage distribution lost ground relative to occupations at the bottom. Moreover, occupations at the high end of the 1979 wage distribution predominantly use non-routine analytic and interactive skills. Occupations in middle of the 1979 wage distribution, in contrast, are characterized by a high usage of routine cognitive tasks. This is consistent with Autor, Levy, and Murnane's (2003) hypothesis that computer technology decreases the demand for jobs that require routine manual or clerical skills (and are found in the middle of the wage distribution), and increases the demand for jobs that require non-routine cognitive and interpersonal skills (and are found at the top of the wage distribution)[9]. This paper thus adds to the growing

[9] Lemieux (2006b, 2007) discusses an alternative demand-based explanation for why the increase in inequality (in the US) is increasingly concentrated at the top. His argument is based on the heterogeneity in

evidence that technology does not simply increase the demand for skilled labor, relative to that of unskilled labor, but instead polarizes the structure of labor demand (see e.g. Autor, Katz, and Kearney, 2005a, 2005b, 2006 for the US and Goos and Manning, 2007 for the UK)[10]. This may begin to supply the unifying international evidence on technological change that so far has been absent – although further research for other advanced countries is need to evaluate this hypothesis.

Finally, based on a CES production framework used by, among others, Katz and Murphy (1992), we show that fluctuations in relative supply go a long way in explaining the evolution of the wage differential between the low- and medium-skilled, but do a poor job in predicting the evolution of the wage differential between the medium- and high-skilled.

To conclude, the evidence provided in this paper is consistent with the idea that technological change is an important driving force behind the widening of the wage distribution, particularly at the top. However, the widening of the wage distribution at the bottom that occurred in the 80s in the US but in the 90s in Germany may be better explained by episodic events - such as changes in labor market institutions and supply shocks. These shocks happened a decade later in Germany.

The plan of the paper is as follows. Section 2 describes the data used for the analysis. Section 3 documents the major changes in the German wage structure over the

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the return to skill, implying that an increase in the return to skill raises wages of workers at the top of the wage distribution (such as workers with post-secondary education) by more than wages of workers at the bottom the wage distribution. As Lemieux (2007) points out, these two explanations do not rule out each other; in fact, the complementarity between non-routine interactive and analytical tasks and technology may provide an explanation for why the return to post-secondary education increased so much while the return to other dimensions of skill did not.

[10] For Germany, Spitz-Oener (2006) focuses on the changes in the usage of routine and non-routine tasks over time, and the extent to which these changes can be accounted for by computerization. She also provides some evidence that is consistent with the polarization of work.

period from 1975 and 2001. We then analyze whether these changes are due to changes in the workforce composition or reflect changes in skill prices (Section 4). Section 5 discusses the impact of selection into unemployment as well as de-unionization on the wage structure. In Section 6, we turn to the polarization of the wage structure. Section 7 analyzes the role of fluctuations in relative supply in explaining the skill premium. We conclude with a discussion of our findings (Section 8).

2. Data Description

Our empirical analysis is based on two data sets: the IABS, a 2 % random sample of social security records, and the LIAB, a linked employer-employee data set. We describe each data set in turn.

2.1. IABS: 2 % Random Sample of Social Security Records, 1975-2001

Our main data set is a two percent sample of administrative social security records in Germany for the years 1975 to 2001. The data is representative of all individuals covered by the social security system, roughly 80 percent of the German workforce. It excludes the self-employed, civil servants, individuals currently doing their (compulsory) military service, as well as individuals on so-called 'marginal jobs', i.e. jobs with at most 15 hours per week or temporary jobs that last no longer than 6 weeks[11]. This data set (or earlier versions of it) has been used to study wage inequality by, among others, Steiner and Wagner (1998), Möller (2005), Fitzenberger (1999), Kohn (2006), and Fitzenberger and Kohn (2006).

The main advantages of our data are the large sample size (more than 200,000 wage observations each year), and the precise measurement of wages. Moreover, while

[11] They are included in the data set from 1999 onwards.

workers can be followed over time, each year the original sample is supplemented by a random sample of new labor market entrants. This guarantees that the sample is representative of workers who pay social security contributions.

A problem of our data is that it is right-censored at the highest level of earnings that are subject to social security contributions. Overall, censoring affect 10 to 14 % of observations each year, making it impossible to analyze changes at the very top of the wage distribution. For university graduates, censoring affects more than 50 % of the wage observations, casting some doubt on whether this data set can be reliably used to analyze returns to education over time. Because of censoring, this paper focuses on the evolution of the 5^{th}, 15^{th}, 50^{th}, and 85^{th} percentile, and –with a few exceptions- impose no assumptions on the distribution of the error term.

Another difficulty is a structural break in the wage measure in 1984. From 1984 onwards, our measure includes bonus payments as well as other one-time payments. As it was first discussed by Steiner and Wagner (1998), ignoring this break would lead us to *overstate* the increase in wage inequality. For this reason, Steiner and Wagner (1998) discard information before 1984. We instead follow Fitzenberger (1999) and correct for the break; the correction is based on the observation that only wages above the median appear to be affected by the break.[12] We provide more information in Appendix B.

Our data does not contain precise information on the number of hours worked; we only observe whether a worker is working full- or part-time (defined as working less than 30 hours per week). Our wage analysis focuses on full-time workers. In our sample of men, part-time work is very rare; less than 0.5 % of the wage spells are part-time spells.

[12] We would like to thank Bernd Fitzenberger for making his computer program that corrects for the 1984 structural break available to us.

As a robustness check, we have also re-run our analysis using all spells. Not surprisingly, our results are very similar if part-time spells are included in the sample. Our wage measure is the *daily* wage, averaged over the number of days the worker was working in a given year[13].

From this data base, we select all men between 21 and 60 years of age. Since the level and structure of wages differs substantially between East and West Germany, we concentrate here on West-Germany (which we often refer to simply as Germany). Further details can be found in Appendix B.

2.2. LIAB: Linked Employer-Employee Data, 1995-2004

The data set just described provides no information on union coverage, and can thus not be used to analyze the impact of de-unionization on the wage structure[14]. Our analysis here is based on the LIAB, a linked employer-employee data set provided by the Institute for Employment Research (IAB). It combines information from the IAB Establishment Panel with information on all workers who were employed in one of these firms as of first of July. As with our main data, information on workers is drawn from social security records. The first wave (1993) contained 4265 establishments (for West Germany). The sample was extended considerably in 2000 to 8416 establishments and in 2001 and the following years to about 10000.

Although the data is principally available from 1993 to 2004, we only use waves 1995 to 2004. This is because consistent information on union recognition exists only

[13] Note that any increase in inequality may either be due to an increase in inequality of the hourly wage, or an increase in inequality in hours worked.
[14] We give below more details on union coverage in Germany.

from 1995 onwards. Our union variable distinguishes between firm- and industry-level agreements.

The IAB establishment panel over-samples large establishments. To make sure that our results are representative for the German economy as a whole, we use the cross-sectional weights provided by the IAB. Further details can be found in Appendix C.

3. Trends in Wage Inequality

We now describe the major changes in wage inequality in Germany from 1975 to 2001.

Standard Deviation of Log-Wages Figure 1 displays the evolution of the standard deviation of log-wages and log-wage residuals. The standard deviation is obtained from a censored regression, estimated separately for each year. Hence, the figure imposes the assumption that the error term is normally distributed. We control for 3 education categories, 8 age categories, as well as all possible interactions between these two variables. The figures show a continuous rise in this measure throughout the 80s, with a slight acceleration in the 90s. Figure 2 plots the evolution of the difference between the 85^{th} and 15^{th} percentile[15]. It has been continuously increasing since 1975, with the exception of the years around the 1980 recession, as well as the years around the re-unification in 1990. The overall increase in real log wage differences was 8.8 log-points between 1979 and 1989, and 12.4 log-points between 1991 and 2001.

[15] We use the 85^{th} percentile instead of the 90^{th} percentile since the 90^{th} percentile is censored in our data. This is never true for the 85^{th} percentile.

The Top versus the Bottom Next, we separately analyze changes in inequality at the bottom and top of the wage distribution. Figure 3 distinguishes between the following interquantile differences: 85th -50th, 50th-15th, and 40th-5th percentile. We include information on the 40th-5th interquantile difference because changes at the very low end of the wage distribution –i.e. below the 15th percentile- have been particularly dramatic. Further details can be found in Table 1. Both Figure 3 and Table 1 show that the difference between the 85th and 50th percentile increased relatively uniformly between 1975 and 2001, by about 0.67 log-points a year. The difference between the 50th and 15th percentile, in contrast, remained largely stable throughout the late 70s and 80s. It started to rise in the early 90s, by about 0.81 log-points a year. The evolution of the difference between the 40th and 5th percentile is even more striking; since 1989, it increased by 1.1 log-points per year.

How do these findings compare with the developments in the United States? Autor, Katz and Kearney (2005b) report that in the US, the 90-50 wage gap increased by about 1 log-point between 1980 and 2003. This is somewhat larger than the observed increase in Germany (0.7 log points between 1980 and 2001). Note, however, that due to wage censoring, we look at the 85-50 wage gap, as opposed to the 90-50 wage gap. The two countries differ sharply with respect to the developments at the bottom of the wage distribution. In the US, the 50-10 wage gap rose substantially in the 80s, but ceased to increase in the 90s[16]. In Germany, the pattern is reversed.

Figure 4 displays the wage growth of the 85th, 50th, and 15th percentile of the wage distribution. We distinguish between the pre- and post-unification period (1975 to 1989

[16] Lemieux, 2006b, 2007 also argues that the rise in inequality in the US is increasingly concentrated at the top.

and 1989 to 2001). The figure replicates the findings in the previous figure. Between 1975 and 1989, the 50th and 15th percentile evolved similarly and increased by about 20 %. Over the same time period, the 85th percentile rose by 30 % (Panel A). The picture looks very different throughout the 90s (Panel B). Between 1993 and 2001, the 15th percentile declined by 4 percentage points, while the 50th and 85th percentile increased by 4 and 9 percentage points, respectively.

Figure 5 illustrates the divergent developments of the lower and upper end of the wage distribution throughout the 80s and 90s in a slightly different manner. It shows log real wage growth along the wage distribution, for the period between 1979 and 1989 as well as between 1991 and 2001. The 80s were a period of remarkably high aggregate wage growth, of about 0.8 percentage points per year on average. Wages grew throughout the distribution, but substantially more so at the upper than at the lower tail. Wage growth accelerates from the 65th percentile onwards. In contrast, between 1991 and 2001, wage growth has been negative up until the 25th percentile, with wage losses of more than 10 log wage points at the 5th percentile. Starting from the 15th percentile, wage growth increases roughly linearly along the wage distribution.

Figure 4 and 5 reveal a further important difference between the US and Germany. In the 80s, average wage growth was substantially larger in Germany than in the US, while the opposite is true in the 90s (see e.g. Figure 2 in Autor, Katz and Kearney (2006)).

Returns to Education For completeness, Figure 6 plots the wage differential between the low- and medium-educated (left y-axis) and the medium- and high-educated (right y-axis), obtained from a censored wage regression estimated separately for each year. The figure imposes the assumption that the error term is normally distributed. The medium-low wage differential declined slightly between 1975 and 1989, and then increased sharply by about 0.9 percentage points a year. Note that this timing coincides with the rise in wage inequality at the bottom. The medium-high wage differential declined between 1975 and 1980, remained roughly constant throughout the 80s and mid-90s, and started to increase in the late 90s[17].

Comparison with Existing Studies for Germany These results seem to contradict the usual view that wage inequality in Germany has been largely stable over the past two decades, and in particular throughout the 80s. What explains this discrepancy? Consider first studies that use the same data base as us, the IABS. Using an earlier version of this data set for the years 1975-1990, Fitzenberger (1999) reports results in line with ours. In particular, he stresses that wage inequality rose during the 80s, and that the increase was concentrated at the top of the distribution. Steiner and Wagner (1998) point out that the analysis of wage inequality is complicated by the fact that starting in 1984, the wage measure includes bonuses as well as other one-time annual payments. Our results correct for this structural break, using the method proposed by Fitzenberger (1999). In Appendix B, we provide further details that the rise in inequality at the top of the distribution in our data is not affected by the structural break, see in particular Table B.1. Other studies using this data set focus on other aspects of the wage structure. For instance, Kohn (2006)

[17] However, these results have to be interpreted with caution since for the high-educated more than half of the wage observations are censored.

concentrates on the recent developments in the 90s[18] as well as differences between East and West Germany (see also Möller 2005), while Fitzenberger and Kohn (2006) analyze trends in the returns to education.

Next, consider studies that use the German Socio-Economic Panel to analyze the evolution of wage inequality in Germany. In line with our results, Gernandt and Pfeiffer (2006) report that the difference between the 50th and 10th percentile remained largely stable in the mid to late 80s, but started to increase sharply around 1993[19]. However, the GSOEP and the IABS yield a different picture of the developments at the upper end of the wage distribution. In particular, in the GSOEP the difference between the 90th and 50th percentile hardly rises in the late 80s (e.g. Steiner and Wagner (1998), Prasad (2004)) or 90s (e.g. Gernandt and Pfeiffer (2006)). We replicate this finding using a sample that resembles our sample in the IABS more closely[20]. We investigate two further reasons that may explain the differences between the GSOEP and IABS. First, the wage measure in the IABS includes bonuses as well as other one-time annual payments, while the wage measure commonly used in the GSOEP does not. Second, the wage measure in the IABS is a *daily* wage, while most studies based on the GSOEP construct an *hourly* wage rate. This cannot explain the differences between the two data sets. Results are available from the authors on request.

We believe that the IABS is the more reliable data source to study changes in the wage structure. First, the IABS is available from 1975 onwards, as opposed to 1984 for the GSOEP. Second, the sample size is much larger in the IABS (more than 200000

[18] For the 90s, Kohn's (2006) results are similar to ours.
[19] See also Riphahn (2003). Using a sample from 1984 to 1997 based on the GSOEP, Prasad (2004) also reports an increase in inequality between 1993 and 1997.
[20] That is, we drop the self-employed, civil servants, as well as workers in the military.

observations per year, as opposed to around 2000 in the GSOEP). Third, wages are measured more precisely, as misreporting by firms in the IABS is subject to severe penalties. Possibly most importantly, attrition rates in the GSOEP are large enough to worry that results are not representative for the population as a whole (see e.g. Spiess and Pannenberg (2003) and Haisken De-New and Frick (2005)). Moreover, the GSOEP is a stock-flow sample and thus under-represents new labor market entrants.

4. The Role of Composition and Prices

Are the changes just described explained by mechanical changes in the workforce composition, or do they reflect changes in skill prices? This section uses a new decomposition method developed by Melly (2006) to address this question. We begin with documenting changes in the workforce decomposition in Germany (Section 4.1). We then briefly describe the method used to decompose the overall increase in inequality into composition and price effects (Section 4.2). Section 4.3 reports results.

4.1 Trends in Workforce Composition

Panel A of Figure 7 displays the share of low- and high-skilled workers over time. The proportion of the high educated increased nearly linearly over the entire period between 1975 and 2001. The supply of the low educated also decreased continuously. However, there is a clear slowdown towards the late 80s in the decline of the relative supply of low educated workers. Interestingly, around the same time the medium-low wage differential started to increase (see Figure 6). The slowdown in skill upgrading is likely to related to the breakdown of the communist regimes in Eastern Europe as well as the reunification of East- and West-Germany. These events lead to a large inflow of East

Germans, Eastern Europeans, as well as ethnic Germans from Eastern Europe into the West-German labor market; many of these immigrants were low-skilled (see Glitz (2006) for more details).

