Nolte, Andre; Gürtzgen, Nicole

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

Nicole Gürtzgen[1, 2)] and André Nolte[1)]
[1)] Centre for European Economic Research, Mannheim
[2)] University of Mannheim*

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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 tracks 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 further approach the question of how workers' low or high-wage status determines their wage and labour market status within and across different regimes. We first demonstrate that unobserved factors are the main drivers of low-wage persistence and are regime-dependent. We further show that, consistent with signalling considerations, economic dependencies across different regimes are only of minor relevance. Genuine state dependence after Unification amounts to relatively large values of about 15 per cent for males and 19 per cent for females. This measure of persistence is heterogeneous across time, indicating a strong adjustment process and the importance of signalling considerations.

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

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

*Full address of correspondence: Nicole Gürtzgen, André Nolte, Centre for European Economic Research, Department of Labour Markets, Human Resources and Social Policy, L 7.1, 68161 Mannheim, Germany, E-Mail: guertzgen@zew.de; nolte@zew.de. Financial support from the German Research Foundation (DFG) is gratefully acknowledged.

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 understand the welfare implications of economic transitions. 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 was immediately transferred to Eastern Germany. 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 being 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 positions, 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 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 in the GDR. 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 was indeed the case, signalling low productivity should not have contributed to genuine low-wage persistence for the pre-unification period. If, in contrast, low-

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

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 labour markets of transition economies. 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. These results indicate that specific human capital was transferable but socialist work experience became obsolete in the post-unification labour

market. However, 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 thus provides 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 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 explores the evolution of wages and provides a description of labour market transitions as well as unconditional probability estimates. Section 5 lays out the econometric strategy and presents the estimation results on short and long-run dynamics. Section 6 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).

Although enterprises were effectively controlled through centralised redistribution 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 late 1960s, 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 than in 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 adopted 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 21st 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 was set up 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 provides 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, with the exception of 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 construct 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. Tables B.1 and B.2 in the appendix provide more detailed descriptions on the variables gained from the *Pension Register* and *Employment Statistics Register*. For former GDR citizens the data lacks 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 (for a short overview see 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 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 average earnings as documented in the German Social Act (SGB VI - see Table B.2). 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.

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 between 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. those 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

[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 pension sub-part 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 German Federal Statistical Office.

use information on pre-unification labour market histories as a key ingredient in explaining post-unification labour market outcomes. The *BASiD*-SUF file provides

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.

monthly information on individuals' pension 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. To exclude seasonal variation in earnings, 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.[7]

[6]We exclude individuals from the wage distribution if their monthly 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.

[7]The *Employment Statistics Register* is available from 1992 and onwards. We do not observe

Table 1 shows the number of individuals over the whole sample period. Overall, 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 in the literature (for example Fuchs Schündeln and Schündeln, 2009). The last column refers to early retirement as a reason for panel attrition, with a relatively strong increase in 1990 and 1991 hinting to a potentially selective process.

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 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.

full-time and part-time decisions before 1992. By excluding individuals with at least one part-time spell after 1991, we rely on the assumption that people who had a preference for part-time employment after 1991 had also been likely to work part-time prior to Unification. Moreover, it is well established that employment participation rates in communist regimes are generally high also among females. The Socialist Unity Party (SED) defined not the family as the basis of society but the socialistic work collectives. This resulted in over 90% labour participation rates (year 1989) among females. Working part-time was associated with lengthy inner-firm disputes and a rather unusual labour market state.

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	0.10	0.10	0.30	0.30
Low-wage	Indicator (1=Low-wage), 2/3 median	-	0.13	-	0.34
Un- and non-employed	Indicator (1=Not working)	0.03	0.16	0.22	0.42
Migrate	Indicator (1=Migrate)	0.001	0.02	0.03	0.14
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.

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. Using information on occupational status from the first available year from the *Employment Statistics Register*, 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 by construction after Unification.

4 Descriptive Statistics

4.1 Wage Information before Unification and the Definition of the Low-Wage Threshold

Regarding wage information prior to Unification, wages until the first half of 1990 were censored above at 600 Mark. Figure 1 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. It shows that the fraction of individuals earning monthly wages below 600 Mark decreased over 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. The figures show 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

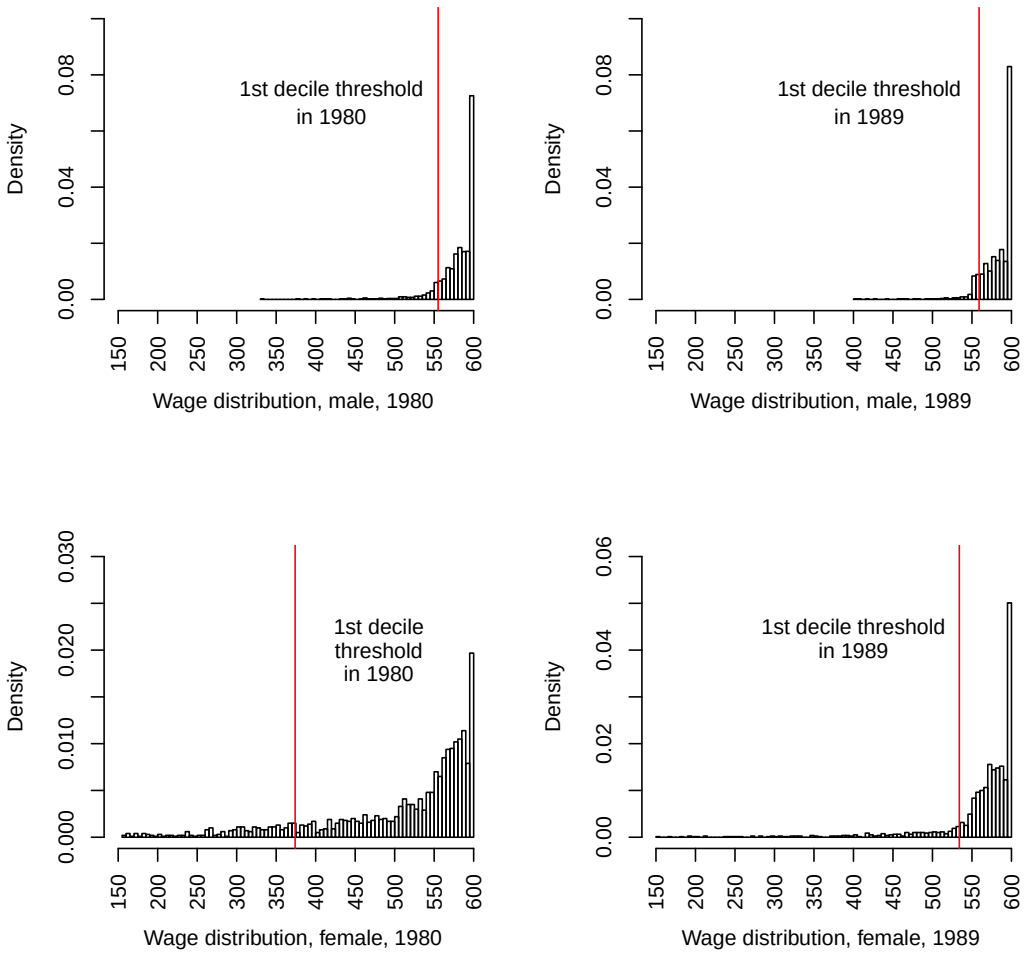


Figure 1: Distribution of Wages between 1980-1989, by Gender

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.[8]

Figure 1 shows 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.[9] 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 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 yields and argument against a systematic measurement error due to underreporting especially within this interval.

[8] Appendix D in the online publication provides robustness results based on the wage distribution pooled for males and females. The reason for that is that the first decile threshold becomes further apart from the 600 Mark censoring limit.

