CenEA Working Paper Series WP06/09

Dynamics of Earnings and Hourly Wages in Germany

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Abstract:
There is by now a vast number of studies which document a sharp increase in cross-sectional wage inequality during the 2000s. It is often assumed that this inequality is of a "permanent nature" which in turn is used as an argument calling for government intervention. We examine these claims using a fully balanced panel of full-time employed individuals in Germany from the German Socio-Economic Panel for the years 1994-2006. In line with previous studies, our sample shows sharply rising inequality during the 2000s. Applying covariance structure models, we calculate the fraction of permanent and transitory wage and earnings inequality. From 1994 on, permanent inequality increases continuously, peaks in 2001 and then declines in subsequent years. Interestingly the decline in the permanent fraction of inequality occurs at the time of most rapid increases in cross-sectional inequality. It seems therefore that it is primarily the temporary and not the permanent component which has driven the strong expansion of cross-sectional inequality during the 2000s in Germany.

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Dynamics of Earnings and Hourly Wages in Germany*

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February 9, 2009

Keywords: Variance Decomposition, Covariance Structure Models, Earnings Inequality.
JEL Classification: C23, D31, J31

*We thank Benny Geys and Viktor Steiner for helpful comments. The usual disclaimer applies. Qari gratefully acknowledges financial support from the Anglo-German Foundation through the CSGE research initiative.
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1 Introduction

The evolution of wage inequality in Germany is commonly perceived to approach the dynamics of the U.S. labour market in recent years. The literature on cross-sectional wage and earnings inequality in Germany typically finds that the wage distribution was stable during the 1980s and inequality started to increase in the middle of the 1990s.[1] Moreover, this increase steepens in the 2000s (Gernandt and Pfeiffer, 2007; Müller and Steiner, 2008). However, a pure cross-sectional approach is unable to identify the dynamics of the respective distributions and as such is not very informative about the mechanism determining the changes. A rise in cross-sectional inequality over time might result from an increasing role of temporary shocks or from growing permanent differences in wages and earnings between individuals. Thus, cross-sectional studies are unable to distinguish between "transitory" and "permanent" inequality. From a policy perspective it is however clearly important to disentangle the two sources of inequality, as it greatly affects the role of government interventions applied to mitigate inequality.

We apply covariance structure models to longitudinal data from the German Socio-Economic Panel (GSOEP) for the years 1994-2006. This allows us to decompose the cross-sectional dispersion into its permanent and transitory elements. Models of this type were used to analyse the wage and earnings structure of the United States (Moffitt and Gottschalk, 2002), Canada (Baker and Solon, 2003) and the UK (Dickens, 2000).[2] Using a similar approach, Biewen (2005) analyses the evolution of disposable household income inequality in East- and West-Germany for the years 1990-1998. He finds a slightly decreasing part of permanent variance for West-Germany compared to a strongly increasing part of permanent variance for East-Germany in these years. Daly and Valletta (2008) use a heterogeneous growth model to compare Germany, UK and the USA during the 1990s. For these three countries they find substantial convergence in the permanent and transitory parts of inequality, mainly caused by an increase in permanent inequality in Germany and a decline of permanent inequality in the United States. Burkhauser and Poupore (1997) and Maasoumi and Trede (2001) compare the United States and Germany during the 1980s in terms of permanent and transitory inequality with different approaches.

We are however not aware of any study covering the longitudinal dimension of earnings and wage inequality in Germany beyond the year 2000. As the increase in cross-sectional inequality steepens in the 2000s (see, for example, Gernandt and Pfeiffer, 2007) it is important to identify

[1] While there is agreement on the expansion of inequality during the 1990s, there is some disagreement about the 1980s. In a recent paper Dustmann et al. (2007) challenge "the view that the wage structure in West-Germany has remained stable throughout the 80s and 90s. Based on a 2 % sample of social security records, [they] show that wage inequality has increased in the 1980s, but only at the top of the distribution."

[2] For earlier examples, see Lillard and Willis (1978), Lillard and Weiss (1979), as well as Abowd and Card (1989). For a study covering Italy, see Cappellari (2000). Gustavsson (2007) provides a recent study applying Swedish data.

how much of this increase can be attributed to changes in the permanent component.

Our main results are threefold. Firstly, the cross-sectional variance in our sample increases – depending on the specification– by 20 to 50 percent from 1994 to 2006. Consistent with previous research, our sample shows that the increase is much steeper in the 2000s. In fact, most of the increase occurs between 1999 and 2006, while from 1994 to 1999 the cross-sectional variance remains relatively stable. Secondly, the rise in the cross-sectional variance is accompanied by an increase in the fraction of its permanent part. Interestingly, this increase also shows a break around the years 2000/2001. While the fraction of the permanent inequality increases from 1994 to 2000 and peaks in 2001, it then declines from there on by approximately 20 percentage points. This implies that the strong expansion of cross-sectional inequality during the 2000s can be increasingly attributed to transitory inequality. Finally, we find virtually no difference between the evolution of earnings and wage inequality in the period from 1994 to 2006. This is to a large extent a consequence of our focus on full-time employees, but reflects also a relatively compressed distribution of working hours in Germany compared the United States and the UK (Burton and Phipps, 2007).

In the following section we describe the dataset we use for our analysis. Section 3 presents the method for separating the permanent and temporary components of the variance. Section 4 provides details on the estimation procedure. We then present and discuss our main results in Section 5 and conclude in Section 6.

2 Data

The analysis uses data from the German Socio-Economic Panel (GSOEP). The GSOEP is a panel study for Germany, which was started in 1984 as a longitudinal survey of households and individuals in West-Germany and was expanded in 1990 to cover the population of the former East Germany. We use a fully balanced subsample of the GSOEP for the years 1994-2006. Thus, we focus on individuals from the first four samples (A, B, C, and D) of the GSOEP in order to make analyses between any two periods of the time frame comparable.[3]

We apply the usual age restrictions and include individuals aged 20-60 who report to be "employed" in all 13 years covered by the analysis and who are full-time employees during the entire period.[4] For these individuals, we analyse monthly gross individual labour income as

[3]Sample A and B are the initial samples with residents in the former Federal Republic of Germany from households with a German household head as well as households with heads from Turkey, Greece, Yugoslavia, Spain, or Italy. Sample C was started in 1990 with German residents from private households in the former German Democratic Republic. Sample D was started in 1994 with immigrants. These samples of the GSOEP are multi-stage random samples, which are regionally clustered. C.f. Haisken-DeNew and Frick (2005) and Wagner et al. (2007) for further details.

[4]Individuals need to report 'full-time' employment status and weekly hours above 19 to be classified as full-time

reported for the month prior to the interview. Earnings are deflated by Consumer Price Index to the base of year 2000.[5] To exclude outliers, the distribution of monthly earnings is truncated at 100 Euros at the low end and 20,000 Euros at the high end.[6]

Table 1: Summary Statistics for Earnings and Wages

	Monthly Earnings				Hourly Wages			
period	mean	min	max	sd	mean	min	max	sd
1994	2,385	370	12,524	1,112	13.09	2.13	54.39	5.61
1995	2,494	272	12,796	1,143	13.69	1.25	54.81	5.69
1996	2,620	314	11,803	1,171	14.36	1.61	49.33	5.87
1997	2,648	274	10,005	1,149	14.42	1.14	41.90	5.71
1998	2,695	421	10,435	1,194	14.70	2.51	42.36	5.88
1999	2,748	290	10,371	1,214	14.90	1.59	48.81	6.03
2000	2,852	341	17,895	1,420	15.49	1.87	68.56	6.61
2001	2,885	381	17,544	1,380	15.63	1.59	67.22	6.55
2002	2,932	464	15,474	1,346	16.03	2.22	64.68	6.73
2003	3,080	478	16,746	1,603	16.78	1.57	67.63	7.43
2004	3,062	330	12,241	1,453	16.73	1.90	56.28	7.07
2005	3,049	369	13,850	1,498	16.70	2.12	63.68	7.33
2006	3,036	145	16,349	1,563	16.55	1.11	84.08	7.71
Total	2,807	145	17,895	1,354	15.31	1.11	84.08	6.62

Source: Own calculations using the GSOEP data (1994-2006).

