DIW BERLIN

1514

Discussion Papers

Deutsches Institut für Wirtschaftsforschung 2015

The Dynamics of Earnings in Germany

Evidence from Social Security Records

Timm Bönke, Matthias Giesecke and Holger Lüthen

IMPRESSUM

DIW Berlin
German Institute for Economic Research
Mohrenstr. 58
10117 Berlin

Tel. +49 (30) 897 89-0
Fax +49 (30) 897 89-200
http://www.diw.de

ISSN electronic edition 1619-4535

Papers can be downloaded free of charge from the DIW Berlin website:
http://www.diw.de/discussionpapers

Discussion Papers of DIW Berlin are indexed in RePEc and SSRN:
http://ideas.repec.org/s/diw/diwwpp.html
http://www.ssrn.com/link/DIW-Berlin-German-Inst-Econ-Res.html

The Dynamics of Earnings in Germany: Evidence from Social Security Records

Timm Bönke
(timm.boenke@fu-berlin.de)
Freie Universität Berlin

Matthias Giesecke
(matthias.giesecke@rwi-essen.de)
RWI Essen

Holger Lüthen
(holger.luethen@fu-berlin.de)
Freie Universität Berlin and DIW Berlin

October 2015

Abstract: This paper uncovers ongoing trends in idiosyncratic earnings volatility across generations by decomposing residual earnings auto-covariances into a permanent and a transitory component. We employ data on complete earnings life cycles for prime age men born 1935 through 1974 that covers earnings between 1960 and 2009. Over this period, the German labor market undergoes a heavy transformation and experiences strong deregulation, deunionization and a shift in employment from the industrial to the service sector. Our findings of increases in both components reflect the distinct phases of this transformation process. In magnitude, the transitory component increases most strongly in the early 1970s and the 1990s for young workers, whereas the permanent component displays the strongest increases for older workers in the early 1980 and the 2000s. Thus, the changes complicate the labor market entry for young workers while widening wage differences for established workers.

Keywords: Earnings dynamics, Life cycle, Earnings distribution, Inequality, Earnings volatility

JEL Classification: D31, D33, H24.

Acknowledgement: We thank the team of the Data Research Centre of the German Federal Pension Insurance for their support as well as Charlotte Bartels, Giacomo Corneo, Peter Haan, Johannes König, Adam Lederer, Carsten Schröder and the participants of various venues for their helpful comments and discussion. We especially thank Lorenzo Cappellari for providing invaluable insights and suggestions. All correspondence to: holger.luethen@fu-berlin.de

1 Introduction

Labor markets and their earnings structure are continuously subject to profound changes. Examples are globalization, skill biased technological change, demographic trends, booms and recessions – frequently followed by adjustments of (labor market related) institutions. All of these are discussed extensively in the literature, impacting labor market earnings and their volatility over the life cycle, altering idiosyncratic earnings risks and earnings levels associated with labor market experience, age, cohort or skill set. In an economic environment characterized by incomplete insurance, a thorough analysis of these earnings dynamics and earnings risks over the life cycle is linked not only to individual financial decisions like wealth accumulation (Hugget, 1996; Castaneda et al., 2003), but also to lifetime earnings inequality (Bönke et al., 2015) and consumption capabilities (Gourinchas and Parker, 2002; Guvenen, 2007). It is also connected to the welfare costs related to earnings fluctuations (Storesletten et al., 2001; Blundell and Preston, 2008), and how insurance through welfare states is able to enhance overall welfare by mitigating these earnings risks efficiently (e.g. Blundell et al., 2014). For these issues, a deep understanding of the (changing) nature of labor market outcomes and of the persistence and variance of labor market shocks is needed.

This paper sheds light on the age related patterns of idiosyncratic earnings volatility over complete life cycles for West German males born between 1935 and 1974 from 1960 through 2009. Considering consistency and comparability, we focus on the main employment phase between 25 and 59. The period extends from the German "Wirtschaftswunder"-era up to the post-unification downturns that coined Germany the *sick man of Europe* (e. g. Economist, 2004). The long time frame offers unique possibilities to analyze cohorts' earnings dynamics against the background of varying economic circumstances and institutional changes like labor market deregulation, deunionization and a shift in employment from the industrial to the service sector.

To analyze earnings dynamics over extended periods, we employ a model that distinguishes between long- and short-term shocks to individual earnings trajectories. This allows disentangling earnings inequality and instability. The model relies on decomposing the auto-covariances of residual earnings into a permanent and a transitory component. Essentially, our model extends the model of Baker and Solon (2003). Our extension explicitly enables us to model the two sources of variation in earnings data (MaCurdy, 2007; Bowlus and Robin, 2012): (1) Macroeconomic dynamics relate to business cycle fluctuations, institutional changes or growth that cause changes to cross-sectional distributions over time. (2) Microeconomic dynamics define the changes of individuals' relative positions within cross-sectional distributions of successive periods. Microeconomic dynamics are modeled as follows: The permanent component considers permanent shocks to, as

well as differences in, individual earnings trajectories by the inclusion of both a random walk and random growth. This captures differences in earnings levels and growth patterns due to education, effort, tenure, as well as permanent up- or downward shifts of earnings paths due to, e.g., health shocks. The transitory component is modeled as an AR(1) process with additional flexibility through a quartic age term that allows diverging shock levels by age. To correctly identify these life cycle parameters, macroeconomic dynamics are explicitly modeled as calendar time shifters for both permanent and transitory component. For an accurate identification of generational differences, the model also includes cohort shifters for both components.

As a general pattern across life cycles, we find that the permanent component steadily increases as the individual ages. The transitory component is almost u-shaped over the life cycle. In the early stages, the predominant share of earnings volatility is explained by short-term fluctuations, which typically vanish after about two years. Long-term divergences then become more relevant, surpassing the transitory component in its relative importance around age 35. This mirrors the structure of earnings trajectories, which are typically settled after age 35 in Germany (e.g. Bönke et al., 2015), and implies that shocks endured thereafter are more likely to be permanent. At the end of the life cycle, the transitory component again increases in relevance. Thus, shocks to the cohorts' earnings paths in close distance to retirement are not likely to be permanent but rather reflect an opting out of the labor market.

Comparing earnings dynamics from 1960 to 2009, our results indeed suggest a rising overall variance through an increase in both permanent and transitory component. For the transitory component, we identify that the increase started in the mid-1970s and intensified in the mid-1990s. The increase is especially pronounced for younger workers. Thus, establishing themselves on the labor market became increasingly more demanding for labor market entrants because earnings paths were interrupted more often. For the permanent component, we find strong increases since the 1980s that amplify in the early 2000s. In terms of magnitude, the permanent component increases more strongly for workers well established in their careers. Hence, persistent differences, such as education, entail a lower earnings path for low skilled workers and a higher one for highly skilled workers (Blundell et al., 2014). Further, the increasing importance of permanent shocks indicates that it becomes more difficult for individuals to reestablish themselves on the labor market after large shocks like health shocks or involuntary job loss both over the life cycle and across generations. The findings relate well to the overall developments on the German labor market.

Our paper relates particularly to three strands of the literature. First, we relate to studies on inequality in Germany, which typically document increasing cross-sectional and lifetime earnings. Reasons are, e. g., overall wage dispersion, increasing plant level heterogeneity (Card et al., 2013), deunionization, deregulation, job polarization (Dustmann et al., 2009) or a steep decrease of employment spells (Bönke et al., 2015). Our findings are consistent with these explanations, as they imply more divergent earnings paths and decreasing job stability. We complement by uncovering what part of inequality is transitory and what part is permanent at various points of the life cycle and how these patterns evolve across generations. This gives a deeper understanding of how past and current and inequality trends are composed.

Second, our study relates to papers similarly decomposing the development of earnings inequality and instability in a specific country over time, e.g. Shin and Solon (2011) and Gottschalk and Moffitt (1994; 2002; 2012) for the United States, Baker and Solon (2003) for Canada or Cappellari (2004) for Italy.[1] Similar to our results, most studies find increasing earnings volatility over time, which is to a larger extent driven by permanent inequality. Since our data allows the analysis of entire earnings life-cycles, we complement by showing how to fit variance decompositions over extensive time periods.[2] Further, we provide comprehensive results for Germany. We confirm many previously documented results and therefore validate the decomposition approach for the shorter panels used in previous studies.

Finally, we look at complete life cycles. Therefore, this paper relates to studies that contribute to the microeconomic dynamics of life cycle earnings risk[3] with the purpose of providing evidence for an improved calibration of macroeconomic models, stressing the importance of heterogeneous age-specific innovations (e.g. Guvenen, 2009; Karahan and Ozkan, 2013). While the parameters of our model can be also used for calibration, our results foremost emphasize the inclusion of cohort differences. Microeconomic dynamics of the life cycle are also analyzed with regard to education (Meghir and Pistaferri, 2004), family context (Blundell et al., 2014; Bingley et al., 2014), and shocks of higher moments across the distribution (Guvenen et al. 2014; Guvenen et al., 2015). We contribute by modeling complete life-cycles with the inclusion of macroeconomic dynamics and generational differences. While still identifying common microeconomic dynamics, we show that permanent and transitory shocks vary substantially across generations.

[1] There are also studies on e.g. Great Britain by Dickens (2000), Luxembourg by Sologon and Van Kerm (2014), Sweden by Gustavsson (2008) or Denmark (Bingley et al., 2013). Oftentimes, subgroup developments are compared (e. g. blue vs. white collar workers, education groups, immigrants vs. natives).

[2] Most studies focus on shorter 15 to 25 year periods and none of the underlying datasets used in other studies include enough data to cover complete life cycles.

[3] These papers disregard macroeconomic dynamics and abstract from cohort and calendar time effects.

The remainder of this study is structured as follows: Section 2 describes key facts on the evolution of the German labor market. Section 3 provides the theoretical model on earnings dynamics, while Section 4 presents the underlying dataset, related issues and sample descriptives. Section 5 covers the main estimation results, discusses the implications and relates the findings to the developments on the German labor market. Section 6 concludes.

2 Macroeconomic trends and institutional changes in Germany since 1950

For classification and interpretation of empirical long run trends, this section gives a concise overview on major changes affecting the West German labor market since 1950 – supported by key indicators in Figures 1 and 2. In addition to standard indicators for overall economic performance, such as annual GDP growth and unemployment, Figure 1 provides an indicator for openness and the shares of employees by sector.[4] Openness relates to international connectedness and increasing connectedness likely threatens wages of low-skilled workers and potentially increases inequality (e. g. Krugman and Venables, 1995; Wood, 1995). The shares of employees reveal which of the three sectors employs most: industry, services or agriculture. Each sector entails distinct properties regarding e.g. remuneration rules or type of employment contracts. Therefore, shifts in sectoral importance can translate into changes in wage dispersion and job security. Figure 2 provides the ratio of union members and employees to the percentage of employees covered by sectoral contracting agreements. Sectoral contracting implies that contracts for these employees are negotiated between employer associations and trade unions on national or federal state level. Both indicators describe union power, which in turn relates to wage compression and inequality (e.g. Acemoglu et al., 2001). Figure 2 also covers indicators of labor market deregulation and shows the shares of subcontracted employees and of those with fixed term contracts.[5]

The developments on the West German labor market following World War II can be divided into three distinct phases. The first phase, the German *Wirtschaftswunder,* lasted from after World War II in the late 1940s throughout the early 1970s. After regaining some political independence from Allied Powers, the West German economy transformed rapidly and began producing consumer goods and equipment. Labor demand increased immensely through a combination of ongoing reconstruction of war damages, increasing consumer demand, as well as the relocation of firms and

[4] We define openness as the combined share of imports and exports over GDP. Alternative measures of openness like foreign direct investment show similar trends.

[5] In addition, Table C.1 provides an overview on the chronology of laws regarding labor market (de)regulation since 1972.

manufacturing bases from East Germany to the West.[6] Until around 1950, large inflows of about 8 million displaced German workers from the former eastern territories of the German Reich satisfied this demand (Bauer et al., 2013). Labor demand was then met by the westward migration of East Germans (until 1961) and the recruitment of guest workers (late 1950s to early 1970s).[7] Naturally, the strong labor demand and high GDP growth rates coincided with extremely low unemployment rates (Figure 1). More than half of the employees worked in the industrial sector, characterized by strong unions, high job security and a rather compressed wage distribution due to sectoral agreements (Figures 1 and 2). Figure 2 also reveals that there was one union member for every three employees[8] and that sectoral contracting covered more than four-fifths of all employees. During this period, legislators expanded the welfare state and enhanced labor contract protection (Bartels, 2014).

Between the mid-1970s and German reunification in 1990, this successful system started to dissolve. Global developments gained influence and increasingly affected the interconnected German economy (Figure 1), while competitiveness became a growing issue. The first oil price shock in 1973 caused a recession with unemployment rates tripling, reaching 5%. The share of employment in the manufacturing sector started declining steadily while that of the service sector grew continuously; employment trends that continue to this day (Figure 1).[9] While unions remained strong, legislators slightly deregulated the labor market and introduced subcontracted work in 1972 to increase flexibility (Table C.1 and Figure 2). After the second oil price shock in 1979/80, another major recession hit Germany, causing unemployment to rise to more than 9% (Figure 1). Legislators considered labor market rigidity to be a key problem and lowered employment protection, expanded possibilities for subcontracted work, and introduced fixed term contracts (Table C.1). At the same time, the ratio of union members to employees declined, while sectoral coverage remained about constant (Figure 2).

[6] For example, Buenstorf and Guenther (2010) find that 23% of the East German machine tools industry reallocated to West Germany shortly after World War II.

[7] Until 1950, the labor force grew mainly due to forced migration of Germans from Eastern Europe following the conclusion of World War II. The bulk of the displaced originated from the former eastern territories of the German Reich (Pomerania, Prussia, Silesia). The inflow of migrants from the German Democratic Republic numbers about 2.6 million and stopped with the closing of the inner German border, best symbolized with the Berlin Wall in 1961. In the late 1950s, the West German government started a large scale recruitment of guest workers due to a shortage in low-skilled labor (Bauer et al., 2005). This active manpower recruitment included treaties with several countries, most notably Italy (1955), Spain and Greece (1961), Turkey (1961) and former Yugoslavia (1968). For a detailed description of the recruitment procedure, see Bauer et al. (2005).