Panel B of Figure 7 focuses on the share of workers less than 31, and older than 49. The share of both age groups increased over much of the late 70s and 80s, but decreased quite dramatically starting in the early 90s. This decrease has been stronger for the young (below the age of 31) than for the old (above the age of 49). Further details on the age structure by education group can be found in Table E.1 in Appendix E. The decline in the share of older workers over the same period is possibly due to early retirement – a policy that became very common in the 90s.

4.2 Decomposition and Estimation of Counterfactual Distributions

This section describes the method used to decompose the overall change in inequality into price and composition effects. As Lemieux (2006a) argues, secular changes in the education and age structure may lead mechanically to higher within- as well as between-group inequality. To see this, consider a simple wage function

$$w_{it} = x_{it}\beta_t + u_{it}\text{, with } u_{it} = a_t e_{it} + v_{it}\,.$$

Here w_{it} denotes wages of individual i in period t, x_{it} is a vector of observed skills (which can be divided into a finite number of j cells), and e_{it} are unobserved skills. The parameters β_t and a_t are weights for observed and unobserved skills that may change over time. Under the assumption of independence between observed and unobserved skills, the variance of wages is given by

$$Var(w_{it}) = Var(x_{it})\beta_t^2 + Var(e_{it})a_t^2 + Var(v_{it}) .$$

Let $\sigma_{jt}^x = Var(x_{it} \in j)$ and $\sigma_{jt}^e = Var(e_{it} \mid x_{it} \in j)$ denote the (conditional) variances of observed and unobserved skills, and let λ_{jt} denote the share of workers in cell j at time t. Then the unconditional variances are simply obtained as $Var(e_{it}) = \sum_j \lambda_{jt}\sigma_{jt}^e$ and $Var(x_{it}) = \sum_j \lambda_{jt}\sigma_{jt}^x$. If the conditional variances of observed and unobserved skills are heteroskedastic, then it is obvious that changes in the share of workers in any skill cells will lead to changes in the unconditional variances, even if the conditional variances σ_{jt}^e, σ_{jt}^x remain constant over time. This is the essence of Lemieux's (2006a) argument. Lemieux (2006a) estimates the (residual) variances of the wage distribution at the counterfactual skill composition distribution in a base year, using an extension of the method first introduced by DiNardo, Fortin and Lemieux (1996). He concludes that a large fraction of residual wage inequality in the US between 1973 and 2003 –and all since 1988- is due to composition effects.

Autor, Katz and Kearny (2005b) argue that it is important to investigate the effects of composition along the distribution of wages. They use a method based on recent work by Machado and Mata (2005) for constructing differences between a factual and counterfactual wage distribution. The aim is to decompose the total change of wages over a period $[t_0, t_1]$ at percentile τ into characteristics and price effects.

Let $Q_\tau(w_t \mid X_t)$ denote the τ th quantile of the distribution of log-wages w_t, conditional on a vector *X*. We model these conditional quantiles as

$$Q_\tau(w_t \mid X_t) = F_w^{-1}(\tau \mid X_t, \beta_t) = X_t\beta_t(\tau) \qquad (1)$$

Here X_t denotes a vector of covariates, $\beta_t(\tau)$ the corresponding coefficients, and $F_w(.\mid X_t, \beta_t)$ is the conditional distribution function of log-wages at time t. The decomposition then takes the form of

$$\begin{aligned}\Delta F_Y^{-1}(\tau \mid X, \beta) &= F_Y^{-1}(\tau \mid X_{t_1}, \beta_{t_1}) - F_Y^{-1}(\tau \mid X_{t_0}, \beta_{t_0}) \\ &= \left\{F_Y^{-1}(\tau \mid X_{t_1}, \beta_{t_1}) - F_Y^{-1}(\tau \mid X_{t_0}, \beta_{t_1})\right\} + \left\{F_Y^{-1}(\tau \mid X_{t_0}, \beta_{t_1}) - F_Y^{-1}(\tau \mid X_{t_0}, \beta_{t_0})\right\}.\end{aligned}$$

The first term in curly braces in the second row represents composition effect, and the second term the price effect.

If equation (1) is specified correctly, it provides a full characterization of the conditional distribution of wages given *X*. However, it does not provide the marginal density of *w*. The marginal density can be obtained by numerically integrating the estimated conditional quantile function over the distribution of *X* and τ. Autor, Katz and Kearny (2005b) achieve this using a bootstrap simulation technique, following Machado and Mata (2005).

We use here a computationally easier method based on a recent approach by Melly (2006) that does not require bootstrapping. A further advantage of the Melly estimator is that it exhibits asymptotic properties that correspond to those of the Machado and Mata estimator if the number of bootstraps goes to infinity. We provide more details on this approach in Appendix D.

Empirically, we implement this as follows. We first estimate the quantiles for a fine grid for two time periods t_0 and t_1 to obtain $\hat{F}_w^{-1}(\tau \mid X_t, \beta_t) = X_t \hat{\beta}_t(\tau)$ [21]. In our first application, X_t consists of all possible interactions between 3 education and 8 age groups.

[21] We first estimate the regression coefficients for a equi-distant grid of quantiles $\tau = 0,1,2,...,100$. Then the quantiles are interpolated linearly to obtain $\tau = 0.1, 0.2, 0.3, ...99.7, 99.8, 99.9, 100$.

In Section 5.3, we include union recognition (interacted with all skill and age categories) as an additional regressor. Because of wage censoring in both data sets, we estimate semiparametric censored quantile regressions. Since all regressors are categorical, the complete quantile process (for the uncensored part of the distribution) can be obtained by computing all uncensored (unconditional) quantiles in each cell of the table spanned up by the regressors (i.e. educ · age; educ · age · union), and by adding up the number of censored observations in each cell (to the upper part of the unconditional distribution) in the integration step described in appendix D.

With these estimates at hand, we then simulate various versions of factual and counterfactual (conditional) distributions of the dependent variable. Note that our censored quantile regressions do not rest on assumptions regarding the shape of the regression function above the censoring point.

To obtain the counterfactual distribution that would result if only one regressor remained at its t_0 state whereas all other characteristics and prices take on their t_1 values, all cells of the regressor matrix are re-weighted such that only the distribution of that variable is as in t_0, whereas all other regressors are distributed as in t_1.

Before we apply this technique, we first check whether the model is able to replicate the observed wage distribution in the data. Figure E.1 in Appendix E compares the observed with the simulated changes in the wage distribution; Panel A (1975-1989) and Panel B (1991-2001) are based on the IABS, while Panel C reports results for the LIAB (1995-2004). The figures indicate a good fit.

It is important to stress that this decomposition ignores general equilibrium effects, as it is based on (the economically unappealing) assumption that changes in quantities do not affect changes in prices.

4.3 Results

For brevity, we focus on two time periods, 1979 to 1989 and 1991 to 2001. Figure 8 plots the factual wage change (i.e. the change predicted by our decomposition) as well as the counterfactual wage change that would have prevailed if the education and age distribution had remained the same as in the base year. Panel A refers to 1979-1989, while Panel B refers to 1991-2001. First note that in both periods wage changes would have been lower throughout the wage distribution in the absence of changes in workforce composition. This is predominantly a consequence of skill upgrading – see Figure 7. The figure also suggests that changes in workforce composition play a more important role at the upper end of the wage distribution.

We provide more details in Table 2. The table distinguishes several sub-periods; the last two columns refer to the same periods as in Figure 8, i.e. 1979-1989 and 1991-2001. We distinguish three interquantile ranges: 85^{th}-15^{th}, 85^{th}-50^{th}, 50^{th}-15^{th}, and 40^{th}-5^{th}. For each difference, the first two rows compare the observed and simulated wage change. The third to fifth row display the counterfactual wage change that we would have observed if only the age distribution (row 3), or only the education distribution (row 4), or the joint education age distribution (row 5) would have remained at the same level as in the base year.

The table shows that the 85^{th}-15^{th} wage gap increased by about 8.6 log-points between 1979 and 1989, and by 12.4 log-points between 1991 and 2001 (row 1). If both the education and age distribution had remained the same as in the base year, the gap would be lower, 5.0 or 9.4 log-points, respectively.

In line with Figure 8, the table further reveals that changes in workforce composition play a more important role at the upper end of the wage distribution. In both periods, changes in composition explain about 40 percent of the change in the log-wage gap between the 85th and 50th percentile, but at most 15 percent of the change in the log-wage gap between the 50th and 15th percentile. For the 40th-15th interquantile difference, skill upgrading and age composition changes worked *against* a widening of the gap in the 90s.

Are changes in the education structure or changes in the age structure more important? The table shows that skill-upgrading plays a much more important role.

As emphasized by Lemieux (2006a), our results demonstrate that it is important to account for changes in the workforce composition. Our results differ from findings for the US, as reported by Autor, Katz and Kearny (2005b). Contrary to our findings, Autor, Katz, and Kearny (2005b) show that the impact of changes in workforce composition is concentrated at the lower end of the earnings distribution, whereas changes in upper tail inequality are almost entirely due to changes in labor market prices, and not mechanical composition effects.

5. Labour Market Institutions

This section focuses on the divergent path of lower and upper tail inequality in the 80s, as well as the divergent path of lower tail inequality in the 80s and 90s. We first ask: Is the increase in unemployment and the corresponding selection into work responsible for why lower tail inequality did not increase in the 80s, although upper tail inequality did

(Section 5.2)? We then investigate whether the rise in lower tail inequality in the 90s can be explained by a decline in unionization (Section 5.3). Before we present results, we briefly describe Germany's system of collective bargaining and unemployment insurance (Section 5.1).

5.1 Labor Market Institutions in Germany

In the US, legal union recognition is attained through a statutory system based on the majority principle. Recognition is granted if the union obtains a majority in elections held at establishment level (see DiNardo and Lee (2004) for details). Highly de-centralized firm-by-firm bargaining is the norm (see Card, Lemieux and Riddel (2004) for more details). Furthermore, beneficiaries of collective bargaining outcomes in firms that recognize unions are often only workers who are union members.

In Germany, in contrast, recognition of trade unions for collective bargaining purposes is to the discretion of the employer. Different from the US, once a firm has recognized the union, collective bargaining outcomes de facto apply to all workers in that firm, no matter whether they are union members or not. A firm recognizes the union by either joining an employer federation (Arbeitgeberverband), or by engaging in bilateral negotiations with the union. In the first case, union wages are negotiated at a regional and industry level, typically on an annual basis.

A further difference to the US is that there is no legal minimum wage in Germany[22]. However, union contracts in Germany specify wage levels for specific groups in specific sectors, and can be considered as an elaborate system of minimum wages.

[22] An exception is the construction industry. Here, a minimum wage exists since 1996.

Panel A in Table 3 lists the share of firms which recognize unions as well as the share of workers covered by union agreements, from 1995 to 2004. Results are based on the IAB firm panel, and refer to West-Germany only. Over this period, the share of workers who are either covered by an industry- or firm-level agreement has decreased by 16 percentage points.

Unfortunately, data on union coverage does not exist before 1995. Panel B in Table 3 reports union membership rates instead[23]. Because collectively bargained agreements apply to all workers in a firm that recognizes the union, union membership is much smaller than union coverage. While union membership declined somewhat in the 80s, the decline is substantially larger in the 90s. This suggests that the erosion of collective bargaining institutions in Germany is mostly a phenomenon of the 90s.

Germany's labor market is further characterized by a generous unemployment insurance system. Unemployment benefits essentially act as a wage floor, as workers will only accept employment if its value exceeds that of unemployment. Recently, several reforms in the unemployment insurance system have taken place, aimed at increasing the incentives for workers to accept low-wage employment (the so-called Harz IV reform, see e.g. Hagen and Spermann (2004), Jacobi and Kluve (2006) for more details). However, these reforms fall outside our observation window. In Appendix A, we describe Germany's unemployment insurance system in more detail.

[23] We would like to thank Joachim Wagner for providing us with additional information from the Allbus survey.

5.2 Selection into Unemployment

It is well-known that in Germany, unemployment sharply rose throughout the 80s and 90s (see also Figure 10). This is likely to have changed the selection into work, which in turn should affect *measured* wage inequality. In this section we address the following question: Is the increase in unemployment and the corresponding selection into work responsible for why lower tail inequality did not increase in the 80s, although upper tail inequality did?[24]

Figure 9 illustrates our basic argument. In the figure, the solid log-wage density refers to 1980. In this year, the unemployment rate was relatively low (3.5 %, we provide more details on this below). In the figure, unemployment arises because of a minimum wage, represented by the vertical line. Alternatively, the wage floor may be due to generous unemployment benefits. All workers who are less productive than the minimum wage become unemployed. Next, suppose that skill-biased technological change affects the distribution of *offered* log-wages equally at the lower and upper tail. The dashed wage density depicts this situation. In the figure, the rising wage dispersion leads to more unemployment, as the share of workers who are less productive than the minimum wage increases. Hence, selection into work becomes stronger, in the sense that the distribution of *accepted (i.e. observed)* wages becomes more truncated. The question we address is

[24] One hypothesis for why wage inequality rose in the US and UK, but not in Continental Europe, is the 'Krugman hypothesis' (Krugman, 1994). According to this hypothesis, wage rigidities in Continental Europe prevent the decline of wages for the low-skilled, and thus lead to unemployment for that skill group. The rise in inequality in the US and the rise in unemployment in Germany are thus 'two sides of the same coin', namely the increase in the demand for skill. At the heart of this hypothesis is the trade-off between the rise in inequality and the rise in unemployment. Our results in this section do not provide a test for this trade-off; instead, we focus on the changing selection into work and the corresponding difference between latent and measured wage inequality. Gottschalk and Joyce (1998), Puhani (2003) and Acemoglu (2003) provide a test of the Krugman hypothesis by focusing on skill premia and differences in unemployment rates across skill groups.

this: Is it possible that for *accepted* wages, upper tail inequality increases, but lower tail inequality does not, although the increase in lower and upper tail inequality is the same for *offered* wages?

In general, the answer will depend on the distribution of log-wages. Next, we show through simulation that for the normal distribution, the answer is yes: selection into work due to wage floors strongly compresses the lower tail of the *accepted* wage distribution. We begin with simulating the distribution of accepted log-wages, assuming that offered log-wages are normally distributed. The standard deviation of offered log-wages is set to 0.31, and the minimum wage is set such that 3.5 % are unemployed. This corresponds roughly to the situation in 1980. We then increase the standard deviation of the offered distribution from 0.31 to 0.33 to 0.43 (columns), as well as the unemployment rate (rows). Table 4, Panel A reports the change in the difference of the 85^{th} and 50^{th}, 50^{th} and 15^{th}, and 40^{th} and 5^{th} percentile of the *observed –i.e. truncated*- log-wage distribution, as the standard deviation and unemployment rises. Note that, due to normality, the rise in the 85^{th} -50^{th} wage gap is the same as that of the 50^{th} -15^{th} wage gap in the *offered – i.e. un-truncated*- log-wage distribution. Panel B displays the difference between the change in wage gaps of the un-truncated and truncated distribution. Several patterns emerge. First, the observed increase in inequality at the upper tail (85^{th} – 50^{th}) always exceeds the observed increase at the lower tail (50^{th}-15^{th}). Second, observed lower tail inequality (50^{th}-15^{th} and 40^{th}-5^{th}) may decline although the standard deviation of offered log-wages increases. Third, these patterns are the stronger the higher unemployment, i.e. the stronger selection into work. Fourth, the difference in the change in wage gaps of the observed and offered distribution is larger at the lower end of the distribution. Fifth, the differences increase with the standard deviation and unemployment.

