Changing Fortunes During Economic Transition - Low-Wage Persistence before and after German Unification

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Abstract

This paper studies whether the transition from a centrally planned to a market economy offers fundamentally new perspectives for those who, in economic terms, were relatively deprived under the old regime. Previous empirical research on this question has been limited by the availability of suitable representative longitudinal micro-data that are able to track individuals' labour market careers across different political and economic regimes. Our study seeks to fill this research gap by looking at the transition of Eastern Germany following German Unification. Using a unique large-scale German administrative data set, we measure individuals' relative economic position by exploiting information on whether individuals were in the bottom of the pre-unification wage distribution. We then proceed to ask as to how workers' low or high-wage status determines their wage and labour market status after the transition. Our results suggest that at the time of economic and political transition persistence in low-wage employment reached its minimum value. The results, however, are heterogeneous for males and females. While there is no evidence of true state dependence for males, female workers' true state dependence amounts to 10 to 13 per cent during transition. Finally, genuine state dependence is shown to be considerably larger during the post-unification than in the pre-unification period for both groups.

Keywords: Low Pay Dynamics, Economic Transition, Unobserved Heterogeneity, State Dependence

JEL-Code: J31, J64, P21, C33, C35

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1 Introduction

Does the transition from a centrally planned to a market economy offer fundamentally new perspectives for those who, in economic terms, were relatively deprived under the old regime? Or does the economic transformation bring along an equally unfavourable position under the new system, thereby reflecting some extent of economic state dependence even across completely different political and economic regimes? This question is of considerable relevance against the background of Eastern and Central Europe's recent history of transitions from centrally planned to market economies and is crucial to understanding economic transitions' welfare implications. The issue is also important from a quantitative point of view, as during a large part of the 20th century about one-third of the world's population lived under communist regimes.

In this paper, we address these issues in the context of Eastern Germany. The former German Democratic Republic (GDR) is a particularly interesting case, because it has experienced a unique pathway of political and economic transformation after 1989 through its Unification with the Federal Republic of Germany (FRG). Compared to other transition countries, the transformation process took place much more quickly as the political and economic system of Western Germany (FRG) was immediately transferred to Eastern Germany (GDR). Although a large body of research has documented the evolution of the Eastern German labour market after Unification, there is barely any evidence on how one's pre-unification relative economic position determined one's fortunes after Unification. Previous empirical research on this question has been limited by the availability of suitable representative longitudinal micro-data that are able to track individuals' labour market careers across different political and economic regimes. Our study seeks to fill this research gap by exploiting a unique large-scale administrative data set (*BASiD*) from the German Pension Register and the German Federal Employment Agency. The *BASiD* data provides an ideal basis for our empirical analysis as it allows us, first, to identify individuals living in Eastern Germany before Unification and, second, it enables us

to track individual employment histories both before and after the fall of the Iron Curtain. To our knowledge, no other study has used administrative data to compare labour market outcomes across different political and economic regimes.

To measure individuals' relative economic position, we will exploit information on the incidence and duration of individuals' position in the bottom part of the pre-unification wage distribution. Even though earnings inequality in the GDR was considerably lower than that in the FRG, one may still identify workers who fared considerably worse than the average. For instance, in 1989 the poorest ten per cent of the working age population earned less than 50 per cent of the overall average of monthly earnings.[1] Having identified individuals' low-wage status prior to Unification, we then proceed to ask as to how workers' low or high-wage status determines their economic fortunes after the transition. In particular, we are interested in the extent of low-wage state dependence across economic regimes, by distinguishing persistence in low pay due to observed and unobserved heterogeneity from true state dependence, also referred to as "genuine state dependence".

The literature on state dependence acknowledges two main explanations for genuine or true state dependence of low-pay. The first one relates to human capital depreciation and the second one to stigmatisation due to signalling low-productivity levels (see e.g. Stewart (2007), Arulampalam et al. (2000)). As to the signalling argument, the heavily regulated pre-unification labour market should have rendered the selection into low-wage jobs based on workers' true productivity very unlikely. Given that workers had their wages set according to a centrally determined wage grid, Bird et al. (1994) suspect that "because the human capital model was obviously not relevant under socialism, the observed correlation between wage income and schooling and experience in the GDR must simply exist because the socialist wage regime took factors like these into account in assigning wages". If this were indeed the case, signalling low-productivity should not have contributed to genuine low-wage persistence and this ought to be true for both the pre-unification

[1] Own calculations from the 1990 German Socio-Economic Panel retrospective GDR survey.

as well as the transition period. If, in contrast, low-wage jobs had to some extent been the result of political discrimination, this might have favoured true persistence due to signalling political opposition. Thus, while signalling may well explain pre-unification genuine state dependence, it is unlikely to contribute to genuine state dependence during transition.

An alternative explanation for low-pay state dependence even during transition relates to human capital depreciation. Given that selection into a pre-unification low-wage job should have been unrelated to workers' true productivity, the latter might still have been depreciated due to unfavourable working or job conditions inherent to low-wage jobs. Whether this led to true state dependence largely depends on the extent to which depreciation has affected workers' job-specific or general human capital. Given that general skills have been shown to be transferable to the post-unification labour market (Fuchs Schündeln and Izem (2012)), a loss in general human capital brought about by pre-unification low-wage jobs might contribute to true low-wage persistence even during economic transition.

In exploring the importance of workers' pre-unification wage positions for their post-unification wage outcomes, our analysis contributes to the literature on transition economies' labour markets. A large body of research has examined how returns to human capital have changed during economic transition. The general picture that emerges is that returns to education generally increased, whereas returns to work experience did not change or even decreased during the transition process (see e.g. Rutkowski (1996), Brainerd (1998), Münich et al. (2005)). For Germany, Bird et al. (1994) and Krueger and Pischke (1995) show that there was little change in returns to education after Unification. Moreover, these studies document very small returns to age and seniority prior to Unification, which - similar to what has been found for other transition economies - declined during the transition process (see also Gathmann (2004)). Orlowski and Riphahn (2009) show that returns to experience and seniority in Eastern Germany were small compared with Western Germany even 20 years after Unification. While these results indicate that specific human capi-

tal gained during socialist work experience became obsolete in the post-unification labour market, very little is known about the consequences of experience accumulated in low-wage jobs. In addressing the relevance of individuals' pre-unification wage positions for their post-unification outcomes, our analysis may thus contribute some new insights into whether low-wage jobs in a centrally planned economy have also been associated with the depreciation of *general* human capital, thereby leading to adverse long-term consequences for post-unification labour market outcomes.

The remainder of the paper is structured as follows. Section 2 provides some institutional background information on the Eastern German labour market prior to and after Unification. Section 3 provides a description of the data set and the sample selection. Section 4 first explores the evolution of wages and then provides a description of labour market transitions. Section 5 lays out the econometric model and presents the estimation results. Robustness checks are shown in Section 6. The final Section 7 concludes.

2 Institutional Background

2.1 The Eastern German Labour Market prior to Unification

Following the Soviet example, the GDR introduced tight central economic planning along with subordination of firms to the state administration. Moreover, all citizens of the GDR had the constitutional right and duty to work (where the 'right' included an unlimited guarantee of employment and the 'duty' brought along the threat to be sentenced for antisocial behaviour if one was suspected of remaining voluntarily jobless). The Eastern German labour market before Unification thus was heavily regulated: controlling the supply of and demand for labour was seen as an instrument for efficient use of resources and for economic growth (see Grünert (1997*a*) for a detailed overview).

However, although enterprises were effectively controlled through centralised re-

distribution of investment capital, salary funds, and other financial means, they were fairly free in planning and using the labour forces they had at their disposal. Under given general institutional constraints, enterprises could influence, for example, employment policies, regulations pertaining to job transfers, salary ranges, and promotion regimes. At the same time, individuals were – in principle – free to choose their workplace. Once employed, they agreed upon an individual labour contract with their firm, which included far-reaching employment rights (such as the right on employment appropriate to acquired skills or the right to be paid according to the quantity and quality of the work done).

There were clear limits to employer and occupational mobility, though. By the late 1970s, careers had become heavily affected by an increasing influence of the "state-governed labour force allocation", a system that restricted younger cohorts in the choice of occupational training and their subsequent job (Huinink and Solga (1994)). Since the 1960s, quotas were set for occupations into which individuals were allocated after leaving secondary education. Since the early 1970s, the opportunity to study at a university was strongly restricted through quotas to high-school and university admissions. This implied that many young people could not get the occupation they actually wanted. Very often, changing one's work was then only possible within one's occupational career via adult education (also see Zühlke and Goedicke (2000)). A restriction to employer mobility was a general tendency among GDR enterprises to keep the fluctuation of their labour force low and to maintain a high level of permanent staff (Stammbelegschaft; see Grünert (1997*b*), Section 1). In addition to offering firm-specific fringe benefits like free childcare, holiday arrangements, etc., an important means of achieving this were bonuses such as 'loyalty premiums' (Treueprämie) for long-term employees. Enterprises had more discretion over bonuses than over base wages, where bonuses have been estimated to account for, on average, six per cent of compensation in the GDR (Krueger and Pischke (1995)). Base wages were determined by state-regulated wage grids based on observables (see Stephan and Wiedemann (1990) for a more detailed account of the wage structure in the GDR). As a consequence, wage dispersion was much

lower than in the FRG. While the empirical evidence on the GDR wage structure has established positive returns to education of 4.5 to 7.7 log points for one year of schooling, age-earnings and seniority-earnings profiles - despite the existence of loyalty premiums - have been suggested to be much flatter as compared to the FRG. Using retrospective information for 1989 from the German Socio-Economic-Panel, Bird et al. (1994) and Krueger and Pischke (1995) estimate returns to experience of about one to two per cent for the first year of experience (compared with about 3.4 to 4.1 log points in the FRG).

2.2 The Eastern German Labour Market after Unification

After unification, the eastern German labour market underwent a period of dramatic structural change. Monetary Union between Eastern and Western Germany took place on June 30, 1990. With monetary union, Eastern Germany overtook the legal and economic system from Western Germany, including also its labour market institutions. As a result, Western German trade unions quite rapidly succeeded in transferring the Western German system of collective bargaining to the East. While the first round of wage negotiations, which already took place during summer 1990, mainly resulted in lump-sum wage increases, the second round in winter 1990/91 stipulated wage schedules being tied to a fixed proportion of the western level (Krueger and Pischke (1995)). This gave rise to tremendous wage increases, which were particularly large within the first year following monetary union. According to Hunt (2001), monthly real wages rose on average by 20 log points between 1990 and 1991, with the lower educated benefitting to a significantly larger extent (compare also the similar figures reported by Krueger and Pischke (1995)). For the time period between 1991 and 1996, Hunt (2001) reports an annual monthly wage growth of about nine log points, yielding a cumulative average real monthly wage growth of 78 per cent over the period between 1990 and 1996. Later studies report that real wage growth in Eastern Germany has come to a halt in the mid-1990s (Franz and Steiner (2000)) and even started to decline in the first years of the 21th century (Aretz (2013)). This presumably reflects that since the mid 1990s unions

lost increasingly in importance, as most employers could not afford the initial wage increases. While union membership rates dropped from about 40 per cent in 1992 to about 18 per cent in 2004 (Addison et al. (2007)), the proportion of employees subject to an industry-level contract declined from 56 per cent in 1996 to 41 per cent in 2004.[2]

At the same time, many Eastern German technologies became obsolete during the transition process. After Unification, Eastern Germany experienced massive inflows of capital and technology from Western Germany. On July 1, 1990 the Treuhand as a holding company for the state-owned sector came into force with the primary purpose to sell all of its holdings. When the Treuhand closed down at the end of 1994, about 860 enterprises had been sold to foreign investors and 3,000 had been acquired through management buy-outs (Kettenacker (2013)). The massive structural change brought about by the privatisation process has led some researchers to inquire into whether human capital accumulated during the old regime became obsolete in the post-unification labour market. Using data from the 1990 German Socio-Economic Panel retrospective GDR survey, Gathmann (2004) finds that returns to pre-unification accumulated work experience drop to zero after Unification. The author interprets her results as evidence of a full obsolescence of socialist work experience, suggesting a full depreciation of job-specific human capital. Contrary to that finding, Fuchs Schündeln and Izem (2012) demonstrate that the low labour productivity in Eastern Germany can mainly be attributed to less favourable job attributes rather than to individual skills.[3] The authors conclude from their findings that a large part of Eastern Germans' human capital accumulated during the socialist regime was transferable to the post-unification labour market and, therefore, should have been of general nature.

[2]Own calculations from the IAB-Establishment Panel. Representative data on collective bargaining coverage in Eastern Germany are available only since 1996.

[3]This finding is derived from regional unemployment differences at the inner German border, based on the argument that, if mainly worker characteristics caused the low labour productivity, then unemployment rates should jump up discontinuously at the former border.

3 Data and Sample

The data used in the empirical analysis are taken from German register data (*BASiD*). The data combine information from the *German Pension Register* with various data sources from the German Federal Employment Agency. The scientific use file of the data (*BASiD*-SUF) is a stratified random 0.25% sample of all birth cohorts from 1940 to 1977, who have at least one entry in their social security records, leading to an overall sample of about 60,000 individuals. The sample has been drawn in a disproportionate manner and can be made representative using a weighting factor that is part of the data set (for a detailed description see Hochfellner et al. (2012) and Bönke (2009)).[4]

The data provide longitudinal information on individuals' entire pension-relevant biographies up to the year 2007. Individual work histories cover the period from the year individuals were aged 14 until the age of 67. In Germany, statutory pension insurance is mandatory for all employees in the private and public sector, thus only excluding civil servants and self-employed individuals. In addition, contributions to the pension insurance are paid by the unemployment or health insurance during periods of unemployment and prolonged illness. As a consequence, the insurance covers more than 90% of the entire population for whom all past pension-relevant periods have been recorded.

The *BASiD* data provide an ideal basis for analysing the impact of former GDR citizens' low-pay status on their later career outcomes for several reasons: First, it is the only German administrative data source that encompasses full employment biographies. In particular, the *Pension Register* contains information on all periods for which contributions were paid (employment, long-term illness, unemployment) as well as periods without contributions, which were still creditable for the pension insurance. The latter refers to activities for which an individual receives pension

[4]Note that the representativeness of the data based upon the sample weights that are provided in the data refer only to the calendar year 2007. Later on, in our analysis, we will use administrative population data to calculate weights for each gender-year cell.

credits, such as periods of school or university attendance after the age of 16, periods of training and apprenticeship and periods of caring.

