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ABSTRACT

Wages and Ageing: Is There Evidence for the "Inverse-U" Profile?*

How individual wages change with time, and how they are expected to change as individuals grow older, is one of crucial determinants of their behaviour on the labour market including their decision to retire. The profile of individual hourly wages has for a long time been assumed to follow an "inverse-U" path, although there has been little work specifically concerning the age-wage profile and documenting it convincingly. The focus of this paper is the relationship between age and wages with special attention given to individuals close to retirement. The analysis is presented in a comparative context for Britain and Germany looking at two longitudinal datasets (BHPS and GSOEP respectively) for years 1995-2004. It stresses the importance of cohort effects and selection out of employment which seem crucial in determining the downward-sloping part of the "inverse-U" profile observed in most cross-sections. There seems to be little evidence that wages fall with age.

JEL Classification: J14, J21, J31, C14

Keywords: wage dynamics, ageing, selection

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1 Introduction

The paper examines the dynamics of wages of British and German men with special attention given to individuals approaching retirement age. This group of individuals is important for several reasons, notwithstanding the policy focus in the light of demographic changes in both countries. Apart from important concerns related to reforms of the public pension systems and private savings for retirement, the question of extending working lives and encouraging employment among the elderly becomes a central policy issue (see, e.g. Börsch-Supan et al. (2005)), Haan and Steiner (2006)). Understanding the dynamics of wages at this stage of life is thus of paramount importance from the point of view of the policymaker, and yet so far there has been relatively little research focusing on the development of wages among older workers.[1] The aim of this paper is to bring the "age factor" more in the center of attention in the context of wage dynamics.

In the original form of the Mincer wage equation (Mincer (1974)) (log) earnings are a function of education and experience, where the latter in most empirical applications is included as potential experience, taken as *age minus age when left full time education*. This specification, which derives from a model of human capital investment, provided the foundation for the extensive literature on returns to education, returns to experience and tenure as well as analysis of pay discrimination.[2] In the Mincer specification age per se does not contribute to the level of the wage. It is *experience* embedded in age which does. As such, although the model (with a quadratic in potential experience) seems to fit a large number of data sets remarkably well, it may seem at odds with the theory it derives from. Although falling returns to experience seem plausible, negative returns, which are often found in empirical studies, are difficult to justify, unless one refers to explanations which are related to ageing. These may include obsolescence of skills with changes in technology and age-related poorer ability to learn new skills, deteriorating physical and mental abilities, and rapid human capital depreciation. These ageing effects are certainly related to the number of years

[1] It is common to use the term "older" workers to refer to individuals aged over 50 years old. This is how we shall use this term in this paper as well.

[2] The original specification presented by Mincer (1974) was $logy = logy_0 + \alpha S + \beta_1 X + \beta_2 X^2$, where $logy_0$ is the log of earnings of an individual with no education and no experience, S is years of schooling and X is years of potential experience. For some interesting discussion of the Mincer wage equation see for example Lemieux (2006).

of accumulated experience, and yet conceptually they are very different.

Since the early work of Mincer, the specification of the wage equation has been extended to account for the separate effects of experience and tenure. With detailed information on experience alone or on both experience and tenure one could also examine the effect of age coming into the relationship as an additional covariate, although identifying the "pure" age effect is anything but easy. This relates to the well-known problem of separate identification of effects of age, cohort and time. Due to the collinearity of age, cohort and time the latter problem cannot be solved even using panel data without some (usually arbitrary) assumptions. As we shall see below, parametrisation of age effects is also somewhat problematic. The third problem which makes identification of age effects difficult is the issue of selection out of employment. This is especially important in the case of older workers.

In what follows we use the comparison between Britain and Germany and focus on the relationship between age and wages among men. In some sense this represents a departure from the Mincer-type analysis and its foundations in terms of human capital theory as we focus on age per se and not on "potential experience". The questions we pose concern the form of the relationship between age and wages, especially among older workers, and the influence of different institutional frameworks on the way the age-wage profile develops in time. In this context the comparison between Britain and Germany proves especially useful, given the differences in labour market institutions and pension arrangements between the two countries.

We examine the importance of selection out of employment for the observed age-wage profiles in the two countries which leads to some very interesting conclusions. Though the problem of the effect of labour market selection on the observed wage distribution is one of the better researched issue in applied microeconomics and has been studied extensively beginning with the seminal papers of Heckman (1974 and 1979) and Green (1981), so far little attention in this context has been given to the specific nature of employment selection among older workers. And yet it is in this case that the problem of selection is especially important. It is also in this case that the standard instruments used to control for selection seem of less value.[3] Given the

[3]In fact most studies examining the selection issue using the Heckman model as instruments use either family structure (most commonly ages and number of children) and non-employment income (see, e.g. Blundell, Reed, and Stoker (2003)). However employment of few individuals who are close to retirement is determined by the presence of young children and as they get close to retirement

mounting research in the area of economics of ageing, the growing concerns about demographic changes and the resulting policy focus on the elderly, we believe that the dynamics of wages of those approaching retirement deserves some special attention.

This paper aims to be a contribution to the understanding of this relationship. We hope that the comparative evidence from Britain and Germany presented below should shed interesting light on several important aspects of the age-wage profile. Existing differences in terms of employment and retirement incentives between the two countries provide an interesting setting for such an analysis, and two long-running panel surveys - BHPS for Britain and GSOEP for Germany - are an excellent resource.

We begin the paper with a discussion on the implications of ageing on wages in Section 2, which is followed by presentation of the data sets we use and some descriptive statistics concerning employment and retirement using BHPS and GSOEP for years 1995-2004 (Section 3). We then look at the details of the relationship between age and hourly wages for the two countries stressing the importance of cohort effects and selection out of employment in determining it (Section 4). This is done using non-parametric estimation methods, and taking advantage of the panel dimension of the datasets. In Section 5 we then investigate further the determinants of these age-wage profiles and potential explanations for (non-random) selection out of employment. Conclusions follow in Section 6.

2 Age and wages

The fact that ability to perform certain tasks begins to deteriorate with age seems intuitive and finds its confirmation in epidemiological research as well as in analysis based on socio-economic surveys such as the HRS, ELSA and SHARE. That physical and cognitive functioning deteriorates with age is confirmed in cross-sectional analysis (see, e.g. Banks (2006) and Börsch-Supan et al. (2005)) and continues to hold also in a panel context, where ability of the same individuals is measured at different intervals and cohort effects can thus be controlled for (Banks et al. (2006)).

Yet whether these deteriorating abilities should translate into reductions in wages, and if so to what extent, is not well understood. The translation of reductions in

current non-labour income becomes less relevant as a determinant of employment decisions.

certain capabilities into lower wages is also not so obvious, as for example, continuing accumulation of experience and tenure could make up for these reductions. In addition to that, continuing to work may reduce the effect of age on abilities, and there is evidence that in some areas older workers have superior abilities relative to their younger peers (Mitchell (1990)). Moreover the precise mechanism through which individuals experience reductions in wages is also not very well documented. Is it in fact the case that individuals experience reductions in their hourly wage in the same jobs, or are they rather forced out from their jobs, and then find some other lower paid employment?

Despite of all the above arguments, since the early work of Mincer on the relationship between age and earnings and since the evidence on the age-wage profiles based on US micro-level data presented by Hurd (1971) the "inverse-U" shape of the profile has been taken for granted. This is despite the fact that both of these studies (as well as many other which find such a relationship) are based on cross-sectional data, in which cohort and age effects cannot be separated, and neither paid much attention to the possible issue of age-related non-random selection.[4]

The pattern of labour market dynamics at the time of retirement is far more complex than a simple move from employment to retirement at the statutory retirement age. Many individuals retire before reaching the official retirement age, either due to the possibility of drawing a private pension or taking advantage of some early retirement scheme. Many others spend some time in various forms of non-employment before being able to draw on their pensions. Employment rates among those over 50 in both Britain and Germany have fallen in recent decades, and exits from employment are far more common than entries into new jobs. At the same time there are those who decide to work beyond the official age of retirement. These decisions are related to financial attractiveness of respective choices, but are also significantly affected by factors such as health, family and caring responsibilities (Vermeulen and Kalwijn (2005), Banks (2006), Banks et al. (2006), Börsch-Supan et al. (2005)). As we shall see below this employment dynamics introduces significant complexities as far as measurement of changes in wages as individuals grow older is concerned. The panel data we use in

[4]Hurd (1971) notes that some of the changes in the age-wage profiles between 1959 and 1967 may have been due to changes in retirement benefits which may have acted in favor of retirement of highly paid individuals. Interestingly Heckman (1974) assumes the "inverse-U" age-wage profile in his life-cycle consumption model with a reference to Hurd but in the paper makes no mention of the possibility of the profile being affected by non-random selection.

this paper demonstrate that selection out of employment (and decisions not to take up a new job) is clearly non-random with respect to the wage distribution and that there are interesting differences between Britain and Germany.