How important is this selection effect due to wage floors empirically? In order to test this, we need to recover the un-truncated offered distribution of log-wages[25]. We do this by imputing a wage for the unemployed. Here, we exploit the panel nature of our data, and estimate fixed effect log-wage regressions separately for the low- and medium skilled. Since more than 50 % of the wage observations are censored for the high-skilled, we do not impute a wage for the unemployed in that education group[26]. Our regressions control for 8 age categories and year dummies. We then use our estimates –including the fixed effect- to predict a wage for those who are registered as being unemployed. We would like to stress that we impute wages only for those who are registered at the employment office, and not for workers who are out of the labor force. One may argue that those registered as unemployed poorly reflects the economic concept of unemployment. Data from the German Microcensus, however, shows that the vast majority of workers who are looking for work are registered at the unemployment office[27]. Hence, our unemployment variable should pick up those workers who are available for work.

Before we present our results, we briefly describe time trends in unemployment. Panel A of Figure 10 plots the unemployment rate in our data as well the official

[25] Several recent papers demonstrate that in the context of the male-female wage differential, selection into work is important (e.g. Neal (2004), Mulligan and Rubinstein (2004)). See Blundell et al. (2007) for a recent approach to recovering the uncensored distribution based on bounds and when only repeated cross-section data is available.
[26] As a robustness check, we have imputed a wage for the unemployed using the worker's wage before or after the unemployment spell. Like this, we can impute a wage also for the unemployed university graduates. Results are very similar.
[27] According to the 1999 German Microcensus, 96% of males in the age range between 21 and 60, and who are out of work, but looking for a job, are registered with the employment office.

unemployment rate, as reported by the Bundesanstalt für Arbeit, over time. Both statistics are very similar, indicating the unemployment information in the IABS is reliable. For comparison, we also show the unemployment rate in the US. At the beginning of the 80s, unemployment was higher in the US than in Germany. Unemployment rates start to differ substantially only in the 90s, when unemployment rises sharply in Germany, but continues to decline in the US. Panel B of Figure 10 shows that in Germany unemployment rates are substantially larger for the low- and medium-skilled than for the high-skilled.

Next, we investigate a key implication of Figure 8, namely that unemployed workers are negatively selected. Figure E.2 in Appendix E plots the distribution of workers' permanent productivity component (i.e. the fixed effect) for the unemployed and employed, for the year with the lowest (1980) and highest (1997) unemployment rate. The figure refers to the medium-skilled, but the picture looks very similar for the low-skilled. While there is considerable overlap of the two distributions, the figure clearly shows that the unemployed are negatively selected in terms of permanent productivity[28].

Figure 11 plots the evolution of the 40th-5th wage gap (Panel A), the 50th-15th wage gap (Panel B), and the 85th-50th wage gap (Panel C), for observed as well as imputed log-wages. In line with our simulations in Table 4, the wage gap based on imputed log-wages exceeds that based on observed log-wages, at least at the lower end of the distribution.

[28] It may be argued that unemployed workers have lower actual experience on average than employed workers. Hence, conditioning on potential experience instead of actual experience may lead us to overstate permanent productivity differences between unemployed and employed workers. For cohorts who entered the labor market after 1975, we observe workers' actual experience and can thus test this hypothesis. Differences in permanent productivity between employed and unemployed workers are indeed lower when we condition on actual experience. However, unemployed workers continue to be negatively selected.

Moreover, the difference is largest for the 40th-5th wage gap, and disappears for the 85th-50th wage gap. However, throughout the time period considered, the imputed difference between 40th and 5th percentile increased at a roughly similar pace as the observed difference[29]. For instance, between 1980 and 1990, the observed difference increased by 5 log-points, compared to 4 log-points for the imputed difference. A similar picture emerges for the difference between the 50th and 15th percentile. We thus conclude that selection into unemployment due to wage floors cannot account for the divergent path of lower and upper tail inequality in the 80s, or the divergent path of lower tail inequality in the 80s and 90s.

5.3 Decline in Unionization

We now analyze whether *changes* in labor market institutions in the 90s, in particular the sharp decline in union coverage (see Table 3 for evidence), can account for the rise in inequality at the bottom of the distribution over that period. There is strong evidence that unions compress the wage structure in Germany, and more so at the lower end of the wage distribution (see Gerlach and Stephan (2005, 2007), Fitzenberger and Kohn (2005), and Dustmann and Schönberg (2004) for evidence.).

To test this hypothesis, we employ the decomposition method described in Section 4.2, and include union recognition in addition to all interactions between 3 education and 8 age groups as regressors. We distinguish between firm- and industry-level agreements. The analysis is based on the LIAB, a linked employer-employee data set, as this data

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[29] In line with Table 4, we find that the difference in the imputed and observed 40th-5th wage gap is larger when unemployment is higher. When regressing the difference on the unemployment rate (which ranges from 0.035 to 0.118), the coefficient on the unemployment rate is 0.225, with a standard rate of 0.087. However, for the 50th-15th wage gap, we find no relationship between the difference in the imputed and the observed wage gap and the unemployment rate.

provides us with information on the union status of the firm (see section 5.1 for details on union coverage in Germany). It is again important to stress that the decomposition method ignores general equilibrium effects; in our application, this means that the union-non-union wage differential is assumed to be independent of union coverage.

Before we present results, we compare mean wages as well as interquantile differences in the LIAB and the IABS. Results can be found in Table E.2 in Appendix E. Both data sources draw a similar picture of the developments in the wage structure over this period. Results based on the LIAB further indicate that the increase in inequality at the bottom and top of the distribution continued between 2001 and 2004.

Figure 12 plots the factual wage change (i.e. the change predicted by our decomposition) as well as the counterfactual wage change that would have prevailed if unionization rates had remained at their 1995 level, for the 1995 to 2004 period. The figure illustrates that workers *throughout* the wage distribution would have experienced a higher wage growth over this period if unionization rates had not declined. However, the impact of de-unionization is substantially stronger at the lower end of the wage distribution. For instance, wages in 2004 would have been 8 % higher at the 5th percentile, but only 0.5 % higher at the 85th percentile.

We provide more details in Table 5. The table distinguishes 3 time periods, 1995-2004, and, to facilitate the comparison with the IABS, 1997-2001 and 1995-2001. We further distinguish three interquantile differences: 85th- 15th, 85th -50th, 50th-15th, and 40th-5th. For each interquantile difference, the first two rows compare the observed and simulated wage change. The third and fourth row report the wage change that would have prevailed if only unionization (row 3) or unionization as well as the age and education distribution had remained the same as in the base year. For brevity, we focus here on the 1995-2004 period. Results are similar for the other periods. From 1995-to 2004, the 85th-15th wage gap increased 0.153 log-points. If we keep unionization rates at its 1995 level, the gap reduces to 12.5 log-points – a reduction of about 20 %. The decline in union coverage explains about 1 log-point of the 7 log-point increases at the upper part of the distribution (85th-50th), and 2 log-points of the 8.2 log-point increase at the lower part of the distribution (50th-15th). The impact of de-unionization is strongest at the very low end of the wage distribution. Between 1995 and 2004, the gap between the 40th and 5th percentiles increased by 20 log-points. Our decomposition shows that 6 log-points (or about one third) of this increase is due to de-unionization. In line with the results in Table 3, workforce characteristics also play an important role, particularly at the upper end of the distribution.

These results indicate that the decline in union recognition in the 90s had a profound impact on the wage structure predominantly, but not only, at the lower end of the distribution. It is not surprising that de-unionization also affected the distribution above the median, as there is no single minimum wage (like in the US), but union minimum wages are set at all levels of qualification (see Section 5.1 for details). It is important to note that, other than in the US, workers are only entitled to a minimum wage if their employer is unionised. Therefore, we can not separate the influence of the minimum wage from that of unions[30].

[30] For the US, DiNardo, Fortin, and Lemieux (1996) and Firpo, Lemieux, and Fortin (2006) show that in the 80s, de-unionization lead to a wage *compression* at the lower end of the wage distribution. However, this effect is outweighed by the decline in the minimum wage, leading to an overall increase in lower tail inequality.

6. Polarization

Our results in the previous two sections indicate that it is important to distinguish between changes in lower and upper tail inequality, a point that has also been made by Autor, Katz, and Kearney (2005a, 2005b, 2006) for the US. These papers also provide a possible explanation for this pattern (see also Autor, Levy, and Murnane 2003). The idea is that technological change, in particular the implementation of computer technology, differently affects the bottom and top of the skill distribution. Suppose that computerization decreases the demand for jobs that require routine analytical or clerical skills, and increases the demand for non-routine cognitive and interpersonal skills. Computer technology neither strongly complements nor strongly substitutes manual skills. If routine analytical skills are predominantly used in the middle, and manual and interactive skills at the bottom and top of the wage distribution, then technological change may lead to 'polarization' (Goos and Manning 2007), and thus differently affect lower and upper tail inequality. For Germany, Spitz-Oener (2006) provides evidence that between 1979 and 1999, the demand for interactive and non-routine analytical skills has increased, while the demand for routine-cognitive skills has declined. Much of these changes can be linked to computerization. This section further investigates this hypothesis for Germany.

As Goos and Manning (2007) point out, one implication of this hypothesis is that occupations in the middle of the wage distribution in, say, the late 70s, should have lower growth rates than occupations at the bottom and top of the wage distribution. We test this hypothesis by ranking the 130 occupations in our data set according to their median wage in 1979. We then group the occupations in 10 groups of roughly equal size. Figure 13 shows the percentage change in the employment share for the 10 groups. Panel A focuses on the 1979-1989 period, and Panel B on the 1991-2001 period. Both time periods show similar trends. The employment share of occupations at the top of the wage distribution (the 8th decile onwards) has increased substantially in both periods. The employment share of occupations in the middle of the wage distribution (4th -7th decile), in contrast, declined. Occupations at the low end of the wage distribution have neither experienced strong losses nor strong gains.

Table 6 provides information on how occupations differ in task usage throughout the wage distribution. The table lists the fraction of workers performing non-routine analytic, interactive, routine cognitive, routine manual and non-routine manual tasks in 1999 for the three largest occupations in the selected decile. The information comes from the *German Qualification and Career Survey*, see Spitz-Oener (2006) for more details. The number in parentheses next to the occupation refers to the growth rate of the occupation from 1979 to 2001 in the IABS. The classification of tasks follows Spitz-Oener (2006)[31]. The results are striking. Occupations at the top of the wage distribution – i.e. occupations that experienced the largest growth rates- are occupations in which predominantly non-routine analytical or interactive tasks are performed. Occupations in the middle of the distribution (we have displayed here deciles 6 and 7) –i.e. occupations that showed the largest decline- are occupations in which mostly routine cognitive tasks

[31] We would like to thank Alexandra Spitz-Oener for making her computer programs available to us. Non-routine analytic tasks include research, evaluation, planning; making plans, construction, designing, sketching; working out rules, prescriptions; using and interpreting rules. Interactive tasks include negotiating, lobbying, coordinating, organizing; teaching or training; selling, buying, advertising; entertaining or presenting; employ or manage personnel. Routine cognitive tasks include calculating, bookkeeping; correcting texts/data; measuring of length/weight/temperature. Routine manual tasks include operating or controlling machines; equip machines. Non-routine manual tasks include repairing or renovating houses / apartments / machines / vehicles; restoring of art/monuments; serving or accommodating.

are used. Occupations at the low end of the wage distribution mostly employ manual tasks.

These results speak against a simple theory of skill-biased technological change according to which technology symmetrically affect the bottom and the top of the wage distribution. They are consistent with a more nuanced view of skill-biased technological change according to which technology substitute routine tasks, but complement non-routine tasks, and thereby asymmetrically affect the bottom and the top of the wage distribution.

7. The Role of Supply Shocks

So far, we have focused on the divergent path of upper and lower tail wage inequality in the 80s and 90s. This section concentrates on *between-group* inequality, and analyzes the role of demand and supply factors in explaining recent trends in the skill premium. This is motivated by Figures 6 and 7 which show that the wage differential between the medium- and low-skilled started to increase around the same time when the increase in the relative supply of the medium-skilled started to slow down – and this timing also coincides with the rise in lower-tail wage inequality. As we argued before, the slowdown in skill upgrading is likely to related to the breakdown of the communist regimes in Eastern Europe as well as the reunification of East- and West-Germany. These events lead to a large inflow of East Germans, Eastern Europeans, as well as ethnic Germans from Eastern Europe into the West-German labor market; many of them were low-skilled.

Following Katz and Murphy (1992), our framework starts with a CES production function for aggregate output Y and three factors, low-, medium-, and high-skilled:

$$Y = f(N_{Lt}, N_{Mt}, N_{Ht}) = [(g_{Ht}N_{Ht})^{(\sigma-1)/\sigma} + (g_{Mt}N_{Mt})^{(\sigma-1)/\sigma} + (g_{Lt}N_{Lt})^{(\sigma-1)/\sigma}]^{\sigma/(\sigma-1)}$$

where N_{Lt}, $N_{Mt,}$ and N_{Ht} are quantities employed of low-, medium-, and high-skilled workers; g_{Lt}, g_{Mt}, and g_{Ht} represent factor-augmenting technological change; and σ is aggregate elasticity of substitution (here assumed to be the same for the medium- and low-skilled as well as the high- and medium-skilled). Under the assumption that labor is paid its marginal product, then the medium-low and high-medium wage differential satisfies

$$\log(w_{Mt} / w_{Lt}) = 1/\sigma[D_{MLt} - \log(N_{Mt} / N_{Lt})], \text{ and} \qquad (2a)$$
$$\log(w_{Ht} / w_{Mt}) = 1/\sigma[D_{HMt} - \log(N_{Ht} / N_{Mt})] \qquad (2b)$$

where $D_{MLt} = (\sigma - 1)\log(g_{Mt} / g_{Lt})$ and $D_{HMt} = (\sigma - 1)\log(g_{Ht} / g_{Mt})$ indexes the relative demand shifts favoring the medium- and high-skilled, respectively. We estimate equations (2a) and (2b) directly, and substitute for the unobserved relative demand shifts with a simple linear time trend.

Panel A of Figure 14 gives a first visual impression about the relationship between relative supply and relative wages. It plots the series of relative supply and relative wage over 1975 to 2001 *deviated from a linear trend*, for the medium- and low-skilled (left panel) as well as the high- and medium-skilled (right panel). For the medium- versus low-skilled, the decline in the de-trended relative wage coincides with a rise in the de-trended relative supply, and vice versa. For the high- versus medium-skilled, in contrast, there is no clear pattern.