Second, the BASiD data is the only individual level data set that contains employment biographies of former GDR citizens before German Unification. After Unification, former GDR citizens became entitled to transfer their pension-relevant activities to the FRG pension insurance system. For this purpose, the FRG Pension Insurance recorded all periods prior to Unification which were creditable for the pension insurance (see above) as well as earnings up to the GDR social security cap. The pension data therefore allow us to track former GDR workers' entire pre- and post-unification employment histories up to the year 2007. Apart from the individual information on pension relevant activities, the *Pension Register* provides information on age and gender.

Starting from 1975 in Western and from 1992 in Eastern Germany, employment spells subject to social security contributions from the *Pension Register* can be merged with data from the German Federal Employment Agency, the *Integrated Labour Market Biographies* and the *Establishment History Panel*. The *Integrated Labour Market Biographies* provide further time varying individual information on blue or white-collar status, occupational status, educational status (six categories) and an establishment identifier. The latter allows us to retrieve information on tenure at the current employer. Finally, the *Establishment History Panel* contains information on the establishment's workforce composition, establishment size as well as sector affiliation. Table B.1 and B.2 in the appendix provide more detailed descriptions on the variables gained from the *Pension Register* and *Employment Statistics Register*. The structure of the data implies that for former GDR citizens the data lack explicit information on education prior to 1992. We therefore impute the educational status by using information from the *Pension Register* on individuals' creditable schooling and apprenticeship periods (see for a short overview Appendix E).

In our analysis, the main outcome variable of interest is labour earnings, which

can be calculated by exploiting information on monthly pension credit points gained from social security employment. Credit points derived from earnings in Eastern Germany before and after Unification are scaled-up to meet the western pension level according to a factor stipulated in the German Social Act (SGB VI). To obtain the original credit points, Eastern credit points reported in the data therefore have to be divided by this factor. One credit point corresponds to the average of annual earnings of all gainfully employed workers in Germany. This implies that monthly earnings can be obtained by multiplying monthly credit points with the average of earnings as documented in the German Social Act (SGB VI - see Table B.1). Earnings are top-coded at the social security contribution limit. Compared with the FRG, where the earnings cap increases over time, the GDR threshold remained constant at 600 Mark throughout the entire GDR period. Due to this unchanged earnings cap, the fraction of GDR workers with top-coded earnings increased substantially over time and was much larger than the corresponding fraction in the FRG. Despite the restrictive earnings information, the data are still suited to analyse low-pay transitions as the earnings information allows us to dichotomise the GDR earnings distribution into a low- and high-wage sector (see Section 4.2).

For our empirical analysis, we focus on the employment biographies of former GDR citizens. Given that our data cover the cohorts 1940-1977, we confine our sample to the cohorts 1940 to 1960 and follow their employment histories starting from the year 1980 until 1999. Focussing on these cohorts enables us to track the pre and post-unification labour market histories of individuals aged between 30 and 50 in 1990. As the employment histories of later cohorts (i.e. born after 1960) can be observed only after 1980, the restriction to the birth cohorts 1940 to 1960 permits us to observe a reasonable amount of pre-unification labour market years for all cohorts.[5] This is crucial to our empirical strategy which will use information on pre-

[5]The cohort structure of our data implies that the earliest period in which we observe insured individuals is the year 1954, when those born in 1940 were 14 years old. During the subsequent years, younger cohorts successively enter the data set, thereby enabling the observation of older age groups. An overview on the age-year structure of the *BASiD*-SUF is given by Bönke et al. (2010). To ensure representativeness within the selected cohorts in terms of the working-age population's age structure, we have constructed weights based upon administrative population data from the

unification labour market histories as a key ingredient in explaining post-unification outcomes. The *BASiD*-SUF file provides monthly information on individuals' pen-

Table 1: Number of individuals in the sample in each year 1980-1999

Year	Number of individuals	West migration (#)	Retire (#)
1980	4801		
1981	4778	23	0
1982	4759	18	1
1983	4749	10	0
1984	4737	10	2
1985	4726	9	2
1986	4712	13	1
1987	4700	5	7
1988	4686	10	4
1989	4670	12	4
1990	4595	65	10
1991	4447	135	13
1992	4285	134	28
1993	4180	81	24
1994	4058	97	25
1995	3954	74	30
1996	3862	59	33
1997	3779	47	36
1998	3695	48	36
1999	3498	167	30

Source: BASiD 2007.

sion credit points as well as their main labour market state in a given month. We follow the literature and use the labour market state in June of any given year. Monthly labour earnings are aggregated to the year level by adding up monthly earnings in a given year and taking the average over the year.[6] Given that our data lack explicit information on working time, we are not able to convert monthly into hourly wages. To avoid measuring persistence in working time decisions instead of earnings, we therefore exclude those individuals who based on the information from the *Employment Statistics Register* worked part-time at least once after Unification.

Table 1 shows the number of individuals over the whole sample period. Overall,

German Federal Statistical Office.

[6]We exclude individuals from the wage distribution if their wages fall short of 150 Mark, as this is considered as unreasonably low. This causes the exclusion of 35 men and 90 women in total.

our sample selection yields an unbalanced panel with 4,801 individuals and 87,671 person-year observations. The main reason for panel attrition is migration from Eastern to Western Germany. While the share of migrants was rather negligible prior to Unification, the fraction of migrants increased to about 3.1 per cent in the first two years after Unification. The observed decline afterwards and the increase in the second half of the 1990s - also referred to as the second wave of migration - is consistent with what has been documented elsewhere in the literature (Fuchs Schündeln and Schündeln (2009)). The last column refers to early retirement as a reason for panel attrition, with the relatively strong increase in 1990 and 1991 hinting to a potential selective process. Note that the number of individuals in the first column does not only comprise employed workers, but also those being un- or non-employed.

Table 2 summarises the main variables and provides summary statistics for both time periods prior to the transition (Pre: 1980-1989) and during and after the transition (Post: 1990-1999). Given that we define low-wage workers as those from the first decile of the wage distribution, the fraction of low-wage workers prior to Unification is close to 10 per cent. After economic transition, the fraction of low-wage employees in the overall sample becomes somewhat smaller. This is due to the fact that the labour market states of un- and non-employment prior to 1990 gained in importance after Unification. As regards qualification, about 14 per cent in the sample did not receive any formal degree, while about two thirds are medium-skilled and thus obtained some sort of vocational training. As mentioned above, entry to higher levels of qualification was extremely constrained prior to Unification, resulting into a small fraction of ten per cent holding a university degree. The educational information for the remaining eight per cent is missing.

Table 2: Variable definition and description

Variables	Description	Mean		Standard Deviation	
		Pre	Post	Pre	Post
Variables over the period 1980-1999					
Low-wage	Indicator (1=Low-wage), p10	0.099	0.097	0.30	0.30
Un- and non-employed	Indicator (1=Not working)	0.03	0.16	0.22	0.42
Age	Age in years	34.7	44.5	6.58	6.54
Female	Indicator (1=female)	0.53	0.52	0.50	0.50
Education					
Low-skilled	No formal degree	0.14	0.13	0.34	0.33
Medium-skilled	Apprenticeship	0.69	0.69	0.47	0.47
High-skilled	University	0.09	0.10	0.31	0.31
Occupational status*					
White-collar	White-collar worker	0.39	0.44	0.49	0.49
Blue-collar	Blue-collar worker	0.48	0.50	0.50	0.50
Skilled occupation	Engineer, professional, manager	0.14	0.17	0.36	0.38
Medium-skilled occupation	Qualified manual, service, commercial	0.55	0.48	0.36	0.38
Simple occupation	Simple manual, service, commercial	0.31	0.35	0.34	0.47
Labour market characteristics					
Experience	Years worked	14.5	23.4	6.96	7.23
# Interruptions	Number of interruptions	3.10	5.01	3.15	4.24
Interruption length	Cum. length of interruptions (in months)	14.7	23.3	23.5	31.3

Source: BASiD 2007.

Notes: * Information for occupational status (white- and blue-collar) and the occupational groups are imputed for the pre-unification period based on information from the first available year from the Employment Statistics Register.

Using information on occupational status from the first available year from the *Employment Statistics Register* from the German Federal Employment Agency, about 50 per cent are blue-collar and 40 to 44 per cent are white-collar workers. Differentiating the occupational status into skilled, medium-skilled and simple occupations, about 14-17 per cent of individuals belong to the first, 48-55 per cent to the second and about one third to the final category. Given the increasing fraction of un- and non-employed individuals after Unification, the evolution of experience and age can be observed to diverge after Unification. Finally, the last two rows show the number of employment interruptions and the accumulated length of employment interruptions measured in months, which both increased markedly after Unification.

4 Descriptive Statistics

4.1 Wages and Wage Development over Time

In order to gain a deeper understanding of the economic dynamics following the transition shock to the Eastern German economy, this subsection first describes the distribution of wages after economic transition from 1990 to 1999. We then describe the available information on pre-unification wages in our data and how we exploit this information for our further analyses.

Figure 1 plots different quantiles of the distribution of monthly wages against time separately for males and females. The figure shows that the distribution of wages after Unification has evolved from a very compressed one right after Unification to a considerably more dispersed distribution at the end of the 1990s. Consistent with what has been found in the literature, this indicates that wage inequality has been considerably increasing after Unification. Despite increasing wage inequality, the figure also points to strong wage growth especially during the first years after Unification. In the first nine years between 1990 and 1999, median wages increased by about 180 per cent for females and about 140 per cent for male workers. The growth rate, however, developed differently at different quantiles of the wage distri-

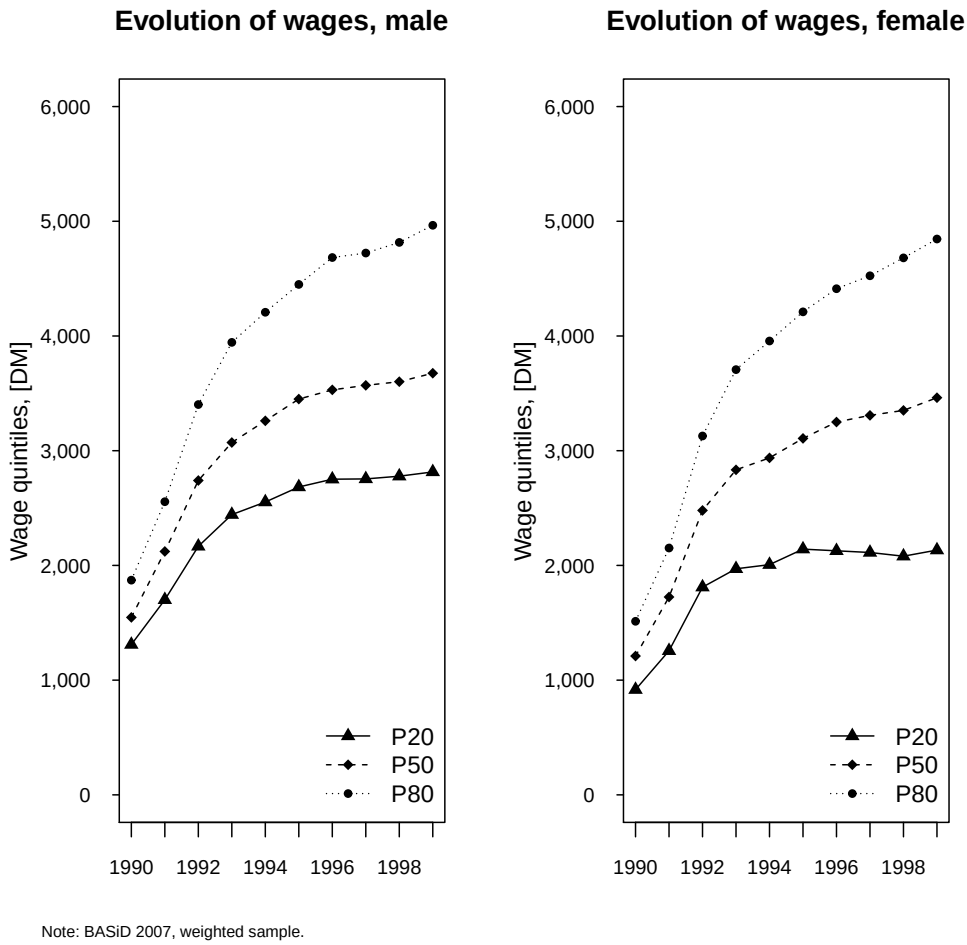


Figure 1: Evolution of wages for the years 1990-1999

bution. While the 80 per cent quantile still experienced significant wage growth at the end of the observation period, wages at the second decile are observed to stagnate since the mid 1990s. For females, the stagnation in wage growth already started in 1993 (see also the study by Riphahn and Schnitzlein (2011) on wage mobility).