3 Data

The data used in this paper come from the British Household Panel Survey (BHPS) and the German Socio-Economic Panel (GSOEP). These are two long-running panel surveys which have been in the past successfully applied to the analysis of retirement and ageing (see, e.g. Smith (2004) , and Haan and Steiner (2006)). We use the panel dimension beginning with 1995 and up to 2004 and focus the analysis on men who were observed in 1995 and were between 29 and 64 years old, regardless if they subsequently appeared in all waves or not, though for the analysis of specific problems we then focus on subsamples of this group. The reason for focusing on men relates primarily to the higher rates of participation among men, and thus less severe selection issue, but also to the related sample size of the employed individuals in both datasets. Since a large part of the analysis is conducted in non-parametric fashion the size of the sample is important. Moreover the legal retirement age for men in Britain and Germany is the same (65 years) while for women it still differs (60 years in Britain and 65 years in Germany) which makes the comparison of pre-retirement female populations more problematic. We focus on people who at the end of the period of analysis are at least 38 years old because we want to look specifically on wage developments among older individuals, and present the analysis for three "mature" cohorts of individuals: those aged 29-37, 38-46 and 47-55. Giving a thorough treatment of the early career wage dynamics in a comparative context is beyond the scope of this paper.

In the 1995 samples from BHPS and GSOEP, given the applied age conditions, there is respectively 2,569 and 4,452 men aged 29-64 (in 1995) (Table 1). These sample-sizes fall due to panel attrition to 1,873 and 2840, while samples of those aged 29-55 fall from 2,143 to 1,564 in the BHPS and from 3,558 to 2,301 in GSOEP. This means that in the groups we shall focus the analysis on (i.e. the sample aged 29-55 in 1995), after ten years since 1995, there are still 73% 65% of the individuals from the original sample in the BHPS and GSOEP respectively. What is important from our point of view is also that this sample attrition does not seem to be related to the age

of individuals - as we show in Table 1 the proportion of individuals by cohort among those in 1995 and those observed both in 1995 and in 2004 are almost identical in both the BHPS and in GSOEP.

Table 1: Sample size of the BHPS and GSOEP panel - 1995 - 2004

Year	BHPS		GSOEP	
	Aged 29-64	Aged 29-55	Aged 29-64	Aged 29-55
1995	2,569	2,143	4,452	3,558
1996	2,439	2,035	4,197	3,357
1997	2,350	1,957	4,020	3,221
1998	2,259	1,881	3,757	3,018
1999	2,189	1,819	3,573	2,872
2000	2,118	1,756	3,406	2,739
2001	2,046	1,697	3,253	2,610
2002	1,984	1,657	3,092	2,488
2003	1,917	1,599	2,971	2,393
2004	1,873	1,564	2,840	2,301
	BHPS		GSOEP	
By cohort: 1995				
Cohort 1: 29-37	825	32.1%	1,463	32.9%
Cohort 2: 38-46	676	26.3%	1,129	25.4%
Cohort 3: 47-55	642	25.0%	966	21.7%
Cohort 4: 56-64	426	16.6%	894	20.1%
By cohort: 1995 (observed in 1995 and 2004)				
Cohort 1: 29-37	584	31.2%	921	32.4%
Cohort 2: 38-46	507	27.1%	738	26.0%
Cohort 3: 47-55	473	25.3%	642	22.6%
Cohort 4: 56-64	309	16.5%	539	19.0%
By cohort: 1995 (observed in 1995 and 2004 and wage observed in 1995)				
Cohort 1: 29-37	428	38.5%	784	35.7%
Cohort 2: 38-46	325	29.2%	640	29.1%
Cohort 3: 47-55	253	22.7%	525	23.9%
Cohort 4: 56-64	107	9.6%	249	11.3%

Source: BHPS and GSOEP data.

In Table 2 we present some more details concerning the number of observations by education group. Each country sample is divided into two groups, created to separate out each sample into two relatively large subsamples. In Britain those qualifying as "higher education group" are all those with highest qualification level above 3 in the 5-level NVQ scale. In Germany those assigned to the higher education group are all those with education level beyond 3 in the 6-level ISCED-1997 scale.[5] As we can see

[5]Although the classification is not directly comparable between countries it is very similar. In each case the higher education group includes all tertiary qualifications. It includes also teaching and nursing as well as all higher vocational and professional qualifications.

Table 2: Number of men by education

	Low education	High education	Total
BHPS:			
Observed in 1995, 2004:			
- and aged 29-55 in 1995:	697	867	1564
- and wage observation in 1995:	377	629	1006
- and wage observation in both years:	266	466	732
GSOEP:			
Observed in 1995, 2004:			
- and aged 29-55 in 1995:	1609	692	2301
- and wage observation in 1995:	1371	578	1949
- and wage observation in both years:	1011	440	1451

Source: BHPS and GSOEP data, 1995-2004.

Table 3: Employment in BHPS and GSOEP - 1995 - 2004

Year	BHPS			GSOEP		
	Employment rate	Proportion of employees	Employees employed in 1995	Employment rate	Proportion of employees	Employees employed in 1995
1995	0.886	0.726	1.000	0.900	0.806	1.000
1996	0.880	0.713	0.949	0.884	0.786	0.939
1997	0.883	0.721	0.930	0.851	0.752	0.885
1998	0.887	0.728	0.919	0.848	0.744	0.861
1999	0.882	0.716	0.896	0.845	0.734	0.844
2000	0.868	0.705	0.872	0.835	0.728	0.825
2001	0.871	0.698	0.855	0.814	0.701	0.795
2002	0.843	0.683	0.833	0.799	0.696	0.785
2003	0.832	0.660	0.810	0.761	0.659	0.750
2004	0.819	0.642	0.790	0.748	0.642	0.732
Number of individuals:	1447	1447	1055	2060	2060	1699

Source: BHPS and GSOEP data, 1995-2004.

Notes: Men aged 29-55 in the 1995 wave.

the number of individuals with wage observations is relatively large. Among those aged 29-55 in 1995 and observed at the beginning and at the end of the period, we have information on wages of 1,006 British men and of 1,949 men in Germany. Of those for 266 British men with lower education and for 466 British men with higher education we have wage observations in both 1995 and 2004. The corresponding numbers for Germany are: 1,011 and 440.[6]

In Table 3 and Table 4 we show changes in employment rates together with proportion of employees in the samples, i.e. a group for whom we can observe individual level wages. In the initial year of the analysis employment rates are relatively close,

[6]The principal reason for dividing the samples by education is to be able to control for education in the non-parametric analysis below. The relative sizes of these groups in each country are therefore not so important.

