Lifecycle Earnings Risk and Insurance: New Evidence from Australia*

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November 2021

Abstract

We study the nature of lifecycle earnings dynamics by documenting higher-order moments of earnings shocks over the lifecycle, using the Household, Income and Labour Dynamics in Australia (HILDA) surveys 2001-2018. Similar to other countries (e.g. see Guvenen et al. (2021) and De Nardi et al. (2021)), the distribution of earnings shocks in Australia displays negative skewness and excess kurtosis, deviating from the conventional linearity and normality assumptions. However, the sources of fluctuations and the role of family and government insurance are quite different. Wages account more for dispersion of earnings shocks (second-order risk), while hours drive negative skewness and excess kurtosis of earnings shocks (the third- and fourth–order risks, respectively). Wage changes are strongly associated with earnings changes, whereas hour changes are largely absent in upward movement and relatively small in downward movement in earnings changes. Family insurance via income pooling within family and government insurance embedded in the progressive tax and transfer system have relatively different roles in reducing the variability of risk over age and by income group. Government transfer is more important in reducing the dispersion of earning shocks; meanwhile, family transfer is more dominant in mitigating the magnitude and likelihood of large and rare earnings shocks. Family insurance interacts with government insurance; however, their joint forces fail to eliminate a long and fat tail on the left side of the distribution. Hence, our results reveal new insights into complexity of earnings dynamics and importance of family and government insurance.

JEL: E24, H24, H31, J31.

Keywords: Income dynamics; Earnings risk; Higher-order moments; Non-Gaussian shocks; Family insurance; Government insurance; Inequality.

*We appreciate comments from Robert Breunig, Timo Henckel, Timothy Kam and the participants of A-LIFE Conference and seminars at Australian National University.

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1 Introduction

Understanding the nature of earnings risk is crucial for better understanding income dynamics, trends in income equality as well as the insurance role of a redistributive tax and transfer system. There is a growing literature that takes advantage of administrative and household datasets, and new statistical techniques to explore the rich dynamics of income process over the life cycle. Recent developments, including Guvenen et al. (2021), Arellano, Blundell and Bonhomme (2017) and De Nardi et al. (2021) have identified non-Gaussian features of the residual income fluctuations. These studies in particular have documented that the persistence of innovations is not uniform but exhibits systematic asymmetries, and that the distribution of innovations to income displays strong (left) negative skewness and (leptokurtic) excess kurtosis than normally distributed shocks.

In a similar vein, our paper is the first to comprehensively examine the distribution of earnings risk that Australians face over the life cycle, using nonparametric methods from Guvenen et al. (2021) and De Nardi et al. (2021). We use microdata from the Household, Income and Labour Dynamics in Australia Survey (HILDA) release 18 (2001-2018), which is a nationally representative panel data of Australian households on a wide range of subjects pertaining to family and labour market dynamics. Our results reveal that the rich dynamics of income process documented for other countries also applies for Australia. However, there are significant differences in the sources of fluctuations and the insurance role of family and government.

Specifically, we begin by calculating higher-order moments of earnings shocks, including variance, skewness and kurtosis for primary earners of Australian households.[1] We uncover rich dynamics of the income shock process that exhibits strong non-linear and non-Gaussian features across income levels and household characteristics. The volatility is most pronounced at the lower income deciles, especially for older cohorts. Those in the upper deciles experience a relatively high dispersion, albeit several times lower than that of the former group. Indeed, there are significant differences in variance and persistence of earnings by age and income history. Moreover, the distribution of earnings risk is negatively skewed and leptokurtic, and the degrees of skewness and kurtosis vary by age and past income. In more colloquial terms, the negative skewness means extreme negative earnings shocks are more severe compared to positive ones. The large excess kurtosis (leptokurtic) implies that most shocks are densely concentrated at the centre (high peakedness) and the tails (thick tails) of distribution. That is, breadwinners seldom encounter any large change to their earnings, but for those who do, the probability of experiencing these extreme changes is higher than otherwise suggested by the standard Gaussian distribution.

