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ABSTRACT

Moderation in Higher-Order Earnings Risk? Evidence from German Cohorts*

Women born later experience greater earnings growth volatility at given ages than older cohorts. This implies a welfare loss due to increased earnings risk. However, German registry data for the years 2001-2016 reveal a moderation in higher-order earnings risk: Men and women born later face higher skewness in earnings changes, indicating fewer large decreases than increases, and lower kurtosis at younger ages, implying fewer large earnings changes. These trends point at a welfare increase and persist for 5-year earnings changes, which are more reflective of persistent changes. During the Great Recession, males' skewness dropped sharply; younger women were unaffected.

JEL Classification: D31, J31, E24
Keywords: wage risk, income dynamics, life cycle, business cycle

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1 Introduction

How did earnings risk evolve for recent German birth cohorts? For risk averse agents, changes in various dimensions of (non fully-insured) earnings risk have first-order implications for welfare as well as for savings decisions (Busch and Ludwig, 2024; De Nardi et al., 2020; Ghosh and Theloudis, 2023; Guvenen et al., 2024). We first document measures of volatility, skewness, and kurtosis of residualized log earnings changes over the life cycle and over the business cycle using registry data from the German Taxpayer Panel (TPP) for the years 2001-2016. In line with recent findings for various countries,[1] we find that earnings changes are non-Gaussian. We then show that earnings risk differs substantially by cohort.

Our first key finding is that at most ages, each female ten-year birth cohort born after 1951 faces higher earnings growth volatility than the next older cohort. This difference between cohorts is less pronounced for men. The finding of increased earnings volatility for younger cohorts is in line with recent findings for Italy (Hoffmann et al., 2022), who document even stronger differences between cohorts. The variability of residualized earnings changes is typically interpreted as a measure of earnings risk. Earnings risk translates into consumption risk as the family and the welfare state do not offer full insurance against earnings shocks (see, e.g., Arellano et al., 2017; Blundell et al., 2016, 2008; Kaplan and Violante, 2010). Therefore, this increase in the volatility of earnings shocks alone would imply a welfare loss for younger generations.

Our second key finding, however, is that differences in higher-order moments of earnings changes imply a welfare improvement for younger cohorts relative to older cohorts. Earnings changes of younger cohorts exhibit higher skewness, i.e., the upward risk of a large wage increase is higher relative to the downside risk of a large wage decline compared to older cohorts. Moreover, the distributions of earnings growth for younger female cohorts exhibit lower kurtosis than those of older cohorts, i.e., younger cohorts face fewer extreme tail events. At younger ages this is also true for men. With constant relative risk aversion (CRRA) utility, at a given variance, higher skewness and/or lower kurtosis of consumption implies higher expected utility.

Our third key finding concerns the difference in the patterns of earnings changes over the business cycle between women and men. Previous work has shown that skewness of

[1] See, e.g., Arellano et al. (2017) and Guvenen et al. (2021) for the US and the articles in the special issue of *Quantitative Economics* on global income dynamics (Volume 13, Issue 4) for various countries.

income shocks is strongly pro-cyclical (Busch et al., 2022; Guvenen et al., 2014). In line with these findings, we observe a slight drop in skewness during the early 2000s recession. Turning to the Great Recession, which in Germany resulted in a large contraction in GDP in 2009, we find that women appear much less affected than men. We see a substantial drop in skewness during the Great Recession, which is much larger for men than for women (see also Drechsel-Grau et al., 2022). Importantly, there is no drop in skewness for women born in the 1970s or later. Volatility increases during the Great Recession. Kurtosis drops for most cohorts of men, but not for the youngest two cohorts born after 1972. For women, kurtosis drops only for the oldest cohort, the one born between 1942 and 1951. Thus, younger cohorts appear overall less affected. We decompose our measures of skewness and kurtosis into contributions from the upper and lower tail and find that men experience a much larger increase in lower tail dispersion during the Great Recession than women. In other words, large earnings decreases for men became much more prevalent during the Great Recession, implying a substantial welfare cost.

The household is an important way to insure against earnings risk. Income pooling and family labor supply can attenuate income shocks. Therefore, a natural question to ask is to what extent differences in the distributions of log earnings changes translate to differences in the distributions of pre-government household income changes. The TPP allows us to identify married couples. It turns out that the differences in volatility and the Crow-Siddiqui measure of kurtosis between cohorts are far less pronounced for changes in household market income than in earnings, while the difference in skewness persists. Interestingly, the volatility of log household income changes is higher than that of log earnings changes, implying that the household does not offer insurance against earnings volatility. In contrast, log household income changes exhibit Kelley skewness and Crow-Siddiqui kurtosis closer to zero than the changes in log earnings, implying some insurance against higher-order earnings risk.

It is well understood that persistent income changes have very different implications than transitory income changes, mainly because households can insure against transitory shocks by saving. For this reason it is common to decompose earnings residuals in transitory and persistent components based on a specific income process. A key advantage of this approach is that it allows to quantify to what extent changes in cross-sectional inequality translate into long-run inequality. However, committing to a specific, restrictive income process can heavily bias results (Shin and Solon, 2011). Instead, to gauge to what extent our results for 1-year earnings changes capture trends in persistent rather than transitory shocks, we follow the recent literature and additionally show results for 5-year changes instead of 1-year changes, which reflect more persistent innovations (Guvenen et al., 2021). Considering 5-year earnings changes, the cohort pattern for women remains unchanged. Except for those born before 1952, younger cohorts consistently face higher volatility and skewness, and lower kurtosis than older cohorts over the life cycle. For men, differences in volatility between cohorts almost vanish. Nonetheless, younger cohorts' consistently face higher skewness. The business-cycle pattern is generally much less pronounced for 5-year changes, suggesting that earnings changes during recessions are driven by transitory shocks.

Besides documenting differences between cohorts, we also show that the life-cycle profiles of earnings risk more generally differ strongly between men and women. Throughout the life cycle, volatility and kurtosis are higher for women than for men. For men, we find that earnings volatility is U-shaped, while for women, volatility is much higher when entering the labor market and decreases until the age of 40. For women, skewness decreases between ages 25 and 30 and afterwards exhibits an inverse U-shape over the life cycle. For men, it is steadily decreasing with age. Finally, kurtosis increases over the life cycle for men and is inverse-U-shaped for women. A subsample analysis reveals that—strikingly—the differences in life-cycle patterns of earnings risk between women and men are entirely driven by mothers.

This paper contributes to a growing strand of recent literature on non-linear or non-normal earnings dynamics (e.g. Arellano et al., 2017; De Nardi et al., 2021; Drechsel-Grau et al., 2022; Guvenen et al., 2021; Halvorsen et al., 2024; Hoffmann et al., 2022). Guvenen et al. (2022) summarize key facts about income dynamics in various countries. Pessoa (2021) and Drechsel-Grau et al. (2022) document non-normalities and non-linearities of individual income changes in Germany. Our paper is strongly related, but we document in detail how income dynamics differ between cohorts. Busch et al. (2022) investigate countercyclical skewness of earnings growth over the business cycle in Germany, Sweden and the United States. For Germany, Busch et al. (2022) use social security data. We complement their analysis by using an alternative data source, the TPP. Moreover, we add to the analysis by investigating how the synchronization of skewness and the business cycle varies between cohorts.

Hoffmann et al. (2022) analyze earnings dynamics for different birth cohorts in Italy. Mainly driven by labor market institutions like fixed-term contracts, income risk significantly increased for younger cohorts. For Germany, we also find higher volatility for younger cohorts, but the trend is less pronounced than in Italy. Importantly, we document that younger cohorts have faced fewer large earnings decreases than older ones, implying that their jobs are at least in one way less "precarious" than the jobs of older cohorts.

Several papers document the "Great Moderation"—the observation that the variability of earnings changes has been declining in the US since the early 1980s. Salgado et al. (2023) show that a decline in variance can be observed for all age groups and Sabelhaus and Song (2010) show that at given ages, the younger cohorts face lower earnings volatility. For our relatively brief observational period, we observe the opposite for Germany: Younger cohorts face somewhat higher volatility. However, focusing on 5-year changes, which mostly reflect volatility in persistent shocks, the difference between age cohorts vanishes for men. Moreover, there is no clear trend in overall volatility. Instead, we document a different type of moderation: Since 2010, skewness has been substantially higher than during the early 2000s, implying that large income drops have become less relevant relative to large income increases.

The remainder of the paper is structured as follows. Section 2 provides information on the institutional background and presents our data source, the sample selection, and the empirical approach used in the analysis. Section 3 presents the main results, section 4 additional analyses and section 5 concludes.

2 Background, Data and Empirical Approach

2.1 Institutional Background

Between 2001 and 2016—the time period we observe in this paper—the German welfare state was subject to far-reaching tax and labor market reforms as well as macroeconomic shocks. First, income tax rates were reduced gradually from 2000 to 2005. A significant institutional shift occurred between 2003 and 2005, when the German government implemented the Hartz reforms, a comprehensive series of labor market reforms aimed at reducing unemployment and increasing labor market flexibility.

Hartz IV, implemented in 2005, was the most transformative of those reforms. It merged long-term unemployment assistance with social welfare benefits, drastically reducing benefit levels for long-term unemployed with relatively high previous earnings and creating stronger incentives for rapid reentry into the labor market. The reforms also facilitated the expansion of so-called mini-jobs, which allow for low-wage employment that is largely exempt from social security contributions and income tax. At the beginning of our observed time period, the threshold for a mini-job was at 325 Euro per month, before being raised to 400 Euro in 2003 and ultimately to 450 Euro in 2013. Mini-jobs became a common form of employment, especially in the service sector.

Another development during this period was the introduction of a national minimum wage in January 2015, set at 8.50 Euro per hour. Prior to this, wage floors were only regulated through sector-specific collective bargaining agreements. The minimum wage law aimed to improve earnings for low-wage workers, particularly in industries with lower union representation or in regions where collective bargaining agreements did not apply. Union coverage and collective bargaining play a vital role in wage setting in Germany, traditionally providing wage floors and regulating wage dynamics. However, union density and collective bargaining coverage have declined during this period (Ellguth and Kohaut, 2019). Sectoral differences in union strength and the erosion of collective wage agreements were notable, with manufacturing maintaining relatively high coverage, while service sectors saw a significant decline.

Germany experienced two major economic downturns during the observed period. The first occurred in the early 2000s, when the global dot-com bubble burst and structural problems of the German economy that became apparent with the introduction of the Euro lead to a recession as well as slightly elevated unemployment rates in Germany (Breuer et al., 2018). The second and more severe recession happened in 2008-2009 as a result of the global financial crisis. Although Germany was hit hard, its economy rebounded relatively quickly due to a combination of robust export performance, targeted stimulus measures, and the implementation of the short-time work scheme. This program helped mitigate the impact of the crisis on both unemployment and earnings volatility, particularly in the industrial sector.

Germany applies joint taxation to married couples. The joint filing allows us to identify married couples in the administrative data and observe household incomes of this group, in addition to individual labor incomes.

2.2 Data: German Taxpayer Panel (TPP)

We employ the TPP, a large administrative dataset that allows us to obtain precise estimates of measures of the moments of earnings growth over time or over the life cycle, even after dividing the sample by birth cohorts. The TPP is provided by the Federal Statistical office and contains tax return data of a stratified 5%-sample of the overall collected personal income tax data by the tax authorities. Our data cover the years 2001 to 2016 and the unit of observation in the data is the tax unit, i.e. an individual or a married couple filing jointly. The tax return data include the individual labor earnings of spouses. Filing a tax return is optional for many employees in Germany. Until 2011 the TPP only includes information on tax filers. Since 2012 non-filers who pay income tax are included as well. In Germany employers withhold wage tax on a monthly basis. Since 2012, information from these payments is contained in the data.

For distributional analyses, the big upside of the TPP is that it contains even the largest incomes without top-coding. On the other hand, low-income earners are underrepresented. Tax filing is optional for many employees in Germany and the TPP only contains data on non-filers since 2012. Moreover, workers on so-called mini jobs (with monthly earnings below 450 Euro in 2016) typically do not pay taxes and thus only appear in our data if they file taxes.

Drechsel-Grau et al. (2022) show that the TPP reasonably covers the distribution of people with positive labor income, while low-medium incomes are somewhat underrepresented. Drechsel-Grau et al. (2022) augment the TTP data with social-security data. The combined data set has better coverage for very low incomes, i.e. mini-jobs, than the TTP. The reason is that low-income earners are less likely to file a tax return.[2] For lower-medium incomes, the combined data set has better coverage than the TPP alone until 2011. With the inclusion of non-filers in 2012, coverage of the TTP improves considerably with no big difference between the earnings distributions according to the two data sources except for the lower coverage of mini-jobs in the TTP (Drechsel-Grau et al., 2022). The structural break in the TTP clearly matters when describing the evolution of earnings inequality. However, we do not observe an apparent break in earning *dynamics* in 2011/12. An important difference between the TTP and the social-security data is that the social-security data are top-coded, which is why the upper tail of the distribution can be described more precisely using the TTP. Moreover, in contrast to social-security data, married couples and parents are identified in the TTP, allowing us to analyze household income and separate subsamples.

[2]Hauck and Wallossek (2024) show that low-income earners are less likely to file a tax return than higher-income earners, which reduces the effective progressivity of the German income tax.

Our sample includes 25-60 year-old employees. Following Drechsel-Grau et al. (2022), we drop individuals who earn under 2,300 Euro per year, eliminating those with low labor market attachment. In 2018 this corresponds to working part-time for one quarter at the national minimum wage.

2.3 Variables and income concepts

This subsection describes the most important variables in our analysis.

Cohorts — We divide the sample into ten-year birth cohorts. A cohort is observed in a given age or year if at least one of the ten birth years is observed at that point, not necessarily individuals from all birth years defining the cohort.

Earnings — We focus on annual labor earnings from dependent employment. These refer to an individual's labor earnings in a calendar year. The variable includes bonus payments and payments for overtime work. The variable might include earnings from various jobs, potentially interrupted by periods of unemployment.

Household Income — This variable includes all taxable pre-government income of the tax unit, i.e., individuals or married couples. Besides labor earnings, the most important components are income from self-employment, business, rental income, and capital income.