To compute hourly wages, we use reported weekly hours actually worked (including hours of paid overtime) and monthly earnings (including overtime pay).[7] The distribution of the resulting hours worked is censored at 84 hours per week. The resulting hourly wage is then

employees.

[5]Note, however, that a deflation of this variable does not affect the analysis of variances later on, since a common factor just alters the level, which in turn does not alter our measure of dispersion.

[6]Although the GSOEP is not generally top-coded with respect to the income distribution, it nevertheless includes only a small number of individuals with high incomes in the samples A-D applied here, c.f. Dustmann et al. (2007), Bach et al. (2007) as well as Bach et al. (2008). These authors moreover conclude that the GSOEP covers the distribution of market income quite well up to the 99th percentile. Bach et al. (2007) also find that a large share of the total market income is actually labour income, in 2001 a share of 83.1 percent on average was wage income and an additional 11.4 percent was income from business activity. We conclude that by analysing labour earnings we capture the main part of market income which is representative for the income distribution in Germany, except for the very rich.

[7]In several cases of missings at the hours, namely 191 individual-year observations, generally mean hours by employment status and year are imputed.

calculated as wage = monthly earnings / (4.35 * weekly hours worked). Table 1 displays some descriptive statistics on monthly earnings and hourly wages in our sample of analysis.

Table 2: Number of Individual-Year Observations in the Samples

	Gender		Nationality		Location		Age				Years of Education				
Sample	male	fem.	German	Non-G.	West	East	20-30	31-40	41-50	51-60	$\leq$ 10	10-13	13-15	15-18	Total
Full	9,464	2,912	11,407	969	8,591	3,785	1,026	4,455	5,106	1,789	1,047	8,134	1,202	1,993	12,376
Male only	9,464	0	8,664	800	7,162	2,302	765	3,523	3,765	1,411	817	6,114	950	1,583	9,646

Source: Own calculations using the GSOEP data (1994-2006).

Although we use different sets of control variables we keep only those observations which do not have any missing information for the full set of covariates. The restrictions lead to an overall sample of 952 individuals (12,376 individual-year observations). When we restrict the sample only to men we end up with 728 individuals (9,464 individual-year observations). Table 2 displays the number of individual-year observations by gender, nationality, location as well as by age and education groups for our balanced panel on the full sample and for the one restricted to men only.

3 Modelling the Dynamics of Earnings and Wages

We assume that real log-earnings (log-wages, respectively) can be modelled by

$$Y_{it} = x'_{it}\beta_t + u_{it} \tag{1}$$

for individuals $i = 1, ...N$ and periods $t = 1, ...T$, with x_{it} denoting a $K \times 1$-vector of individual-specific characteristics including a time-varying constant, β_t denoting a $K \times 1$ time-varying parameter vector, and u_{it} the error term. This model is computed for every $t = 1, ...T$ in two variants. In the first variant, $x_{it} \equiv 1$, so that log earnings are only regressed on a time-varying constant. In the second variant, x_{it} contains several individual-specific covariates, i.e. log-age, log-age-squared, region of residence (East- or West-Germany), years of education in four groups, and gender for the full sample of males and females.

For each variant, we decompose the residuals u_{it} into a permanent and a transitory part. Throughout the entire paper we assume that these two parts are uncorrelated, i.e. $Cov(\mu_i, v_{it}) = 0$.

Our simplest model is the "enhanced canonical" permanent-transitory model with year-specific factor loadings p_t and λ_t on the two components. It assumes that there is no serial correlation among transitory shocks, i.e $Cov(v_{it}, v_{it-s}) = 0$ for $s \neq 0$:[8]

$$u_{it} = p_t \mu_i + \lambda_t v_{it} \tag{2}$$

Intuitively, $x'_{it}\beta_t$ defines the population's mean profile and the term μ_i introduces individual heterogeneity, which allows the individuals to deviate from the mean profile. The variance of this individual heterogeneity constitutes the source for permanent inequality and the respective factor loadings allow changes of the permanent component over time.

The variance of the residual of log-earnings (log-wages, respectively) in this model, given independence of the permanent and the transitory component, is:

$$Var(u_{it}) = p_t^2 \sigma_\mu^2 + \lambda_t^2 \sigma_v^2 \tag{3}$$

An increase in either factor loading in period t leads to an increase in the cross-sectional variance of period t. The interpretation of such an increase, however depends crucially on which factor changes. An increase in p_t can be interpreted as an increase in the returns to unobserved individual-specific permanent components, e.g. ability. On the contrary, an increase in λ_t without an increase in p_t can be interpreted as an increase in year-to-year volatility due to short-term factors, such as e.g. temporarily powerful labour unions or demand shocks affecting specific sectors of the economy, without any shifts in the permanent component of earnings.

To remove the implausible assumption that temporary shocks do not have any effect on the following periods, we consider two models for the transitory component. The first model is an AR(1) process. In this case, the transitory part of the residuals is equal to:

$$v_{it} = \rho v_{it-1} + \varepsilon_{it} \tag{4}$$

In the second model, the transitory component is assumed to follow an ARMA(1,1) process:

$$v_{it} = \rho v_{it-1} + \gamma \varepsilon_{it-1} + \varepsilon_{it} \tag{5}$$

Under the assumption that $E[\mu_i] = E[v_{it}] = E[\varepsilon_{it}] = 0$ and $E[\mu_i \varepsilon_{it}] = E[\varepsilon_{it}\varepsilon_{js}] = 0$ for all i and j and for all $t \neq s$, the covariance matrix of residuals is given by:

$$cov(u_{it}, u_{it-s}) = p_t p_{t-s} \sigma_\mu^2 + \lambda_t \lambda_{t-s} E[v_{it} v_{it-s}] \tag{6}$$

[8]C.f. Moffitt and Gottschalk (2002), Baker and Solon (2003), and Haider (2001) for other applications of such a model.

where p_t, p_{t-s}, λ_t, and λ_{t-s} are time specific factor loadings and $E[v_{it}v_{it-s}]$ is equal to:

$$E\left[v_{it}v_{it-s}\right]=\begin{cases}\sigma_{v0}^2 & ,t=0,s=0\\ \rho^2\sigma_{v0}^2+\sigma_\epsilon^2 & ,t=1,s=0\\ \rho^2E\left[v_{it-1}v_{it-1}\right]+\left(1+\gamma^2+2\rho\gamma\right)\sigma_\epsilon^2 & ,2\leq t,s=0\\ \rho^{s-1}(\rho E\left[v_{it-s}v_{it-s}\right]+\gamma\sigma_\epsilon^2) & ,s+1\leq t,1\leq s\leq T-1\end{cases} \tag{7}$$

In Equation (7), $\sigma_\mu^2 = var(\mu_i)$ and $\sigma_\varepsilon^2 = var(\varepsilon_{it})$.[9] $\sigma_{v_0}^2 = var(v_{i0})$ is the initial condition for the ARMA-process.[10] In Equation (7), the AR(1) specification is nested with $\gamma = 0$. Summarising, we consider three different specifications:

$$\text{(S-CAN)}\quad u_{it} = p_t\mu_i + \lambda_t v_{it} \tag{8}$$

$$\text{(S-AR)}\quad u_{it} = p_t\mu_i + \lambda_t\left(\rho v_{it-1} + \varepsilon_{it}\right) \tag{9}$$

$$\text{(S-ARMA)}\quad u_{it} = p_t\mu_i + \lambda_t\left(\rho v_{it-1} + \gamma\varepsilon_{it-1} + \varepsilon_{it}\right) \tag{10}$$

Specification (S-CAN) is the "enhanced canonical" model with factor loadings. Specification (S-AR) models the transitory component as an AR(1) process, while specification (S-ARMA) models the transitory component as an ARMA(1,1) process. (S-CAN) is nested in (S-AR) which in turn is nested in (S-ARMA).