Next, we disentangle the moments of earnings changes into those of wage and work hour changes to identify the sources behind the detected non-normalities and non-linearities. Our findings broadly indicate that wage changes mainly account for the dispersion of earnings changes (second-order risk). Meanwhile, changes in hours induce the negative skewness and the excess kurtosis (third and fourth-order risks). Restricting the sample to workers with consistent employment history does not alter the result. In addition, we observe asymmetry between the compositions of negative and positive earnings changes. Barring those in the bottom

[1] Note that, the terms *shocks* and *changes* are used interchangeably. We use primary (male or female) earner as a measurement unit since a sizeable proportion (30%) of household heads in the HILDA data is female.

decile, earnings changes are associated with substantial wage movement. In contrast, the role of hours is limited and only contributes, by a lesser degree, to negative earnings changes. This asymmetry is likely driven by: (i) the means-tested government transfers targeting low income households (particularly, parents of dependent children), and (ii) the institutional structure in Australia including the National Minimum Wage Law and National Employment Standards, both of which may have influenced the labor market decisions and activities of households and firms.

Last, we examine the extent to which lifecycle earnings risk is mitigated by implicit and explicit forms of insurance arrangement. There are two dominant sources of insurance: *within family responses (the added worker effect),* i.e. family market income insurance, and *net public transfers,* i.e. government transfer insurance. To measure the quantitative importance of family and government insurance, we compare distributional properties of income changes at various levels. Technically, the differences between moment statistics of the distributions of individual regular market income changes and family pre-government income changes capture the insurance components related to family market earnings and family private transfers. Analogously, the differences between those of family pre- and post-government income changes imply the role of government insurance provided via the tax and transfer system.[2]

In our framework, insurance has two primary roles: (i) as a mitigator of the variation of shocks or the second-order risk, and (ii) as a mitigator of the magnitude and probability of shocks at the extreme which are the third- and fourth-order risks corresponding to skewness and kurtosis of the distribution of income changes, respectively. In terms of insurance against the second-order risk, family market income insurance is limited to primary earners at the bottom decile of past income, whereas government insurance is relatively larger and more robust across a wide range of specifications, especially for lone parents. In terms of insurance against the third and fourth-order risks, it appears that family insurance plays a more dominant role. Overall, family market income and government transfer are vital sources of insurance against lifecycle earnings risks in Australia. However, they are not capable of providing full insurance to completely eliminate the non-Gaussian elements from the household disposable income dynamics.

As an extension, we further investigate how lifecycle earnings risk is affected by demographic characteristics. We mainly focus on three demographic attributes: *gender*, *marital* and *parental status*. Our results indicate the distribution of earnings shocks still displays negative skewness and excess kurtosis even after taking into account these demographic factors. There are also pronounced disproportionate effects of government insurance on different types of households. This is partly a result of the disparities in income dynamics of different groups in Australia. For instance, we find that certain groups, namely, lower-income female primary earners and non-parents, confront persistently high income risks. Persistent risks are harder to self-insure, and this has important implications for optimal tax and transfer policies and for quantitative modelling of Australian households. De Nardi, Fella and Paz-Pardo (2020) explore this issue in a structural lifecycle model of couples using data from the UK. Consequently, the differential insurance impacts due to the targetedness of the transfer programs substantially shrink the gap

[2]Throughout the discussion, post-government income may also be referred to as after-tax-and-transfer income or disposable income.

in risk outcomes across groups. Conversely, family insurance appears to be more important for those not targeted by the means-tested public transfer programs including non-parents and upper income partnered parents. Together with our finding of weak spousal and strong public responses to individual earnings shocks, this implies the provision of government insurance potentially crowds out family insurance, which helps explain the M-shape Australian female age-profile of labour supply and is consistent with the conjecture in De Nardi et al. (2021) based on a comparison of the US and the Netherlands.