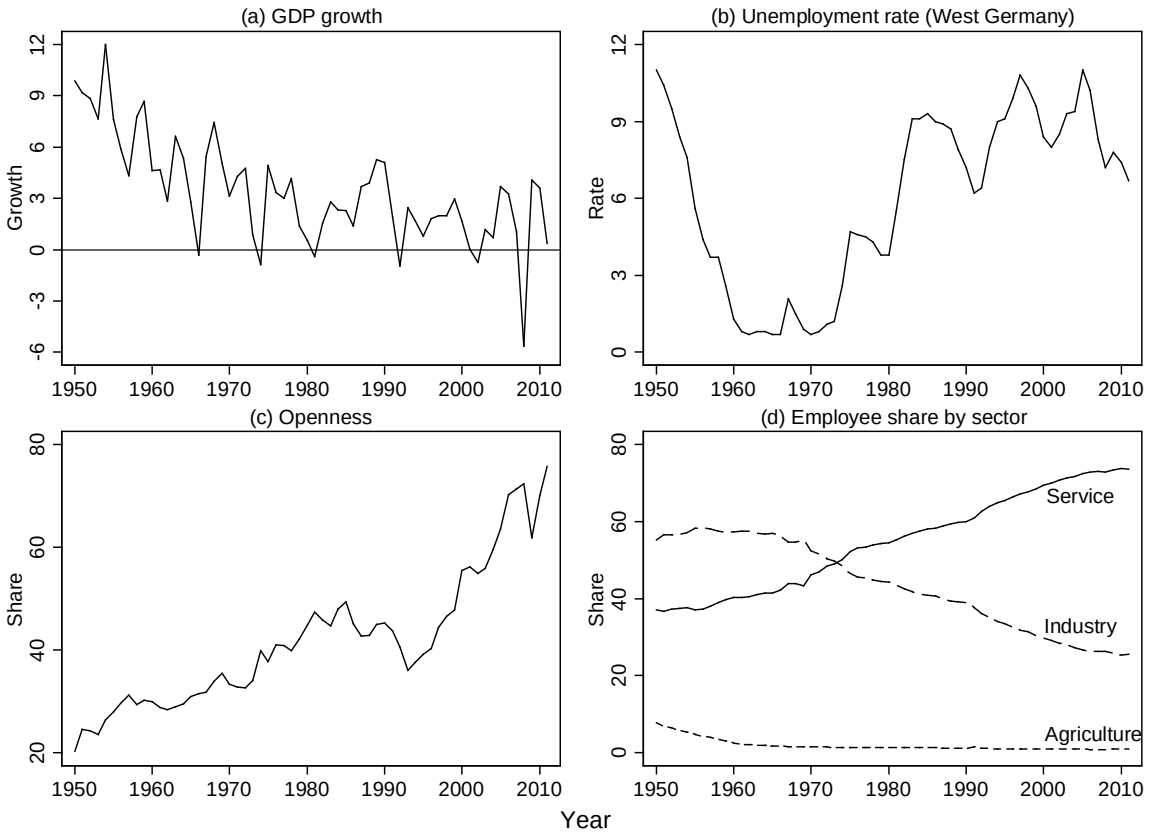
[8] The large migration inflow reduced the ratio of union members to employees until 1960, but this does not qualify as a trend.

[9] For example, the number of West German firms in textile industry dropped from 14,400 in 1960 to 4,000 in 2000, a trend common in industrialized countries (Bartels, 2014).

After a short lived boom following reunification in the early 1990s, a subsequent recession marked another turning point for the German labor market. Already experiencing mass unemployment, growing competition from the former socialist European countries put additional pressure especially on low skilled individuals. Further, the West German labor market was the target of migration for about 5 million people between 1989 and 1995, amplifying this pressure.[10] Influx and availability of new labor directly affected unemployment, reaching 10.8% in 1997. In addition, East Germans started to leave unions after reunification. Overall union membership dwindled even more rapidly than before, falling below 25% in 1997 (Figure 2). At the same time, sectorial contracting covered only about two-thirds of employees. Especially after 1996, newly established plants are no longer part of the classical sectoral contracting system (Card et al., 2013). The manufacturing sector employed less than one-third of the work force, with the remainder finding employment in the service sector (Figure 1). The decline in both union coverage and the industrial employment reflected continuing trends that started in the 1970s. Simultaneously, the fiscal imbalance grew: in particular social expenditures steadily rose due to costs related to unifying Germany's labor market and social security system (Bartels, 2014). By the mid-1990s, a high public deficit, low growths rates and peaking unemployment made Germany the *sick man of Europe* (e. g. Economist, 2004). Again, legislators saw labor market rigidity and high per unit labor costs as the key labor market problem and strongly expanded the possibilities of fixed term and subcontracted work (see Table C.1.). In what followed, economic openness strongly increased as Germany became a more integrated economy. Germany eventually recovered from being *the sick man of Europe,* but its labor market radically changed in the process- with effects on the evolution of earnings dynamics.

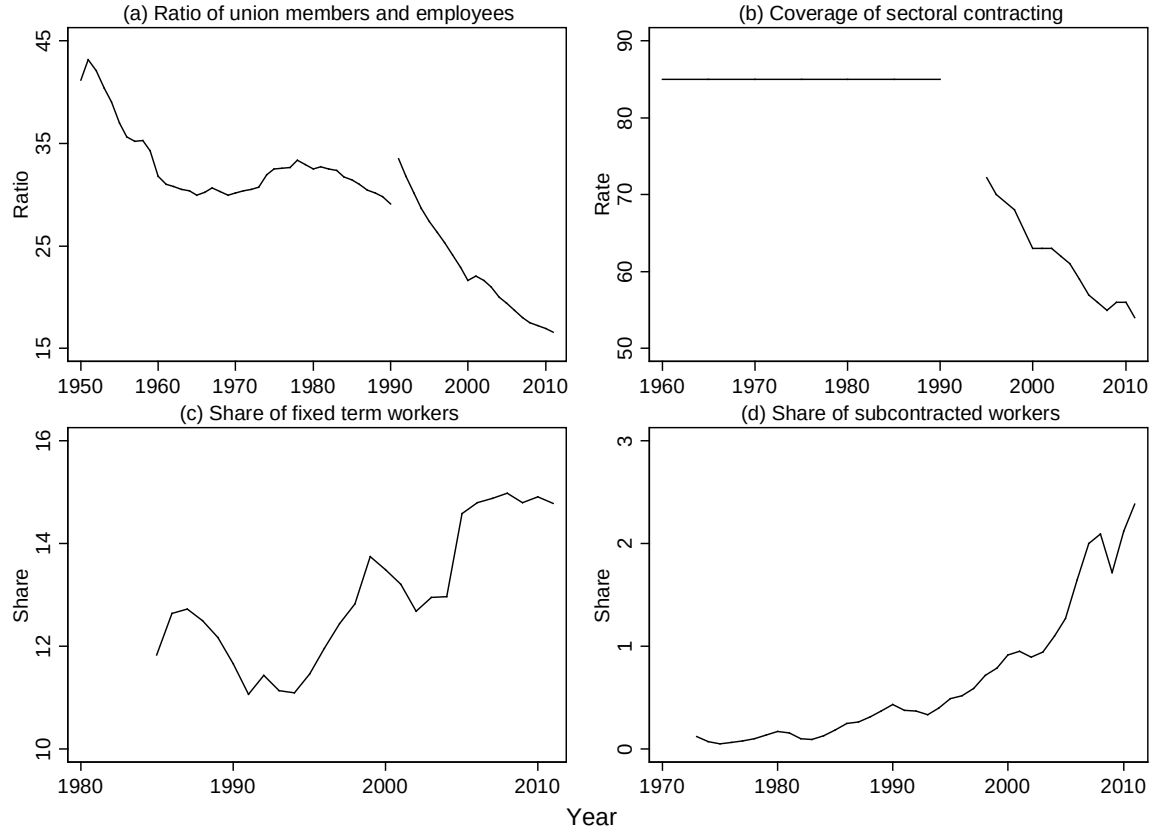
Figure 1: Macroeconomic development in Germany: GDP, unemployment, openness and sectoral employment

[10] The majority of the immigrants to West Germany originated from former socialist Eastern Germany. However, starting with the fall of the Irion Curtain in 1989 until 1995, each year several hundred thousand native German immigrants (Spätaussiedler) and foreign workers from former socialist Eastern European territories immigrated to Germany (Bauer et al., 2005). Bauer et al. (2005) further report that asylum-seekers and refugees led to the historical peak of 782,000 net immigrants in 1992.



Note: Panels (a), (c) and (d) display West Germany before 1990 and reunited Germany thereafter. Panel (b) shows West Germany only, as East German unemployment rates are substantially higher. Openess is defined as the combined share of imports and exports over GDP.
Source: Federal Statistical Office (2015), own calculations.

Figure 2: Union membership, sectoral coverage and shares of fixed term and subcontracted workers



Note: Panels (a), (c) and (d) display West Germany before 1990 and reunited Germany thereafter. Panel (b) displays results for West Germany only.

Source: Panel (a): Deutscher Gewerkschaftsbund (2015); Panel (b) until 1990: Armingeon et al. (2014): Panel (b) after 1995: Kohaut and Schnabel (2002), Ellgut and Kohaut (2005, 2008, 2013); Panels (c) and (d): Federal Statistical Office (2015)

3 Model and estimation

Our aim is to model earnings dynamics over entire life cycles, while explicitly modeling micro- and macroeconomic dynamics. Further, we distinguish between permanent (or long-term) and transitory (or short-term) earnings path deviations.[11] The microeconomic dynamics of the permanent income component should mirror the most important, well documented, features of labor markets. Therefore, we rely on two processes- a random growth and a random walk. The random growth process relates to a Mincerian approach and captures earnings growth due to labor market experience or on the job training/tenure. This allows individuals to have permanently higher or lower growth paths than other individuals (or the cohort average). Different paths are caused by e.

[11] Comparable models date back to Lillard and Weiss (1979) and Hause (1980). Our model is essentially an extension of the model developed by Baker and Solon (2003). See Meghir and Pistaferri (2011) for an overview on the evolution of related models.

g. different levels of innate abilities, effort levels or education. The random walk captures permanent divergences from the individual's expected earnings path that do not fade over time, e. g. through job displacements, negative health shocks, or additional qualifications achieved after entering the labor market.[12] Transitory shocks on the other hand describe temporary deviations from individual permanent earnings paths that fade as the individual ages. The shock persistence is modeled by assuming an AR(1) process. We now build the model step by step.

Decomposing individual i's log earnings into period t and cohort c specific mean earnings $\bar{y}_{ct}$ and the deviations from it, we get:

(1) $$earnings_{ict} = \bar{y}_{ct} + y_{ict},$$

where y_{ict} is the individual deviation from the cohort mean. In the present case, individuals range from $i = 1, \dots N$, periods and cohorts covered are $t = 1960, \dots, 2009$ and $c = 1935, \dots, 1974$. An important feature of modelling individual deviations from cohort and period specific mean earnings is its equivalency to including cohort specific age dummies. This is crucial as we investigate individual life cycles of up to 35 years (from age 25 to 59) and cover a 50 year period (from 1960 to 2009). Therefore, individual profiles are likely to be subject to cohort and age specific wage growth. By subtracting the mean (de-meaning), this growth is controlled for.[13] The individual specific deviation is now assumed to be additively decomposable into a permanent (y_{ict}^P) and a transitory component (y_{ict}^T):

(2) $$y_{ict} = y_{ict}^P + y_{ict}^T$$

Further, we define $E\left[y_{ict}^P\right] = E\left[y_{ict}^T\right] = 0$ and $E\left[y_{ict}^P y_{ict}^T\right] = 0$. Thus, expected values of both components are zero and orthogonal. Considering the aforementioned specification of the permanent earnings as a combination of a random walk and a random growth, the assumed process has the following form:

(3) $$y_{ict}^P = \pi_t \kappa_c [\mu_i + \gamma_i (t - c - 25) + r_{ict}]$$

[12] This captures the idea that an additional degree obtained parallel to working from e.g. evening classes or weekend seminars permanently shifts the individual earnings path.

[13] This idea is introduced by Baker and Solon (2003) and is used by e. g. Bingley et al. (2013). Alternatives are regression approaches that include individual characteristics (e.g. Gottschalk and Moffitt, 2012; Meghir and Pistaferri, 2004). Since our dataset lacks most of the commonly used socio-economic characteristics, de-meaning seems the superior strategy. Further, Bingley et al. (2013) find that de-meaning gives similar results to first-stage regressions that include information on industry, education or local unemployment.

The permanent component differs by period through shifters π_t and by cohort through shifters κ_c. These factor loadings capture macroeconomic dynamics and time trends in the permanent earnings component and ensure correct identification of the microeconomic dynamics in core model parameters. They allow institutional changes like the introduction of temporary employment to affect cohorts in a different way. Still, all cohorts share the same core process of initial earnings μ_i, random growth $\gamma_i(t-c-25)$ and random walk r_{ict}. The random growth process $\gamma_i(t-c-25)$ reads as follows. Starting at age 25, the initial earnings of an individual μ_i grow with the individual specific growth rate γ_i over time. This specification ensures that earnings levels vary both in absolute terms and by the individual's ability to accumulate skills or exert effort over the life cycle.[14] Initial earnings as well as the growth rate are assumed to stem from zero mean distributions:

$$(\mu_i, \gamma_i) \sim \left[(0,0); \left(\sigma_\mu^2, \sigma_\gamma^2, \sigma_{\mu\gamma}\right)\right],$$

where σ_μ^2 captures the variance of the starting level and σ_γ^2 the variance of subsequent earnings growth. Then, $\sigma_{\mu\gamma}$ denotes the covariance between the two components. A positive $\sigma_{\mu\gamma}$ means that those with initially high earnings also experience higher subsequent earnings growth. If the covariance is negative, this suggests the existence of Mincerian cross-overs (e. g. Mincer 1974; Lillard and Weiss 1979; Hause, 1980; Baker and Solon, 2003; Bingley et al., 2013). Then, individuals with initially high earnings upon entering the labor market experience lower subsequent earnings growth. If so, within cohort earnings inequality will decrease in the beginning and then increase at later stages of the life cycle.

The random walk component r_{ict} is defined as:

(4) $$r_{ict} = r_{ic(t-1)} + u_{ict}.$$

As mentioned above, the permanent component includes shocks with permanent effects like job changes, job displacements or disabling injuries (e.g. MaCurdy 1982; Moffitt and Gottschalk, 1995; 2012; Baker and Solon, 2003). The random walk component is assumed to be i.i.d. with $u_{ict} \sim (0; \sigma_u^2)$. Then, the (independent) variance of permanent re-orderings is captured by σ_u^2, which allows a linear 'white noise' innovation in the permanent component (Baker and Solon, 2003). Note that these innovations do not vanish over the life course. In sum, the auto-covariance structure of permanent earnings for period t and period s can be written as:

[14] See e.g. Baker (1997), Baker and Solon (2003), Cappellari (2004), Bingley et al. (2013).