Residualized log income changes — Our measures of risk are based on residualized growth rates. We construct k-year growth rates of variable $y_{i,t}$ for individual i in year t as

$$\Delta_k \ln y_{i,t} = \ln y_{i,t+k} - \ln y_{i,t}. \tag{1}$$

Most of our analysis focuses on 1-year growth rates, but we also report results for 5-year growth rates, which are more reflective of persistent income changes. We construct residualized—or idiosyncratic—growth rates $\Delta_k \ln \tilde{y}_{i,t}$ as the residuals from a regression of growth rates on the full set of interactions of year, age, and sex dummies to account for year and age effects as well as for the different dynamics of women and men. In practice, some of the idiosyncratic changes in earnings might be expected by the individual or might be the result of choices. Then the idiosyncratic variability is an upper bound for actual income risk.

2.4 Measures of Earnings Risk

Our measures of various dimensions of income risk are measures of moments of residualized earnings growth. The first measure is the volatility of idiosyncratic income growth. It is measured as the difference between the 90th and 10th percentile—formally $P90-P10$—of residualized log income changes and is frequently used in the earnings dynamics literature. One key advantage is that it is more robust to outliers than the variance. Moreover, it can be decomposed into contributions of the upper and lower tail.

Beyond the earnings growth dispersion, we analyze measures of the third and fourth moment of the earnings growth distribution: skewness and kurtosis. Again, with robustness to outliers and decomposability into changes in the upper and the lower tail in mind, we use measures based on percentiles of the distribution. The Kelley skewness, or formally $S_K = \frac{(P90-P50)-(P50-P10)}{P90-P10}$ describes the relative weight of the upper and lower tail within the $P90-P10$ volatility (Kelley, 1947). For the kurtosis we use the measure introduced by Crow and Siddiqui (1967). The Crow-Siddiqui measure of kurtosis is calculated as $K_{C-S} = \frac{P97.5-P2.5}{P75-P25}$.

2.5 Summary Statistics for Earnings

Table 1 displays summary statistics for earnings of men and women in our sample by year as well as the average age in each year. Note that there is a structural break in 2012, as from then onward non-filers are included in the sample. In consequence, average age and earnings decrease. However, we show below that no break is observable for various measures on earnings risk. Focusing on men (upper panel), we find that earnings of the lower ten percent experienced a drop but have partially recovered before the structural break in 2012. We also observe a substantial increase in Earnings at P10 from 2012 to 2016. In contrast, Drechsel-Grau et al. (2022) document that earnings at the P10 are about 20 percent lower in 2011 than than in 2001 and do not recover from 2012 to 2016. The difference likely occurs because they augment the TTP with social security data, which have better coverage for low earnings. Like that paper, we find that earnings at the P25 in 2011 have declined relative to 2001 and we also observe a slight drop at the median. Instead, earnings in the upper half of the distribution have increased substantially, with earnings at P90 in 20111 exceeding the 2001 value by about 5 percent.

Table 1: Descriptive Statistics by Year

Year	N	Age	Earnings								
		Mean	Mean	P5	P10	P25	P50	P75	P90	P95	P99
Men											
2001	755,025	42.1	48,127	12,644	19,947	30,974	41,332	56,557	78,811	98,398	171,077
2002	758,601	42.3	47,893	11,992	19,339	30,690	41,235	56,584	78,950	98,069	169,229
2003	766,125	42.5	47,669	11,406	18,752	30,404	41,254	56,673	79,022	98,115	167,117
2004	781,063	42.7	47,496	10,948	18,157	29,760	40,864	56,423	79,342	98,570	170,104
2005	790,149	42.9	47,443	10,675	17,694	29,142	40,423	56,161	79,277	99,296	175,418
2006	757,595	43.2	47,730	11,125	17,772	28,855	40,281	56,251	79,813	100,500	181,372
2007	750,729	43.4	48,017	11,627	18,148	28,781	40,127	56,230	80,423	102,170	187,102
2008	740,373	43.7	48,109	12,192	18,423	28,652	40,043	56,293	80,756	102,883	188,464
2009	738,537	43.8	47,545	11,085	17,550	27,973	39,560	56,026	80,945	103,012	187,372
2010	741,282	43.9	48,082	11,447	17,659	28,046	40,058	56,748	81,704	104,165	189,470
2011	741,233	44.0	48,925	12,274	18,405	28,462	40,399	57,593	82,996	106,254	196,437
2012	852,406	43.4	45,871	9,070	15,692	26,118	38,262	54,858	79,160	100,988	181,006
2013	837,234	43.6	46,402	9,776	16,400	26,553	38,677	55,425	79,708	101,459	181,872
2014	819,486	43.8	47,376	10,386	17,109	27,352	39,456	56,472	81,275	103,351	184,557
2015	799,373	44.1	48,604	11,304	18,379	28,062	40,273	57,731	83,211	106,099	189,388
2016	776,725	44.3	49,728	12,004	19,121	28,934	41,132	58,879	84,770	108,252	195,479
Women											
2001	690,695	42.0	28,927	5,771	9,196	16,467	26,353	38,123	50,265	58,993	84,048
2002	704,963	42.2	29,142	5,828	9,270	16,555	26,436	38,437	50,780	59,545	85,351
2003	707,893	42.4	29,324	6,102	9,448	16,642	26,548	38,725	51,143	59,811	86,008
2004	728,546	42.6	29,239	6,018	9,201	16,432	26,295	38,549	51,138	60,241	88,031
2005	741,686	42.8	29,156	6,016	9,125	16,292	26,142	38,391	51,000	60,255	88,538
2006	706,495	43.1	29,049	5,971	9,049	16,181	25,947	38,145	50,812	60,123	90,391
2007	703,178	43.3	28,813	5,966	8,916	15,930	25,585	37,720	50,392	60,059	91,367
2008	692,656	43.6	28,718	5,996	8,892	15,804	25,352	37,610	50,285	60,136	91,744
2009	691,462	43.8	29,081	6,010	8,972	15,851	25,534	38,147	51,273	61,378	92,999
2010	697,753	43.9	29,220	5,986	8,899	15,811	25,535	38,330	51,925	62,025	94,390
2011	698,642	44.0	29,305	5,974	8,986	15,798	25,541	38,373	51,965	62,311	95,431
2012	762,651	43.7	28,463	5,576	8,383	15,146	24,766	37,487	50,879	61,018	92,700
2013	754,035	43.9	28,974	5,880	8,851	15,525	25,277	37,966	51,489	61,785	94,811
2014	742,061	44.1	29,553	6,082	9,142	15,920	25,821	38,640	52,366	62,907	96,666
2015	728,476	44.3	30,216	6,229	9,530	16,469	26,316	39,332	53,303	64,059	98,800
2016	711,436	44.5	30,848	6,413	9,773	16,810	26,910	40,114	54,316	65,314	101,665

Note: Weighted with household weights. Monetary values in 2018 Euro.

For women (bottom panel), we find increases in earnings throughout the distribution from 2001 to 2016. In line with findings in Drechsel-Grau et al. (2022), earnings at various parts of the distribution declined from 2001 to 2008 and increased afterwards.

3 Main Results

3.1 Earnings Dynamics over the Life Cycle and over Time

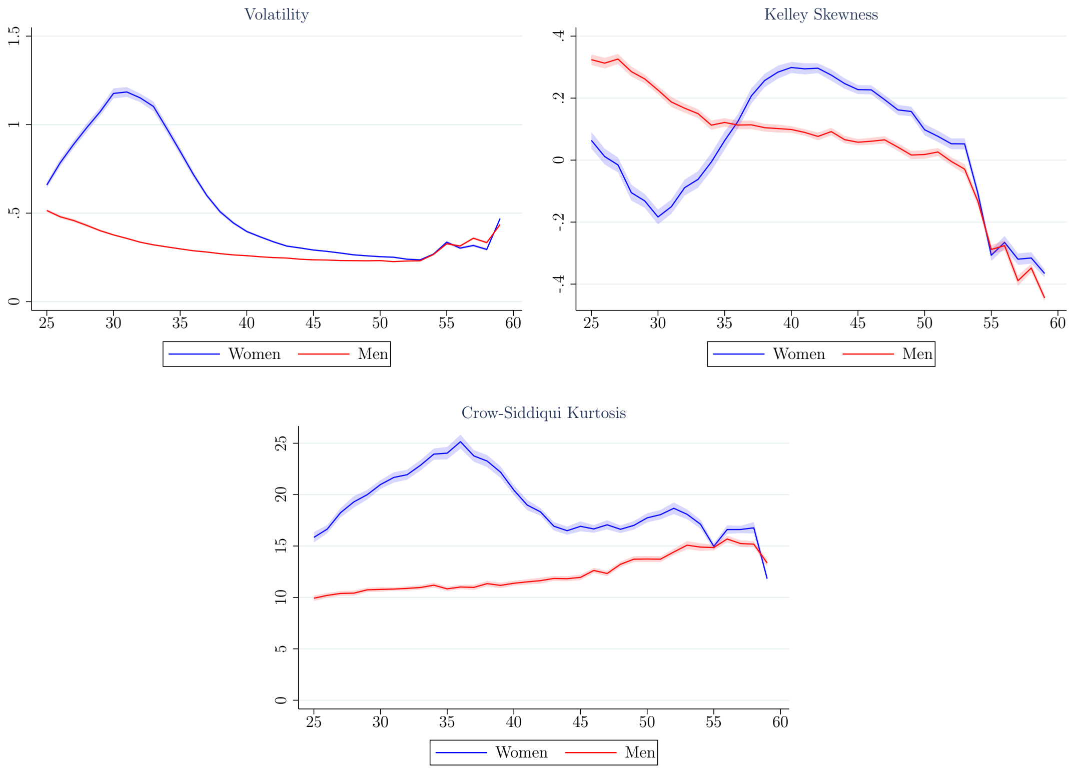

Figure 1: Moments of residualized earnings growth by age

Note: Prime age individuals in the TPP, years 2001-2016. The figure shows moments of residualized 1-year changes of log real annual earnings (from t to $t+1$). Shaded areas are bootstrapped 95-percent confidence intervals.

Before splitting the sample into cohorts, we investigate the earnings dynamics of the pooled sample (distinguishing only between women and men) over the life cycle and over time. Figure 1 shows measures of the second, third and fourth moment of the distribution of residualized earnings growth by age, separately for women and men. For these moments we use the measures described in subsection 2.4. The upper left panel depicts volatility. While men and women start out and end up at very similar levels of volatility of idiosyncratic earnings changes, their life cycle trajectories diverge substantially. While men's volatility follows a U-shaped path over the life cycle, women experience a large increase in volatility between age 25 and into the early 30s. In subsection 4.1, we show through subsample analyses that this is due to childbearing (see also Kleven et al., 2019), hence the steep decline in volatility between the ages 35 and 40 back towards the path of men.

The upper right panel shows the Kelley skewness. Throughout the working life, men's residualized earnings growth follows a downward trend going from a positive skew early in the career—implying that large positive changes occur more frequently than large negative ones—to a skewness of zero around age 50 and then further declining sharply. Women, in turn, reach a negative skew already early in life, which, as we also show below, mainly reflects mothers taking a step back from the labor market (perhaps dropping out, reducing hours, or changing to lower-paid, more family-friendly jobs). The flipside of this effect is the strong increase between roughly the ages of 30 and 40, surpassing the skewness in men's earnings growth in large parts of the life cycle. The decline in skewness over the working life is in line with findings in Guvenen et al. (2021) for the US.

Finally, we show the Crow-Siddiqui measure of kurtosis in the lower panel of Figure 1. The value for men at the beginning of working life is 10. For comparison, the Crow-Siddiqui measure of kurtosis of a normal distribution is 2.91. Kurtosis increases slightly throughout men's working life, meaning that with higher age, extreme deviations from the expected earnings path become more likely relative to smaller deviations. Job losses, job changes and switching between full-time and part-time can be reasons for such substantial changes. As is the case for volatility, women's kurtosis of earnings growth increases sharply early in life and later decreases until age 45, but peaks a little later than the volatility. Nonetheless, the pattern of kurtosis over the life cycle is heavily affected by motherhood.

Beyond the age of 55, when the impact of children on labor supply vanishes, volatility, Kelley skewness and Crow-Siddiqui kurtosis are all very similar between women and men. The increases in volatility and decreases in skewness towards the end of working life likely reflect early or partial retirement. As pointed out in Guvenen et al. (2021), non-employment can only result in negative skewness if it is permanent—as is the case for partial or early retirement. In contrast, transitory non-employment episodes contribute both one negative and one positive earnings change.

We now describe the distribution of residualized earnings growth over time, which is reported in Figure 2. The years 2003 and 2009 are marked as recession years in Germany. The GDP-loss during the Great Recession in 2009 was far larger than the decline in 2003 and hence the observable business cycle effects on earnings risk materialize more prominently for the log earnings changes from 2008 to 2009.

Volatility increased markedly during the Great Recession, whose effects are visible in 2008 due to our representation of earnings changes measured at time t as the first difference between $t + 1$ and t. Moreover, the majority of large shocks in the crisis year

Figure 2: Moments of residualized earnings growth by year

Note: Prime age individuals in the TPP, years 2001-2016. The figure shows moments of residualized 1-year changes of log real annual earnings (from t to $t+1$). Shaded areas are bootstrapped 95-percent confidence intervals. The gray bars indicate recessions.

were negative, implying a negative skew. Procyclical skewness in Germany has also been documented in Busch et al. (2022) and Drechsel-Grau et al. (2022). This drop in skewness that is caused by job-losses and reducing hours or wages (or not increasing them as much as expected) is much more pronounced for men. In the year following the crisis, the rebound is similarly strong. In terms of kurtosis, the cyclicality is not as clear as the cyclicality of volatility and skewness. While men experienced a decrease in kurtosis in 2008, women's earning changes became more leptokurtic.

3.2 Earnings Dynamics by Cohort and Age

The large number of observations in the TPP allows us to repeat this analysis with the sample split into 10-year cohorts. Figure 3 shows measures of the second to fourth moments of idiosyncratic changes in individual labor earnings. In the left panels, from top to bottom, the volatility, Kelley skewness and Crow-Siddiqui kurtosis are plotted for women, in the right panels for men. Within each panel, every line represents one cohort encompassing 10 birth years.