Related literature. Our paper contributes to a growing literature that studies non-Gaussian features of earnings dynamics (e.g., Guvenen et al. (2021), De Nardi et al. (2021) and Halvorsen et al. (2020)). We provide a new case study on lifecycle earnings dynamics using a rich and well-documented Australian microdata. Unlike prior studies revolving around male workers, ours focuses on primary earners in order to account for the sizeable proportion (30%) of female headed households in our sample of Australian workers (who are not self-employed). The results point at the resemblance between Australia and the OECD countries previously examined in the literature - in particular the US (Guvenen et al. (2021); De Nardi et al. (2021)), the Netherlands (De Nardi et al. (2021)) and Norway (Halvorsen et al. (2020)) among others - in terms of the dynamics of earnings and the importance of family market earnings and government transfers in insuring households against both transitory and persistent idiosyncratic risks. However, there are some significant differences. First, as opposed to the US and the Netherlands where the second-order earnings risk is brought about by hours, in Australia the principal driver appears to be wage changes. Hour changes, on the other hand, drive the third- and fourth-order risks. Second, the roles of family and government insurance generally do not overlap in Australia. Indeed, government insurance tends to smooth out small and moderate shocks, while family insurance tends to respond to more extreme events. What constitutes this outcome and the implications it may have on household lifecycle decisions and ultimately household welfare are research avenues worth further pursuing.

Furthermore, this paper is related to the literature studying the role of government insurance in heterogeneous agent models accounting for family structure (e.g., Kaygusuz (2015), Nishiyama (2019) and De Nardi, Fella and Paz-Pardo (2020)). Kaygusuz (2015) and Nishiyama (2019), for instance, find that the US's spousal and survival benefits transfer welfare from two-earner to single-earner households. Our results show that female headed households (typically with both male and female spouses working) benefit significantly more than their male headed counterparts (typically single earners) from government insurance against earnings risk. Similarly, De Nardi, Fella and Paz-Pardo (2020) show the extent to which the government can help households depends on the risk distribution that they face and their family structure. Therefore, relaxing the Gaussian and linear assumption may influence quantitative results.

Our work contributes directly to the understanding of earning dynamics and inequality in Australia. The early literature studying labor earnings or income dynamics in Australia (e.g., Chatterjee, Singh and Stone (2016), Kaplan, Cava and Stone (2018) and Freestone (2018)) show an increase in inequality in labor earnings is mainly due to residual factors reflecting idiosyncratic risks drawn from normal distributions. These studies commonly assume that the income shock follows a Gaussian process and estimate a linear model of risk. Our findings indicate that the shock process is more complex and deviates from the normality and asymmetry assumptions.

Finally, our paper connects to the body of empirical studies on the redistributive effects of the Australian tax and transfer system (e.g., Herault and Azpitarte (2015) and Tran and Zakariyya (2021)). These studies mainly focus on the first-order moment of income. Differently, we focus on higher-order moments of income changes. In doing so, we uncover the drivers of income risk and limitations of family and government insurance, which is fundamentally important for understanding the dynamics of income inequality as well as the insurance role of the Australian tax and transfer system.

The paper hereinafter proceeds as follows. Section 2 provides a description of the dataset, descriptive statistics and methodology. Section 3 presents the main results. Section 4 presents extensions. Section 5 concludes. Appendices report additional results and further discussion.

2 Data and Methodology

2.1 Data and variable construction

We use data from the Household, Income and Labour Dynamics in Australia Survey (HILDA) release 18 (2001−2018). Began in 2001 and has since been conducted on an annual basis, HILDA is a nationally representative panel data of Australian households on a wide range of subjects pertaining to family and labour market dynamics. The survey collects detailed information on respondents that allows for estimations of total individual and household incomes, and includes rich demographic information that makes possible a more accurate estimation of tax payments and transfer benefits.