(5) $$Cov\left(y_{ict}^{P} y_{ics}^{P}\right) = \pi_t \pi_s \kappa_c^2 \left[\sigma_\mu^2 + \sigma_\gamma^2 ts + \sigma_{\mu\gamma}(t+s) + \sigma_u^2 s\right]$$

In an exemplary case for cohort $c = 1935$ in period $t = 1970$ the variance (hence for $t = s$) of the permanent component according to (5) is displayed in equation (5a). Note that the process builds on earnings of individuals who are at least 25 years of age. Therefore, cohort 1935 entered in 1960 and is 10 years past its entry in 1970:

(5a) $$Var\left(y_{i,1935,1970}^{P}\right) = \pi_{1970}^2 \kappa_{1935}^2 \left(\sigma_\mu^2 + 100\sigma_\gamma^2 + 20\sigma_{\mu\gamma} + 10\sigma_u^2\right)$$

For the microeconomic dynamics of the transitory component, several studies establish that a low order ARMA-process is sufficient. [15] Specifically, we follow e. g. Baker and Solon (2003) and model an AR(1) process for the transitory earnings component. Similarly, we adopt period (τ_t) and cohort (λ_c) specific shifters to explicitly model the influence of institutional changes or macroeconomic trends on specific cohorts and to correctly identify the microeconomic dynamics of earnings insecurity. For the transitory component we obtain:

(6) $$y_{ict}^{T} = \tau_t \lambda_c \nu_{it} \text{ and } \nu_{it} = \rho \nu_{i,t-1} + \epsilon_{it}$$

where ϵ_{it} is a random shock with $\epsilon_{it} \sim (0; \sigma_\epsilon)$ and $0 < \rho < 1$ the persistence of the transitory shock. The initial transitory variation at the first period of observation, $\nu_{i0} \sim (0; \sigma_0^2)$, is observed at $t - c - 25 = 0$ (thus at age 25). Subsequent earnings instability is captured by the variance of innovations σ_ϵ^2. Typically, earnings or wage instability is associated with a u-shaped pattern in age with higher instability for young (labor market entry) and old (labor market exit) workers. To allow earnings instability to vary with age, we follow Baker and Solon (2003) and incorporate a quartic age function (polynomial of the fourth degree) of the variance σ_ϵ. [16] In sum, the auto-covariance structure of transitory earnings can be written as:

(7) $$\begin{aligned} Var\left(y_{ict}^{T} y_{ict}^{T}\right) = \lambda_c^2 \big[& \rho^2 Var\left(\nu_{i,t-1}\right) \\ & + \tau_t^2 \left(\sigma_{\epsilon,0}^2 + (t-c)\sigma_{\epsilon,1}^2 + (t-c)^2 \sigma_{\epsilon,2}^2 + (t-c)^3 \sigma_{\epsilon,3}^2 \right. \\ & \left. + (t-c)^4 \sigma_{\epsilon,4}^2 \right) \big] \end{aligned}$$

[15] E. g. Moffitt and Gottschalk (2012) find that higher order ARMA-parameters are not significant.

[16] However, we deviate from Baker and Solon (2003) not only in the incorporation of permanent cohort shifters, but also in the incorporation of a transitory cohort shifter, λ_c , in addition to the usual transitory period shifter, τ_t. Further, Baker and Solon (2003) model cohort specific initial variances. However, more recent literature shows that those are subject to a potential bias due to left-censoring (e.g. Moffitt and Gottschalk, 2012). Since we observe cohorts from the beginning (here age 25), this bias does not apply to our setting. In order to ensure a comparison with other recent models and in order to be able to shorten the timeframe for a robustness test, we moved away from the cohort specific initial variances to cohort specific transitory shifters. The results for both specifications are not qualitatively different. Still, the latter specification gives a slightly better fit. Additional results are displayed in Appendix A.

And for $t \neq s$ we obtain:

(7a) $$Cov\left(y_{ict}^{T} y_{ics}^{T}\right) = \lambda_c^2\left(\rho Cov(v_{i,t-1} v_{is})\right)$$

Returning to our example from (5a), the variance of the transitory component for cohort 1935 in period 1960 amounts to:

(7b) $$Var\left(y_{i1935,1970}^{T}\right) = \lambda_{1935}^2\left[\rho^2 Var\left(v_{i1935,1969}\right) + \tau_{1970}^2(\sigma_{\epsilon,0}^2 + 10\sigma_{\epsilon,1}^2 + 100\sigma_{\epsilon,2}^2 + 1{,}000\sigma_{\epsilon,3}^2 + 10{,}000\sigma_{\epsilon,4}^2)\right]$$

Due to the orthogonality assumption, the total auto-covariance structure results from the sum of the permanent component (5) and the transitory component (7) or (7a) respectively. For the estimation procedure, we apply equally weighted minimum distance. See Appendix B for details.

4 Data and descriptives

4.1 Sample selection

We use *Versicherungskontenstichprobe* (VSKT)*,* German social security data, as provided by Deutsche Rentenversicherung.[17] A stratified random sample, the VSKT provides the records of mandatorily insured employees in Germany. The requirements are at least one (pension relevant) entry in the employment biography and 30 to 67 years of age in the reference year. We use the waves of the reference years 2002 and 2004-2009. The VSKT contains the employment biographies after 14 years of age until the age in the reference year (up to a maximum of 67 years of age). These biographies include monthly information on (un-)employment, sickness and pension contributions. The latter are used to calculate the individual earnings. In line with most of the literature on earnings component models using administrative data, we only consider earnings covered by social security. Earnings from self-employment and government transfers are not included in our wage measure.[18] In addition, civil servants are not covered. Still, the VSKT represents about 80% of the total male work force in West Germany (Bönke et al., 2015).

We consider men only to ensure comparability to related studies and to avoid sample selection issues due to changing labor market participation rates of women (Bönke et al., 2015). Further, we

[17] Our dataset, FDZ-RV—VSKT2002, 2004–9_Bönke, is accessible through controlled remote computing and provided by the Data Research Centre of Deutsche Rentenversicherung (the German statutory pension scheme). Cohorts and the underlying sample are constructed in the same way as in Bönke et al. (2015).

[18] Jenson and Shore (2015) find that earnings volatility and its evolution differ between self-employed and employed.

focus on men between 25 and 59 years of age. This excludes from our analysis both the unstable years of very young workers (including military and civil service) and the retirement transition period. This enables comparisons to other studies, which exclusively focus on comparable populations. Then, we focus on native Germans who have always worked in West Germany to avoid the problem of fractured biographies.[19] Individuals who have worked in East Germany are excluded because their earnings information and earnings level over time is not comparable to that of West Germans. This especially holds for the older sample cohorts. Younger East German cohorts are then excluded to ensure sample consistency for the investigation of long run trends.

The oldest cohort we observe is born in 1935. For this cohort and all others up to cohort 1950, we observe complete life cycles from age 25 to age 59. For those born after 1950, we observe biographies that are right censored at the cohort's age in 2009. We include 40 cohorts up to the one born in 1974 to ensure a sufficiently long period of observation.[20]

Although the VSKT is virtually free from measurement errors, we perform three adjustments in order to ensure time consistency in the earnings data. First, since one-time payments are only subject to social security since 1984, earnings prior to 1984 are adjusted according to their spurious growth between 1983 and 1984.[21] Second, we deal with the problem of different levels of social security contributions over time and subgroups. Therefore, we add the employers' social security contributions to the individual gross wages. These contributions can be seen as an approximation of the value of insurance that employees would have bought if the insurance had not been supplied by governmental institutions (Bönke et al., 2015). In this sense, the earnings we analyze represent the market value of labor.[22] Our third adjustment is an imputation of top-coded earnings. In Germany earnings are only subject to social security up to a contribution ceiling. This causes our earnings data

[19] This excludes immigrants as well as native German immigrants ("Spätaussiedler") who worked in their country of origin. Further, West-East migration is negligible before reunification and extremely small thereafter (Fuchs-Schündeln and Schündeln, 2009).

[20] This subsequent entry of younger cohorts might be a problem for the identification of time and cohort effects of early calendar years since in these years only few cohorts are observed at the same time. Therefore we include a robustness test and estimate the model starting in 1979, discarding all prior years and adjusting the sample selection. We observe no qualitative difference in the results (see Appendix A). It seems that the auto-covariances ensure consistent estimates even for periods when only few cohorts are present.

[21] The method is documented in Bönke et al. (2015). It is an extension of Fitzenberger's (1999) cross sectional adjustment of administrative data to spurious growth. It exploits the panel structure of the VSKT and adjusts the wage according to the individual age and rank in the earnings distribution.

[22] Since, e. g., miners have higher levels of social security contributions and a changing relative weight over the cohorts, subgroup consistency can only be assured when using the market value concept. This also solves the problem of changing levels of social security contributions (to pension, unemployment, health, and nursing care insurance) over time. For instance, contributions were lower in the 1960s than in the 2000s. All parameters of the social security system used for constructing the market values are provided in Bönke et al. (2015).

to be right-censored at this ceiling. Our imputation method is extensively documented in Bönke et al. (2015) and assumes a Pareto-distribution for the upper tail. The imputation is done separately by year and cohort. Since we do not want to artificially impute variance into the sample, we follow Bönke et al. (2015) in the assignment of wage above the contribution ceiling and preserve the individual ranks prior to the censored wages. This is an assumption of minimal mobility for individuals who consistently earn wages above the ceiling.[23]

Finally, the sample is restricted to those with consistent earnings biographies. We are left with at least 1,000 observations per cohort and about 50,000 in total, amounting to about 1.2 million person years. Details are provided in Appendix A. Our results are robust to conditioning on at least 5 years of consecutive earnings. [24] All earnings are real earnings with the base year 2000.

4.2 Sample descriptives

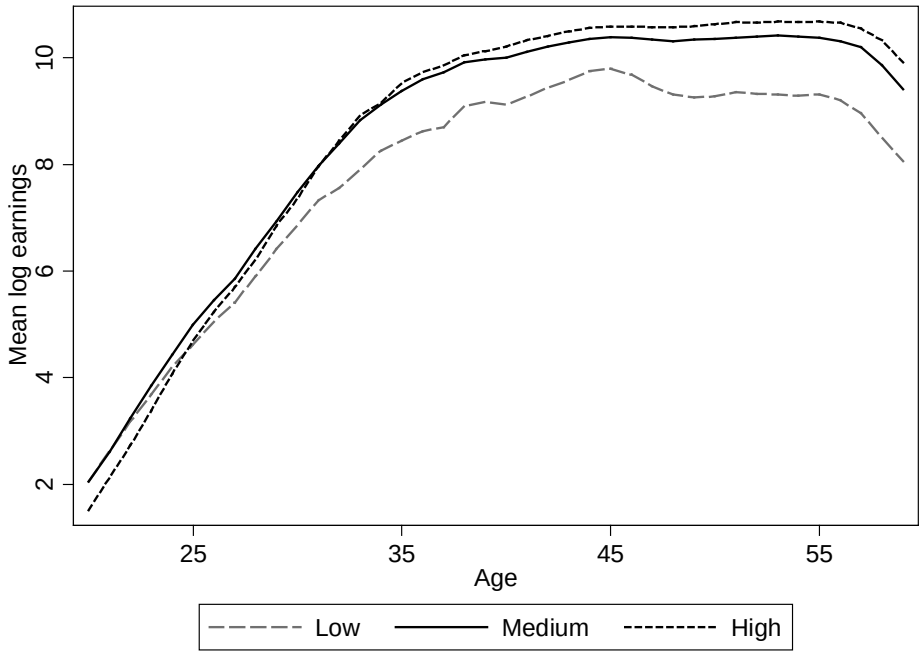
To provide some empirical motivation to our model, this section presents important attributes of the evolution of earnings and their dispersion in Germany. Figure 3 displays age-earnings profiles for three groups sorted according to their lifetime earnings into low (1st quartile), medium (2nd and 3rd quartile) and high (4th quartile) earners. Lifetime earnings are calculated as real (CPI-deflated) net present values from ages 17 to 59. The means show the expected inverted u-shape over the life cycle, are closest at young ages and fan out at later ages. In line with theoretical predictions and empirical findings, Figure 3 reveals Mincerian cross-overs,[25] e. g. when the high earners' mean passes the low earners' mean at 26 and does not fall below again.

Figure 3: Means of logarithmic earnings by lifetime earnings, pooled cohorts 1935-1950

[23] The opposite would be an assumption of maximal mobility, which would introduce artificial variance into the sample. Further, to limit the influence of outliers, we censor the highest wage at 5 times the average social security wage. Very few observations are affected by this censoring. Limiting the influence of outliers is common in the literature; see e.g. Bingley et al. (2013). Further details of the imputation method are provided by Bönke et al. (2015), who also validate the imputation procedure with survey data and find no difference between the cross-sectional earnings distributions of the VSKT and the survey data. There is no robustness-test with completely censored data on purpose. Since the ceiling changes by calendar year and is, in general, increasing over time, it must be imputed. For a thorough representation of the ceiling's evolution see e.g. Lüthen (2015).

[24] We consider biographies to be consistent if the sample provides a nearly gapless record of individual labor market activities after age 30 (equal to Bönke et al., 2015). The idea of consecutive information follows Bingley et al. (2013), who sought a criterion that neither constructs a fully unbalanced panel nor one that excludes too many observations. Conditioning on consecutive earnings yields a slightly worse fit but no qualitative differences. The results are displayed in Appendix B.

