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Abstract

This paper documents earnings dynamics over the life-cycle and income level using a large administrative database from German tax records. I find that labor earnings display important deviations from the typical assumptions of linearity and normality. For the bottom earners, large income changes are driven equally by hours and wages which is consistent with transitions between labor status or jobs, whereas for those at the top, earnings changes are mainly induced by wage rate growth. There are also asymmetries in mean reversion of earnings growth mainly driven by the asymmetric hours dynamics. Finally, there is no evidence of an added-worker effect but government insurance and income pooling can mitigate the pass-through of individual earnings changes to the household level and attenuate the deviations from normality of the male earnings growth distribution.

JEL-Codes: E240, H240, J310.

Keywords: earnings dynamics, earnings risk, insurance, wages, hours, higher-order earnings risk, skewness, kurtosis.

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1 Introduction

Earnings dynamics play a key role in models of household behavior which are important tools for macroeconomics research. The common approach of these models is to focus on uniform income processes, so that all agents face the same income shocks. Recent empirical work with newly available micro data documents significant deviations of labor earnings changes from standard assumptions of normality and important state dependencies of earnings dynamics for the United Sates (Guvenen et al. 2019). This paper contributes to the literature by studying the distribution and dynamics of earnings changes for Germany.

I start by characterizing the distribution of earnings growth and its differences over the life-cycle and along the earnings distribution. Secondly, motivated by the importance of extreme observations for deviations from normality, I examine the role of some life-cycle events together with the contribution of hours and wages for large earnings changes. Then, I study the mean reversion patterns of earnings changes which are frequently modeled as simple AR(1) or low-order ARMA processes imposing strong premises as, for example, uniformity of mean reversion. Contrarily to these assumptions, I examine its state dependencies with respect to the income level, sign, and size of the changes. Finally, given that for households the risk of disposable income is more relevant than the earnings risk, this paper also assesses whether families and the welfare system can provide any insurance against individuals earnings risk and attenuate the heterogeneities and deviations from normality documented for the male workers.

For this analysis, I use administrative data from the German Taxpayer Panel consisting of tax records from 2001 to 2012. It contains information on individual and household income, taxes, transfers, and some demographic characteristics. Given that the data is not censored, it contains the very top earners. It allows precise estimates of the dynamics of earnings shocks as well as studying the role of family and government insurance. I supplement the analysis using survey data from the German Socio-Economic Panel as, unlike the Taxpayer Panel, it contains information about total hours worked and more details on life-cycle events. Given that the nature of the deviations from normality and linearity are difficult to anticipate, I take on a non-parametric approach to characterize the earnings dynamics in Germany.

I find strong deviations from normality and salient heterogeneities in the distribution and

dynamics of earnings changes across age groups and along the earnings distribution. First, the distribution of earnings growth is more disperse for the young and poor workers and more negatively skewed and leptokurtic for older and richer workers. Yet, when excluding the tails of the distribution and analyzing outlier robust measures for the second and third moments, the distribution becomes negative skewed only for the 45-54 age group and more leptokurtic for the workers at the bottom half of the distribution. Furthermore, decomposing labor earnings shows that deviations from normality, as excess kurtosis, are also present in the distributions of hours and wage changes.

Secondly, the drivers behind large earnings swings, which are important for the sharp non-normalities documented, differ across income groups. The role of wage and hours changes is highly dependent on the sign of the change and earnings history of the workers. Small labor earnings changes are mainly driven by wages. Large income changes experienced by poor workers are driven by a mix of hours and wage changes, which is consistent with unemployment spells and job switches. However, as we move up the earnings distribution, wage growth becomes considerably more relevant than hours, highlighting the job stability of the top earners.

Then, I find that there are clear asymmetries in mean reversion of earnings shocks which is not compatible with frequent modeling choices of earnings dynamics, like AR(1) processes. For poor workers, the negative shocks are transitory and the positive ones are permanent but, as we move to the top of the earnings distribution, negative shocks become more permanent and positive more transitory. This non-linearity in mean reversion is mainly driven by the hours growth dynamics, since wage dynamics are close to linear.

Finally, I also document differences across income groups in the role of family and welfare system to provide insurance against individual earnings swings. Spouses' labor supply remains, on average, unchanged after a change in the head's earnings, which implies that families' ability to self-insure against income risk is solely driven by income pooling. On the other hand, the German government is able to provide considerable insurance as taxes and transfers significantly reduce the pass-through of large individual earnings shocks to the household level, especially for the bottom earners. In addition, accounting for taxes and transfers attenuates the heterogeneities and deviations from log-normality of the male earnings growth distribution.

This paper contributes to the empirical literature that characterizes the distribution and dy-

namics of income changes. In particular, it adds to the growing literature on higher-order moments of income shocks which has received renewed interest since the contribution by Guvenen et al. (2019). The authors use a large administrative dataset from the United States to document that the distribution of earnings changes exhibits substantial deviations from log-normality and that the extent of these non-normalities depends on the level of income and age. Guvenen et al. (2019) also document that the persistence of labor income changes in the United States depends on the size of the change and earnings level. Halvorsen et al. (2020) and De Nardi et al. (2021a) use administrative data from Norway and the Netherlands, respectively, to study higher-order moments not only of income changes, but also of hours and wage growth. Both confirm rich earnings dynamics with heterogeneities and deviations from usual assumptions of normality and linearity. De Nardi et al. (2021b) study the wage risk in the UK and document that the persistence and riskiness of wages depends on workers' age and position in the wage distribution. Importantly, De Nardi et al. (2021b) show that allowing for rich wage dynamics is important to properly evaluate the effects of a benefit reform in the UK. In spite of using a different approach, Arellano et al. (2017) find asymmetries in mean reversion and non-Gaussian features in earnings changes for the US and Norway that are consistent with evidence provided by other methods and datasets.

A growing literature has also been studying the determinants of these non-normalities. Kurmann and McEntarfer (2019) show that the distribution of hourly wage growth features high excess kurtosis for job-stayers in the United States. Hoffmann and Malacrino (2019) use Italian data to argue that changes in weeks worked generate the tails of the one-year and five-year earnings growth distributions. Halvorsen et al. (2020) and De Nardi et al. (2021a) dissect the earnings growth into the contribution of hours and wage growth. While for Norway, Halvorsen et al. (2020) find that both wages and hours contribute to negative skewness and high kurtosis, for the Netherlands, De Nardi et al. (2021a) conclude that hours are the main driver of the negative skewness and, to a lesser extent, the high kurtosis of earnings changes. Exploring the role of life events, Halvorsen et al. (2020) also find that transitions to unemployment and occupation changes are important drivers of earnings growth in the Norwegian data.

There is also some recent literature that investigates the evolution of the earnings growth risk over time or with special focus on the role of business cycles. In particular, Friedrich et al. (2021) concentrate on longer-run Swedish data, Pruitt and Turner (2020) focus on IRS data for the United

States, Hoffmann and Malacrino (2019) use administrative data for Italy, and Guvenen et al. (2014) for the United States, while Bayer and Juessen (2012), Bartels and Bönke (2013), and Busch et al. (2018) provide evidence for a panel of countries including Germany. Busch et al. (2018) find that the skewness of individual income growth is procyclical, while the variance is cyclical with both hours and wage margins being important. Notably, they also find that household smoothing does not effectively mitigate skewness fluctuations but tax-and-transfer policies do.

This paper also contributes to the broader literature on risk sharing including, among others, Attanasio and Davis (1996), Blundell and Preston (1998), Heathcote et al. (2014), and Blundell et al. (2015), and more recent contributions by Pruitt and Turner (2020), Halvorsen et al. (2020), and De Nardi et al. (2021a). Most find, for different countries, that households effectively insure against much of the risk facing primary earners. For the Netherlands and Norway, De Nardi et al. (2021a) and Halvorsen et al. (2020) document that the welfare system substantially attenuates individual income shocks and is able to attenuate the deviations from normality documented for male earnings distributions. However, neither of them find any evidence of insurance through spousal labor supply. These results are all qualitatively similar to mine. For Germany, but taking a different approach from mine, Bartels and Bönke (2013) study the role of welfare state and households in smoothing earnings shocks over time using data from the SOEP. They find that taking institutions of the welfare state and risk-sharing households into account decreases transitory and permanent variances of net household income, even though over time both have remained fairly stable.

The remainder of the paper proceeds as follows. Section 2 describes the data and approach. Sections 3, 4, 5, and 6 present the results. Section 3 characterizes the distribution of earnings changes, while Section 4 discusses the sources of the non-normalities documented. Section 5 describes the asymmetric mean reversion patterns of earnings dynamics. Section 6 investigates the role of household and government insurances in mitigating individual income risk and attenuating the deviations from normality present in male earnings changes. Finally, Section 7 concludes.

2 Data and Variable Construction

2.1 Data

The German Taxpayer Panel (TPP) and Socio-Economic Panel (SOEP) are the main databases used in the analysis. The TPP is an administrative dataset collected by German tax authorities, provided and administered by the German Federal Statistical Office, based on the universe of personal income tax returns. The unit of observation is the taxpayer, i.e., either a single individual or a couple filing taxes jointly.[1] It includes a detailed decomposition of labor and asset income, taxable income, allowances and special benefits, taxes, and transfers. Furthermore, it contains demographic information about individual taxpayers and households as for example gender, year of birth, and number of children.

Annual individual labor income is the main variable used in the analysis and it is computed as the sum of total wage income and a labor share of self-employment income. The total household labor earnings, total income, and income net of taxes and transfers are then used in Section 6. I use a 5% representative sample from 2001 until 2012 and employ the respective weights provided by the German Federal Statistical Office.

Given the design of the data, the measurement error is much lower than in survey data where earnings are self-reported. The TPP has nonetheless some caveats. First, given that tax filing is mostly optional, low income taxpayers are likely to be non-filers and therefore to be misrepresented in the sample (Hauck and Wallossek 2020). However, there are certain cases in which filing tax returns is strongly beneficial or even mandatory as, for example, when taxpayers have other income sources for which taxes are not or only partially withheld. This allows a good coverage of the German population with some labor market attachment, which is the primary focus of this analysis.[2]

The second caveat is that the dataset does not contain information about the number of hours worked which would be important to understand the drivers of income swings. Finally, since 2005, some important social assistance subsidies received, like unemployment, maternity or sickness benefits, are reported together and thus, the individual amounts from different social programs cannot be recovered. To overcome these last limitations, I supplement the analysis with survey data from the German SOEP. This survey has been running annually since 1984 and in-

[1] It is not possible to link couples who deliver separate tax forms.

[2] See Hauck and Wallossek (2020) for more detail on tax return (non-)filers.

terviewing nearly 15,000 households and about 30,000 persons. It contains detailed information about labor status, income statements, and demographics. Importantly, it also asks exhaustive questions about live events and employment experiences like job changes and unemployment.

2.2 Sample Selection

The base sample is a panel consisting of males with some labor market attachment and it is designed to maximize the sample size which is important for precise computation of higher-order moments in finely defined groups. The baseline sample is composed only of males between 25 and 59 to abstract from education and retirement decisions.

Moreover, an observation is included only if earnings are above a minimum income threshold defined as 5% of each year's median labor earnings. The panel for year *t* then selects individuals that are admissible in $t-1$ and at least in $t-2$ or $t-3$. This ensures labor market participation and that a reasonable measure of recent earnings can be computed - a variable that is described next. [3]

2.3 Variable Construction

Recent Earnings

I now define "recent earnings" (RE), a term that will be used throughout the paper. For a given worker, I compute his RE between $t-1$ and $t-3$. Let $y^i_{t,h} \equiv log(Y^i_{t,h})$ denote the log of labor earnings of individual *i* who is *h* years old in year *t*. To control for age and year effects, I first estimate age average earnings, $d_{t,h}$, by regressing log individual earnings on a set of age and year dummies. Then, following Halvorsen et al. (2020), I compute RE for each worker as follows:

$$\bar{Y}^i_{t-1} \equiv \sum_{\{k=1\}}^{3} \frac{Y^i_{t-k,h-k}}{exp(d_{t-k,h-k})}$$

Growth Rate Measures

Next, I compute income changes up to the five-years, which is useful to distinguish between income growth over the short (1-year change) and long (5-year change) horizons to study "tran-

[3] To avoid possible outliers, the top 1% of labor earnings observations in the SOEP are excluded.

sitory" and "persistent" earnings changes. For each $k = 1, ..., 5$, the k-year log change of income net of age and year effects is defined as:

$$\Delta_k \tilde{y}_{i,t} = \tilde{y}^i_{t+k,h+k} - \tilde{y}^i_{t,h} = (y^i_{t+k,h+k} - d^z_{t+k,h+k}) - (y^i_{t,h} - d^z_{t,h})$$

where $y^i_{t,h}$ is the log of income and $y^i_{t,h}$ is the log of income net of age and year effects. Income can be male or female labor earnings or household level income.

3 Distribution of Earnings Growth

Figure 1 displays the distribution of one- and five-year labor earnings growth for male workers in the base sample, along with Gaussian densities chosen to have the same standard deviation as in the data. The distributions display left skewness and excess kurtosis relative to a Gaussian density that would feature no skewness and a kurtosis of 3. The negative skewness indicates that there are more positive earnings changes than negative ones but while income increases are mostly very small, the long left-tail indicates more large income drops than rises. The excess kurtosis reveals that most changes are very small but from time-to-time there are very large ones.

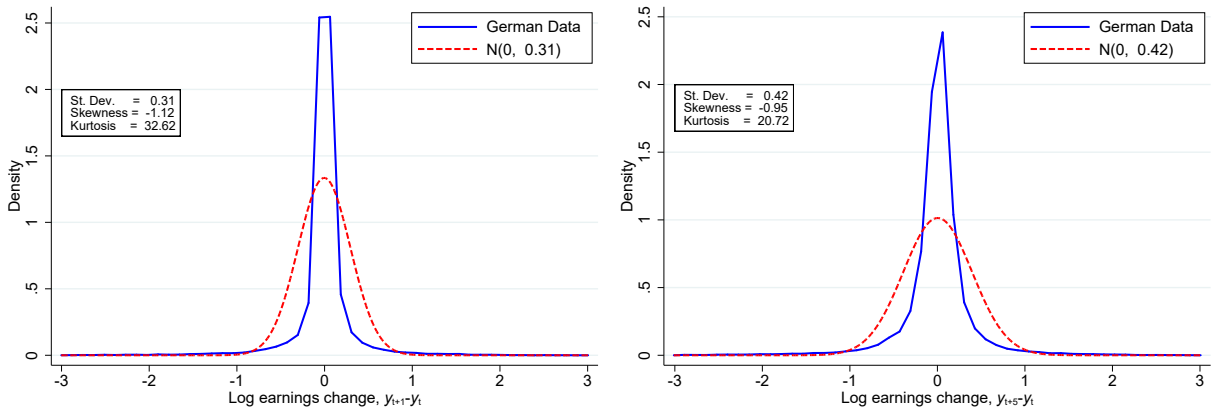
This section studies in more detail the distribution of one-year earnings growth for German male workers by documenting its second to fourth moments over the life-cycle and along the RE distribution. [4]

3.1 Empirical Methodology

The main goal of this section is to document heterogeneities of higher-order moments of earnings growth, namely with respect to RE and age. To this end, for each year t, individuals are divided into seven equally-sized groups based on their age in year $t-1$ and then, within each age group, they are sorted into ten deciles by their RE. If these groupings are done at sufficiently fine level, we can think of all individuals within a given age/RE group to be ex-ante identical or at least very similar. Then, for each such group, the cross-sectional moments of earnings growth between t and $t+k$ can be viewed as the properties of earnings changes that workers within that group

[4] Appendix B and Appendix C show the results for female workers and five-year earnings changes, respectively.