Our core unit of measurement is an adult individual who legally pays taxes in Australia. After excluding dependent children and students, we arrive at $267,963$ observations. Restricting the sample further to include only employees (i.e., not self employed), we retain $133,697$ observations. Family is another unit of analysis. For our purpose, the terms "family" and "household" are interchangeable. Note that household unit defined in the data may include multiple family units. As an example, the survey records all independent lone persons in a shared household as separate family units living within the same household unit.[3]

At the annual level, the estimate of family income encompasses all individual regular market income flows accruing to the sampling unit, which jointly with private transfer, make up family pre-government (i.e., family income before tax and transfer) income. Regular market income comprises all market sources of earnings such as wage and salary, business income, investment income, and regular private pension. Family market income may contain additional regular market earnings by spouse, independent children, and other family members of the same family unit. The values of income, tax liabilities and transfers are expressed in 2018 dollar. At the weekly level, the HILDA survey reports usual weekly earnings and usual work hours corresponding to the year of observation. Our measures of weekly wage rates are derived from these two figures. A caveat is that these variables do not capture interim unemployment spells and other short-term hour changes within a year. Our estimates of earnings dynamics and its constituents

[3]The current sample involves single and married (or in de facto relationship) primary earners distinguished by their unique family unit identifier. Family unit in HILDA is not limited to the conventional nuclear family (a.k.a, elementary family or conjugal family) comprising only parents and children. Family unit may include other members who are related to the elementry family and reside within the same residence. The survey then assigns separate income unit identifiers to these members if they happen to also be income earners.

at the weekly level are thus subject to measurement errors that likely result in an underestimation of the role of hours.[4] As a partial remedy when exploring the dynamics of earnings and its relationship with wage and hour changes, we restrict the sample to employees with consistent workforce participation history - defined as those having worked for one day or more per week for at least 15 periods (years) of observation and received the minimum hourly wage of AUD20 (in 2018 dollar). We relax this requirement, by setting the cutoff work duration to 7 years, for certain subgroups (e.g., non-parents) to allow sufficient sample size and ensure reliability of our moment estimates. Regardless, because the differences found in our study between the roles of wages and hours changes are large, it is quite unlikely that the true patterns deviate in any significant manner from our results.

For our analysis on the family and government insurance effects, on the other hand, we include all employees regardless of their employment history. The reason is major welfare programs such as the Family Tax Benefit (FTB part A and part B) and JobSeeker Payment are not conditional on labour market participation. Thus, comprehending the full impact of the Australian government insurance demands that we do not drop those who temporarily exited the workforce. Moreover, the measurement error problem is not of concern to our annual estimates. Simply multiplying the usual weekly earnings by the number of work weeks to obtain annual figures would indeed introduce significant measurement errors from the high clustering of hours that inevitably emerges as a consequence of omitting information on changes during the year (i.e., by implicitly assuming workers always maintain the usual pattern of work within each year of observation). HILDA eases this constraint by collecting income, tax, and transfer information on a completed financial year immediately preceding the date of interview, which permits more accuracy in imputing tax, transfer, and gross and disposable income. Inputting these estimates into the HILDA tax-benefit model yields income tax figures that compare favourably with the national aggregates produced by the Australian Tax Office (ATO).[5]

Since the annual data captures more within-year variation, annual income variables are examined separately from weekly variables. Besides, because tax and benefit are reported annually[6], it is through the annual variables that the effects of government insurance are estimated.

More precisely, the schema is as follows:

Weekly income variables:

$$\begin{cases} \text{Hourly Wage} \xrightarrow[\text{(via work hours)}]{\text{self-insurance}} \text{Total weekly earnings} \\ \text{Total weekly earnings} \xrightarrow[\text{(via primarily spouse's earnings)}]{\text{family market income insurance}} \text{Total weekly family earnings} \end{cases}$$

Annual income variables:

[4] De Nardi et al. (2021) reports an overestimation of the role of wages in driving the earnings dynamics by comparing their estimates based on household surveys to those using administrative datasets, but their margins of errors are small and the qualitative patterns are maintained.