Table 4: Employee rate conditional on being an employee in 1995

	Cohort by age in 1995			
	Aged 29-55	Aged 29-37	Aged 38-46	Aged 47-55
BHPS				
1995	1.000	1.000	1.000	1.000
1996	0.949	0.970	0.953	0.914
1997	0.930	0.962	0.920	0.900
1998	0.919	0.961	0.917	0.863
1999	0.896	0.937	0.895	0.842
2000	0.872	0.927	0.893	0.774
2001	0.855	0.916	0.877	0.750
2002	0.833	0.884	0.887	0.707
2003	0.810	0.869	0.863	0.674
2004	0.790	0.868	0.838	0.635
Number of obs.	1056	425	345	286
GSOEP				
1995	1.000	1.000	1.000	1.000
1996	0.939	0.953	0.926	0.935
1997	0.885	0.897	0.887	0.870
1998	0.861	0.875	0.889	0.815
1999	0.844	0.898	0.862	0.766
2000	0.825	0.911	0.849	0.704
2001	0.795	0.864	0.837	0.670
2002	0.785	0.861	0.855	0.621
2003	0.750	0.840	0.812	0.580
2004	0.732	0.854	0.802	0.520
Number of obs.	1699	660	566	473

Source: BHPS and GSOEP data - men observed in all ten waves 1995-2004.

but the reduction in the employment rate is much faster in Germany, and by the end of the period of analysis employment rates are higher by about 7 percentage points in the BHPS. Similarly employee rates fall much faster in Germany than in Britain between 1995-2004, from 80.6% to 64.2% compared to the fall from 72.6% to 64.2%. Column three and six of Table 3 show the employee rates conditional on being in the sample of employees in 1995. The numbers therefore show the degree of selection out of employee type employment over the years for the group aged 29-55 in 1995. Out of the employee sample in 1995 79.0% are also employed in 2004 in Britain and the rate in Germany is 73.2%. These rates are also presented by cohort in Table 4 which demonstrates how the selection out of employment varies by age group. Over 85% of individuals aged 29-37 in 1995 who were employees in that year are still employed nine years later. However, in the 47-55 cohort only 64% are still working in 2004 in Britain and just 52% in the German sample.

4 A non-parametric look at the age-wage relationship

We begin the analysis of the age-wage relationship with demonstrating how wages change with age using a set non-parametric regressions. There are well-known advantages and disadvantages of using non-parametric methodology versus a parametrised model. The disadvantage is the limited ability to include control variables in the regression given the high data demands of nonparametric methods. But for the purpose of demonstration of the age-wage profile the possibility of avoiding the need to impose a functional form of this relationship seems crucial. The results are presented for the overall sample in each country and also separately for the low and high education groups. Given high data requirements of non-parametric methods and the relatively small samples in both panels some of the results will have to be treated with a degree of caution, although the most important conclusions can be formulated with a high degree of statistical significance. Unfortunately, since some of the elements of the analysis I present rely on the panel aspect of the data, little more can be done regarding precision of the estimates given the data available.

4.1 Age and wage using the kernel regression

If we limit our relationship of interest to:

$$y = g(x) + \varepsilon, \tag{1}$$

where in our case y is the logarithm of hourly wage and x is age, then function $g(x)$ can be replaced by a local estimator of the conditional mean $E(y|x)$:[7]

$$E(y|x) = \int y f(y|x) dy, \tag{2}$$

where $f(y|x)$ is the conditional density of y. Since $f(y|x) = f(x,y)/f(x)$ and $f(x) = \int f(y,x)dy$, we can write (2) as:

$$E(y|x) = \frac{\int y f(y,x) dy}{\int f(y,x) dy}. \tag{3}$$

We can use kernel regression methods in which the numerator and the denominator in (3) are replaced with estimators based on locally weighted averages. The weights

[7] See, e.g. Yatchev (2003) or Blundell and Duncan (1997).

used in the averaging depend on the distance from the point of estimation, and the specified kernel function determines how these weights change with this distance. Taking $K(.)$ to be the kernel function and h to stand for the bandwidth we can write the Nadaraya-Watson kernel estimator of (3) as:

$$\hat{g(x)}_h = \frac{\frac{1}{h}\sum_1^n K(\frac{x_i - x_0}{h})W_i}{\frac{1}{h}\sum_1^n K(\frac{w - W_i}{h})}. \quad (4)$$

In equation (4) x_i stands for the individual age, while W_i for individual wage. In the estimations presented in this section we use the Gaussian kernel function with optimal bandwidth according to the Silverman's rule (see Silverman (1986)). Below we apply the kernel regression methods to demonstrate how wages changed with time for specific age groups and cohorts in the BHPS and GSOEP.

4.2 Age and wage in cross-sections

The analysis starts with a demonstration of the age-wage relationship in a cross-sectional context for two years of the panel, 1995 and 2004. Figure 1 presents a set of cross-sectional relationships between age and wages for 1995.[8] The figures are drawn separately for Britain and Germany, and for both countries we show age-wage profiles separately by the two education groups. For all kernel regressions we also present 90% confidence intervals.[9]

The most notable points coming out of the age-wage profiles from the 1995 cross-section are the rather obvious differences in the profiles between Britain and Germany. While the age profile in Britain reflects the "inverse-U" shape with the highest wage rate at the age of about 42 years old, in Germany hourly wages seem to be flat for those aged between 29 and 40, with growing wages for those in their early 40s, peaking at about 46 and falling for the higher age groups. This pattern is closely reflected in Germany for the lower educated group (with wages falling somewhat with age for those between 29 and 40), while there seems to be a positive relationship between wages and age for the better educated group with a closer "inverse-U" pattern. In Britain wages of the better educated group peak at the age of about 43, while for the lower educated group about two years earlier. While the profiles differ by country

[8] All wages in this paper are presented in 2000 prices, and wages for Britain are converted into euro using the conversion factor of 1.4885 (as of 6th September 2006).

[9] These are generated using non-parametric bootstrap methods.

and education group, for all subgroups wages are lower for those aged over about 45 compared to younger employees.

Figure 2 presents such cross-sectional age-wage profiles for the first and the last year of the period of the analysis, 1995 and 2004. These are drawn for individuals which were observed in both waves to avoid the results being affected by attrition (though the individuals do not necessarily have to be employed in both years) and are presented as conditional on their age in 1995. In the figures wage progression - if we want to compare the two cross-sections - is reflected in the vertical increases in the log of wages. Such presentation means that we show age-wage profiles for individuals aged 29-55 in 1995 and 38-64 in 2004. Since the figures are drawn conditional on age in 1995 the curves for subsequent years lying above each other imply positive (real) gains in hourly wages between these years, while the opposite implies that expected wages have fallen for a given cohort between 1995 and 2004. These changes should not be interpreted as "return to age" per se, since clearly they are a combination of returns to age, experience, tenure, as well as overall gains in productivity (often labelled as time effects). Yet the presented relationships are indicative of the relationship between ageing and changes in wages, and provide important insights into the relationship. In Figure 2 the pattern we observe in the data is as if we compared two cross-sections nine years apart.

Interestingly, comparing the two cross-sections for Germany, there seems to be no evidence of wages being lower at older ages in Germany. The cumulative wage growth over the nine years in Germany is clearly more substantial (and statistically significant) for the early cohorts, but even among those aged 55 in 1995 there seem to be gains in hourly wages of about 10% over the period. What is also notable is that in Germany the gains in hourly wages among older individuals seem to be greater for the lower educated group compared to the higher educated.

The cross-sectional comparison of wages between 1995 and 2004 for Britain seems to confirm the hypothesis that wages fall with age. On average hourly wages in Britain in 2004 are higher for those aged up to about 47 in 1995 (i.e. aged 56 in 2004), but they are lower for older individuals. Importantly this is the case both for the lower and the higher educated group. Among those with higher education hourly wages are about 20% lower for the oldest cohorts in the sample.

An important point to note here is also that while in Germany the 1995 age-wage profile suggests that wages peak at the age of about 46, the 2004 profile seems to suggest that highest hourly wages are at around 55, i.e. among the same cohort who enjoyed highest hourly wages in 1995 (though in 2004 the difference between this cohort and younger groups is no longer statistically significant). In Britain wages in 1995 are highest for those aged 42, while in 2004 for those aged about 45 (those aged 36 in 1995). In Germany the age-wage profiles in 2004 are much "flatter" compared to 1995 for the same age groups, and this holds for the whole sample and also for the two education groups, suggesting much quicker wage growth among younger cohorts over the period of analysis.

It is also important to note that in all profiles presented in Figures 1 and 2 there are obvious non-linearities, which suggests a necessary degree of caution in parametrising the age-wage relationship.