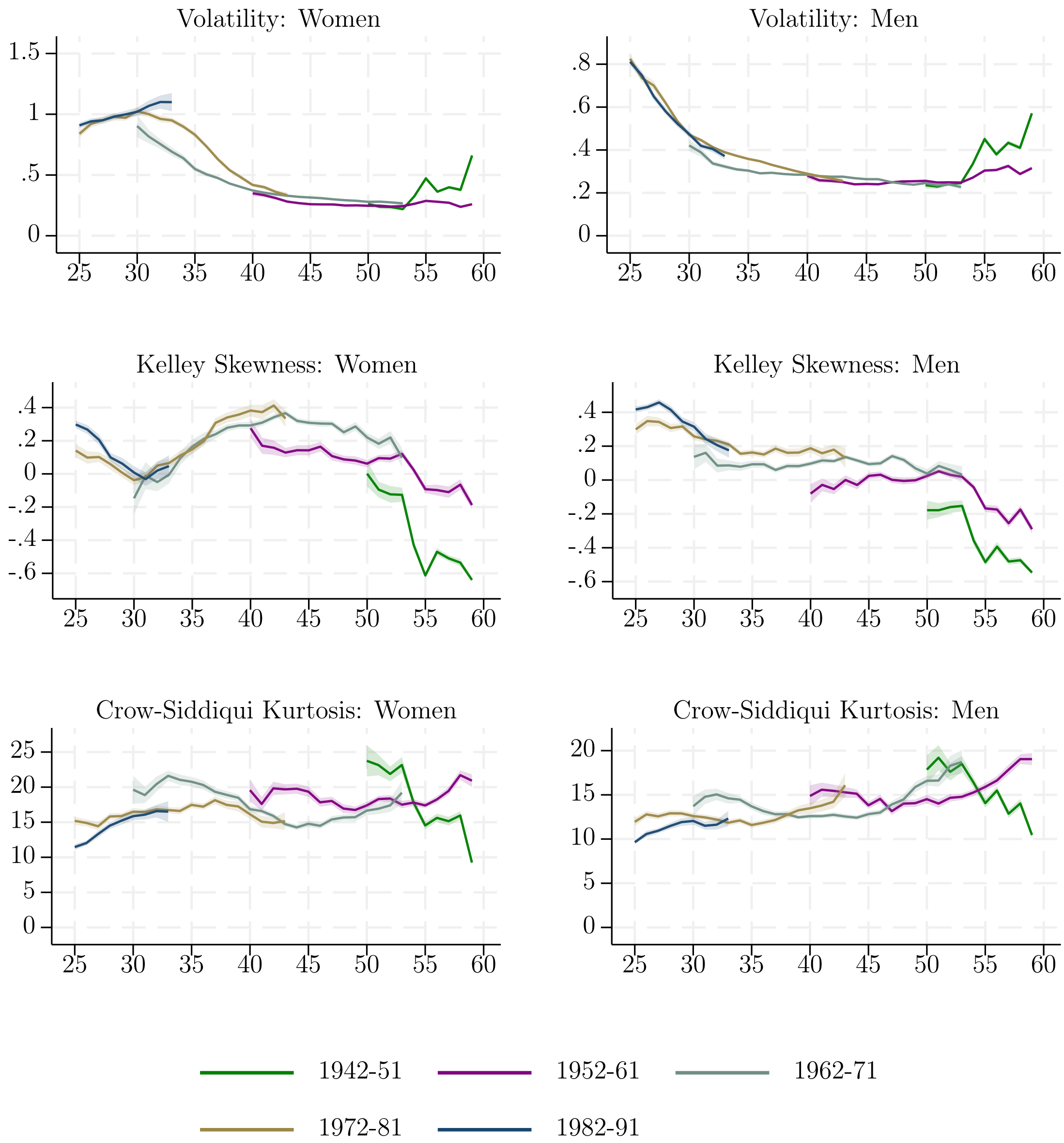

Figure 3: Moments of residualized earnings growth over the life cycle by cohorts

Note: Prime age individuals in the TPP, years 2001-2016; The figure shows moments of residualized 1-year changes of log real annual earnings (from t to $t+1$). Shaded areas are bootstrapped 95-percent confidence intervals.

Once again, men's U-shaped earnings volatility trajectory over the life cycle and the hump early in life of women's earnings volatility are observable. Comparing the cohorts, for women we observe a trend of higher volatility in younger cohorts at most ages, i.e., the volatility plot of one cohort lies above the next older cohort's. For men, there is no obvious pattern in volatility between the cohorts. The youngest cohort, born 1982 and later, tends to face lower volatility than the next older cohort, while the cohort born 1972 and later faces higher volatility than the next older one. For both men and women, the oldest cohort, the one born until 1951, which we only observe from age 50 and older, faces higher volatility at given ages than the cohort born directly afterwards.

Looking at the volatility of female earnings growth alone, younger generations in Germany are therefore somewhat worse off than older ones (provided they are risk averse), a finding that coincides with a similar result for Italy in Hoffmann et al. (2022). Rows two and three of Figure 3 show measures of higher order earnings risk by cohort and age. For both genders, the earnings growth distributions of younger cohorts tend to exhibit higher skewness than that of older cohorts. Higher skewness implies a lower welfare cost of income risk under CRRA utility. Thus, while younger cohorts face higher income growth variance, it is not clear if they face higher welfare cost of earnings risk than older ones. Moreover, females born later face lower Crow-Siddiqui kurtosis of log earnings changes than older cohorts, which again implies an improvement in welfare under CRRA utility. The same is true for males at the beginning of working life, where male cohorts born later face lower kurtosis than the next older cohorts, but the lines cross later in life.

3.3 Earnings Dynamics by Cohort and Year

Figure 4 shows how the business cycle affects different moments of earnings growth across birth cohorts. In particular, the Great Recession led to a notable increase in the volatility of men's earnings growth across most cohorts. The increase in volatility is much less pronounced for women.

Turning to skewness of female earnings growth, we observe slight declines during the recession in the early 2000s. As we only observe one pre-crisis year, we do not know if the drop is part of a longer trend or likely related to that crisis. In contrast, the Great Recession appears to have affected skewness, but a clear drop can only be observed for the cohorts born between 1952 and 1971. The oldest cohort, born 1941-51, also experiences a drop in skewness, but no rebound, such that it is difficult to distinguish the effect of the recession from an age-related drop. Interestingly, cohorts born after 1972 appear to be unaffected by the crisis. For men, skewness also slightly declines from 2002 to 2003 and all cohorts experience a significant drop during the Great recession followed by an immediate rebound. However, the drop is smaller for younger cohorts. Remarkably, the lines for the different cohorts do not cross and, as is the case when plotting skewness over the life cycle (Figure 3), younger cohorts consistently face higher skewness than older cohorts.

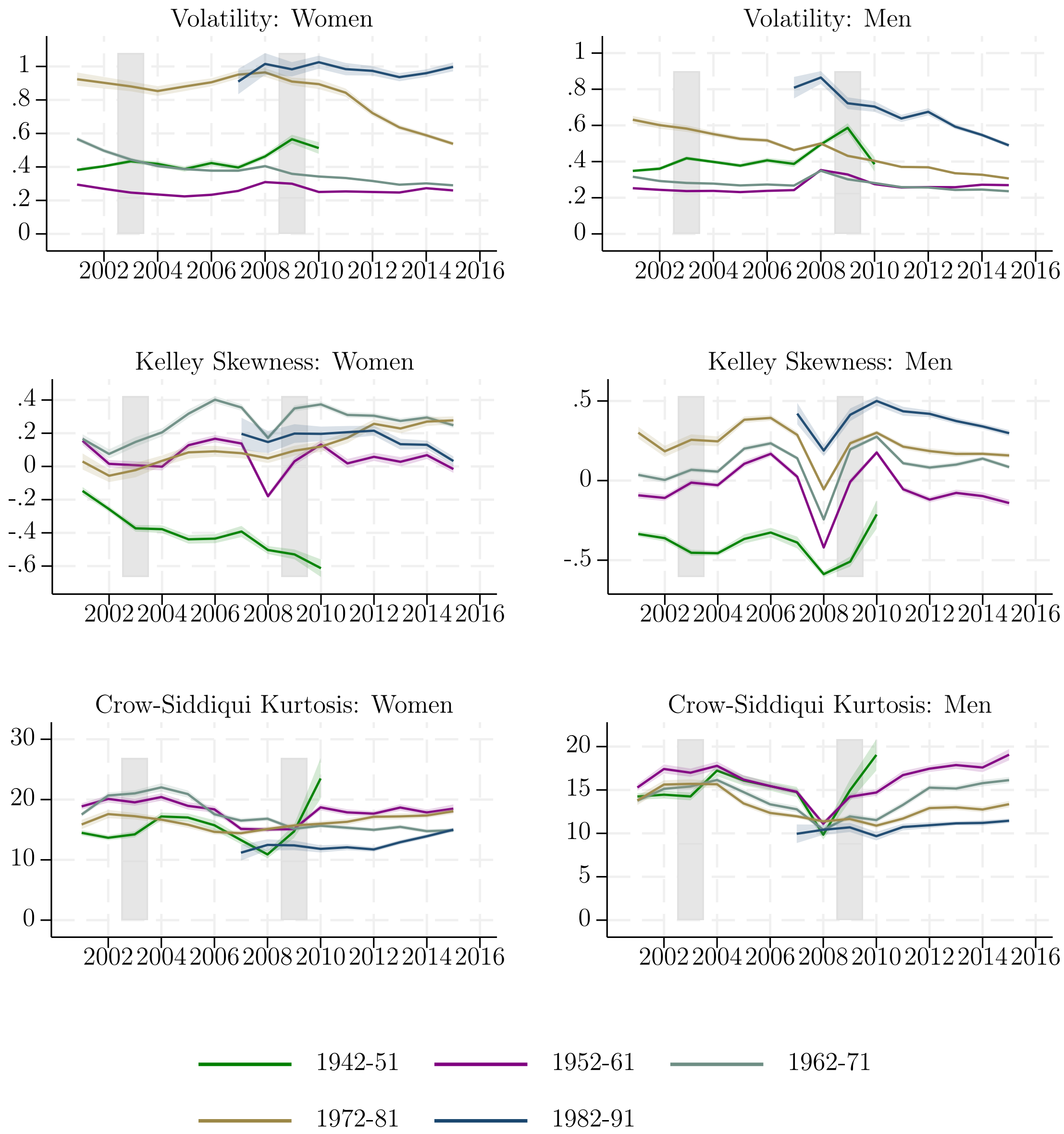

Figure 4: Moments of residualized earnings growth over time by cohorts

Note: Prime age individuals in the TPP, years 2001-2016. The figure shows moments of residualized 1-year changes of log real annual earnings (from t to $t+1$). Shaded areas are bootstrapped 95-percent confidence intervals. The gray bars indicate recessions.

The final row of Figure 4 reports the Crow-Siddiqui measure of kurtosis. During the Great Recession kurtosis drops only for the oldest cohort of women and for the two oldest cohorts of men. The drop in kurtosis implies that the distribution of earnings changes contained fewer outliers during the crisis. For men, earnings growth of younger cohorts tends to exhibit less kurtosis than that of older generations—with the exception of the oldest cohort born in 1942-1951.

4 Additional Results

4.1 Subsample Analyses

Some of the key results may be driven by a specific subgroup of the population. Specifically, the large difference in earnings growth volatility between women and men in their late 20s and early 30s raises the question to what extent having children influences their earnings dynamics. To answer this question, in Figure 5 we show the moments of residualized earnings growth over the life cycle analogous to Figure 3, but for a subsample restricted to individuals without children. Individuals who have children later in life still appear in this subsample. In the appendix in Figure A.1, we also show moments over time analogous to Figure 4.

Over the life cycle, there does not appear to be a substantial difference in the trajectories of earnings volatility between childless women and men. In stark contrast to the results for the full sample, at young ages, childless men's volatility even exceeds that of childless women of the same age. The difference in volatility between female cohorts becomes much smaller when excluding mothers. Men's and women's life cycle patterns of skewness and kurtosis also become very similar when excluding parents from the sample. The finding of higher skewness in younger cohorts persists. The life-cycle patterns of skewness are apparently much less affected by parenthood as they are quite similar between the full sample and the restricted sample.

In contrast to the life-cycle perspective, the business cycle patterns in the full sample and the sample of individuals without children (Appendix Figure A.1) are quite similar. In both samples, the drops in Kelley skewness due to the Great Recession were smaller for women than for men. For completeness, we show the moments of residualized earnings growth with observations of parents in Figures A.3 and A.4. While the life-cycle profiles for men and women are similar to those of the full sample, volatility for mothers at the beginning of working life is substantially higher than for the full sample and Kelley skewness is slightly negative at young ages.

To what extent are cohort differences in earnings dynamics driven by unemployment spells? We can identify unemployed individuals as long as they receive unemployment benefits as these impact the tax burden and are therefore included in the tax data. As we exclude individuals with annual earnings under 2,300 Euro, only those who are unemployed for less than a calendar year are part of the main analysis. In Figure 6 and—for the

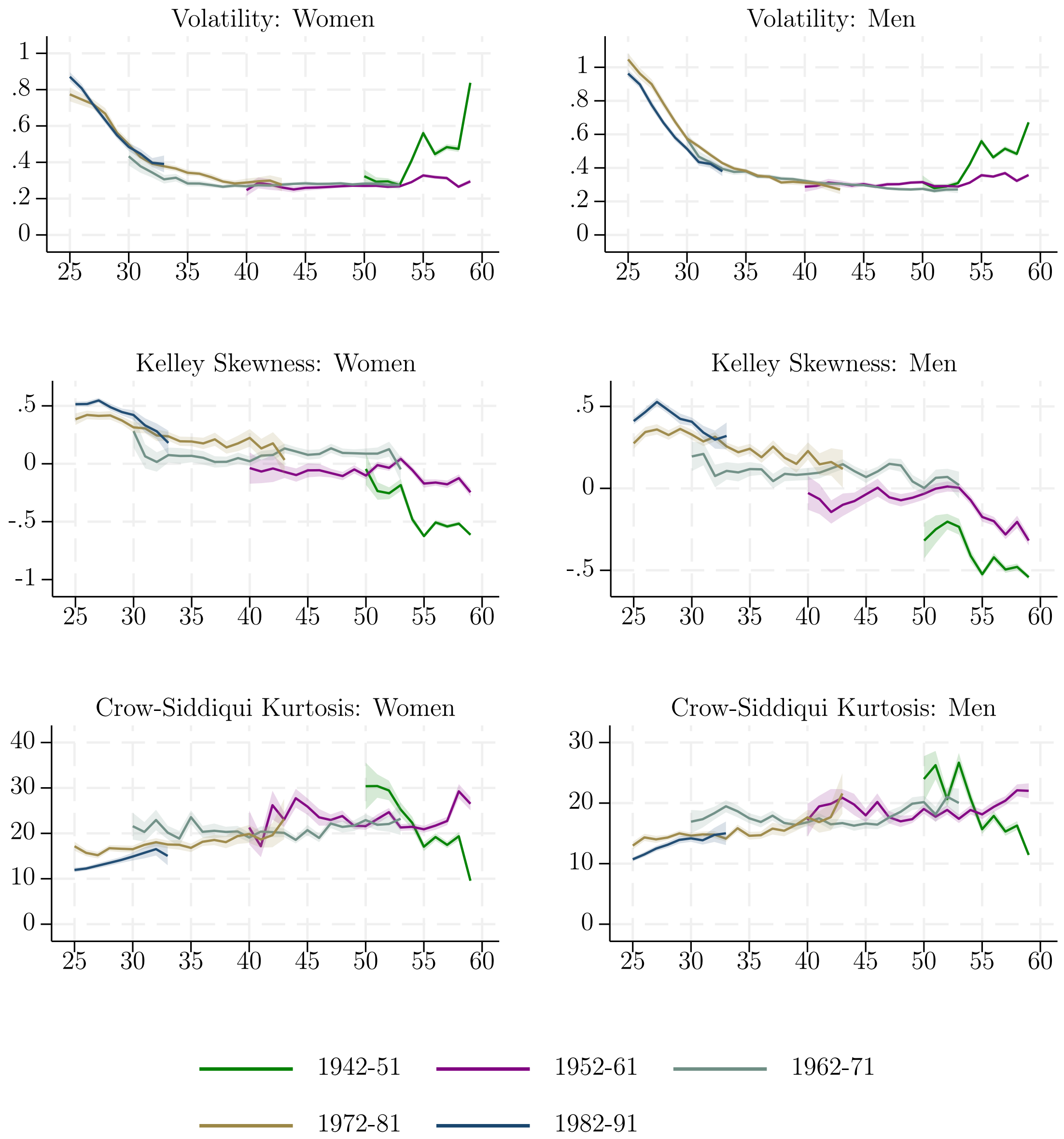

Figure 5: Moments of residualized earnings growth over the life cycle by cohorts (excluding parents)