Regarding wage information prior to Unification, wages until the first half of 1990 were censored at 600 Mark. Figure 2 illustrates the pre-unification wage distribution (separately for male and female workers) for 1980 and 1989, respectively. The figure also marks the first deciles in relation to the censoring limit. The figure shows that the fraction of individuals earning monthly wages below 600 Mark decreased over

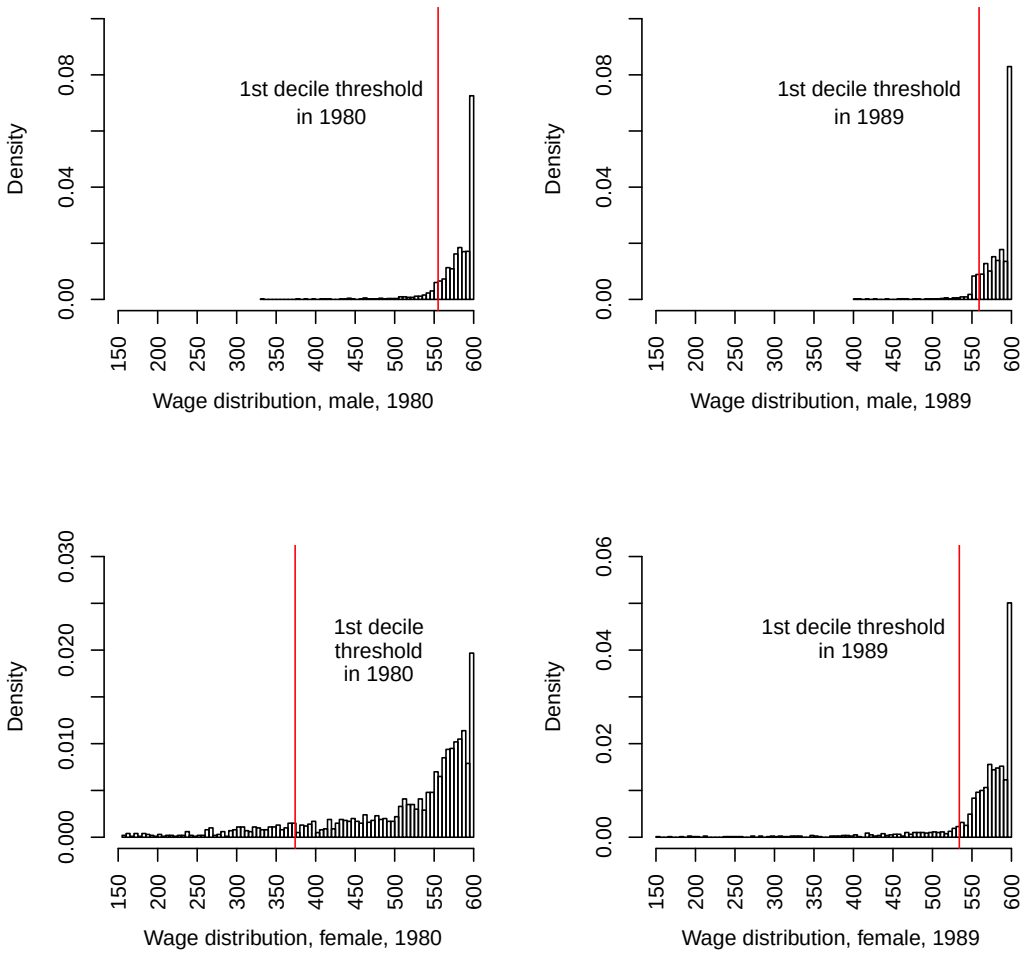


Figure 2: Distribution of wages between 1980-1989

time. The lower panel illustrates that the first decile for men increased only slightly between 1980 and 1989, whereas for females it grew from about 370 Mark in 1980 to 530 Mark in 1989. For the sake of completeness, Figure 3 also shows the wage distribution for the pooled sample for three selected years prior to Unification. The lower right hand figure shows that for the pooled sample, the first decile grew from about 450 Mark in 1980 to 550 Mark in 1989.

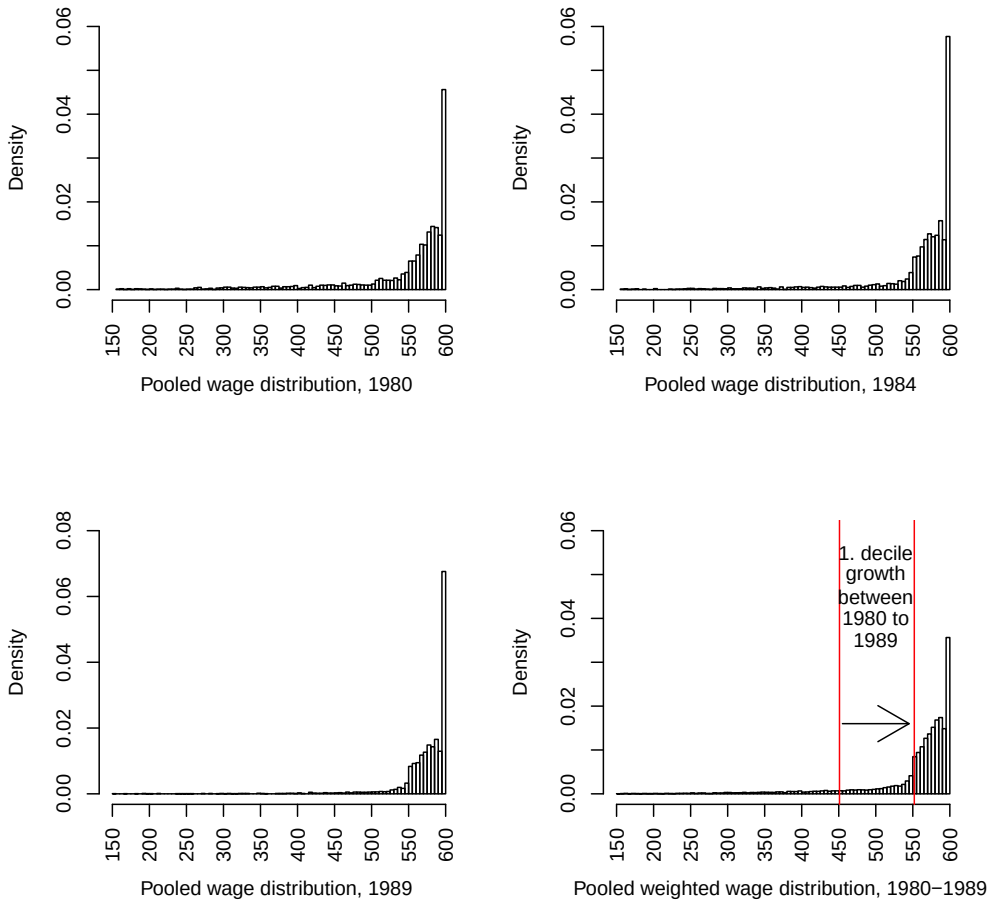


Figure 3: Distribution of wages between 1980-1989

4.2 Low-pay Threshold

The previous section has shown that due to the large extent of censoring in our data we are only capable of fully observing the lower part of the wage distribution. To measure individuals' relative economic position, we will exploit this information to measure the incidence and duration of individuals' position in the bottom part of the pre-unification wage distribution. Note that because our analysis focuses on birth cohorts from 1940 to 1960, the relative position needs to be interpreted in relation to this specific sub-population. In accordance with the literature on low pay, individuals are defined as being "low-paid" if their wage does not exceed a

specified threshold. Previous studies have used different definitions of the low-pay threshold, such as lower quantiles of the wage distribution (Cappellari (2002) and Cappellari (2007)) or alternatively some fixed proportion of a quantile, such as two thirds of the median wage (Cappellari and Jenkins (2008) and Uhlendorff (2006)). Given that in 1989, especially among male workers, only a small fraction earned less than the social security contribution limit of 600 Mark, we therefore have to adopt a somewhat more restrictive definition of low-pay by fixing the low-pay threshold at the first decile of the wage distribution. Because for the pooled decile the fraction of low-paid workers among women is 14 per cent and that among men only about five per cent, we report as our baseline findings results based on the separate wage distributions by gender. As robustness checks, we also present results based on the pooled distribution as shown in Figure 3.

Figures 2 and 3 show that shortly before Unification the first deciles approach the censoring limit of 600 Mark. A particular concern is therefore that measurement error due to underreporting might misclassify a certain fraction of individuals as falling below the censoring limit. Even though we cannot fully rule out such kind of measurement error, we argue that there are at least two reasons speaking against it. First, if measurement error due to underreporting played a significant role, this should lead to a downward biased estimate of the first decile of the monthly wage distribution. To check whether this is the case, we compare the decile obtained from our data set with figures from external data sources. An ideal candidate data set is the German Socioeconomic Panel (GSOEP), whose retrospective survey in 1990 provides representative and uncensored information on former GDR workers' monthly labour earnings for the year 1989. According to the GSOEP, the first decile of monthly wages was about 560 Mark in 1989, whose order of magnitude is broadly in line with our pooled figure of 550 Mark.[7] A second reason speaking against underreporting stems from the administrative nature of the pension data. Central to this argument is the view that earnings dependent pension entitlements should

[7]Source: German Socioeconomic Panel, own calculations. The figure is obtained by pooling male and female working age individuals with positive earnings, after excluding apprentices, civil servants and the self-employed.

create large incentives to correctly report (or at least not to underreport) earnings. In Appendix C, we demonstrate that even though GDR pension entitlements were only to a limited extent earnings dependent, monthly earnings which fell into a small earnings interval (between 500 and 600 Mark - depending on the number of creditable pension years) effectively raised pension entitlements. This rather argues against a systematic measurement error due to underreporting especially within this interval.

Apart from measurement error, another crucial issue concerns the interpretation of our low-pay threshold in terms of real consumption possibilities. Krueger and Pischke (1995) argue that due to the subsidisation of necessities, low-paid individuals in a centrally planned economy were relatively better off than comparable individuals in a market economy. Given that individuals at the lower end of the earnings distribution spend a larger fraction on subsidised goods, the real earnings distribution should have been therefore more compressed than the nominal one. This raises the question as to whether earnings below our low-pay threshold also reflect economic deprivation in terms of real consumption possibilities. A tentative answer to this question may be provided based on measures of absolute poverty in the GDR. Manz (1992) derives such a measure by defining a minimum consumption level as the poverty threshold. Based on data on the consumption price level from the GDR Statistical Office, the author estimates the nominal value of this minimum consumption basket for a single household to amount to approximately 350 Mark in 1972 and 550 Mark in 1988. However, it needs to be stressed that these results have to be interpreted with caution as the data sources for the underlying consumption basket are lacking in this study.

4.3 Labour Market Transitions

Table 3 reports transition rates of being low-paid, high-paid and being un- or non-employed in period t conditional on the state in period *t-1* for the pre- and post-unification period (Panel A and C) as well as for the transition period (Panel B).

The first noteworthy fact that emerges from Table 3 is that transition patterns differ markedly across male and female workers. In general, the probability of staying low-paid is considerably higher for females in each of the three time periods. Comparing the change in transition rates between the pre- and post-Unification period also reveals large differences across gender. The probability of staying low-paid increases for male workers from 21 per cent prior to Unification to about 54 per cent after unification. For females, in contrast, the probability decreases by five percentage points to 58 per cent. Both groups experience a decline in low-pay persistence at the time of transition. The drop amounts to about one third for male workers and almost 25 per cent for females. Comparing the row transitions across the pre- and post-Unification period after Unification, the labour market state *not working* (i.e. being un- or non-employed) becomes considerably more important. The figures show that after unification the probability of becoming un- or non-employed is three times (twice) as high for male (female) initially low-paid as compared with initially highly-paid workers. Note that, even though the probabilities of entering

Table 3: Transition rates, first decile, by gender

	Males			Females		
	Low-wage	High-wage	Not working	Low-wage	High-wage	Not working
Panel A: 1980-1989						
Low-wage	21.0	76.7	2.3	62.7	33.7	3.6
High-wage	8.5	90.3	1.2	3.1	94.0	2.9
Not working	11.7	81.1	7.3	16.0	74.4	9.6
Total (%)	9.9	88.4	1.6	9.6	86.9	3.6
Panel B: 1989-1990						
Low-wage	17.2	81.7	1.1	43.9	53.9	2.2
High-wage	9.0	90.2	0.8	5.9	92.6	1.5
Not working	19.3	72.7	8.0	15.0	69.7	15.3
Total (%)	9.9	89.3	0.9	9.4	88.5	2.1
Panel C: 1991-1999						
Low-wage	53.9	28.8	17.3	58.1	19.0	22.9
High-wage	3.1	91.1	5.8	2.5	86.8	10.7
Not working	14.0	22.3	63.7	5.9	20.8	73.3
Total (%)	8.6	78.9	12.5	7.3	69.0	23.7

Source: BASiD 2007.
Notes: Pooled weighted transitions for the years 1980-1999.

un- or non-employment were considerably lower prior to Unification, the (relative)

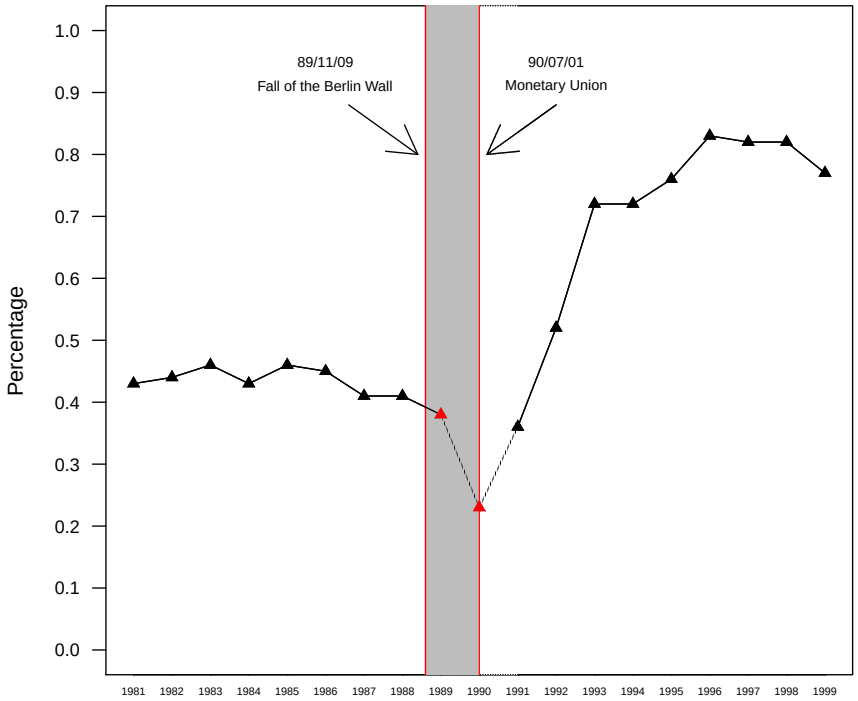
differences across initially highly and low-paid workers were already visible before Unification and of similar magnitude as in the post unification period. Moreover, comparing labour market retention across the pre-unification and transition period, the transition probabilities from employment (low and high wage) into the state *not working* in Panel B do not change tremendously as compared to Panel A. Thus, at least the comparison of low-wage persistence across these periods (17.2 per cent in panel B with 21.0 per cent in panel A) is unlikely to be biased by selective labour market retention.