Table 7 reports results from a constrained regression that restricts the coefficient on the relative supplies (i.e. $1/\sigma$) to be the same for the medium- and low-skilled as well as the high- and medium-skilled. Panel B in Figure 14 plots the observed wage gap as well as the wage gap predicted by the Katz-Murphy model against time. The table and the figure confirm the visual impression in Panel A: The simple Katz-Murphy model predicts trends in the wage differential between the medium- and low-skilled surprisingly well. However, it does a poor job in forecasting the evolution in the wage differential between the high- and medium-skilled.[32] Controlling also for the unemployment rate (specification 2) makes little difference. Note that the coefficient on the relative supply of 0.24 implies an estimate for the elasticity of substitution of about 4 (1/0.24); this estimate is considerably larger than the estimate of around 1.4 typically found in the US. However, since we distinguish three education groups instead of only two, this is not that surprising.[33]

These results suggest that the changes in the skill mix following the breakdown of the Communist regimes in Eastern Europe had a profound impact on skill prices and thus the wage structure, particularly at the lower tail of the wage distribution.

8. Discussion and Conclusion

This paper challenges the common view that the rise in wage inequality is a phenomenon observed only in a handful of countries, such as the US, UK, or Canada. In particular, we revisit trends in wage inequality in (West-) Germany, a country that so far

[32] We would like to stress again that our results for the high-skilled have to be interpreted with caution due to the incidence of wage censoring for this education group

[33] Using a more elaborate framework than ours, Fitzenberger and Kohn (2006) report estimates for the elasticity of substitution that are in line with our estimate.

has been singled out as a country with a stable wage distribution. Based on a large administrative data set, we find that wage inequality in Germany has increased in the 80s, but mostly at the top of the distribution. In the early 90s, wage inequality started to rise also at the bottom of the distribution. Hence, while the US and Germany experienced similar changes at the top of the distribution throughout the 80s and 90s, the two countries markedly differ with respect to the lower end of the wage distribution: The rise in lower tail inequality happened in the US in the 80s, but in Germany in the 90s.

We show that changes in workforce composition play an important role in explaining changes in the wage structure. Different from the US, changes in composition are more important at the top of the wage distribution. However, they cannot fully account for the divergent path of upper and lower tail inequality in the 80s, or for the divergent path of lower tail inequality in the 80s and 90s. We find little evidence for the hypothesis that the changing selection into work throughout the 80s is responsible for why we see only small changes in lower tail inequality over this time period.

Moreover, our results are consistent with a polarization of work: Occupations that were at the top of the 1979 wage distribution experienced the largest growth rates, while occupations in the middle declined relative to occupations at the bottom. This speaks against a simple theory of skill-biased technological change according to which technology increase the demand for skilled jobs, relative to that of unskilled jobs. It is, however, consistent with a more nuanced view of technological change according to which technology asymmetrically affect the bottom and the top of the wage distribution, by substituting for routine tasks and complementing non-routine tasks (e.g. Autor, Levy, and Murnane, 2003). Since results consistent with a polarization of labor demand have now been found in three advanced countries (see Autor, Katz, and Kearney, 2005a, 2005b, 2006 for the US, and Goos and Manning, 2007 for the UK)[34], this may begin to provide the unifying international evidence on technological change that so far has been absent – although more research for other advanced countries is needed to fully assess this hypothesis.

Can the polarization of work alone account for the divergent path of lower and upper tail inequality in the US as well as Germany, and in particular for the finding that lower tail inequality increased in the 80s in the US, but in the 90s in Germany? We believe that the widening of the wage distribution at the bottom may be better explained by episodic events, such as changes in labor market institutions and supply shocks. The hypothesis we put forward here is that these episodic events happened in the 80s in the US, but in the 90s in Germany.

First, the 80s in the US are characterized by an erosion of labor market institutions, such as labor unions as well as a declining minimum wage. In Germany, in contrast, this process appears to have started in the 90s only. Several papers in the US show that these changes are important in explaining changes in inequality, in particular at the lower end of the wage distribution (e.g. DiNardo, Fortin, and Lemieux (1996), Lee (1999), and Card and DiNardo (2002)). We find that between 1995 and 2004, de-unionization can explain one third of the increase in lower tail inequality.

Second, in the US skill upgrading started to slow down in the early 80s. In Germany, in contrast, the slowdown in skill upgrading, in particular the slowdown in the decline in the share of the low-skilled, started only in 1990 (see Figure 6, Panel A).

[34] For Germany, Spitz-Oener (2006) also provides some evidence consistent with polarization – although the focus of her paper is the changes in skill requirements over time.

Several US studies show that fluctuations in relative labor supply play an important role in explaining trends in the skill premium (e.g. Katz and Murphy (1992), Card and Lemieux (2001)). We find that fluctuations in relative supply go a long way in explaining trends in the wage differential between the medium- and low-skilled, but only weakly predict trends in the wage differential between the high- and the medium-skilled.

Why did the slowdown in skill upgrading and the erosion in labor market institutions happen a decade earlier in the US than in Germany? The relative increase in the share of the low-skilled that started in 1990 in Germany is likely to be a consequence of the breakdown of the communist regimes in Eastern Europe as well as the reunification of East- and West-Germany. These events lead to a large inflow of East Germans, Eastern Europeans, as well as ethnic Germans from Eastern Europe into the West-German labor market; many of these immigrants were low-skilled (see Glitz (2006) for more details). What about the different timing in de-unionization in the US and Germany? Note that throughout the 80s, aggregate wage growth was much higher in Germany than in the US. Moreover, although unemployment kept rising through most of the 80s in Germany, it was not much higher than in the US (see Figure 9). A possible hypothesis therefore is that the high incidence of collective bargaining was affordable in the 80s, but the rising unemployment rates and the changes in the skill mix of the workforce in the 90s put increasing pressure on this institution.

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Appendix

Appendix A: Unemployment Insurance in Germany

The German unemployment compensation scheme distinguishes, at least over the period we consider, between unemployment insurance benefits (UI) and unemployment assistance (UA). To be eligible, employees must have contributed for at least 12 months over the preceding 3 years to the scheme. The scheme is financed by employer and employee contributions in equal parts (amounting to 3.25 percent of the employee's salary). There is a waiting period of 12 weeks if the separation was induced by the employee. If the separation was initiated by the employer, receipt of UI starts immediately. The compensation is oriented on past *net* earnings, and it amounts to 67 percent of the previous net wage (60 percent for employees without children). There is an upper threshold (for instance, about 2600 Euro in 1984, and 3000 Euro in 1990). UI can be received for up to 32 months, with the duration of the entitlement period depending on age and the length of contributions to the scheme. The minimum period of eligibility is 156 days (see Kittner, 1995, p. 192, for more details).

If UI is exhausted, or if the employee is not eligible for UI, workers can claim UA. A condition for receiving UA in case of non-eligibility for UI is having been in insured employment for at least 150 days during the last year. Like UI, UA is based on past earnings, and amounts to 57 percent of past net earnings (50 percent for employees without children). UA is means tested, and its duration is unlimited.

Appendix B: IABS

Sample Selection In addition to the selection criteria described in Section 3, we drop wage spells of workers in apprenticeship training. We further impose the restriction that daily wages (in 1995 DM) have to be at least 20 DM. For the wage analysis, we use full-time spells only. When computing unemployment rates as well as supplied and demanded quantities, part-time spells are included, though at a lower weight (see below). Observations with a missing education variable are dropped (less than 0.1 % of the observations).

Variable Description Our wage variable is the average *daily* wage. If a worker worked for more than one employer a year, we compute a weighted average, where the weights are the number of days worked for an employer. Our results are employment duration-weighted: A worker who works 365 days a year gets a weight of 365, whereas a worker who works only 7 days a year gets a weight of 7. Wages are deflated by the Consumer Price Index, with 1995 as the base year. Sine 1999, wages are measured in Euros; we use an exchange rate of 1 Euro = 1,95583 DM to convert Euros into Deutschmarks.

Our education variable distinguishes three groups which we label low, medium and high. The low-skilled are workers who enter the labor market without post-secondary education. The medium-skilled are workers who completed an apprenticeship or A-levels (*Abitur*). The high-skilled are workers who graduated from university or college (*Universität* or *Fachhochschule*). In the raw data, the education variable is missing for 10.62 % observations. However, since our data is longitudinal, we can impute a value by looking at past and future values of the education variable. We replace the education variable by its previous value if it is missing. If there is no valid past value, it is replaced by the first future valid value. Finally, if the education variable drops from one period to the next, it is replaced by the previous higher value. Like this, we insure that the education variable is missing for less than 0.1 % of the observations. We distinguish 8 age groups, 21-25, 26-30, …, 51-55, and 56-60.

Unemployment refers to registered unemployment. Evidence from the Microcensus suggest that the vast majority of workers who are looking for work are also registered as unemployed.

Supplied quantities in each year are comprised of days in unemployment, days in full-time employment, as well as days in part-time employment. Our part-time variable distinguishes between a 'short' (15-20 hours) and 'long' (20-30 hours) part-time; short and long part-time is weighted down by 0.5 and 0.67, respectively.

The structural break in 1984 Starting in 1984, one-time payments, such as bonuses, are included in our wage measure (see Bender et al. (1996) for more details). As pointed out by for instance Steiner and Wagner (1998), ignoring this structural break results in a spurious increase in inequality. We correct for this break in the same way as Fitzenberger (1999). The correction is based on the assumption that only quantiles above the median are affected by the structural break, and thus have to be corrected upwards. To this end, wage growth between 1983 and 1984 is assumed to be constant below the median, and wage growth above the median is specified as a linear function in the percentage point difference between the respective percentile and the median. See Fitzenberger (1999) for more details.

Table B.1 provides information on interquantile difference in the raw and corrected data. The table shows a discontinuous increase in the raw 85^{th}-15^{th} wage gap from 1983 to 1984. Clearly, the increase is much larger for the 85^{th}-50^{th} wage gap, justifying the assumption that only wages above the median are affected. However, the increase in interquantile differences we observe between 1975 and 1984 at the upper end of the wage distribution is not entirely due to the discontinuous jump in 1984. The uncorrected difference between the 85^{th} and 50^{th} percentile increased by 5.8 log-point between 1979 and 1983 and by 3.3 log-points between 1984 and 1989 (i.e. 9.1 log-points in total, ignoring any increase from 1983 to 1984), compared to 11.5 log-points between 1974 and 1989 for the corrected data.

Table B.1: Interquantile Ranges When We Do Not Correct for the Structural Break

		1975	1979	1983	1984	1989
85^{th}-15^{th}	(1)	0.528	0.576	0.598	0.608	0.662
	(2)	0.500	0.537	0.546	0.608	0.662
85^{th}-50^{th}	(1)	0.280	0.322	0.356	0.362	0.395
	(2)	0.255	0.293	0.313	0.362	0.395
50^{th}-15^{th}	(1)	0.248	0.255	0.242	0.246	0.267
	(2)	0.245	0.243	0.233	0.246	0.267
40^{th}-5^{th}	(1)	0.407	0.411	0.411	0.424	0.445
	(2)	0.405	0.402	0.401	0.424	0.445
	N	200543	211179	209166	221242	230377

Note: The table compares interquantile ranges in the corrected (row 1) and uncorrected (row 2) data. The correction is based on Fitzenberger (1999).Only wages before 1984 are corrected.

Appendix C: LIAB

Most of the variables in the LIAB closely correspond to those in the IABS. There are a few exceptions. First, the wage variable refers to the first of July in the LIAB, as opposed to an annualized average in the IABS. Second, since the LIAB does not contain complete biographies of workers, it is impossible to impute missings in the education variable. We therefore recode missings as an additional education category.

The union variable distinguishes three categories: agreements at the firm-level, agreements at industry level, and no collective agreement. In 1999, the question on union agreements changed slightly. The category 'firm-level collective agreement' was replaced by 'firm-level collective agreement underwritten by a union'. We did ignore this modification since its impact is almost invisible on time series plots of the evolution of union recognition. An additional category (orientation of payment schemes on branch-level agreements for firms without agreement) is available from 1999 onwards but not before and is therefore not used in our analysis.

In addition to the selection criteria described in Section 3, we discard all firms in which the union variable is missing. The maximum loss of establishments due to these missings is 72 (around 0.8 %) in 2001.

Appendix D: Melly's Decomposition Method

This section provides further details on the decomposition technique proposed by Melly (2006). Melly (2006) adopts a three-step procedure: First, invert the conditional quantile function to obtain the conditional distribution function. Second, obtain the unconditional distribution function by integrating the conditional distribution function over X. And third, reconstruct the quantile function by inversion of the unconditional distribution function. Next, we formally describe these three steps.

The quantile regression delivers the conditional quantile function $F_Y^{-1}(\tau \mid X_i)$ for each observation $i = 1,...,N$. From this, we obtain in the first step the conditional distribution function by

$$F_w(q \mid X_i) = \int_0^1 1\left(F_w^{-1}(\tau \mid X_i) \leq q\right)\, d\tau = \int_0^1 1\left(X_i \beta(\tau) \leq q\right)\, d\tau$$

Where $1(\cdot)$ denotes the boolean operator returning 1 if its argument is true and 0 otherwise. Then we integrate the right hand side expression numerically

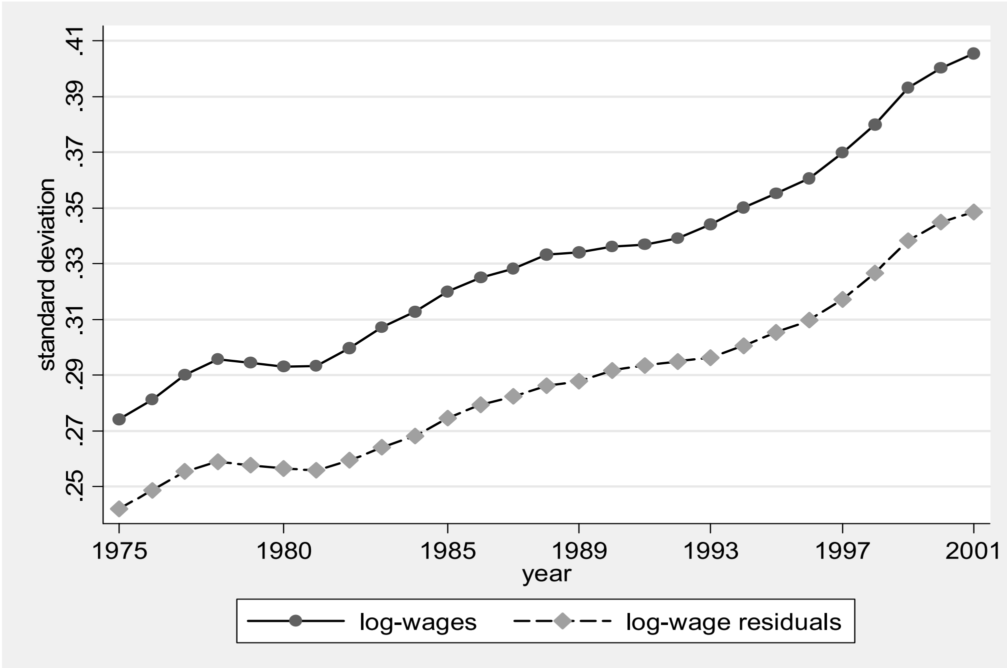
$$\hat{F}_w(q \mid X_i) = \sum_{j=1}^{J} (\tau_j - \tau_{j-1}) 1\left(X_i \beta(\tau) \leq q\right).$$