[5] See HILDA user manual release 18, page 65.

[6] We work with annual data and thus lack information on benefits or components of benefits that accrue fortnightly.

$$\begin{cases} \text{Regular market income} \xrightarrow[\text{(via members' annual earnings)}]{\text{family market income insurance}} \text{Family regular market income} \\ \text{Family regular market income} \xrightarrow[\text{(via private and irregular transfers)}]{\text{family transfer insurance}} \text{Family pre-gov't income} \\ \text{Family pre-gov't income} \xrightarrow[\text{(via combined income taxes)}]{\text{government tax insurance}} \text{Family post-tax private income} \\ \text{Family post-tax private income} \xrightarrow[\text{(via public transfers)}]{\text{government transfer insurance}} \text{Family post-gov't income} \end{cases}$$

Both individual and family units play different but equally important roles throughout the analysis. Individual unit is pivotal for computing life-cycle and tax statistics due to the separate tax filing system in Australia. Family unit, on the other hand, is the primary basis for computing transfer statistics because public transfers are assumed (as done in the HILDA survey) to be shared among members of the same family, except for maternity support which is assigned to only mothers. Particularly, because one of the determinants of eligibility for major transfer programs requires means testing combined family income (e.g., gross adjusted taxable family income) instead of individual income, variables at the family level must be calculated and handled explicitly apart from those at the individual level. This is done by modifying the HILDA tax-benefit model to first decouple the benefit system from the tax system and calculate individual taxable and adjusted taxable income before merging them back together to calculate the various social benefits and their related supplements. In this manner, the approach allows us to bypass the need for parametric functions in deriving relevant tax-benefit variables and in calculating higher-order moments of pre- and post-government income variables.[7]

Tables 1 presents descriptive statistics of the main variables in 2018.

Table 1: Summary statistics 2018

Primary Earner		N	Mean	Median	SD	Min	Max
Age	Individual	6,507	39.32	37	13.75	16	81
	Family	6,507	-	-	-	-	-
Weekly hours	Individual	6,507	38.26	40	12.63	0	130
	Family	6,507	57.34	50	35.03	0	234
Weekly wage	Individual	6,507	1,429.57	1,216.00	1,005.81	0.00	14,527.00
	Family	6,507	2,220.65	1,936.00	1,546.90	0.00	17,777.00
Labour Income	Individual	6,507	74,078.86	64,896.00	57,184.73	0.00	805,757.00
	Family	6,507	117,214.46	92,000.00	79,857.93	0.00	1.29e+06
Market income	Individual	6,507	76,603.26	65,921.00	60,642.27	-25,000.00	1.58e+06
	Family	6,507	127,164.35	109,450.00	99,673.42	-46,170.00	2.12e+06
Private transfer	Individual	6,507	475.65	0.00	3,926.71	0.00	200,000.00
	Family	6,507	1,044.15	0.00	8,021.99	0.00	303,468.00
Total income tax	Individual	6,507	17,252.77	12,723.00	22,461.12	-4,705.00	715,464.00
	Family	6,507	27,283.99	19,662.00	34,459.02	-7,997.00	892,464.00
Public transfer	Individual	6,507	1,966.84	0.00	5,245.99	0.00	52,067.00
	Family	6,507	4,881.84	0.00	9,864.12	0.00	75,125.00

[7]An example is family post-tax (pre-transfer) income which excludes tax offsets for targeted groups - e.g., LITO (Low Income Tax Offset) and SAPTO (Senior Australians and Pensioners Tax Offset) - but is not readily available in the dataset.