Based on observations in Table 3, we compute the extent of aggregate state dependence (ASD), defined as the difference in the probabilities of low-pay conditional on being initially low-paid and highly-paid in period $t-1$. Thus, ASD is defined as

$$ASD = P(L_t|L_{t-1} = 1) - P(L_t|L_{t-1} = 0), \tag{1}$$

with $L_t = 1$ and $L_t = 0$ denoting low and high-pay in year t, respectively. This approach does not take into account the state of not working. Therefore, the figures deviate slightly compared to Table 3. At the time of transition, aggregate state dependence amounts to about 8 per cent and 37 per cent for male and female workers, respectively. This implies that the probability of staying low-paid is 8 per cent (37 per cent) higher for initially low paid male (female) workers as compared to their initially highly paid counterparts. In order to describe the evolution of low-wage persistence, figure 4 plots ASD against time. Distinguishing the pre-unification (to the left of the grey bar), the transition (between the vertical lines) and the post-unification period (i.e. the time after monetary union), several noteworthy facts emerge from Figure 4. During the pre-transition period aggregate state dependence varied around 43 per cent. The first vertical line indicates the start of the political and economic transition. During transition, aggregate state dependence decreased markedly by more than 20 percentage points to 25 per cent in 1990 compared to the pre-unification period. The third part of the figure (to the right of the grey

Figure 4: Aggregate state dependence

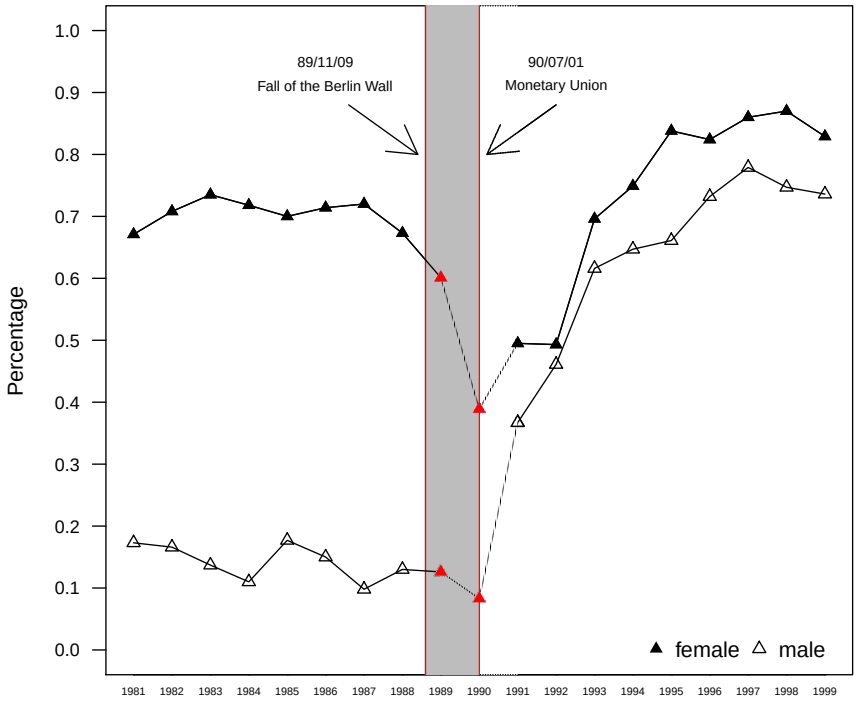


Note: BASiD 2007, pooled weighted sample.

bar) indicates a sharp rise in low-pay persistence, with aggregate state dependence increasing from 40 per cent in 1991 to values above 70 per cent in the late 1990s. Figure 5 shows the evolution of aggregate state dependence by gender. The figure reveals that the sharp decline in aggregate state dependence during transition is mostly accounted for by female workers. After Unification, there appears to be a strong convergence between male and female workers. Finally, Figure A.1 in the appendix reports the gender-specific evolution of aggregate state dependence based on the pooled wage distribution. Compared to Figure 5, the observed minimum in aggregate state dependence during transition becomes somewhat more pronounced for males.

The overall picture that emerges from Figure 4 along with Figure 5 and Figure

Figure 5: Aggregate state dependence, by gender



Note: BASiD 2007, weighted sample.

A.1 is that aggregate state dependence plummeted with the beginning of a market-orientated economy. The post-unification period is characterised by a steady rise in low-pay persistence. Overall, the figures show that the importance of previous low-wage employment for low-pay in the future reaches its minimum during the time of transition, albeit less pronounced for male workers. This is consistent with signalling considerations suggesting that the precision of the low-pay status as a productivity signal should be least pronounced during the economic and political transformation.

4.4 Conditional and Unconditional Probabilities

Before we turn to an econometric framework, Tables 4 and 5 provide unconditional and conditional estimates of being low-paid based on individual characteristics, sep-

arately for males and females. Columns (1) and (2) provide unconditional probabilities of getting a low wage, again distinguishing between the pre- and post-unification period. Several results stand out here: First, the raw unconditional probability of being low-paid decreases with skills. For males, this decline is somewhat stronger during the post-unification period. Second, while younger individuals are slightly more likely to be low-paid than older ones, there appear to be no large differences across both periods.

Third, blue-collar workers and those with simple occupations feature larger low-pay probabilities, with the differences between occupations becoming slightly more pronounced during the post-unification period. Finally, as to the importance of the labour market history, the probability of low-pay decreases with experience and increases with the number and cumulative length of labour market interruptions.

Columns (3) and (4) provide conditional probabilities depending on the low-pay status in $t-1$. The figures show that the conditional probabilities vary greatly across socio-demographic characteristics. The most pronounced patterns emerge for age and experience. While in unconditional terms there was no large difference across age groups, low-pay persistence - as measured by the probability of having a low wage job in t conditional on the same status in $t-1$ - now strongly increases with age. Not surprisingly, the same is true for years of experience, which are strongly correlated with age. This implies that once older and more experienced workers face a low-wage job, it is much harder for them to escape the low-wage sector. Note that this is consistent with larger wage growth during early labour market careers. Comparing differences in low-pay persistence across age and experience categories reveals that for females the relationship between these attributes and low-pay persistence is relevant for both the pre- and post-unification period. For males, in contrast, low-pay persistence increases with age only after Unification. This is consistent with male workers exhibiting much flatter pre-unification age-earnings profiles as compared to their female counterparts (Gathmann (2004)).

Table 4: Conditional and unconditional probabilities, males

	Unconditional		Low-wage $t-1$		Not working $t-1$	
	Pre	Post	Pre	Post	Pre	Post
Low-wage	10.0	10.0	21.3	58.8	22.1	24.6
Education						
Low-skilled	12.4	15.3	30.4	61.5	37.6	34.7
Medium-skilled	10.4	10.1	19.6	58.9	22.9	24.9
High-skilled	5.4	2.5	22.1	38.4	0	8.9
Age groups						
20-29	12.9	-	21.9	-	24.5	-
30-39	9.7	11.4	21.7	46.6	22.0	21.5
40-49	8.8	9.0	21.6	60.7	17.8	23.4
50-59	-	10.6	-	71.4	-	35.8
Occupation						
White-collar	6.2	3.4	18.3	46.4	7.2	9.5
Blue-collar	11.3	12.5	19.8	61.3	26.1	30.2
Skilled occupation	5.3	2.0	11.6	40.1	7.0	5.6
Medium-skilled occupation	10.9	9.8	24.2	58.6	26.1	23.5
Simple occupation	10.8	13.3	20.0	60.5	19.4	32.9
Labour market history						
Experience						
$>$ 20 years	9.2	9.6	22.4	63.5	16.0	25.4
$\leq$ 20 years	10.4	10.4	21.0	49.0	22.6	23.4
# Interruptions						
$>$ 5 times	20.7	14.2	30.7	61.8	30.8	35.6
$\leq$ 5 times	9.5	9.2	20.3	58.2	21.6	21.9
Length Interruptions						
$>$ 20 months	21.8	31.0	48.0	68.2	44.3	49.8
$\leq$ 20 months	10.0	8.7	20.8	57.7	21.8	17.3

Source: BASiD 2007.

Notes: Pooled weighted data for the years 1980-1999. Left numbers are probabilities prior to Unification. Right numbers refer to probabilities during transition and after Unification. Low-wage threshold is the first decile.

Table 5: Conditional and unconditional probabilities, females

	Unconditional		Low-wage $t-1$		Not working $t-1$	
	Pre	Post	Pre	Post	Pre	Post
Low-wage	10.0	10.0	64.0	67.0	24.1	15.1
Education						
Low-skilled	11.7	11.0	67.1	61.6	34.1	19.1
Medium-skilled	10.4	10.9	64.4	70.4	24.1	15.0
High-skilled	3.0	2.7	39.3	45.4	11.0	6.2
Age group						
20-29	9.7	-	44.6	-	17.4	-
30-39	10.3	10.7	65.5	49.1	27.2	16.4
40-49	9.4	9.6	73.4	70.8	39.4	14.8
50-59	-	9.1	-	79.4	-	16.0
Occupation						
White-collar	7.9	5.2	60.7	60.8	18.0	10.1
Blue-collar	8.3	15.7	57.5	70.7	22.2	17.2
Skilled occupation	4.5	1.6	54.1	25.4	11.4	5.7
Medium-skilled occupation	11.4	9.5	66.0	65.9	27.6	15.5
Simple occupation	9.7	15.2	62.0	72.2	22.1	18.1
Labour market information						
Experience						
$>$ 20 years	6.9	8.9	67.7	72.4	32.9	13.6
$\leq$ 20 years	11.0	10.8	63.1	58.8	23.6	16.9
# Interruptions						
$>$ 5 times	9.7	9.7	65.3	63.4	28.8	17.0
$\leq$ 5 times	10.1	9.5	63.4	71.2	22.3	11.9
Length Interruptions						
$>$ 20 months	13.2	11.2	68.6	66.7	30.6	18.0
$\leq$ 20 months	7.3	7.3	57.8	67.4	14.5	7.7

Source: BASiD 2007.

Notes: Pooled weighted data for the years 1980-1999. Left numbers are probabilities prior to Unification. Right numbers refer to probabilities during transition and after Unification. Low-wage threshold is the first decile.

5 A Dynamic Model of Low-pay Transitions

5.1 The Model

The descriptive figures from the previous sections may hide potential compositional effects and do not allow us to infer any conclusions about the extent of the causal effect of the previous low-pay status. In what follows, we will therefore attempt to isolate persistence in low-pay due to observed and unobserved heterogeneity from "genuine" state dependence. The latter basically measures to what extent low-wage employment today causes low-wage employment in the future. We therefore now turn to an econometric framework. In order to estimate the propensity of being low-paid, we specify a dynamic random effects model

$$y_{it}^* = \gamma y_{it-1} + x_{it}'\beta + \vartheta_{it} \tag{2}$$

$$y_{i1}^* = x_{i1}'\beta + \vartheta_{i1}, \tag{3}$$

where y_{it}^* is a latent unobservable variable measuring the propensity of earning a low wage for individual i in year t for $t > 2$. The propensity is a function of an individual's previous low-wage status, y_{it-1}, individual characteristics x_{it}, observed by both the individual and the econometrician and henceforth considered as explanatory variables, as well as unobserved characteristics ϑ_{it}, which are unknown to the econometrician. The variables on the right hand side may be vectors. y_{i1}^* refers to the initial process. We do not observe y_{it}^* itself, instead we observe

$$y_{it}^* = \begin{cases} 1 & \text{if } y_{it}^* > k \\ 0 & \text{if } y_{it}^* \leq k \end{cases} \tag{4}$$

Without loss of generality, k is set to 0. Thus, the model written in its reduced form can be specified as:

$$y_{it} = I\ (y_{it}^* > 0) \tag{5}$$

$$y_{it} = I\ (y_{i1}^* > 0) \tag{6}$$

where I is an indicator variable that takes on the value 1 if individual i is low-paid and zero if individual i is highly-paid. We further assume the unobserved part to consist of an individual specific component, ϵ_i which is assumed to be time-invariant, and a time-variant idiosyncratic component, i.e. $\vartheta_{it} = \epsilon_i + u_{it}$. By making distributional assumptions, we follow Papke and Wooldridge (2008) and impose the link function to be standard normal cumulative distribution function (cdf) Φ. For the model to be identified, we assume that $u_{it} \sim N(0,1)$. Furthermore, the time-persistent unobserved individual effect is assumed to be $\epsilon_{it} \sim N(0, \sigma_\epsilon^2)$. These model assumptions imply the well known equi-correlation structure of the error term, that is $Cov(\vartheta_{it}, \vartheta_{is}) = Cov(\epsilon_i, \epsilon_i) + Cov(u_{it}, u_{is}) = \sigma_\epsilon^2$ with $Cov(u_{it}, u_{is}) = 0$ for $t \neq s$.

5.2 The Initial Condition Problem

Estimating the dynamic random effects probit model without modelling the initial condition will bias the estimation results of the coefficients (see for example Heckman (1981*b*), Stewart and Swaffield (1999), Honoré and Kyriazidou (2000), Arulampalam et al. (2000)). The dynamic structure of the model implies that individual i's labour market position in period 1, y_{i1}, depends on its status in period $t = 0$ (Heckman (1981*a*)). Given the recursive structure of the data, we are not able to estimate a representative wage distribution prior to 1980, which would be crucial to modelling the initial condition.[8] Given the endogeneity of the first period's outcome due to a correlation with the time-invariant individual effect (selection), the estimation of state dependence is likely to be overestimated (see Chay and Hyslop (1998)).

In order to treat the initial condition, Heckman (1981*b*) suggest modelling the joint distribution for the entire sample ($t = 1, ..., T$) of an individual's current status. This estimator is, for example, used by Arulampalam and Stewart (2009), Uhlendorff (2006) and Knabe and Plum (2013) and involves the specification of an equation for the initial condition. As pointed out by Prowse (2012), in the case of

[8]Note that even if we were to observe individuals' full low-pay histories, their first low-pay status would be very unlikely to be fully exogenous (see a discussion in Wooldridge (2010)).

non-stationary variables (age-trending variables), modelling the joint distribution becomes infeasible and one needs to approximate the distribution of the initial condition. This approximation can be written as a linear equation of y_{i1} explained by exogenous instruments and an error term that is likely to be correlated with the individual-specific random effect ϵ_i. The literature has used instruments, such as parents' educational background and regional labour market conditions (Cappellari and Jenkins (2008)). The use of such instruments is infeasible in the context of our administrative data set.[9]

Alternatively, Wooldridge (2005) proposes a different approach to model the initial condition. Instead of modelling the density of y_{it} for all $t = 1, ...T$ given covariates x_{it}, he proposes to start at $t = 2$ and condition the density of y_{it} for $t = 2, ...T$ on y_{i1} and x_{it}. This approach is computationally less demanding and comparable to the correlated random-effects model put forward by Chamberlain (1984). To account for a potential correlation of the unobserved individual effect with observed explanatory variables, we follow Mundlak (1978) and Chamberlain (1984) and model the individual effect, ϵ_i, as a linear projection on the means of all time-varying explanatory variables, $\bar{x}_i$, the initial condition, y_{i1}, and a random effect, α_i, that is assumed to be $\alpha_i \sim N(0, \sigma_\alpha)$. Thus, we can write:

$$E(\epsilon_i|\bar{x}_i, y_{i1}) = a_0 + a_1 y_{i1} + a_2 \bar{x}_i \tag{7}$$

$$Var(\epsilon_i|\bar{x}_i, y_{i1}) = \sigma_\alpha^2 \tag{8}$$

Given the simplicity of the *Wooldridge* approach, the estimators behave differently depending on the length of the panel. As shown by Akay (2012) using Monte Carlo results, both estimators (*Heckman* and *Wooldridge*) tend to perform similarly in long panels (above 6 time periods), with the *Heckman* approach producing less biased results for a small T-dimension.