4 Estimation

The estimation is conducted in two steps.[11] In the first step, we obtain an estimate of u_{it}, which is just the vector of residuals from the regression model $Y_{it} = x'_{it}\beta_t + u_{it}$. From these residuals, we construct an empirical covariance matrix.[12] In the second step, we estimate the parameters of our theoretical covariance matrix by fitting the implications of specifications (S-CAN), (S-AR), and (S-ARMA) to the empirical covariance matrix.

Formally, let the vector C collect all distinct elements of the empirical covariance matrix obtained from the first stage. For each specification, we can express the corresponding theoretical moments in Equations (6)-(7) as a function $f(\theta)$, where the vector θ collects all parameters which are needed to construct these moments. For example, in specification (S-AR), θ collects the initial variance, as well as the permanent variance, the year-to-year variance, the

[9]See Biewen (2005) for similar specifications in the context of household income.

[10]The initial condition is needed for an unbiased estimation of the parameters of the ARMA-process, c.f. MaCurdy (1982).

[11]C.f. MaCurdy (1982); Haider (2001); Biewen (2005).

[12]The covariance matrices for earnings as well as wages can be found in Tables 4 to 11 in the Appendix.

persistence parameter of the AR(1) process, and the factor loadings for the permanent and transitory components. This results in 27 parameters for specification (S-AR) and 28 for specification (S-ARMA), respectively.[13] The model's parameters are estimated by the generalised method of moments (Chamberlain, 1984); that is the estimate $\hat{\theta}$ minimises the distance between the empirical and the theoretical moments:

$$\hat{\theta} = \arg\min_{\theta} \left[C - f(\theta)\right]' W \left[C - f(\theta)\right] \tag{11}$$

We follow the recent literature and use the identity matrix as the weighting matrix W.[14] This approach, called "equally weighted minimum distance estimation" (Baker and Solon, 2003), boils down to using nonlinear least squares to fit $f(\hat{\theta})$ to C.

5 Results

The estimation results are compiled in Table 3. It shows the 27 (28, respectively) parameter estimates for the specifications (S-AR) and (S-ARMA). These results are obtained from the full sample.[15] The distribution of working hours for full-time employees is fairly constant over time. As a consequence, the evolution of earnings dynamics in our sample closely resembles the one for wage dynamics. We therefore focus on the results for wages here.

In specification (S-AR), the variance of the transitory part (σ_ε^2) for wages is estimated to between one third and two thirds of the permanent variance (σ_μ^2). Meanwhile, transitory shocks die out rather quickly. An estimate for ρ of 0.57 implies that already after two periods almost 70% of a shock is vanished. Also in specification (S-ARMA), the persistence of transitory shocks is relatively modest with an estimated ρ of about 0.85 and a γ of about -0.48. Similarly, this implies that a shock is reduced to about 31% after two periods. The evolution of the factor loadings (p_t) suggests that the permanent component becomes increasingly important during the years 1994 to 2001. In line with that, the factor loadings of the transitory part (λ_t) are initially only slightly below unity, then decline continuously until the year 2001, whereupon until 2006, they grow sharply up to slightly above unity.

We can now use Equation (6) and calculate the fraction of the permanent part of the variance from our parameter estimates as $(\hat{p}_t^2 \cdot \hat{\sigma}_\mu^2) \,/\, var(\hat{u}_{it})$, where $var(\hat{u}_{it})$ denotes the variance of the predicted residuals in period t. Figure 1 shows the evolution of this fraction for wages regressed

[13] Note that p_{1994}, λ_{1994} and λ_{1995} are normalised to unity in order to identify the parameters of the stochastic process.

[14] While an asymptotically optimal choice of W is the inverse of a matrix that consistently estimates the covariance matrix of C (Chamberlain, 1984), Altonji and Segal (1996) as well as Clark (1996) provide Monte Carlo evidence of potentially serious finite sample bias in $\hat{\theta}$ using this approach.

[15] C.f. Table 12 in the Appendix for the respective results on the restricted sample of males.