The relationship between age and wages discussed in this section is the type of relationship we would observe in cross-sectional data in the different years. But as we showed in Table 4, selection out of employment quite strongly relates to age, and if it is non-random with respect to the wage distribution - as most likely it is - then the differences in the age profiles we observe between 1995 and 2004 will reflect both the effects of changes in individual wages and the effects of this selection. The implied conclusions presented above concerning cohort effects or wage changes in time (or with age) are very likely to be biased because of this selection. Below we look at the effect of this selection on the dynamics of age-wages profiles.

4.3 Age-wage profiles and selection out of employment

In this section we use the panel dimension of the data to present the likely effects of selection out of employment on the observed relationship between age and hourly wages in Britain and Germany. We use the wage information from 1995 and draft the age-wage profiles for men in Britain and Germany conditional on observing the individuals as employees in the 1995 data and jointly in 1995 and 2004.

Thus in Figure 3 we present the age-wage profiles for individuals observed in 1995 conditional on observing them as employees (i.e. observing their wages) only in 1995 and in both the first and the last year under analysis (i.e. 1995 and 2004). The black

lines in Figure 3 represent the age-wage profiles for those with wages observed in both years, while the grey lines show the profiles for those with wages observed only in 1995. The most important point to note, which holds for the overall sample and by education group, is the fact that in Britain the men who maintain their employment status are more likely to be the lower wage individuals, with the pattern especially noticeable for men with higher level of education aged above 45. The opposite is true for Germany, where selection out of employment shifts the age-wage profile *upwards*, suggesting that individuals with higher wages are more likely to remain employed.

Figure 4 presents the 1995 and the 2004 age-wage profiles (once again conditional on age in 1995) using wages for only those individuals who are observed in both waves as employees. Selection out of employment is therefore controlled for. A similar exercise is conducted for 1999 and 2004 and presented in Figure 5. The latter allows us to focus more closely on wage progression in the last years before retirement for the oldest part of the sample.

The comparison of Figures 4 and 5 with Figure 2 shows how important selection out of employment, especially among the older part of the sample, is for the observed age-wage profiles. The difference in the nature of selection, with better paid individuals more likely to leave employment in Britain, and those relatively lower paid in Germany, is especially interesting. Two important conclusions can be drawn here, with a caveat to which we shall return later, that their are based on those observed as employed. First of all there is no convincing evidence that hourly wages fall prior to becoming eligible for retirement in either Britain or Germany, and certainly there is no evidence that wage dynamics takes an "inverse-U" shape with a peak in hourly wages in early or mid-40s. Individual hourly wages keep growing until very late in people's careers, and it is only the last two or three years prior to reaching the official retirement age of 65 that there is some sign of wage reductions in Britain (and no such indication in Germany) (see Figure 5).

The evidence from BHPS and GSOEP suggests that age-wage profiles observed in cross-sections are very strongly driven by cohort effects and the more pronounced "inverse-U" shape in Britain is to a large extent due to selection out of employment among those approaching retirement age. Below we examine the dynamics of wages in more detail further using the panel dimension of the data. We analyze if information on variation in wages could shed more light on the observed age-wage profiles and provide

insights into the reasons for wage-related differences in selection out of employment between Britain and Germany.

5 Age and differences in wage variation

The story of the age-wage profile so far is that among those who stay employed there is very little evidence of wages falling with age, and what evidence there is - for Britain only - suggests that wages may fall in the very last years prior to retirement. Two further important issues can be addressed using the data at hand to look a little more deeper in the relationship between age and wages. The first is to check if the average age-wage profiles presented in Section 4 hide any obvious age-related differences concerning progression of wages. The evidence presented so far, for example, does not say anything about the way wages progress in different age groups. The average age-wage profile could hide important differences in the variance of wages by age group. Average wage increases are consistent with falls in one part of the wage distribution and increases in another and the conclusions of the previous sections can be made stronger if we can show no support for such scenarios. Secondly, an obvious question to ask concerning selection out of employment, relates to differences in wage developments among those who were employed at the beginning and at the end of the period of analysis compared to the wage dynamics of those who leave employment before 2004. We address these two issues below.

5.1 Wage variation by cohort

Developments in average age-wage profiles as presented in Section 4 may hide important differences as far as individual wage developments are concerned. In the following two sections we focus on details of the distributions of individual wage changes to check if there are important age-related differences which could give further insights into the age-wage profiles observed in Britain and Germany.

In the analysis we use information on individual hourly wages among those who are in the sample in both 1995 and in 2004, though not necessarily in all years and not necessarily employed in throughout the period. We examine the distributions of

proportional wage changes between two consecutive wage observations (regardless if these are in two consecutive years or further apart).

In Figure 6 we show kernel densities of proportional wage changes observed for all years between 1995 and 2004 for two cohorts: those aged 29-37 in 1995 (Cohort 1) and those aged 47-55 in 1995 (Cohort 3). The distributions for both countries are very close to normal and are centered around zero. For Britain - interestingly - there is very little difference between the younger and the older cohort in the lower end of the distributions, so despite the higher wage flexibility there seems to be no age/cohort-related difference in prevalence of wage reductions. On the other hand the positive tail of the distribution is thicker for Cohort 1 which confirms the pattern documented in Section 4 - wages grow faster for the younger cohorts. In Germany the difference in the distribution of wage changes between Cohorts 1 and 3 is most pronounced for those with higher education - those from the younger cohort seem to be much more likely to see their wages grow. But differences in wage reductions are again very small. So the evidence suggests that wages of individuals from Cohort 3 are clearly more likely to be stable than to grow, but hourly wage reductions hardly differ between the older and the younger groups. Once again therefore there seems to be no indication of wages falling in the later stage of working life.

5.2 Wage variation by employment status in 2004

A similar exercise as in Section 5.1 is conducted here with a focus on Cohort 3 - i.e. those who by 2004 reach the age of 56-64. Of this group of individuals many of those for whom we observe wages since 1995 are no longer employed in 2004 (see Table 4). While we cannot say anything about their wage at the time when they are no longer employed, in this section we examine if there is evidence for systematic differences in wage progression between those who remain employed until 2004 and those who don't. Since one reason for leaving employment may be past experience of wage reductions or greater variance of hourly wages, we hope that this analysis will help us understand the forces driving the process of selection, and at the same time allow us to draw more robust conclusions on the basis of evidence from Section 4.

As in Section 5.1 we use all pairs of individual wage observations for individuals in Cohort 3 for the period between 1995-2004. The proportional changes in hourly

wages are then drafted as kernel densities conditional on having a wage observed both in 1995 and 2004 and only in 1995. These kernel densities are presented in Figure 7 for Britain and Germany for all individuals and by education group. Surprisingly there is very little difference between the distributions of wage changes in Britain, though those who no longer have a wage observed in 2004 are slightly more likely to see their wages grow beforehand (especially among the lower educated). This reaffirms the picture we saw in Section 4 - not only those with higher wages, but also those with wages growing faster are more likely to leave employment in Britain.

The comparison is very different for Germany. Here while the overall differences between those observed and not observed as employees in 2004 are again hardly noticeable, there are important differences when we focus on the two education groups separately. For the lower educated we see a picture which in some sense represents a standard expectation - those with higher wage variation (and thus higher uncertainty) leave employment, while those with lower variation remain employed. For those with the higher level of education the opposite is true and the differences are much more pronounced: those who leave employment by 2004 seem to have had much more secure wages in the period after 1995. Those who continue to be observed as employed experience much greater wage uncertainty, but remain employed regardless. This is a striking and a very interesting difference, and stems probably from the greater prevalence of early retirement or unemployment among state employees who normally have much more stable wages. Another possible explanation is also likely - those with less flexible labour contracts may be more likely to be fired. Examination of the process driving the differences in the variation of wages by the timing of retirement could be a an interesting extension and remains for future research.

6 Conclusions and extensions

Age is one of the key characteristics which determine the distribution of wages. It is to a large extent age which determines when people appear in this distribution and when they leave it. Age is also likely to play a crucial role in the dynamics of individual wages through time. For a long time it has been argued that in the late stage of the working life wages begin to fall reflecting falling productivity as individuals grow older. This "inverse-U" pattern of wages is often observed in cross-sectional data. Such age-

wage profile has been confirmed in this study in a series of cross-sections from British and German longitudinal panels for years 1995-2004. However, some closer analysis of the age-wage relationship showed very limited signs that wages fall with age. If they do then the "peak" of the wage profile is far beyond that which has been suggested in analysis based on cross-sectional data.