[9] In our data, potential instruments could principally be derived from workers' labour market histories prior to 1980 (school, vocational training, absent from the labour market, missing). Given the highly uniform labour market careers, these instruments work rather poorly.

5.3 Empirical Specification and Results

To quantify genuine state dependence over the entire time period, we specify the following empirical model:

$$y_{it} = \Phi((\gamma + \gamma^{\tau} H_{\tau}) y_{it-1} + x'_{it}\beta + \epsilon_i + u_{it}) \tag{9}$$

where x_{it} are the explanatory variables presented in Table 2 and y_{it-1} denotes the low-wage status in $t-1$. We further interact the lagged endogenous variable with period dummy variables H_{τ}, where $\tau \in [1990, FRG]$, with the baseline coefficient, γ , referring to the pre-transition period. This approach allows the parameter capturing state dependence, γ, to vary across the pre- and post-unification period (FRG) as well as the transition period 1990 (see Könings (2014) for a similar strategy).[10] The model includes as time-varying explanatory variables the number of labour market interruptions, cumulated labour market interruptions measured in months and a full set of experience dummy variables. Unobserved individual heterogeneity is very likely to be correlated with the measures of interruptions and experience, such that one should condition on these variables. Using the Mundlak-Chamberlain device, we model the individual-specific effect ϵ_i as:

$$\epsilon_i = a_0 + a_{11}\overline{experience_i} + a_{12}\overline{interrupt_i} + \alpha_i \tag{10}$$

where α_i is assumed to be $N(0, \sigma_{\alpha}^2)$ distributed. The difference between Heckman's method and the approach by Wooldridge is that the latter adds the low-pay status in the first period, that is

$$\epsilon_i = a_0 + a_{11}\overline{experience_i} + a_{12}\overline{interrupt_i} + a_2 y_{i1} + \alpha_i \tag{11}$$

where $experience_i$ and $interrupt_i$ are vectors of the associated measures. We additionally include the initial state that captures working or not working in our em-

[10] Later, we will perform robustness checks with respect to these specified interactions. We also run a regression with specified interactions for every year. The main results of obtaining a minimum at the time of economic transition does not change.

pirical specification. This accounts for selection not only into low and high wage employment, but also into the states working or not working. Having specified the treatment of the initial state, we are able to estimate the entire dynamic process by additionally adding the lagged state of not working Arulampalam (2001). Thus, y_{it-1} is a vector capturing the lagged states of low-wage and not working. Wooldridge suggests a conditional maximum likelihood estimator that models the density of $y_{i2}, ..., y_{iT}$ conditional on (y_{i1}, x_i). For the likelihood function one needs to specify $f(\alpha_i|x_{it}, y_{i1})$ instead of a density function for the first period. Under the assumption of a normal distribution, the likelihood function can be calculated as:

$$L = \frac{1}{\sqrt{2\pi}\sigma_\alpha} \int_{\infty}^{\infty} [\prod_{t=2}^{T} P_{it}(\alpha)] \exp^{\frac{\alpha^2}{(\sqrt{2}\sigma_\alpha)^2}} d\alpha \tag{12}$$

$$P_{it} = \Phi((2y_{it} - 1)(\gamma_p y_{it-1} + x'_{it}\beta + \sigma_\alpha \alpha_i)) \tag{13}$$

where P_{it} denote individual contributions to the likelihood function. Moreover, y_{it-1} is a vector including all interaction terms in eq. (9). This one-dimensional integral is solved using Gaussian-Hermite Quadrature methods.[11]

Using a random-effects specification under the assumption of a normal distribution might be rather too restrictive. To allow for more flexibility, we introduce an unobserved heterogeneity term that is assumed to be constant over time and uncorrelated with observed individual characteristics. The distribution of the unobserved term is specified with M points of support. Following Van den Berg et al. (2013), a multinomial logit parameterisation is used for the latent class probabilities:

$$\pi_m = \frac{exp(\omega_m)}{\sum_{m=1}^{M} exp(\omega_m)}, m = 1, ..., M, \omega_1 = 0 \tag{14}$$

This function maps into the $(0, 1)$-interval and sums to one. In the estimation we start with $M = 2$ and increase the number of mass points until the likelihood value

[11]The individual-specific random effects model can be solved using standard software such as xtprobit in Stata.

does not increase anymore. Given that we neither observe the latent classes nor the probabilities, the individual likelihood contributions are estimated using a weighted average:

$$P_{it} = \sum_{m=1}^{M} \pi_m \prod_{t=2}^{T} [\Phi((2y_{it} - 1)(\gamma_p y_{it-1} + x'_{it}\beta + \mu_m))] \tag{15}$$

Results. Table 6 shows the estimation results for the main coefficients of interest separated by gender. For comparison purposes, Columns (1a) and (1b) give the results from using a standard pooled probit model without modelling unobserved heterogeneity.

Columns (2a) and (2b) report the estimates of γ based on a random effects model. The last two columns present the results assuming a discrete distribution for unobserved heterogeneity. Comparing males and females, the estimate of γ is significantly larger for females throughout the three specifications. The coefficients in rows (2) and (3) refer to interactions of the lagged endogenous variable with the two time dummies. The interaction term in row (2) shows that state dependence decreases significantly in 1990 and this is true for all specifications. For the post-unification period, the figures in row (3) indicate that state dependence increases in the second half of the sample period. However, the increase is more pronounced for males. The estimates in row (4) show that the probability of being low-paid also depends significantly on the un- or non-employment status in $t-1$. Again, the influence becomes stronger after Unification. The estimates in row (6) and (7) refer to the initial condition. The positive and significant estimates suggest a positive correlation between the initial low-wage state and the probability of being low-paid in t. The interaction with the second half of the sample period is negative which implies that the initial state in 1980 becomes less important. Using a discrete distribution, we find support for three mass points. Comparing the random effects model with the model using latent classes, we do not find strong indications in terms of the model selection criteria (Log-Likelihood and AIC) in favour of one model.

Table 6: Dynamic probit results for low-pay probabilities, by gender

Variables	Probit		RE Probit		Discrete Distribution	
	Males (1a)	Females (1b)	Males (2a)	Females (2b)	Males (3a)	Females (3b)
(1) $Lowwage_{t-1}$	0.542***	2.461***	0.290***	1.880***	0.292***	1.881***
	(0.036)	(0.037)	(0.045)	(0.059)	(0.043)	(0.061)
(2) $\times H_{1990}$	-0.263***	-1.102***	-0.195**	-1.218***	-0.195***	-1.222***
	(0.118)	(0.108)	(0.107)	(0.138)	(0.126)	(0.124)
(3) $\times H_{FRG}$	1.608***	0.059	1.717***	0.258***	1.714***	0.247***
	(0.058)	(0.064)	(0.076)	(0.096)	(0.072)	(0.092)
(4) $Not\ working_{t-1}$	0.519***	1.207***	0.412***	1.160****	0.415****	1.156***
	(0.036)	(0.052)	(0.093)	(0.073)	(0.101)	(0.063)
(5) $\times H_{FRG}$	0.910***	-0.147*	1.037***	-0.143	1.035***	-0.148
	(0.107)	(0.076)	(0.123)	(0.106)	(0.118)	(0.091)
(6) $Lowwage_{i1}$			0.362***	0.874***	0.373***	0.871***
			(0.053)	(0.072)	(0.050)	(0.081)
(7) $\times H_{FRG}$			-0.255***	-0.527***	-0.258***	-0.520***
			(0.084)	(0.111)	(0.093)	(0.103)
Unobserved heterogeneity						
σ_α			0.331***	0.577***		
			(0.021)	(0.028)		
$Prob.1$					0.762	0.350
$Prob.2$					0.109	0.558
$Prob.3$					0.128	0.092
$Unobs.het.1$					0	0
$Unobs.het.2$					-0.891	-0.811***
					(0.631)	(0.085)
$Unobs.het.3$					0.623***	0.694***
					(0.069)	(0.110)
Controls	yes	yes	yes	yes	yes	yes
Log-Likelihood	-9386.76	-6567.47	-9233.10	-6321.92	-9232.74	-6317.99
AIC	18847.52	13208.94	18559.20	12735.84	18557.47	12719.99
Total # observations	35891	36366	35891	36366	35891	36366
# individuals	2243	2531	2243	2531	2243	2531
Estimation Method	ML	ML	Gauss-Hermite	Gauss-Hermite	NPML	NPML

Note: Robust standard errors are in parentheses. Standard errors for the random effects probit model are bootstrapped using 100 replications. All estimations contain a constant, the specified Mundlak-Chamberlain device, a variable of initially unemployed and its change after Unification and control for missings in the education variable. Controls include age dummies, educational dummies, experience dummies, the number of labour market interruptions, the cumulated length of labour market interruptions, occupational status (white-collar and blue-collar worker) and occupational groups. Asterisks next to coefficients indicate significance levels as follows: *** 1%, ** 5%, * 10%.

To quantify the extent of genuine state dependence, we estimate the average partial effect (APE) for each of the time periods considered. The method used is based on counterfactual outcome probabilities based on the lagged endogenous variable, i.e. $APE = P(y_t = 1|y_{t-1} = 1) - P(y_t = 1|y_{t-1} = 0)$. Following Papke and Wooldridge (2008), the specified average structural function (ASF) for period t can be written as:

$$ASF_t = N^{-1} \sum_{i=1}^{N} \Phi[(x'_{it}\hat{\beta} + \hat{\gamma}_t y_{it-1} + \hat{a}_0 + \hat{a}_{11}\overline{experience_i} + \hat{a}_{12}\overline{interrupt_i} + \hat{a}_2 y_{i1})(1+\hat{\sigma}^2_\alpha)^{-1/2}] \tag{16}$$

for $t = 1981 - 1999$. In the discrete case, we estimate the average partial effect as a weighted mean taking into account the estimated latent classes and the corresponding probabilities. Table 7 reports the results. We first observe that after accounting

Table 7: Average partial effects, by gender

	Aggregate		Pooled probit		Random effects		Discrete distribution	
	Males	Females	Males	Females	Males	Females	Males	Females
$P(y_t = 1\|y_{t-1} = 1) - P(y_t = 1\|y_{t-1} = 0)$								
APE_{GDR}	14.1	69.3	11.3	64.5	5.0	35.1	5.1	36.4
APE_{1990}	8.3	38.9	5.3	34.2	1.6	10.6	1.0	8.1
APE_{FRG}	63.8	73.9	56.0	66.3	47.9	44.8	46.9	44.3
$P(y_t = 1\|z_{t-1} = 1) - P(y_t = 1\|y_{t-1} = 0)$								
APE_{GDR}	9.0	47.4	10.7	19.5	9.3	22.7	7.7	16.5
APE_{FRG}	26.5	53.2	29.1	15.8	31.5	19.8	27.6	12.9

Source: BASiD 2007, weighted sample.
Note: $y_t = 1$ denotes the low-wage and $z_t = 1$ the un- or non-employment status. Estimation of average partial effects based on results in Table A.1, Appendix A.

for observed heterogeneity, state dependence declines for both males and females during all three defined periods. However, the decline is rather small, suggesting that low-pay persistence is largely independent from differences in observables that are available in our data set. Additionally controlling for unobserved heterogeneity based upon the random effects and discrete distribution specification reduces the estimates for all time periods considered. However, the decline in genuine state

dependence is again most pronounced for the pre-unification and transition period. Interestingly, the interaction term for the year 1990 becomes close to zero for males. For females, genuine state dependence also reaches its minimum in 1990, albeit at a higher level (8-10 per cent) than that for males. After Unification, state dependence increases substantially and remains on a high level compared to the pre-unification period. The lower part of the table reports the estimates of the probability of being low-paid conditional on being initially un- or non-employed as compared the probability of being low paid conditional on being initially highly-paid. Accounting for both observed and unobserved heterogeneity, we find that this measure of state dependence is reasonably high and increases after Unification for males indicating that previously un- or non-employed individuals exhibit a higher probability of entering low-pay as compared to initially highly-paid workers. For females, this measure of state dependence decreases in the second period. However, the estimated change is not significant (cf. Tabel 6).

6 Robustness

6.1 Robustness Check I - Pooled Wage Distribution

The analysis thus far has relied on low-wage thresholds derived from gender-specific wage distributions. Figure 2 has shown that the male low-wage threshold comes fairly close to the censoring point. Even though we have demonstrated that the incentive to underreport earnings is lowest in this area, the fact that male workers' first deciles exhibit only very small growth rates during the pre-unification period raises some concerns about measurement error. To check the robustness of our results with respect to the chosen threshold, we therefore re-run our specifications based on the first decile of the pooled wage distribution as shown in Figure 3. Note that from a welfare perspective this is a reasonable strategy, as an individual's relative economic position is likely to be determined by the overall working-age population rather than by (arguably narrowly defined) specific peers. While the pooled decile has the advantage that it is farther away from the censoring limit and thereby re-

Table 8: Average partial effects, pooled wage distribution, by gender

	Aggregate		Pooled probit		Random effects		Discrete distribution	
	Males	Females	Males	Females	Males	Females	Males	Females
$P(y_t = 1\|y_{t-1} = 1) - P(y_t = 1\|y_{t-1} = 0)$								
APE_{GDR}	23.6	65.2	14.4	62.2	5.6	40.1	6.6	41.2
APE_{1990}	9.8	44.2	3.4	38.6	0.5	19.1	0.6	13.2
APE_{FRG}	55.9	78.9	47.7	71.1	31.2	58.6	33.3	58.9
$P(y_t = 1\|z_{t-1} = 1) - P(y_t = 1\|y_{t-1} = 0)$								
APE_{GDR}	11.1	40.1	4.5	29.3	4.8	29.2	3.1	25.2
APE_{FRG}	41.47	40.8	8.8	30.5	11.2	32.4	7.6	27.0

Source: BASiD 2007, weighted sample.
Note: $y_t = 1$ denotes the low-wage and $z_t = 1$ the un- or non-employment status. Detailed results on estimated coefficients are shown in Table A.2, Appendix A.

duces the concern of misclassifying males as falling below the censoring limit, it comes at the expense of a considerably lower fraction of male workers obtaining a low-wage (about 5 per cent).