2.2 Methodology

We employ a nonparametric approach from Guvenen et al. (2021) to characterize earnings dynamics and distributions of earnings risk. We use similar metrics as in De Nardi et al. (2021) to measure the insurance role of family and government transfers. Accordingly, the terms "*insurance*" formally refers to the extent to which the second- and higher-order risks (*standard deviation*, *skewness* and *kurtosis* of the income shock distribution) are mitigated by a particular income component of interest. The current practice involves comparisons of moment properties between distributions of shocks (or changes) of different income components in a successive fashion from individual market earnings to household disposable income to capture each component's positive or negative contribution (i.e., insurance) to the eventual risk outcome.

Income growth rate. As in Guvenen et al. (2021), we first purge age and time effects from income variables by taking a least squares regression of log income on quadratic age terms and dummy year variables:

$$\log y_{i,t} = age_{i,t} + age_{i,t}^2 + year_t + \mu_{i,t}, \tag{1}$$

where $y_{i,t}$ is income. We then take the estimated residuals ($\widehat{\mu}_{i,t}$) from equation 1 for each individual i in year t and calculate the changes of these residuals between two years.

The n^{th}-order difference of the resulting residuals is given by $\Delta^n_{\widehat{\mu}_{i,t}} = \widehat{\mu}_{i,t} - \widehat{\mu}_{i,t-n}$. Technically, $\Delta^n_{\widehat{\mu}_{i,t}}$ represents a change in income of person i at time t occurring in n periods after controlling for the age and time effects. For example, when $n = 1$, $\Delta^n_{\widehat{\mu}_{i,t}}$ is the annual growth rate of the income residuals. These 'residual' income changes are named *income shock*s. The second, third, and fourth moments of their distributions are named *second-*, *third-*, and *fourth-order earnings risk*, respectively. In this analysis, we examine both annual (when $n = 1$) and 3-year (when $n = 3$) average residual changes. The former represents transitory shocks, and by partially removing the transitory component, the latter captures the more persistent element of shocks. Figure 1 reports an empirical distribution of annual residual income changes.

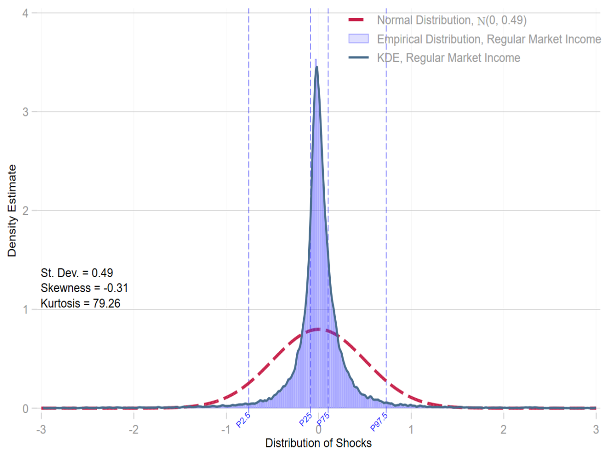

Figure 1: Empirical distribution of annual growth of individual regular market income of primary earners aged $25 - 64$. See Figure 20 in the appendix for a corresponding distribution of 3-year average income growth (when $n = 3$).

Group-specific income shocks. Individual income shocks are then grouped by (i) age cohort and (ii) discrete past income distribution. There are four age cohorts, namely $\{25-34,\ 35-44,\ 45-54,\ 55-64\}$. The past income, measured by either past usual weekly wages or past regular annual market income, is divided into ten deciles. Subsequently, for every group conditioning on (i) and (ii), we study their respective empirical distributions.