[9] 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.

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.

4.2 Unconditional Probabilities

In order to validate the data internally, Table 3 provides unconditional estimates of being low-paid based on individual characteristics, separately for males and females. 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 present 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 being low paid decreases with experience and increases with the number and cumulative length of

Table 3: Unconditional probabilities, by Gender and Period

	first decile				2/3 median	
	male		female		male	female
	Pre	Post	Pre	Post	Post	Post
Low-wage	10.0	10.0	10.0	10.0	7.1	19.3
Education						
Low-skilled	12.4	15.3	11.7	11.0	10.2	21.9
Medium-skilled	10.4	10.1	10.4	10.9	7.3	20.1
High-skilled	5.4	2.5	3.0	2.7	2.1	4.8
Age groups						
20-29	12.9	-	9.7	-	-	-
30-39	9.7	11.4	10.3	10.7	7.2	18.5
40-49	8.8	9.0	9.4	9.6	6.7	17.8
50-59	-	10.6	-	9.1	8.2	19.2
Occupation						
White-collar	6.2	3.4	7.9	5.2	2.7	10.4
Blue-collar	11.3	12.5	8.3	15.7	8.8	30.6
Skilled occupation	5.3	2.0	4.5	1.6	1.4	4.0
Medium-skilled occupation	10.9	9.8	11.4	9.5	7.2	17.0
Simple occupation	10.8	13.3	9.7	15.2	9.4	29.8
Labour market history						
Experience						
$>$ 20 years	9.2	9.6	6.9	8.9	7.0	17.7
$\leq$ 20 years	10.4	10.4	11.0	10.8	7.3	19.2
# Interruptions						
$>$ 5 times	20.7	14.2	9.7	9.7	10.3	20.0
$\leq$ 5 times	9.5	9.2	10.1	9.5	6.7	17.1
Length Interruptions						
$>$ 20 months	21.8	31.0	13.2	11.2	27.4	22.2
$\leq$ 20 months	10.0	8.7	7.3	7.3	6.1	13.7

Source: BASiD 2007.
Notes: Pooled weighted data for the years 1980-1999. Left numbers (*Prior*) are probabilities prior to Unification. Right numbers (*Post*) refer to probabilities after Unification.

labour market interruptions.

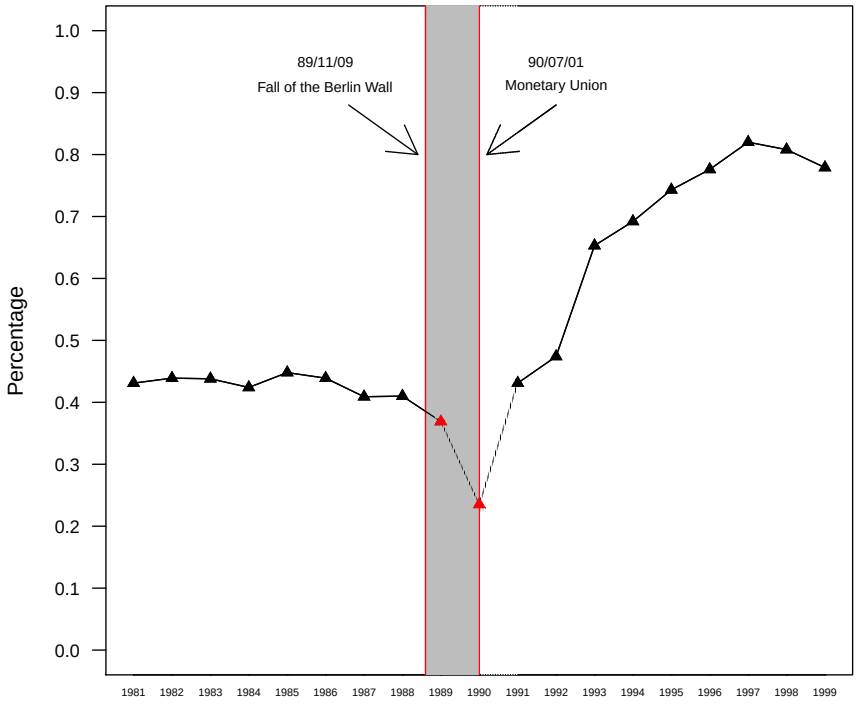
For completeness, the last column shows probability estimates based on the more conventional low-wage threshold of two-thirds of the median. Due to data availability the figures refer to the post-unification period. While the overall pattern of results remains unchanged, the magnitude of the differences becomes somewhat more pronounced.

4.3 Labour Market Transitions

To calculate labour market transitions 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

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

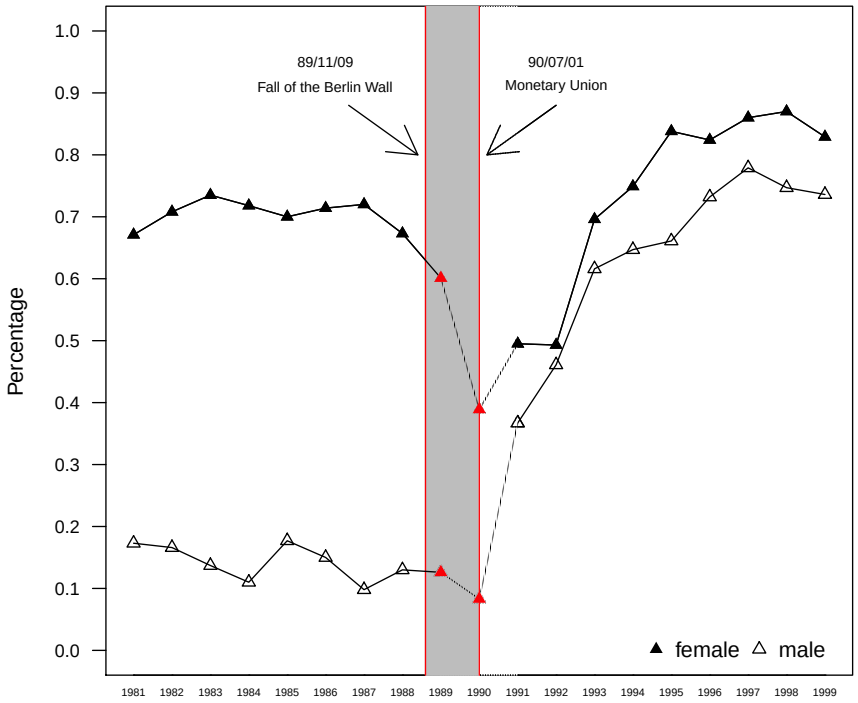
with $L_t = 1$ and $L_t = 0$ meaning low and high pay in year t, respectively. In order to describe the evolution of low-wage persistence, Figure 2 plots ASD against time. Distinguishing the pre-unification (to the left of the grey bar), the transition (be-



Source: BASiD 2007, weighted sample.
Notes: The figure shows the difference in the probability of being in low-wage employment given low-wage and high-wage employment in *t-1*. The first line marks the fall of the Berlin Wall. The second line marks Monetary Union.

Figure 2: Aggregate State Dependence

tween the vertical lines) and the post-unification period (i.e. the time after monetary union), several noteworthy facts emerge from Figure 2. During the pre-transition



Source: BASiD 2007, weighted sample.
Notes: The figure shows the difference in the probability of being in low-wage employment given low-wage and high-wage employment in *t-1*. The first line marks the fall of the Berlin Wall. The second line marks Monetary Union.

Figure 3: Aggregate State Dependence, by Gender

period, aggregate state dependence varied around 42 per cent. During transition, aggregate state dependence decreased markedly by more than 20 percentage points to 24 per cent in 1990 compared to the pre-unification period. The third part of the figure (to the right of the grey 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 3 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

3, the observed minimum in aggregate state dependence during transition becomes somewhat more pronounced for males.