Note: Prime age individuals without children in the TPP, years 2001-2016. The figure shows percentiles of residualized 1-year changes of log real annual earnings (from t to $t+1$). Shaded areas are bootstrapped 95-percent confidence intervals.

business-cycle perspective—in Appendix Figure A.2, we exclude all observations where individuals receive unemployment benefits. We make two observations. First, the youngest female cohort faces substantially lower volatility than the next older cohort when excluding the unemployed. This is also the case for men, but the shift is smaller. This suggests that unemployment spells have a relevant impact on earnings volatility of that cohort. Second, for both genders the differences in Kelley skewness and Crow-Siddiqui kurtosis

Figure 6: Moments of residualized earnings growth over the life cycle by cohorts (excluding unemployed)

Note: Prime age individuals in employment in the TPP, years 2001-2016. The figure shows residualized percentiles of 1-year changes of log real annual earnings (from t to $t+1$). Shaded areas are bootstrapped 95-percent confidence intervals.

between cohorts become much more pronounced with no overlap in skewness between the cohorts and no overlap in kurtosis except for the two oldest cohorts.

4.2 Dissection of the Earnings Change Distribution

Changes in moments of the earnings change distribution might be caused by changes in the upper or the lower tail. For instance, skewness might increase because the upper tail expands or because the lower tail declines. To quantify the contributions of the upper and lower tail to the life-cycle and business-cycle patterns we have documented, we first plot the upper tail dispersion ($P90 - P50$) and lower tail dispersion ($P50 - P10$) of the different cohorts over the life cycle in Figure 7. These are the components of both our measure for volatility and our measure for skewness.

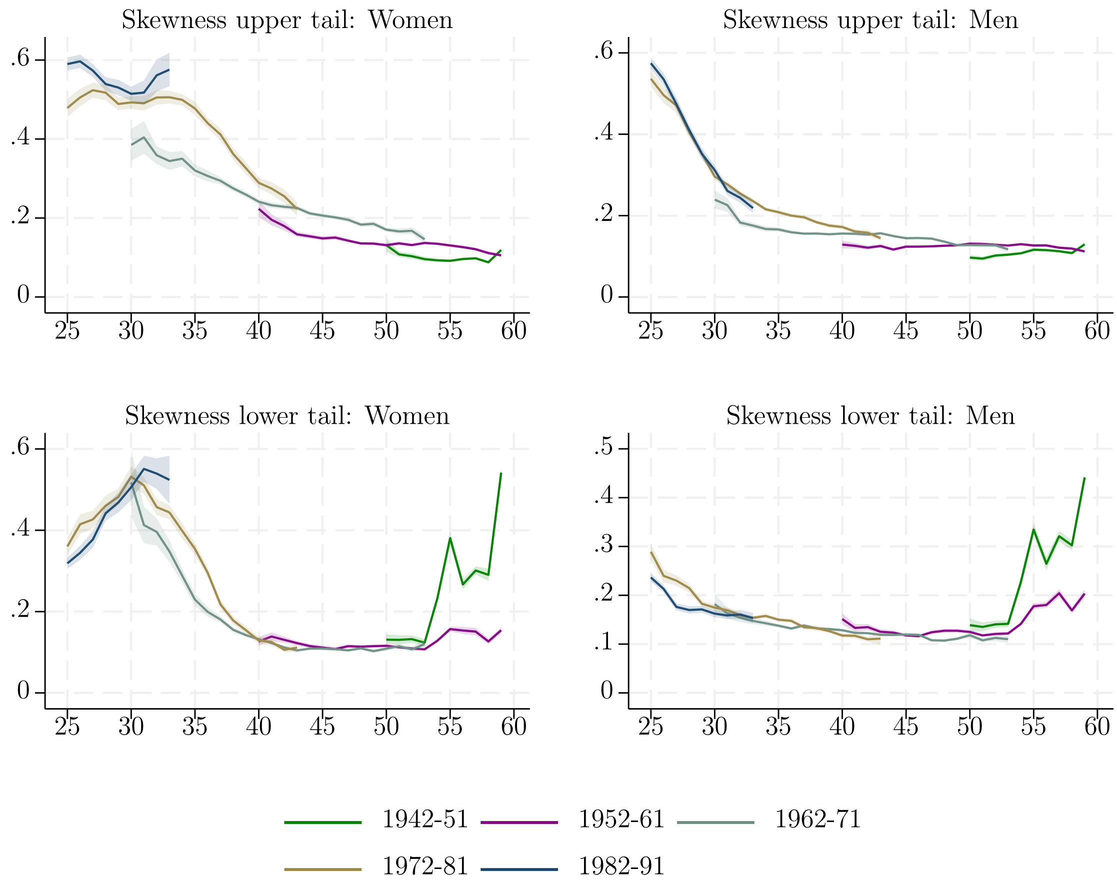

Figure 7: $P90 - P50$ and $P50 - P10$ of residualized earnings growth over the life cycle by cohorts

Note: Prime age individuals in the TPP, years 2001-2016. The figure shows the components of Kelley skewness of residualized 1-year changes of log real annual earnings (from t to $t + 1$). Shaded areas are bootstrapped 95-percent confidence intervals.

For women, we have documented an uptick in female earnings volatility during child-bearing ages and an increase in volatility towards the end of working life. Skewness declines at the beginning of working life, increases from 30 to 40 and then declines from

40 onwards. We make three observations regarding the impact of lower and upper tail dispersion on women's life-cycle profiles of volatility and skewness. First, the increase in volatility and the drop in skewness for women at age 30 and toward the end of working life are entirely due to an increase in lower tail dispersion. Second, from age 30 to 40, lower tail dispersion declines, leading to a decline in volatility and an increase in skewness. Third, upper tail dispersion steadily declines over the life cycle, leading to a steady decline in volatility and skewness from age 40 onward.

For men, volatility and skewness decline over most of the life cycle with a sharp increase in volatility toward the end of working life. The decline in volatility results from declines in both upper and lower tail dispersions, but the decline in $P90 - P50$ is much more pronounced. The larger decline in upper tail dispersion implies a continuing decrease in skewness. Towards retirement age, the lower tail increases strongly, pushing the skewness into the negative realm. As is the case for women, the increase in volatility and the drop in skewness are both driven by an increase of lower tail dispersion ($P50 - P10$).

Comparing cohorts, we noted that at given ages women and men born later face higher volatility and skewness than earlier-born cohorts. Figure 7 shows that, particularly for women, this cohort difference is mostly driven by differences in upper tail dispersion. Later cohorts enjoy large increases in earnings more often than earlier ones. An exception occurs at ages 55-60, where we observe an increase in volatility and drop in skewness for the cohort born in 1942-51, which are substantially larger than the change for the cohort born in 1952-61. The difference is driven by a large expansion in lower tail dispersion for the 1942-51 cohort.

For both women and men, the business cycle patterns we observed in subsection 3.3—a minor increase in volatility and a large drop in skewness during the Great Recession—can be traced back to strong procyclical reactions at the lower tails (Figure 8). The decrease in $P90-P50$ is small for men and minuscule for most female cohorts, whereas the increase in $P50 - P10$ at the time of the recession is quite prominent. While we observed that women born between 1972 and 1991 did not face a drop in Skewness during the Great Recession, $P50 - P10$ did increase modestly for this group. However, for women born in 1982-91 the increase was offset by an increase in upper tail dispersion.

To better understand the life- and business-cycle patterns of the kurtosis of residualized earnings changes, we decompose the distribution into further percentile ranges. The Crow-Siddiqui measure of kurtosis increases with increasing numerator and/or decreasing denominator. Hence, a larger distance between the extreme quantiles P97.5 and P2.5

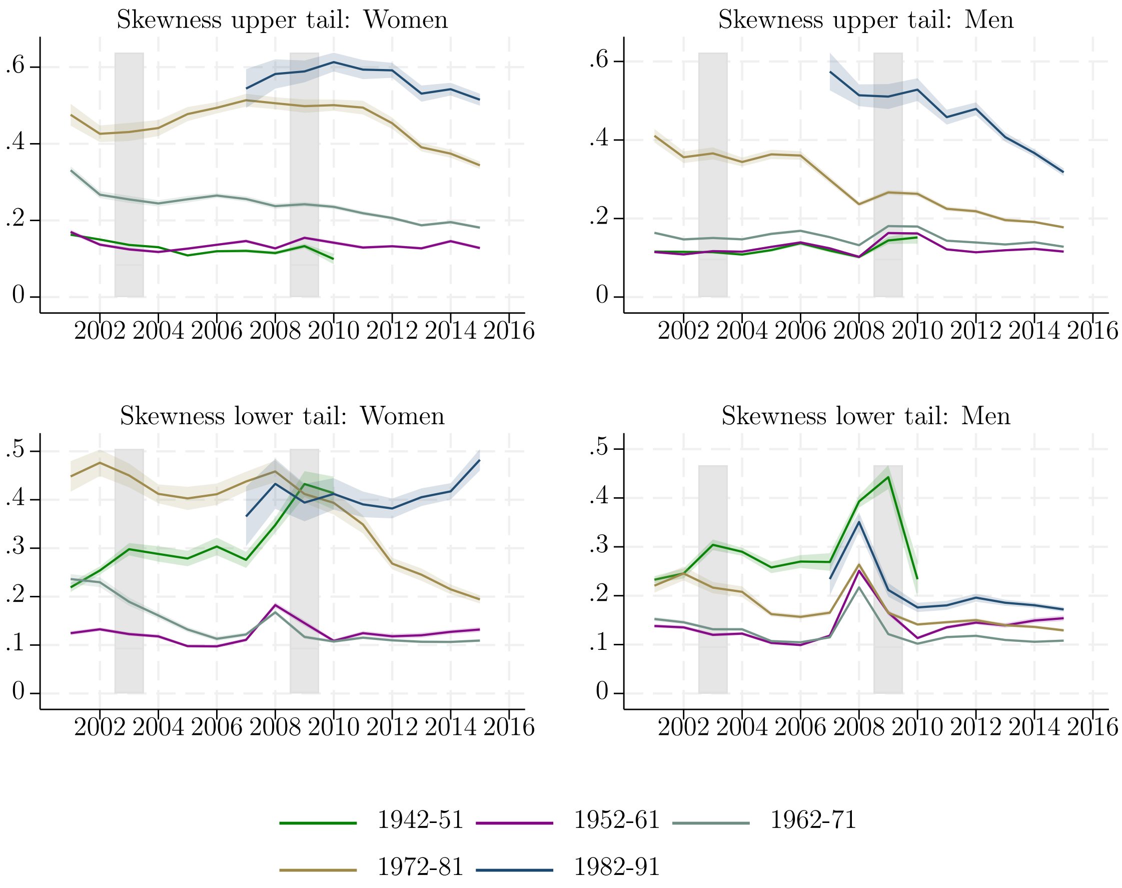

Figure 8: $P90 - P50$ and $P50 - P10$ of residualized earnings growth over time by cohorts

Note: Prime age individuals in the TPP, years 2001-2016. The figure shows the components of Kelley skewness of residualized 1-year changes of log real annual earnings (from t to $t+1$). Shaded areas are bootstrapped 95-percent confidence intervals. The gray bars indicate recessions.

positively influences the kurtosis but it can be offset or even reversed by a decline in the interquartile range of the distribution. To disentangle these effects, we decompose the Crow-Siddiqui measure of kurtosis into $K_{C-S} = \frac{P97.5-P2.5}{P75-P25} = \frac{(P97.5-P75)+(P75-P25)+(P25-P2.5)}{P75-P25}$. Figures 9 and 10 show the three components equivalent to the numerator, allowing us to observe the partial effects of changes in the dispersion at the upper or lower quarters of the distribution, and the interquartile range on the kurtosis.