The unconditional distribution function is then obtained by numerical integration over the sample:

$$\hat{F}_w(q) = \frac{1}{N} \sum_{i=1}^{N} F_w(q \mid X_i).$$

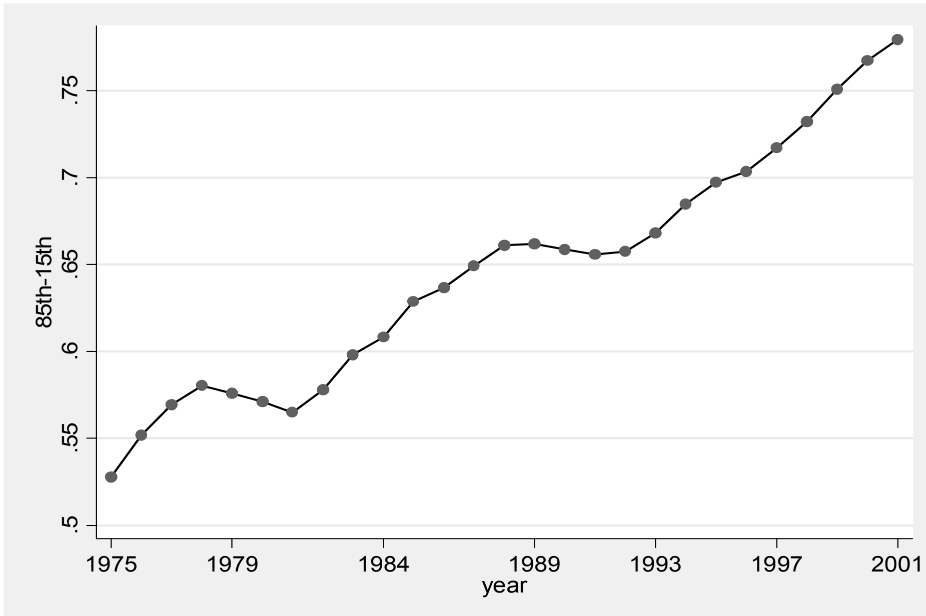
This completes the second step. In the third step, the quantiles result from inversion of the distribution function using the infimum operator $q(\tau) = \inf\left\{q : \hat{F}_w(q) \geq \tau\right\}$.

Figure 1: Evolution of the Standard Deviation of Log-Wages and Log-Wage 'Residuals'



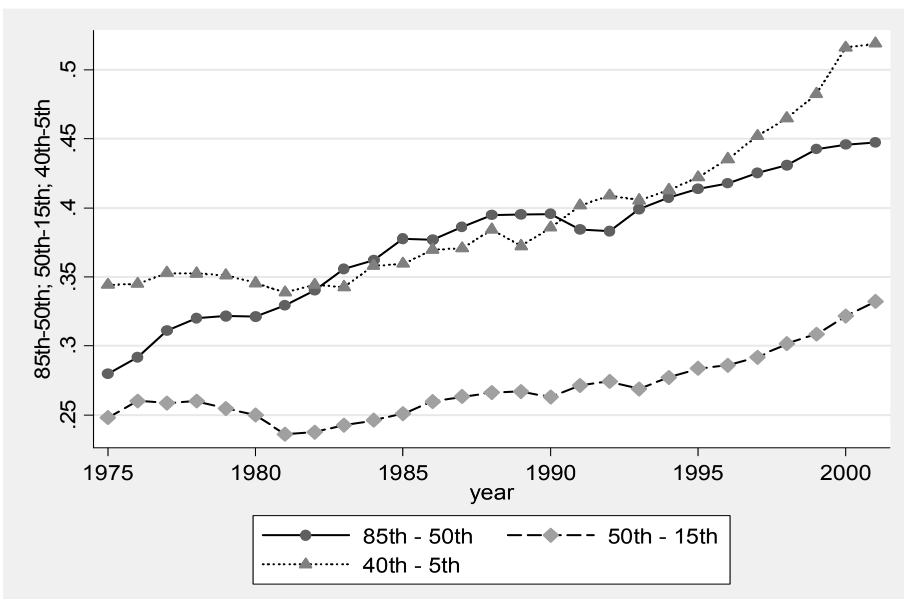
Note: The figure plots the evolution of the standard deviation of log-wages and log-wage residuals. The standard deviation is obtained from a censored regression, estimated separately for each year. We control for 3 education categories, 8 ge categories, as well as all possible interactions between these two variables.

Figure 2: Evolution of the 85th-15th Wage Gap



Note: The figure plots the difference between the 85th and 15th percentile of the log-wage distribution over time. We correct for the structural break in the measurement of wages following Fitzenberger (1999).

Figure 3: The Top versus Bottom: The 85th-50th, 50th-15th, and 40th-5th Wage Gap



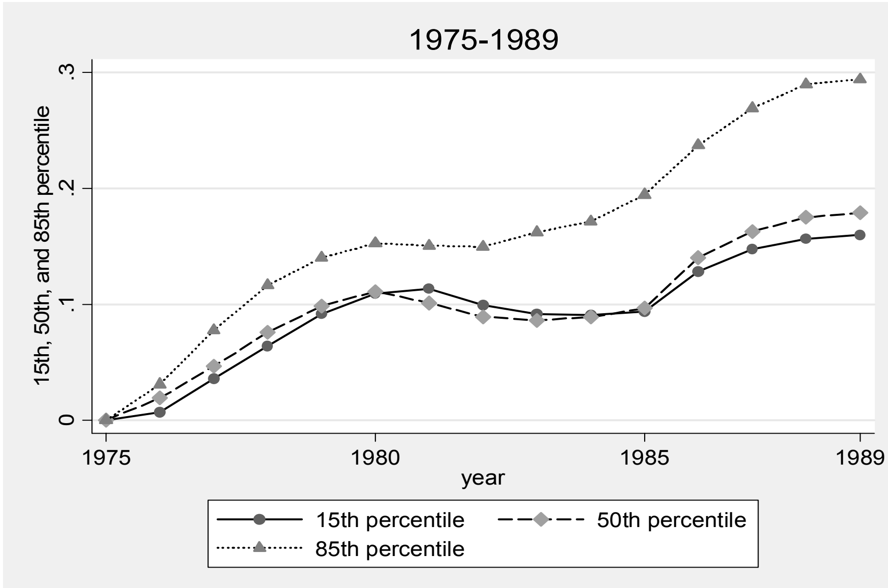
Note: The figure plots the difference between the 85th and 50th, 50th and 15th, as well as 40th and 5th percentile of the log-wage distribution over time.

Table 1: The 5th, 15th, 50th, and 85th Percentile of the Log-Wage Distribution Over Time

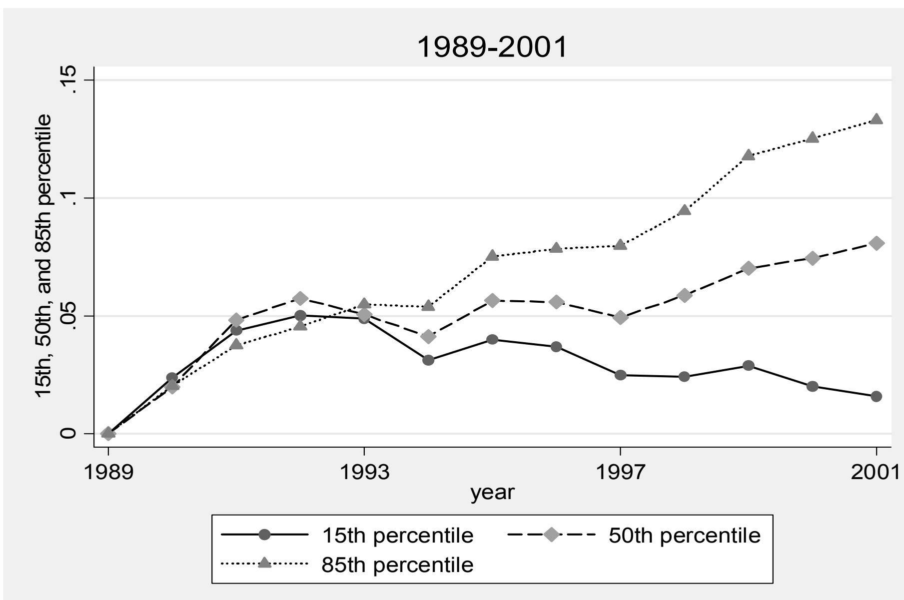
	1975	1979	1984	1989	1993	1997	2001
5th	4.445	4.540	4.517	4.586	4.607	4.553	4.502
	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
15th	4.604	4.696	4.695	4.764	4.813	4.789	4.780
	(0.003)	(0.001)	(0.000)	(0.000)	(0.002)	(0.000)	(0.001)
40th	4.789	4.891	4.876	4.958	5.013	5.005	5.021
	(0.002)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)
50th	4.852	4.951	4.941	5.031	5.082	5.080	5.112
	(0.002)	(0.000)	(0.000)	(0.000)	(0.002)	(0.000)	(0.001)
85th	5.132	5.272	5.303	5.426	5.481	5.506	5.559
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)
N	200543	211179	209166	221242	230377	214683	211525

Note: The table reports the 5th, 15th, 40th, 50th, and 85th percentile for selected years.

Figure 4: Indexed wage growth for the 15th, 50th, and 85th percentile
Panel A: 1975-1989

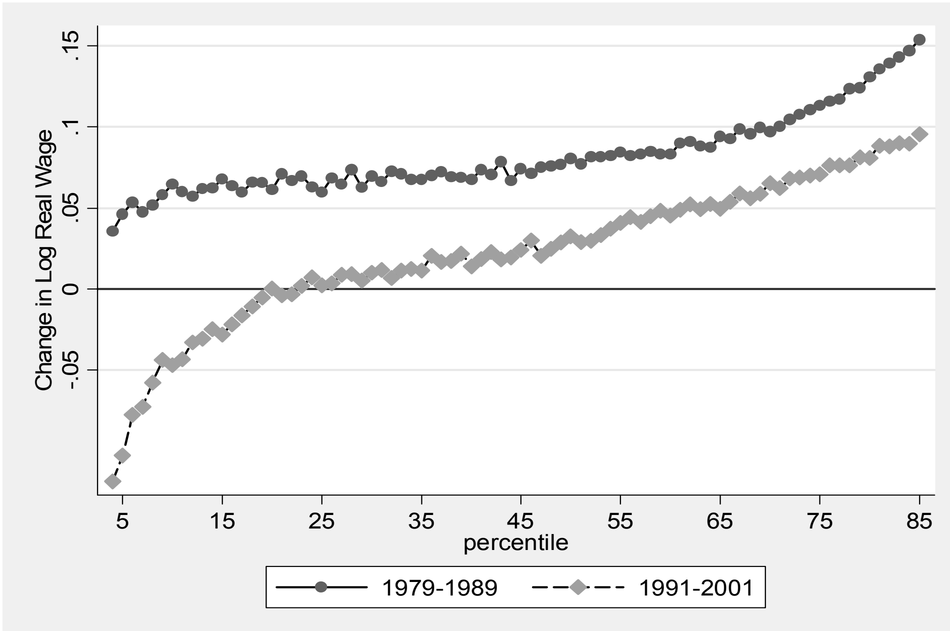


Panel B: 1989-2001



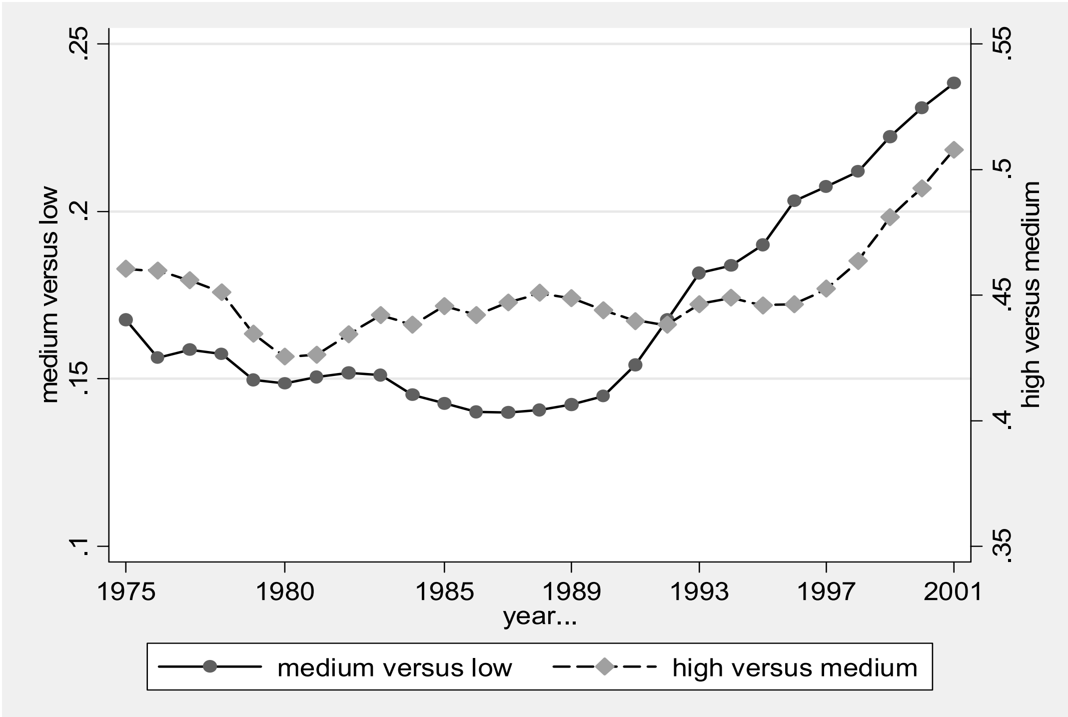
Note: The figures show the indexed wage growth for the 15th, 50th, and 85th percentile of the wage distribution.Panel A focuses on the (pre-unification) period between 1975 and 1989, with 1975 as the base year. Panel B focuses on the (post-unification) period between 1989 and 2001, with 1989 as the base year.

Figure 5: Wage Growth by Percentile: The 80s vs the 90s



Note: The figure plots wage growth by percentile from 1979 to 1989 as well as from 1991 to 2001.