Cohort effects - be it pure effects or different returns to some characteristics for specific cohorts (see e.g. Boockmann and Steiner (2006)) - seem to be very important determinants of the observed age-wage profiles. Such effects may be related to productivity shocks experienced by different cohorts at different ages, or to differences in demand for and supply of particular skills at specific points in time. Neglecting these cohort-related factors and assigning these effects to age, which is what cross-sectional analysis does, introduces important misperceptions as far as the effect of age is concerned.

As we demonstrated neglecting selection out of employment - quite strongly related to age, especially for those approaching retirement - further contributes to the wrong interpretation of the effects of age on individual wages. In Britain it is the better paid who leave employment earlier, which means that as time goes by the lower paid are more likely to stay in the sample of employees. We showed that this effect is very strongly responsible for the downward part of the "inverse-U" shape. When controlling for cohort effects and for selection out of employment we find almost no evidence for the "inverse-U" shape of the age-wage profiles.

The paper has also tried to address the question of whether wage progression and wage variance differ by age and cohort and we found no evidence for that either - whether in Britain or in Germany. Older men do not appear more likely to experience wage reductions than younger individuals, though as one would expect their wages are less likely to grow. In Britain we also found no evidence that greater wage variation is behind people's decisions to leave the labour market. This leaves us with the conclusion that the most likely reason for leaving employment prior to reaching retirement age are private retirement provisions among those relatively better paid, rather than falling hourly wages. An interesting wage-related picture concerning the timing of retirement emerged for Germany. Among those with higher education individuals with lower wage variation seem more likely to leave employment before reaching the official retirement age. These most likely are individuals in different forms of public sector employment

who take advantage of various (often generous) pre-retirement exit options.

Understanding how age affects productivity and how in turn this translates into the dynamics of wages seems crucial from the point of view of labour market policy focusing on the "greying workforce". There has so far been little literature focusing on this specific topic and yet any good policy directed at increasing the participation of older workers must be based on a thorough understanding of the age-wage profile. Using longitudinal panel data sets for Britain and Germany this paper has found almost no evidence of an established assumption that individual wages fall with age. It has also pointed out to important and potentially long-lasting cohort effects in the age-wage profiles, and to the role employment selection plays in determining these profiles.

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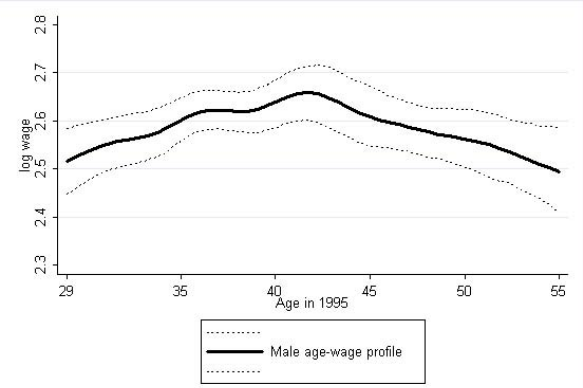
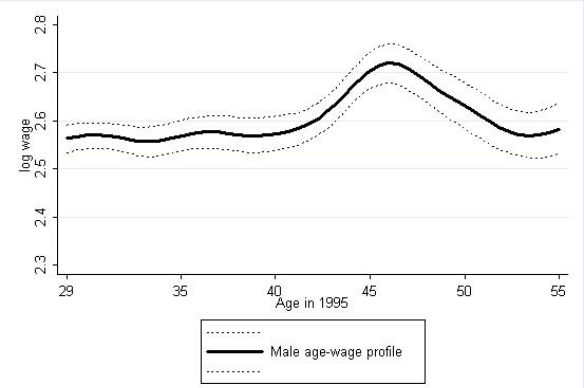
Appendix - Figures

Figure 1: Age-wage profiles of British and German men in 1995

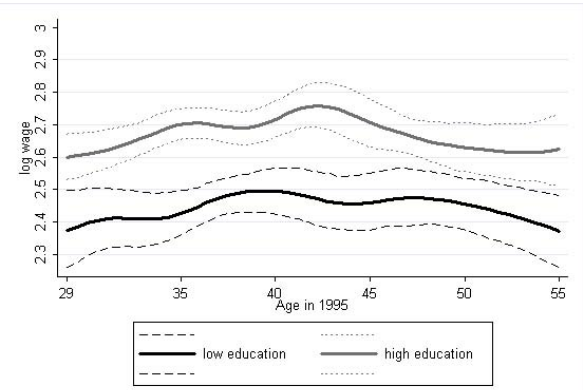
Britain



Germany



Britain - by education



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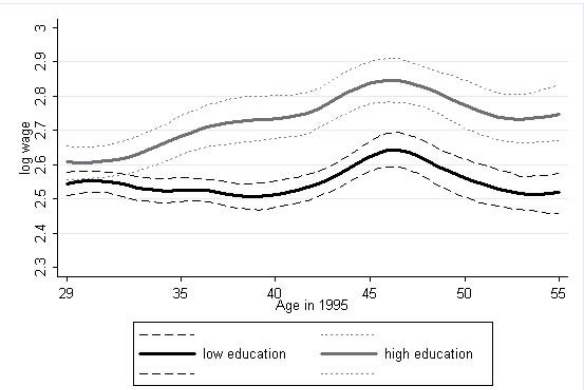
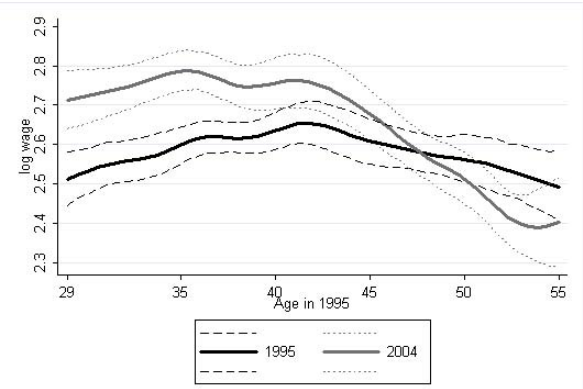


Note: Dashed lines represent 90% confidence intervals

Source: Based on BHPS and GSOEP 1995.

Figure 2: Wage progression: 1995 to 2004

Britain



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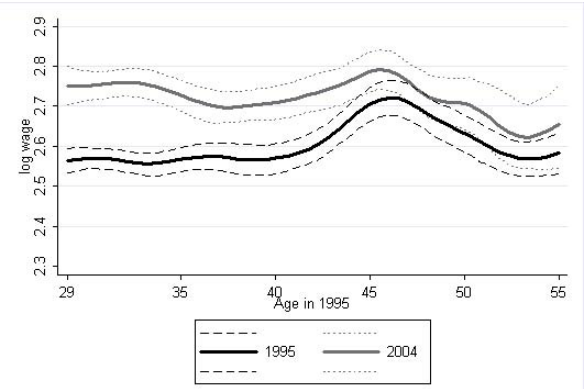
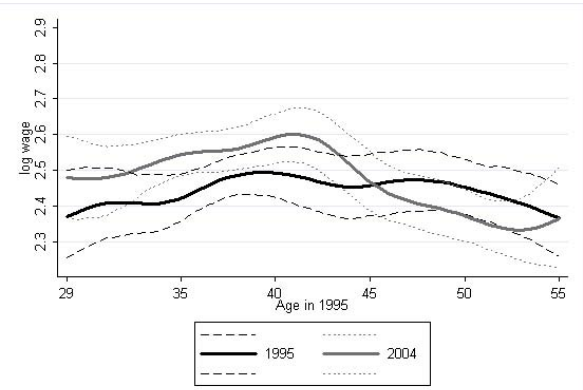
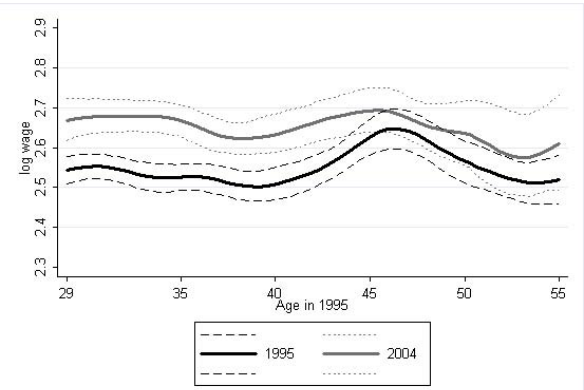