The overall picture that emerges from Figure 2 along with Figure 3 and Figure 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 during the first years and is facing a level-off at the end of the 1990s. Overall, the figures show that the importance of previous low-wage employment for low-pay in the current period reaches its minimum during the time of transition, albeit less pronounced for male workers.

5 Econometric Approach

5.1 Short-run Dynamics within and across Political Regimes

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 will start the econometric analysis by setting up a joint model of low pay over the whole sample period. This is important in order to learn about observed and unobserved factors and the difference in the estimated parameters for the different regimes. To quantify the importance of observables and unobservables at the aggregate level, we specify the following baseline model of low-pay employment:

$$y_{it}^{*} = (\gamma + \delta H_{\tau t}) y_{it-1} + x_{it}'\beta + \epsilon_i + u_{it} \tag{2}$$

$$y_{it} = I(y_{it}^{*} \geq 0) \tag{3}$$

where x_{it} are the explanatory variables presented in Table 2, ϵ_i is an individual-specific random effect and y_{it-1} denotes the low-wage status in $t-1$. We further assume u_{it} to be an idiosyncratic error term with $u_{it} \sim N(0,1)$.[10] To allow for a change in the short-run persistence across the pre- and post-unification period (FRG), we further interact the lagged endogenous variable y_{it-1} with a period dummy variable $H_{\tau t}$, where $H_{\tau t} = 1$ iff $t \geq \tau$ and $\tau = 1990$. The model includes as time-varying explanatory variables the number of labour market interruptions, cumulated labour market interruptions measured in months and a set of experience dummy variables. We additionally include a lagged non-employment indicator variable.

Estimating the dynamic random effects 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* depends on status in period 0 (Heckman, 1981*a*). Given the endogeneity of the first period's outcome due to a correlation with the time-invariant individual effect (selection), state dependence is likely to be overestimated (see Chay and Hyslop, 1998).

In order to treat the initial condition, we follow Wooldridge (2005) and model the density of y_{it} for all $t = 1, ..., T$ given covariates x_{it}, start at $t = 2$ and condition the density of y_{it} for $t = 2, ..., T$ on y_{i1} and x_{it}. This approach is comparable to the correlated random-effects model put forward by Chamberlain (1984) (see also Prowse, 2012).[11] To account for a potential correlation of the unobserved individual effect

[10] Note that this approach does not take into account the state of not working in period t. Given that the labour market institutions are different across the regimes, modelling selection out of employment is exaggerated. The right and the duty to work before Unification caused only few individuals to stay non-employed, indication that selection out of employment is not a concern. This is true especially for males. In our sample 85 per cent among male workers did never experience a non-employment spell between 1980 and 1989 and 95 per cent experienced no or one year of non-employment. Among females, the numbers are 70 per cent and 85 per cent, respectively.

[11] Another approach developed by Heckman (1981*b*) models 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) and involves the specification of an equation for the initial condition.

with observed explanatory variables, we follow Mundlak (1978) and Chamberlain (1984) and model the individual effect, ϵ_i, as:

$$\epsilon_i = a_1 y_{i1} + a_2 \bar{x} + \alpha_i \tag{4}$$

where $\bar{x}$ presents individual time averages of all time varying variables, y_{i1} is the initial low-wage status in the first period and $\alpha_i \sim N(0, \sigma_\alpha^2)$.[12]

In general, the assumptions made in the specified baseline model (equation 2 to 4) of a constant random effect α_i and β's over time might be too strong. To provide an example on the former, one may think about one's political attitude (e.g. civil rights campaigner) that might increase the probability of being at the bottom of the wage distribution. This effect will reverse or at least change after Unification. Moreover, the unconditional probability estimates (Table 3) indicate a change in the estimated β-coefficients. Therefore, we estimate a bunch of models that allow sequentially for a change in the coefficients after Unification. We start with the

Table 4: Modelling Approach

Model	observed heterogeneity	unobserved heterogeneity
Baseline model	β constant	α_i constant
Model 1	β variable	α_i constant
Model 2	β constant	α_i variable
Model 3	β variable	α_i variable

Notes: The models are specified over the time periods between 1980 and 1999. All models in the random effects specification account for the initial condition using the *Wooldridge approach* and follow the literature using the Mundlak-Chamberlain devise. Model 2 and 3 are estimated by simulation using 100 Halton draws.

baseline model (equation 2) where β and α_i are held constant across time. *Model 1* allows additionally for a change in β after Unification while α_i remains constant. In *model 2*, we allow for a change in α_i holding β constant. *Model 3* sets up the process of low pay over the whole period jointly by allowing both coefficients to change after Unification. The baseline model and model 1 are estimated use quadrature methods

[12]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.

whereas the last two models are estimated by simulated maximum likelihood using 100 Halton draws. This sequential estimation approach allows us to learn about regime effects and the importance of confounding factors for two different regimes.

Results. To quantify the importance of observables and unobservables, 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. Following Papke and Wooldridge (2008), the specified average structural function (ASF) for period t can be written as:

$$ASF_t = N^{-1} \sum_{i=1}^{N} \Phi[(\hat{\gamma} + \hat{\delta} H_{\tau t}) y_{it-1} + x'_{it}\hat{\beta} + \hat{a}_0 + \hat{a}_1 \overline{x_i} + \hat{a}_2 y_{i1})(1 + \hat{\sigma}^2_{\alpha})^{-1/2}] \quad (5)$$

for $t = 1981 - 1999$. This function corresponds to state dependence accounting for observables and unobservables. By setting $y_{it-1} = 1$ and subtract the function value for $y_{it-1} = 0$ we get the average partial effect of being in low-wage employment at time t for individuals being low-paid in *t-1* compared to high-paid individuals in *t-1*. Tables 5 and 6 report the results for the defined periods (GDR, FRG). The first table reports average partial effects without modelling unobserved heterogeneity. The aggregate effects are taken from Figure 3, averaged over the two time periods. We first observe that after accounting for observed heterogeneity (β constant), state

Table 5: Average Partial Effects of Pooled Probit Models, by Gender and Period

	Aggregate		β constant		β variable	
	(1a) Males	(1b) Females	(2a) Males	(2b) Females	(3a) Males	(3b) Females
$P(y_t = 1 \mid y_{t-1} = 1) - P(y_t = 1 \mid y_{t-1} = 0)$						
APE_{GDR}	14.1	69.3	11.4	64.5	10.7	64.8
APE_{FRG}	58.3	70.4	47.8	60.5	45.9	58.4

Source: BASiD 2007, weighted sample.
Notes: The table reports the results from dynamic discrete choice probit models on the probability of being low paid. $y_t = 1$ denotes the low-wage status. All estimated average partial effects are significant at the 5% level using 100 bootstrapped replications. Each regression for the male (female) sample has 39425 (43445) observations with 2244 (2534) individuals. Detailed results on estimated coefficients are shown in our online appendix.

dependence declines for both males and females during both periods. However, the

decline is rather small, suggesting that low-pay persistence is largely independent of differences in observables that are available in our data set. Allowing the β-coefficients to change after Unification reduces the point estimates of the average partial effects slightly.