Figure 1: Histograms of One- and Five- Year Log Earnings Change



(a) 1-Year earnings growth

(b) 5-Year earnings growth

Notes: The figure depicts the empirical densities of one- and five-year labor earnings changes along with Gaussian densities with the same standard deviation as the data. Data is from 2007 German tax records and only male workers between 25 and 59 years of age are used. Source: German TPP.

expect to face looking ahead.

The figures that follow plot, for each age/RE group, the average moments between 2004 and $2012 - k$ (1987 and $2018 - k$ for the SOEP data). This approach allows computing higher-order moments precisely because each bin contains a large number of observations, especially for administrative data like the taxpayer panel. In what follows, the second to fourth moments of earnings changes are reported. Regarding the third and fourth moments, both conventional (centered moments) and outlier robust measures are presented. Kelley coefficient of skewness (Kelley 1947) is given by:

$$\text{Kelley Skewness} = \frac{(P_{90} - P_{50}) - (P_{50} - P_{10})}{P_{90} - P_{10}}$$

where a zero implies a symmetric distribution, positive values represent right skewness, and negative values represent left skewness. Concerning kurtosis, Crow-Siddiqui (CS) measure (Crow and Siddiqui 1967) is also less sensitive to outliers than the centered fourth moment and can be computed as follows:

$$\text{CS Kurtosis} = \frac{P_{97.5} - P_{2.5}}{P_{75} - P_{25}}$$

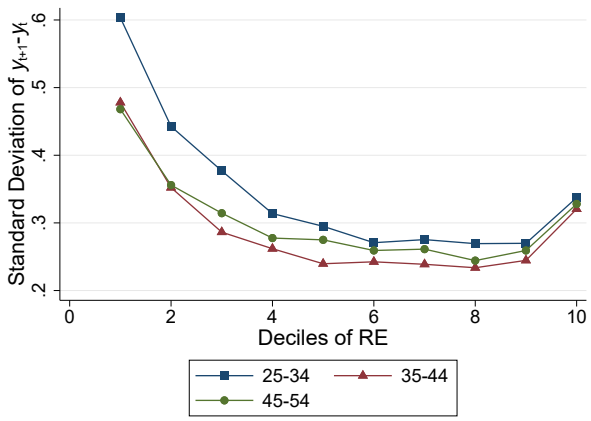
CS Kurtosis is high if $P_{97.5} - P_{2.5}$ is large relative to the probability mass that is concentrated between the 75^{th} and the 25^{th} percentiles, corresponding to heavy tails.

3.2 Age, Gender, and Earnings Heterogeneities

Second Moment: Variance

Figure 2 shows that, the standard deviation of earnings changes displays a U-shape along the RE distribution. Earnings changes are more than twice as disperse for workers at the lowest percentiles of RE than for workers around the median and then, it tends to increase for earners in the top 10% of the distribution. There are significant differences in earnings volatility over the life cycle as well, especially for bottom earners, with young workers experiencing the largest volatility. This is in line with the results by Bönke et al. (2019) who, using other methods and the SOEP, show that younger cohorts face higher total earnings variance.

Figure 2: Standard Deviation for One-Year Earnings Growth



Notes: Cross-sectional second moment of one-year labor earnings growth of male workers over the life-cycle. Source: German TPP.

Despite the higher volatility, earnings changes persistence is smaller at the beginning of the working life. Figure A.1 shows that there is significant age variation in the persistence of labor earnings changes, unlike typically assumed by standard AR(1) processes. Earnings persistence starts from a value of about 0.7 at age 27, consistent with younger people switching jobs and careers frequently without permanent impact on their labor income. It then increases fast, reaching 0.9 at age 40, where it stabilizes. This evidence indicates that shocks to labor earnings at younger

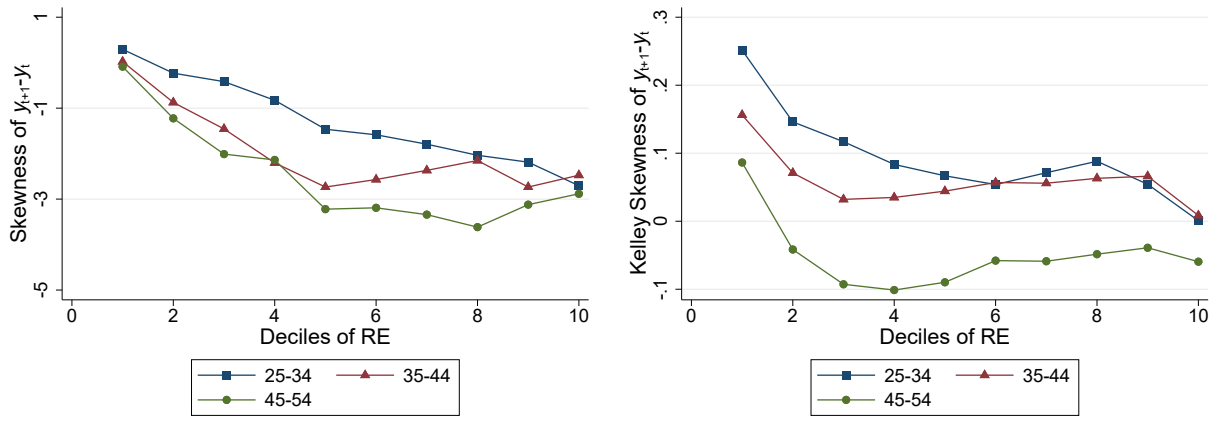
ages are not as long-lived as at older ages.

Figure B.2 in the appendix depicts the cross-sectional moments that characterize the distribution of one-year labor earnings changes for female workers. Relative to men, females' distribution presents stronger life-cycle differences women, with changes being more disperse for younger women which is potentially associated to maternity as discussed later in Section 4.2.

Third Moment: Skewness

Figure 3a plots the centralized third moment over the life-cycle and RE distribution. Skewness starts around zero at low levels of RE but becomes negative as income level increases, meaning that experiencing very large income declines becomes more likely than seeing large increase. This seems to imply that the higher the RE, the more room for earnings to fall and the less room for rises. Figure 3a also shows that the distribution is more negatively skewed for older workers which supports the idea that younger workers are still climbing up the job ladder and therefore, are less likely to experience very large income drops.

Figure 3: Skewness for One-Year Earnings Growth



(a) Standardized Skewness

(b) Kelley Skewness

Notes: Cross-sectional moments of one-year labor earnings growth of male workers over the life-cycle. Source: German TPP.

The conventional centered measure of skewness can be very sensitive to the existence of long tails. Thus, Figure 3b plots the Kelley measure of skewness for labor earnings changes which is robust to outliers. It is very close to zero or positive for most age groups and for most deciles of the RE, indicating a symmetric distribution of earnings growth outside the tails of the distribution.

Another important question is whether skewness becomes more negative over the life cycle because of a compression of the upper tail (fewer opportunities for large gains) or because of an expansion in the lower tail (higher risk of large declines). Figure A.2 in the appendix plots the P90-P50 and P50-P10 for different age groups. With the exception of the top RE deciles, it shows a compression of both upper and lower tails over the life cycle. However, since P90-P50 changes more between age groups than P50-P10, the upper tail compress more strongly, implying that this result is mainly driven by fewer large gains. This figure documents an expansion of the lower tail and an increase in risk of large declines only for top earners.

Regarding the distribution of female earnings growth, Figure B.2 documents strong differences in the level and patterns of skewness for females relative to males. Life-cycle and RE heterogeneities are even more salient than for male workers.

Fourth Moment: Kurtosis

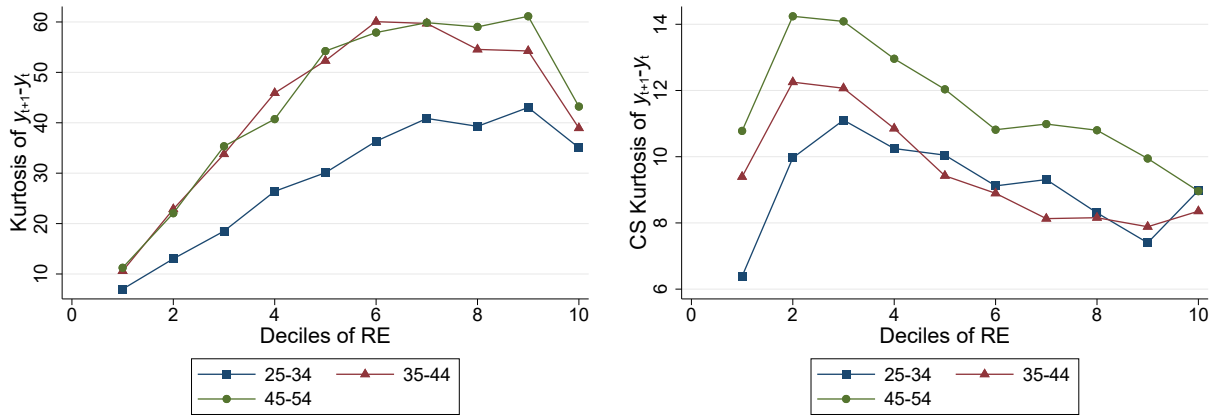
Figure 4a shows that the distribution of earnings changes features excess kurtosis implying that, even though most changes are very small, there are some large income swings at the tails. Moreover, kurtosis of earnings growth has an inverted-U shape that is especially striking for the prime-aged workers. Thus, kurtosis is increasing with previous earnings up to the 7^{th} or 8^{th} decile indicating that changes become less frequent but larger at these percentiles of RE. Kurtosis is larger for older than for younger workers, even though this difference is more salient only for middle class earners.

Since kurtosis can also be sensitive to extreme observations, Figure 4b plots a version of kurtosis that is outlier robust and shows that indeed a considerable part of excess kurtosis can be explained by the changes at the tails. Crow-Siddiqui kurtosis is still significantly larger for older workers but it is now higher for workers at the bottom half of the distribution.

For females, the distribution of earnings growth features higher kurtosis when compared to male workers and varies more over the life-cycle (Figure B.2). These patterns are similar to the evidence provided for Norway by Halvorsen et al. (2020), but contrasts with the results for the UK by De Nardi et al. (2021b), for which age differences are less striking.

Overall, these findings suggest that earnings changes in Germany exhibit strong deviations

Figure 4: Kurtosis Moments for One-Year Earnings Growth



(a) Standardized Kurtosis

(b) Crow-Siddiqui Kurtosis

Notes: Cross-sectional moments of one-year labor earnings growth of male workers over the life-cycle. Source: German TPP.

from normality which depend on the life-cycle, gender, and history of earnings: earnings volatility is highly dependent on the past earnings; most workers do not experience any earnings changes and very few workers face large shocks; large drops are more likely than large income rises.

This section provides evidence consistent with job ladder models in which most workers keep their jobs and face very small earnings changes, while few of them become unemployed and experience large earnings drops. Differences over the life-cycle indicate that younger workers are more likely to experience positive earnings changes associated with career switches up, whereas older workers (with long job tenures) are more likely to experience relatively large cuts when they find a new job after displacement. These qualitative properties are in line with findings for other countries like the United States, Norway, and the Netherlands (Guvenen et al. 2019; Halvorsen et al. 2020; De Nardi et al. 2021a).

4 Sources of Non-normalities

So far, the analysis has focused on the distribution of annual labor earnings changes, but one important question to ask is what are the sources of these deviations from normality. Motivated by the importance of extreme earnings changes for negative skewness and excess kurtosis and

using data from the SOEP, this section provides evidence on the contribution of hours and wages and the role of life events for large earnings swings experienced by male workers.[5]

4.1 Decomposing Earnings Changes

For many economic questions, it is not only important to understand the earnings dynamics but also its sources, that is, if they are induced by hours, wages, or both. To investigate the drivers behind the deviations from normality, this section starts by documenting whether the left skewness and excess kurtosis reported for earnings are also present in the hours and wage growth distributions. Table A.1 documents the non-Gaussian features of one-year earnings, hours, and wages changes over the life-cycle in the SOEP.[6] It shows that there are significant deviations from normality also in the distributions of both hours and wage changes, especially for older workers. Yet, the distribution of wage growth features less negative skewness and excess kurtosis than those of earnings and hours independently of the age group.

Figure A.3 reports the cross-sectional moments of wage and hours changes along the RE distribution, reinforcing the deviations from normality. Kurtosis is especially higher for hours than for wages, suggesting that hours adjustments are very infrequent but that, when they happen, they tend to be of a large magnitude (plot A.3c). This provides some support for models of life-cycle labor supply where workers' labor supply is inelastic and subject to unemployment shocks or only subject to adjustments of a discrete nature. These patterns are similar to what has been documented for other countries like the Netherlands (De Nardi et al. 2021a).

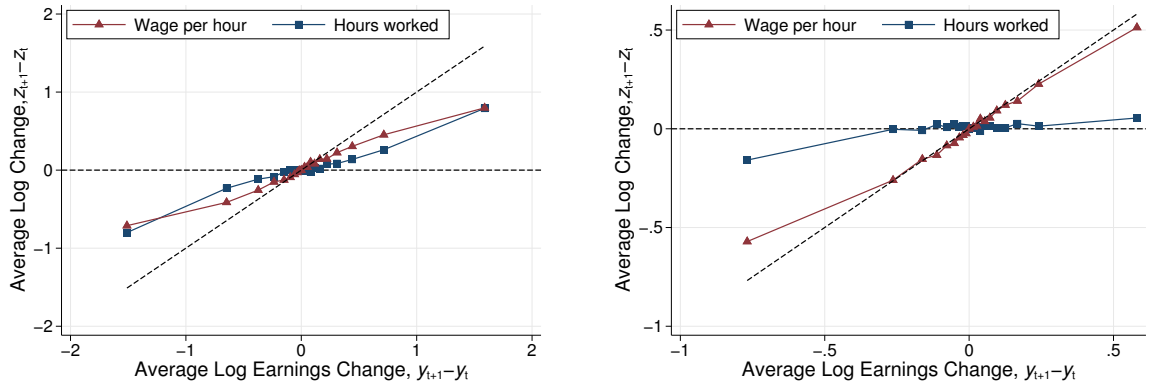
A complementary way of understanding the sources of earnings swings is to dissect them into the contribution of wage and hours changes. While most literature has focused on uniform relations between movements in wages and hours, I now investigate their co-movement for different income levels and earnings changes of different signs and sizes. Figure 5 plots, for different groups of workers, the average growth of hours and wages on the y-axis conditional on their average labor earnings growth between t and $t+1$ on the x-axis. For this purpose, on top of conditioning on workers' recent earnings, individuals are grouped according to their earnings

[5] Appendix B and Appendix D show the results for females and prime-aged workers, respectively.