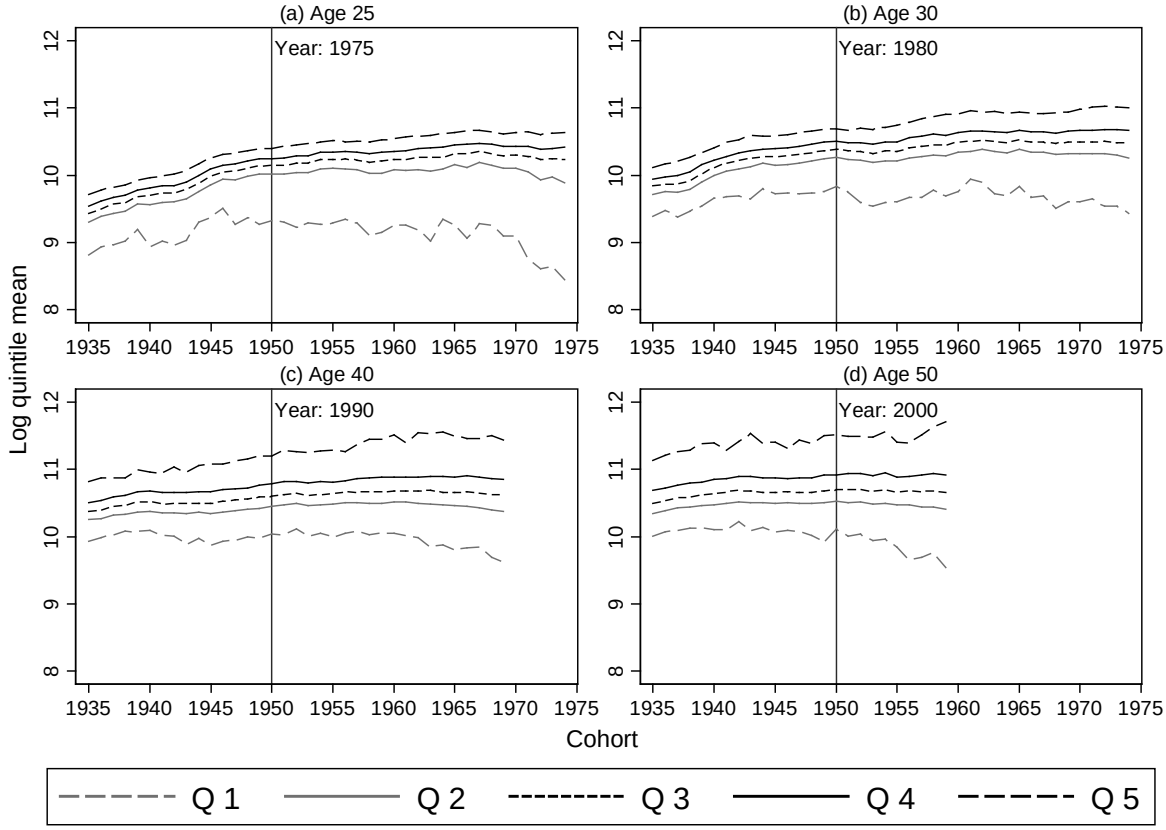
[25] This implies that those with high earnings at young ages are not those with the steepest permanent earnings paths (see Section 2.1 for more details).



Source: FDZ-RV – VSKT2002, 2004-2009_Bönke, own calculations.
Note: "Low" depicts mean earnings of individuals in the lowest quarter of lifetime earnings, "Medium" of those between the 25th and the 75th percentile and "High" of those in the highest quarter.

Figure 4 concentrates on developments across cohorts and shows quintile means of logarithmic earnings for selected ages by cohort. For ages 25 and 30, Figure 4 displays stable earnings growth as well as stable quintile distances across cohorts except for the lowest quintile. The lowest quintile fluctuates strongly and its distance to the other quintiles increases. For later ages, Figure 4 reveals moderate cohort specific earnings growth for quintiles 2 to 4. The highest quintile gains more and the lowest quintile declines across cohorts. However, distances between the lowest quintile and other quintiles decrease for later ages and its evolution stabilizes. This indicates more earnings instability in the early stages of the life cycle, which increases for younger cohorts and decreases after age 30 for all cohorts. Widening distances between the earnings quintiles on the other hand suggest increasing permanent divergences for younger cohorts and later ages. These findings are in line with Dustmann et al. (2014), who find decreasing wages for the 15th percentile, a rather stable median and increasing wages for the 85th percentile since 1990. This first impression underlines the importance of certain key aspects of our model: An age and cohort specific modeling of permanent and transitory components is needed to uncover underlying trends across life-cycles and generations.

Figure 4: Means of logarithmic earnings for selected ages



Source: FDZ-RV − VSKT2002, 2004-2009_Bönke, own calculations.
Note: Q1 to Q5 relate to the respective quintile means of logarithmic earnings at various ages.

5 Results

5.1 Microeconomic dynamics: Core model estimates

Table 1 presents our core model estimates based on Equations (5) and (7). It shows that the assumed flexibility of the theoretical structure of the permanent and the transitory component are key to fitting the model to life-time earnings data. The model identifies heterogeneity both in starting levels (σ_μ^2) and in subsequent earnings growth (σ_γ^2). The estimates suggest that individuals whose earnings grow one standard deviation above the mean accumulate an average income advantage of about 1.6% per year ($100 \cdot \sqrt{\sigma_\gamma^2} = 1.63$). The result lies between the findings of Baker and Solon (2003) for Canada (1%) and those of Baker (1997) for the USA and Bingley et al. (2013) for Denmark (both about 2.8%). Since we estimate the average annual growth rate to be 0.24%, our model outcome indicates considerable growth rate heterogeneity.[26] Like most studies on earnings dynamics (e. g. Baker and Solon, 2003; Moffitt and Gottschalk, 2012; Bingley et al., 2013), we

[26] We follow Bingley et al. (2013) and estimate the comparison estimate of average annual growth as a regression of low-wages on a linear age trend. Bingley et al. (2013) find a larger estimate of 0.9% for Denmark.

estimate a negative covariance between initial earnings and subsequent earnings growth, ($\sigma_{\mu\gamma}$<0). This is typically interpreted as a trade-off between initially relative high earnings and subsequent earnings growth as predicted by the Mincer-earnings-model. Following Hause (1980) and Bingley et al. (2013), $t^* = -\sigma_{\mu\gamma}/\sigma_\gamma^2$ gives the point of lowest (permanent) inequality due to diverging earnings paths (abstracting from permanent shocks of the random walk). Here, we find an estimate of 1.2 years, implying a low shortly after 26 years of age. The estimate confirms the impressions of Figure 3 and can be related to Bönke et al. (2015), who find that earnings paths of highly educated individuals start below the earnings paths of the lesser educated, rise steeper, cross in the late 20s and exceed thereafter.

Table 1: core model estimates

Permanent component			Transitory component		
	Coeff.	SE		Coeff.	SE
σ_μ^2	0.05	0.02	σ_0^2	0.1	0.057
σ_γ^2	0.0003	0.0001	$\sigma_{\epsilon,0}^2$	0.0955	0.0547
σ_u^2	0.01	0.004	$\sigma_{\epsilon,1}^2$	-0.018	0.01
$\sigma_{\mu\gamma}$	-0.0003	0.00017	$\sigma_{\epsilon,2}^2$	0.002	0.001
			$\sigma_{\epsilon,3}^2$	-7.3E-05	4.2E-05
			$\sigma_{\epsilon,4}^2$	1.17E-06	6.81E-07
			ρ	0.28	0.005

Note: Remaining model estimates are provided in Appendix B.
Source: FDZ-RV – VSKT2002, 2004-2009_Bönke, own calculations.

The estimation of transitory innovations, $\sigma_{\epsilon,i}^2$, suggests a u-shape over the life cycle and is in line with Baker and Solon's (2003) most comparable estimates. The innovations fall more than 60% from the mid-twenties to the early forties, flatten out over the forties and rise again in the early fifties and then reach the levels observed in the early stages of the life cycle again. Our estimate of 0.28 for ρ is relatively low compared to other studies and suggests low shock persistence for transitory innovations in Germany (Baker and Solon (2003) find a value of 0.54 for Canada). The results are robust to a left-censoring like a later start of the analysis in 1979. This robustness test shows that the low value of ρ is not driven by the higher weight of older cohorts.[27] Further robustness tests include an estimation of the baseline model with a different sample selection criterion (5 years of consecutive employment) and an estimation of a model that exchanges the transitory cohort shifters for cohort-specific initial variances (following Baker and Solon, 2003). All robustness checks and the

[27] The robustness-test further reveals no qualitative difference apart from a strong increase in significance. In line with Gottschalk and Moffitt (2012), the robustness test includes an additional parameter to deal with left-censoring. Details are provided in Appendix A.

remaining parameters for period and cohort shifters of both the transitory and the permanent component are presented in Appendix B.

Our findings for the underlying microeconomic dynamics indicate more earnings instability during very early and very late stages of the working career and increasing permanent divergences over the life cycle. This finding is similar even regarding country-specific aspects and differences in data quality. Studies that model age-dependent innovations typically find a considerable decline of earnings instability after age 25, reaching a trough between ages 35 – 45 and rising again thereafter (e .g. Baker and Solon (2003) for Canada, Karahan and Ozkan (2013) for the U.S. and Blundell et al. (2014) for Norway). Guvenen et al. (2015), while accounting for variation in higher order moments, conclude with similar results for the U.S.

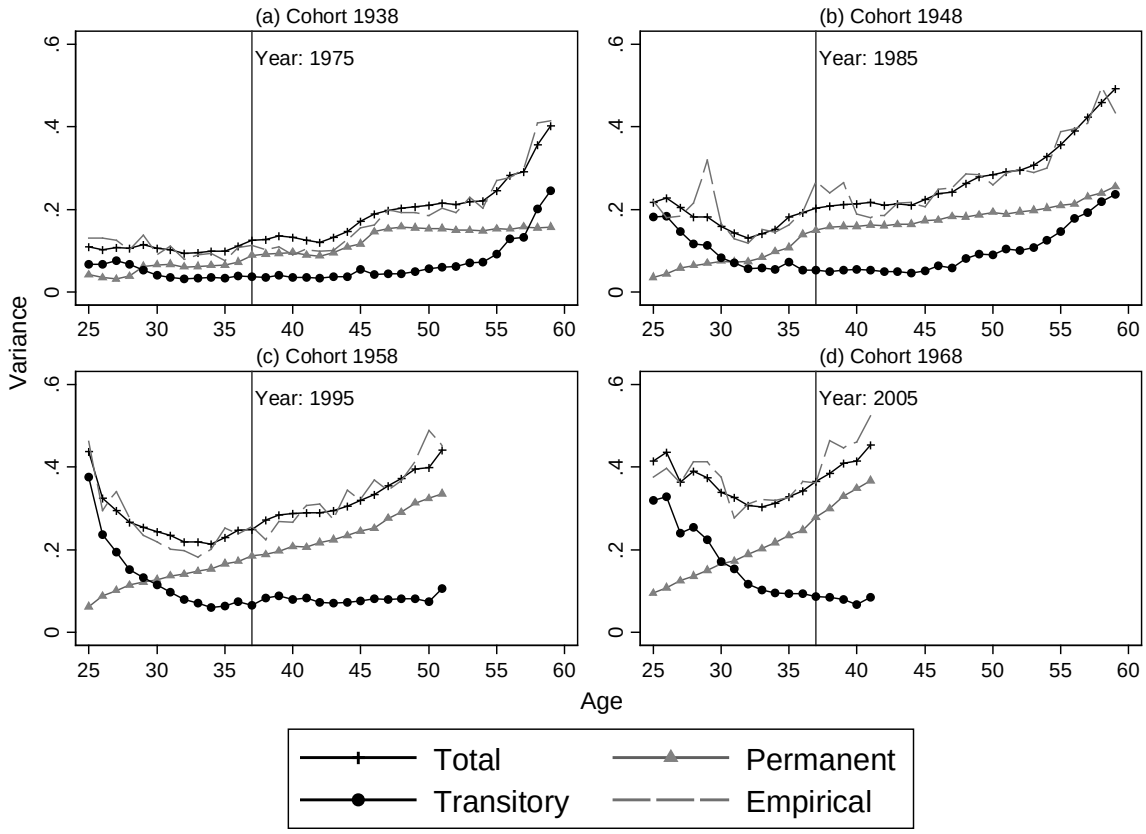
5.2 Earnings dynamics over the life cycle

Figure 5 outlines the empirical and predicted variances over the life cycle for selected cohorts.[28] The empirical variance evolutions (line: dash) are well matched by the predictions of the total variances (line: +). The total variance decreases until the early 30s and increases afterwards. This is in line with studies examining inequality over the life-cycle (e. g. Björklund, 1993; Kopczuk et al., 2010; Bönke et al., 2015), which estimate the lowest point of overall cross-sectional inequality to be around this age. The evolution of the transitory component (line: ●), which is about u-shaped over the life cycle also after the inclusion of period and cohort shifters. The permanent component (line: Δ) usually rises over life cycle.

Figure 5 also reveals two other important findings. First, younger cohorts face higher total earnings variance and both higher transitory and permanent variances. Second, the results suggest a different composition of variance components across generations. For younger cohorts we find a more pronounced u-shape of the transitory component and a steeper rising permanent component. Thus, younger cohorts face higher earnings instability at the beginning of their life cycle and a steeper rising permanent component, hence more divergence between earnings paths over their life cycle.

[28] The interpretation given for the selected cohorts is in line with the results for all cohorts. Figures for all cohorts are available from the authors upon request.

Figure 5: Empirical and predicted variance for selected cohorts



Source: FDZ-RV – VSKT2002, 2004-2009_Bönke, own calculations.

5.3 Evolution of earnings dynamics across generations

The structural shift in the variance components across cohorts becomes more apparent when comparing variances at various ages. Figure 6 displays the actual observed empirical variance (line: dash) and the according estimation for the permanent (line: Δ) and transitory (line: ●) component for each cohort at the beginning (age 25 and 30), in the midst (age 40), and toward the end (age 50) of the earnings career. In addition, the total estimated variance as the sum of both components is displayed (line: +) to give an impression of the model fit. Comparing empirical and estimated variances reveals a satisfying fit across all cohorts and age groups. Figure 7 complements Figure 6 and displays the respective growth of the permanent and transitory components at these respective ages, normalized by estimates for cohort 1935.