Table 6 shows the results based on random effects specifications. The baseline specification (β and α_i constant) shows a reduction in estimated state dependence for all time periods compared to the pooled model. However, the decline in state de-

Table 6: Average Partial Effects of Random Effect Probit Models, by Gender and Period

	β constant α_i constant		β variable α_i constant		β constant α_i variable		β variable α_i variable	
	(1a) Males	(1b) Females	(2a) Males	(2b) Females	(3a) Males	(3b) Females	(4a) Males	(4b) Females
$P(y_t = 1\|y_{t-1} = 1) - P(y_t = 1\|y_{t-1} = 0)$								
APE_{GDR}	5.1	36.9	4.6	36.4	5.0	41.5	4.9	41.9
APE_{FRG}	39.2	37.7	36.4	35.2	37.4	46.7	34.8	45.2
Random Effects								
σ^2	0.113	0.311	0.119	0.326				
σ^2_{GDR}					0.205	0.527	0.189	0.480
σ^2_{FRG}					0.696	0.612	0.667	0.638

Source: BASiD 2007, weighted sample.
Notes: The table reports the results from dynamic discrete choice probit models on the probability of being low paid. $y_t = 1$ denotes the low-wage status. All estimated average partial effects are significant at the 5% level using 100 bootstrapped replications. Each regression for the male (female) sample has 39425 (43445) observations with 2244 (2534) individuals. Detailed results on estimated coefficients are shown in an online appendix.

pendence in absolute terms compared to the pooled probit model is most pronounced for the pre-unification period. A concern for the APE_{FRG} is not to account for selection out of employment after Unification. This selection process is less of a concern during GDR because of the right and the duty to work. After Unification, state dependence for male workers increases substantially to a high level compared to the pre-unification period whereas for female workers the change is not significant. The lower part of the table reports the estimates of the random effects. The variance of the random effect is higher for female workers indicating a more heterogeneous group. Model 2 (a and b) allows for a change in all β-coefficients after Unification

but assuming again a constant random effect. Similar to the results in Table 5, changing β has only modest effects on the average partial effects. Compared to the first specification of the same table (*models 1a-1b*), the reduction in state dependence after Unification is between about two to three percentage points. The next two models allow for a change in the random effects after Unification. In both applications, the variance increases stronger for the period after Unification. It is an indication of offsetting forces within the different economic environments that drive the variances down under the constancy restriction. This means that there are unobservable factors in place that increase the probability of being low paid in one regime and change their character after the systemic transformation.

From the approach so far, we observe that unobserved heterogeneity is the driving force and that it appears to be regime-specific. Compositional effects based on observable characteristics are less important in explaining state dependence. The analysis, however, fails to account for selection out of employment. This is of considerable importance for the post-unification period and we might overestimate the average partial effect, APE_{FRG}, if low-wage individuals are more likely to experience a transition into non-employment. Moreover, the analysis only sheds light on short-run within-regime dependence. Therefore, we will focus on economic dependence across the different regimes (from socialism to market economy) by changing the empirical strategy.

5.2 Selection, Long-run Effects and Heterogeneous Short-run Dynamics after Unification

The main purpose now is to model the selection mechanism out of employment after Unification that will otherwise bias the estimation results on the short-run measures of state dependence and to estimate across-regime effects of low-wage employment. The multivariate analysis using a bivariate random effect model has shown that the random effects are regime-specific. Given that the institutional setting (socialism, market-economy) changes at the time of Unification we will start the analysis in

1990, the first year after the fall of the Berlin Wall, and model the stochastic process of low pay until 1999. This has the advantage of modelling a constant random effect and accounting for selection within the new regime. A further important point is the fact that we can analyse long-run across-regime economic dependence and use detailed variables of firm characteristics in the market economy which is otherwise not possible due to data availability. Another concern is the chosen low-wage threshold of the first decile. Focussing on the post-unification period enables us to measure the low-pay outcome by adopting the more conventional measure of two-thirds of the median. Our econometric model becomes:

$$y^*_{ikt} = \gamma_k y_{it-1} + x'_{it}\beta_k + \vartheta_{ikt} \tag{6}$$

$$y^*_{ik1} = x'_{i1}\beta_k + \vartheta_{ik1}, \tag{7}$$

where y^*_{ikt} is a latent unobservable variable measuring the propensity of earning a high wage ($k = 0$), a low wage ($k = 1$) or being non-employed ($k = 2$) for individual i in year t for $t > 1$. Similar to the model above, the propensity is a function of an individual's previous states, y_{it-1}, individual characteristics, x_{it}, as well as unobserved characteristics, ϑ_{ikt}. y^*_{ik1} refers to the initial process. We further assume the unobserved part ϑ_{ikt} to consist of an individual and state specific random component, ϵ_{ik}, which is assumed to be time-invariant and uncorrelated with all x-variables at every point in time, and a time-variant idiosyncratic component, u_{ikt}, i.e. $\vartheta_{ikt} = \epsilon_{ik} + u_{ikt}$. By making distributional assumptions about u_{ikt}, we follow the literature and assume a type I extreme value distribution. For identification we set the state of high-wage employment as the reference state.

Our approach to analyse across-regime dependence is twofold. The first issue concerns the modelling of the initial condition. Given that we start directly at the time of Unification, the initial condition is supposed to be in the year 1990. The motivation of modelling the initial condition is generally to account for selection in the first period, as not accounting for it will bias the estimates on the short-run measures of state dependence. Usually, a (positive) significant value would

indicate that the start of the modelled stochastic process does not coincide with the first period of data observations. Thus, the first observation depends on the observation in the period(s) before. Therefore, we can speak of an endogenous initial values assumption if the initial observation has been determined by the evolution of observed and unobserved characteristics (Akay, 2009). To put it in another way, if the initial condition is not significant one can consider the stochastic process after 1990 as exogenous. This strategy would allow us to test across-regime dependence without knowledge about the individual relative economic position before 1990.

Second, the data situation allows us to estimate effects of past performance on current low-wage propensities. As a first measure of past performance we count the years an individual has been below the first decile between 1980 and 1989. In our sample there are 1074 (49 per cent) male and 637 (27 per cent) female workers who spend at least one year below the first wage decile during 1980 and 1989. From those individuals, 90 per cent of males and 66 per cent of females have between one to three years of low-wage experience. Table 7 reports the descriptive statistics on the probability of being below two-third of the median over the time period between 1990 and 1999 conditional on the across-regime variable *number of years below the first decile*. From the table we first observe that the low-wage sector

Table 7: Percentage of Low-wage Employment Conditional on the Number of Years below the First Decile before Unification

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Males										
$low-wage$	5.2	7.5	5.4	5.9	7.1	7.4	8.6	8.8	8.5	9.5
$low-wage \mid \#1-3$	6.0	8.3	5.7	6.4	7.4	7.8	9.6	10.5	9.4	9.9
$low-wage \mid \#>3$	14.4	18.2	16.9	14.4	13.6	11.7	7.9	9.8	13.8	17.9
Females										
$low-wage$	14.1	15.0	14.7	18.3	18.7	18.9	21.4	23.3	24.4	25.1
$low-wage \mid \#1-3$	23.0	23.1	19.7	24.9	25.6	21.6	27.3	30.0	28.7	29.7
$low-wage \mid \#>3$	49.8	43.2	33.2	41.1	35.4	33.2	37.7	39.7	43.6	44.4

Source: BASiD 2007, weighted statistics.

has been increasing over time for both, males and females. Experiencing a low wage episode between one and up to three years during 1980 and 1989 raises the probability of belonging to the low-wage sector after Unification only slightly for

male workers, whereas the difference becomes more pronounced for females. The probability of being below two-thirds of the median wage increases further if the number of low-wage years prior to Unification was above three. For both, males and females, the probability has been increasing at the end of the sample period. Thus, individuals who were relatively low-paid during the GDR regime are associated with lower wages in a market-based economy. Given the higher uncertainty about one's individual productivity due to weaker signalling potentials, the connection between the low-wage status prior to and after Unification seems to be decreasing first and then starting to increase again. Additionally to this low-wage measure, the data set allows us to construct employment history measures of labour market interruptions. This includes all kind of interruptions such as child-care and illness. We calculate the number of non-employment months between labour market entry and 1989 (see Mosthaf, 2011 for an empirical strategy to include pre-sample variables into the model).[13]