For women, dispersion in the upper quarter is flat until the age of 35. Child-rearing appears to affect mostly the lower quarter, the $P25 - P2.5$ spread, which increases until the age of 30 and then starts to decline. This explains why kurtosis peaks between 35 and 40. For men, all components of the Crow-Siddiqui measure of kurtosis decline during the first half of working life. The decline of the interquartile range dominates, such that curtosis overall increases. For both genders, toward the end of working life, the

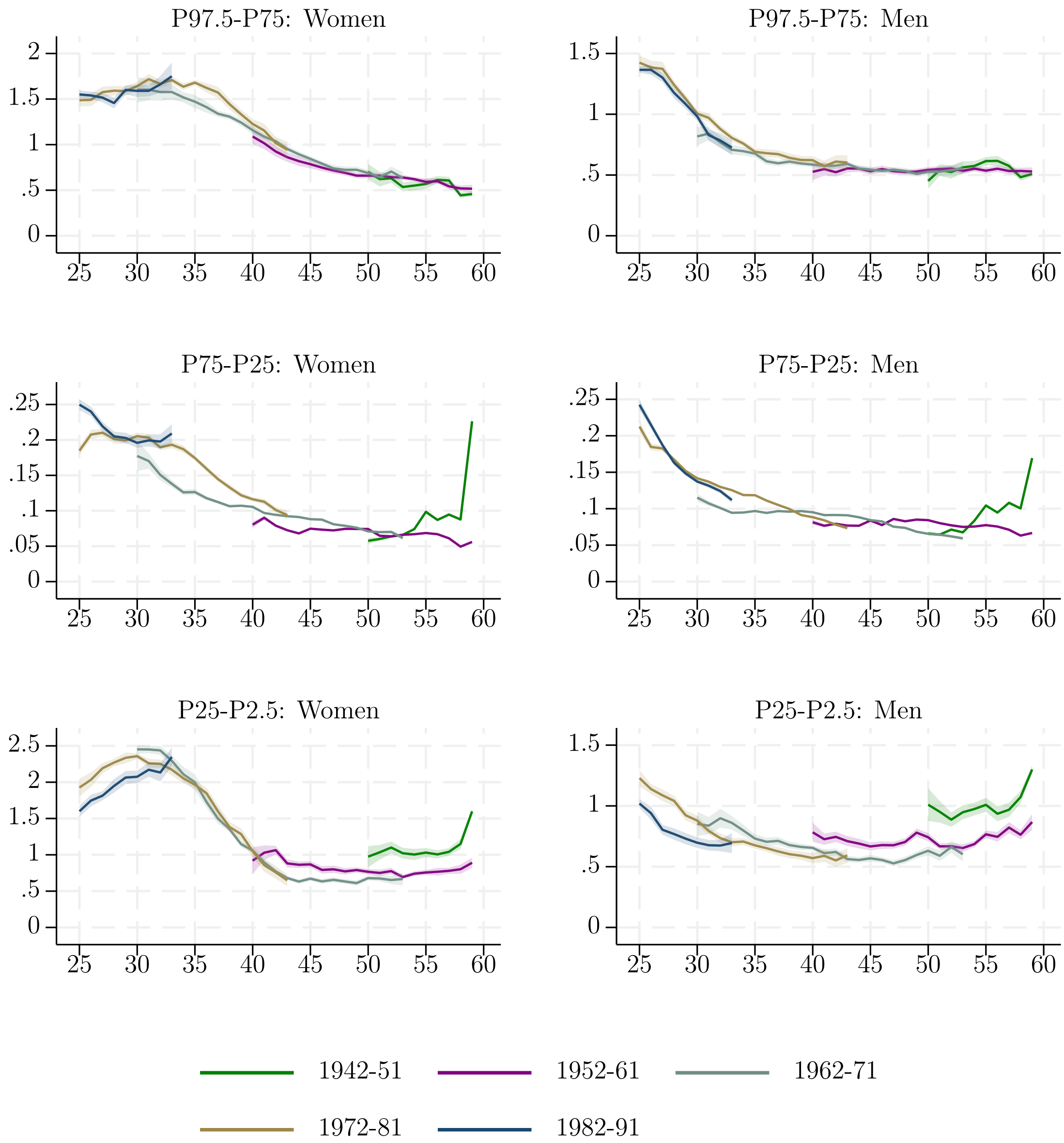

Figure 9: $P97.5 - P75$, $P75 - P25$, and $P25 - P2.5$ of residualized earnings growth over the life cycle by cohorts

Note: Prime age individuals in the TPP, years 2001-2016. The figure shows the components of Crow-Siddiqui kurtosis of residualized 1-year changes of log real annual earnings (from t to $t+1$). Shaded areas are bootstrapped 95-percent confidence intervals.

interquartile range and lower quartile dispersion ($P25 - P2.5$) increase. The increase in the interquartile range dominates, implying an increase in kurtosis.

Differences between the cohorts are more visible for women for the interquartile range of the distribution with larger dispersions for younger cohorts. Thus, the Crow-Siddiqui measure of kurtosis is smaller for younger cohorts because the denominator is larger.

In contrast, men born later face lower kurtosis at young ages mostly because the lower quartile dispersion is lower than for cohorts born later.

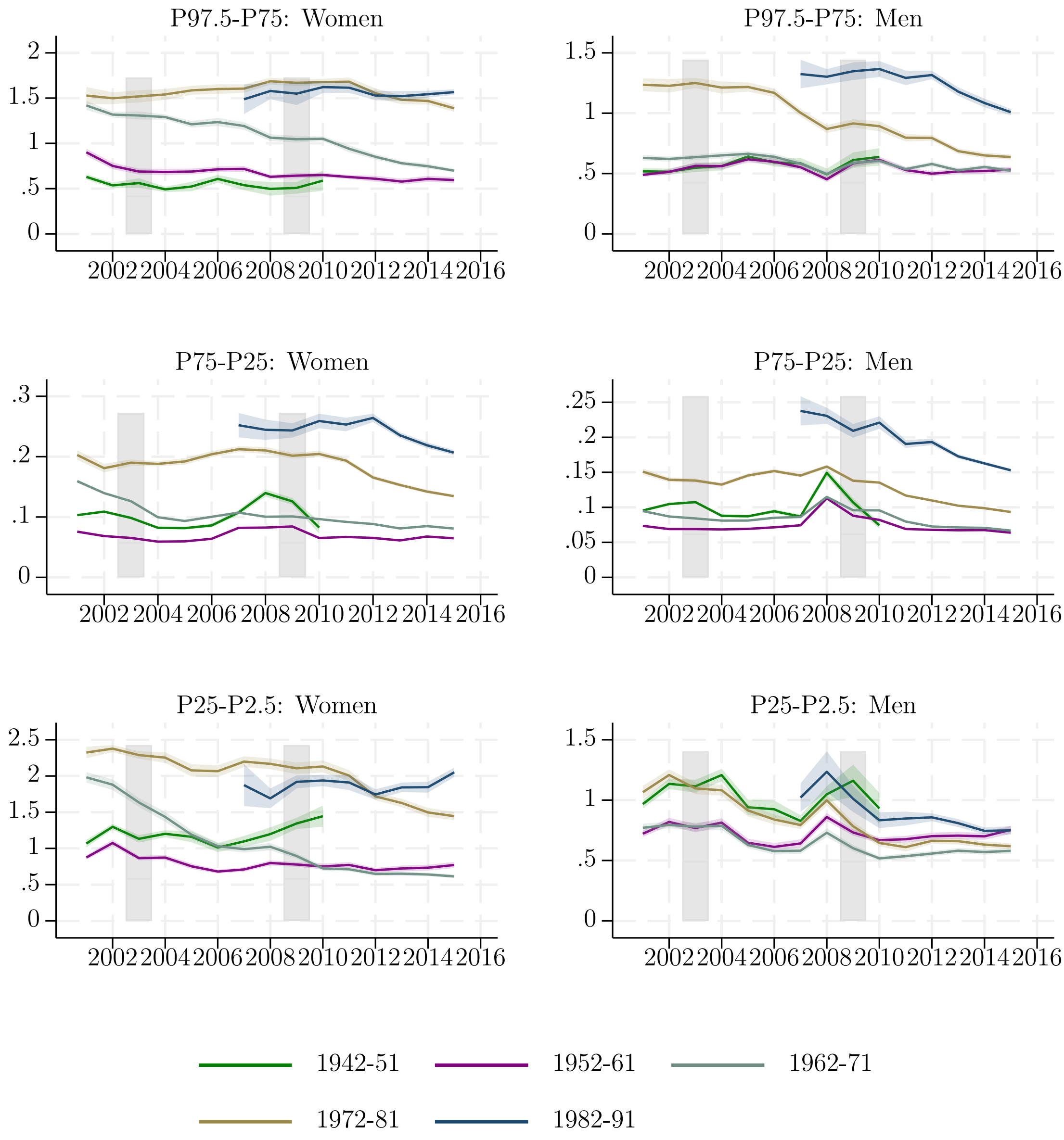

Figure 10: $P97.5 - P75$, $P75 - P25$, and $P25 - P2.5$ of residualized earnings growth over time by cohorts

Note: Prime age individuals in the TPP, years 2001-2016. The figure shows the components of Crow-Siddiqui kurtosis of residualized 1-year changes of log real annual earnings (from t to $t+1$). Shaded areas are bootstrapped 95-percent confidence intervals. The gray bars indicate recessions.

Business-cycle effects on kurtosis are more prominent for men and mostly driven by the middle 50% and the lower end of the distribution (Figure 10). The large drop in men's kurtosis during the Great Recession, which we described above, suggests that the increase in income risk was not as bad as the same increase in volatility at constant kurtosis would have been, since it indicates fewer extreme deviations from the expected income path. However, it turns out that this effect is driven predominantly by an increased interquartile range—the denominator of the Crow-Siddiqui measure of kurtosis—and only slightly by a small drop of P97.5-P75. Strikingly, the gap between P25 and P2.5 even increased implying more extreme negative income changes, in line with the sharp decrease in skewness. The life- and business-cycle paths of percentiles of the earnings growth distribution—as opposed to percentile ranges—can be found in Figures A.5-A.10 in the appendix.

4.3 Pre-government Household Income

Individual earnings risk might be mitigated by the household. Via income pooling or the added-worker effect, a partner's labor market outcomes can offset—or increase—the individual risk. Hence, we repeat the exercise from subsections 3.2 and 3.3, but use household income (before taxes and transfers) instead of individual earnings. This new outcome—residualized log changes in household gross income—is constructed by adding up labor income as well as capital income and income from rents. For married couples with joint filing, the variable contains both spouses' income components. Figure 11 depicts the usual quantile-based measures of income risk over the life cycle. For both women and men, household income volatility follows a U-shaped pattern over the life cycle, implying that the life-cycle pattern of household income volatility is driven by the pattern of male earnings. Before the age of 40, the cohort differences for females are quite small, but beyond that age, older cohorts experience a higher volatility—in contrast to what we observed for earnings. The youngest male cohort faces lower household income volatility than older cohorts and the oldest cohort shows a significantly higher volatility than others at the same age.

Middle-aged women and men expose a higher volatility of household income than individual earnings. This can be caused by higher volatility of other sources of income like capital and rent income that are included in household income or because the volatility of pooled earnings is actually larger than that of individual earnings.

Regarding higher-order risk, skewness and kurtosis of household income appear to change much less over the life cycle compared to individual earnings. The positive skewness at younger ages and the downward shift towards negative skewness at higher ages are less amplified for household income. Even more clearly, the kurtosis of household

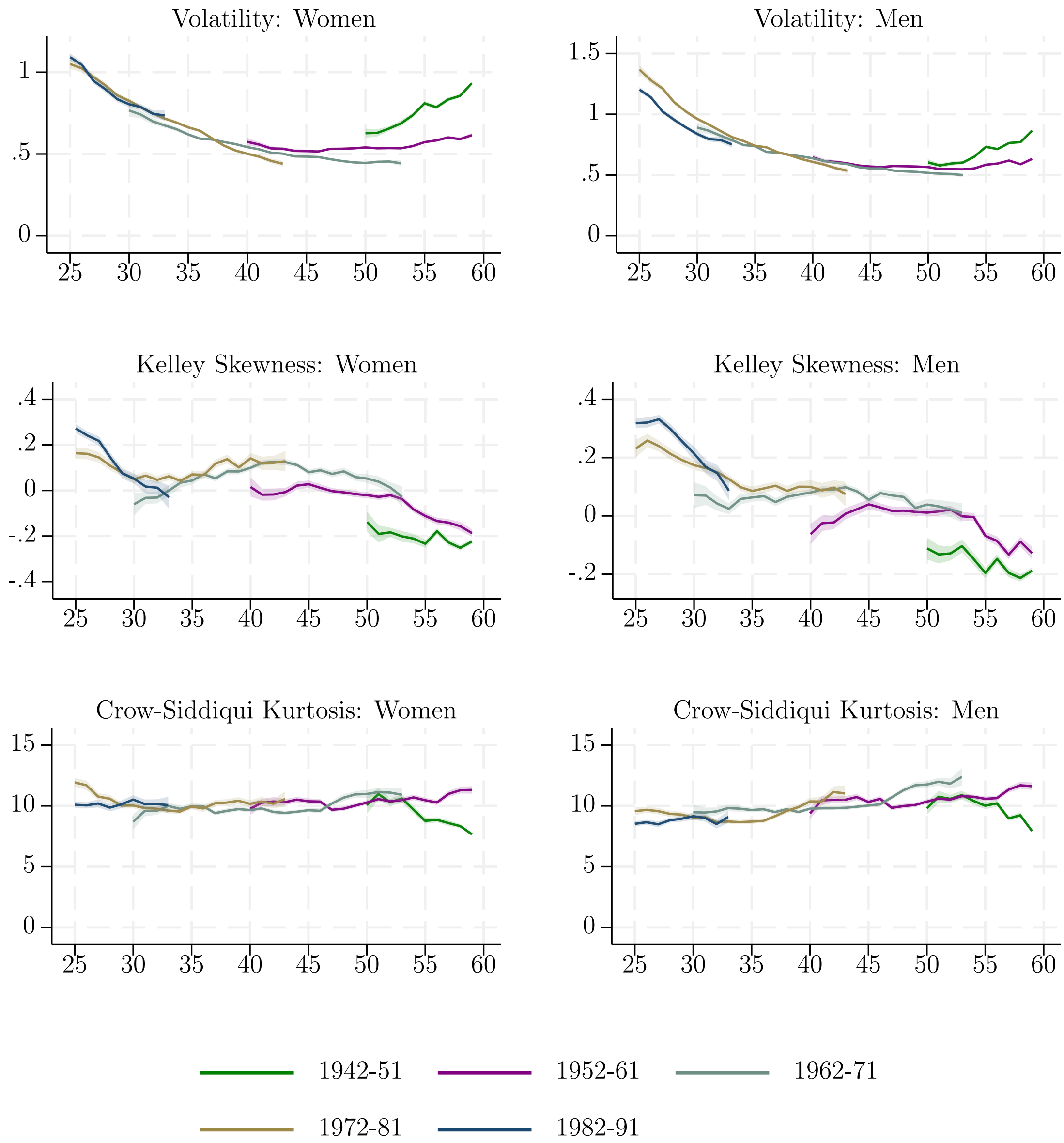

Figure 11: Moments of residualized household gross income growth over the life cycle by cohorts

Note: Prime age individuals in the TPP, years 2001-2016. The figure shows percentiles of residualized 1-year changes of log real annual earnings (from t to $t+1$). Shaded areas are bootstrapped 95-percent confidence intervals.

income is lower and almost flat over the life cycle for both women and men. Although the distribution still has much fatter tails than the normal distribution, household income is significantly less prone to extreme deviations from its predicted path than individual labor income. Importantly, the pattern that younger cohorts face higher skewness than older ones remains largely intact for household income, but the pattern of lower Crow-Siddiqui kurtosis for younger cohorts does not.