Table 3: Parameter Estimates - Full Sample

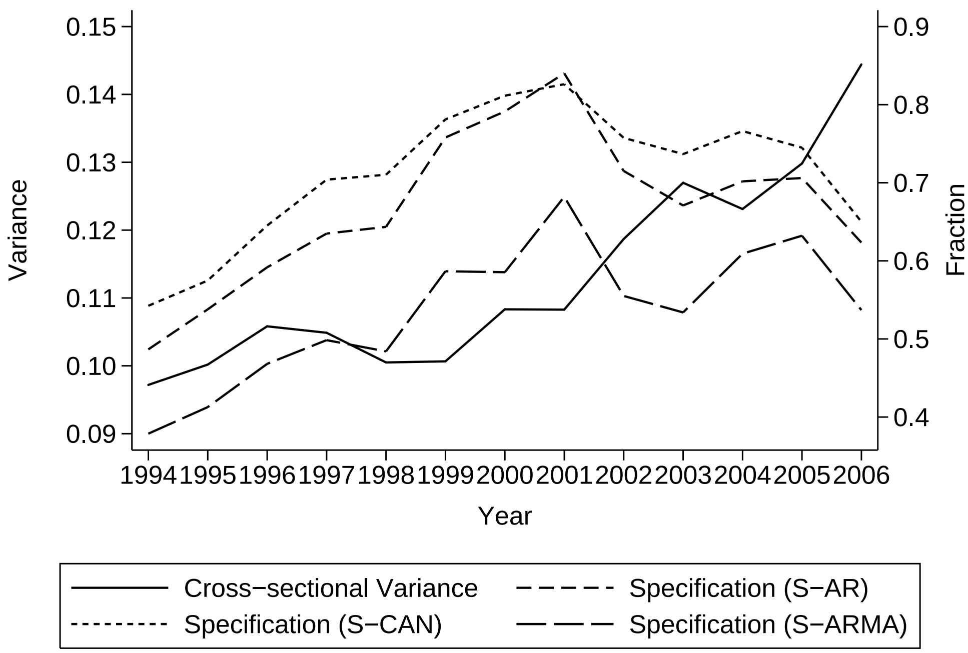
	AR(1)				ARMA(1,1)			
	Earnings		Wages		Earnings		Wages	
	constant	covariates	constant	covariates	constant	covariates	constant	covariates
$\sigma^2_{v_0}$	0.092	0.064	0.093	0.063	0.054	0.035	0.054	0.034
	(0.015)	(0.014)	(0.021)	(0.019)	(0.006)	(0.005)	(0.006)	(0.005)
σ^2_{μ}	0.109	0.048	0.108	0.047	0.098	0.037	0.095	0.037
	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)	(0.003)	(0.004)	(0.003)
σ^2_{ε}	0.026	0.024	0.032	0.029	0.033	0.032	0.036	0.034
	(0.003)	(0.003)	(0.004)	(0.004)	(0.002)	(0.002)	(0.002)	(0.002)
ρ	0.618	0.663	0.572	0.574	0.839	0.887	0.842	0.873
	(0.021)	(0.022)	(0.024)	(0.025)	(0.027)	(0.015)	(0.027)	(0.021)
γ					-0.431	-0.444	-0.483	-0.486
					(0.032)	(0.017)	(0.029)	(0.021)
p_{1995}	1.034	1.066	1.030	1.060	1.033	1.053	1.035	1.065
	(0.011)	(0.023)	(0.014)	(0.027)	(0.008)	(0.018)	(0.009)	(0.020)
p_{1996}	1.061	1.139	1.046	1.137	1.079	1.155	1.066	1.156
	(0.012)	(0.025)	(0.014)	(0.028)	(0.012)	(0.026)	(0.012)	(0.027)
p_{1997}	1.078	1.149	1.073	1.181	1.097	1.156	1.094	1.198
	(0.013)	(0.026)	(0.015)	(0.030)	(0.013)	(0.029)	(0.014)	(0.031)
p_{1998}	1.094	1.188	1.058	1.162	1.108	1.180	1.072	1.155
	(0.013)	(0.028)	(0.015)	(0.031)	(0.014)	(0.033)	(0.015)	(0.035)
p_{1999}	1.131	1.256	1.110	1.251	1.152	1.259	1.139	1.270
	(0.015)	(0.031)	(0.017)	(0.034)	(0.018)	(0.039)	(0.018)	(0.040)
p_{2000}	1.161	1.340	1.139	1.330	1.169	1.272	1.159	1.313
	(0.015)	(0.034)	(0.017)	(0.037)	(0.018)	(0.054)	(0.020)	(0.057)
p_{2001}	1.204	1.383	1.169	1.358	1.222	1.427	1.204	1.414
	(0.018)	(0.038)	(0.019)	(0.039)	(0.023)	(0.062)	(0.023)	(0.054)
p_{2002}	1.123	1.313	1.115	1.321	1.137	1.292	1.143	1.336
	(0.015)	(0.034)	(0.017)	(0.036)	(0.018)	(0.051)	(0.021)	(0.054)
p_{2003}	1.162	1.333	1.134	1.331	1.183	1.312	1.171	1.359
	(0.015)	(0.033)	(0.017)	(0.036)	(0.019)	(0.053)	(0.021)	(0.057)
p_{2004}	1.154	1.339	1.121	1.344	1.191	1.368	1.177	1.433
	(0.014)	(0.032)	(0.016)	(0.036)	(0.019)	(0.054)	(0.022)	(0.057)
p_{2005}	1.165	1.368	1.137	1.379	1.208	1.420	1.201	1.495
	(0.014)	(0.032)	(0.016)	(0.035)	(0.020)	(0.055)	(0.023)	(0.059)
p_{2006}	1.191	1.355	1.171	1.376	1.230	1.372	1.230	1.454
	(0.014)	(0.030)	(0.016)	(0.034)	(0.019)	(0.053)	(0.022)	(0.056)
λ_{1996}	0.884	0.951	0.919	0.976	0.858	0.922	0.911	0.976
	(0.062)	(0.069)	(0.069)	(0.073)	(0.032)	(0.027)	(0.032)	(0.030)
λ_{1997}	0.828	0.909	0.858	0.930	0.822	0.891	0.889	0.956
	(0.071)	(0.076)	(0.075)	(0.078)	(0.038)	(0.031)	(0.038)	(0.035)
λ_{1998}	0.780	0.881	0.822	0.900	0.814	0.890	0.892	0.952
	(0.076)	(0.081)	(0.078)	(0.080)	(0.044)	(0.034)	(0.041)	(0.037)
λ_{1999}	0.609	0.753	0.629	0.736	0.705	0.827	0.758	0.854
	(0.090)	(0.087)	(0.091)	(0.087)	(0.056)	(0.041)	(0.051)	(0.044)
λ_{2000}	0.709	0.761	0.672	0.711	0.814	0.911	0.812	0.887
	(0.086)	(0.093)	(0.091)	(0.094)	(0.054)	(0.045)	(0.054)	(0.051)
λ_{2001}	0.413	0.582	0.539	0.617	0.666	0.730	0.726	0.776
	(0.127)	(0.113)	(0.106)	(0.104)	(0.069)	(0.061)	(0.060)	(0.056)
λ_{2002}	0.830	0.868	0.843	0.869	0.889	0.925	0.931	0.963
	(0.077)	(0.086)	(0.080)	(0.085)	(0.046)	(0.039)	(0.045)	(0.042)
λ_{2003}	0.954	1.008	0.931	0.971	0.979	1.014	0.986	1.023
	(0.077)	(0.086)	(0.080)	(0.084)	(0.045)	(0.038)	(0.044)	(0.042)
λ_{2004}	0.946	0.982	0.893	0.913	0.935	0.956	0.909	0.925
	(0.076)	(0.085)	(0.079)	(0.084)	(0.045)	(0.038)	(0.045)	(0.043)
λ_{2005}	0.978	1.017	0.903	0.927	0.953	0.968	0.910	0.920
	(0.076)	(0.085)	(0.078)	(0.084)	(0.046)	(0.037)	(0.046)	(0.043)
λ_{2006}	1.143	1.191	1.067	1.114	1.092	1.101	1.058	1.089
	(0.081)	(0.091)	(0.081)	(0.087)	(0.050)	(0.040)	(0.048)	(0.044)
N	91	91	91	91	91	91	91	91

Notes: See Section 3 for the full list of covariates.

Source: Own calculations using the GSOEP data (1994-2006).

on the full set of covariates for all three specifications.[16] It also includes the cross-sectional variance $var(u_{it})$.

Figure 1: Cross-sectional Variance and its Permanent Component, for **Wages** in the specification with **covariates** on the full sample



Notes: See Section 3 for the full list of covariates.

The plots show a clear break in the years 2000/2001. From 1994 to 1999, the cross-sectional variance is more or less constant, followed by a sharp increase starting in 2000. This sharp increase in cross-sectional inequality is in line with previous research as mentioned earlier. However, the permanent part of the variance increases sharply only in the first time frame. The estimated parameters of specification (S-AR) set the fraction of permanent inequality to roughly 50% in 1994. For the subsequent years, permanent inequality firstly climbs up, peaks with over 80% in 2001, and then declines to roughly 60% in 2006. These two findings imply that it is an increasing fraction of the *transitory* variance which is driving the sharp increase in cross-sectional inequality from 2001 to 2006.

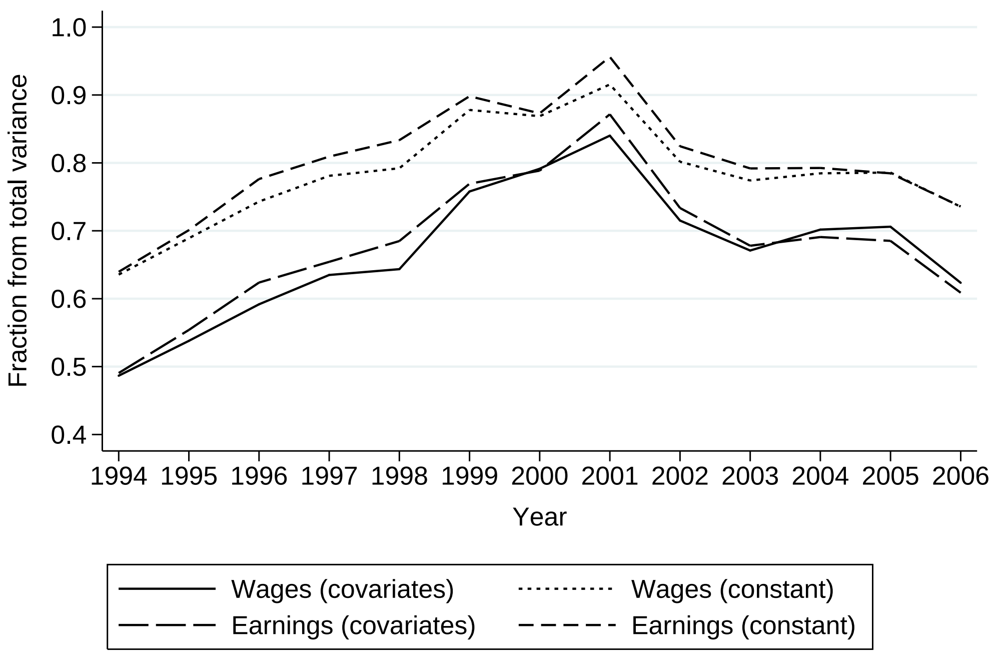
This pattern is very similar for the other two specifications. Generally, it becomes evident that the evolution of the permanent fraction is more pronounced the more complex the model specification. While the graph for specification (S-CAN) wraps around the graph for (S-AR) with a relatively smooth course, the graph for specification (S-ARMA) depicts a more prominent

[16] C.f. Figure 3 in the Appendix for the respective results in the case of a constant instead of covariates.

peak in 2001 as well as a slightly more projecting increase in 2003 to 2005. Moreover, at (S-ARMA), there is a shift in the level of the permanent variance compared to the other specifications. Over all the years, the permanent inequality is estimated to between 10 and 20 percentage points lower than in the other models. This downward shift, however, is not surprising, since the ARMA(1,1) model contains the additional parameter γ, which picks up additional transitory dispersion.