Accounting for the pre-unification information, our empirical model becomes:

$$y^*_{ikt} = \gamma_k y_{it-1} + x_{it}\beta_k + \Gamma_i \varphi_k + a_{1k} y_{i1} + a_{2k}\bar{x}_i + \alpha_{ik} + \vartheta_{ikt} \tag{8}$$

where y_{ikt} is the propensity of individual i being in state k at time t with $t = 1991 - 1999$. As shown in the descriptive analysis, the main labour market states k are high-wage, low-wage and out-of-employment (including unemployed and non-employed and referred to as non-employment in the following) which *high-wage* being the reference category.[14] x_{it} represents the explanatory variables and y_{it-1} is a vector of labour market states in $t-1$. The pre-unification variables are included

[13]See Appendix B for the possible economic states in the data set. To allow for a flexible dependence we construct labour market interruption intervals that are different for males and females. Due to institutional settings and socio-cultural norms, male individuals typically exhibit rather few interruptions. Therefore, the baseline interval for males is zero interruptions. We further define medium interruptions between one and six months and more than six months to be the high category. The baseline for females is up to 12 months. The medium category is defined between 12 and 48 months and more than 48 months is defined as the high category.

[14]This state should be interpreted as an absorbing state that might affect the low-wage dynamic process. We therefore include the migration decision (see Table 2) into the state to control for selective migration.

in Γ_i. Assuming a multivariate normal distribution of the random intercepts leads to a 2-dimensional integral. We estimate this model by simulation (MSL) using 100 Halton draws. For a detailed description for MSL properties see for example Gourieroux and Monfort (1993). Train (2003) discusses illustratively the properties of Halton draws in terms of coverage and efficiency.

The importance of firm characteristics for wage mobility is well established in the literature on low-wage persistence (see Gürtzgen and Heinze, 2010). However, estimating multinomial logit models with different sets of covariates is not common in the literature. We include therefore firm size dummies, the share of female workers, the share of low-skilled workers and the median age of the establishment work force as well as detailed occupational information in the low-wage equation to control firm characteristics in the dynamic process.

5.3 Empirical Results

For expositional purposes, we confine the presentation of the results to the main variables of interest. The upper part of Table 8 shows marginal effects of the lagged low-wage indicator on the probability of belonging to the low-wage sector. For male workers (*model (1a)*), the probability of belonging to the low-wage sector is 18.5 percentage points higher if one has been low-paid in $t-1$. For females (*model (1b)*), the estimate of true state dependence is with 31.1 percentage points almost twice as high. The interrelation between non-employment and low-wage employment is also found to be statistically significant and is in line with the literature.

The middle part of the table shows the results for the initial condition using the Wooldridge approach. Focussing on the first model, the initial condition is not found to be significant. The modelled stochastic process of low-wage employment is independent from the relative position in the past. This provides first evidence of no economic dependencies across different economic regimes. The initial condition of being non-employed is significant for female workers. The lower part of the table shows the marginal effects of the pre-unification variables (Γ_i).

Table 8: Marginal Effects of Multinomial Logit Models with Random Effects, by Gender

	Males (1a)		Females (1b)		Males (2a)		Females (2b)	
	low-wage	*non-empl.*	*low-wage*	*non-empl.*	*low-wage*	*non-empl.*	*low-wage*	*non-empl.*
Short-run dynamics								
$Low-wage_{t-1}$	0.185***	0.068***	0.311***	0.084***	0.151***	0.032	0.196***	0.096***
	(0.018)	(0.021)	(0.020)	(0.018)	(0.015)	(0.027)	(0.014)	(0.019)
$Non-employed_{t-1}$	0.095***	0.134**	0.127***	0.168***	0.090***	0.100***	0.126***	0.128***
	(0.012)	(0.007)	(0.012)	(0.007)	(0.012)	(0.009)	(0.012)	(0.007)
Initial condition								
$Low-wage_{1990}$	0.007	-0.006	0.002	-0.008	0.014	0.004	0.010	-0.002
	(0.010)	(0.004)	(0.010)	(0.017)	(0.011)	(0.006)	(0.009)	(0.007)
$Non-employed_{1990}$	-0.005	0.010	-0.009	0.021***	0.010	0.007	0.009	0.010
	(0.012)	(0.007)	(0.007)	(0.009)	(0.015)	(0.008)	(0.016)	(0.008)
Long-run dynamics								
# Low-wage years								
$1-3$	0.002	-0.004	0.007	-0.003	0.002	-0.004	-0.005	0.002
	(0.005)	(0.006)	(0.007)	(0.008)	(0.005)	(0.010)	(0.007)	(0.008)
>3	0.010	0.005	0.031***	-0.001	0.003	0.003	0.022*	0.001
	(0.010)	(0.006)	(0.013)	(0.006)	(0.010)	(0.007)	(0.013)	(0.006)
# Interruptions†								
Medium	-0.005	0.004	0.006	0.001	-0.003	0.002	0.007	-0.001
	(0.005)	(0.008)	(0.007)	(0.007)	(0.005)	(0.008)	(0.007)	(0.007)
High	-0.006	0.008	-0.004	0.004	-0.003	0.002	0.016	-0.004
	(0.006)	(0.006)	(0.009)	(0.006)	(0.007)	(0.005)	(0.010)	(0.006)
Controls	√		√		√		√	
Occupation	√		√		√		√	
Firm charac.	x		x		√		√	
obs. (total)	17526		18041		16256		16424	
obs. (ind.)	2166		2286		2154		2264	
LogLik	-6267.8		-8171.0		-4831.8		-5810.0	

Source: BASiD 2007, weighted sample.

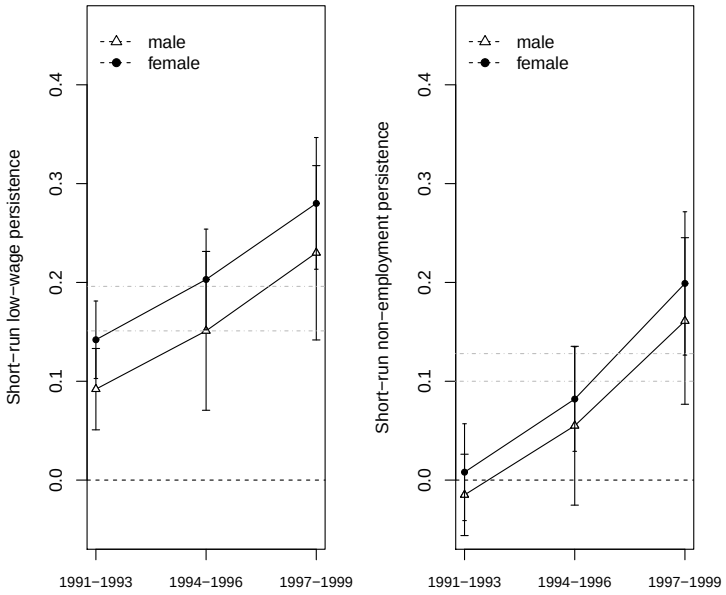
Notes: †The reference category differs by gender. For males, the reference is zero labour market interruptions; medium: up to six months; high: more than six months. For females, the reference is zero to 12 months; medium: 12 to 48 months; high: more than 48 months. Robust standard errors are in parentheses. All estimations contain a constant, the specified Mundlak-Chamberlain device, and control for missings in the education variable. Control variables include age dummies, education dummies, year dummies, regional dummies and experience dummies. The out of work equation includes lagged dummy variables of white-collar, skilled and simple occupation. Before Unification, the low-wage threshold is the first decile, while after unification two-thirds of the median is used. The average marginal effects are estimated by averaging over the average marginal effects of 100 Halton draws. Asterisks next to coefficients indicate significance levels as follows: *** 1%, ** 5%, * 10%. Detailed results on estimated coefficients and random effects are shown in an online appendix.