4.4 Moments of 5-Year Earnings Changes

The welfare implications of persistent income shocks might be quite different from those of transitory shocks. Generally, savings can be used to self-insure against transitory shocks, but not against permanent shocks. Hence, we extend the analysis by comparing the earnings risk measures described above of 1-year changes to those of 5-year changes. These short and long term changes can be seen as being more reflective of transitory or persistent shocks, respectively. Guvenen et al. (2021) derive higher-order moments of earnings growth for the standard permanent-transitory income process. Busch et al. (2022) provide intuition, why longer-term income changes increasingly reflect persistent changes, which we reproduce in the following. Consider the canonical process of log earnings:

$$y_t = z_t + \epsilon_t,$$
$$z_t = z_{t-1} + \eta_t,$$

where ϵ_t and η_t are mean-zero random shocks and z_t and ϵ_t are the transitory and permanent components of earnings, respectively. The k-year change in earnings is then given by $y_{t+k} - y_t = \sum_{j=1}^{k} \eta_{t-j} + \epsilon_t - \epsilon_{t-s}$. This term contains k permanent shocks and only two transitory ones. Thus, the higher k, the more important are persistent shocks for the overall earnings change.

Similarly to 1-year changes, we plot the moments of 5-year changes in individual earnings in Figure 12 and Appendix Figure A.11 over the life cycle and the business cycle, respectively. For volatility, the difference between cohorts found for women's 1-year changes are more clear-cut when turning to 5-year changes. With exception of the oldest cohort, younger female cohorts experience higher volatility of more persistent income shocks at given ages. Conversely, cohort effects observed in the main results for men's volatility appear to be fully driven by transitory income shocks and disappear in the analysis of 5-year changes.

In contrast to volatility, skewness in earnings changes is solely caused by the skewness of persistent innovations or due to time-variations in the distribution of transitory innovations (Guvenen et al., 2021). The Kelley skewness of residualized 5-year earnings growth is higher for younger cohorts at a given age, especially at higher ages for both women and men. Moreover, younger cohorts also face lower values of kurtosis. For women, this is true at all ages for all cohorts except the oldest one, while men display smaller cohort differences and towards the end of the observed ages, some younger cohorts exhibit higher kurtosis than the next older cohort. Thus, our key result of moderation of higher-order income risk also holds for 5-year changes.

Business cycle effects are smoothed out and less clearly visible when increasing the horizon of earnings changes from one year to five years, see Figure 3.3 in the appendix.

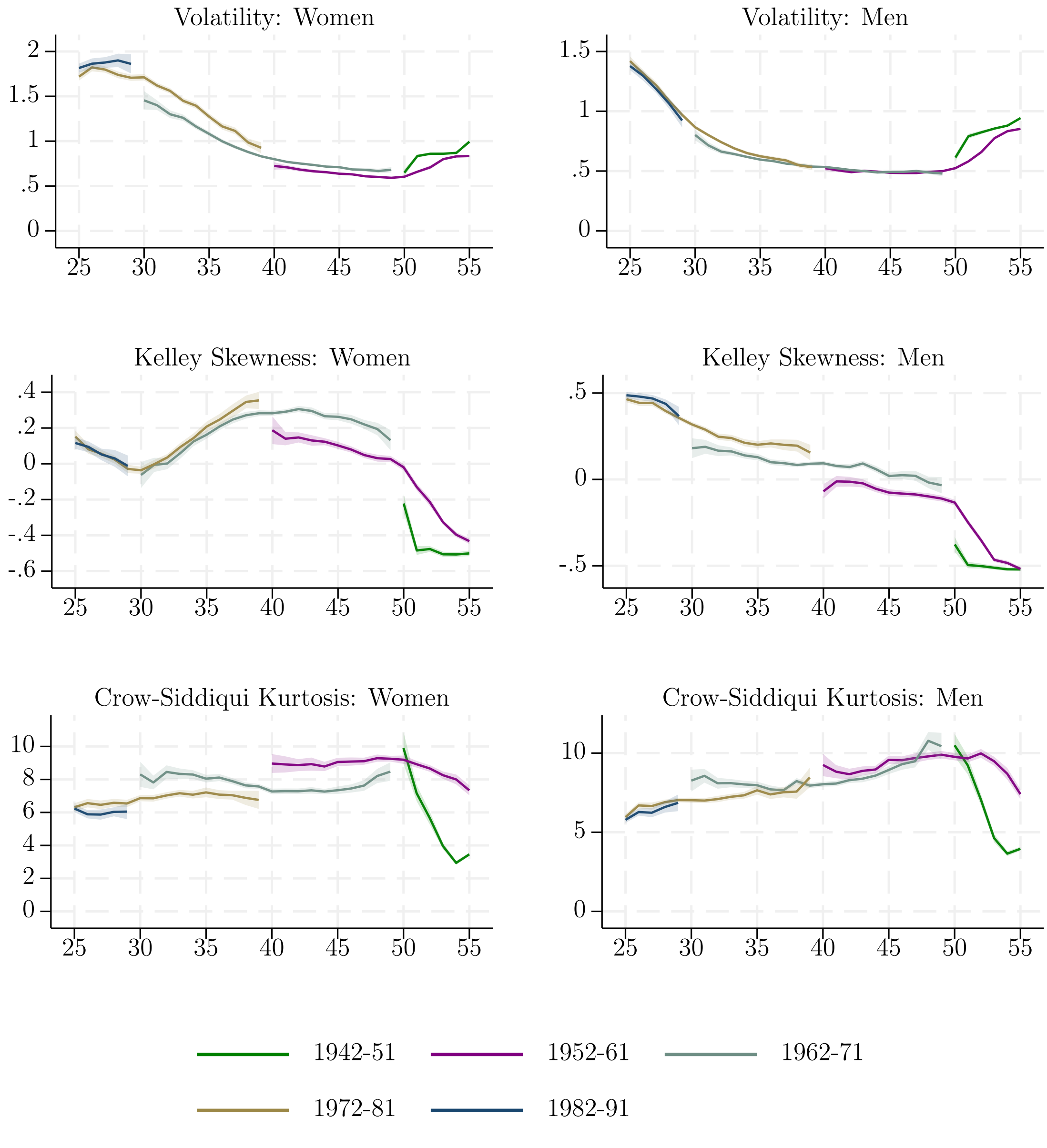

Figure 12: Moments of residualized 5-year labor earnings growth over the life cycle by cohorts

Note: Prime age individuals in the TPP, years 2001-2016. The figure shows moments of residualized 5-year changes of log real annual earnings (from t to $t + 5$). Shaded areas are bootstrapped 95-percent confidence intervals.

5 Conclusions

In this paper, we have used administrative tax data to describe the distributions of residualized earnings growth for different birth cohorts in Germany over the life cycle and over time. A comparison between cohorts reveals that volatility for females at given ages has increased over time, while this is not true for men. While this observation alone suggests that women born later face higher earnings risk than older cohorts, accounting for higher-order risk changes the picture. For both men and women, younger cohorts' earnings growth exhibits higher Kelley skewness at given ages—which by itself implies higher welfare under CRRA utility. Moreover, we observe that at given ages the Crow-Siddiqui measure of kurtosis is lower for cohorts born later, implying that they face fewer extreme events compared to cohorts born earlier. We find that this pattern in cohort-specific higher-order income risk persists for 5-year earnings growth, which is more reflective of persistent changes.

An avenue for future research would be to calculate the effects of the changes in the distributions of innovations to earnings between the cohorts on consumption behavior and welfare. To this end, it is important to consider to what extent changes in the distribution of earnings growth result in changes in disposable income, i.e., how much insurance households and the welfare state offer (see, e.g., Blundell et al., 2015). As the tax-payer panel only offers very limited information on transfer payments and households, a different data source might be preferable. We have made a first step in this direction by analyzing how the distributions of 1-year pre-government household income growth differ between the cohorts and have found that the pattern of increased Kelley skewness remains.

An inspection of the tails of the distributions reveals that for women the difference in skewness between the cohorts is driven by the upper tail—women born later are more likely to face large increases in earnings than those born later. During the Great Recession, men's skewness dropped sharply, driven by greater lower-tail earnings risk, whereas younger women born in the 1970s or later were essentially unaffected. Future research could explore the economic drivers behind changes in earnings growth distributions across cohorts, particularly why different age groups and genders were affected so unevenly by the Great Recession.

Men and women exhibit quite different life-cycle patterns of volatility and Kelley skewness. While volatility is U-shaped for men, it plateaus during the child-bearing age for women. Kelley Skewness hits a local minimum at 30 for women, while it decreases steadily over the life cycle for men. Interestingly, when mothers are excluded, the female pattern mirrors that of men. This suggests that at least parts of the differences in earnings growth changes across gender and cohorts do not reflect risk alone, but are to some degree the expected result of decisions by the agent. Investigating to what extent differences in residualized earnings growth changes reflect differences in risk is another fruitful avenue for future research.

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Appendix

A Additional Figures

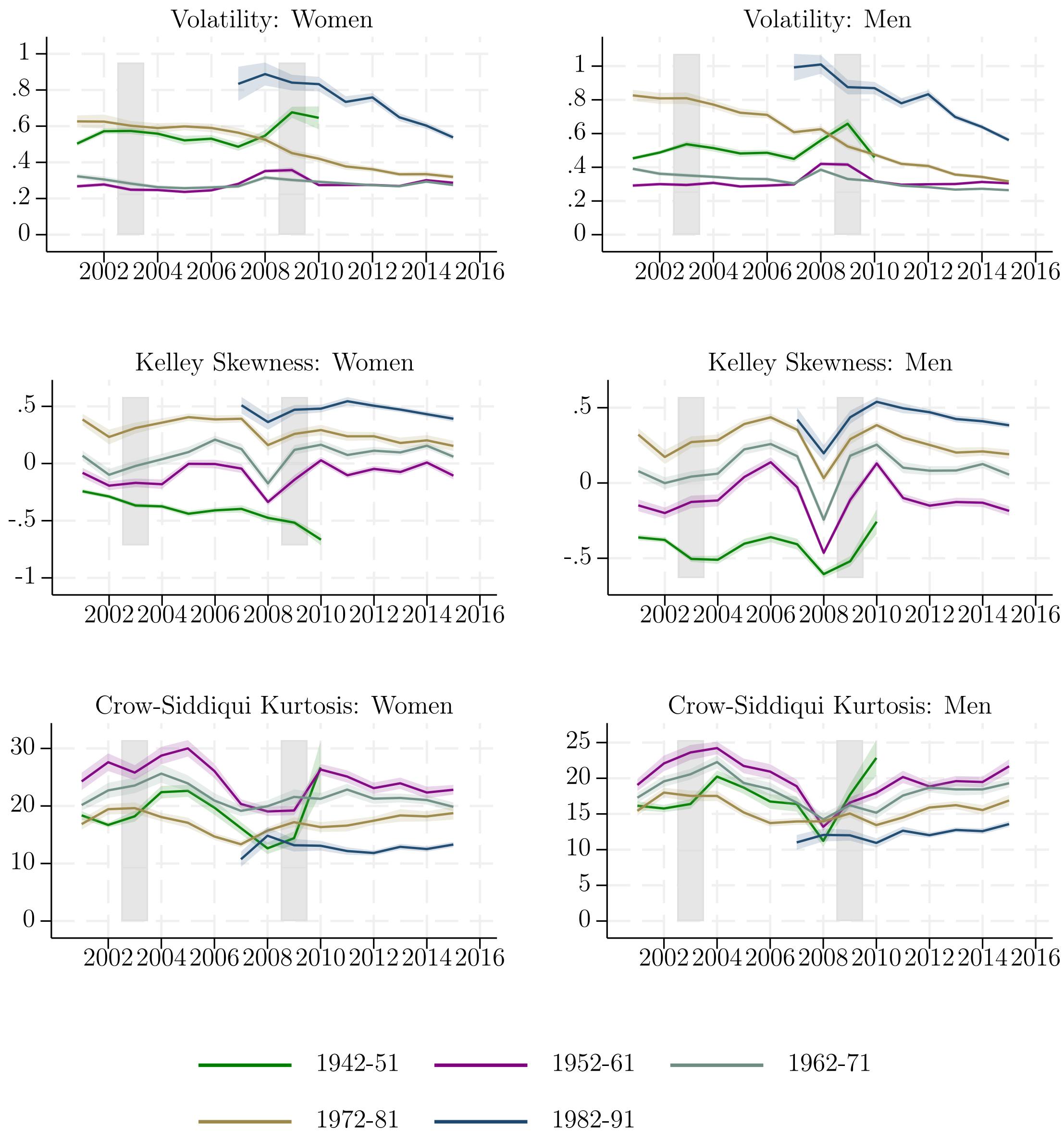

Figure A.1: Moments of residualized earnings growth over time by cohorts (excluding parents)

Note: Prime age individuals without children in the TPP, years 2001-2016. The figure shows percentiles of residualized 1-year changes of log real annual earnings (from t to $t+1$). Shaded areas are bootstrapped 95-percent confidence intervals. The gray bars indicate recessions.

Figure A.2: Moments of residualized earnings growth over time by cohorts (excluding unemployed)

Note: Prime age individuals in employment in the TPP, years 2001-2016. The figure shows percentiles of residualized 1-year changes of log real annual earnings (from t to $t+1$). Shaded areas are bootstrapped 95-percent confidence intervals. The gray bars indicate recessions.

Figure A.3: Moments of residualized earnings growth over the life cycle by cohorts (parents only)

Note: Prime age individuals with children in the TPP, years 2001-2016. The figure shows percentiles of 1-year changes of log real annual earnings (from t to $t+1$). Shaded areas are bootstrapped 95-percent confidence intervals.

Figure A.4: Moments of residualized earnings growth over time by cohorts (parents only)

Note: Prime age individuals with children in the TPP, years 2001-2016. The figure shows percentiles of residualized 1-year changes of log real annual earnings (from t to $t+1$). Shaded areas are bootstrapped 95-percent confidence intervals. The gray bars indicate recessions.