Figure 2 compares wage and earnings dynamics. It uses the parameter estimates from Table

Figure 2: Evolution of the Fraction of the Permanent Variance Component, in specification (S-AR) on the full sample



Notes: In the specifications of a constant and of covariates. See Section 3 for the full list of covariates.

3 for the (S-AR) specification and shows the resulting fraction of permanent inequality (as a fraction from the total variance) for both wages and earnings. We can see that its evolution is virtually identical for earnings and wages in both variants, regressed on a constant and on the full set of covariates. Figure 6 in the Appendix depicts the corresponding results for the (S-ARMA) specification.

So far, all models predict an increase in the fraction of permanent inequality starting in 1994, a peak in 2000/2001 and a decline in subsequent years. While all specifications find this pattern, the exact level of permanent inequality depends on the underlying model. As a robustness check, we repeat the analysis on the subsample of only males. The results from these additional regressions, given graphically in Figures 7 and 8 in the Appendix, confirm our findings.

Influence of Individual Characteristics

It becomes evident from Table 3 that controlling for individual characteristics leads to qualitatively similar results as fitting just a constant. Most of the individual characteristics are time-invariant (gender or education) and it is essentially only age and possibly region which vary with time. The importance of controlling for individual characteristics thus primarily lies in accounting for changes in age (which proxies experience) and potentially for changing returns to these characteristics. It is of course not surprising that controlling for these factors reduces the level of dispersion. This follows simply from the fact that the fraction of explained variance from the first stage regression (Section 3) is larger. Figure 2 provides a direct comparison of the two sets of results. The variance after controlling for individual characteristics shrinks by about 20 percentage points. However, apart from this level effect, the same pattern emerges: rising relevance of permanent inequality from 1994 to 2000/2001, followed by a decline thereafter.

6 Concluding Remarks

There is by now a vast number of studies which document a sharp increase in cross-sectional wage inequality during the 2000s. It is often assumed that this inequality is of a "permanent nature" which in turn is sometimes used in policy discussions as an argument for a greater role of government regulation concerning the determination of wages and earnings. Applying longitudinal data on full-time working individuals in Germany from the GSOEP for the years of 1994 to 2006, we do not find unambiguous empirical support for this position.

By decomposing the cross-sectional variance into a permanent and a transitory part, we find that the fraction of permanent inequality in 2006 is greater compared to what it was in 1994. However this fraction is found to have declined by approximately 20 percentage points from 2001 to 2006, at the time of rapidly growing cross-sectional inequality. This implies that from about 2000 onward it is the year-to-year transitory volatility which becomes the increasingly important element of the growing cross-sectional inequality of wages and earnings in Germany.[17]

Our results are of course subject to a number of caveats. The analysis is by its nature limited to individuals who can be followed throughout the period we look at. This means that we do not take into account changes in wages of those who did not work at some point during the time

[17] Recent empirical evidence suggests that permanent inequality increased in the United States during the 2000s (Moffitt and Gottschalk, 2008). Thus, our results may indicate a new divergence between the United States and Germany during the 2000s in contrast to the increased convergence during the 1990s reported by Daly and Valletta (2008).

frame covered, as well as the new cohorts who came into the labour market since 1995. What reassures the validity of our conclusions is the fact that essentially the same results are obtained on a more restrictive sample excluding women. To further confirm the results obtained here one could consider dividing the analysis into several shorter periods or conducting it on other sub-samples of the population. This, however is left for future research.

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Appendix - Figures

Figure 3: Cross-sectional Variance and its Permanent Component, for **Wages** in the specification with **a constant** on the full sample

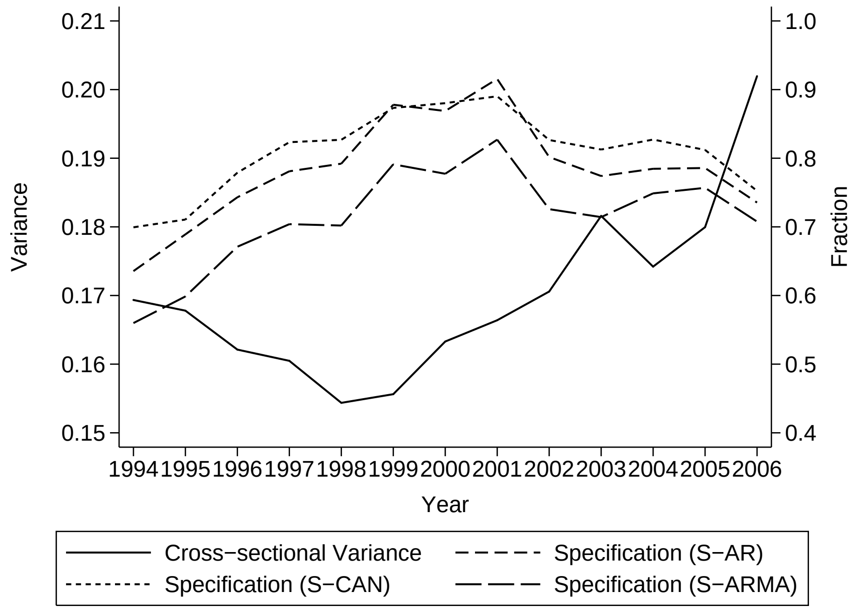
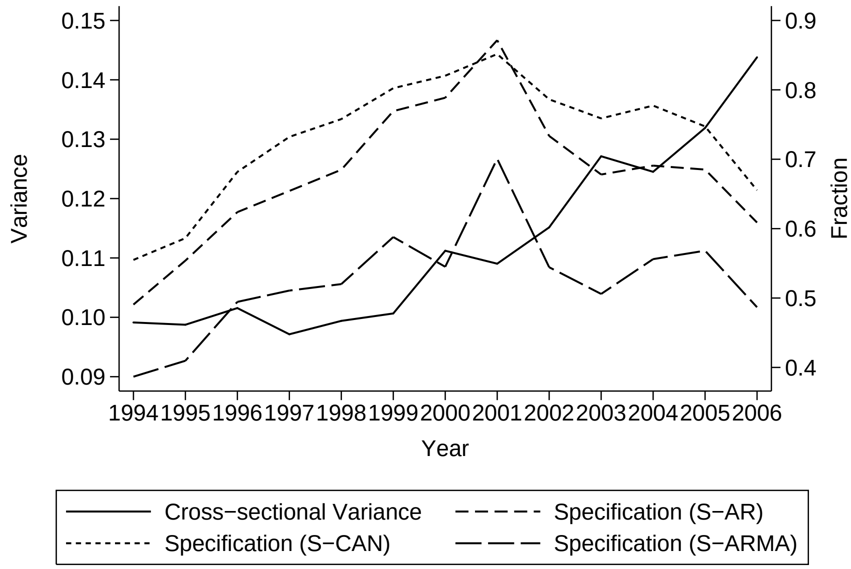


Figure 4: Cross-sectional Variance and its Permanent Component, for **Earnings** in the specification with **covariates** on the full sample



Notes: See Section 3 for the full list of covariates.