[6] Consistent with the taxpayer panel evidence, Table A.1 indicates that the distribution of labor income changes is left skewed and exhibits excess kurtosis, with age patterns that are also in line with those computed using administrative data.

growth.[7] In particular, within each RE group, workers are sorted by the size of their log earnings change between t and $t+1$ and grouped into twenty equally-sized quantiles. Hence, all individuals within a group have similar earnings history and experience a similar earnings change from t to $t+1$ and thus, such finely defined group can be treated as homogeneous. For simplicity, results are documented only for the bottom (first and second) and top (ninth and tenth) RE deciles.[8]

Figure 5: Contribution of Hours and Wages to Earnings Changes



(a) Bottom RE deciles

(b) Top RE deciles

Notes: The figure displays the one-year average log change of annual hours and hourly wage for 20 different groups of male workers in the bottom (1st and 2nd) and top (9^{th} and 10^{th}) RE deciles, plotted against their contemporaneous one-year average log change in annual labor earnings. Figure A.4 in the appendix shows the results for the median RE deciles. Source: German SOEP.

Figure 5 indicates that small earnings changes are mainly driven by wage growth independently of the earnings history. However, for larger labor income swings, there is some heterogeneity with respect to the sign of the change and level of RE. Panel 5a shows that, for the bottom RE deciles, large income changes (both negative and positive) are driven by a combination of changes in wages and hours. For example, the group of bottom earners whose earnings increased around 160 log points on average experience an increase of about 80 log points in hours and an increase of 80 log points in hourly wages. For the top earners, independently of the size, earnings changes are mainly driven by changes in wage per hour rather than by changes in the number of hours worked (Figure 5b). The results for the middle deciles are somewhat an intermediate case

[7] Alternatively to conditioning only on the workers' RE, I consider also their age by grouping them into young and prime-age earners, 25-34 and 35-54 years old, respectively. Results remain unchanged and are documented on Figure D.2 in the appendix.

[8] To control for differences in mean reversion between different groups of workers, the changes on both the x- and y-axes such that their values at the median quantile of $y_{t+1} - y_t$ cross at zero.

between the bottom and the top (Figure A.4).

These findings imply that, along the RE distribution, different mechanisms account for large earnings swings. Moreover, the heterogeneous role of hours suggests large unemployment risk for the poor, but consistent job stability for the top earners independently of the earnings change experienced.

4.2 The Role of Life Events

A natural question to ask in this context is what are the drivers of large earnings swings and whether some specific life events can account for part of the risk faced by the workers, e.g. job change, a transition to unemployment, a long-term sickness, parental or maternity leaves. Tracing changes in earnings back to labor market or life events is not merely of interest from a positive perspective but also from a normative perspective as many changes in earnings might not constitute risk from the household perspective but could result from labor market choices (Hubmer 2018; Low et al. 2010).

The analysis starts by splitting, according to their magnitude, one-year earnings changes computed from the administrative data into six groups. Then, Table A.2 documents the share of workers who experience certain life events contemporaneously to these income changes. It shows that, on the one hand, many workers with large earnings drops experience a contemporaneous increase in social assistance received by the government (which includes unemployment, sickness, and maternity/parental benefits). The opposite is true for workers whose income rises, i.e., their total welfare benefits received decrease on average when labor earnings rise. On the other hand, becoming handicapped or having more children are only marginally relevant in accounting for the earnings changes experienced by male workers in Germany.

To supplement this analysis, the German SOEP is used to shed light on the role of life and employment events for which the TPP does not provide sufficient detail. For instance, the SOEP contains detailed data about job changes and labor status transitions. Similar to the evidence from the administrative data, Tables 1 and 2 present the share of workers who experienced certain events contemporaneously to large, medium, and small negative or positive income changes, respectively.

Job changes are the main driver of earnings decreases for male workers in Germany - more

Table 1: Negative income shocks and life-cycle events

	One-Year Earnings Change, $\Delta y \in$		
	< -1	$[-1, -0.25)$	$[-0.25, 0)$
Into non-employment	22.80	10.65	1.82
Into unemployment	16.53	7.54	1.22
Into regular part-time	1.48	1.66	0.58
Changed job	26.54	16.71	6.66
Involuntary changes	16.46	12.15	2.83
Due to parental leave	0.25	0.28	0.09
Change no. of children	3.45	4.10	4.03
Lost second job	4.09	4.36	3.06
Into disability	4.02	1.93	1.08
Share (%)	1.90	8.41	36.14
$\mathbb{E}\,\Delta^1_{log} y^i_t$	-1.64	-0.47	-0.07
$\mathbb{E}\,\Delta^1_{log} w^i_t$	-0.81	-0.34	-0.07
$\mathbb{E}\,\Delta^1_{log} h^i_t$	-0.82	-0.12	-0.01
$\mathbb{E}\,\Delta^5_{log} y^i_t$	-0.31	-0.20	-0.04
$\mathbb{E}\,\Delta^5_{log} w^i_t$	-0.27	-0.19	-0.01
$\mathbb{E}\,\Delta^5_{log} h^i_t$	-0.02	-0.02	-0.03

Notes: Part-time worker accounts only for regular part-time employment. Individuals are considered unemployed if are not working and are registered unemployed and excluded those who are not working but sometimes have a second job, were working past the 7 days, or have a regular second job. Individuals are considered not employed if they are not full- or part-time employed or attending vocational training. Workers experience a job change if their jobs in t and $t+1$ are not the same and a change of employer can happen either via an unemployment spell or through a direct job-to-job movement. I consider a forced job change in the following cases: the employment link was terminated by the employer, a temporary contract expired, the education or training was completed, the company transfers the employee, the company closed down. The option of job change due to maternity/parental leave is only asked in some waves of the survey (from 1991 to 1998 and since 2011). Source: German SOEP.

than 26% of the workers who experience large income drops, change their job. Compared to the workers with small changes, they are four times more likely to transition between jobs. Moreover, 15% of the workers with large earnings cuts were forced to change their job either because the employment contract was terminated by the employer, the company closed down or the temporary employment tie was not renovated. Halvorsen et al. (2020) and Guvenen et al. (2019) find for Norway and the U.S. significant differences in the distribution of earnings changes for job stayers and job switchers. While for skewness their results differ, both find that annual earnings changes for switchers tend to be substantially more dispersed and significantly less leptokurtic than those for stayers.

Another important driver of earnings losses is the transition between labor force status. 22% of the workers who suffer large income drops became non-employed, from which 16% became

unemployed. Table 1 shows that, for the workers in this group, the average income changes are equally driven by a drop in wages and hours worked. So, this confirms the idea that unemployment risk and unstable employment plays an important role in explaining earnings drops and is consistent with evidence provided in Figure 5 for the bottom RE workers. Extensive margin events (e.g. layoffs) can also lead to large declines in hours and wages at the same time. These results underline the importance of the extensive margin for the tails of the earnings change distribution.

Similarly to drops, Table 2 shows that switching jobs and becoming employed, especially at full-time jobs, are the main reasons for positive income changes. About 10% move out of unemployment or inactivity into a full-time job or a regular part-time. Extra jobs seem relatively more important to explain intermediate labor income changes.

Table 2: Positive income shocks and life-cycle events

	One-Year Earnings Change, $\Delta y \in$		
	$[0, 0.25]$	$(0.25, 1]$	> 1
Into full-time			
from not full-time	1.20	6.00	17.18
from regular part-time	0.49	1.62	3.94
Into full- or regular part-time			
from not working	0.64	3.28	9.43
from unemployment	0.44	2.26	5.39
Changed job	5.95	13.89	25.47
Involuntary change	2.08	6.47	9.50
Extra job	2.88	4.27	4.04
Out of disability	0.49	0.76	0.33
Share (%)	42.52	9.43	1.60
$\mathbb{E}\,\Delta^1_{log} y^i_t$	0.08	0.46	1.60
$\mathbb{E}\,\Delta^1_{log} w^i_t$	0.07	0.35	0.91
$\mathbb{E}\,\Delta^1_{log} h^i_t$	0.01	0.10	0.68
$\mathbb{E}\,\Delta^5_{log} y^i_t$	0.06	0.34	1.58
$\mathbb{E}\,\Delta^5_{log} w^i_t$	0.08	0.27	0.86
$\mathbb{E}\,\Delta^5_{log} h^i_t$	-0.01	0.07	0.73

Notes: Part-time worker accounts only for regular part-time employment. Individuals are considered unemployed if are not working and are registered unemployed and excluded those who are not working but sometimes have a second job, were working past the 7 days, or have a regular second job. Individuals are considered not employed if they are not full- or part-time employed or attending vocational training. Workers experience a job change if their jobs in t and $t+1$ are not the same and a change of employer can happen either via an unemployment spell or through a direct job-to-job movement. I consider a forced job change in the following cases: the employment link was terminated by the employer, a temporary contract expired, the education or training was completed, the company transfers the employee, the company closed down. Source: German SOEP.

In addition, large positive income changes are, on average, driven by a mix of wage and hours changes which is again consistent with evidence for the bottom RE workers documented in section 4.1. Tables 1 and 2 show that independently of the sign of the change, small and intermediate income changes are accounted for by wage changes that are only mildly related to job switching.

Table B.1 in the appendix provides the counterpart for female workers in Germany. Similarly to males, switching jobs and, in particular, unwanted job changes are the main reason for the income cuts. However, the share of females who claim having been forced to change jobs because of parental leave is considerably larger than for the male counterparts. Maternity seems to be an important driver of income dynamics of women in the German labor market since it is also clear that many experience a fall in earnings contemporaneously to an increase in the number of children or taking a maternity leave. Unlike males, transitions into and out of inactivity and part-time employment are important to account for labor income fluctuations experienced by female workers. These results are in line with evidence by Kleven et al. (2019) who find strong and persistent earnings penalties for females after birth of their first child. For Germany, they find that the penalty is driven by the intensive margin (hours worked) and wage-rate effects.

5 Earnings Dynamics

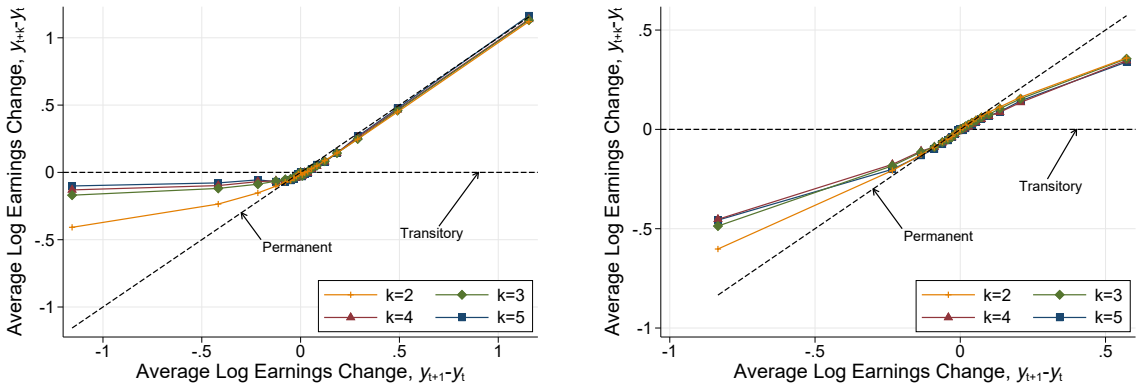
Earnings dynamics are frequently modeled as simple AR(1) or low-order ARMA processes which impose strong assumptions as, for example, uniformity of mean reversion. This section examines the mean reversion patterns of the earnings, wages, and hours changes and their dependencies on the level of income and size and sign of the changes. In particular, to describe the mean reversion patterns of earnings growth, I estimate their non-parametric impulse responses conditional on workers' RE, size and sign of the change. [9]

Figure 6 shows the response of earnings changes of different sizes and signs conditional on the workers RE. In particular, it plots the average earnings change after up to five years against the initial change in labor earnings. The x-axis represents the initial average log change $y^i_{t+1} - y^i_t$

[9]For this analysis, the entire baseline sample is used but Appendix D presents the results for a sub-sample of prime-aged workers.

for each RE group of workers, sorted by the size of their earnings shock. The y-axis plots the average log change of earnings from t to $t+k$, where $k = 2, ..., 5$.

Figure 6: Persistence of Labor Earnings Changes by RE Decile



(a) Bottom RE deciles

(b) Top RE deciles

Notes: The figure displays the k-year average log change of annual labor earnings for 20 different groups of male workers in the bottom (1st and 2nd) and top (9^{th} and 10^{th}) RE deciles, plotted against their contemporaneous one-year average log change in annual labor earnings. Figure A.5 in the appendix shows the results for the median RE deciles. Source: German TPP.

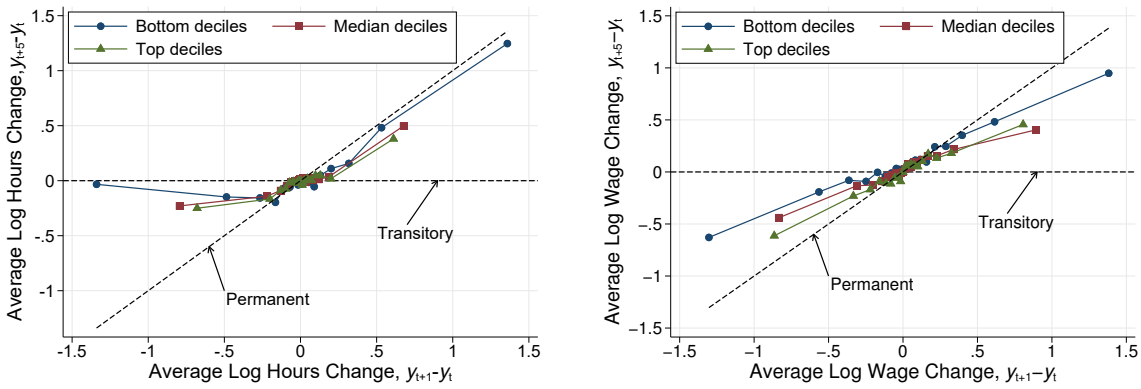
Figure 6 shows that labor earnings shocks are partially reversible in the first two years after the change takes place. Nevertheless, for most cases, a non-negligible fraction of these changes is still present after five years, suggesting a very persistent component in earnings growth. For example, top RE workers with earnings drops of 80 log points recover, on average, less than 50% of the earnings loss in the following five years.

More importantly, Figure 6 indicates that there are strong asymmetries depending on the sign of the change and along the distribution of RE. Positive earnings changes are almost permanent, especially for bottom earners. Earnings drops are transitory for the bottom workers, but permanent when experienced by those at the top. The results for the median RE deciles are somewhat an intermediate case between the bottom and the top (Figure A.5).

To understand what explains the asymmetric mean reversion pattern of earnings, it is important to study the persistence of hours and wage changes separately. In line with the strategy for labor earnings, conditional on their RE, workers are grouped with respect to their hours or wage growth between t and $t+1$. Using data from the SOEP, Figure 7 presents, for each group,

the average change in hours and wages from t to $t+5$ against their average initial changes.[10] It shows significant differences between hours and wage dynamics.

Figure 7: Persistence of Hours and Wages Changes



(a) Hours (b) Wages

Notes: The figure displays the five-year average change in hours and wages for 20 different groups of males workers in the bottom (1^{st} and 2^{nd}), median (5^{th} and 6^{th}), and top (9^{th} and 10^{th}) RE deciles, plotted against their respective one-year average change. Source: German SOEP.