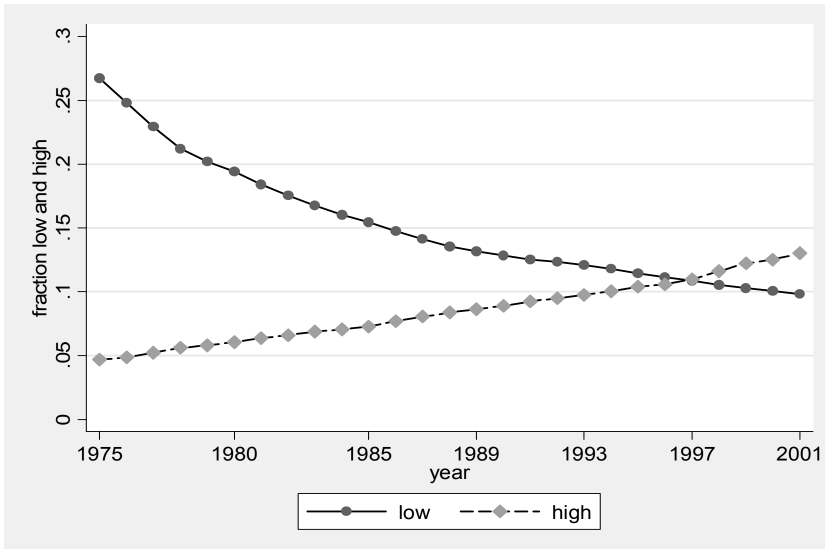
Figure 6: Returns to Education



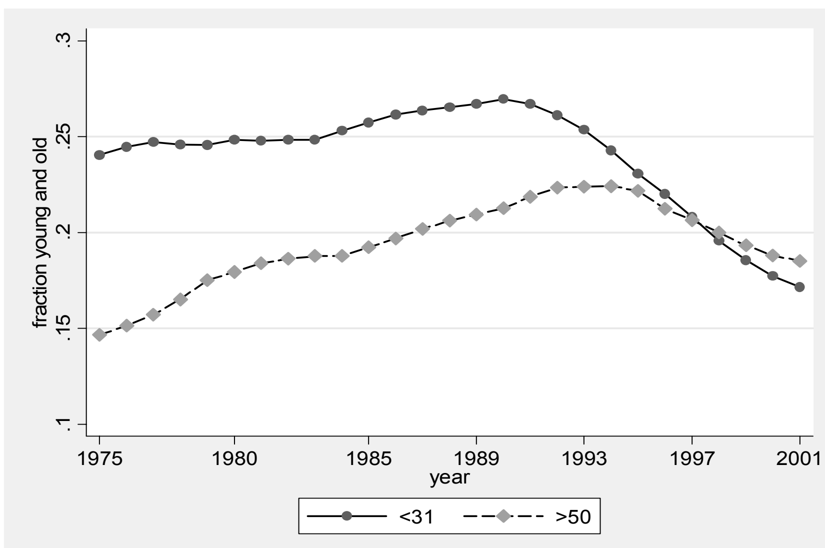
Note : The figure plots the evolution of the return to education, obtained from censored wage regression estimated separately for each year.

Figure 7: Changes in Workforce Composition

Panel A: The Share of Low- and High-Skilled



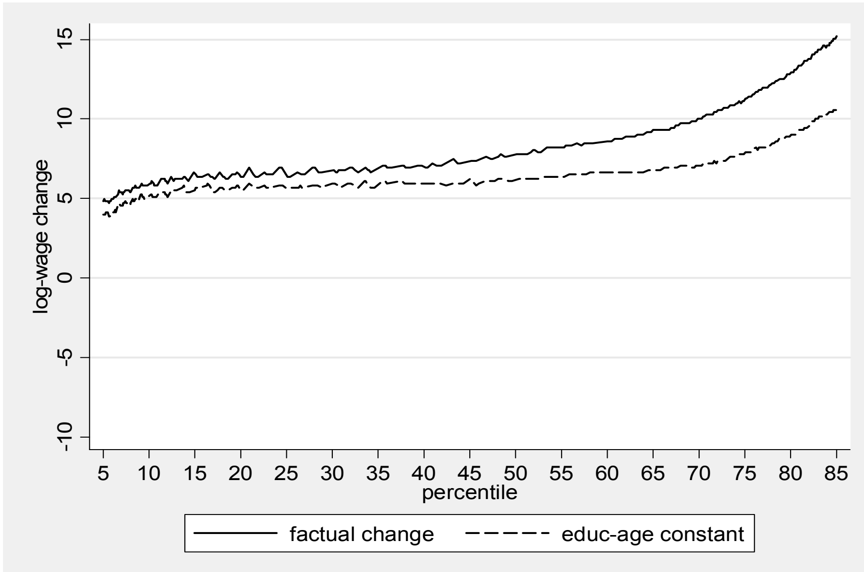
Panel B: The Share of 'Young' and 'Old' Workers



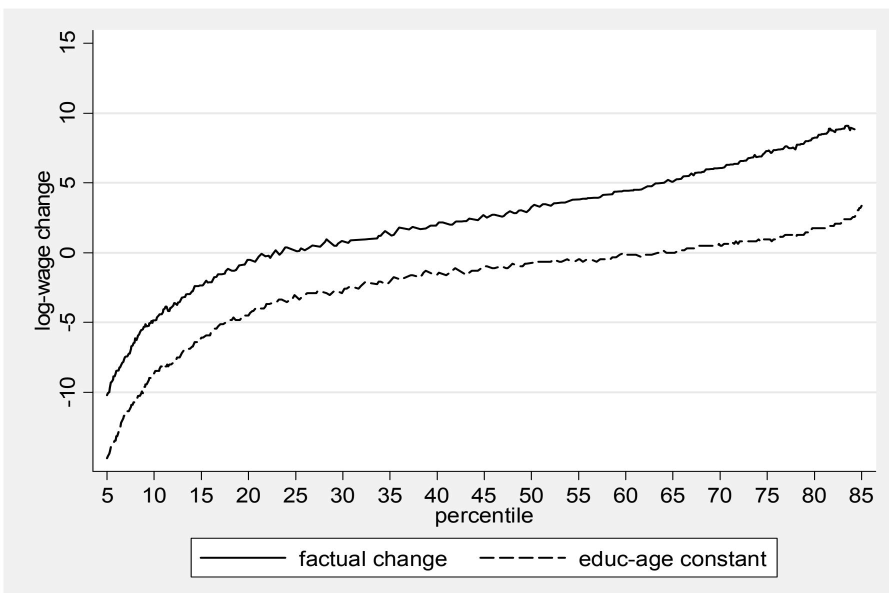
Note: The figure plots the share of low- and high-skilled (Panel A) and the share of 'young' (<31) and 'old' (>50) workers (Panel B) over time. The respective share is computed as the number of days spent working or in unemployment of the group, devided by the number of days spent working or in unemployment of all workers. Part-time work is weighted down.

Figure 8: The Role of Composition and Prices

Panel A: 1979-1989



Panel B: 1991-2001



Note: The figure plots factual wage growth by percentile from 1979-1989 (Panel A) and 1991-2001 (Panel B), as well as the wage growth that would have prevailed if the age-education distribution had remained the same as in the base year.

Table 2: The Role of Composition, Sub-Periods

		75-79	79-84	84-89	89-93	93-97	97-01	79-89	91-01
		85th - 15th							
total									
(1)	observed	0.048	0.032	0.054	0.006	0.049	0.067	**0.086**	**0.124**
(2)	predicted	0.044	0.036	0.049	0.012	0.043	0.063	**0.085**	**0.119**
composition									
(3)	age	0.043	0.036	0.056	0.018	0.048	0.053	**0.092**	**0.125**
(4)	educ	0.030	0.022	0.033	0.003	0.034	0.054	**0.053**	**0.090**
(5)	age+educ	0.030	0.020	0.036	0.006	0.038	0.048	**0.050**	**0.094**
		85th-50th							
total									
(1)	observed	0.042	0.041	0.033	0.004	0.026	0.027	**0.073**	**0.063**
(2)	predicted	0.038	0.041	0.033	0.002	0.029	0.026	**0.074**	**0.064**
composition									
(3)	age	0.038	0.042	0.039	0.007	0.029	0.018	**0.077**	**0.062**
(4)	educ	0.030	0.032	0.019	-0.004	0.019	0.016	**0.048**	**0.040**
(5)	age+educ	0.029	0.029	0.023	-0.001	0.021	0.018	**0.042**	**0.042**
		50th-15th							
total									
(1)	observed	0.007	-0.008	0.021	0.002	0.023	0.040	**0.013**	**0.061**
(2)	predicted	0.005	-0.004	0.016	0.011	0.014	0.037	**0.011**	**0.054**
composition									
(3)	age	0.005	-0.006	0.017	0.011	0.019	0.035	**0.015**	**0.062**
(4)	educ	0.000	-0.010	0.014	0.007	0.014	0.032	**0.006**	**0.050**
(5)	age+educ	0.001	-0.010	0.013	0.007	0.018	0.030	**0.008**	**0.053**
		40th-5th							
total									
(1)	observed	0.007	0.007	0.014	0.033	0.047	0.067	**0.021**	**0.117**
(2)	predicted	0.010	0.000	0.021	0.027	0.050	0.069	**0.021**	**0.122**
composition									
(3)	age	0.012	0.000	0.024	0.032	0.056	0.067	**0.024**	**0.139**
(4)	educ	0.007	-0.001	0.020	0.027	0.051	0.067	**0.020**	**0.126**
(5)	age+educ	0.009	-0.003	0.019	0.029	0.054	0.066	**0.020**	**0.131**

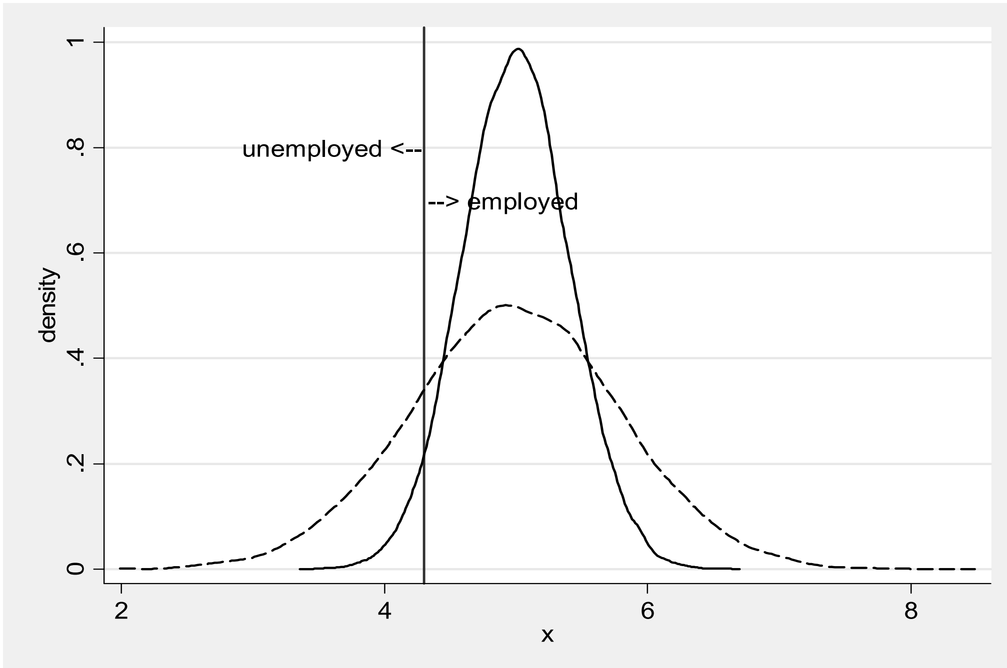
Note: Row (1) reports the observed change in the difference between the 85th and 15th, 85th and 50th, 50th and 15th, as well as 40th and 5th percentile, for various sub-periods. Row (2) displays the change predicted by the Melly decomposition. Row (3) to (5) show the change that would have prevailed if the age distribution (row (3)), the education distribution (row (4)),or the age+education distribution (row (5)) had remained the same as in the base year.

Table 3: Decline in Union Coverage

A: Share of establishments (male workers) covered by union agreements			
	LIAB		
	establishments	workers	
1995	66.5%	87.4%	
1996	65.7%	87.1%	
1997	64.3%	86.5%	
1998	55.8%	81.1%	
1999	53.4%	78.0%	
2000	54.4%	75.9%	
2001	55.9%	75.2%	
2002	53.0%	74.7%	
2003	53.1%	74.7%	
2004	52.1%	71.7%	
B: Union Membership			
	S & W		OECD
	all	male	all
1960	n.a.	n.a.	34.7%
1970	n.a.	n.a.	32.0%
1980	32.7%	39.6%	34.9%
1982	29.8%	35.2%	35.0%
1984	31.6%	38.7%	34.9%
1986	31.2%	39.4%	33.9%
1988	29.4%	37.5%	33.1%
1990	32.2%	38.7%	31.2%
1992	28.7%	36.0%	33.9%
1994	25.5%	30.4%	30.4%
1996	26.6%	33.8%	27.8%
1998	26.0%	30.5%	25.9%
2000	25.4%	31.0%	26.0%

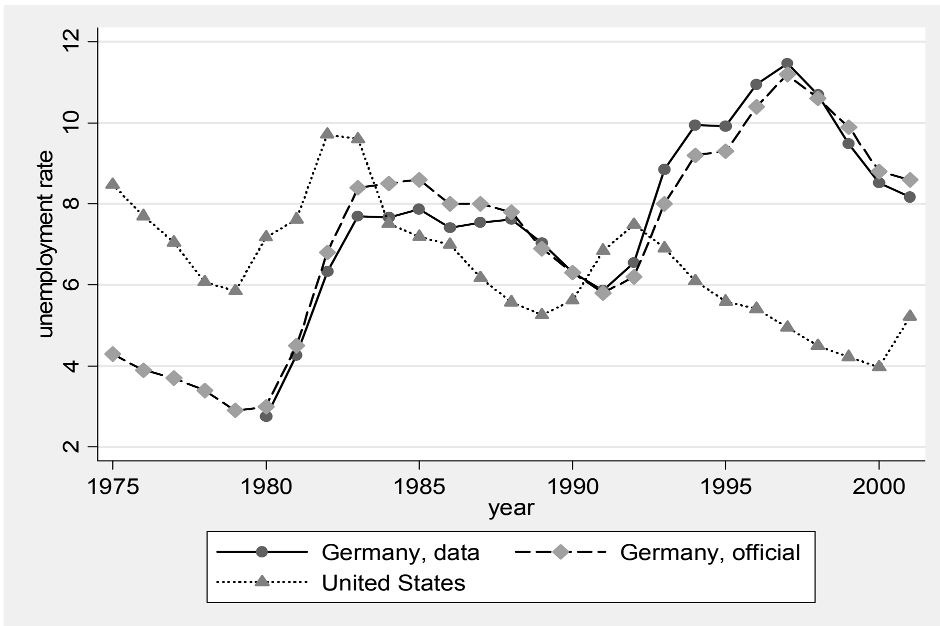
Note: Panel A refers to union coverage. Entries of the first two columns are based on the IAB-Betriebspanel (our estimation sample, West-German full-time male workers). The first column reports the share of firms that are bound either by industry- or by firm-level union agreements. The second column lists the share of workers covered by such agreements. Panel B refers to (net) union membership. Entries in the first two column are from Schnabel and Wagner (2006), and based on ALLBUS social surveys. Entries in the second column are taken from OECD (2004). Here, entries from 1992 onwards refer to East- and West-Germany.