Figure 5: Cross-sectional Variance and its Permanent Component, for **Earnings** in the specification with **a constant** on the full sample

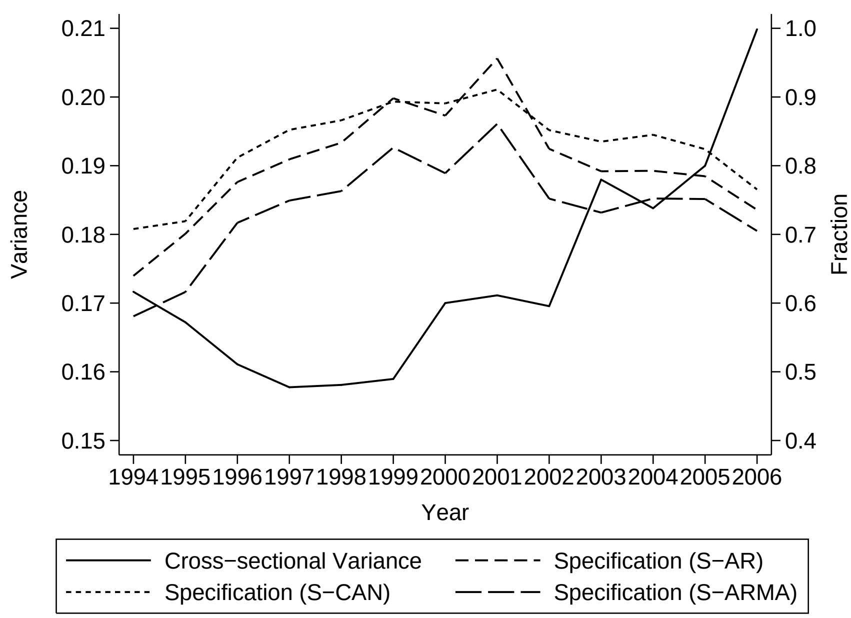
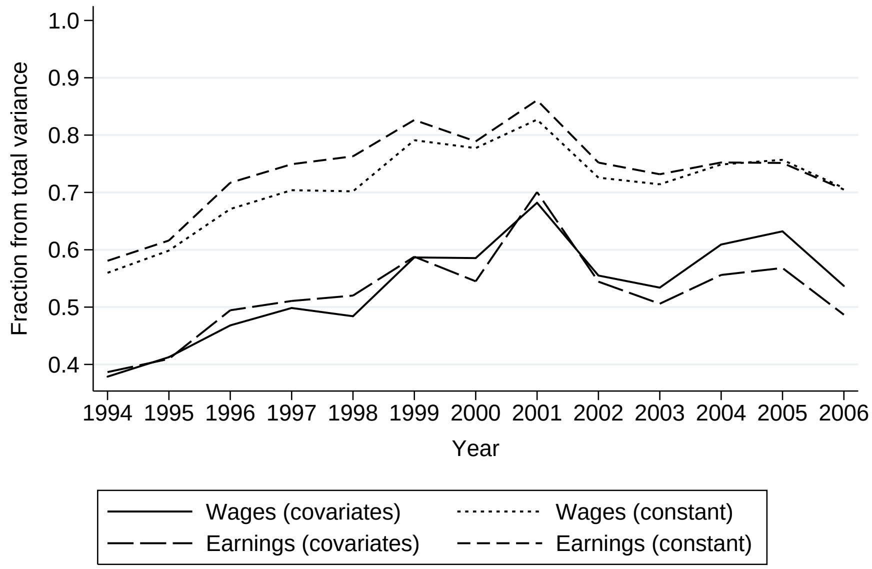
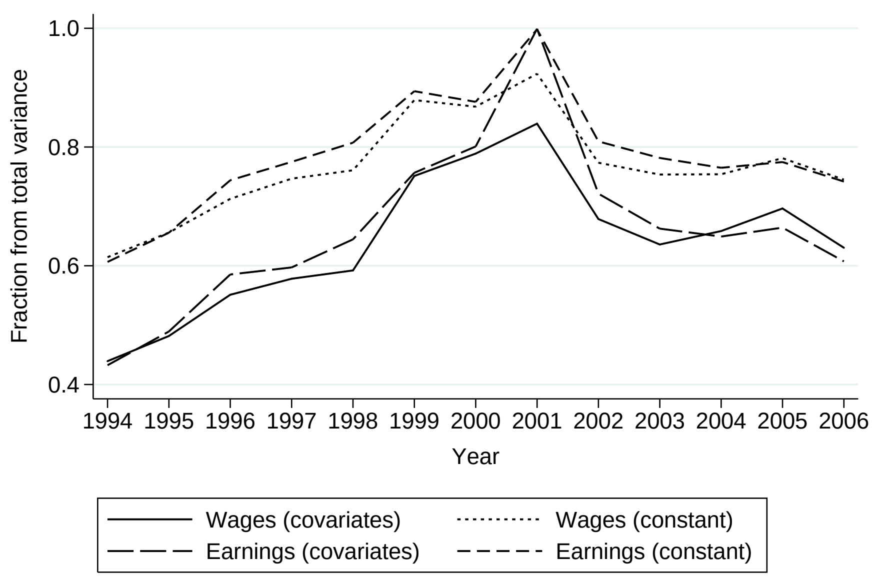


Figure 6: Evolution of the Fraction of the Permanent Variance Component, in specification (S-ARMA) on the full sample



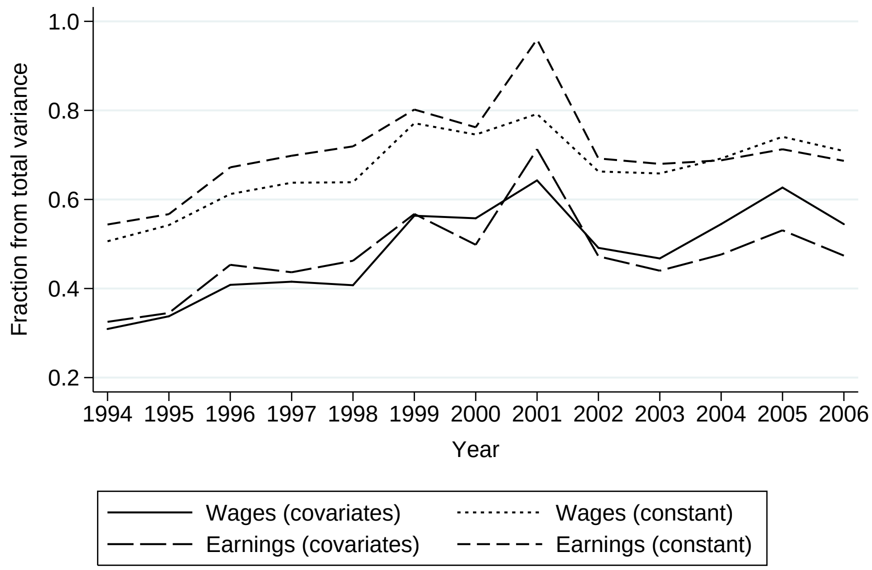
Notes: In the specifications of a constant and of covariates. See Section 3 for the full list of covariates.

Figure 7: Evolution of the Fraction of the Permanent Variance Component, in Specification (S-AR) on the reduced sample (male only)



Notes: In the specifications of a constant and of covariates. See Section 3 for the full list of covariates.

Figure 8: Evolution of the Fraction of the Permanent Variance Component, in Specification (S-ARMA) on the reduced sample (male only)



Notes: In the specifications of a constant and of covariates. See Section 3 for the full list of covariates.