To better understand the dynamics of income shocks, let us consider a parsimonious permanent and transitory component model for the residual income given in equation 1

$$\widehat{\mu}_{i,t} = z_{i,t} + \epsilon_{i,t}$$

where $z_{i,t}$ is the permanent component which follows a random walk such that $z_{i,t} = z_{i,t-1} + \eta_{i,t}$, and $\epsilon_{i,t}$ is the transitory component. The permanent $(\eta_{i,t})$ and transitory $(\epsilon_{i,t})$ innovations are drawn from distributions $F_\eta \sim \left(0, \sigma_\eta^2\right)$ and $F_\epsilon \sim \left(0, \sigma_\epsilon^2\right)$, respectively. Note that we do not restrict the innovation terms to be drawn from a normal distribution. Accordingly, we can compute $n-$year log income growth

$$\Delta^n_{\widehat{\mu}_{i,t}} = \widehat{\mu}_{i,t} - \widehat{\mu}_{i,t-n} = \sum_{j=t-n+1}^{t} \eta_{i,j} + \epsilon_{i,t} - \epsilon_{i,t-n}. \tag{2}$$

This implies that the income shock process (or earnings risk) is driven by the permanent $(\eta_{i,t})$ and transitory $(\epsilon_{i,t})$ innovations.

Higher-order moments. We can characterize the distribution of income shocks using higher-order moments: (a) *Variance*, (b) *Standardized (Pearson) Skewness*, and (c) *Standardized (Pearson) Kurtosis*. Let σ_x, S_x and K_x denote the standard deviation, skewness and kurtosis of distribution F_x, $x \in \{\eta, \epsilon\}$, respectively. Given the parametric model defined in Equation 2, we can compute the second to fourth moments of the $n-$year log income growth $\Delta^n_{\widehat{\mu}_{i,t}}$ analytically

$$\begin{aligned}
\sigma^2_{\Delta^n_{\widehat{\mu}_{i,t}}} &= n\sigma_\eta^2 + 2\sigma_\epsilon^2 \\
S_{\Delta^n_{\widehat{\mu}_{i,t}}} &= \frac{n \times \sigma_\eta^3}{\left(n \times \sigma_\eta^2 + 2 \times \sigma_\epsilon^2\right)^{\frac{3}{2}}} S_\eta \\
K_{\Delta^n_{\widehat{\mu}_{i,t}}} &= \frac{n \times \sigma_\eta^4}{\left(n \times \sigma_\eta^2 + 2 \times \sigma_\epsilon^2\right)^2} K_\eta + \frac{2 \times \sigma_\epsilon^4}{\left(n \times \sigma_\eta^2 + 2 \times \sigma_\epsilon^2\right)^2} K_\epsilon
\end{aligned}$$

The previous literature assume that the permanent and transitory innovation terms are drawn from normal distributions $N_\eta \sim \left(0, \sigma_\eta^2\right)$ and $N_\epsilon \sim \left(0, \sigma_\epsilon^2\right)$, respectively. This implies that $\Delta^n_{\widehat{\mu}_{i,t}}$ follows a normal distribution $N_{\Delta^n_{\widehat{\mu}_{i,t}}} \sim \left(0, n\sigma_\eta^2 + 2\sigma_\epsilon^2\right)$. For example, Chatterjee, Singh and Stone (2016) estimate the random-walk permanent/transitory model for Australia. If we use similar assumptions and moment conditions, we can estimate σ_η and σ_ϵ and work out $\sigma_{\Delta^n_{\widehat{\mu}_{i,t}}}$, $S_{\Delta^n_{\widehat{\mu}_{i,t}}}$, and $K_{\Delta^n_{\widehat{\mu}_{i,t}}}$.

However, we take a different path in this analysis. We adopt the nonparametric approach as in Guvenen et al. (2021) and directly calculate all higher-order moments of income shocks, which is an intuitive way to examine whether the Gaussian distribution assumption is valid. Moreover, it is more flexible and allows us to identify the sources behind the nonnormalities and nonlinearities.

For comparability with the literature, we also document quantile-based measures of skewness and kurtosis, namely,

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

and

$$Crow - Siddiqui\ Kurtosis = \frac{P_{97.5} - P_{2.5}}{P_{75} - P_{25}}.$$

3 Results

We present two main results and their related findings. We begin with a section on the dynamics of earnings, wages, and hours of primary earners who meet the minimum workforce participation prerequisite as described in subsection 2.1. Because of the strict sampling requirement, only aggregate statistics over age are considered to ensure sufficient sample size. In the subsequent section, we discuss the role of family and government in insuring primary earners against earnings risk by comparing the second- and higher-order moments of shock distributions of different income components by age group and past income decile as detailed in subsection 2.2. Afterwards, results by gender, marital and parental status are examined to better understand the differential family and government insurance effects.