We comment on the transitory component first. Confirming the upward shift pictured in Figure 5, Figure 6 and 7 reveal a marked increase at younger ages (upper panels), a considerable less pronounced trend for age 40 and almost no clear trend for age 50 (lower panels). The differences by age pertain to the importance of the transitory component at the beginning of the working career

(e. g. Baker and Solon, 2003). The strong trend at young ages relates to the three phases of institutional changes and macroeconomic trends outlined in Section 2, which particularly affect labor market entrants. Cohorts born until the mid-1940s entered the labor market before 1973 during favorable economic circumstances of the *Wirtschaftswunder*-period. For these cohorts, the transitory component remains comparably low and rather stable, mirroring low unemployment, high job security and no fixed term or temporary employment. Cohorts entering between the early 1970s and the mid-1990s encountered less favorable economic conditions and ongoing labor market deregulation, including the introduction of fixed term employments for first time employees (see Figure 4 and Table C.1.). This reflects in a tripling transitory component between pre-1946 cohorts and 1960s cohorts at age 25 and a doubling at age 30. Finally, those born in the early 1970s experienced another strong increase in the transitory innovations upon labor market entry. They joined the labor force around and after the mid-1990s during Germany's period as the *sick man of Europe*, a time of economic hardship characterized by mass immigration, high unemployment, sectoral shifts, deunionization, and competition with the former socialist East. This conjoins further labor market deregulation regarding dismissal protection, fixed term contracts and temporary employment (Figures 3 and 4; Table C.1). All this contributes to the steep surge of the transitory variance observed at ages 25 and 30 for cohorts born in 1970s. In comparison to cohorts born before the mid-1940s, 1970s cohorts face an earnings insecurity that is about five to seven (age 25) and three to five (age 30) times higher. The earnings risk still doubles for 40 year olds in course of the mid-1990s events. For 50-year-olds, the earnings risks increases only slightly after 1995, mirroring long and stable earnings careers and favorable employment contracts.

For the permanent variance, Figures 6 and 7 display an increase at all ages. The largest relative increase occurs for the young at age 30. Still, since the permanent component is more pronounced at later ages, its absolute gain is largest at ages 40 and 50 (see also Figure 5). In contrast to the transitory component, the increase initially starts after the second oil crises in 1980. Between 1980 and 1990, the permanent component doubles for ages 25 and 30; the 40 year olds are slightly less and the 50 years olds are not affected. Thus, our results suggest that the favorable conditions of the *Wirtschaftswunder*-period only diminish after the more fierce recession following the second oil crises. In the 1980s, mass unemployment and deregulation put permanent pressure on the wage structure. In addition, the increasing number of workers in the service sector was mainly recruited from younger cohorts. These contracts do not offer the same security and wage compression as the long-term industry contracts most prominent for older cohorts. This could also explain why older, well-established workers (aged 50) are not affected by the 1980s recession.

After reunification, we observe a second surge in the permanent component, coinciding with several severe global and local changes. While the increase at age 25 is rather small, the increase at age 30 is already distinct. At ages 40 and 50, a steady rise begins around 1995 and surges in the early 2000s. These increases coincide with four important developments starting in the early 1990s. First, the ongoing globalization puts pressure on low skilled labor, e. g. through offshoring and growing international competition. This also reflects in the strong increases in openness since 1990 (Figure 3). Second, changing job requirements cause job polarization on German labor markets. Job polarization describes a shift in demand toward very highly skilled, non-routine labor at the expense of workers tasked with routine operations, e.g. due to the effect of computerization on clerical work. For Germany since the mid-1990s, Dustman et al. (2009) find job polarization a driving force for wage inequality. Third, deunionization and the opting out of sectoral agreements have also had long term consequences (e. g. Acemoglu et al., 2001).[29] Antonczyk et al. (2010) attribute a considerable share of rising wage inequality to de-unionization and the decline in collective wage bargaining coverage, especially at the lower end of the wage distribution. Card et al. (2013) find that this joint decline of traditional German wage bargaining institutions increases employer-specific compensations and widens wage differences among employees in the same industry. Since the 1990s, wage negotiations have shifted from collective bargaining to the individual level. In particular establishments founded after 1996 are more likely to pay lower wages, to exhibit larger wage heterogeneity and to not participate in the sectoral contracting system. Since younger workers are more likely to work at these establishments, our result of rising permanent dispersion and earnings instability for younger cohorts are in line with a declining coverage by collective sectoral wage bargaining. Forth, the probability of job changes increased since the 1990s. Voluntary turnover grew since the pecuniary gains of job changes increase, which provides an incentive to change employers more often (Card et al., 2013). Involuntary job changes increased due to lowered dismissal protection and the enhancement of fixed term contracts and subcontracted work (Figure 4; Table C.1; Figure C.1). The rising permanent variance since the 1990s therefore reflects more diverse permanent earnings paths as well as larger shifts of the paths. The increasing importance of permanent shocks also implies greater difficulty in returning to the previous path after a negative shock like a health shock or involuntary job loss.

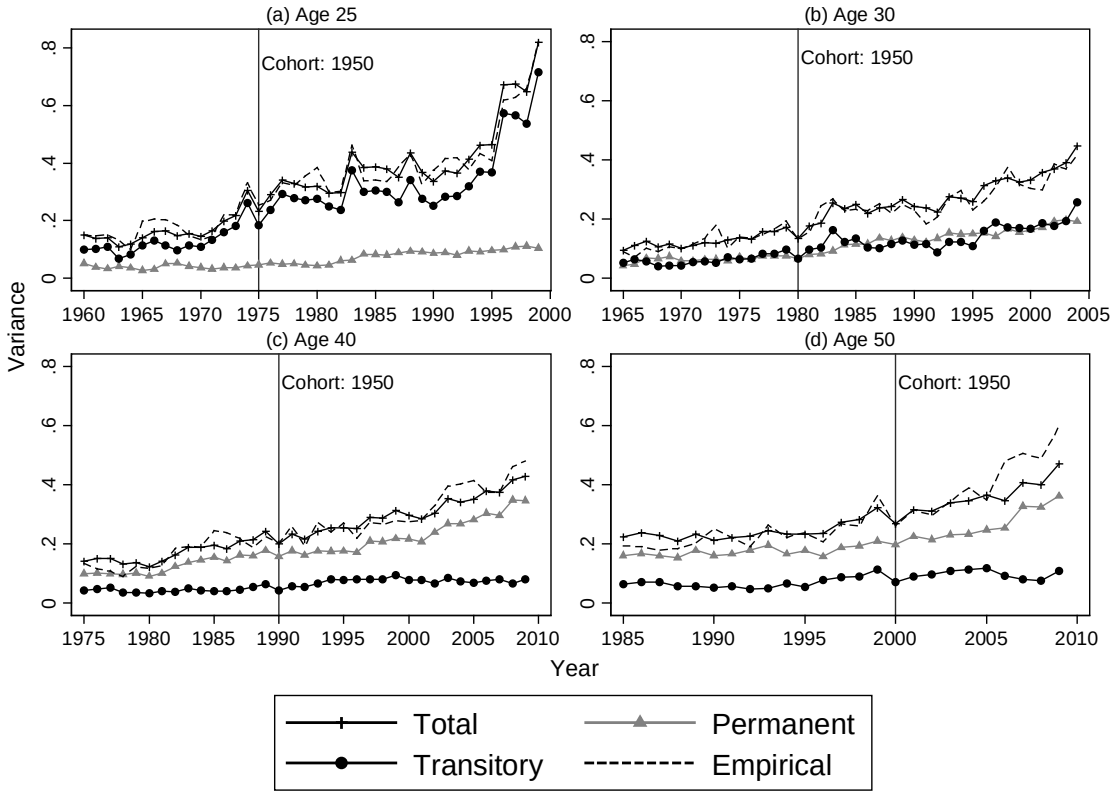
The observed developments mirror macroeconomic trends and institutional changes that affect income distributions in the long run. Therefore, the permanent variance and its growth follow a

[29] These developments are not independent; e.g. skill-biased technological change is a likely driver of both job polarization (Dustmann et al., 2009) and deunionization (e. g. Acemoglu et al., 2001).

smoother trend than the transitory variance. In contrast to the transitory component, the increase in the permanent components starts after the second oil crisis in 1979 at ages 25, 30 and 40 and after the mid-1990s at age 50. Existing contracts seem to dampen immediate effects of large scale events on the permanent component, causing a slowed response. On the other hand, these events immediately hit the most vulnerable- young workers without a strong labor market attachment and job seekers. This causes immediate effects in insecurity for young workers after macro-shocks and delayed effects on permanent divergences at later ages.

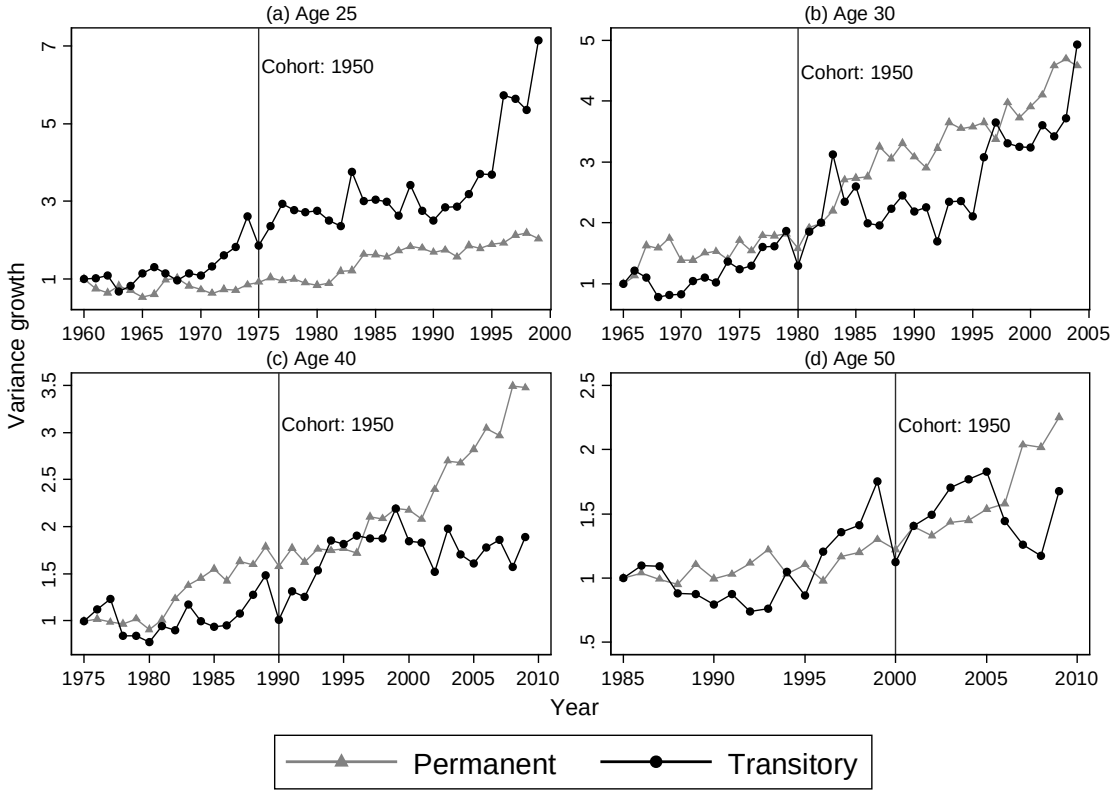
Studies on other countries report comparable results for men. For the U.S., Moffitt and Gottschalk (2012) report a substantial increase in earnings instability throughout the 1970s and 1980s and major more immediate shifts during recessions. They further identify a considerable rise in the permanent component since the mid-1990s. Although their data does not allow for controlling cohort differences, these results roughly align with ours. For Canada, Baker and Solon (2003) and Ostrovsky (2010) document a rise in both components after the second oil crises in 1980 and another steady increase since the early 1990s. For Italy, Cappellari (2004) finds similar trends with a stronger increasing permanent component. Apart from recessions, he ascribes the rise to higher demand for skilled labor and the decline of the strongly regulated pay-system in Italy. In this process wages become more often determined at the firm level, which can be compared to what happened in Germany. Further, Sologon and Van Kerm (2014) provide a visual summary of existing studies on European countries and the US, confirming the upward trends in both components (except for the transitory component in Luxembourg).

Figure 6: Empirical and predicted variance at selected ages



Source: FDZ-RV − VSKT2002, 2004-2009_Bönke, own calculations.

Figure 7: Vartiance growth rates at selected ages



Source: FDZ-RV − VSKT2002, 2004-2009_Bönke, own calculations.

5.4 Implications and discussion

Albeit all the presented findings relate to gross earnings, they have several implications for net disposable income and consumption. The extent that an individual or society and its welfare is affected depends on the welfare state's ability to insure against earnings risk and to compensate for permanent income differences through redistribution. Younger cohorts and lower skilled individuals experience higher transitory fluctuations of gross earnings and more pronounced inequality in terms of a more dispersed permanent income component. Without insurance or the adjustment of existing social security schemes, those transitory fluctuations translate directly into additional welfare costs (Storesletten et al., 2001; Blundell and Preston, 2008). So far the German welfare state seems to cope well in smoothing transitory earnings shocks, even for younger cohorts (Bartels and Bönke, 2013). Mitigating increasing long-term disparities, on the other hand, would require increasing redistributive capabilities, e.g. by more progressive income tax schedule. However, recent modifications to German income taxes show an opposite trend and it is unlikely that this trend will change.[30]

As discussed above, many forces that drive rising permanent disparities are global in nature. However, developments in Germany tend to amplify this trend. The formerly strong equalizing influence of trade unions is diminishing, reflected declines in coverage of sectoral contracting agreements and union membership. Further, to strengthen international competitiveness, the adopted labor market deregulation aimed at cutting employment costs and increasing flexibility. In terms of employment and economic recovery, the deregulation is successful, however at the cost of higher inequality (Dustmann et al., 2014). This flexibility, along with decentralization of wage determination from the industry level to single firms or even workers, coincides with a decrease of real wages at the lower end of the wage distribution. In sum, the changing German labor market institutions further fostered the dispersion of wages and earnings careers. At the same time, adjustments in the tax and transfer system reduced the redistributive impact of the German welfare state (Bartels and Bönke, 2013). Hence, gross earnings inequality translates into net earnings and disposable income inequality.

Although Germany's economy is recently performing exceptionally well, it is unlikely that Germany will ever regulate the labor market in the way that it was in the 1960s, due to the fear of losing its competitive advantage. Increased flexibility might also attract more volatility industries and

[30] Figure C.2 displays the evolution of marginal and average income tax rates from 1958 through 2013 for varying earnings levels. Figure C.2 shows a reduction in progressivity of the German income tax since the mid-1980s.

therefore amplify the trend of increasing earnings instability and inequality (Cunat and Melitz, 2012). Hence, employees starting their earnings career after the 2000s will likely experience a continuing trend in rising levels of inequality and uncertainty. Still, excesses at the lower end of the wage distribution are of concern and in 2015 Germany introduced a nationwide minimum wage. Its impact on earnings inequality and volatility remains to be investigated. On the one hand, it might increase the unemployment risk for low-skilled workers, but on the other hand, it might decrease the pressure on low wages (see e.g. Lee and Saez (2012) for a discussion).