Figure 9: Selection into Work and the Observed Wage Distribution

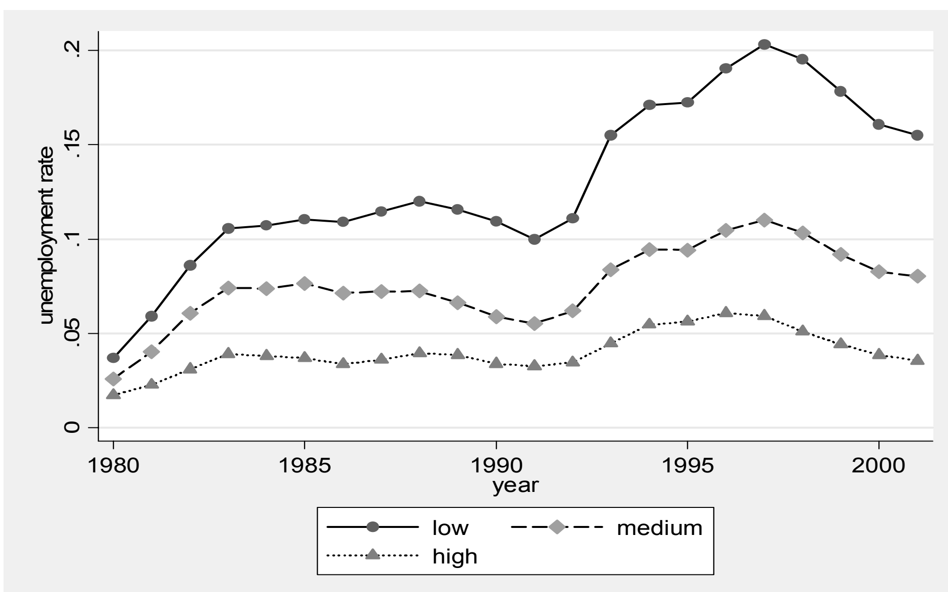


Note: The solid (log) wage density refers to 1980, a year with a relatively low unemployment rate. The vertical line represents the minimum wage. All workers who are less productive than the minimum wage become unemployed. Suppose that due to skill-biased technological change, the distribution of offered wages fans out, and to the same degree at lower and upper tail. This is depicted by the dashed (log) wage density. The share of workers who are less productive than the minimum wage increases. Hence, the selection into work becomes stronger, and the distribution of observed log-wages becomes more truncated.

Figure 10: Unemployment
Panel A: United States vs Germany



Panel B: Unemployment by Education, Germany



Note: Panel A compares the unemployment rate in our data, the offical unemployment rate as reported by the Bundesanstalt für Arbeit, and the US unemployment rate over time. We compute the unemployment rate as the number of days in (registered) unemployment divided by the number of days working and in unemployment. Part-time work is weighted down. The US unemployment rate is based on the CPS.

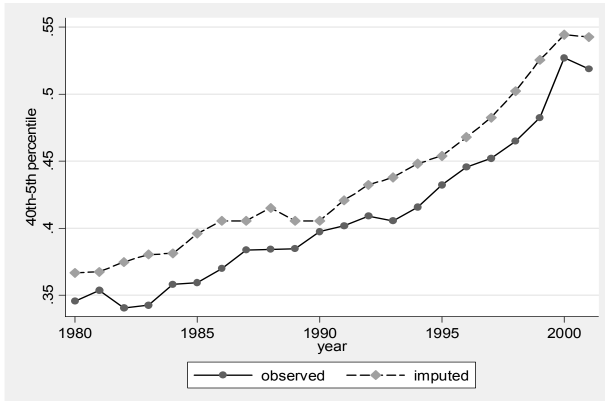
Table 4: Selection into Work: A Simulation Exercise

		Panel A: 85th-50th, 50t-15th, and 40th-5th percentile, truncated					
		sd=0.33	sd=0.35	sd=0.37	sd=0.39	sd=0.41	sd=0.43
	85-50	0.020	0.040	0.059	0.080	0.101	0.121
u=3.5	50-15	0.017	0.038	0.056	0.076	0.096	0.114
	40-5	0.020	0.046	0.068	0.094	0.117	0.138
	85-50	0.014	0.036	0.055	0.076	0.096	0.116
u=5.5	50-15	0.007	0.024	0.042	0.063	0.081	0.097
	40-5	-0.006	0.015	0.036	0.062	0.083	0.103
	85-50	0.012	0.032	0.051	0.071	0.089	0.112
u=7.5	50-15	-0.006	0.010	0.030	0.047	0.066	0.081
	40-5	-0.030	-0.010	0.010	0.032	0.054	0.073
	85-50	0.007	0.028	0.047	0.064	0.086	0.106
u=9.5	50-15	-0.017	0.002	0.016	0.035	0.052	0.069
	40-5	-0.050	-0.029	-0.011	0.009	0.029	0.047
	85-50	0.004	0.024	0.043	0.062	0.083	0.099
u=11.5	50-15	-0.026	-0.011	0.007	0.025	0.041	0.056
	40-5	-0.067	-0.049	-0.031	-0.010	0.008	0.023
	85-50	0.000	0.019	0.039	0.057	0.076	0.097
u=13.5	50-15	-0.037	-0.019	-0.003	0.012	0.030	0.045
	40-5	-0.084	-0.063	-0.045	-0.029	-0.011	0.007
		Panel B: Difference untruncated - truncated					
		sd=0.33	sd=0.35	sd=0.37	sd=0.39	sd=0.41	sd=0.43
	85-50	0.000	0.001	0.001	0.002	0.002	0.003
u=3.5	50-15	0.004	0.004	0.007	0.006	0.008	0.010
	40-5	0.008	0.009	0.017	0.017	0.021	0.031
	85-50	0.005	0.004	0.006	0.005	0.007	0.007
u=5.5	50-15	0.014	0.018	0.021	0.019	0.022	0.027
	40-5	0.034	0.040	0.048	0.049	0.055	0.066
	85-50	0.008	0.009	0.009	0.010	0.014	0.012
u=7.5	50-15	0.027	0.031	0.033	0.035	0.037	0.043
	40-5	0.058	0.066	0.074	0.079	0.085	0.096
	85-50	0.013	0.013	0.014	0.017	0.017	0.018
u=9.5	50-15	0.037	0.039	0.046	0.047	0.052	0.056
	40-5	0.078	0.084	0.095	0.101	0.110	0.122
	85-50	0.015	0.017	0.017	0.020	0.020	0.024
u=11.5	50-15	0.047	0.052	0.056	0.057	0.062	0.068
	40-5	0.095	0.104	0.115	0.120	0.131	0.146
	85-50	0.020	0.021	0.022	0.025	0.027	0.027
u=13.5	50-15	0.057	0.061	0.066	0.070	0.073	0.079
	40-5	0.112	0.118	0.130	0.140	0.149	0.162

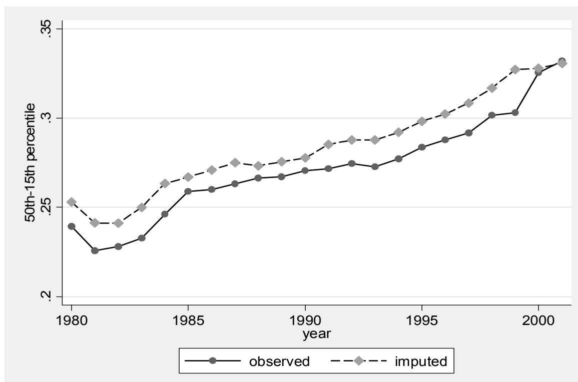
Note: We start out with a situation with an unemployment rate of 3.5 % and a standard deviation of 0.31. This roughly mimicks the 1980 situation. We then increase the standard deviation and unemployment rate. Panel A reports the difference between the 85th and 50th, 50th and 15th, and 40th and 5th percentile of the truncated distribution. Panel B shows the difference in the interquartile range between the untruncated and truncated distribution.

Figure 11: Imputed versus Observed Wages

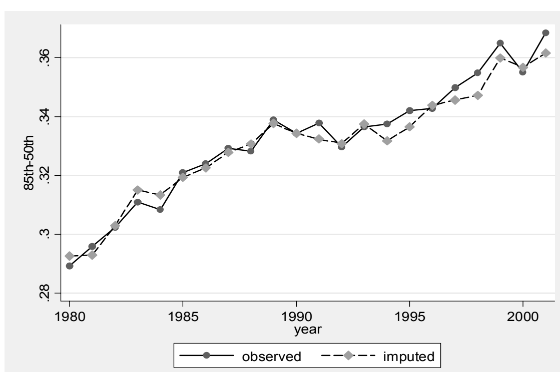
Panel A: The 40th-5th Wage Gap



Panel B: The 50th-15th Wage Gap

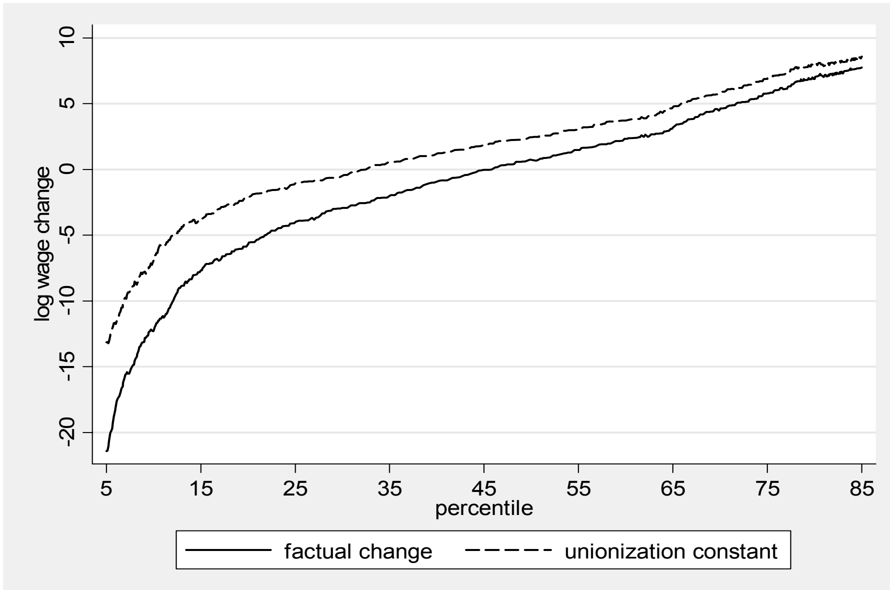


Panel C: The 85th-50th Wage Gap



Note: The figure plots the observed and imputed difference between the 40th and 15th percentile (Panel A), the 50th and 15th percentile (Panel B), and 85th and 50th percentile (Panel C). The observed difference refers to working men only. The imputed difference uses observed wages for those employed, and predicts a wage for the unemployed using estimates from a fixed effect regression. Panel C is based on the low- and medium-skilled only.

Figure 12: The Role of Deunionization, 1995-2004



Note: The figure plots actual wage growth by percentile from 1995-2004, as well as the wage growth that would have prevailed if unionisation had remained at its 1995 level. The figure is based on the LIAB, a linked employer-employee panel data set.

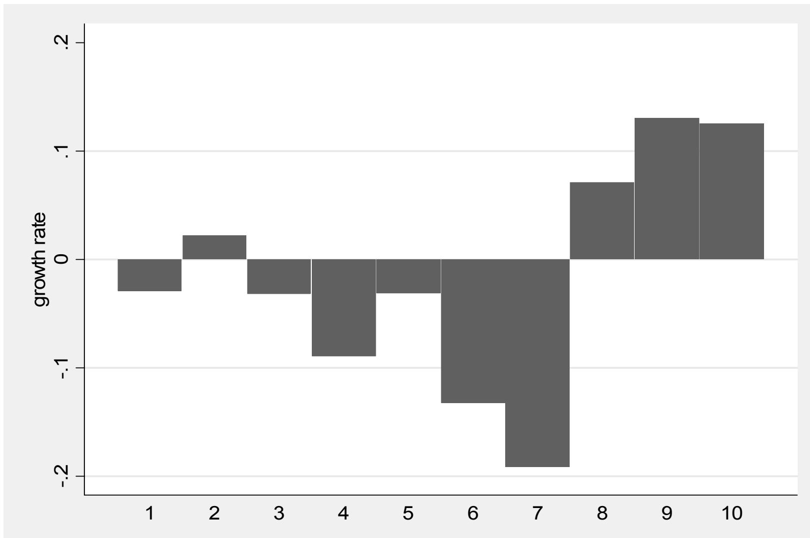
Table 5: The Role of Deunionization, Sup-Periods

		95-04	97-01	95-01
		85th - 15th		
	total			
(1)	observed	0.153	0.049	0.075
(2)	predicted	0.154	0.048	0.075
	composition			
(3)	nionisation	0.123	0.025	0.049
(4)	all	0.093	0.018	0.033
		85th-50th		
	total			
(1)	observed	0.071	0.027	0.042
(2)	predicted	0.070	0.027	0.042
	composition			
(3)	nionisation	0.061	0.018	0.031
(4)	all	0.039	0.016	0.021
		50th-15th		
	total			
(1)	observed	0.082	0.021	0.033
(2)	predicted	0.085	0.021	0.034
	composition			
(3)	nionisation	0.062	0.006	0.018
(4)	all	0.055	0.001	0.012
		40th-5th		
	total			
(1)	observed	0.204	0.065	0.100
(2)	predicted	0.204	0.072	0.107
	composition			
(3)	nionisation	0.143	0.027	0.060
(4)	all	0.153	0.027	0.056

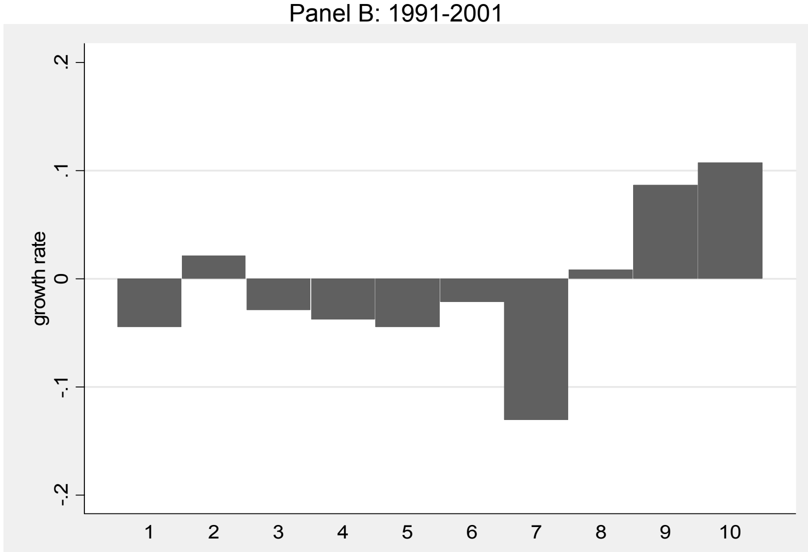
Note: Row (1) reports the observed change in the difference between the 85th and 15th, 85th and 50th, 50th and 15th, as well as 40th and 5th percentile, from 1995-2004, 1997-2001, and 1995-2001, respectively. Row (2) dipslays the change predicted by the Melly decomposition. Row (3) shows the change that would have prevailed if unionisation had remained the same as in the base year. Row (4) reports the change that would have prevailed if unionisation as well as the education and age distribution had remained the same as in the base year.