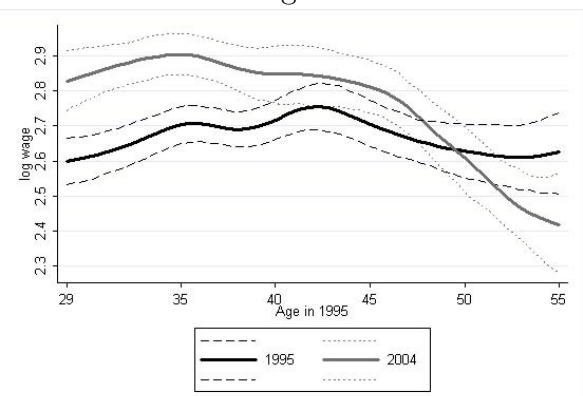
Britain - low education



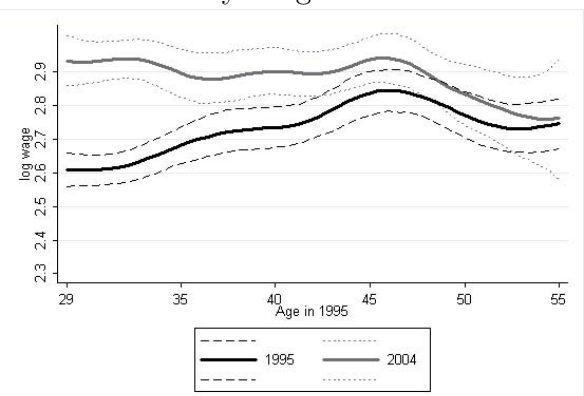
Germany - low education



Britain - high education



Germany - high education

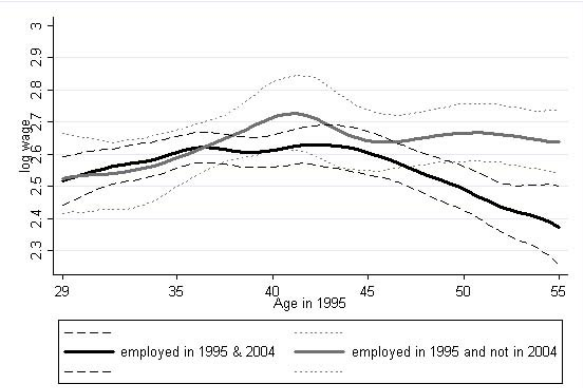


Note: Dashed lines represent 90% confidence intervals

Source: Based on BHPS and GSOEP 1995-2004.

Figure 3: Wages and selection out of employment

Britain



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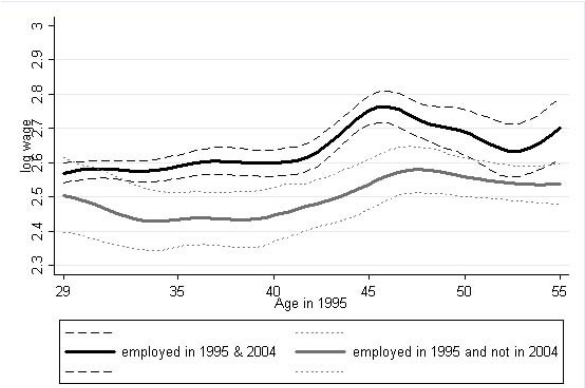

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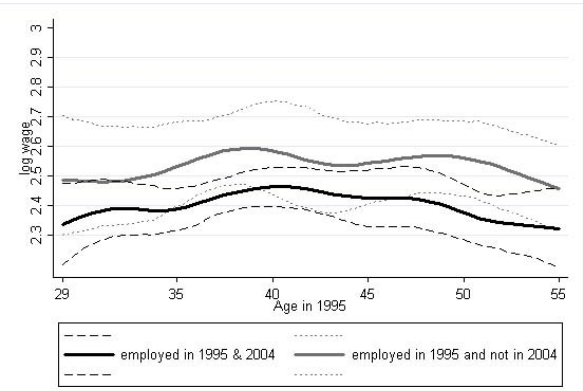

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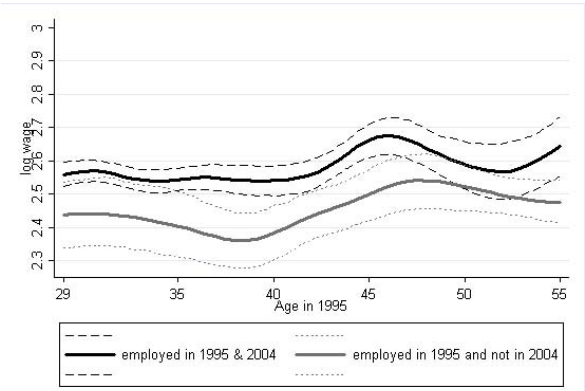

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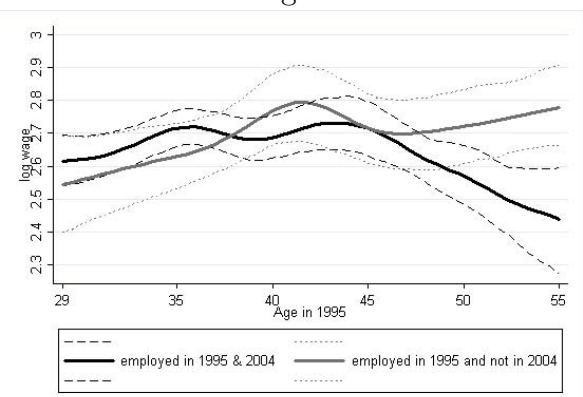

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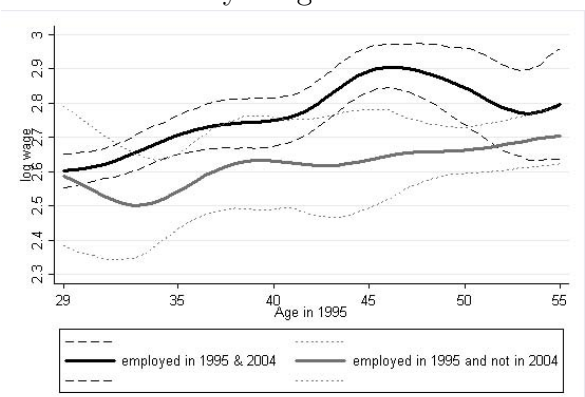
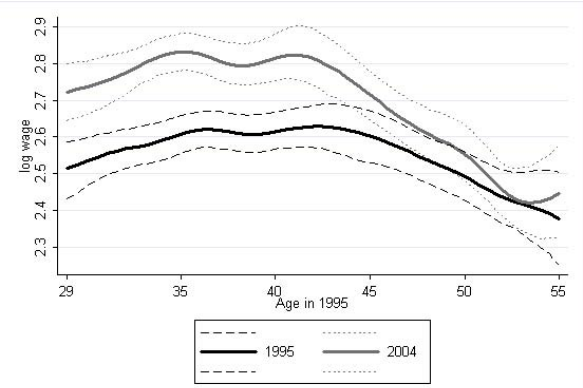


Note: Dashed lines represent 90% confidence intervals
Source: Based on BHPS and GSOEP 1995-2004.