Figure 7a shows that large increases in hours are persistent but large negative changes are more transitory. This indicates that employment tends to last much longer than the duration of unemployment spells. Unlike hours, wage changes are more symmetric and both drops and rises are only partially transitory or persistent (Figure 7b). This indicates that the non-linear persistence of labor earnings documented in Figure 6 is mainly driven by the non-linearity of hours changes.

There are also some noticeable differences in the persistence of hours and wage changes across RE groups. As one moves to higher RE deciles, increases in hours and wages become slightly more transitory, while declines become somewhat more persistent. For hours, this evidence is consistent with transitions between unemployment and employment being one of the main drivers of income fluctuations for workers at the bottom of the income distribution. This contrasts with the hours and wage fluctuations for other RE groups which are possibly related to more flexible occupations, overtime work, accumulation of tasks, or complex compensation packages which tend to be cyclical and performance related (Parker et al. 2011).

[10]Figure A.6 shows that the patterns documented using the TPP and the SOEP for earnings are very similar which reassures confidence on the SOEP.

6 Household and Public Insurance

Given that for households the risk of disposable income is more relevant than the earnings risk of an individual family member, this section discusses the extent to which German families are insured against individual labor income risk through private and public insurances. First, I discuss the role of the second earner and document the pass-through of individual earnings changes to the household level (Section 6.1). Then, Section 6.2 studies whether accounting for family and government insurances can attenuate the deviations from normality and state dependencies of the cross-sectional moments documented before for male earnings changes.[11]

6.1 Household Earnings Dynamics

Income pooling within a household can potentially be source a of insurance for two reasons. First, when only the male head experiences an earnings shock, part of the family income remains unchanged. Second, the second earner of the household may react to earnings changes experienced by the head by changing the number of hours worked. Thus, spouse's labor earnings can be informative about family insurance because if there was an added worker effect, after an earnings shock experienced by the male head, spouses would be expected to adjust the number of hours worked.

For this reason, this analysis starts by investigating the spouses' reaction to head's earnings changes. Even thought, the TPP does not provide information on the hours worked, for couples that file taxes together, spouses' labor earnings are reported separately. Figure 8 plots, for these couples in the sample, the two-year response of spouses' labor income to changes in male labor earnings between t and $t+1$. Conditional on their RE, male workers are grouped in twenty deciles according to their labor earnings change between t and $t+1$. The y-axis represents the average spouses' labor income changes. Studying two-year windows allows capturing changes of spousal labor supply that are not exactly contemporaneous to the head's earnings shock but that may be a delayed response to them.

Figure 8 shows that there is no apparent relation between changes in male heads and female

[11] Whenever applicable, the analysis for five-year changes is also documented in Appendix C. Even though the results presented in this section consider the whole baseline sample, the counterparts for prime-aged workers are documented in Section D.

Figure 8: Two-Year Spouse Labor Earnings Responses to Male Earnings Changes

Notes: The figure displays the average two-year change of spouse labor earnings for 20 different groups of males married workers, plotted against their one-year log change in average labor earnings. The sample comprises married male workers. Results are documented only for the bottom RE deciles (first and second), Median RE deciles (fifth and sixth), and top RE deciles (ninth and tenth).Source: German TPP.

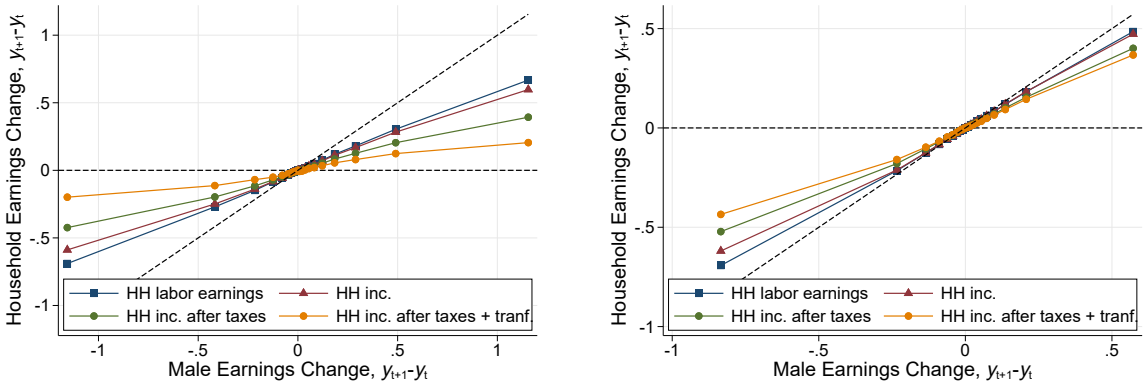
spouses earnings, indicating no evidence of an added worker effect in Germany.[12] This evidence suggests that any household insurance recorded can only be driven by income pooling at the family level rather than labor supply reactions of secondary earners, which is also in line with findings for other countries (Halvorsen et al. 2020; De Nardi et al. 2021a).

Figure 9 summarizes the roles of family and government insurance by showing the pass-through of male earnings shocks to the household level. In particular, it reports the average one-year change of household income as a response to changes in male labor earnings between t and $t+1$ for male married workers. When comparing male and household labor earnings, Figure 9 shows that there is some insurance provided by income pooling at the family level, especially for the bottom earners. For instance, for workers at the bottom, average families with a male labor income drop of about 120 log points only experience about half this change when pooling labor earnings at the household level.

Comparing total household income to income net of taxes and transfers helps shedding light on the role of the welfare system as a source of insurance against labor income risk. Figure 9 indicates that government insurance through taxes and transfers is not negligible, especially for households at the bottom of the RE distribution and against large income swings. For example, households in the first deciles of RE with a negative household income change of about 60

[12]Figure A.7 in the appendix shows that the same results also apply to contemporaneous changes in spouses' earnings.

Figure 9: Response of Household Income to Male Earnings Changes



(a) Bottom RE deciles, 1-year

(b) Top RE deciles, 1-year

Notes: The x axis shows the average one-year male earnings growth and the y-axis plots the average one-year growth of household labor earnings, gross income and income after taxes and transfers. . The sample used includes all male married workers between 25 and 55 years old from the baseline sample. Results are documented only for the bottom RE deciles (first and second) and top RE deciles (ninth and tenth). Figure A.8 in the appendix shows the results for median RE deciles. Source: German TPP.

log points experience on average a drop of only 20 log points in household disposable income. Households with top earners heads receive, as expected, less insurance from progressive taxation and transfers in case of a negative shocks (the difference between the slopes is smaller).

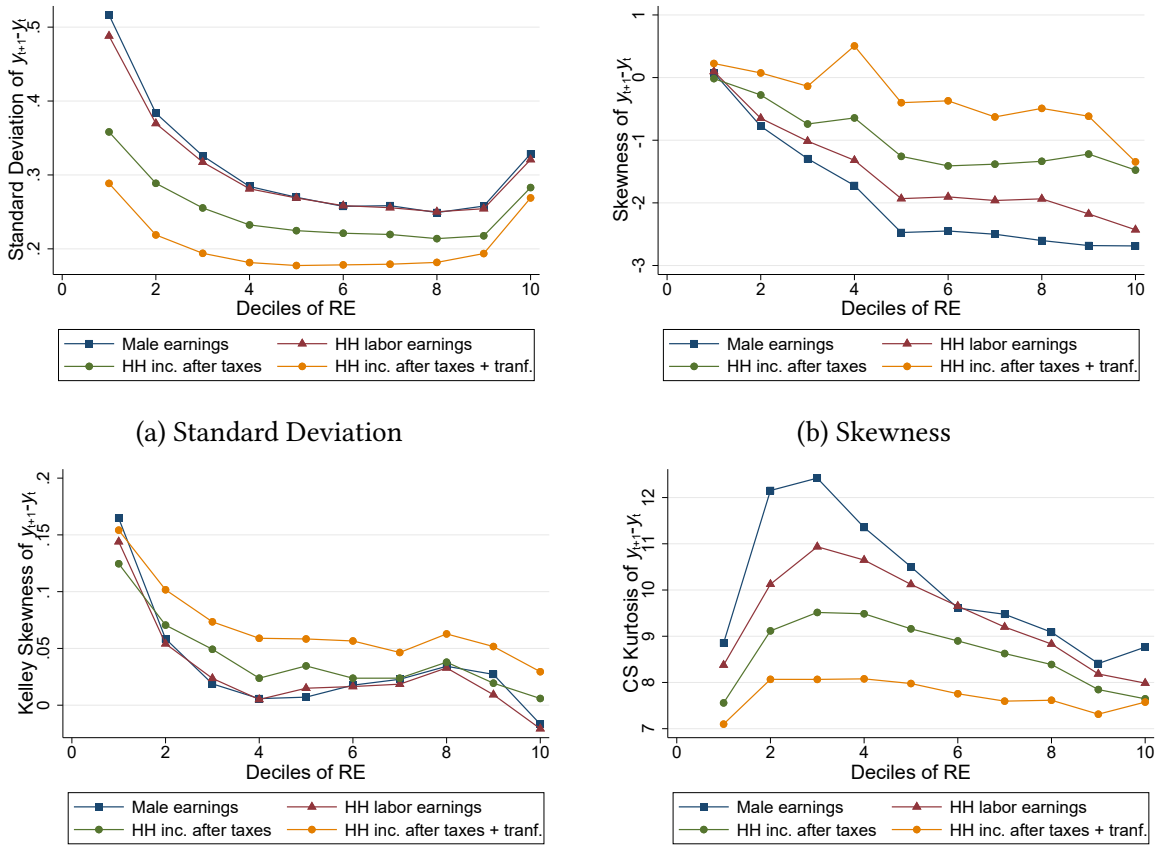
Overall, income pooling at the family level and the welfare system together provide a great source of insurance to households and can attenuate disposable income fluctuations against individual earnings swings. A household whose male experiences a very large earnings drop is, on average, insured against over 80% of the earnings loss if he is at the bottom of the distribution and almost 50% if he is a top earner.

This evidence is broadly in line with evidence from administrative datasets for other countries (De Nardi et al. 2021a; Halvorsen et al. 2020), but also from survey data for Germany (Bartels and Bönke 2013). Bartels and Bönke (2013) find that taking institutions of the welfare state and risk-sharing households into account decreases transitory and permanent variances of net household income, even though over time both have remained fairly stable.

6.2 Higher Order Moments of Household Earnings

This section investigates the role of household and government insurance in attenuating the deviations of male labor earnings changes from log normality. Following the approach described in Section 3.1, Figure 10 reports the cross-sectional moments for household labor earnings and income net of taxes and transfers. It shows that the cross-sectional moments for household earnings differ sharply from those of male earnings growth, which is in line with results for other European countries (Halvorsen et al. 2020; De Nardi et al. 2021a).

Figure 10: Cross-Sectional Moments for One-Year Household Earnings Growth



(a) Standard Deviation

(b) Skewness

(c) Kelley Skewness

(d) Crow-Siddiqui Kurtosis

Notes: Cross sectional moments of one-year growth of individual and household labor earnings, household gross and net income of married male workers. Source: German TPP.

Income pooling with spouse labor earnings helps attenuating mainly the negative skewness (driven by the tails) and the excess kurtosis of the distribution of male earnings growth (Figures 10b and 10d). However, as discussed before, this should be interpreted as a mechanical second-

earner effect.

Figure 10 also shows that taxes and transfers mitigate the risk experienced by individual earners, especially for those at the bottom half of the RE distribution. In particular, insurance through the government can attenuate the volatility, negative skewness, and excess kurtosis of income changes. For instance, at the lowest percentiles of RE, the standard deviation declines from about 0.5 before taxes and transfers to below 0.3 after considering them. The Crow-Siddiqui kurtosis at the household level falls from the peak of about 11 before taxes and transfers to 8 after. This means that, at the household level, income changes are relatively more frequent but smaller, while at the individual level changes in earnings are more infrequent but, when they happen, they are large. Even though this represents a considerable mitigation of risk, the distribution of household income after taxes and transfers is still leptokurtic and features excess kurtosis compared to a normal distribution.

Figure 10 also shows that family and household insurance are able to attenuate the presence of state dependencies. The amplitude of cross-sectional moments across RE groups is much smaller when accounting for these sources of insurance than for male earnings. Comparing Figure 10 to Figure D.6 highlights that the age dependencies are also mitigated. Therefore, even though some deviations from log-normality are still noticeable, this section makes documents that accounting for government and family insurances can attenuate their magnitude and heterogeneities with respect to income level and age.

7 Conclusion

This paper studies the nature of earnings changes in Germany and investigates the drivers of potential deviations from standard linear and symmetric models of labor income risk using a large dataset based on workers' tax records. First, it documents large deviations of earnings growth from a Gaussian distribution, namely negative skewness and excess kurtosis. The extent of these deviations depends on the income level and changes over the life-cycle.

Secondly, the drivers behind large earnings swings, which are important for the sharp non-normalities documented, differ across income groups. For the top earners, large labor income growth is solely explained by wage rate changes, while for the bottom earners, they are driven

by a mix of changes in hours and wages which is consistent with periods unemployment and job switches.

Then, this paper identifies considerably asymmetries in mean reversion patterns of earnings changes, which is not compatible with frequent modeling choices of earnings dynamics, like AR(1) processes. Positive income changes are more permanent, while negative changes are transitory for the bottom earners and more permanent for the top. These non-linearities are mainly accounted for by the dynamics of hours worked, since wage rate dynamics are close to linear.

Finally, I investigate the role of family and government insurance to mitigate individual earnings risk and attenuate deviations from log-normality. I find that the presence of a secondary earner in the household can smooth out earnings shocks. However, as the data does not provide evidence of an added worker effect, this is purely driven by income pooling. Moreover, government taxes and transfers in Germany mitigate the pass-through of large individual earnings swings to the household level. Both sources of insurance can attenuate the large deviations from log-normality of male earnings growth and its heterogeneities across income level and age groups.

Despite all the labor institutional and welfare state differences, the moments and dynamics documented for Germany are qualitatively similar to the ones documented for other countries like the Netherlands, Norway, and the United States.

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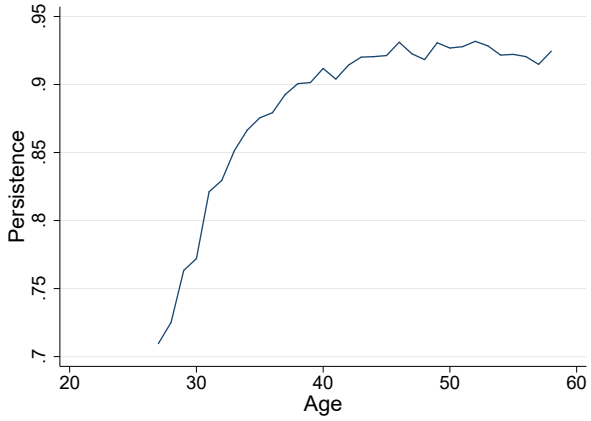
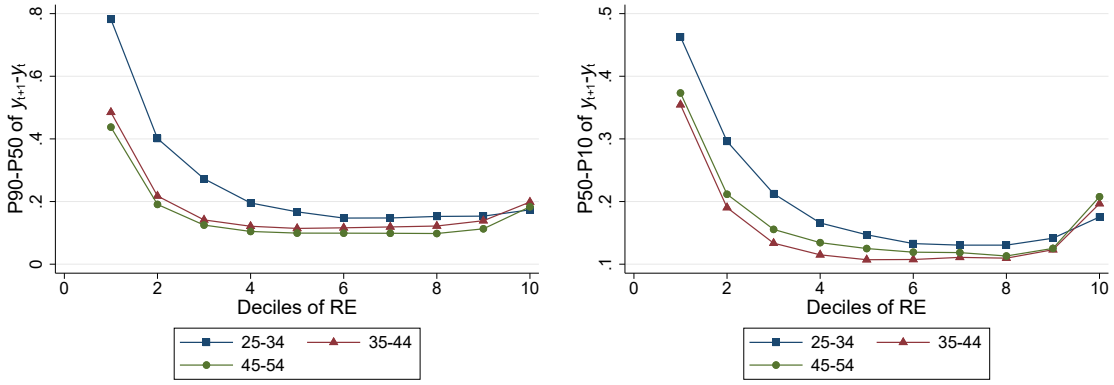
A Other Results

Figure A.1: Persistence of Earnings



Notes: Persistence of male earnings as function of age. Source: German TPP.