Appendix - Tables

Table 4: Variance-Covariance Matrix - **Earnings** in the specification with **a constant** on the full sample

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1994	.1716												
1995	.148	.1672											
1996	.1341	.1425	.1611										
1997	.1324	.1399	.1422	.1577									
1998	.131	.136	.1398	.1421	.1581								
1999	.129	.133	.1372	.1392	.1422	.159							
2000	.1299	.1346	.1399	.1453	.1466	.1518	.17						
2001	.1334	.138	.1423	.143	.1453	.1503	.1581	.1711					
2002	.1227	.1278	.1346	.1352	.1379	.1428	.1489	.1532	.1696				
2003	.1293	.1341	.1352	.1396	.1418	.1461	.1525	.1559	.156	.188			
2004	.1255	.1312	.1333	.1357	.1397	.1457	.1512	.1555	.1536	.1677	.1838		
2005	.124	.1306	.1351	.1385	.141	.1464	.1505	.1548	.1552	.1644	.1688	.19	
2006	.1251	.1306	.1366	.1401	.143	.1493	.1542	.157	.1554	.1672	.1719	.1772	.2099

Notes: Number of observations for computing covariances is 952.
Source: Own calculations using the GSOEP data (1994-2006).

Table 5: Variance-Covariance Matrix - **Earnings** in the specification with **covariates** on the full sample

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1994	.0991												
1995	.0784	.0987											
1996	.0703	.0796	.1016										
1997	.0685	.0767	.0822	.0971									
1998	.0683	.0738	.0807	.0825	.0994								
1999	.0682	.0723	.0787	.0799	.0839	.1007							
2000	.0656	.0709	.0782	.0825	.0848	.0896	.1112						
2001	.0679	.0728	.0794	.079	.0822	.0869	.0977	.109					
2002	.0634	.0683	.0762	.0755	.0789	.0834	.0926	.0952	.1151				
2003	.0661	.071	.0733	.0763	.0794	.0836	.0928	.0947	.0987	.1271			
2004	.0639	.0693	.0723	.0734	.0781	.0836	.0922	.095	.0968	.1076	.1245		
2005	.0622	.0684	.0741	.0763	.0794	.0842	.092	.0946	.0988	.1048	.1101	.1319	
2006	.0606	.0654	.0716	.0739	.0777	.0836	.0909	.0922	.0949	.1031	.1089	.1147	.1438

Notes: Number of observations for computing covariances is 952. See Section 3 for the full list of covariates.
Source: Own calculations using the GSOEP data (1994-2006).

Table 6: Variance-Covariance Matrix - **Wages** in the specification with **a constant** on the full sample

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1994	.1694												
1995	.1465	.1678											
1996	.1303	.1381	.1621										
1997	.1303	.1384	.139	.1605									
1998	.1257	.1311	.1331	.1373	.1544								
1999	.1263	.1287	.1313	.135	.1352	.1556							
2000	.124	.1274	.1346	.1395	.1373	.145	.1633						
2001	.128	.1323	.1369	.1387	.1362	.1415	.1497	.1664					
2002	.1198	.1243	.1297	.1302	.1306	.1375	.1442	.1479	.1706				
2003	.1234	.1291	.1279	.1339	.1317	.1382	.1446	.148	.15	.1816			
2004	.1203	.1247	.1268	.1292	.1292	.1377	.1434	.1468	.1465	.1576	.1742		
2005	.1199	.1246	.1285	.1325	.1307	.1379	.1423	.1471	.1505	.155	.1562	.18	
2006	.1219	.1256	.1299	.1351	.1344	.1434	.147	.1492	.1513	.1582	.1599	.1639	.202

Notes: Number of observations for computing covariances is 952.
Source: Own calculations using the GSOEP data (1994-2006).

Table 7: Variance-Covariance Matrix - **Wages** in the specification with **covariates** on the full sample

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1994	.0972												
1995	.0774	.1002											
1996	.0684	.0772	.1058										
1997	.0688	.0778	.0831	.1049									
1998	.0652	.0716	.0781	.0826	.1005								
1999	.0671	.07	.0761	.0799	.0811	.1007							
2000	.0624	.0666	.0771	.0819	.0808	.0873	.1083						
2001	.0649	.0697	.0781	.0798	.0783	.0827	.0933	.1083					
2002	.0622	.0667	.0744	.0747	.0759	.0816	.091	.0933	.1187				
2003	.0635	.0695	.071	.0767	.0754	.0813	.09	.0921	.0971	.127			
2004	.0634	.0676	.0721	.0741	.0749	.0821	.0905	.0926	.0952	.1047	.1231		
2005	.0627	.0672	.0738	.0775	.0764	.0822	.0898	.0931	.0993	.1024	.1056	.1298	
2006	.0615	.0647	.0707	.0758	.0759	.0838	.0897	.0907	.0962	.1013	.1051	.1096	.1444

Notes: Number of observations for computing covariances is 952. See Section 3 for the full list of covariates.
Source: Own calculations using the GSOEP data (1994-2006).

Table 8: Variance-Covariance Matrix - **Earnings** in the specification with **a constant** on the reduced sample (male only)

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1994	.1606												
1995	.1401	.1627											
1996	.1268	.1387	.1612										
1997	.125	.1346	.1386	.1558									
1998	.1261	.1331	.1389	.1411	.1613								
1999	.1242	.1295	.1364	.1378	.1428	.1617							
2000	.1242	.1305	.1384	.1443	.1474	.1539	.1733						
2001	.1281	.1336	.1401	.1402	.1452	.1514	.159	.1724					
2002	.1151	.1208	.1314	.1303	.1365	.1416	.1475	.1516	.1698				
2003	.1188	.1261	.1304	.1342	.1385	.1431	.1502	.1528	.151	.1828			
2004	.1155	.1233	.1278	.1291	.1362	.1432	.1485	.1523	.1486	.162	.1808		
2005	.1155	.1231	.1315	.1338	.1395	.1457	.1499	.1529	.1521	.1581	.1664	.1863	
2006	.1143	.1201	.1303	.1328	.1403	.1474	.1529	.154	.1504	.162	.168	.1733	.1967

Notes: Number of observations for computing covariances is 728.
Source: Own calculations using the GSOEP data (1994-2006).

Table 9: Variance-Covariance Matrix - **Earnings** in the specification with **covariates** on the reduced sample (male only)

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1994	.0921												
1995	.0717	.0936											
1996	.0656	.0766	.1042										
1997	.0625	.071	.08	.0951									
1998	.0639	.07	.0805	.0807	.1011								
1999	.063	.0672	.078	.0771	.0824	.1009							
2000	.0604	.066	.0774	.0804	.0838	.0896	.1125						
2001	.064	.0689	.0789	.0763	.0816	.0873	.0976	.1104					
2002	.0576	.0625	.0749	.071	.0772	.0814	.0905	.0938	.1153				
2003	.0578	.0644	.0709	.0715	.0761	.0803	.0901	.0921	.0944	.1232			
2004	.056	.0626	.069	.0672	.0741	.0804	.0889	.0921	.0922	.1027	.1222		
2005	.055	.0615	.0721	.0714	.077	.0824	.09	.0923	.0952	.0984	.1076	.1275	
2006	.0522	.0564	.0675	.0671	.0749	.0815	.0895	.0901	.091	.0993	.1063	.1115	.1329

Notes: Number of observations for computing covariances is 728. See Section 3 for the full list of covariates.
Source: Own calculations using the GSOEP data (1994-2006).

Table 10: Variance-Covariance Matrix - **Wages** in the specification with **a constant** on the reduced sample (male only)

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1994	.1623												
1995	.1406	.1639											
1996	.126	.1358	.1655										
1997	.126	.1346	.1372	.1601									
1998	.1225	.1285	.1323	.1356	.1576								
1999	.125	.1268	.1322	.1354	.1371	.1617							
2000	.1205	.1244	.1344	.1387	.1377	.1491	.1671						
2001	.1238	.1284	.1354	.1358	.1349	.1433	.151	.1666					
2002	.1141	.1176	.1272	.1242	.1283	.1375	.1437	.1453	.17				
2003	.1154	.1219	.1238	.1277	.1273	.137	.143	.1435	.1441	.1769			
2004	.1128	.1175	.1227	.1231	.1254	.1371	.1421	.1439	.1418	.1526	.1727		
2005	.1139	.1182	.1268	.1287	.1284	.1392	.1429	.1459	.1475	.1488	.1538	.1774	
2006	.114	.1167	.125	.129	.1312	.1441	.1477	.146	.1468	.1531	.1567	.1607	.1915

Notes: Number of observations for computing covariances is 728.
Source: Own calculations using the GSOEP data (1994-2006).