We do not find any across-regime effects if the number of years below the first decile in the wage distribution between 1980 and 1989 is between one and three. However, having experienced more than three years at the bottom of the wage distribution increases the probability of being low paid after Unification for females by about three percentage points. There is no effect for males. The other variable that measures across-regime dependence is the number of labour market interruptions. Interestingly, there is no effect of socialist interruptions on the probability of low pay during the first decade after Unification. The last two models in Table 8 include as additional control variables in the low-wage equation firm characteristics such as firm size, share of female workers, low-skilled share and median age. All variables enter the specifications with their expected sign. The short-run measures of state dependence are significantly affected by including firm characteristics. For male workers, estimated state dependence decreases slightly while for females the coefficient reduces by almost ten percentage points. This points to a selection into low-wage firms, especially for female workers and shows how important it is to control for firm characteristics. The variables that measure across-regime dependence are not significant except the one for female workers. Having experienced more than 3 years at the bottom of the wage distribution in the GDR increases the probability of being low-paid after Unification by 2.2 percentage points.

Heterogeneity across Time. The results in general do not provide any evidence of across-regime economic dependence except for females who have a higher probability of being low-paid if the number of years one has been below the defined threshold between 1980 and 1989 exceeds three. These results refer to the whole post-unification period. In principal, it might be conceivable that across-regime effects are present during the first few years after Unification or even in later years depending on the intensity of the adjustment process. Moreover, Figure 3 suggests an adjustment process of the short-run measure of state dependence after Unification. To account for effect heterogeneity during the post-unification period, we estimate a model similar to model 2 of Table 8 including interaction effects for the time periods 1994-1996 and 1997-1999 for the short- and long-run dynamic vari-

ables and the initial condition. Figure 4 shows the results of the short-run dynamics (*t-1*) for the two modeled states (*low-wage* and *non-employment*). The left hand

Figure 4: Effect Heterogeneity - Short-run Dynamics



Source: BASiD 2007, weighted sample.
Notes: The figure shows marginal effect and the corresponding 95% confidence intervals of the probability of being in state k conditional on being in the same state in *t-1* using a multinomial logit model with random effects and firm characteristic variables for the low-wage state distinguished by time and gender. Thus, the left hand figure shows the marginal effects of being low paid conditional on being low paid in t-1. The right hand figure shows marginal effects of being out of employment conditional on being out of employment in t-1. The marginal effects are estimated by averaging over 100 Halton draws. The light grey lines are the estimates from Table 8. Each regression for the male (female) sample has 16256 (16424) observations with 2154 (2264) individuals. Detailed results on estimated coefficients are shown in an online appendix.

side shows the marginal effects on the probability of being low paid for individuals who have been low-paid in *t-1* (ref.: *high-wage*). Over time, short-run persistence increased from about 9 per cent (14 per cent) for males (females) in the first period (1991-1993) after Unification to 23 per cent (28 per cent) during the last three years of the decade. While all estimates do not significantly differ from the estimate in Table 8 (see light grey lines), the difference between the first period (1991-1993) and the last period (1997-1999) is significant for both groups. For completeness, the right hand figure plots the marginal effects of being non-employed given non-employment in *t-1*. During the first six years after Unification, the last state in *t-1* does not determine the non-employment state in *t*. The point estimates, however,

significantly increase to above 15 per cent for the last three years in the 1990s indicating that individuals who have been out of employment in *t-1* are 16 to 20 per cent more likely to stay in the same state compared to individuals who have been in high-wage employment in *t-1*.

To identify across-regime dependence, we have found in the previous table of results that the initial condition is not significant. This indicates that the modeled stochastic low-wage process is independent of the low-wage states during socialism. Given that the lagged endogenous variable is interacted with two period dummy variables, we follow the literature and interact the initial condition variable with the same period dummies. Table 9 shows the results. The point estimate of the initial

Table 9: Marginal Effects of the Initial Condition for the Low-wage Equation, by Gender

	Males	Females	Males	Females
initial condition: $low - wage$	Joint Model with Interactions		Separate Estimation by Sub-period	
$1991 - 1993$	0.029	0.015	0.013	0.015
	(0.020)	(0.013)	(0.012)	(0.014)
$1994 - 1996$	0.018	0.026	0.206***	0.165***
	(0.016)	(0.017)	(0.070)	(0.041)
$1997 - 1999$	0.004	-0.001	0.261***	0.229***
	(0.016)	(0.014)	(0.075)	(0.065)

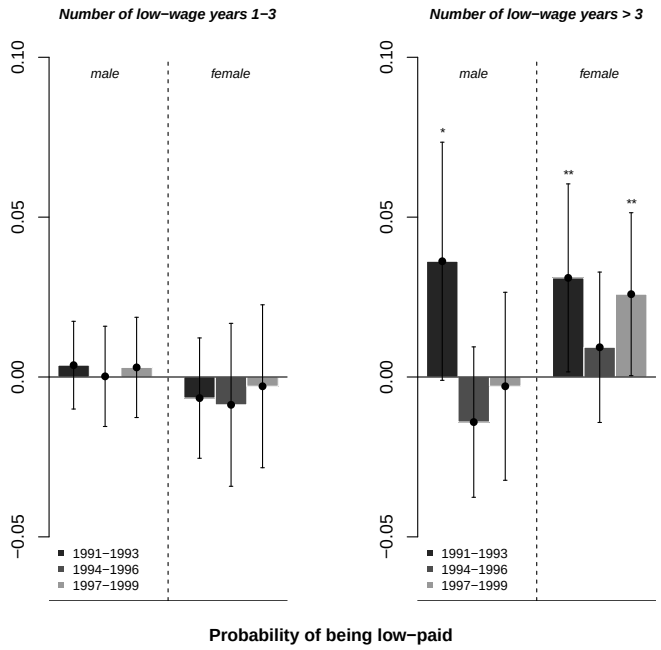
Source: BASiD 2007, weighted sample.
Notes: The table shows the marginal effects of the initial condition $low - wage_{1990}$ for the stochastic low-wage process. The initial condition is interacted with two period dummies. The baseline estimate is for the period between 1991-1993. The second period is the time between 1994-1996 and the third period captures the time between 1997-1999. The marginal effects are estimated by averaging over 100 Halton draws. The last two columns report the estimation results separated by the three periods. The initial conditions for the three periods are 1990, 1993 and 1996, respectively. Each regression for the male (female) sample with interactions has 16256 (16424) observations with 2154 (2264) individuals. Detailed results on estimated coefficients are shown in an online appendix.

condition for the first period (1991-1993) is slightly more positive compared to Table 8, albeit not significant. It basically supports the findings above that the first observation has not been determined by the evolution of past observed and unobserved factors. This is a strong result as it enables us to draw conclusions without knowing one's relative position in the socialistic regime. The last two columns visualise the importance of the initial condition when the estimations for the sub-periods are done separately. Again, the initial condition for the first period is not significant. However, the initial condition (the year 1993) for the second defined period (1994-1996)

is significantly positive and important for the dynamic stochastic process between 1994 to 1996. The same holds true for the last sub-period and supports the findings.