Figure A.2: Skewness Decomposed: P90-P50 and P50-P10



(a) P90-P50 (b) P50-P10

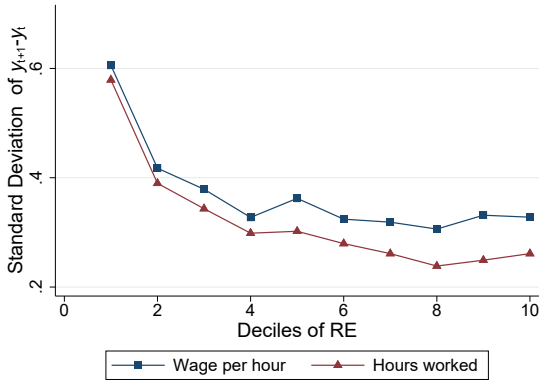
Notes: Figure A.9a plots the difference between P90-P50 for older age groups and age 25–34. Figure A.9b plots the same for P50-P10.Source: German TPP.

Table A.1: Cross-Sectional Moments of One-Year Earnings, Wage, and Hours Growth

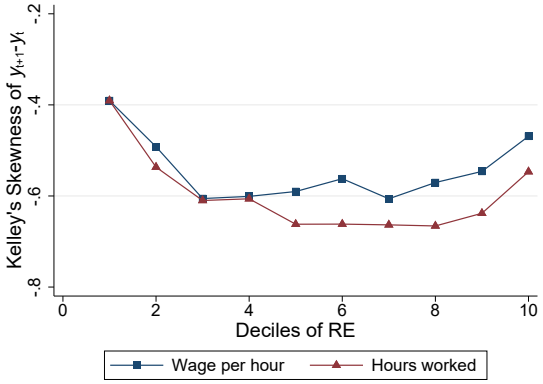
	All			25-34			35-54		
	earnings	wage	hours	earnings	wage	hours	earnings	wage	hours
Variance	0.35	0.37	0.32	0.36	0.37	0.33	0.33	0.34	0.29
Kelley Skewness	-0.56	-0.54	-0.60	-0.34	-0.36	-0.44	-0.52	-0.50	-0.57
CS Kurtosis	7.84	6.69	10.80	6.69	5.92	9.05	8.14	6.96	11.28

Notes: The figure plots the empirical densities of one- and five-year labor earnings change superimposed on Gaussian densities with the same standard deviation. Data is from SOEP and only male workers between 25 and 54 years of age are used. Wages are obtained by dividing annual labor earnings of male heads of households by their annual hours worked. Source: German SOEP.

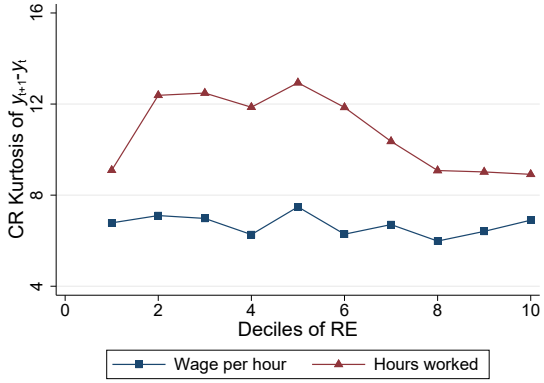
Figure A.3: Cross-Sectional Moments for One-Year Hours and Wage Growth



(a) Standard Deviation



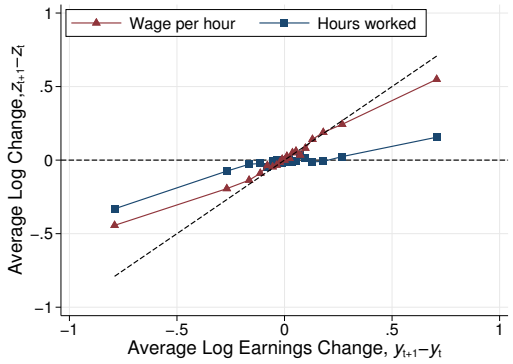
(b) Kelley Skewness



(c) Crow-Siddiqui Kurtosis

Notes: Cross-sectional moments of one-year growth in annual hours worked and hourly wage of male workers in the baseline sample. Source: German SOEP.

Figure A.4: Contribution of Hours and Wages to Earnings Changes, median RE deciles



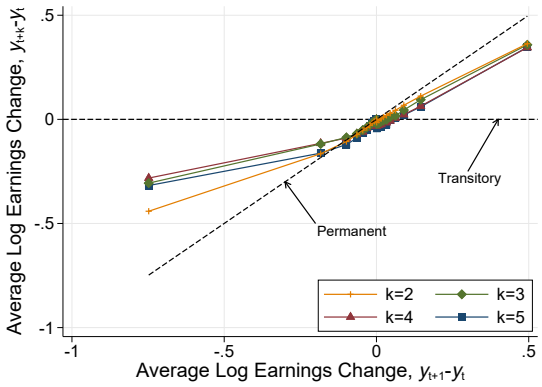
Notes: The figure displays the one-year average log change of annual hours and hourly wage for 20 different groups of male workers in the median (5th and 6th) RE deciles, plotted against their contemporaneous one-year average log change in annual labor earnings. Source: German SOEP.

Table A.2: Important Life Cycle Events Associated with Earnings Changes

	One-Year Earnings Change, $\Delta y \in$					
	< -1	$[-1, -0.25)$	$[-0.25, 0)$	$[0, 0.25]$	$(0.25, 1]$	> 1
Short-time work	5.41	13.88	4.22	3.07	4.03	2.77
Unemployment	64.94	45.22	7.04	7.02	39.72	50.67
Short-term allowances	6.03	19.29	6.71	6.36	8.31	4.18
Social assistance allowances	53.67	37.75	8.13	7.32	33.52	43.13
Handicapped	6.11	4.50	2.18	0.68	0.60	0.69
Change no. children	3.69	4.57	4.29			
# Obs	112850	421666	1931401	1996966	491727	78618

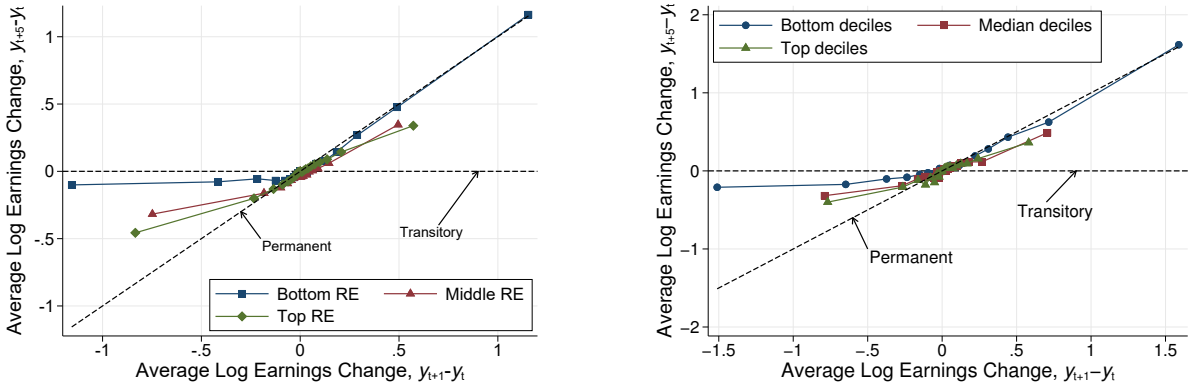
Notes: The table sorts individuals into six groups according to the size of their earnings change from t to $t+1$ and documents the share of workers who contemporaneously experience certain life events. Short-time work (*Kurzarbeiter*) and unemployment account for the households who get in or out of these status for negative and positive income changes respectively. These are documented only until 2005. Short-term allowances include short-time work allowances/subsidies (*Kurzarbeitergeld*/*Zuschuss*), maternity benefits (*Mutterschaftsgeld*) and top-up amounts under the partial retirement law (*Aufstockungsbeträge nach dem Altersteilzeitgesetz*). Social assistance allowances account for unemployment (*Arbeitslosengeld*), sickness (*Krankengeld*), maternity (*Mutterschaftsgeld*), and parental (*Elterngeld*) benefits. Handicapped documents the share of workers who experience an increase or decrease in the handicapped allowance contemporaneously to a decrease or increase in the labor earnings, respectively. Change in the number of children accounts for workers whose number of children increased contemporaneously to the income change. Source: German Taxpayer Panel (DOI 10.21242 / 73111.2014.00.01.1.1.0), own calculations.

Figure A.5: Persistence of labor Earnings Changes, median RE deciles



Notes: The figure displays the k-year average log change of annual labor earnings for 20 different groups of male workers in the median (5th and 6th) RE deciles, plotted against their contemporaneous one-year average log change in annual labor earnings.Source: German TPP.

Figure A.6: Persistence of Labor Earnings Changes, TPP and SOEP



(a) TPP (b) SOEP

Notes: The figure displays the five-year average change in labor earnings for 20 different groups of males workers in the bottom (1^{st} and 2^{nd}), median (5^{th} and 6^{th}) and top (9^{th} and 10^{th}) RE deciles, plotted against their respective one-year average change. Sources: German Taxpayer Panel (DOI 10.21242 / 73111.2014.00.01.1.1.0) and German SOEP (DOI: 10.5684/soep.v34), own calculations.

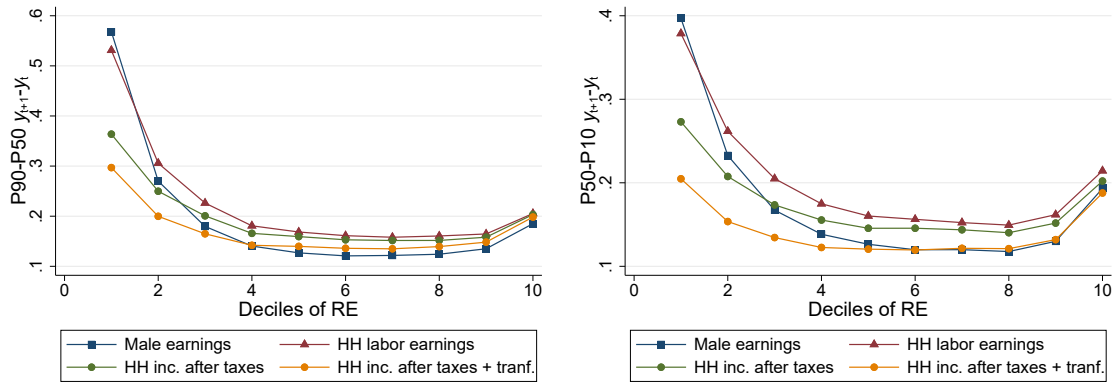
Figure A.7: One-Year Spouse Labor Earnings Responses to Male Earnings Shocks

Notes: The figure displays the average one-year change of spouse labor earnings for 20 different groups of males married workers, plotted against their one-year log change in average labor earnings. The sample comprises married male workers. Results are documented only for the bottom RE deciles (first and second), Median RE deciles (fifth and sixth), and top RE deciles (ninth and tenth).Source: German TPP.

Figure A.8: One-Year Growth of Household Labor Earnings, Gross and Net Income, Median RE Deciles

Notes: The x axis shows the average one-year male earnings growth and the y-axis plots the average one-year growth of household labor earnings, gross and net income. The sample comprises married male workers. Results are documented only for the median RE deciles (fifth and sixth) RE deciles. The sample used includes all male married workers between 25 and 55 years old from the baseline sample.Source: German TPP.

Figure A.9: Skewness Decomposed for Household Labor Earnings, Gross and Net Income



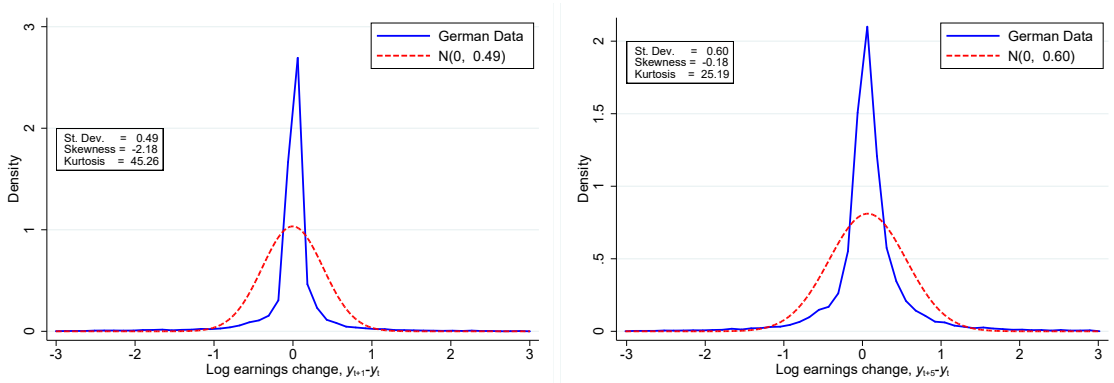
(a) P90-P50 (b) P50-P10

Notes: Figure A.9a plots the difference between P90-P50 for older age groups and age 25–34. Figure A.9b plots the same for P50-P10.Source: German TPP.

B Results for Female Workers

Similarly to men, Figure B.1 shows that the distributions of one- and five-year female earnings changes also comprise strong deviations from log-normality. Then, Figure B.2 presents the persistence and higher-order moments of these distributions over the life-cycle and earnings distribution. Regarding the standard deviation, Figure B.2b shows that, for women above 35, the distribution of earnings growth is both qualitatively and quantitatively quite similar to those of men. However, earnings changes for young females are significantly more volatile than of young males, which is likely explained by the role of maternity, leaves of absence and part-time work (as will be discussed in Section 4.2). Figure B.2c displays the negative skewness of the earnings growth distribution for females. Relative to males, there are more differences over the life cycle and along the RE groups, however, when accounting for possible outliers, the distribution is close to symmetric (Figure B.2d). For most RE deciles, the kurtosis of earnings growth is lower for young females than for young males, but higher for older females than older males (Figure B.2e). Thus, the distribution of female earnings growth also displays strong deviations from normality but differences over the life-cycle are even more pronounced than for males.