6 Conclusion

We scrutinize the effects of historic and recent event which transformed the German labor market on earnings dynamics in Germany by decomposing earnings' variances into a permanent and a transitory component. Using administrative data covering complete earnings life cycles of West German males born between 1935 and 1974, we can show how the profound changes of the German labor market affected inequality and stability over a period of 50 years. To model the evolution of earnings within individual life-cycles, we specify both a random walk and a random growth for the permanent and an AR(1)-process and a quartic age term for the transitory component. Next to these microeconomic dynamics, both components include period and cohort specific shifters to explicitly model macroeconomic dynamics and generational differences. In this regard the model leaves us with greater detail compared to approaches utilized in comparable studies. For the development of microeconomic dynamics across life cycles, we find an increasing permanent and about u-shaped transitory component. We also identify a trade-off between initially high earnings and subsequent earnings growth. While our results validate most of the findings from studies on shorter panels, we find that modeling extensive time frames requires explicit accounting for cohort specific differences.

Although we identify common life-cycle features, our main results stem from comparing volatility across generations. Looking at the evolution at different stages of the life-cycle, we find an upward trend for both transitory and permanent component. This finding is also commonly identified in studies on other countries despite differences regarding institutions, periods investigated, data used or methodology applied. The results mirror how some global long-term trends like declining manufacturing sectors, deunionization, increasing international economic integration and job polarization affect many Western societies. Still, first the unique situation following World War II and second the reunification with its both its financial obligations and the massive inflow of migrants make Germany a special case. The order of magnitude and explanatory power of the two components differs substantially across countries and time. For Germany, we find a strongly

increasing transitory component at young ages with a trend starting in the early 1970s and intensification in the mid-1990s. For older workers, we find moderate increases. The permanent component starts increasing in the early 1980s and strongly increases in the early 2000s for all ages. Our results suggest that structural labor market changes affect both components and immediately translate into increasing short-term earnings risks especially for young workers. With delay, these structural changes also translate into increasing permanent divergences, especially at later ages.

The described trends of earnings dynamics are likely to continue and have several implications. Earnings risks upon labor market entry will remain high and it will become increasingly difficult to obtain stable employment. At later stages of the life cycle after labor market entry, permanent divergences will become more important. This implies increasing lifetime earnings inequality. Thus, although the flexibility gained through deregulation is deemed an important source of Germany's recent economic success, the downsides are rising insecurity and inequality. This burden, is carried mainly by the younger generations.

In general, short-term earnings risks are rather successfully mitigated by welfare state insurance (Bartels and Bönke, 2013). Mitigating increasing long-term disparities on the contrary would require increasing redistributive capabilities, which is currently unlikely. Therefore, permanent disparities are likely to gain even more importance in the future, reflecting in a continuing trend of rising lifetime earnings inequality. By the nature of our study, the most recent developments cannot be captured. The most interesting event is probably the introduction of the German minimum wage in 2015, which is left for future research.

Appendix A: Data

Bönke, Corneo and Lüthen (2015) provide further information on sample selection, dataset and indicators of the social security system; see also their online Appendix.

Table A.1: Sample descriptives

Cohort	Number of observations	Person years	Start year	End year	Last age observed	Years included	Moments	VSKT wave
1935	1005	33745	1960	1994	59	35	630	2002
1936	962	32168	1961	1995	59	35	630	2002
1937	993	33094	1962	1996	59	35	630	2004
1938	1026	34235	1963	1997	59	35	630	2005
1939	1054	34979	1964	1998	59	35	630	2006
1940	1025	33382	1965	1999	59	35	630	2007
1941	1072	34889	1966	2000	59	35	630	2008
1942	1035	33822	1967	2001	59	35	630	2009
1943	1029	33639	1968	2002	59	35	630	2009
1944	987	32267	1969	2003	59	35	630	2009
1945	1091	35327	1970	2004	59	35	630	2009
1946	1063	34377	1971	2005	59	35	630	2009
1947	1058	34124	1972	2006	59	35	630	2009
1948	1066	33971	1973	2007	59	35	630	2009
1949	1027	32483	1974	2008	59	35	630	2009
1950	1069	34434	1975	2009	59	35	630	2009
1951	1096	34083	1976	2009	58	34	595	2009
1952	1097	33218	1977	2009	57	33	561	2009
1953	1118	32942	1978	2009	56	32	528	2009
1954	1150	32930	1979	2009	55	31	496	2009
1955	1178	32803	1980	2009	54	30	465	2009
1956	1232	33209	1981	2009	53	29	435	2009
1957	1231	31854	1982	2009	52	28	406	2009
1958	1258	31696	1983	2009	51	27	378	2009
1959	1290	31012	1984	2009	50	26	351	2009
1960	1315	30498	1985	2009	49	25	325	2009
1961	1379	30855	1986	2009	48	24	300	2009
1962	1432	30706	1987	2009	47	23	276	2009
1963	1443	29352	1988	2009	46	22	253	2009
1964	1426	27798	1989	2009	45	21	231	2009
1965	1480	27487	1990	2009	44	20	210	2009
1966	1505	26387	1991	2009	43	19	190	2009
1967	1519	25195	1992	2009	42	18	171	2009
1968	1554	24304	1993	2009	41	17	153	2009
1969	1635	23791	1994	2009	40	16	136	2009
1970	1619	22138	1995	2009	39	15	120	2009
1971	1470	18764	1996	2009	38	14	105	2009
1972	1464	17354	1997	2009	37	13	91	2009
1973	1510	16576	1998	2009	36	12	78	2009
1974	1469	14797	1999	2009	35	11	66	2009
Total	49,432	1,200,685					17000	

Source: FDZ-RV − VSKT2002, 2004-2009_Bönke, own calculations.

Appendix B: Model estimation and robustness

(1) Estimation

After de-meaning the earnings, cohort specific variances and covariances are calculated and then stacked upon each other. This provides the vector of sample moments, $C = f(\theta)$. Then, we employ GMM to minimize the distance between this vector and the theoretical vector provided by the model parameters:

(B.1) $$Q = [C - f(\hat{\theta})]' W [C - f(\hat{\theta})]$$

As shown by Altonji and Segal (1996) and Clark (1996), the asymptotically optimal weighting matrix induces a bias in finite sample. Therefore, following e. g. Haider (2001) and Altonji and Segal (1996), we use the identity matrix as weighting matrix W. The estimation, often called equally weighted minimum distance, effectively becomes a nonlinear least squares estimation (Chamberlain, 1984). Standard errors are derived using the delta-method employing the fourth moments matrix. Standard errors are calculated with the delta-method, $V(\theta) = (G'G)^{-1}G'VG(G'G)^{-1}$, with V being the fourth moment matrix and G the gradient matrix derived from the estimation (e. g. Cappellari, 2004). Our dataset provides 17,000 sample moments used in the estimation procedure.

(2) Robustness

At first, we give a brief overview about the models shown in this section. Although the estimation of some parameters varies, our results of a shift in the variance components as well as our other results are qualitatively alike. Figures for all scenarios can be obtained from the authors upon request.

Model 1: This is the baseline model. See Section 3 in the main text for description.

Model 2: Here we estimate the baseline model on a different sample selection. We follow Bingley et al. (2013) and condition on 5 years of consecutive earnings.

Model 3: This model deviates from our baseline model in equation (7). We follow Baker and Solon (2003) and, instead of including cohort shifters for the transitory component, we estimate cohort specific initial variances $\nu_{i0} \sim (0; \sigma^2_{0,c})$. Equation (7) now becomes:

(B.2) $$\begin{aligned} Var(y^T_{ict} y^T_{ict}) = {} & \rho^2 Var(\nu_{i,t-1}) \\ & + \tau_t^2 (\sigma^2_{\epsilon,0} + (t-c)\sigma^2_{\epsilon,1} + (t-c)^2\sigma^2_{\epsilon,2} + (t-c)^3\sigma^2_{\epsilon,3} \\ & + (t-c)^4\sigma^2_{\epsilon,4}) \end{aligned}$$

Model 4: Because the oldest cohorts are included over their entire life cycle, we might face a bias in our estimation results due to their "overrepresentation." Therefore, we start estimating our model in 1979 instead of starting in the estimation in 1960. This leads to a decreased weight of the older cohorts in the model estimation. Still, we estimate similar shock persistence ρ. A comparison of the

permanent and the transitory component does not show qualitative differences. Still, the core model parameter estimates are expected to differ because the cohort shifters are normalized to 1979 and not to 1960, as in the baseline model. Since our observation period is left-censored, the estimation of the initial transitory variance σ_0^2 might be biased. Therefore, we follow Moffitt and Gottschalk (2012) and estimate an additional parameter α for all left-censored cohorts. For left-censored cohorts, σ_0^2 is now included as follows: $(1 + \alpha \cdot age79)\sigma_0^2$. At this, $age79$ is the distance of the cohorts' age in 1979 and age 25. By way of an example, this bias-correction obtains 19 for cohort 1935 in the year 1979 and yields a transitory variance of $Var\left(y_{i1935,1970}^T\right) = (1 + 19\alpha)\sigma_0^2$.

Table B.1: Core model estimates

Coefficient	**Model 1**		**Model 2**		**Model 3**		**Model 4**	
	Coeff	SE	Coeff	SE	Coeff	SE	Coeff	SE
σ_μ^2	0.051	0.022	0.084	0.026	0.050	0.022	0.016	0.001
σ_u^2	2.65E-04	1.18E-04	9.02E-05	3.86E-05	2.70E-04	1.22E-04	8.32E-05	9.34E-06
σ_γ^2	0.0101	0.0043	0.0154	0.0048	0.0097	0.0042	0.0033	0.0003
$\sigma_{\mu\gamma}^2$	-3.28E-04	1.75E-04	-9.83E-04	3.23E-04	-3.17E-04	1.72E-04	-1.76E-04	3.79E-05
σ_0^2	0.100	0.057	0.123	0.067			0.089	0.015
$\sigma_{\epsilon,0}^2$	0.095	0.055	0.114	0.062	0.090	0.004	0.090	0.015
$\sigma_{\epsilon,1}^2$	-0.018	0.010	-0.013	0.007	-0.016	0.001	-0.018	0.003
$\sigma_{\epsilon,2}^2$	1.73E-03	9.97E-04	1.59E-03	8.88E-04	1.27E-03	5.78E-05	1.91E-03	2.82E-04
$\sigma_{\epsilon,3}^2$	-7.27E-05	4.20E-05	-7.96E-05	4.52E-05	-4.33E-05	2.09E-06	-8.54E-05	1.23E-05
$\sigma_{\epsilon,4}^2$	1.17E-06	6.81E-07	1.60E-06	9.27E-07	5.54E-07	2.73E-08	1.44E-06	2.05E-07
ρ	0.278	0.005	0.258	0.005	0.277	0.005	0.269	0.005
α							-0.055	0.012

Source: FDZ-RV − VSKT2002, 2004-2009_Bönke, own calculations.

Table B.2: Permanent cohort shifter

	Model 1: Base		Model 2: Adj. sample selection		Model 3: Cohort inital variances		Model 4: Shorted time frame	
Cohort	Coeff	SE	Coeff	SE	Coeff	SE	Coeff	SE
1935	1	-	1	-	1	-	1	-
1936	1.03	0.03	1.04	0.04	1.04	0.03	1.03	0.05
1937	1.04	0.03	1.04	0.04	1.04	0.03	1.03	0.04
1938	1.06	0.03	1.04	0.04	1.05	0.03	1.05	0.04
1939	1.16	0.04	1.10	0.04	1.15	0.03	1.17	0.05
1940	1.15	0.04	1.14	0.04	1.14	0.04	1.14	0.05
1941	1.20	0.04	1.17	0.04	1.19	0.04	1.18	0.05
1942	1.28	0.04	1.20	0.04	1.27	0.04	1.27	0.05
1943	1.34	0.04	1.26	0.04	1.33	0.04	1.33	0.05
1944	1.27	0.04	1.20	0.04	1.25	0.04	1.25	0.05
1945	1.31	0.04	1.23	0.04	1.30	0.04	1.30	0.05
1946	1.27	0.04	1.24	0.04	1.26	0.04	1.26	0.05
1947	1.41	0.04	1.29	0.04	1.40	0.04	1.40	0.06
1948	1.44	0.05	1.34	0.04	1.43	0.05	1.43	0.06
1949	1.56	0.05	1.43	0.04	1.56	0.05	1.55	0.06
1950	1.52	0.05	1.42	0.04	1.51	0.05	1.51	0.06
1951	1.65	0.05	1.49	0.04	1.65	0.05	1.64	0.07
1952	1.63	0.05	1.47	0.05	1.62	0.05	1.62	0.06
1953	1.70	0.05	1.56	0.05	1.70	0.05	1.69	0.06
1954	1.74	0.06	1.58	0.05	1.74	0.05	1.73	0.07
1955	1.75	0.06	1.52	0.05	1.76	0.06	1.74	0.07
1956	1.78	0.06	1.66	0.05	1.77	0.06	1.77	0.07
1957	2.00	0.07	1.77	0.06	1.98	0.07	1.99	0.08
1958	2.00	0.06	1.77	0.06	1.99	0.06	1.99	0.08
1959	2.13	0.06	1.87	0.06	2.13	0.06	2.12	0.08
1960	2.14	0.07	1.89	0.06	2.13	0.07	2.13	0.09
1961	2.13	0.07	1.85	0.06	2.12	0.07	2.11	0.08
1962	2.30	0.07	1.94	0.06	2.28	0.07	2.29	0.09
1963	2.46	0.08	2.08	0.07	2.46	0.08	2.45	0.10
1964	2.49	0.08	2.06	0.07	2.47	0.08	2.47	0.10
1965	2.51	0.08	2.06	0.07	2.48	0.08	2.49	0.10
1966	2.61	0.08	2.12	0.07	2.59	0.08	2.59	0.11
1967	2.54	0.08	2.07	0.07	2.54	0.08	2.53	0.11
1968	2.78	0.09	2.21	0.08	2.77	0.09	2.76	0.12
1969	2.80	0.09	2.26	0.08	2.77	0.09	2.78	0.12
1970	2.88	0.10	2.23	0.08	2.88	0.10	2.87	0.13
1971	3.00	0.11	2.32	0.09	3.03	0.11	2.98	0.14
1972	3.20	0.12	2.44	0.09	3.21	0.12	3.18	0.15
1973	3.26	0.12	2.43	0.09	3.27	0.12	3.25	0.15
1974	3.27	0.13	2.44	0.10	3.37	0.13	3.26	0.16

Source: FDZ-RV − VSKT2002, 2004-2009_Bönke, own calculations.