Table 8 shows the results from re-running our specifications based on the pooled low-wage threshold. The numbers reports average partial effects similar to Table 7. The figures show that the overall pattern of results pointing to a minimum of genuine state dependence during economic transition remains unchanged. While the point estimates of the average partial effects do not differ substantially from the estimates in Table 7 in the pre-unification and transition period, the average partial effects in the post-unification period for males are considerably reduced from 47 per cent to about 32-33 per cent (see the random effects and discrete distribution specification). For females, however, true state dependence increases compared to Table 7. Overall, these results suggest that for males a low-wage position is of more temporary nature the closer the low-wage threshold comes to the very bottom of the wage distribution.

6.2 Robustness Check II - Placebo Test

Given that we did not specify annual interactions during the pre- and post-unification period, a further concern is that the true minimum value of genuine state dependence is not reached in 1990, but rather in one of the years in the pre- and post-unification period. To test whether the estimated average partial effect APE_{1990} reaches its

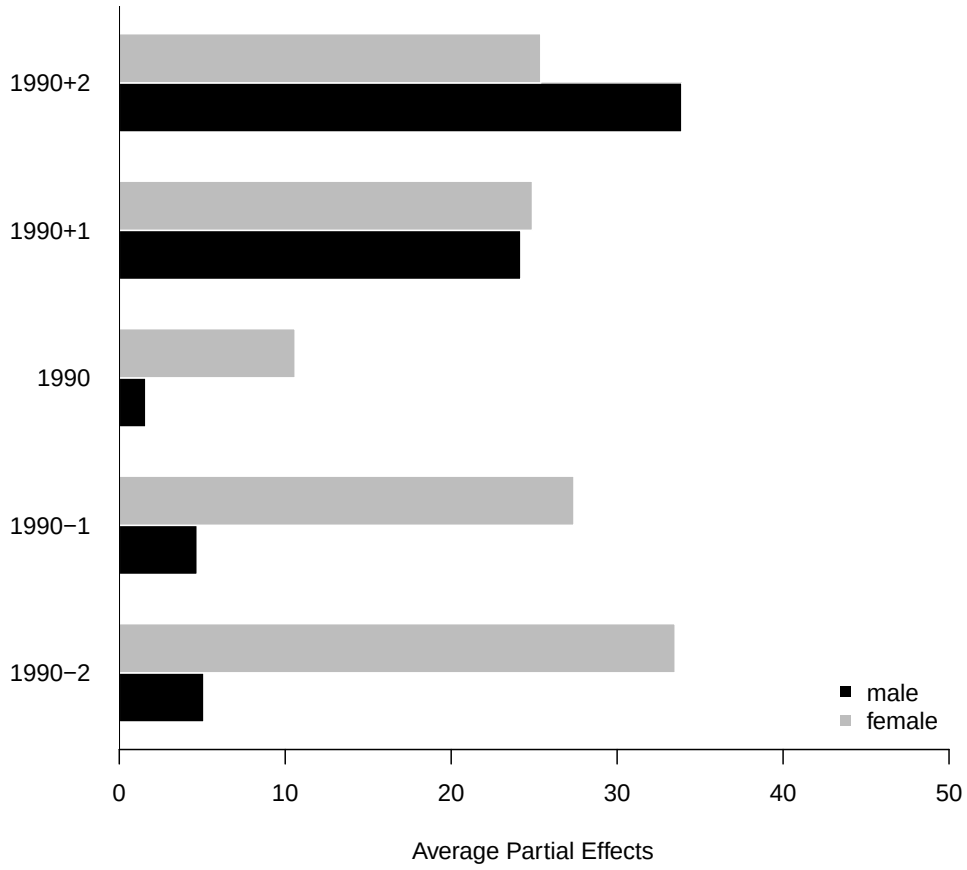


Figure 6: Interaction within a two year window
Source: BASiD 2007, weighted sample.
Notes: Every bar corresponds to a dynamic random effects probit regression. The values for 1990 are those presented in Table 7.

true minimum in 1990, we vary the timing of the event of Unification by artificially postponing Unification within a window of +/− two years. The model chosen is the dynamic random effects model using the separate wage distributions by gender

(baseline specification). Figure 6 shows average partial effects for these placebo estimates. The middle part of the figure refers to the baseline estimates, with the lagged low-pay status being interacted with the true year 1990. For 1990 - 1 and 1990 - 2, we let the transition take place one and two years earlier, respectively, whereas for 1990 + 1 and 1990 + 2 we postpone the transition by one or two years, respectively. The figure clearly illustrates that for both males and females, the lowest average partial effect arises in 1990. Imposing interactions one or two years earlier results in an increase of the estimated effect to the level close to the estimate of APE_{GDR} in the tables above. The same holds true if we artificially postpone the transition period by specifying interactions one and two years later. Overall, the placebo analysis therefore provides strong evidence of 1990 being the true minimum for the extent of genuine state dependence.

6.3 Robustness Check III - Changing the Low-wage Threshold after Unification

Thus far, our results were based on the first decile as the low-wage threshold prior to and after Unification. Given the fundamental changes the wage distribution underwent during and after economic transition, one might argue that interpreting an escape from out of the first decile into the upper deciles as a transition into the "high-wage sector" might be too restrictive after Unification. For this reason and to adopt a more conventional definition of low-pay, we re-run our specifications by defining the low-wage threshold after 1990 as two thirds of the median wage. Table 9 displays average partial effects using the change in the threshold after Unification. Overall, the pattern of results does not change dramatically. At least for males, the average partial effect in 1990 increases only slightly for the random effects specification. The reason is that wages have been still relatively compressed and just started to increase and diverge afterwards (see Figure 1). As regards genuine state dependence after Unification, all models show, as expected, an increase compared to previous results.

Table 9: Average partial effects, changing low-wage threshold after Unification, by gender

	Aggregate		Pooled probit		Random effects		Discrete distribution	
	Males	Females	Males	Females	Males	Females	Males	Females
$P(y_t = 1\|y_{t-1} = 1) - P(y_t = 1\|y_{t-1} = 0)$								
APE_{GDR}	14.2	69.5	13.5	64.5	6.8	40.6	6.4	42.2
APE_{1990}	8.3	48.3	5.8	41.1	3.2	17.6	2.2	15.2
APE_{FRG}	63.8	77.8	56.9	79.6	44.8	65.0	43.5	65.1
APE_{GDR}	9.0	47.4	10.7	20.9	9.7	23.3	8.0	17.1
APE_{FRG}	26.5	53.2	24.6	34.8	28.1	35.4	23.5	28.7

Source: BASiD 2007, weighted sample.
Notes: Estimation of average partial effects. Detailed results on estimated coefficients are shown in Table A.3, Appendix A.

7 Conclusions

Focussing on the economic and political transformation in East Germany, the aim to this study was to investigate how one's pre-unification relative economic position determined one's fortunes after Unification. In answering this question, we attempt to improve our understanding about whether the transition from a centrally planned to a market economy offers fundamentally new perspectives for those who, in economic terms, were relatively deprived under the old regime. To address these issues, we use a novel administrative data set, the *BASiD* data set, focussing on individuals with a sufficiently long period of labour market experience during the pre-unification regime. The data provide an ideal basis for our analysis as they allows us, first, to identify individuals living in Eastern Germany before Unification and, second, as they enables us to track individual employment histories both before and after the fall of the Iron Curtain. To measure individuals' relative economic position, we exploit information on the incidence and duration of individuals' position in the bottom part of the pre-unification wage distribution.

In our empirical analysis, particular emphasis is given to the extent of genuine low-wage state dependence during economic and political transition. We estimate

a dynamic discrete choice model taking into account the initial condition problem and different specifications of unobserved heterogeneity. Our findings suggest that genuine state dependence reaches its minimum in 1990. However, the results point to heterogenous effects for males and females. While state dependence is almost zero for male workers, we still document a positive extent of state dependence for females of around 8 to 10 per cent. After the transformation, genuine state dependence is shown to increase for both groups up to a similar level.

What drives this reduction in true low-wage persistence? Based on signalling considerations, we would expect a sharp decrease in true low-wage persistence, if the heavily regulated pre-unification labour market had rendered the selection into low-wage jobs based on workers' true productivity. Given the low estimated level of genuine state dependence during transition, our findings are therefore consistent with the notion that in the post-unification labour market a worker's pre-unification low-wage status did not serve as a productivity signal. On the other hand, the transformation from a centrally planned economy to a market-based economy also comes along with high degree of uncertainty. Thus, even if there were a link between workers' productivity and low-wage status, our results would also be consistent with initial uncertainty about true productivity right after Unification. This high initial uncertainty would result in a weaker short-run relationship between the relative labour market position in the last year of the GDR (1989) and the transition period (1990). Favouring either of these explanations ultimately requires the analysis of the long-term consequences of workers' pre-unification low-wage status for their post-unification labour market outcomes and will be an important question for future research.

Appendix

Appendix A: Empirical Results

Table A.1: Dynamic probit results for low-pay probabilities, separated wage distribution, by gender

Variables	Probit		RE Probit		Discrete Distribution	
	Males (1a)	Females (1b)	Males (2a)	Females (2b)	Males (3a)	Females (3b)
$Lowwage_{t-1}$	0.542***	2.461***	0.290***	1.880***	0.292***	1.881***
	(0.036)	(0.037)	(0.045)	(0.059)	(0.043)	(0.061)
$\times H_{1990}$	-0.263***	-1.102***	-0.195**	-1.218***	-0.195***	-1.222***
	(0.118)	(0.108)	(0.107)	(0.138)	(0.126)	(0.124)
$\times H_{FRG}$	1.608***	0.059	1.717***	0.258***	1.714***	0.247***
	(0.058)	(0.064)	(0.076)	(0.096)	(0.072)	(0.092)
$Not\ working_{t-1}$	0.519***	1.207***	0.412***	1.160****	0.415****	1.156***
	(0.036)	(0.052)	(0.093)	(0.073)	(0.101)	(0.063)
$\times H_{FRG}$	0.910***	-0.147*	1.037***	-0.143	1.035***	-0.148
	(0.107)	(0.076)	(0.123)	(0.106)	(0.118)	(0.091)
$Lowwage_{i1}$			0.362***	0.874***	0.373***	0.871***
			(0.053)	(0.072)	(0.050)	(0.081)
$\times H_{FRG}$			-0.255***	-0.527***	-0.258***	-0.520***
			(0.084)	(0.111)	(0.093)	(0.103)
$Not\ Working_{i1}$			0.228	0.748***	0.177	0.376***
			(0.343)	(0.061)	(0.373)	(0.112)
Individual Characteristics						
Agegroup 2	-0.035	-0.032	-0.005	-0.028	-0.003	-0.025
	(0.053)	(0.059)	(0.055)	(0.062)	(0.085)	(0.067)
Agegroup 3	0.100*	-0.074	0.019	0.035	0.022	0.036
	(0.058)	(0.066)	(0.066)	(0.075)	(0.113)	(0.083)
Agegroup 4	0.028	-0.070	0.141	0.156	0.145	0.158
	(0.085)	(0.088)	(0.091)	(0.108)	(0.154)	(0.111)
$Low-skilled$	0.098***	-0.003	0.128**	0.059	0.132***	0.057
	(0.036)	(0.036)	(0.057)	(0.051)	(0.051)	(0.050)
$High-skilled$	-0.156***	-0.318***	-0.214***	-0.392***	-0.218***	-0.387***
	(0.047)	(0.062)	(0.071)	(0.057)	(0.06)	(0.092)
$White-collar$	-0.276***	-0.256***	-0.305***	-0.316***	-0.306***	-0.327***
	(0.031)	(0.026)	(0.042)	(0.041)	(0.042)	(0.043)
Skilled occupation	-0.224***	-0.346***	-0.196***	-0.443***	-0.191***	-0.427***
	(0.042)	(0.046)	(0.058)	(0.062)	(0.056)	(0.068)
Simple occupation	0.035	-0.019	0.061***	0.007	0.063***	0.006
	(0.021)	(0.027)	(0.024)	(0.038)	(0.029)	(0.042)
Experience medium	-0.087*	-0.048	0.003	0.033	0.003	0.034
	(0.051)	(0.052)	(0.058)	(0.061)	(0.066)	(0.066)
Experience high	-0.134*	-0.150*	0.033	0.111	0.033	0.111
	0.079	(0.084)	(0.093)	(0.098)	(0.112)	(0.110)
Interruption length	0.008***	0.004***	0.010***	0.003*	0.010***	0.003**
	(0.001)	(0.001)	(0.002)	(0.002)	(0.003)	(0.002)
Number Interruptions	0.031***	-0.012***	-0.042***	0.024*	-0.043**	0.024*
	(0.005)	(0.004)	(0.010)	(0.013)	(0.022)	(0.014)
Individual Means						
$\overline{Experience_{i,medium}}$			-0.366***	-0.299***	-0.365***	-0.305***
			(0.100)	(0.116)	(0.149)	(0.112)
$\overline{Experience_{i,high}}$			-0.590***	-1.105***	-0.588***	-1.110***
			(0.146)	(0.205)	(0.249)	(0.197)
$\overline{InterruptionLength_i}$			0.000	0.001	0.000	0.001
			(0.003)	(0.002)	(0.012)	(0.002)
$\overline{\#Interruptions_i}$			0.088***	-0.040***	0.088***	-0.040***
			(0.014)	(0.015)	(0.040)	(0.017)
Unobserved Heterogeneity						
σ_α			0.331***	0.577***		
			(0.21)	(0.028)		
Prob. 1					0.762	0.364
Prob. 2					0.109	0.558
Prob. 3					0.128	0.092
Unobs. Het. 1					0.000	0.000
Unobs. Het. 2					-0.891	-0.811***
					(0.631)	(0.085)
Unobs. Het. 3					0.623***	0.694***
					(0.069)	(0.110)
Year dummies	yes	yes	yes	yes	yes	yes
Log-Lik	-9386.76	-6567.47	-9233.10	-6321.92	-9232.74	-6317.99
AIC	18847.52	13208.94	18558.20	12735.84	18557.47	12729.99
Total # observations	35891	36366	35891	36366	35891	36366
# of individuals	2243	2531	2243	2531	2243	2531
Estimation Method	ML	ML	Gauss-Hermite	Gauss-Hermite	NPML	NPML

Source: BASiD 2007.