Figure 4: Wage progression of those employed in 1995 and 2004

Britain



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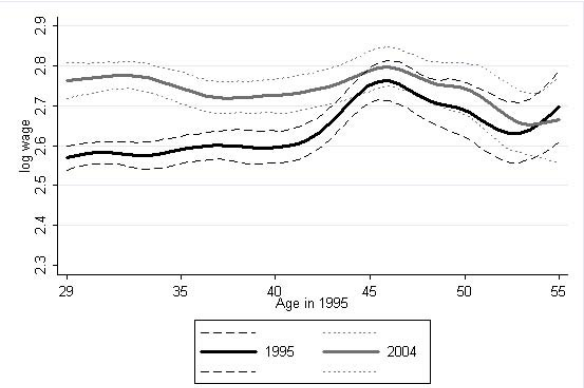

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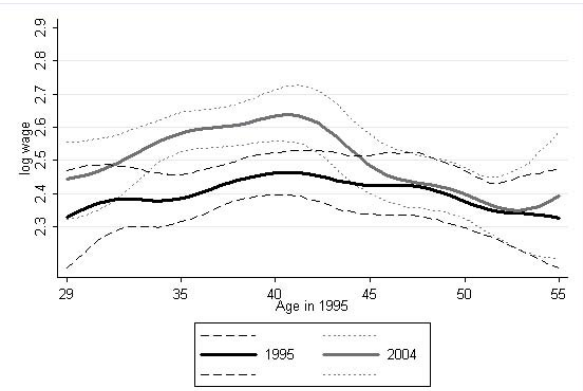

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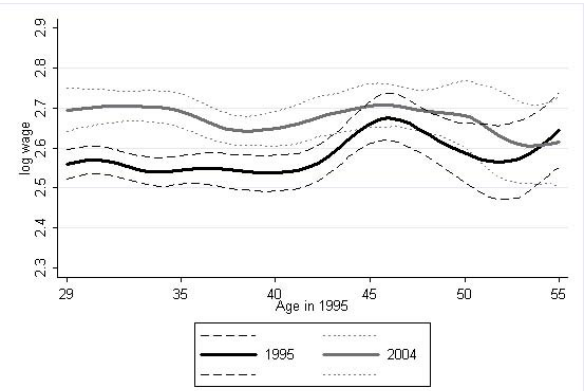

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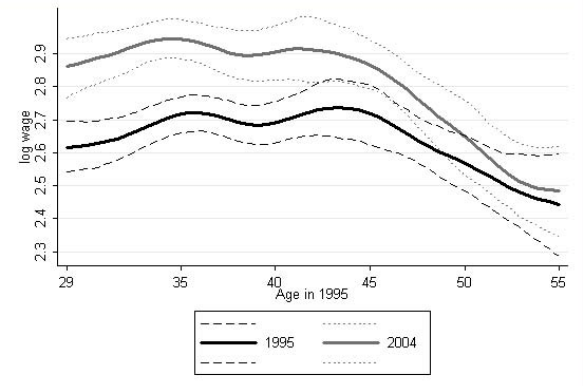

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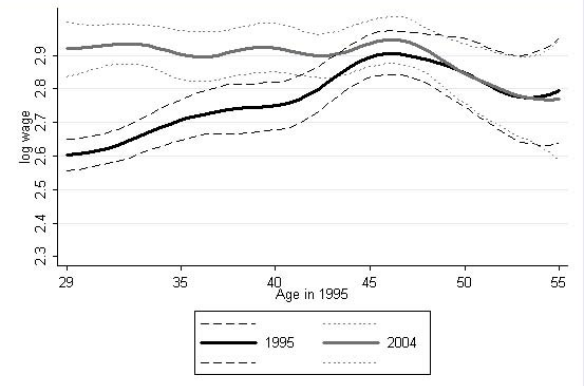
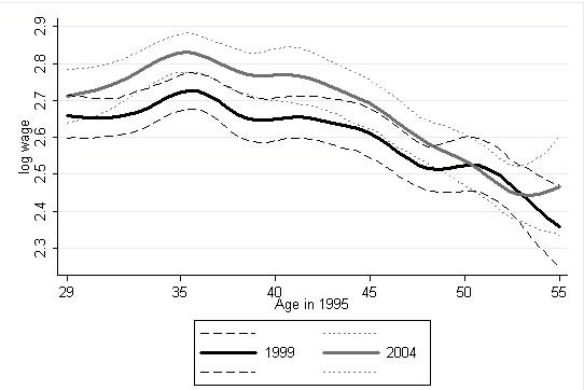


Note: Dashed lines represent 90% confidence intervals
Source: Based on BHPS and GSOEP 1995-2004.

Figure 5: Wage progression of those employed in 1999 and 2004

Britain



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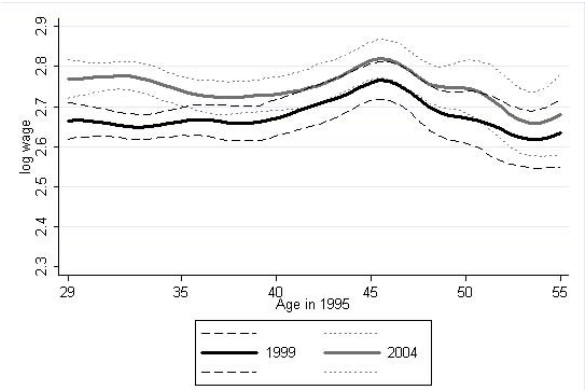

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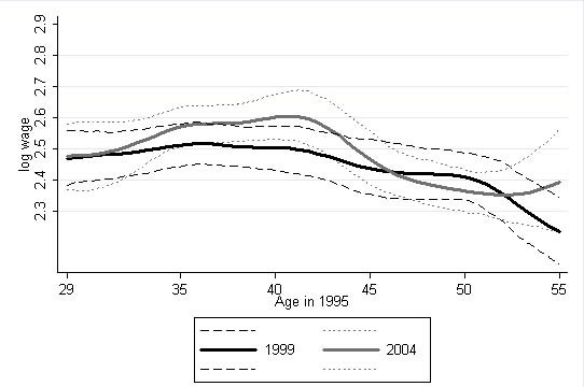
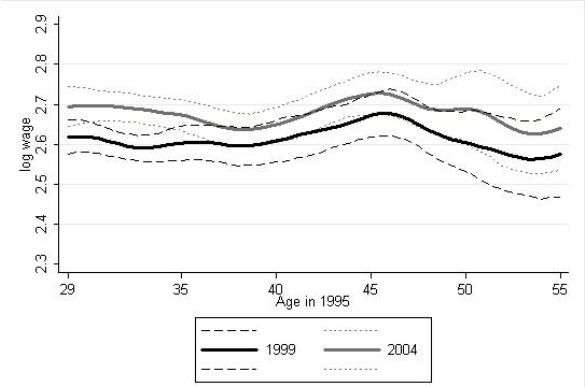
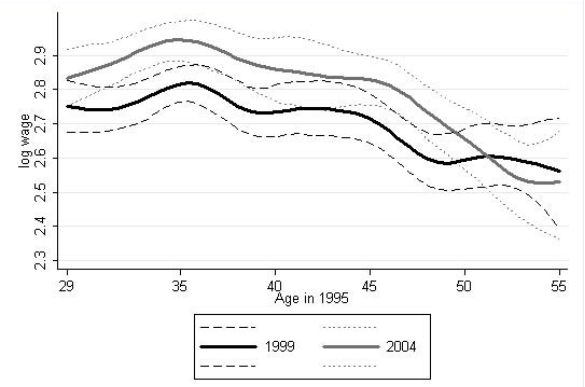