Table B.3: Transitory cohort shifter/Cohort specific transitory initial variances

	Model 1: Base		Model 2: Adj. sample selection		Model 3: Cohort inital variances		Model 4: Shorted time frame	
Cohort	Coeff	SE	Coeff	SE	Coeff	SE	Coeff	SE
1935	1	-	1	-	0.10	0.06	1	-
1936	1.08	0.02	1.08	0.02	0.14	0.08	1.11	0.02
1937	1.06	0.02	1.05	0.03	0.11	0.06	1.10	0.02
1938	0.95	0.02	0.97	0.03	0.13	0.08	0.94	0.02
1939	0.97	0.02	0.99	0.03	0.06	0.04	0.99	0.02
1940	0.97	0.02	1.05	0.03	0.17	0.06	0.95	0.03
1941	1.03	0.03	1.10	0.03	0.15	0.05	1.04	0.02
1942	1.01	0.03	1.08	0.03	0.14	0.05	0.99	0.03
1943	0.98	0.03	1.15	0.04	0.14	0.05	0.96	0.03
1944	1.05	0.04	1.18	0.04	0.09	0.07	1.07	0.03
1945	1.03	0.03	1.21	0.05	0.08	0.03	1.00	0.03
1946	1.07	0.04	1.27	0.05	0.08	0.03	1.07	0.03
1947	1.12	0.04	1.25	0.06	0.12	0.03	1.16	0.04
1948	1.21	0.05	1.38	0.07	0.11	0.04	1.24	0.04
1949	1.34	0.05	1.50	0.08	0.15	0.04	1.37	0.05
1950	1.16	0.05	1.47	0.08	0.09	0.02	1.22	0.05
1951	1.34	0.06	1.61	0.09	0.10	0.03	1.45	0.06
1952	1.39	0.07	1.66	0.10	0.12	0.04	1.46	0.07
1953	1.48	0.07	1.74	0.11	0.12	0.03	1.59	0.08
1954	1.49	0.07	1.79	0.12	0.14	0.02	1.61	0.09
1955	1.58	0.08	1.81	0.12	0.18	0.03	1.70	0.09
1956	1.43	0.08	1.91	0.14	0.09	0.02	1.55	0.09
1957	1.40	0.09	1.82	0.14	0.09	0.02	1.51	0.10
1958	1.48	0.10	1.96	0.16	0.11	0.01	1.62	0.11
1959	1.58	0.10	2.04	0.17	0.09	0.02	1.74	0.12
1960	1.58	0.10	2.08	0.17	0.09	0.01	1.75	0.12
1961	1.62	0.10	2.21	0.19	0.08	0.02	1.80	0.12
1962	1.49	0.11	2.13	0.20	0.10	0.01	1.66	0.12
1963	1.69	0.12	2.31	0.22	0.11	0.01	1.90	0.14
1964	1.55	0.11	2.29	0.22	0.07	0.01	1.75	0.13
1965	1.57	0.12	2.37	0.23	0.10	0.02	1.78	0.14
1966	1.69	0.12	2.40	0.24	0.12	0.02	1.92	0.15
1967	1.80	0.13	2.50	0.26	0.13	0.02	2.07	0.16
1968	1.82	0.13	2.51	0.27	0.09	0.01	2.09	0.16
1969	1.78	0.13	2.66	0.29	0.08	0.01	2.06	0.16
1970	1.93	0.14	2.83	0.32	0.09	0.01	2.24	0.17
1971	2.10	0.16	2.96	0.34	0.11	0.01	2.44	0.19
1972	2.06	0.16	3.11	0.37	0.10	0.01	2.40	0.20
1973	2.15	0.17	3.27	0.40	0.12	0.01	2.51	0.21
1974	2.44	0.20	3.54	0.44	0.15	0.01	2.86	0.24

Source: FDZ-RV − VSKT2002, 2004-2009_Bönke, own calculations.

Table B.4: Permanent period shifter

	Model 1: Base		Model 2: Adj. sample selection		Model 3: Cohort inital variances		Model 4: Shorted time frame	
Period	Coeff	SE	Coeff	SE	Coeff	SE	Coeff	SE
1960	1		1		1			
1961	0.84	0.13	0.81	0.09	0.84	0.14		
1962	0.77	0.13	0.82	0.11	0.77	0.14		
1963	0.86	0.15	0.83	0.11	0.87	0.16		
1964	0.72	0.13	0.73	0.10	0.72	0.13		
1965	0.63	0.12	0.68	0.09	0.65	0.12		
1966	0.65	0.12	0.69	0.09	0.66	0.13		
1967	0.77	0.15	0.77	0.11	0.79	0.16		
1968	0.75	0.14	0.77	0.10	0.77	0.15		
1969	0.72	0.14	0.70	0.09	0.73	0.14		
1970	0.65	0.13	0.65	0.09	0.66	0.13		
1971	0.62	0.12	0.64	0.09	0.63	0.13		
1972	0.61	0.12	0.61	0.08	0.62	0.12		
1973	0.58	0.11	0.64	0.09	0.59	0.12		
1974	0.59	0.12	0.64	0.09	0.60	0.12		
1975	0.63	0.12	0.68	0.10	0.64	0.13		
1976	0.61	0.12	0.66	0.09	0.62	0.13		
1977	0.60	0.12	0.65	0.09	0.61	0.12		
1978	0.58	0.12	0.63	0.09	0.59	0.12		
1979	0.55	0.11	0.61	0.08	0.55	0.11	1	
1980	0.52	0.10	0.58	0.08	0.53	0.11	0.95	0.01
1981	0.53	0.11	0.59	0.08	0.54	0.11	0.96	0.01
1982	0.55	0.11	0.60	0.08	0.55	0.11	0.99	0.01
1983	0.55	0.11	0.60	0.08	0.56	0.11	1.00	0.01
1984	0.60	0.12	0.63	0.09	0.61	0.12	1.09	0.01
1985	0.60	0.12	0.64	0.09	0.60	0.12	1.08	0.01
1986	0.59	0.12	0.63	0.09	0.60	0.12	1.07	0.01
1987	0.57	0.11	0.62	0.09	0.58	0.12	1.03	0.01
1988	0.55	0.11	0.61	0.09	0.56	0.11	1.00	0.01
1989	0.54	0.11	0.60	0.08	0.55	0.11	0.97	0.01
1990	0.52	0.10	0.58	0.08	0.53	0.11	0.94	0.01
1991	0.51	0.10	0.57	0.08	0.52	0.11	0.91	0.01
1992	0.49	0.10	0.55	0.08	0.50	0.10	0.89	0.01
1993	0.49	0.10	0.55	0.08	0.50	0.10	0.89	0.01
1994	0.48	0.10	0.54	0.08	0.49	0.10	0.86	0.01
1995	0.48	0.10	0.54	0.08	0.48	0.10	0.86	0.01
1996	0.46	0.09	0.53	0.08	0.47	0.10	0.84	0.01
1997	0.46	0.09	0.53	0.08	0.46	0.09	0.82	0.01
1998	0.45	0.09	0.54	0.08	0.46	0.09	0.82	0.02
1999	0.44	0.09	0.52	0.07	0.44	0.09	0.79	0.01
2000	0.43	0.09	0.52	0.07	0.44	0.09	0.78	0.02
2001	0.43	0.09	0.51	0.07	0.43	0.09	0.77	0.02
2002	0.42	0.09	0.51	0.07	0.43	0.09	0.76	0.02
2003	0.42	0.08	0.51	0.07	0.43	0.09	0.76	0.02
2004	0.41	0.08	0.51	0.07	0.42	0.09	0.75	0.02
2005	0.42	0.08	0.54	0.08	0.43	0.09	0.76	0.02
2006	0.42	0.08	0.53	0.08	0.42	0.09	0.76	0.02
2007	0.43	0.09	0.54	0.08	0.43	0.09	0.77	0.02
2008	0.42	0.09	0.54	0.08	0.42	0.09	0.76	0.02
2009	0.42	0.08	0.54	0.08	0.42	0.09	0.76	0.02

Source: FDZ-RV – VSKT2002, 2004-2009_Bönke, own calculations.

Table B.5: Transitory period shifter

	Model 1: Base		Model 2: Adj. sample selection		Model 3: Cohort inital variances		Model 4: Shorted time frame	
Period	Coeff	SE	Coeff	SE	Coeff	SE	Coeff	SE
1960	1		1		1			
1961	0.93	0.32	1.03	0.30	0.89	0.12		
1962	0.98	0.31	0.96	0.28	1.03	0.09		
1963	0.86	0.28	0.91	0.26	0.84	0.10		
1964	0.94	0.28	1.00	0.28	1.08	0.06		
1965	1.10	0.32	1.04	0.29	0.99	0.09		
1966	1.11	0.33	1.04	0.28	1.05	0.06		
1967	1.06	0.31	1.08	0.30	1.04	0.07		
1968	1.00	0.29	0.93	0.26	0.98	0.06		
1969	1.01	0.32	0.93	0.26	1.08	0.06		
1970	1.01	0.30	0.92	0.26	1.12	0.06		
1971	1.07	0.32	0.99	0.27	1.22	0.05		
1972	1.13	0.33	0.95	0.26	1.21	0.07		
1973	1.11	0.33	0.99	0.27	1.29	0.06		
1974	1.21	0.35	1.02	0.28	1.38	0.06		
1975	1.17	0.34	0.99	0.27	1.47	0.06		
1976	1.15	0.33	0.96	0.27	1.46	0.05		
1977	1.23	0.36	1.03	0.29	1.61	0.06		
1978	1.13	0.33	0.88	0.25	1.52	0.06		
1979	1.11	0.32	0.88	0.25	1.49	0.06	1	
1980	1.05	0.31	0.87	0.24	1.38	0.05	1.02	0.07
1981	1.10	0.32	0.85	0.24	1.67	0.05	1.07	0.07
1982	1.10	0.32	0.88	0.25	1.66	0.06	1.06	0.07
1983	1.31	0.38	0.92	0.26	1.93	0.05	1.25	0.09
1984	1.09	0.32	0.82	0.23	1.73	0.05	1.04	0.07
1985	1.10	0.32	0.83	0.23	1.76	0.05	1.04	0.07
1986	1.06	0.31	0.78	0.22	1.78	0.05	1.00	0.07
1987	1.09	0.32	0.73	0.21	1.73	0.04	1.02	0.07
1988	1.09	0.32	0.75	0.21	1.76	0.04	1.02	0.07
1989	1.07	0.31	0.71	0.20	1.85	0.05	0.99	0.07
1990	1.01	0.30	0.67	0.19	1.68	0.04	0.93	0.07
1991	1.00	0.29	0.67	0.20	1.64	0.04	0.92	0.07
1992	0.94	0.28	0.63	0.18	1.57	0.04	0.86	0.06
1993	0.98	0.29	0.63	0.18	1.80	0.04	0.89	0.07
1994	1.08	0.32	0.68	0.20	2.03	0.04	0.98	0.07
1995	0.99	0.29	0.64	0.19	1.91	0.04	0.90	0.07
1996	1.14	0.34	0.72	0.21	2.20	0.04	1.03	0.08
1997	1.15	0.34	0.72	0.21	2.30	0.05	1.04	0.08
1998	1.08	0.32	0.68	0.20	2.18	0.04	0.97	0.08
1999	1.10	0.33	0.68	0.20	2.24	0.05	0.98	0.08
2000	1.00	0.30	0.61	0.18	2.19	0.05	0.89	0.07
2001	0.97	0.29	0.59	0.18	2.14	0.04	0.87	0.07
2002	0.97	0.29	0.57	0.17	2.16	0.04	0.86	0.07
2003	0.97	0.29	0.59	0.18	2.21	0.05	0.86	0.07
2004	0.99	0.30	0.55	0.17	2.29	0.05	0.87	0.07
2005	0.94	0.28	0.56	0.17	2.29	0.05	0.82	0.07
2006	0.93	0.28	0.52	0.16	2.34	0.05	0.80	0.07
2007	0.88	0.27	0.51	0.16	2.31	0.05	0.76	0.07
2008	0.80	0.24	0.46	0.14	2.17	0.05	0.68	0.06
2009	0.91	0.28	0.49	0.15	2.45	0.00	0.76	0.07

Source: FDZ-RV – VSKT2002, 2004-2009_Bönke, own calculations.