Notes: Robust standard errors are in parentheses. Standard errors for the random effects probit model are bootstrapped using 100 replications. All estimations contain a constant, the specified Mundlak-Chamberlain device and control for missings in the education variable. Age group 2 is age between 30-40, age group 3 is age between 40-50, age group 4 is age above 50. Reference category is age group between 20-30. Medium experience is experience between 10-30 years, high experience is above 30 years. Reference category is experience below 10 years. Asterisks next to coefficients indicate significance levels as follows: *** 1%, ** 5%, * 10%.

Table A.2: Dynamic probit results for low-pay probabilities, pooled wage distribution, by gender

Variables	Probit		RE Probit		Discrete Distribution	
	Males (1a)	Females (1b)	Males (2a)	Females (2b)	Males (3a)	Females (3b)
$Lowwage_{t-1}$	1.223***	2.157***	0.793***	1.678***	0.831***	1.680***
	(0.092)	(0.029)	(0.106)	(0.040)	(0.118)	(0.045)
$\times H_{1990}$	-0.788***	-0.871***	-0.706	-0.870***	-0.715***	-0.876***
	(0.233)	(0.087)	(0.925)	(0.095)	(0.244)	(0.096)
$\times H_{FRG}$	1.090***	0.362***	1.208***	0.598***	1.195***	0.598***
	(0.123)	(0.051)	(0.145)	(0.074)	(0.152)	(0.070)
$Not\ working_{t-1}$	0.638***	1.278***	0.527***	1.185****	0.512****	1.184***
	(0.129)	(0.047)	(0.155)	(0.063)	(0.145)	(0.053)
$\times H_{FRG}$	0.345**	0.111	0.473**	0.146**	0.479***	0.145**
	(0.151)	(0.069)	(0.180)	(0.086)	(0.167)	(0.077)
$Lowwage_{i1}$			0.676**	0.714***	0.663***	0.692***
			(0.299)	(0.052)	(0.226)	(0.051)
$\times H_{FRG}$			-0.307	-0.573***	-0.300	-0.570***
			(1.693)	(0.067)	(0.446)	(0.075)
$Not\ Working_{i1}$			0.288	0.302***	0.312	0.303***
			(1.579)	(0.094)	(0.373)	(0.100)
Individual Characteristics						
Agegroup 2	0.121	0.025	0.147	0.029	0.150	0.035
	(0.098)	(0.049)	(0.108)	(0.055)	(0.104)	(0.055)
Agegroup 3	0.107	-0.007	0.280**	0.092	0.283***	0.092
	(0.106)	(0.055)	(0.131)	(0.070)	(0.115)	(0.071)
Agegroup 4	0.216	-0.041	0.462***	0.142	0.461***	0.140
	(0.139)	(0.075)	(0.170)	(0.107)	(0.156)	(0.094)
$Low-skilled$	0.212***	-0.006	0.273***	0.022	0.275***	0.023
	(0.056)	(0.027)	(0.075)	(0.040)	(0.071)	(0.041)
$High-skilled$	0.023	-0.382***	-0.057	-0.455***	-0.066	-0.464***
	(0.077)	(0.051)	(0.089)	(0.056)	(0.101)	(0.078)
$White-collar$	-0.265***	-0.241***	-0.380***	-0.300***	-0.268***	-0.304***
	(0.056)	(0.022)	(0.064)	(0.030)	(0.098)	(0.033)
Skilled occupation	-0.359***	-0.277***	-0.380***	-0.329***	-0.410***	-0.320***
	(0.078)	(0.036)	(0.099)	(0.045)	(0.098)	(0.057)
Simple occupation	-0.027	0.025	0.018	0.039	0.011	0.033
	(0.035)	(0.023)	(0.043)	(0.029)	(0.053)	(0.031)
Experience medium	-0.263***	-0.148***	-0.143	-0.137**	-0.135	-0.140***
	(0.087)	(0.043)	(0.103)	(0.055)	(0.100)	(0.053)
Experience high	-0.382***	0.175**	-0.117	-0.031	-0.096	-0.038
	(0.125)	(0.071)	(0.124)	(0.077)	(0.154)	(0.086)
Interruption length	0.009***	0.004***	0.004**	0.006***	0.006***	0.004***
	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)
Number Interruptions	0.014**	-0.006**	-0.005	0.015	-0.004	0.014
	(0.007)	(0.003)	(0.017)	(0.011)	(0.020)	(0.011)
Individual Means						
$\overline{Experience_{i,medium}}$			-0.492***	-0.180**	-0.481***	-0.176**
			(0.184)	(0.019)	(0.080)	(0.093)
$\overline{Experience_{i,high}}$			-0.937***	-0.757***	-0.913***	-0.746***
			(0.255)	(0.000)	(0.158)	(0.153)
$\overline{InterruptionLength_i}$			0.015***	-0.001	0.013***	-0.001
			(0.005)	(0.002)	(0.004)	(0.002)
$\overline{\#Interruptions_i}$			0.011	-0.020*	0.008	-0.018
			(0.023)	(0.012)	(0.024)	(0.013)
Unobserved Heterogeneity						
σ_α			0.442***	0.463***		
			(0.041)	(0.018)		
Prob. 1					0.242	0.404
Prob. 2					0.705	0.579
Prob. 3					0.054	0.017
Unobs. Het. 1					0.000	0.000
Unobs. Het. 2					-0.073	-0.780***
					(3.807)	(0.058)
Unobs. Het. 3					0.984	.993***
					(2.589)	(0.480)
Year dummies	yes	yes	yes	yes	yes	yes
Log-Lik	-3115.74	-9573.78	-3055.04	-9300.59	-3051.55	-9299.10
AIC	6305.48	19221.57	6202.07	18693.18	6197.10	18629.16
Total # observations	40199	36366	40199	36366	40199	36366
# of individuals	2243	2531	2243	2531	2243	2531
Estimation Method	ML	ML	Gauss-Hermite	Gauss-Hermite	NPML	NPML

Source: BASiD 2007.

Notes: Robust standard errors are in parentheses. Standard errors for the random effects probit model are bootstrapped using 100 replications. All estimations contain a constant, the specified Mundlak-Chamberlain device and control for missings in the education variable. Age group 2 is age between 30-40, age group 3 is age between 40-50, age group 4 is age above 50. Reference category is age group between 20-30. Medium experience is experience between 10-30 years, high experience is above 30 years. Reference category is experience below 10 years. Asterisks next to coefficients indicate significance levels as follows: *** 1%, ** 5%, * 10%.

Table A.3: Dynamic probit results for low-pay probabilities, changing low-wage threshold after unification

Variables	Probit		RE Probit		Discrete Distribution	
	Males (1a)	Females (1b)	Males (2a)	Females (2b)	Males (3a)	Females (3b)
$Lowwage_{t-1}$	0.624***	2.484***	0.379***	2.047***	0.374***	2.039***
	(0.032)	(0.032)	(0.032)	(0.049)	(0.039)	(0.048)
$\times H_{1990}$	-0.134	-1.076***	-0.060	-1.222***	-0.059	-1.179***
	(0.132)	(0.107)	(0.152)	(0.123)	(0.140)	(0.119)
$\times H_{FRG}$	1.767***	0.344***	1.864***	0.466***	1.874***	0.466***
	(0.053)	(0.064)	(0.055)	(0.071)	(0.065)	(0.079)
$Not\ working_{t-1}$	0.523***	1.270***	0.429***	1.238****	0.449****	1.170***
	(0.090)	(0.055)	(0.092)	(0.078)	(0.096)	(0.061)
$\times H_{FRG}$	1.061***	0.223***	1.208***	0.143**	1.190***	0.206***
	(0.111)	(0.072)	(0.117)	(0.091)	(0.119)	(0.081)
$Lowwage_{i1}$			0.337***	0.779***	0.346***	0.767***
			(0.048)	(0.069)	(0.051)	(0.068)
$\times H_{FRG}$			-0.287***	-0.557***	-0.296***	-0.547***
			(0.111)	(0.105)	(0.106)	(0.103)
$Not\ Working_{i1}$			0.178***	0.372***	0.174	0.374***
			(0.336)	(0.105)	(0.342)	(0.112)
Individual Characteristics						
Agegroup 2	-0.038	-0.027	-0.003	0.040	-0.001	-0.035
	(0.054)	(0.064)	(0.059)	(0.062)	(0.004)	(0.067)
Agegroup 3	-0.083	-0.086	0.050	-0.014	0.053	0.013
	(0.060)	(0.069)	(0.072)	(0.075)	(0.053)	(0.082)
Agegroup 4	-0.032	-0.122	0.161	0.053	0.160*	0.092
	(0.092)	(0.086)	(0.129)	(0.119)	(0.099)	(0.107)
$Low-skilled$	0.062	0.007	0.087	0.056	0.097**	0.060
	(0.039)	(0.030)	(0.056)	(0.044)	(0.051)	(0.047)
$High-skilled$	-0.157***	-0.369***	-0.212***	-0.440***	-0.232***	-0.451***
	(0.049)	(0.058)	(0.061)	(0.065)	(0.079)	(0.085)
$White-collar$	-0.260***	-0.283***	-0.293***	-0.363***	-0.286***	-0.370***
	(0.033)	(0.026)	(0.040)	(0.037)	(0.045)	(0.040)
Skilled occupation	-0.174***	-0.359***	-0.141***	-0.443***	-0.143***	-0.431***
	(0.044)	(0.043)	(0.053)	(0.062)	(0.057)	(0.065)
Simple occupation	0.019	0.033	0.046*	0.070**	0.045	0.068**
	(0.023)	(0.026)	(0.027)	(0.035)	(0.029)	(0.035)
Experience medium	-0.094*	-0.044	-0.010	-0.002	-0.010	-0.012
	(0.052)	(0.054)	(0.047)	(0.057)	(0.020)	(0.053)
Experience high	-0.160*	-0.054	0.011	0.133	0.014	0.151
	(0.086)	(0.078)	(0.093)	(0.088)	(0.093)	(0.100)
Interruption length	0.006***	0.004***	0.008***	0.007***	0.008***	0.007***
	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
Number Interruptions	0.039***	-0.011***	-0.039***	0.012	-0.039***	0.013
	(0.005)	(0.004)	(0.011)	(0.010)	(0.011)	(0.013)
Individual Means						
$\overline{Experience_{i,medium}}$			-0.349**	-0.170**	-0.335***	-0.227***
			(0.100)	(0.085)	(0.098)	(0.109)
$\overline{Experience_{i,high}}$			-0.625	-0.878***	-0.618***	-0.968***
			(0.154)	(0.189)	(0.143)	(0.190)
$\overline{InterruptionLength_i}$			-0.001	-0.003	-0.001	-0.003
			(0.003)	(0.002)	(0.003)	(0.002)
$\overline{\#Interruptions_i}$			0.093***	-0.028**	0.093***	-0.028**
			(0.014)	(0.012)	(0.014)	(0.015)
Unobserved Heterogeneity						
σ_α			0.338***	0.515***		
			(0.020)	(0.022)		
Prob. 1					0.735	0.405
Prob. 2					0.222	0.152
Prob. 3					0.044	0.651
Unobs. Het. 1					0	0
Unobs. Het. 2					-0.837***	-0.845***
					(0.319)	(0.060)
Unobs. Het. 3					0.727***	0.737***
					(0.225)	(0.136)
Year dummies	yes	yes	yes	yes	yes	yes
Log-Lik	-8251.92	-7290.03	-8115.02	-7084.69	-8116.45	-7121.87
AIC	16569.85	14926.55	16314.03	14253.38	16324.91	14337.73
Total # observations	40199	36366	40199	36366	40199	36366
# of individuals	2243	2531	2243	2531	2243	2531
Estimation Method	ML	ML	Gauss-Hermite	Gauss-Hermite	NPML	NPML

Source: BASiD 2007.

Notes: Robust standard errors are in parentheses. Standard errors for the random effects probit model are bootstrapped using 100 replications. All estimations contain a constant, the specified Mundlak-Chamberlain device and control for missings in the education variable. Age group 2 is age between 30-40, age group 3 is age between 40-50, age group 4 is age above 50. Reference category is age group between 20-30. Medium experience is experience between 10-30 years, high experience is above 30 years. Reference category is experience below 10 years. Before unification, the low-wage threshold is the first decile, while after unification two-thirds of the median is used. Asterisks next to coefficients indicate significance levels as follows: *** 1%, ** 5%, * 10%.