Figure B.1: Histograms of One- and Five-Year Log Earnings Change of females

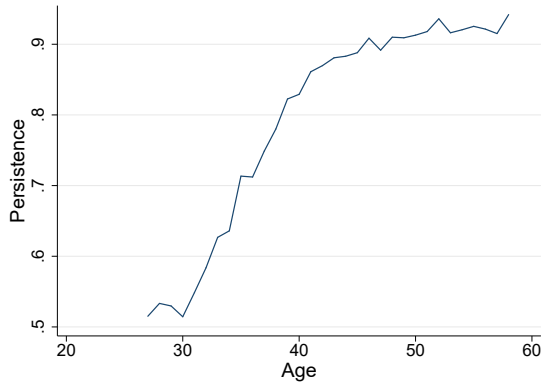


(a) 1-Year earnings growth

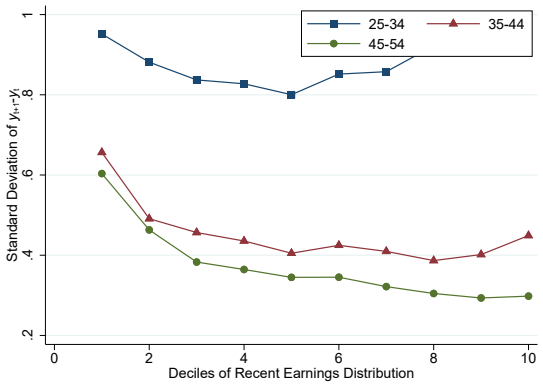
(b) 5-Year earnings growth

Notes: The figure plots the empirical densities of one- and five-year labor earnings change superimposed on Gaussian densities with the same standard deviation. Data is from TPP and only female workers between 25 and 60 years of age are used.Source: German TPP.

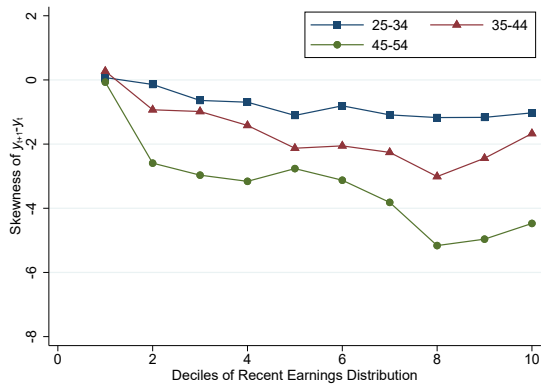
Figure B.2: Persistence and Cross-Sectional Moments for One-Year Earnings Growth



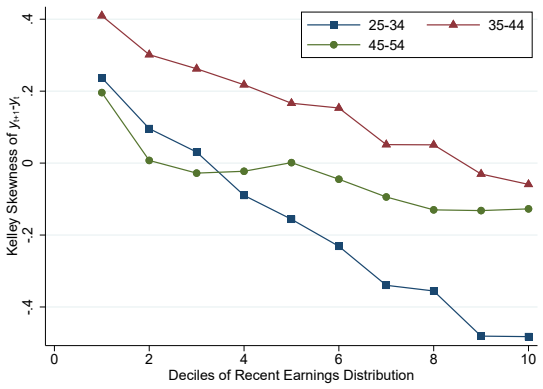
(a) Persistence



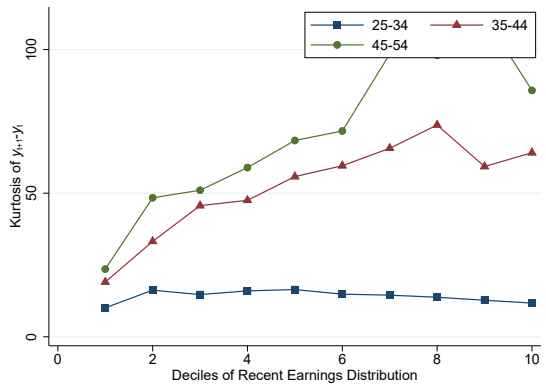
(b) Standard Deviation



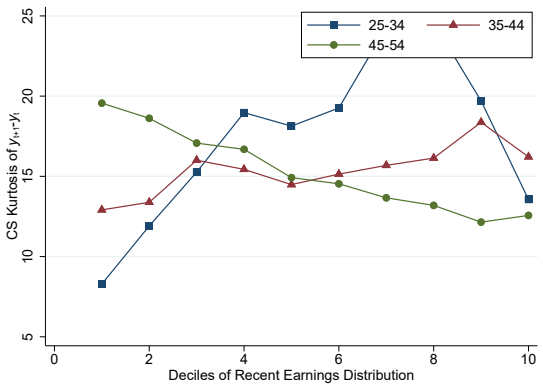
(c) Skewness



(d) Kelley Skewness



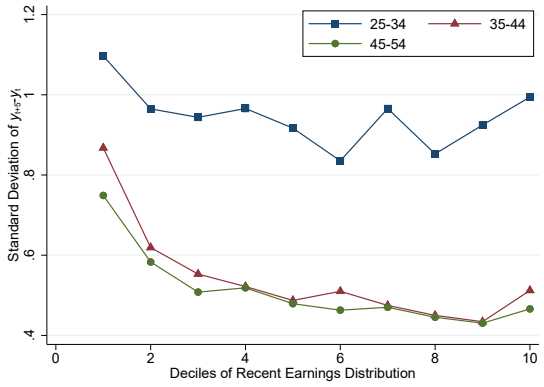
(e) Kurtosis



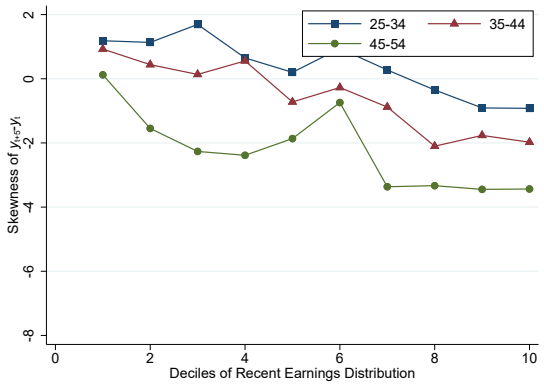
(f) Crow-Siddiqui Kurtosis

Notes: Cross-sectional moments of one-year labor earnings growth of female workers over the life-cycle.Source: German TPP.

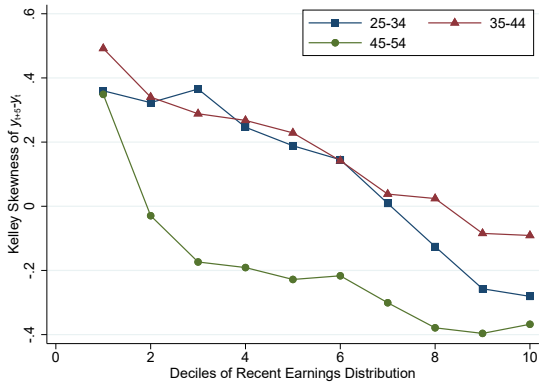
Figure B.3: Cross-Sectional Moments for Five-Year Earnings Growth



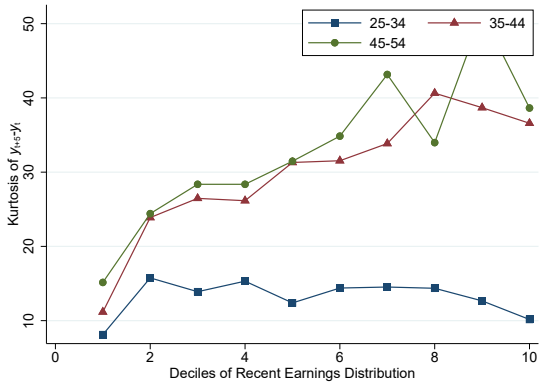
(a) Standard Deviation



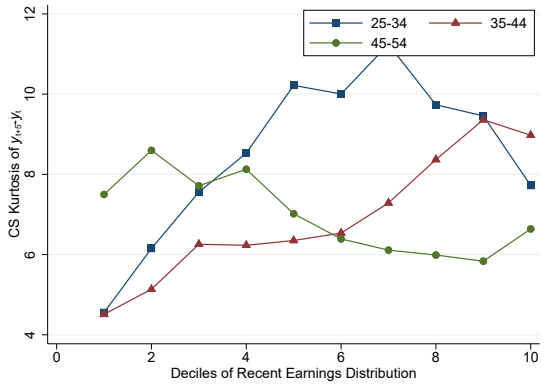
(b) Skewness



(c) Kelley Skewness



(d) Kurtosis



(e) Crow-Siddiqui Kurtosis

Notes: Cross-sectional moments of one-year labor earnings growth of female workers over the life-cycle.Source: German TPP.

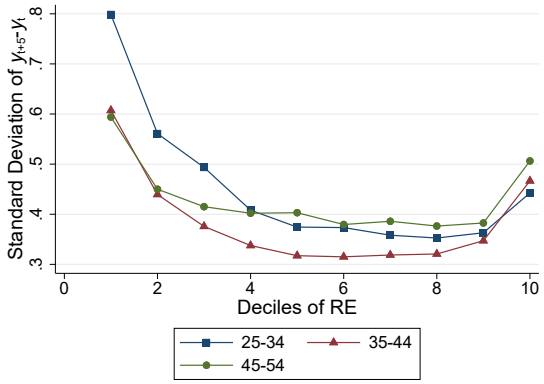
Table B.1: Labor Earnings Shocks and Life Events for Female Workers

	1-Year Negative Change, $\Delta y \in$				1-Year Positive Change, $\Delta y \in$		
	< -1	$[-1, -0.25)$	$[-0.25, 0)$		> 1	$(0.25, 1]$	$[0, 0.25]$
Into non-employment	23.22	15.98	3.44	Into full-time			
Into unemployment	6.42	5.73	1.26	from not full-time	12.58	8.19	3.11
Into regular part-time	2.94	5.37	2.90	from regular part-time	5.07	5.88	2.67
Changed job	23.93	16.97	6.499	Into full- or regular part-time			
Involuntary change	10.37	9.06	2.40	from not working	9.64	3.17	0.62
Due to parental leave	6.19	4.05	0.70	form unemployed	2.39	1.17	0.23
Change no. of children	16.14	10.20	1.74	Changed job	22.22	12.92	5.49
In maternity leave	13.47	6.27	1.07	Involuntary change	5.88	4.58	1.75
Lost second job	5.50	7.00	3.52	Out of maternity leave	3.19	1.85	1.36
Into disability	1.80	1.90	1.10	Extra job	7.00	6.96	3.19
				Out of disability	0.34	0.47	0.56
Share (%)	3.98	10.88	32.83	Share (%)	3.38	12.09	36.84
$\mathbb{E}\,\Delta^1_{log} y^i_t$	-1.63	-0.51	-0.07	$\mathbb{E}\,\Delta^1_{log} y^i_t$	1.57	0.50	0.08
$\mathbb{E}\,\Delta^1_{log} w^i_t$	-1.63	-0.51	-0.07	$\mathbb{E}\,\Delta^1_{log} w^i_t$	0.88	0.33	0.07
$\mathbb{E}\,\Delta^1_{log} h^i_t$	-0.90	-0.21	-0.01	$\mathbb{E}\,\Delta^1_{log} h^i_t$	0.68	0.17	0.01
$\mathbb{E}\,\Delta^5_{log} y^i_t$	-0.45	-0.17	-0.06	$\mathbb{E}\,\Delta^5_{log} y^i_t$	1.40	0.41	0.05
$\mathbb{E}\,\Delta^5_{log} w^i_t$	-0.35	-0.12	-0.01	$\mathbb{E}\,\Delta^5_{log} w^i_t$	0.69	0.24	0.07
$\mathbb{E}\,\Delta^5_{log} h^i_t$	-0.10	-0.04	-0.04	$\mathbb{E}\,\Delta^5_{log} h^i_t$	0.71	0.17	-0.01

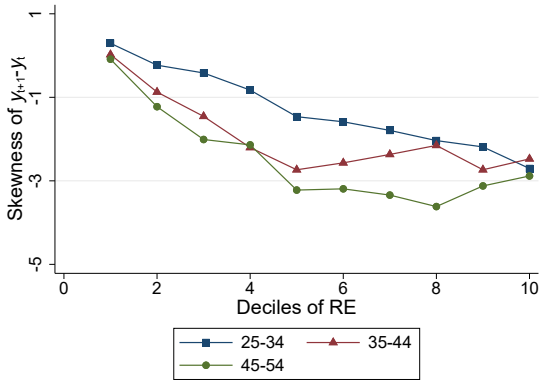
Notes: Part-time worker accounts only for regular part-time employment. Individuals are considered unemployed if are not working and are registered unemployed and excluded those who are not working but sometimes have a second job, were working past the 7 days, or have a regular second job. Individuals are considered not employed if they are not full- or part-time employed or attending vocational training. I consider a forced job change in the following cases: the employment link was terminated by the employer, a temporary contract expired, the education or training was completed, the company transfers the employee, the company closed down. The option of job change due to maternity/parental leave is only asked in some waves of the survey (from 1991 to 1998 and since 2011). Source: German SOEP.

C Results for Five-Year Income Changes

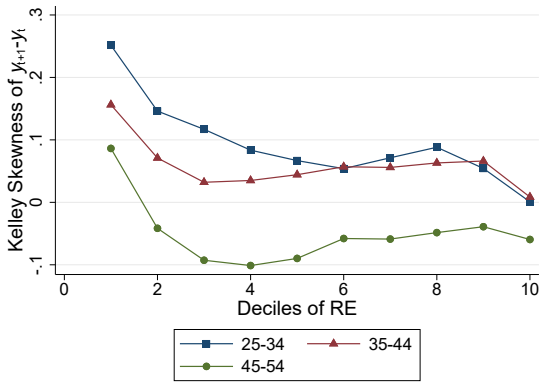
Figure C.1: Cross-Sectional Moments for Five-Year Earnings Growth



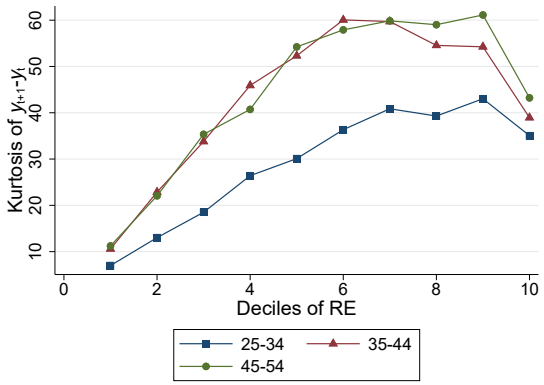
(a) Standard Deviation



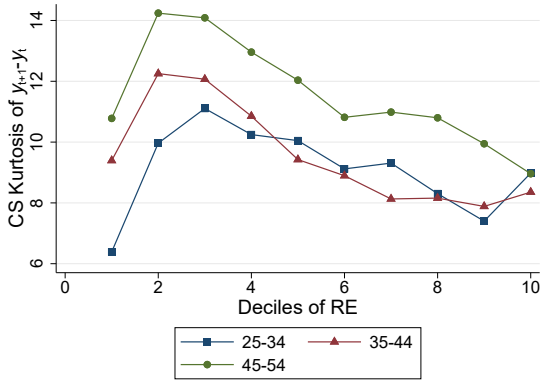
(b) Skewness



(c) Kelley Skewness



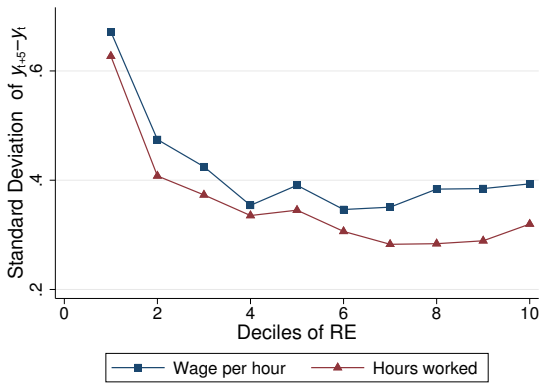
(d) Kurtosis



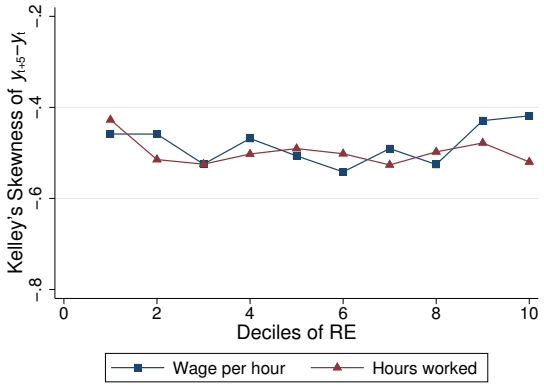
(e) Crow-Siddiqui Kurtosis

Notes: Cross sectional moments of five-year labor earnings growth of male workers over the life-cycle.Source: German TPP.