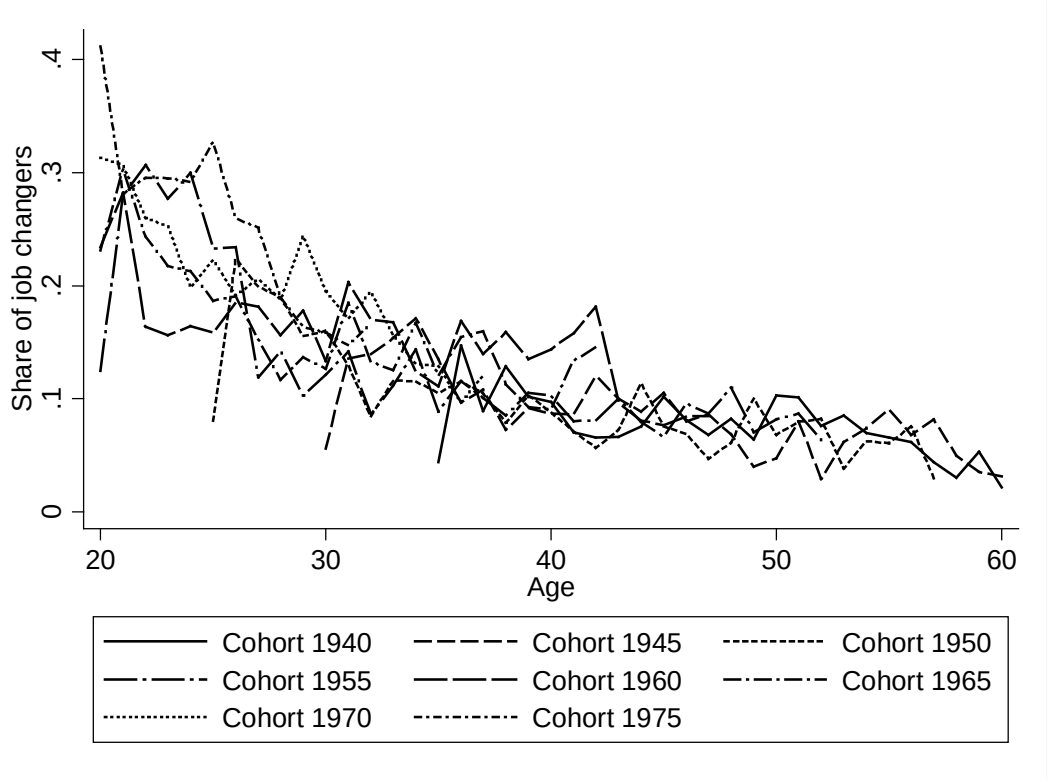
Appendix C: Supplements

Table C.1: Changes in labor market regulations since 1972

Year	Law (German Abbreviation)	Summary of Content
1972	AÜG	Permission of subcontracted work for up to 3 month
1985	BeschFG	1. Reduction of dismissal protection and weakening of standard employment contracts 2. Introduction of fixed term contracts for first time employees (up to 18 month) 3. Extension of maximum time for subcontracted work from 3 to 6 month
1990	BeschFG	Relaxation of justification requirements for fixed term contracts
1993	KündFG	Harmonization of employment protection (abolishment of special arrangements)
	1. SKWGP	Extension of maximum time for subcontracted work from 6 to 9 month
1996	BeschFG	1. Fixed term contracts can be applied multiple times 2. Fixed term contracts enhanced to 24 month 3. Further reduction of employment protection through the introduction of severance pay rules and for employees in small businesses
1997	ARFG	Extension of maximum time for subcontracted work from 9 to 12 month
1998	Gesetz zur Sicherung der Arbeitnehmerrechte	Rollback of employment protection legislation to the regulations in place prior to BeschFG 1996
2002	Job-AQTIV_Gesetz	Extension of maximum time for subcontracted work from 12 to 24 month
2003	Hartz 1	Abolishment of time limit for subcontracted work Reintroduction of employment protection legislation according to BeschFG 1996

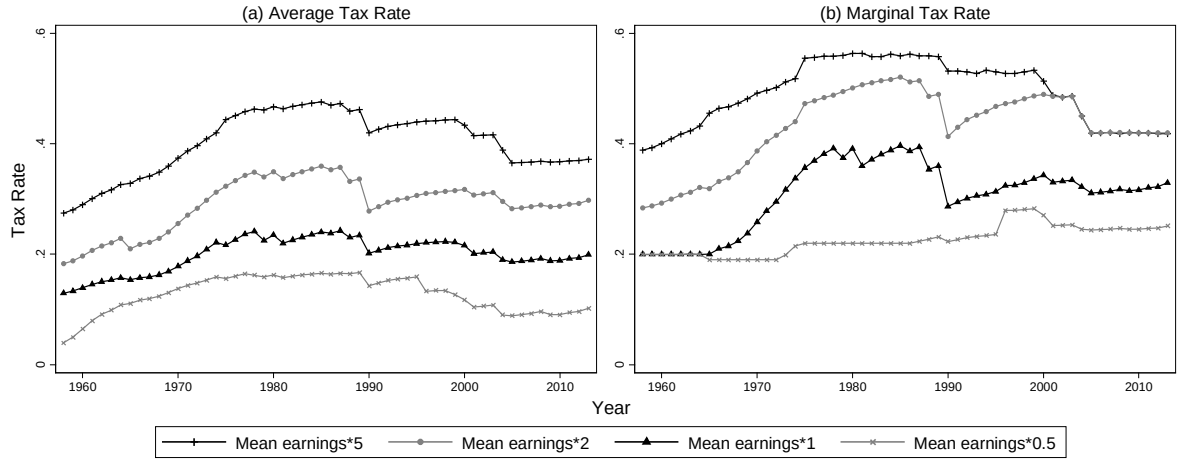
Source: Bundesgesetzblätter, various issues (available on request).
Note: Year is the year of parliamentary decision on passing the law, the entry of the law into force can deviate. For a more detailed overview on labor market regulation see Bartels (2014).

Figure C.1: Share of job changers by age and cohort



Source: Bartels et al. (2015)

Figure C.2: Average and marginal tax rates, 1958 - 2013



Note: Mean earnings according to average earnings published in Appendices 1 and 2 of Social Code VI (Sozialgesetzbuch VI), Federal Ministry of Labour and Social Affairs. Marginal and average tax rates on yearly wage income of unmarried employees without children.

References

Acemoglu, D., Aghion, P. and Violante, Giovanni L., (2001). Deunionization, technical change and inequality, Carnegie-Rochester Conference Series on Public Policy, 55(1), 229-264.

Altonji, Joseph G., and Segal, Lewis M. (1996). Small-Sample Bias in GMM Estimation of Covariance Structures. Journal of Business and Economic Statistics 14, 353–66.

Antonczyk, D., Fitzenberger, B. and K. Sommerfeld (2010). Rising wage inequality, the decline of collective bargaining, and the gender wage gap. Labour Economics 17 (5), 835 – 847.

Armingeon, K., L. Knöpfel, D. Weisstanner and S. Engler (2014). *Comparative Political Data Set I 1960-2012.* Bern: Institute of Political Science, University of Berne.

Baker, M. (1997). "Growth-Rate Heterogeneity and the Covariance Structure of Life-Cycle Earnings," Journal of Labor Economics 15(2), 338-75.

Baker, M. and G. Solon (2003). Earnings Dynamics and Inequality among Canadian Men, 1976-1992: Evidence from Longitudinal Income Tax Records. Journal of Labor Economics 21 (2), 267–288.

Bartels, C. (2014). Versicherung und Anreize im deutschen Wohlfahrtsstaat, Springer Gabler: Wiesbaden.

Bartels, C. and T. Bönke (2013). Can households and welfare states mitigate rising earnings instability?, Review of Income and Wealth 59(2), 250-282.

Bartels, C., T. Bönke and H. Lüthen (2015). Bildungs- und Jobmobilität in Deutschland. mimeo.

Bauer, T. K., Braun, S. and Michael Kvasnicka (2013). The Economic Integration of Forced Migrants: Evidence for Post-War Germany. The Economic Journal 123 (571), 998–1024.

Bauer, T. K., Dietz, B., Zimmermann, K. F. and Zwintz, Eric (2005): German Migration: Development, Assimilation, and Labor Market Effects. In: European Migration - What do We Know?, edited by Klaus F. Zimmermann, Oxford University Press, Oxford.

Bingley, P., Cappellari, L. and Westergård-Nielsen, N. (2013), Unemployment Insurance, Wage Dynamics and Inequality Over the Life Cycle. The Economic Journal 123 (568): 341–372.

Björklund, A. (1993). A comparison between actual distributions of annual and lifetime income: Sweden, 1951–89. Review of Income and Wealth 39, 377–86.

Blundell, R. and I. Preston (1998). Consumption Inequality And Income Uncertainty. The Quarterly Journal of Economics 113 (2), 603–640.

Blundell, R., M. Graber and M. Mogstad (2014). Labor income dynamics and the insurance from taxes, transfers and the family. Journal of Public Economics (forthcoming).

Bönke, T., G. Corneo, and H. Lüthen (2015). Lifetime Earnings Inequality in Germany. Journal of Labor Economics 33 (1), pp. 171–208.

Bowlus, A. J. and Robin, J.-M. (2012). An International Comparison of Lifetime Inequality: How Continental Europe Resembles North America. Journal of the European Economic Association (10), 1236–1262.

Card, D., Heining, J. and P. Kline (2013). Workplace Heterogeneity and the Rise of West German Wage Inequality. Quarterly Journal of Economics 128 (3), 967 – 1015.

Castaneda, A., Diaz-Jimenez, J., Rios-Rull, J.V., 2003. Accounting for earnings and wealth inequality. Journal of Political Economy 111 (4), 818–857.

Cappellari, L. (2004). The Dynamics and Inequality of Italian Men's Earnings: Long-term Changes or Transitory Fluctuations? Journal of Human Resources 39 (2), 475–499.

Chamberlain, G. (1984). 'Panel data', in (Z. Griliches and M. Intriligator, eds.), Handbook of Econometrics, vol. 2, pp. 1247–318, Amsterdam: North-Holland.

Clark, Todd. "Small-Sample Properties of Estimators of Nonlinear Models of Covariance Structure." Journal of Business and Economic Statistics 14 (July 1996): 367–73.

Cuñat, A. and Melitz, M. (2012). Volatility, Labor Market Flexibility, And The Pattern Of Comparative Advantage. Journal of the European Economic Association 10(2), 225–254.

Dickens, R. (2000). The Evolution of Individual Male Earnings in Great Britain: 1975-95. Economic Journal 110 (460), 27–49.

Dustmann, C., J. Ludsteck and U. Schönberg (2009): Revisiting the German wage structure, Quarterly Journal of Economics 124, 843-881.

Dustmann, C., Fitzenberger, B., Schönberg, U. and A. Spitz-Oener (2014): From Sick Man of Europe to Economic Superstar: Germany's Resurgent Economy. Journal of Economic Perspectives 28 (1), 167-188.

Economist (2004). “Germany on the Mend.” November 17. http://www.economist.com/node/3352024.

Ellgut, P. and Kohaut, S. (2005). Tarifbindung und betriebliche Interessenvertretung: Aktuelle Ergebnisse aus dem IAB-Betriebspanel. WSI Mitteilungen 7/2005, 398-406.

Ellgut, P. and Kohaut, S. (2008). Tarifbindung und betriebliche Interessenvertretung: Aktuelle Ergebnisse aus dem IAB-Betriebspanel 2007. WSI Mitteilungen 9/2008, 1-5.

Ellgut, P. and Kohaut, S. (2013). Tarifbindung und betriebliche Interessenvertretung: Ergebnisse aus dem IAB-Betriebspanel 2012. WSI Mitteilungen 4/2013, 281-288.

Fuchs-Schündeln, N. and M. Schündeln (2009): Who stays, who goes, who returns? Economics of Transition 17, 703–38.

Gottschalk, P. and R. Moffitt (1994). The Growth of Earnings Instability in the U.S. Labor Market. Brookings Papers on Economic Activity 25 (2), 217–272.

Gourinchas, P.-O., Parker, J.A., 2002. Consumption over the life cycle. Econometrica 70, 47–89.

Guvenen, F., 2007. Learning your earning: Are labor income shocks really very persistent? American Economic Review 97 (3), 687–712.

Guvenen, F., 2009. An Empirical Investigation of Labor Income Processes. Review of Economic Dynamics 12(1), 58-79.

Gustavsson, M. (2008). A New Picture Of Swedish Earnings Inequality: Persistent And Transitory Components, 1960-1990. Review of Income and Wealth 54 (3), 324–349.

Guvenen, F., S. Ozkan, and J. Song (2014). The Nature of Countercyclical Income Risk. Journal of Political Economy 122 (3), 621 – 660.

Guvenen, F., F. Karahan, S. Ozkan, and J. Song (2015). What Do Data on Millions of U.S. Workers Reveal about Life-Cycle Earnings Risk? Federal Reserve Bank of New York Staff Reports, no. 710.

Fitzenberger, B. (1999): Wages and employment across skill groups: An analysis for West Germany, ZEW Economic Studies, Physika-Verlag: Heidelberg, New York.

Haider, S. J. (2001). Earnings Instability and Earnings Inequality of Males in the United States: 1967-1991. Journal of Labor Economics 19 (4), 799–836.

Hause, J.C. (1980). ‘The fine structure of earnings and the on-the-job training hypothesis’, Econometrica, vol. 48(4), pp. 1013–29.

Huggett, M., 1996. Wealth distribution in life-cycle economies. Journal of Monetary Economics 38, 469–494.

Jenson, S. and S. Shore (2015): Changes in the Distribution of Earnings Volatility. The Journal of Human Resources 50(3), 811-836.

Karahan, F. and S. Ozkan (2013). On the Persistence of Income Shocks over the Life Cycle: Evidence, Theory, and Implications. Review of Economic Dynamics 16 (3), 452–476.

Kohaut, S. and Schnabel, S. (2002). Tarifverträge – nein danke? IAB Materialien 1/2002, 4-5.

Kopczuk, W., E. Saez and J. Song (2010). Earnings inequality and mobility in the United States: Evidence from social security data since 1937. Quarterly Journal of Economics 125, 91–128.

Krugman, P. and A.J. Venables (1995). Globalization and the inequality of nations. The Quarterly Journal of Economics 110, 857–880.

Lee, D., & Saez, E. (2012). Optimal minimum wage policy in competitive labor markets. Journal of Public Economics 96(9), 739-749.

Lillard, L. and Weiss, Y. (1979). Components of variation in panel earnings data: American scientists, 1960–70, Econometrica, vol. 47(2), pp. 437–59.

MaCurdy, Thomas (2007). A Practitioner's Approach to Estimating Intertemporal Relationships using Longitudinal Data: Lessons from Applications in Wage Dynamics. In: Handbook of Econometrics, Vol. 6, J. Heckman and E. Leamer (eds), Elsevier.

Meghir, C. and Pistaferri, L. (2011). Earnings, consumption, and life cycle choices. In: Handbook of Labor Economics', Vol. 4B, O. Ashenfelter and D. Card (eds), Elsevier.

Mincer, J. (1974). Schooling, Experience and Earnings, New York: Columbia University Press.

Moffitt, R. A. and P. Gottschalk (2002). Trends in the Transitory Variance of Earnings in the United States. The Economic Journal 112 (478), C68–C73.

Moffitt, R. and Gottschalk, P. (2012). Trends in the transitory variance of male earnings: methods, and evidence, Journal of Human Resources, vol. 47(1), pp. 204–36.

Ostrovsky, Yuri. 2010. Long-Run Earnings Inequality and Earnings Instability among Canadian Men Revisited, 1985-2005. The B.E. Journal of Economic Analysis & Policy. 10(1).

Shin, D. and Solon, G. (2011). Trends in men's earnings volatility: what does the panel study of income dynamics show?, Journal of Public Economics, vol. 95(7–8), pp. 973–82.

Sologon, D. and Van Kerm, P. (2014). Earnings dynamics, foreign workers and the stability of inequality trends in Luxembourg 1988-2009, CEPS/INSTEAD Working Paper Series 2014-03.

Storesletten, K., Telmer, C., Yaron, A., (2001). The welfare costs of business cycles revisited: Finite lives and cyclical variation in idiosyncratic risk. European Economic Review 45, 1311–1339.

Wood, A. (1995). How Trade Hurt Unskilled Workers. The Journal of Economic Perspectives 9 (3), 57-80.