Figure A.1: Aggregate state dependence, pooled wage distribution, by gender

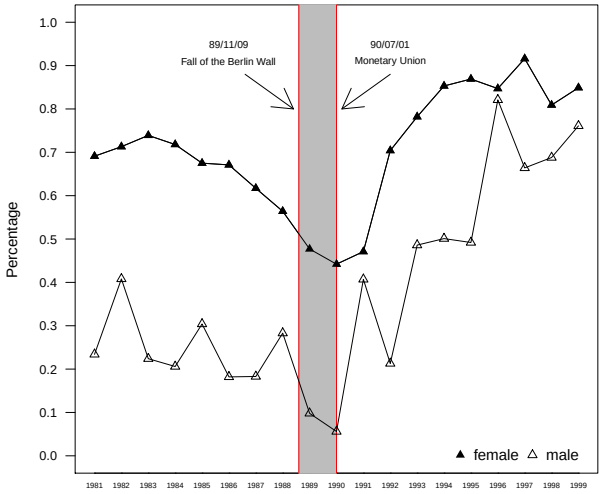
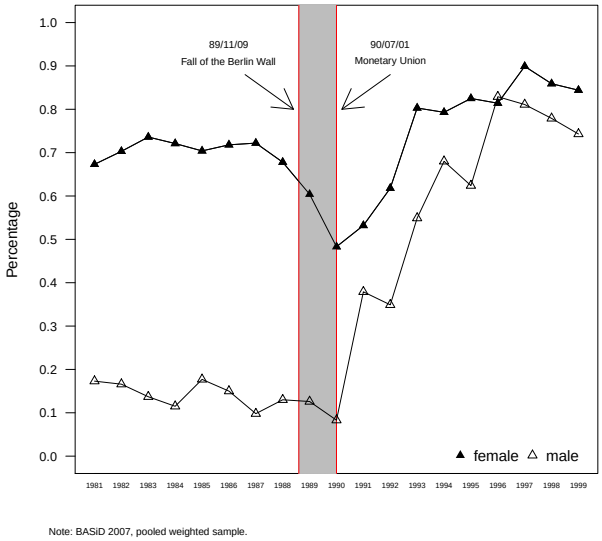


Figure A.2: Aggregate state dependence, changing low-wage threshold after unification, by gender



Appendix B: Data Description

Variable	Definition
Employment Status[1)]	
EMPLOYMENT	Employment spells include periods of employment subject to social security contributions and (after 1998) marginal employment.
UNEMPLOYMENT	Unemployment spells include periods of unemployment with and without transfer receipt (only FRG).[2)]
NON-EMPLOYMENT	Non-employment spells include periods of child raising, care giving as well as periods with missing information on the employment status.
ILLNESS	Illness spells include periods of long-term illness (FRG $>$ 6 weeks; GDR $>$ 4 weeks before 1984, no minimum restriction afterwards).
TRAINING	Training spells include periods of school or university attendance after the age of 16 and periods of training and apprenticeship.
# UN(NON)EMPLOYMENT_SPELLS	Number of un- or non-employment spells. An unemployment spell is counted as a new spell if the gap between a preceding unemployment spell exceeds four weeks.

Table B.1: Description of individual employment history variables gained from the *Pension Register*

[1)] Note that the recorded pre-unification pension activity histories are less precise than the post-unification histories. The reason is that the transfer of the activities was mainly based on former GDR citizens' social security cards. These cards record the number of months of employment, illness and maternity leave during a particular year, but do not allow for tracking these spells on a monthly basis. As a result, compared to the pension spells after Unification, which provide exact monthly information on all pension relevant activities, information on the incidence of pre-unification employment, illness and maternity leave spells is available only on an annual basis.

[2)] A spell of unemployment in the *Pension Register* requires individuals to be registered as unemployed *and* to obtain public transfers. The latter include benefits such as unemployment insurance, and - prior to 2005 - the means-tested social assistance and unemployment assistance benefits. After 2004, unemployment and social assistance were merged into one unified benefit, also known as 'unemployment benefit II' (ALG II). As the latter targets only employable individuals, a spell involving the receipt of ALG II automatically fulfills the requirements to be recorded as unemployed in the *Pension Register*. Prior to 2005, spells with social assistance benefits fulfill the above requirements only if individuals were registered as unemployed. Otherwise they are recorded as non-employment spells. As a consequence, the *Pension Register* does not permit a consistent definition of un- and non-employment prior to and after 2005.

Variable/Categories	Definition
GDR-Spell	GDR spells are identified based on the regional origin (*Beitrittsgebiet*) of the pension contributions
Educational Status	
LOW-SKILLED	No degree or highschool degree (Reference category)
MEDIUM-SKILLED	Completed vocational training
HIGH-SKILLED	Technical college degree or university degree
Age	Age in years
Occupational Type	
WHITE-COLLAR	White-collar worker (Reference: blue-collar)
Seniority	
TENURE	Number of previous months at current employer. Employment interruptions a the same employer may not exceed 6 months - otherwise tenure is reset to zero after the employment interruption.
Earnings	
EARNINGS	Gross monthly earnings are retrieved from credit points to the German Pension Insurance. GDR credit points are divided by a factor as specified in Appendix 10 to the German Social Act (SGB VI). One credit point corresponds to the average of yearly earnings of all gainfully employed workers in (Western)Germany. Monthly earnings are thus obtained by multiplying monthly credit points with the average of earnings as documented in the Appendix 1 to the German Social Act (*SGB VI*). Credit points are reported up the contribution limit of the German social security system.

Table B.2: Description of individual characteristics gained from the *Pension and Employment Statistics Register*

Variable	Definition/Categories:
Establishment size	Size $\leq$ *20* (Reference category)
	20 $\leq$ Size $<$ *50*
	50 $\leq$ Size $<$ *200*
	200 $\leq$ Size $<$ *1000*
	Size $\geq$ *1000*
Workforce composition	Share of employees younger than 30 years
	Share of employees older than 50 years
	Share of low-skilled employees
	Share of female employees
Sector affiliation	Agriculture/Forestry (Reference category)
	Mining and manufacturing
	Energy/Water supplies
	Construction
	Wholesale and retail trade
	Transport and communication
	Financial intermediation
	Other service activities
	Public administration

Table B.3: Definition of establishment characteristics gained from the *Employment Statistics Register*

Appendix C: The GDR Pension Formula

Creditable years for pension insurance	Minimum amount (1)	Fixed amount (earnings independent) (2)	Maximum variable amount[1)] (3)	Maximum amount (4)
$t < 15$	330	170	90	330
$15 \leq t < 20$	340	170	120	340
$20 \leq t < 25$	350	170	150	350
$25 \leq t < 30$	370	180	180	370
$30 \leq t < 35$	390	190	210	400
$35 \leq t < 40$	410	200	240	440
$40 \leq t < 45$	430	210	270	480
$45 \leq t$	470	210	300	510

Source: Rosenschon (1990). [1)]The variable earnings dependent amount is one per cent of average monthly earnings multiplied by the number of creditable years. Earnings threshold above which earnings increase pension entitlements calculated as 100·(Col. (1) - Col. (2))/(#Creditable years).

Table C.1: Calculation of GDR Pensions

GDR pension entitlements were only to a limited extent earnings dependent. Column (2) in Table C.1 shows that in 1989, pension rules stipulated an earnings independent amount, which varied between 170 and 210 Mark (depending on the number of contribution years). The additional earnings dependent amount corresponded to one per cent of average monthly earnings multiplied by the number of years creditable for the pension insurance. However, this variable component only applied up to the contribution limit of 600 Mark. Thus, for an individual who e.g. paid pension contributions for 40 years, monthly pensions were capped at a maximum amount of 450 Mark (210 plus 40·6 Mark). The GDR pension system also guaranteed a minimum pension amount that varied between 330 and 470 Mark (again depending on the number of creditable years) shown in Column (1). For a worker who earned on average 300 Mark per months during 40 years, this implied that her pension earnings did not correspond to the amount according to the pension formula (330 = 210 plus 40·3 Mark), but was rather fixed at the minimum pension level of 430 Mark. Figure C.1 shows the earnings threshold above which earnings increased pension entitlements. The threshold depends on the number of creditable years for the pension insurance and is calculated as 100·(Column (1) - Column (2))/(Number of creditable years). For example, the minimum pension level implied that for a worker with 40 creditable years, the threshold of monthly earnings above which earnings raised pension entitlements was 550 Mark. I.e., within the range of

550 and 600 Mark additional earnings increased monthly pensions by an amount of up to 20 Mark (corresponding to about 5 per cent of the minimum pension level). In contrast, for a worker with 44 creditable years, the threshold of monthly earnings above which higher earnings led to higher pensions was already reached at 500 Mark, giving rise to a potential increase in pension entitlements of more than 10 per cent of the minimum pension level (44 Mark). According to the German Ministry of Labour and Social Affairs, in 2012 the average number of creditable years was 44.6 for Eastern German males and to 39.1 years for females.

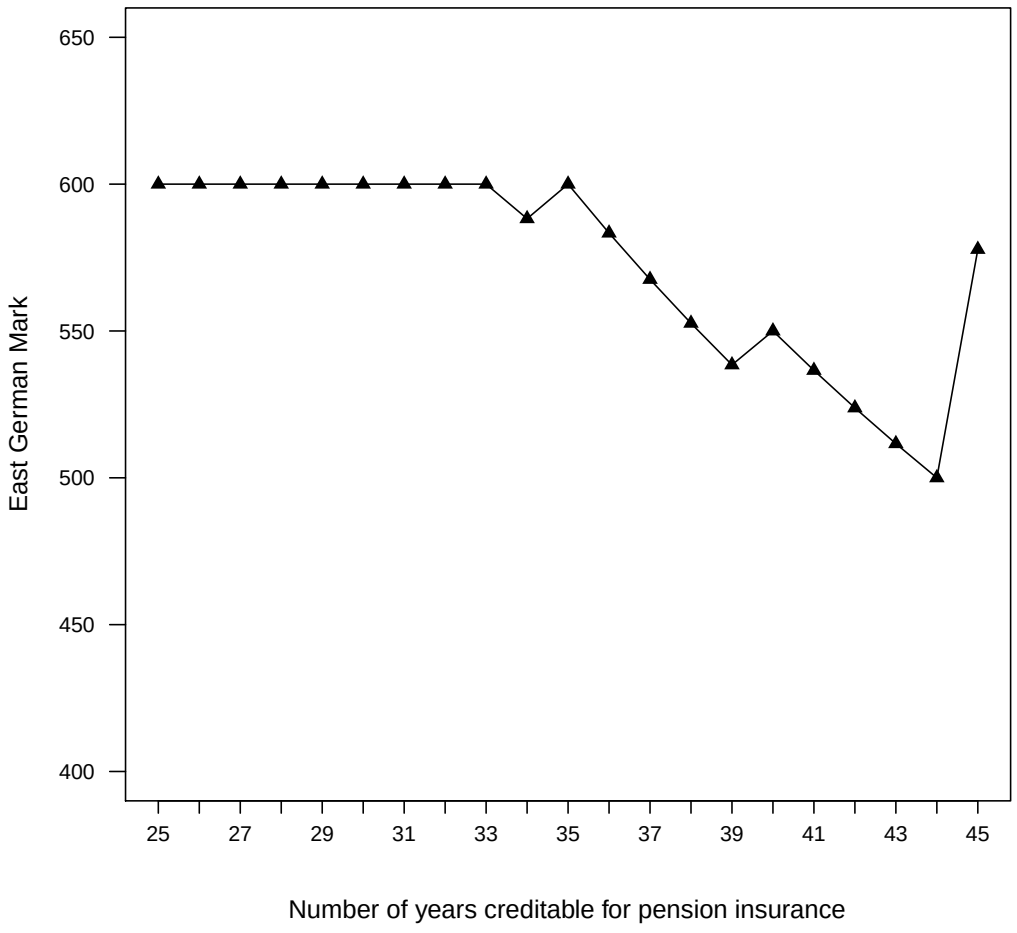


Figure C.1: Earnings threshold above which earnings increase pension entitlements

Appendix D: Individuals above 600 Marks

Table D.1: Distribution of individuals above the censoring threshold, in %

Year	Total	Wages using MEGPT	Wages using GMEGPT
1980	4801	17.1	61.9
1981	4778	22.3	66.7
1982	4759	23.8	68.5
1983	4749	23.8	70.3
1984	4737	24.5	72.0
1985	4726	25.0	74.1
1986	4712	25.6	77.6
1987	4700	25.7	79.8
1988	4686	26.7	80.7
1989	4670	26.7	82.3

Source: BASiD 2007.

Notes: The number of observations is based on the sample selection described in the main text. *Megpt* corresponds to credit points based on earnings derived from employment subject to social security contributions and is used for the empirical analysis. *Gmegpt* corresponds to all credit points due to other creditable periods, such as maternity leave, illness etc. In order to account for potential measurement error, we set the threshold to 605 Marks instead of 600 Marks. Between 1980 and 1990 there are 616 individuals (12 per cent based on the initial sample) whose earnings are continuously above 605 Marks using *megpt*. Using *Gmegpt*, we observe 2421 individuals continuously above 605 Marks.

Appendix E: Imputation of Education Variable

In order to understand the imputation procedure, it is inevitable to obtain institutional knowledge about the educational system in the former German Democratic Republic (GDR). This part only describes the rules. Detailed information will be given in a forthcoming technical paper. For the analysis below, we generally distinguish between three groups of qualification, which are low-skilled, medium-skilled and high-skilled. Low-skilled workers enter the labor market without postsecondary degree. Medium-skilled workers have completed apprenticeship training and high-skilled workers obtained a degree from a (technical) university. The underlying data set (BASiD) provides no information on educational status prior to 1992 for East German citizens. The pension subpart, however, does give information on school, vocational training, unemployment and employment episodes that are creditable for the pension insurance. For the imputation of the educational degree, we use information on creditable periods for school and vocational training spells. By law, students obtain credit points after the age of 17 and up to 8 years if they are full-time students. The length of any apprenticeship or school sequence allows us then to define rules for the imputation of the formal degree. Our approach to the education variable targets directly three possible outcomes (low, medium, high) rather then identifying six levels of education compared to the IAB information.[12]

For reasons of completeness and precision, we choose in this paper the imputation procedure shown in this appendix (*broader imputation*). These rules are shown in Table E.1. The criteria for low-skilled workers is that they do not have a school spell as their first spell at the age of 17 or below. This means that the first spell is a labour market spell.

Table E.1: Imputation rules

Category	Characteristics	Criteria
Low-skilled	First socio-economic spell	Labour market
	at age	≤ 17
	or	
	School/apprenticeship spell	None observed
Medium-skilled	Sum of apprenticeship spells	> 1.5 years
High-skilled	Sum of school spells	> 3 years

[12] In a forthcoming technical paper, we will perform robustness checks using different imputation rules. The first alternative targets the six level of education directly, while the second alternative is based on so-called "potential years of education".

We furthermore define individuals as low-skilled if they never exhibit a school or an apprenticeship spell. Skilled-workers need to have at least 1.5 years of formal apprenticeship and the condition for high-skilled workers is that the sum of school sequences has to be at least 3 years.

The validation of the results is first approached by using external data provided by Steiner (1986) and Maaz (2002). For representative purposes, we compare the fraction of people in the three defined categories for the same cohorts in 1984. The main results are that the three imputation procedures do not differ substantively. Comparing the data with official data used by Steiner (1986) and Maaz (2002), we obtain high discrepancies for the oldest and the youngest cohorts. The *broader imputation* procedure fits the official data best. After discussing potential errors, we proceed and compare the data with the degree variable provided by the IAB, manipulated using the imputation algorithm proposed by Fitzenberger et al. (2006). For a comparison analysis, we follow closely Wichert and Wilke (2012) and perform a regression analysis in order to identify the importance of misclassification. While misclassification is related to observables, we do not find any systematic patterns across the models.

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