Figure 13: Percentage Change in Employment Share by Job Quality Decile
Ranking by Median Wages (1979)

Panel A: 1979-1989



Panel B: 1991-2001



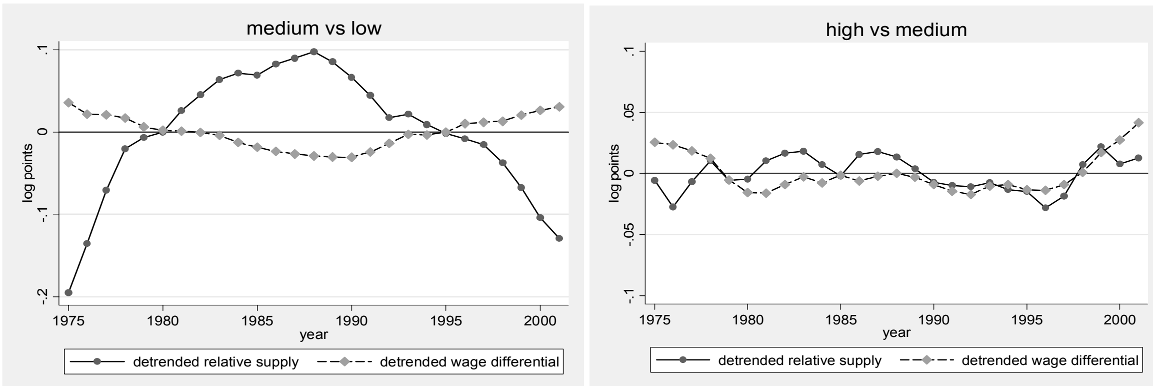
Note: The figure plots the percentage change in the employment share by job quality decile, between 1979 and 1989 and 1991 and 2001. The 130 occupations are ranked by median wages in 1979, and then grouped into 10 equally sized groups.

Table 6: Job Quality and Task Usage in 1999

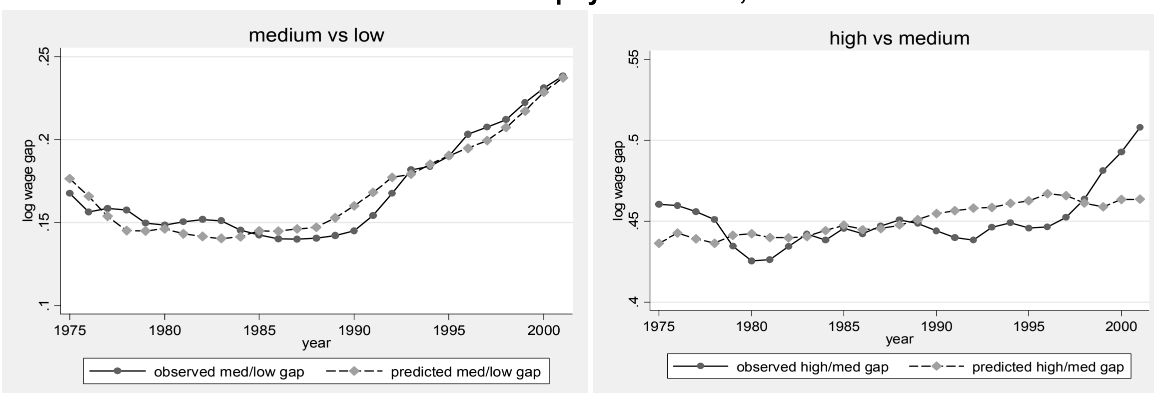
	non-routine analytic	inter-active	routine cognitive	routine manual	non-routine manual
Decile 1					
Moebelpacker, Transportarbeiter (30.92 %)	5.08%	7.11%	15.66%	10.68%	15.84%
Unskilled Construction Worker (-54.28 %)	3.03%	4.94%	18.59%	17.89%	19.10%
Cook (98.24 %)	9%	36.67%	22.44%	45.83%	31.41%
Decile 2					
Storekeeper, Warehouse Keeper (-19.8 %)	4.36%	20.95%	25.75%	14.67%	20.36%
Painter (-11.84 %)	11.94%	24.67%	9.25%	8.37%	30.62%
Product Tester (2.47 %)	6%	6.67%	28.89%	19.44%	17.22%
Decile 6					
Electricians (5.87 %)	7.94%	22.46%	**45.18%**	27.68%	47.86%
Chemical Processing (-19.72 %)	7.65%	11.64%	**84.43%**	**75.82%**	22.13%
Plasterer (-25.17 %)	7.78%	20.27%	15.04%	26.81%	27%
Decile 7					
Machine Operator (-40.89 %)	3.48%	8.89%	**84.13%**	**64.02%**	24.93%
Tool Maker (-31.87 %)	8.42%	18.74%	**76.58%**	**70.27%**	29.28%
Locksmith (-9.12 %)	6.48%	13.33%	**49.19%**	**46.60%**	39.64%
Decile 9					
Technicians (26.68 %)	**19.82%**	**52.28%**	3.46%	1.73%	26.64%
Banker (36.96 %)	**18.63%**	**36.13%**	38.74%	24.87%	23.43%
Sales Personnel (16.64 %)	**15.13%**	**62.06%**	6.87%	5.60%	33.45%
Decile 10					
Entrepeneurs, Consultants (8.44 %)	**28.38%**	**61.98%**	12.61%	10.89%	22.61%
Engineers (25.18 %)	**30.97%**	**49.47%**	34.21%	25.88%	14.03%
Cumputer Expert (214.10 %)	**25.39%**	**38.89%**	28.68%	21.18%	19.73%
all	5.57%	10.11%	33.47%	24.55%	18.68%

Note: The table lists the fraction of workers performing non-routine analytic, interactive, routine cognitive, routine manual and non-routine manual tasks for the three largest occupations in each decile. The number in parantheses next to the occupation is the growth rate of the occupation between 1979 to 2001. The classification of tasks follows Spitz-Oener (2006). *Non-routine analytic tasks*: research, evaluation, planning; making plans, construction, designing, sketching; working out rules, presriptions; using and interpreting rules. *Interactive tasks*: negotiating, lobbying, coordinating, organizing; teaching or training; selling, buying, advertising; entertaining or presenting; employ or manage personnel; *routine cognitive tasks*: calculating, bookkeeping; correcting texts/data; measuring of length/weight/temperature; *routine manual tasks*: operating or controlling machines; equip machines; *non-routine manual tasks*: repairing or renovating houses/apartments/machines/vehicles; restoring of art/monuments; serving or accomodating.

Figure 14: Fluctuations in Relative Supply
Panel A: Detrended Skill Premia and Relative Supply, 1975-2001



Panel B: Katz-Murphy Prediction, 1975-2001



Note: Panel A plots the detrended relative supply and the detrended relative wage gap (medium vs low; high vs medium). Panel B plots the observed wage gap as well as the gap predicted by the Katz-Murphy model.

Table 7: Regression Models for the Education Wage Gap, 1975-2001

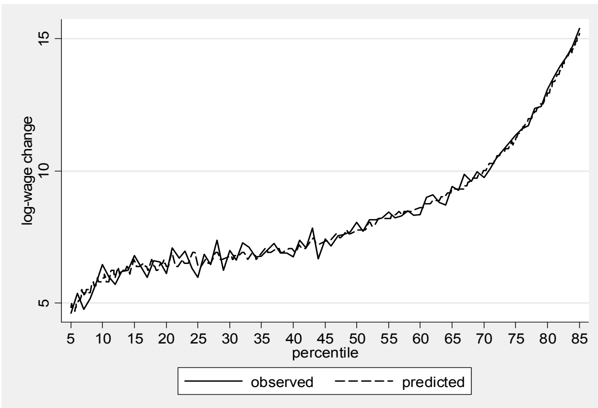
	medium vs low		high vs medium	
	(1)	(2)	(1)	(2)
relative supply	-0.230	-0.240	-0.230	-0.240
	(0.020)	(0.020)	(0.020)	(0.020)
time	0.013	0.013	0.009	0.010
	(0.001)	(0.001)	(0.001)	(0.001)
unemp. rate		0.002		-0.001
		(0.001)		(0.002)
constant	0.380	0.386	-0.189	-0.214
	(0.022)	(0.021)	(0.054)	(0.055)
R squared	0.934	0.941	0.176	0.180

Note: The table reports the coefficients from a constrained OLS regression of the medium-low (high-medium) wage differential on the indicated variables. The coefficient on relative supply -which identifies the elasticity of substitution- is restrcited to be the same for medium/low and high/medium. Standard errors in parentheses.

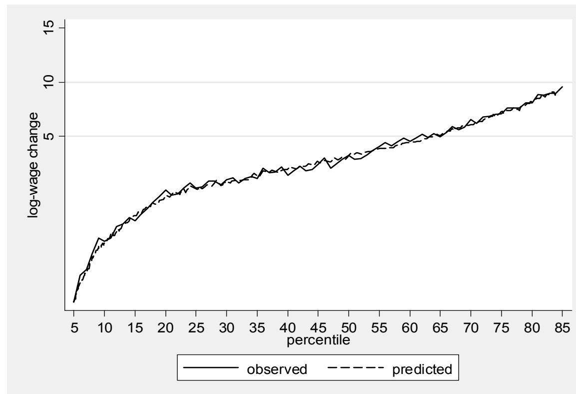
Appendix E: Additional Results

Figure E.1: Observed versus Predicted Wage Changes

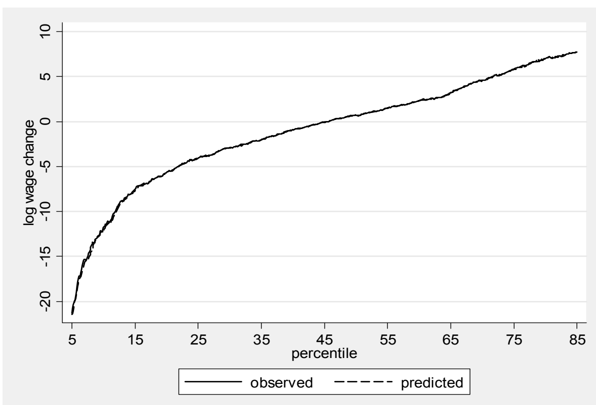
Panel A: IABS, 1979-1989



Panel B: IABS, 1991-2001



Panel C: LIAB, 1995-2004



Note: The figure plots the wage change observed in the data and the wage change predicted by our decomposition method.Panel A (1979-1989) and Panel B (1991-2001) are based on the IABS, a 2 % random sample of social security records. Panel C (1995-2004) is based on the LIAB, a linked employer-employee panel data set.

Table E.1: Changes in Workforce Composition

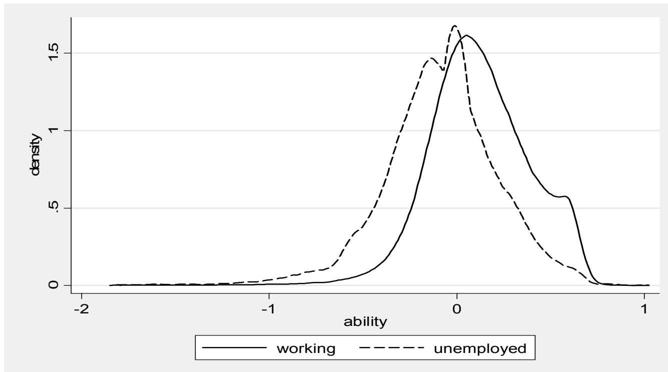
	1975	1979	1984	1989	1993	1997	2001
	age by education						
low							
<31	21.25%	19.41%	22.26%	27.37%	29.03%	25.89%	24.03%
31-50	62.76%	59.38%	52.18%	44.31%	43.73%	50.80%	56.70%
>50	15.99%	21.21%	25.57%	28.32%	27.24%	23.31%	19.28%
medium							
<31	25.53%	26.33%	26.76%	27.86%	25.10%	21.37%	17.63%
31-50	60.16%	56.86%	55.43%	51.87%	52.67%	58.03%	63.62%
>50	14.31%	16.81%	17.82%	20.27%	22.23%	20.61%	18.74%
high							
<31	18.26%	20.11%	16.86%	15.16%	14.03%	11.87%	9.16%
31-50	69.48%	66.17%	68.86%	69.09%	67.65%	69.82%	74.23%
>50	12.26%	13.72%	14.28%	15.76%	18.32%	18.31%	16.61%

Note: The table lists the fraction of 'young', 'middle-aged', and 'old' workers by education group for selected years. The respective share is computed as the number of days spent working or in unemployment of the age-education-group, devided by the number of days spent working or in unemployment of all workers in the education group.

Figure E.2: Are the Unemployed Negatively Selected?

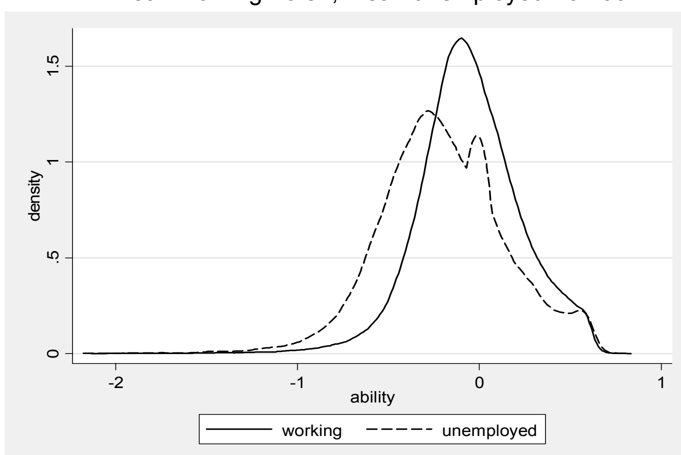
Panel A: 1980, UR=2.58 %

mean working: 0.121, mean unemployed: -0.086



Panel B: 1997, UR=11.0 %

mean working: -0.54, mean unemployed: -0.200



Note: The figure plots the density of workers' permanent productivity ('ability') for unmployed and employed workers, for the year with the lowest (1980) and highest (1997) unemployment rate. We also report the mean of unemployed and employed workers. Results refer to the medium-skilled.

Table E.2: Comparison LIAB and IABS

		1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
					median						
(1)	LIAB	5.075	5.078	5.063	5.067	5.084	5.096	5.090	5.091	5.095	5.086
(2)	IABS, annual average	5.088	5.087	5.080	5.090	5.101	5.106	5.112			
(3)	IABS, July	5.094	5.093	5.086	5.096	5.113	5.110	5.112			
					85-15						
(1)	LIAB	0.675	0.679	0.702	0.702	0.716	0.750	0.750	0.770	0.790	0.842
(2)	IABS, annual average	0.697	0.704	0.717	0.732	0.751	0.767	0.779			
(3)	IABS, July	0.693	0.701	0.713	0.728	0.746	0.752	0.763			
					85-50						
(1)	LIAB	0.396	0.401	0.411	0.418	0.423	0.430	0.438	0.446	0.463	0.476
(2)	IABS, annual average	0.414	0.418	0.425	0.431	0.443	0.446	0.447			
(3)	IABS, July	0.412	0.416	0.423	0.429	0.431	0.442	0.446			
					50-15						
(1)	LIAB	0.279	0.278	0.291	0.284	0.293	0.320	0.312	0.324	0.327	0.366
(2)	IABS, annual average	0.284	0.286	0.292	0.302	0.308	0.322	0.332			
(3)	IABS, July	0.282	0.286	0.290	0.300	0.314	0.310	0.317			

Note: The table compares selected moments of the wage distribution in the linked employer-employee data (LIAB) and the IABS. In the linked data, wages refer to the July 1 (row 1). Our results in the IABS are based on annual duration-weighted averages if a worker has worked for more than one employer a year (row 2). To facilitate comparison with the LIAB, we also report results based on the July wage spell (row 3).