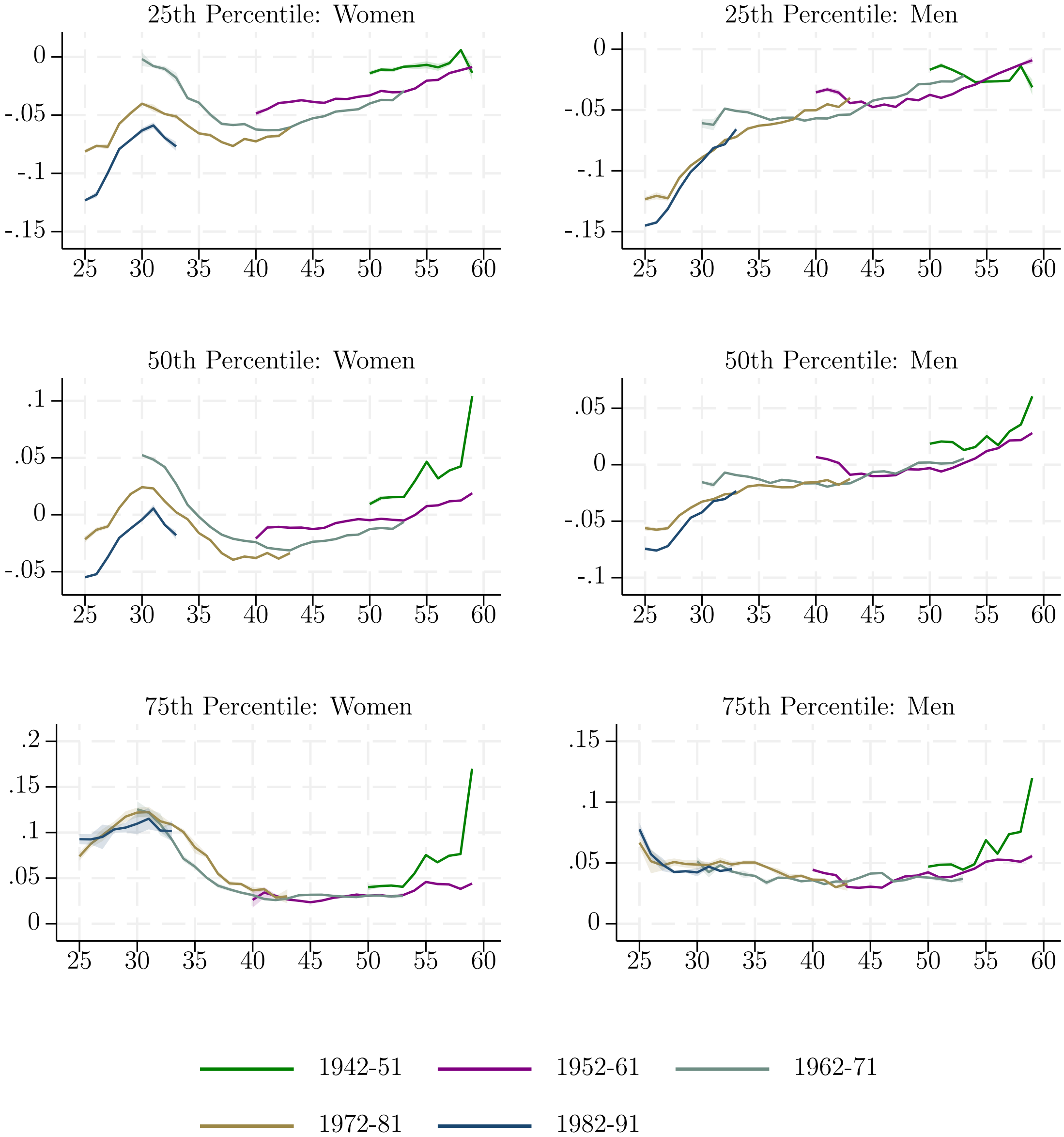

Figure A.5: Percentiles of earnings growth over the life cycle by cohorts I

Note: Prime age individuals in the TPP, years 2001-2016. The figure shows percentiles of residualized 1-year changes of log real annual earnings (from t to $t+1$). Shaded areas are bootstrapped 95-percent confidence intervals.

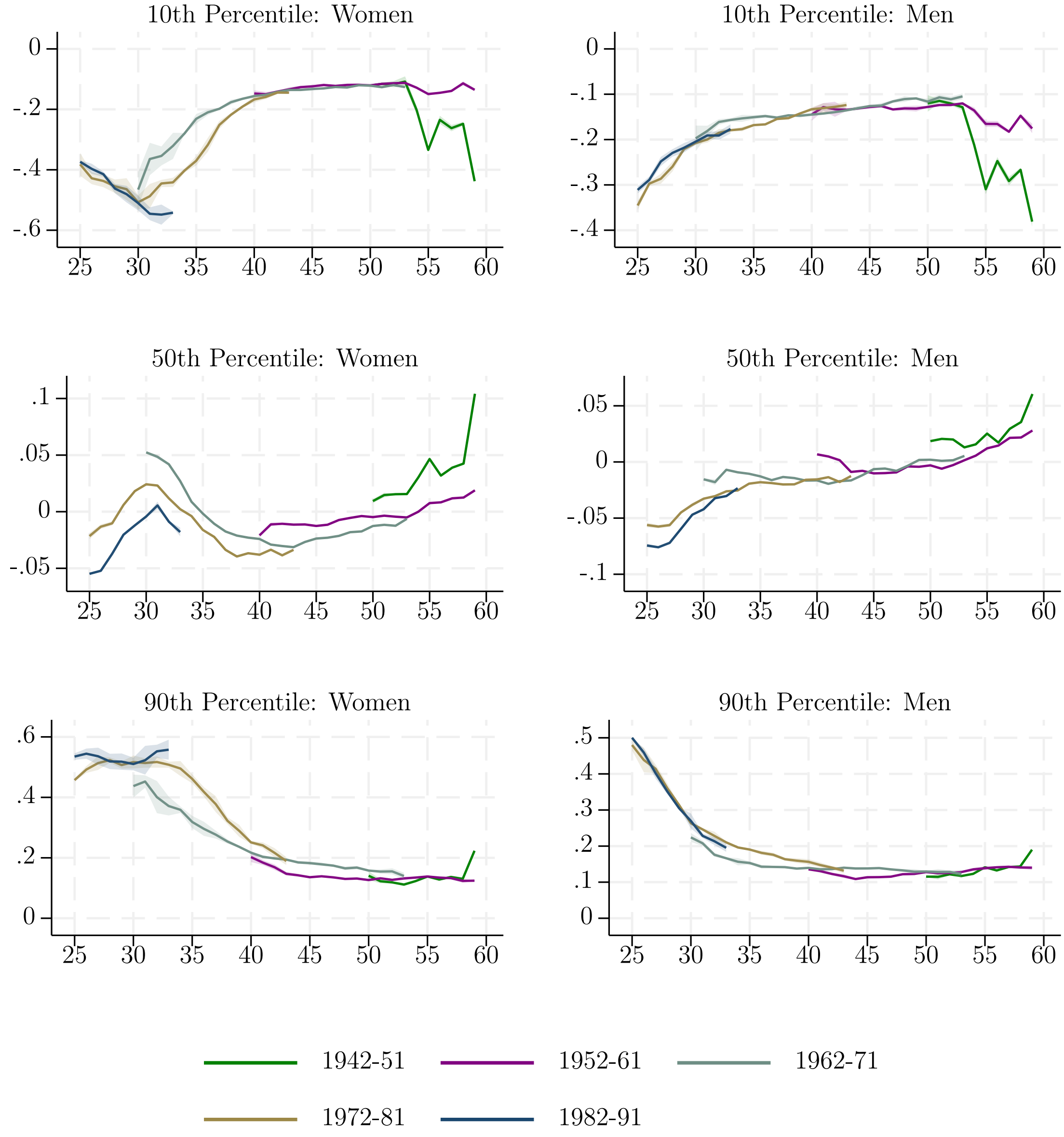

Figure A.6: Percentiles of residualized earnings growth over the life cycle by cohorts II

Note: Prime age individuals in the TPP, years 2001-2016; The figure shows moments of residualized 1-year changes of log real annual earnings (from t to $t+1$). Shaded areas are bootstrapped 95-percent confidence intervals.

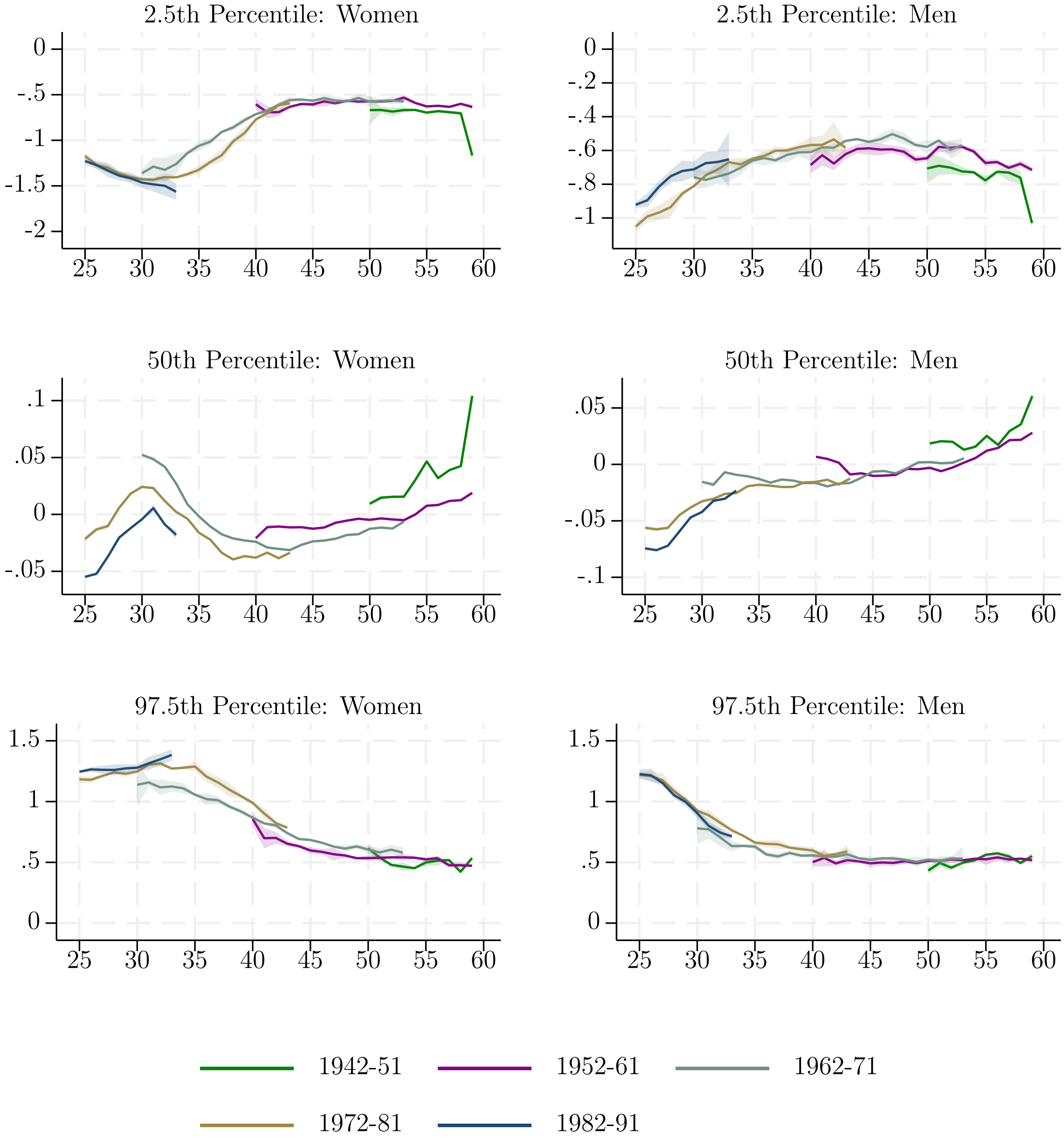

Figure A.7: Percentiles of residualized earnings growth over the life cycle by cohorts III

Note: Prime age individuals in the TPP, years 2001-2016; The figure shows moments of residualized 1-year changes of log real annual earnings (from t to $t+1$). Shaded areas are bootstrapped 95-percent confidence intervals.