Turning to the long-run variables that measure across-regime dependence we first focus on the effect of the number of years one has been below the first decile between 1980 and 1989 on the probability of being low-paid after Unification. Figure

Figure 5: Long-run Dynamics - Number of Low-wage Years



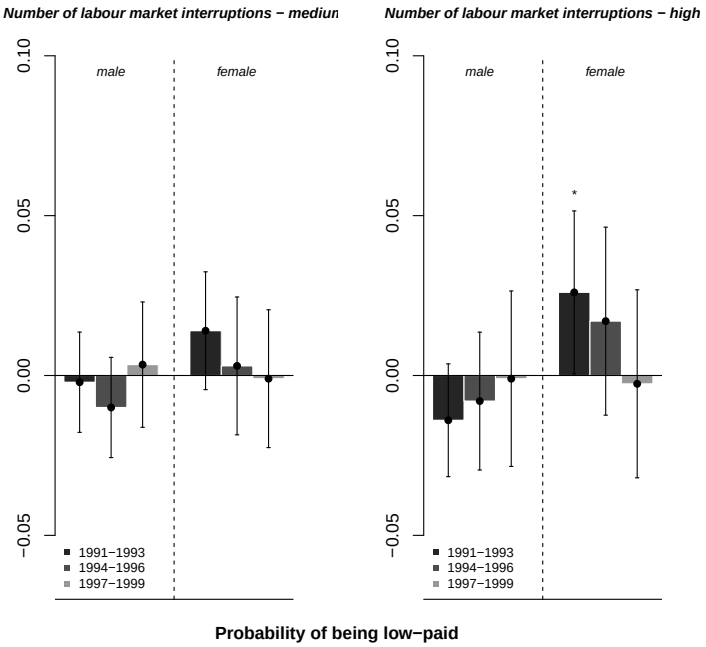
Source: BASiD 2007, weighted sample.
Notes: The figure shows marginal effects and the corresponding 95% confidence intervals of the probability of being low-paid given the long-run persistence variables "number of years an individual has been below the first decile between 1980 and 1989" using a multinomial logit model with random effects and firm characteristic variables for the low-wage state distinguished by time and gender. The marginal effects are estimated by averaging over 100 Halton draws. Each regression for the male (female) sample has 16256 (16424) observations with 2154 (2264) individuals. Detailed results on estimated coefficients are shown in an online appendix.

5 illustrates the marginal effects for the variables *1-3 years below the first decile* and *more than 3 years below the first decile*. The figure shows that there is no heterogeneity with respect to the first variable. However, the right hand side of the figure shows that having experienced more than 3 years at the bottom of the distribution in the GDR has an effect on the probability of being low paid after Unification. For male workers, the probability of being low paid during the first three years after Unification increases by about 4 percentage points (10% significance level). The

effect vanishes after 1993. For females, the point estimates are positive throughout the post-unification period and significant at the 5%-level in the first and third sub-period. Female workers have a three percentage points higher probability of being in low-wage employment (instead of high-wage employment) if they have experienced more than three years at the bottom of the wage distribution between 1980 and 1989 instead of zero years. The results indicate that across-regime dependence is more pronounced and persistent for female workers and less persistent for male workers.

The last across-regime measure of economic dependence is the *number of labour market interruptions*. Previous research has documented a significant correlation between cumulated unemployment experience in the past and the probability of being in low-wage employment (Schnitzlein and Stephani (2013)). Figure 6 shows

Figure 6: Long-run Dynamics - Number Labour Market Interruptions



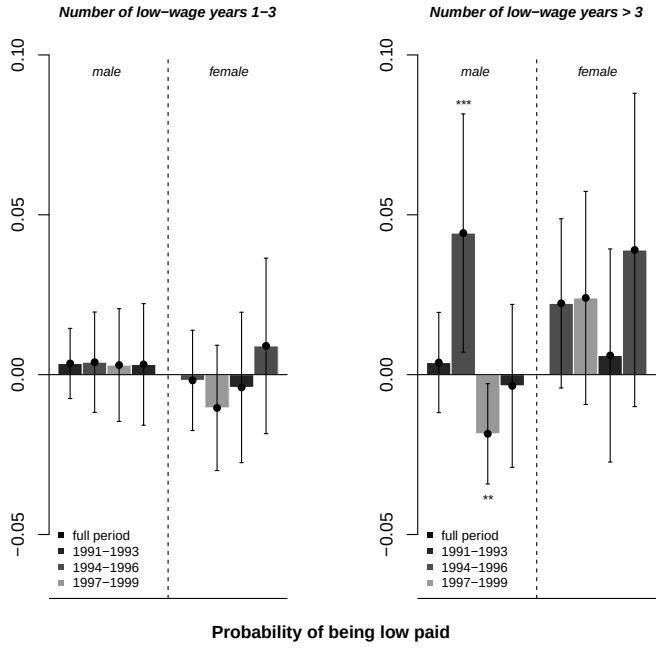
Source: BASiD 2007, weighted sample.
Notes: The figure shows marginal effects and the corresponding 95% confidence intervals of the probability of being out of employment given the long-run persistence variables "number of labour market interruptions between 1980 and 1989" using a multinomial logit model with random effects and firm characteristic variables for the low-wage state distinguished by time and gender. The marginal effects are estimated by averaging over 100 Halton draws. The reference category differs by gender. For males, the reference is zero labour market interruptions; medium: up to six months; high: more than six months. For females, the reference is zero to 12 months; medium: 12 to 48 months; high: more than 48 months. Each regression for the male (female) sample has 16256 (16424) observations with 2154 (2264) individuals. Detailed results on estimated coefficients are shown in an online appendix.

the impact of labour market interruptions during GDR on the probability of be-

ing in low-wage employment after Unification. While there is no effect for males, females have a 2.6 percentage points higher probability of being low-paid during the first three years if they have more than four years of cumulated labour market interruptions. The effect vanishes in the second and the third defined sub-period.

Heterogeneity across Educational Groups. Thus far, the effects for the long-run dynamics have been assumed to be equal across educational groups. To the extent that the established across-regime dependence in Figure 5 results from human capital devaluation, one might expect a stronger effect for high-skilled individuals. To address this issue, we exclude individuals without any level of education and repeat our regressions for the sub-population of medium and high-skilled individuals. Figure 7 illustrates the results for the whole sample period and its sub-periods. Compared to the results above, having one to three years of pre-unification low-wage

Figure 7: Long-run Dynamics for Skilled Individuals - Number of Low-wage Years



Source: BASiD 2007, weighted sample.
Notes: The figure shows marginal effects and the corresponding 95% confidence intervals of the probability of being low-paid given the long-run persistence variables "number of years an individual has been below the first decile between 1980 and 1989" for skilled individuals using a multinomial logit model with random effects and firm characteristic variables for the low-wage state distinguished by time and gender. The marginal effects are estimated by averaging over 100 Halton draws. Each regression for the male (female) sample has 14266 (11732) observations with 1883 (1601) individuals. Detailed results on estimated coefficients are shown in an online appendix.

experience has again no effect on the probability of post-unification low-wage employment. However, the effects of having more than three years pre-unification low-wage experience show the same pattern with different confidence intervals. While the formerly established significant estimates for female workers lose their precision, the picture for male workers becomes more pronounced especially for the first period (1991-1993) after Unification. The probability increases by 4.5 per cent for males if the number of low-wage years during GDR exceeds three. The effect, however, does not last long and turns out to be significantly negative during the second period. While these findings lend support to the hypothesis that genuine state dependence results from human capital devaluation, they also suggest that formerly low-paid men are able to catch up with their highly-paid counterparts within a relatively short period of time.