Table 11: Variance-Covariance Matrix - **Wages** in the specification with **covariates** on the reduced sample (male only)

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1994	.0913												
1995	.0704	.0937											
1996	.0634	.0731	.1088										
1997	.063	.0711	.0799	.102									
1998	.0601	.0658	.0755	.0781	.1005								
1999	.0629	.0644	.0745	.0766	.0789	.1021							
2000	.0567	.0604	.0748	.0777	.0774	.087	.1077						
2001	.0596	.064	.0757	.0749	.0744	.0817	.0913	.1066					
2002	.0557	.0588	.071	.0669	.071	.0785	.0872	.0886	.1155				
2003	.0553	.0614	.0665	.0688	.0689	.0776	.0854	.0857	.0894	.121			
2004	.0557	.0596	.0677	.0665	.069	.079	.0867	.0883	.0888	.0985	.1208		
2005	.0555	.0591	.0711	.0715	.0713	.0802	.0868	.0895	.0938	.0941	.1013	.1245	
2006	.0535	.055	.0654	.0681	.0708	.0822	.0877	.0861	.0903	.0952	.1013	.1049	.1339

Notes: Number of observations for computing covariances is 728. See Section 3 for the full list of covariates.
Source: Own calculations using the GSOEP data (1994-2006).

Table 12: Parameter Estimates - Reduced Sample (Male Only)

	AR(1)				ARMA(1,1)			
	Earnings		Wages		Earnings		Wages	
	constant	covariates	constant	covariates	constant	covariates	constant	covariates
$\sigma^2_{v_0}$	0.080	0.060	0.084	0.062	0.046	0.033	0.056	0.035
	(0.015)	(0.014)	(0.022)	(0.020)	(0.006)	(0.005)	(0.007)	(0.005)
σ^2_μ	0.097	0.039	0.101	0.040	0.086	0.029	0.083	0.028
	(0.002)	(0.002)	(0.003)	(0.002)	(0.004)	(0.003)	(0.005)	(0.003)
σ^2_ε	0.029	0.025	0.034	0.031	0.038	0.034	0.039	0.036
	(0.004)	(0.004)	(0.005)	(0.004)	(0.003)	(0.002)	(0.003)	(0.002)
ρ	0.652	0.655	0.590	0.574	0.868	0.897	0.867	0.880
	(0.024)	(0.024)	(0.027)	(0.027)	(0.028)	(0.015)	(0.027)	(0.022)
γ					-0.418	-0.437	-0.497	-0.494
					(0.032)	(0.020)	(0.027)	(0.022)
p_{1995}	1.046	1.077	1.030	1.052	1.041	1.062	1.040	1.060
	(0.014)	(0.030)	(0.017)	(0.033)	(0.011)	(0.027)	(0.013)	(0.028)
p_{1996}	1.099	1.231	1.071	1.205	1.113	1.263	1.100	1.245
	(0.015)	(0.033)	(0.018)	(0.037)	(0.016)	(0.043)	(0.017)	(0.040)
p_{1997}	1.111	1.198	1.085	1.203	1.121	1.193	1.113	1.228
	(0.016)	(0.034)	(0.019)	(0.038)	(0.017)	(0.046)	(0.020)	(0.045)
p_{1998}	1.153	1.283	1.085	1.207	1.158	1.266	1.105	1.206
	(0.017)	(0.037)	(0.019)	(0.040)	(0.019)	(0.054)	(0.022)	(0.051)
p_{1999}	1.205	1.376	1.172	1.357	1.219	1.395	1.225	1.427
	(0.018)	(0.040)	(0.022)	(0.045)	(0.024)	(0.066)	(0.029)	(0.060)
p_{2000}	1.242	1.495	1.193	1.434	1.231	1.377	1.227	1.453
	(0.019)	(0.045)	(0.023)	(0.048)	(0.028)	(0.084)	(0.032)	(0.081)
p_{2001}	1.322	1.661	1.213	1.454	1.377	1.633	1.263	1.553
	(0.018)	(0.043)	(0.024)	(0.051)	(0.032)	(0.115)	(0.035)	(0.079)
p_{2002}	1.176	1.433	1.132	1.373	1.160	1.354	1.165	1.409
	(0.019)	(0.044)	(0.021)	(0.046)	(0.025)	(0.077)	(0.031)	(0.077)
p_{2003}	1.203	1.427	1.142	1.367	1.196	1.358	1.187	1.413
	(0.018)	(0.043)	(0.021)	(0.045)	(0.025)	(0.078)	(0.032)	(0.080)
p_{2004}	1.192	1.420	1.135	1.400	1.203	1.416	1.206	1.529
	(0.018)	(0.041)	(0.020)	(0.045)	(0.024)	(0.079)	(0.032)	(0.082)
p_{2005}	1.217	1.466	1.168	1.456	1.243	1.527	1.263	1.662
	(0.018)	(0.041)	(0.020)	(0.046)	(0.024)	(0.084)	(0.035)	(0.092)
p_{2006}	1.232	1.446	1.193	1.449	1.257	1.478	1.285	1.611
	(0.017)	(0.040)	(0.020)	(0.044)	(0.024)	(0.080)	(0.034)	(0.082)
λ_{1996}	0.875	0.959	0.932	1.008	0.859	0.938	0.941	1.015
	(0.062)	(0.070)	(0.074)	(0.078)	(0.034)	(0.034)	(0.034)	(0.033)
λ_{1997}	0.822	0.918	0.873	0.957	0.818	0.908	0.921	0.990
	(0.070)	(0.077)	(0.080)	(0.083)	(0.039)	(0.036)	(0.041)	(0.038)
λ_{1998}	0.778	0.892	0.844	0.934	0.805	0.907	0.927	0.991
	(0.075)	(0.082)	(0.083)	(0.085)	(0.044)	(0.041)	(0.045)	(0.041)
λ_{1999}	0.574	0.731	0.603	0.728	0.676	0.804	0.754	0.858
	(0.089)	(0.087)	(0.102)	(0.094)	(0.057)	(0.053)	(0.062)	(0.051)
λ_{2000}	0.647	0.699	0.646	0.692	0.769	0.909	0.818	0.886
	(0.088)	(0.097)	(0.102)	(0.109)	(0.062)	(0.055)	(0.065)	(0.060)
λ_{2001}	-0.076	-0.046	0.485	0.593	0.316	0.679	0.745	0.794
	(0.103)	(0.114)	(0.124)	(0.115)	(0.140)	(0.097)	(0.070)	(0.065)
λ_{2002}	0.791	0.835	0.850	0.881	0.866	0.935	0.961	0.985
	(0.077)	(0.087)	(0.085)	(0.090)	(0.049)	(0.047)	(0.050)	(0.048)
λ_{2003}	0.882	0.956	0.906	0.965	0.921	0.998	0.993	1.036
	(0.076)	(0.086)	(0.084)	(0.089)	(0.048)	(0.046)	(0.050)	(0.047)
λ_{2004}	0.916	0.980	0.900	0.940	0.909	0.966	0.937	0.962
	(0.076)	(0.087)	(0.084)	(0.089)	(0.048)	(0.046)	(0.050)	(0.048)
λ_{2005}	0.910	0.978	0.858	0.897	0.886	0.932	0.873	0.882
	(0.076)	(0.087)	(0.084)	(0.089)	(0.049)	(0.046)	(0.053)	(0.054)
λ_{2006}	1.007	1.090	0.969	1.035	0.953	1.010	0.964	1.014
	(0.079)	(0.091)	(0.085)	(0.089)	(0.051)	(0.046)	(0.053)	(0.049)
N	91	91	91	91	91	91	91	91

Notes: See Section 3 for the full list of covariates.

Source: Own calculations using the GSOEP data (1994-2006).