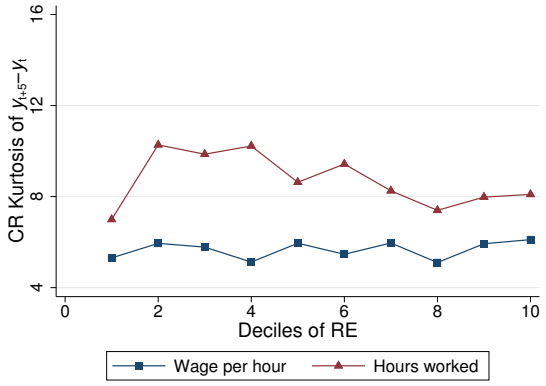
Figure C.2: Cross-Sectional Moments for Five-Year Hours and Wage Growth



(a) Variance



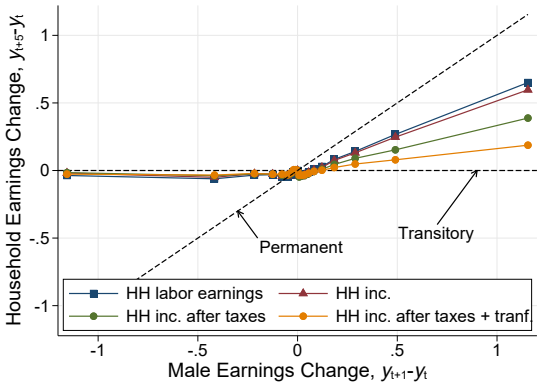
(b) Kelley Skewness



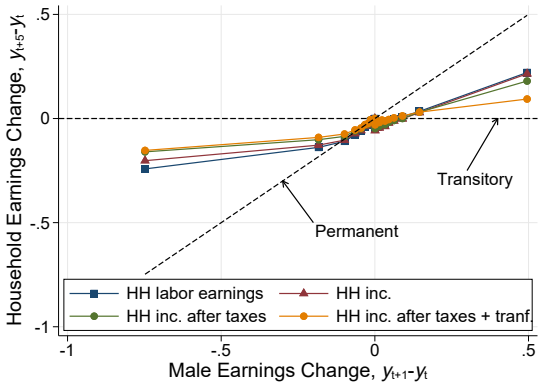
(c) Crow-Siddiqui Kurtosis

Notes: Cross sectional moments of five-year growth in annual hours worked and hourly wage of male workers. Source: German SOEP.

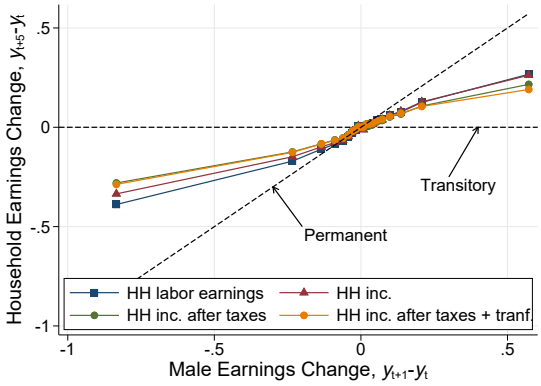
Figure C.3: Five-year growth of Household Income



(a) Bottom RE deciles, 5-year



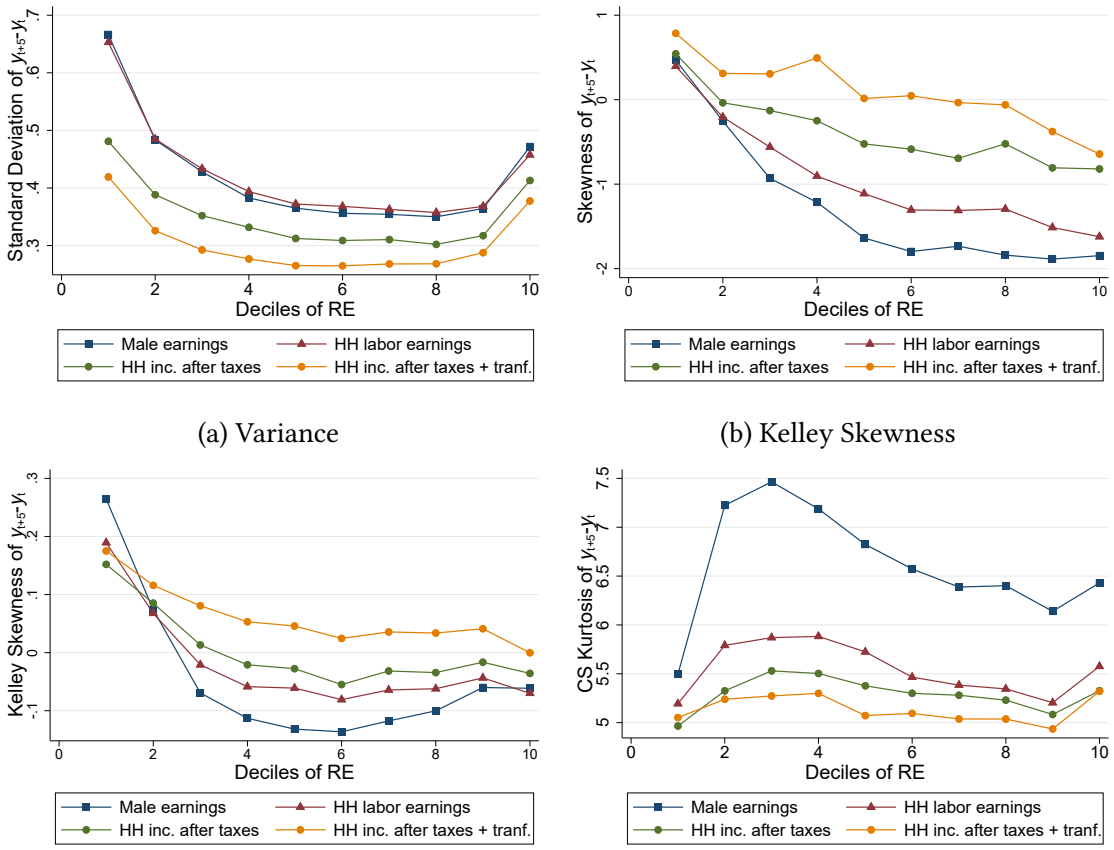
(b) Median RE deciles, 5-year



(c) Top RE deciles, 5-year

Notes: The x axis shows the average one-year male earnings growth and the y-axis plots the average five-year growth of household labor earnings, gross and net income. The sample comprises married male workers. Results are documented only for the bottom RE deciles (first and second), Median RE deciles (fifth and sixth), and top RE deciles (ninth and tenth). The sample used includes all male married workers between 25 and 55 years old from the baseline sample.Source: German TPP.

Figure C.4: Cross-Sectional Moments for Five-Year Household Income Growth



(a) Variance

(b) Kelley Skewness

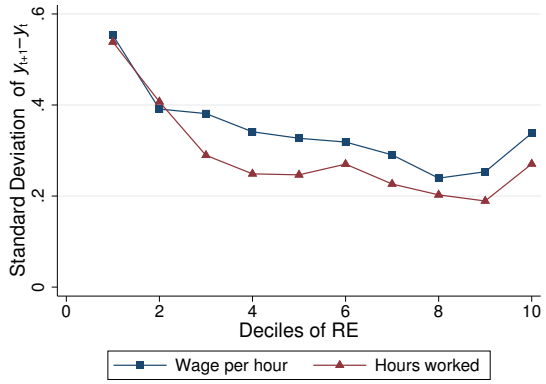
(c) Kelley Skewness

(d) Crow-Siddiqui Kurtosis

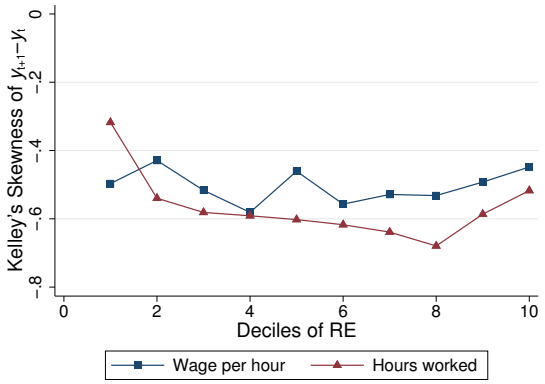
Notes: Cross sectional moments of five-year growth of individual and household labor earnings, household gross and net income of married male workers. Source: German Taxpayer Panel (DOI 10.21242 / 73111.2014.00.01.1.1.0), own calculations

D Results for Prime-age Workers

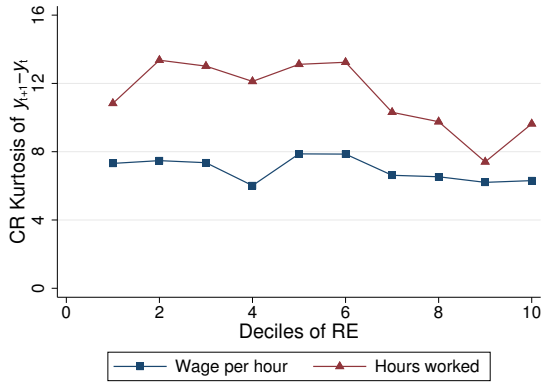
Figure D.1: Cross-Sectional Moments of Hours and Wage Growth



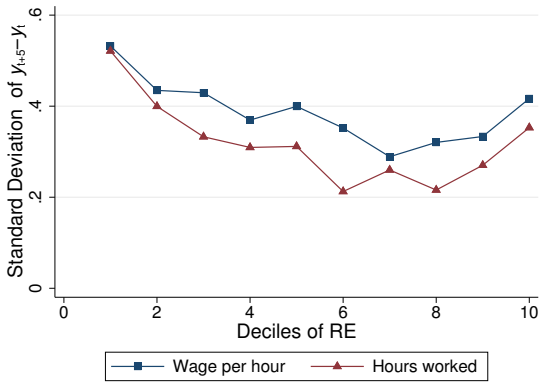
(a) Variance, 1-year growth



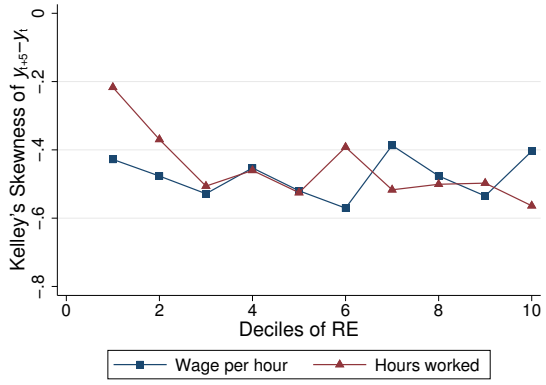
(b) Skewness, 1-year growth



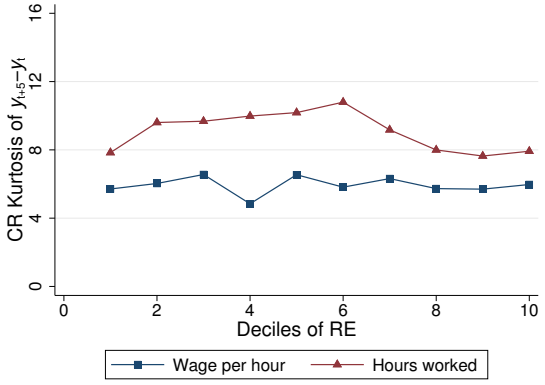
(c) Kurtosis, 1-year growth



(d) Variance, 5-year growth



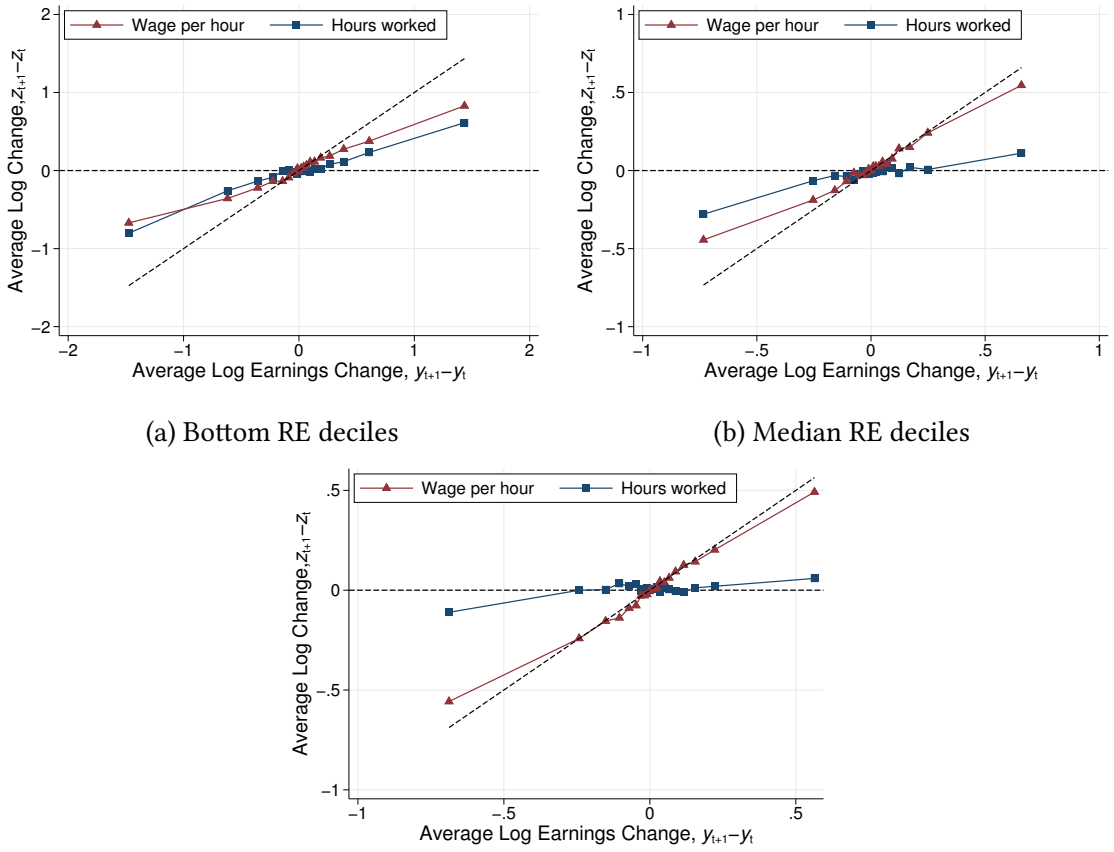
(e) Skewness, 5-year growth



(f) Kurtosis, 5-year growth

Notes: Cross sectional moments of one- and five-year growth in annual hours worked and hourly wage of male workers between 35 and 54 years old. Source: German SOEP.