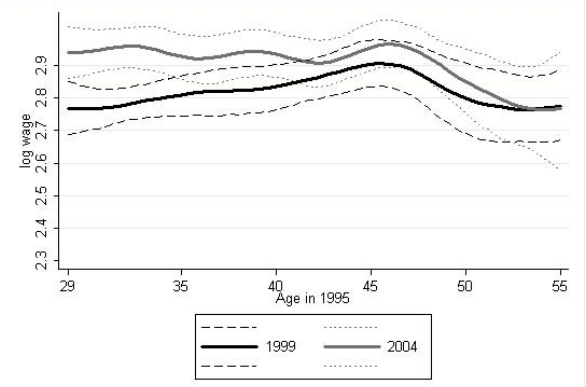
Germany - low education



Britain - high education



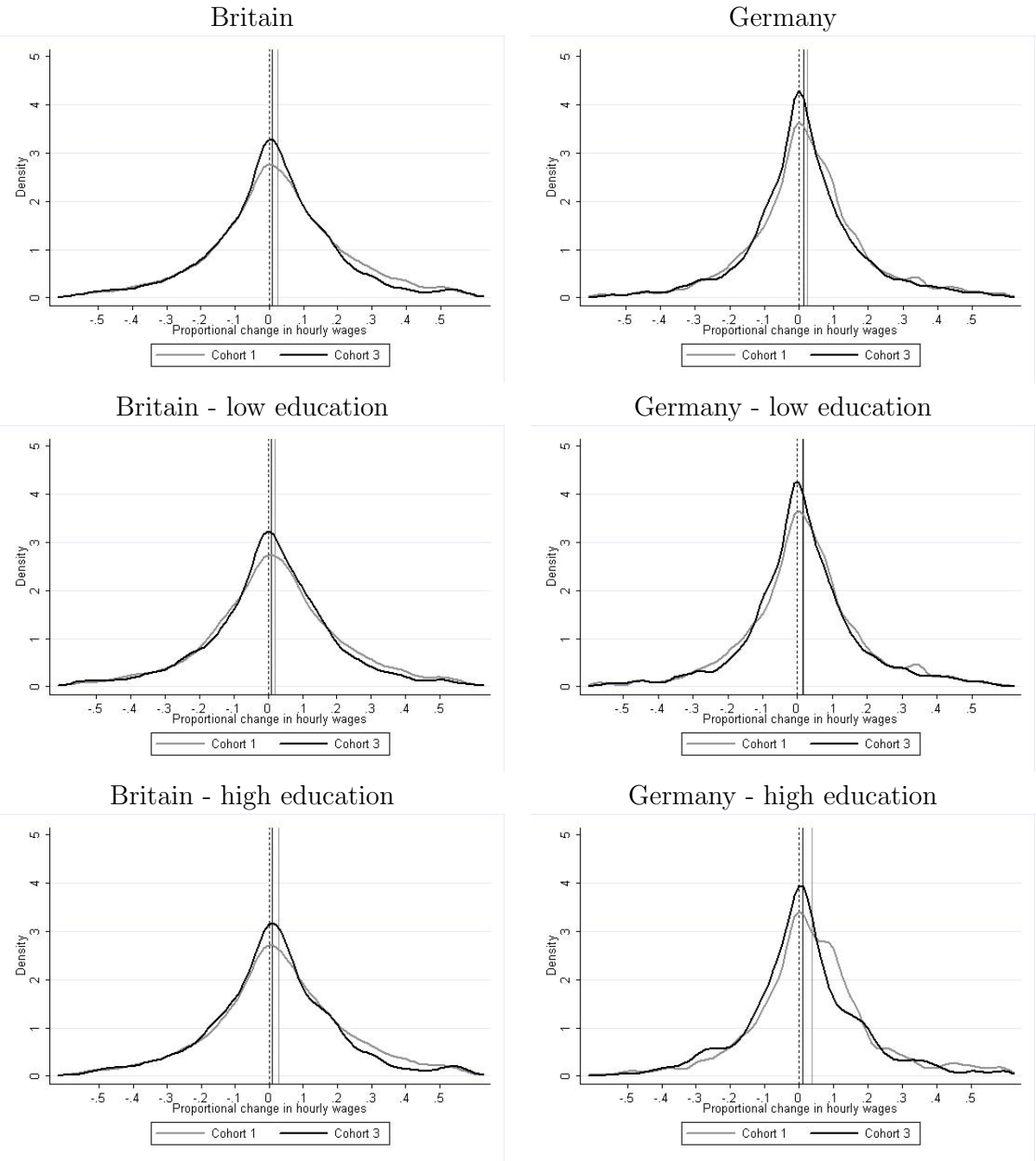
Germany - high education



Note: Dashed lines represent 90% confidence intervals

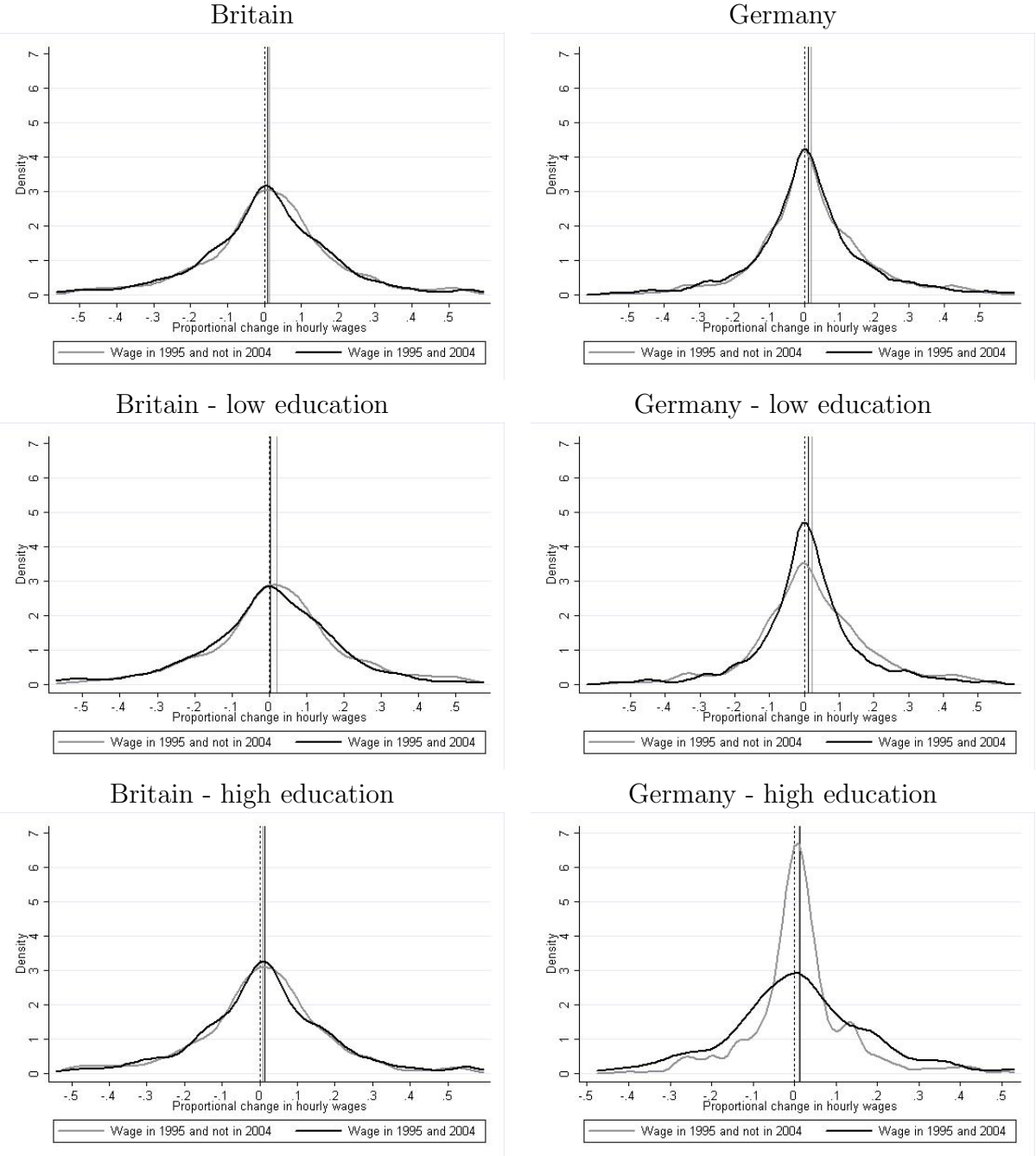
Source: Based on BHPS and GSOEP 1995-2004.

Figure 6: Kernel distributions of proportional hourly wage changes by cohort



Note: Vertical lines represent mean changes (line colors as for kernel distributions)
Source: Based on BHPS and GSOEP 1995-2004.

Figure 7: Kernel distributions of proportional hourly wage changes by employment status in 1995 and 2004



Note: Vertical lines represent mean changes (line colors as for kernel distributions)

Source: Based on BHPS and GSOEP 1995-2004.