6 Conclusions

Focussing on the economic and political transformation in East Germany, the aim of 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 allow us, first, to identify individuals living in Eastern Germany before Unification and, second, as they enable 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 their 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 dynamic discrete choice models taking into account the initial condition problem and different specifications of unobserved heterogeneity and selection effects. First, we show that unobserved factors are the main drivers of low-wage persistence and that these unobservables are regime-dependent. Moreover, true state dependence after Unification is with about 15 per cent for males and 19 per cent for females significant and relatively high. This measure of persistence is heterogenous across time, indicating a strong adjustment process and the increasing importance of signalling considerations. By measuring across-regime dependencies, our empirical strategy is twofold. We first exploit the modelling of the initial condition in 1990. We show that the initial condition is not significant indicating the exogeneity of the modeled stochastic process. This supports the exogenous initial value assumptions indicating that observed and unobserved characteristics in the past have not determined the initial observation. We then proceed by using information on individuals' pre-unification labour market outcomes and show that, consistent with signalling theory, economic dependencies across different political and economic regimes are only weakly present. An individual with more than 3 years of experience below the first decile during 1980 and 1989 has a 2.5 to 3 percentage points higher probability of being in low-wage employment during the first three years after Unification. Across all skill groups, this effect is weak and vanishes for males while it seems to persist for females.

What drives these findings in weak across-regime dependence and an increase in low-wage persistence after Unification? As to across-regime dependence, signalling considerations lead us to expect no relationship between the pre and post-unification relative wage position, if the heavily regulated pre-unification labour market had precluded any selection into low-wage jobs based on workers' true productivity. The structure of the Eastern German labour market before 1990 characterized by control of labour supply and demand and its central wage and price setting system indeed suggests that individuals' productivity should have been rather unconnected to their low-wage status. Given that general skills have been shown to be transferable to the

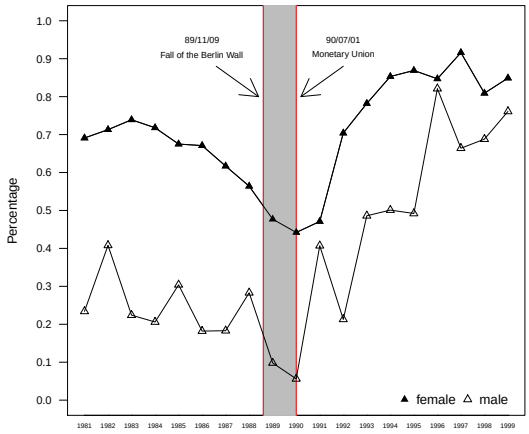
post-unification labour market, an alternative explanation for the established, albeit weak across-regime persistence might stem from a loss in general human capital. Especially for men this hypothesis is borne out by the estimates. The empirical results show that spending a reasonable amount of time at the bottom of the wage distribution before Unification is associated with a higher post-unification low-pay probability and that this is particularly pronounced for medium and high-skilled workers.

As to the evolution of short-run persistence, the observed increase after Unification points to signalling having gained in importance as human capital effects are rather unlikely to considerably change within two consecutive years. While both effects might be in place, the strong observed increase in state dependence within less than 10 years suggests that uncertainty after the Unification shock has been vanishing and that the signal being conveyed by the relative position in the wage distribution has become more relevant in the post-unification market economy.

Appendix

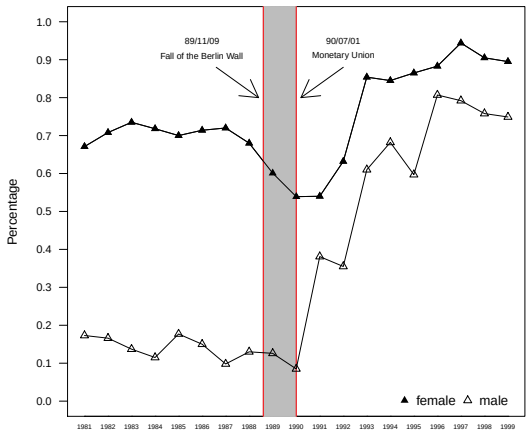
Appendix A: Aggregate State Dependence

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



Source: BASiD 2007, weighted sample.
Notes: The figure shows the difference in the probability of being in low-wage employment given low-wage and high-wage employment in *t-1* using the pooled wage distribution. The first red line marks the fall of the Berlin Wall. The second one marks Monetary Union.

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



Source: BASiD 2007, weighted sample.
Notes: The figure shows the difference in the probability of being in low-wage employment given low-wage and high-wage employment in *t-1* and changing the low-wage threshold from the first decile before Unification to two-thirds of the median after Unification. The first red line marks the fall of the Berlin Wall. The second one marks Monetary Union.

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)EMPLOY-MENT_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 dependant. 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.

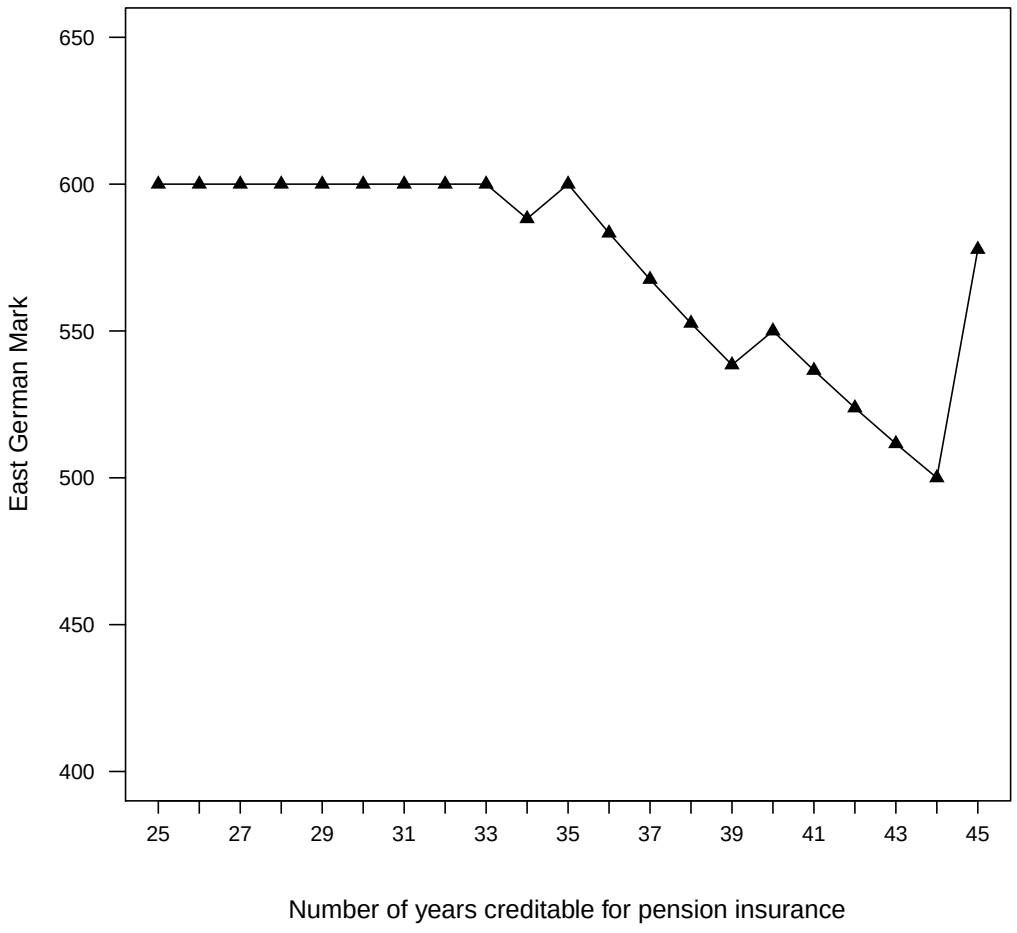


Figure C.1: Earnings threshold above which earnings increase pension entitlements

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