Figure D.2: Contribution of Hours and Wages



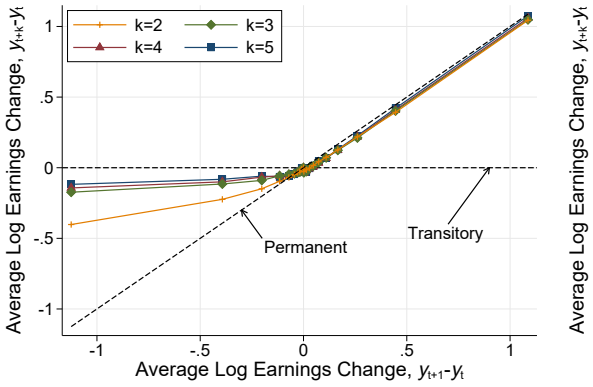
(a) Bottom RE deciles

(b) Median RE deciles

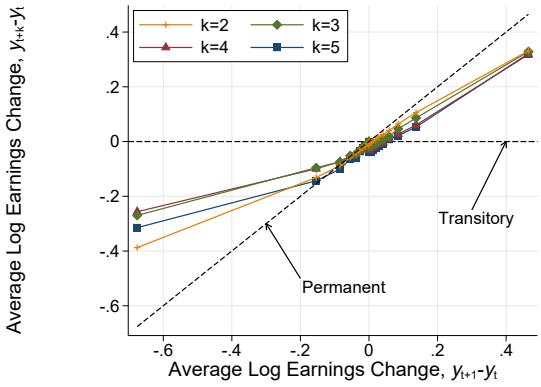
(c) Top RE deciles

Notes: The figure displays the one-year average log change of annual hours and hourly wage for 20 different groupsof male workers between 35 and 54 years old in the bottom (1^{st} and 2^{nd}), median (5^{th} and 6^{th}) and top (9^{th} and 10^{th}) RE deciles, plotted against their contemporaneous one-year average log change in annual labor earnings. Source: German SOEP.

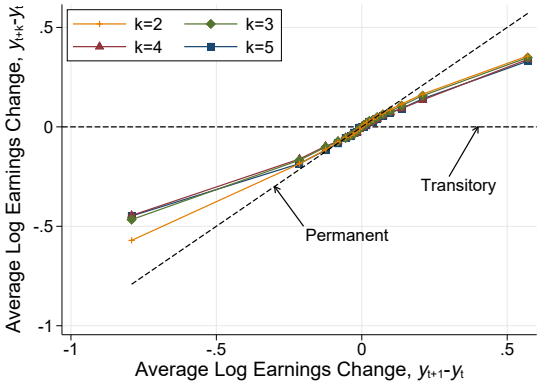
Figure D.3: Persistence of labor Earnings Changes by RE Decile



(a) Bottom RE deciles



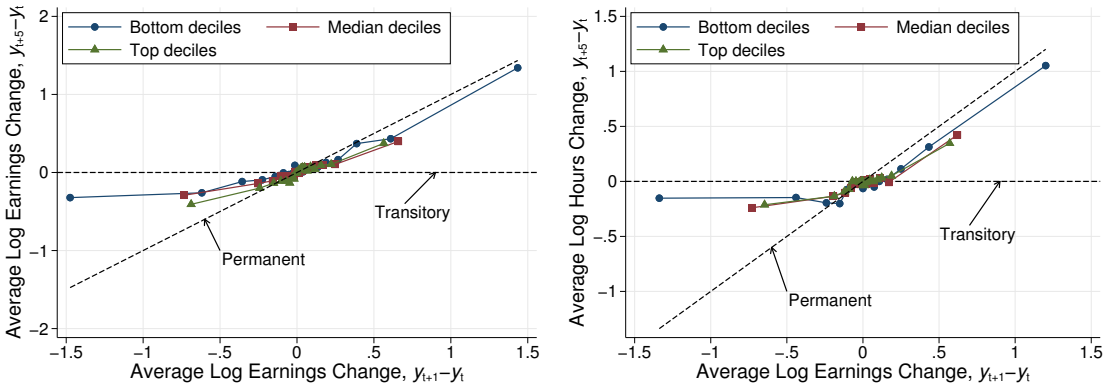
(b) Median RE deciles



(c) Top RE deciles

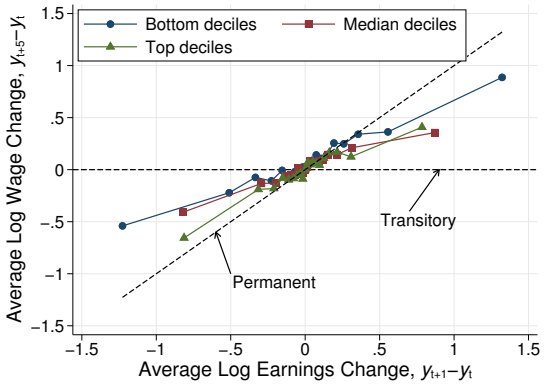
Notes: The figure displays the k-year average log change of annual labor earnings for 20 different groups of male workers in the bottom (1^{st} and 2^{nd}), median (5^{th} and 6^{th}) and top (9^{th} and 10^{th}) RE deciles, plotted against their contemporaneous one-year average log change in annual labor earnings.Source: German TPP.

Figure D.4: Persistence of Hours and Wages Changes



(a) Earnings

(b) Hours



(c) Wages

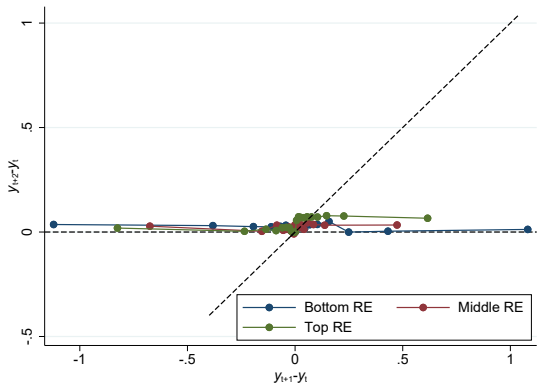
Notes: The figure displays the five-year average change in hours and wages for 20 different groups of males workers in the bottom (1^{st} and 2^{nd}), median (5^{th} and 6^{th}) and top (9^{th} and 10^{th}) RE deciles, plotted against their respective one-year average change. Source: German SOEP.

Table D.1: Labor Earnings Shocks and Life Events for Prime-aged Male Workers

	1-Year Negative Change, $\Delta y \in$				1-Year Positive Change, $\Delta y \in$		
	< -1	$[-1, -0.25)$	$[-0.25, 0)$		> 1	$(0.25, 1]$	$[0, 0.25]$
Into non-employment	21.46	10.24	1.44	Into Full-time			
into unemployment	16.66	7.68	0.98	from not full-time	17.80	4.97	1.02
Into regular part-time	1.98	1.70	0.51	from regular part-time	4.67	1.42	0.45
Changed job	28.02	14.25	5.24	Into full- or regular part-time			
involuntary change	16.85	11.49	2.37	form not working	9.96	3.12	0.53
due to parental leave	0.36	0.23	0.08	from unemployment	5.75	2.23	0.38
Change no. of children	2.87	2.66	2.55	Changed job	21.39	11.62	4.78
Lost second job	3.69	3.70	2.92	involuntary change	9.35	6.45	1.79
Into disability	4.45	2.07	1.10	Extra job	3.29	3.99	2.75
				Out of disability	0.63	0.82	0.49
Share (%)	1.65	8.05	37.04	Share (%)	1.22	8.80	43.24
$\mathbb{E}\,\Delta^1_{log} y^i_t$	-1.65	-0.46	-0.07	$\mathbb{E}\,\Delta^1_{log} y^i_t$	1.64	0.45	0.08
$\mathbb{E}\,\Delta^1_{log} w^i_t$	-0.81	-0.35	-0.07	$\mathbb{E}\,\Delta^1_{log} w^i_t$	1.03	0.35	0.07
$\mathbb{E}\,\Delta^1_{log} h^i_t$	-0.83	-0.11	-0.01	$\mathbb{E}\,\Delta^1_{log} h^i_t$	0.61	0.10	0.01
$\mathbb{E}\,\Delta^5_{log} y^i_t$	-.39	-0.23	-0.05	$\mathbb{E}\,\Delta^5_{log} y^i_t$	1.49	0.29	0.06
$\mathbb{E}\,\Delta^5_{log} w^i_t$	-0.30	-0.19	-0.01	$\mathbb{E}\,\Delta^5_{log} w^i_t$	0.89	0.26	0.08
$\mathbb{E}\,\Delta^5_{log} h^i_t$	-0.08	-0.04	-0.04	$\mathbb{E}\,\Delta^5_{log} h^i_t$	0.62	0.04	-0.02

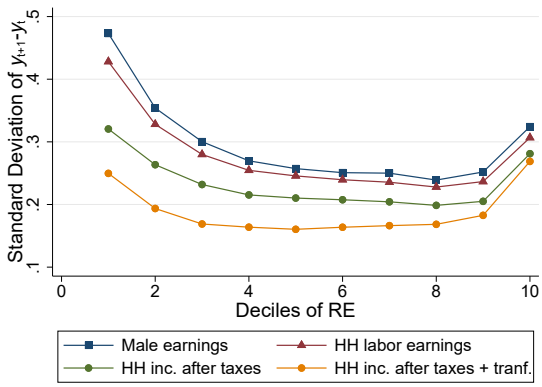
Notes: Part-time worker accounts only for regular part-time employment. Individuals are considered unemployed if are not working and are registered unemployed and excluded those who are not working but sometimes have a second job, were working past the 7 days, or have a regular second job. Individuals are considered not employed if they are not full- or part-time employed or attending vocational training. I consider a forced job change in the following cases: the employment link was terminated by the employer, a temporary contract expired, the education or training was completed, the company transfers the employee, the company closed down. The option of job change due to maternity/parental leave is only asked in some waves of the survey (from 1991 to 1998 and since 2011). Source: German SOEP.

Figure D.5: Two-year Growth of Spouses' labor Earnings

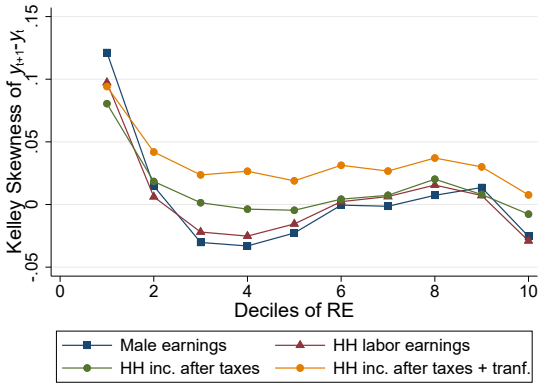


Notes: The x axis shows the average one-year male earnings growth and the y-axis plots the average two-year growth of spouses earnings. The sample used includes all male married workers between 35 and 54 years old from the baseline sample. *Source:* German TPP.

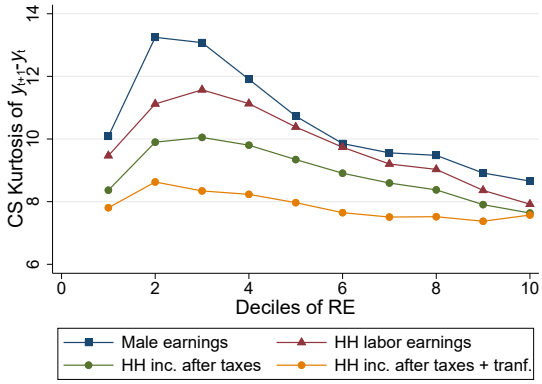
Figure D.6: Cross-Sectional Moments of Household Income Growth



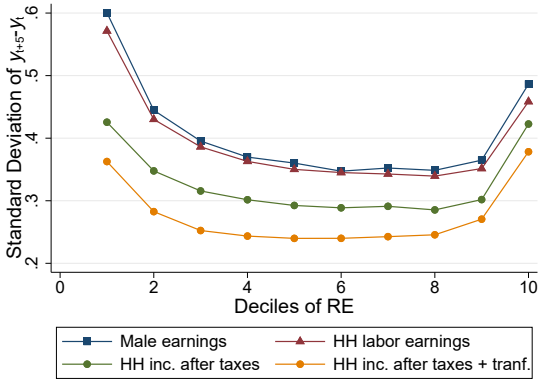
(a) Standard Deviation, 1-year



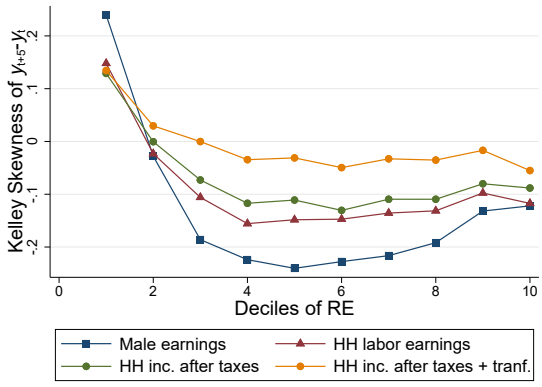
(b) Kelley Skewness, 1-year



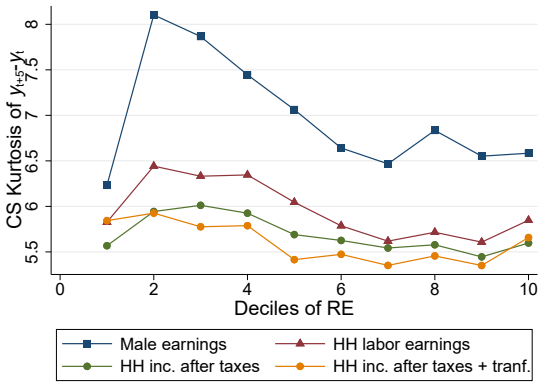
(c) Crow-Siddiqui Kurtosis, 1-year



(d) Standard Deviation, 5-year



(e) Kelley Skewness, 5-year



(f) Crow-Siddiqui Kurtosis, 5-year

Notes: Cross sectional moments of one- and five-year growth of individual and household labor earnings, household gross and net income of married prime-aged male workers. Source: German TPP.