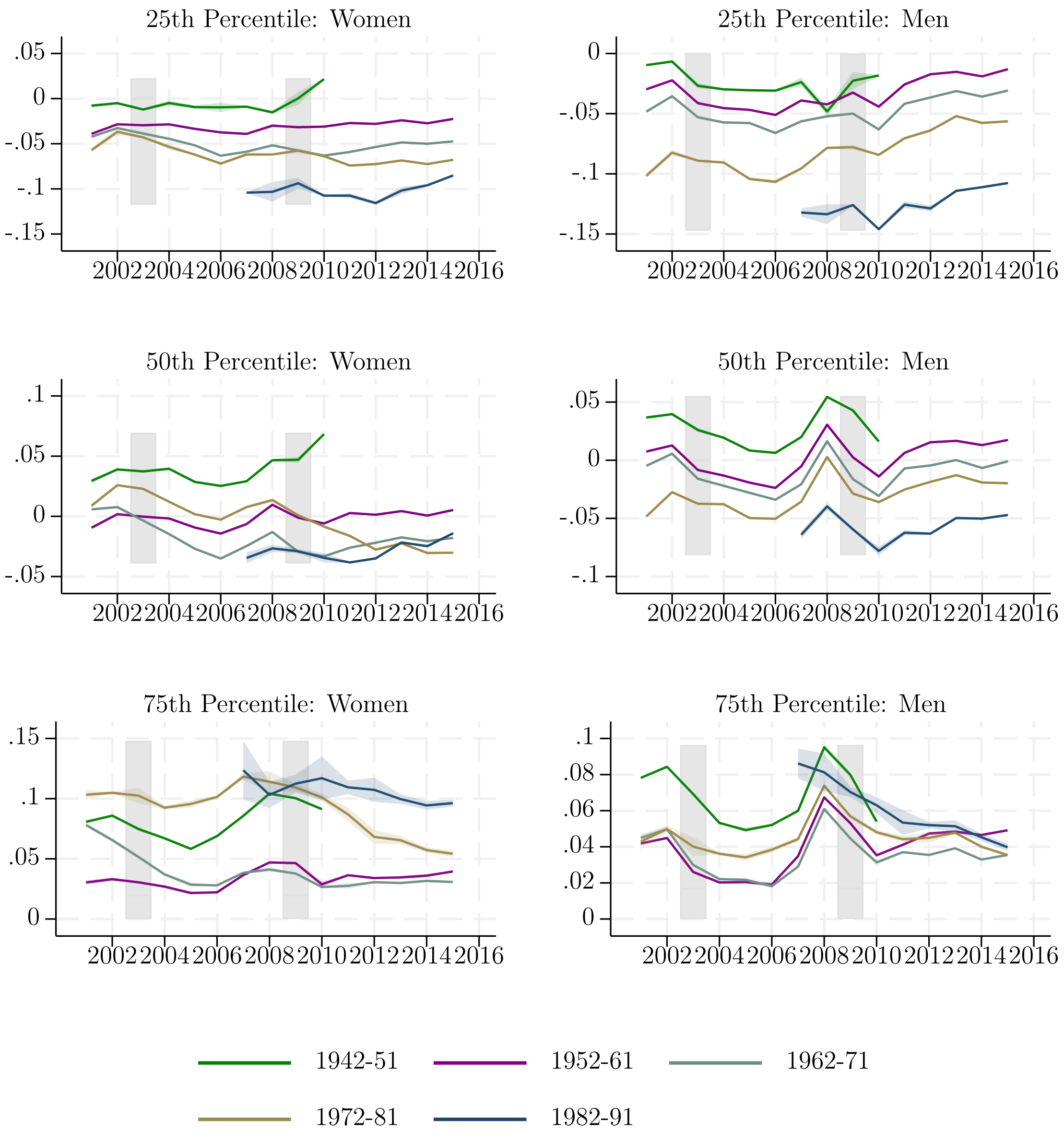

Figure A.8: Percentiles of residualized earnings growth over time by cohorts I

Note: Prime age individuals in the TPP, years 2001-2016. The figure shows percentiles of residualized 1-year changes of log real annual earnings (from t to $t+1$). Shaded areas are bootstrapped 95-percent confidence intervals. The gray bars indicate recessions.

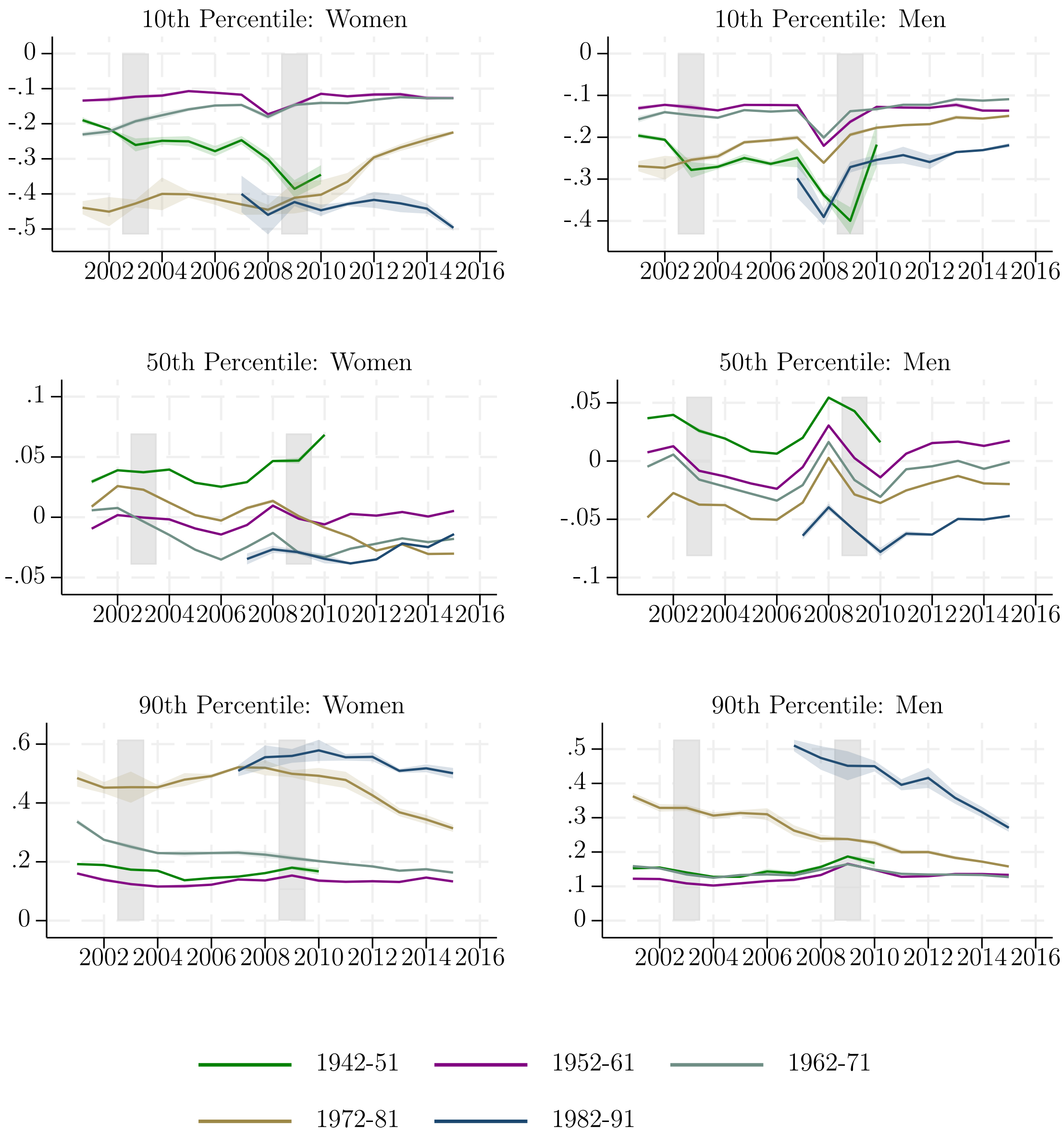

Figure A.9: Percentiles of residualized earnings growth over time by cohorts II

Note: Prime age individuals in the TPP, years 2001-2016. The figure shows percentiles of residualized 1-year changes of log real annual earnings (from t to $t+1$). Shaded areas are bootstrapped 95-percent confidence intervals. The gray bars indicate recessions.

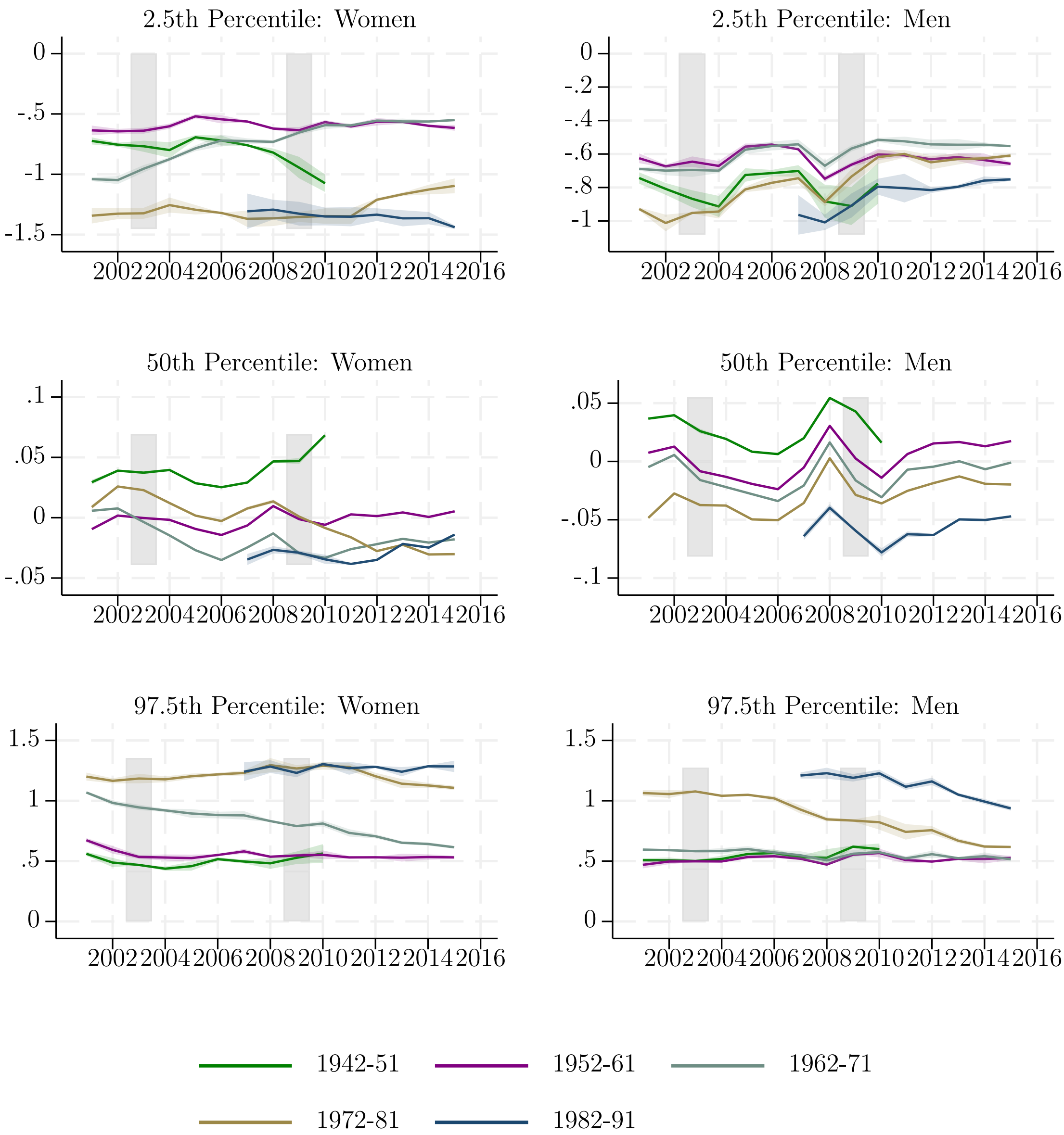

Figure A.10: Percentiles of residualized earnings growth over time by cohorts III

Note: Prime age individuals in the TPP, years 2001-2016. The figure shows percentiles of residualized 1-year changes of log real annual earnings (from t to $t+1$). Shaded areas are bootstrapped 95-percent confidence intervals. The gray bars indicate recessions.

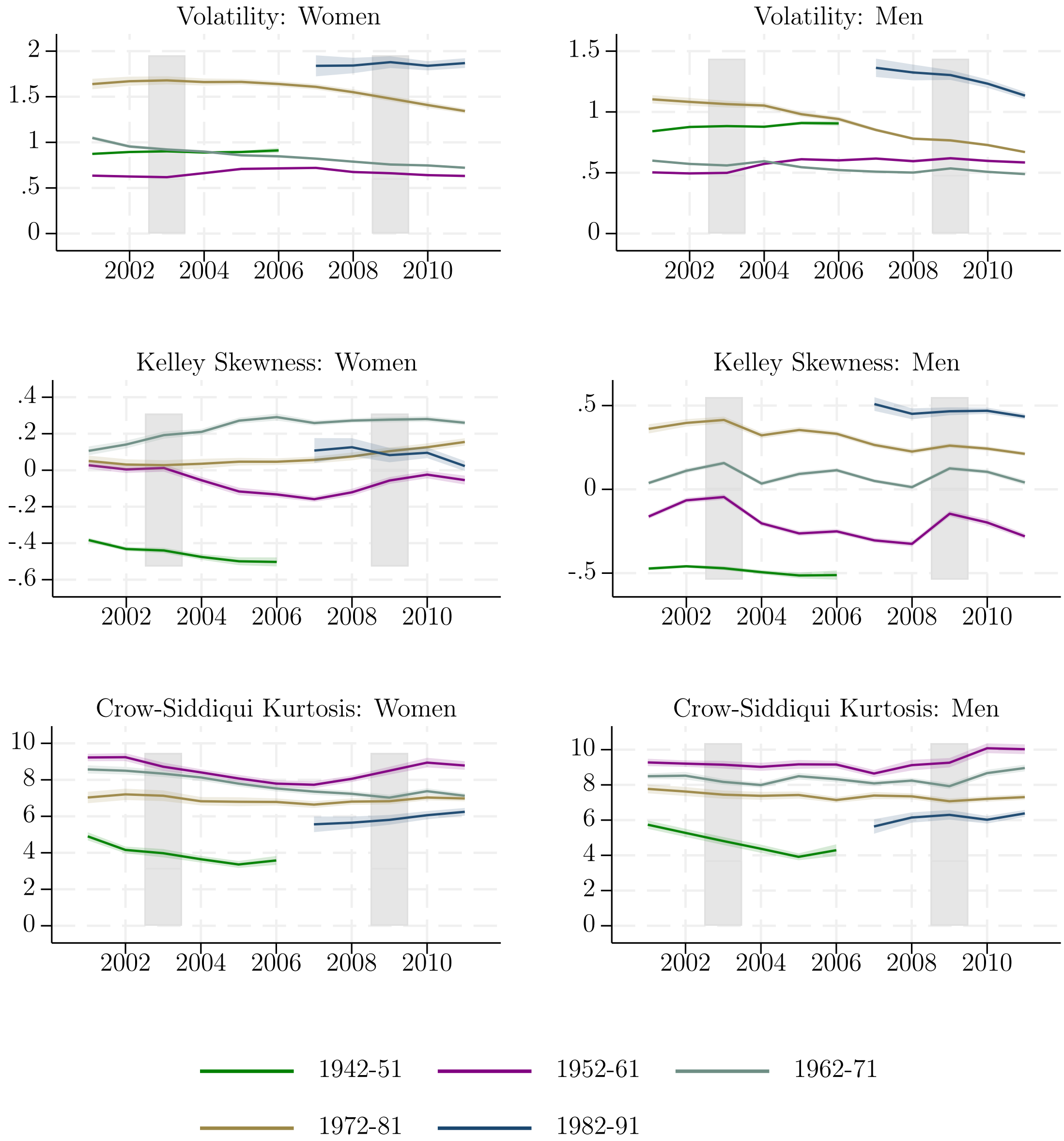

Figure A.11: Moments of residualized 5-year labor earnings growth over time by cohorts

Note: Prime age individuals in the TPP, years 2001-2016. The figure shows moments of residualized 5-year changes of log real annual earnings (from t to $t+5$). Shaded areas are bootstrapped 95-percent confidence intervals. The gray bars indicate recessions.