3.1 Higher-order Moments

3.1.1 Dispersion

The left and right panels in Figure 2 reports the variance of annual and 3-year average earnings, wage, and hour changes of primary earners with consistent work history, respectively.

There are a few notable common features between the two panels. First, the lowest three deciles of past earnings face a relatively high dispersion of earnings, wage, and hour changes. The variance is especially pronounced for the bottom-most decile, more than twice those of the remaining income groups. That the same pattern is still observed for the 3-year average changes, though to a much smaller degree in absolute terms, suggests that low income primary earners face a relatively higher second-order risk associated with both transitory and persistent shocks. While primary earners in the top decile do experience a somewhat larger variance in their earnings and wage changes, the difference to those in the upper lower and middle income deciles is trivial. The fact that casual and part-time employment is more flexible might account for the persistently higher variance associated with the bottom decile's hour changes since a large proportion of part-time (≈%50) and casual (≈%30) workers in the sample belong to this group. Second, changes in wages play a markedly larger role in explaining earnings fluctuation, except for the bottom decile where hour and wage changes exert virtually equal influence sizewise on the variance of annual earnings changes. We find similar relationships across subsamples. Third, the large negative covariance, $COV(\Delta w, \Delta h)$, especially for the lower past income deciles, suggests a strong negative income effect. In other words, low-income earners encountering adverse wage shocks make up for the loss by significantly increasing their work hours.[8]

[8]We report more dispersion statistics in the appendix. Table 4 and 5 reports statistics on part-time and casual employment by age cohort and past decile of weekly main wage. Figure 21 and 22 report second-moment

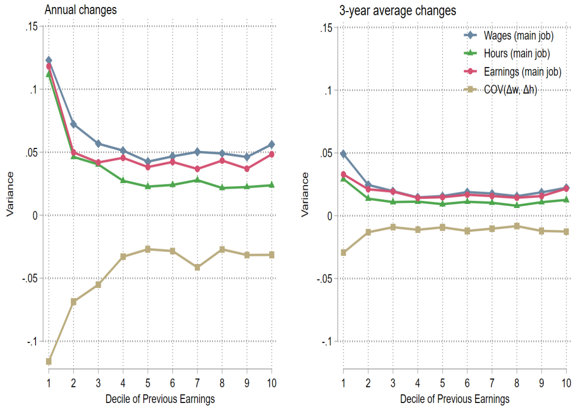

Figure 2: Variances of annual and 3-year average changes in usual weekly earnings, wages, and hours of primary earners

There are also important differences between the annual and 3-year average change statistics. Although the U-shaped age profiles of variances are preserved in the latter, they undergo a substantial decline. The dispersion of hour changes falls by a lesser extent for most deciles compared to that of wage changes, but the steepest decline is for the poorest such that the role of hours diminishes considerably and the variance of their wage changes becomes the sole dominant contributor to the second-order risk of persistent earnings shocks. Together with their relatively larger covariance, the second-order earnings risk associated with the 3-year statistics falls precipitously for the bottom decile to a comparable level with their higher income counterparts. Provided that a large segment of the low income earners works under an irregular employment arrangement, job switching might occur more frequently for the group, which could explain the more persistent dispersion of wage changes. For the rest of the income group, the variance level of the 3-year average earnings changes decreases by less than proportional the decrease in wage change dispersion. This outcome can be ascribed to the accompanying shrinkage of income effect as reflected by the lesser covariance magnitude. In other words, while the persistent wage shocks are less volatile, the intensive margin response to wage swing also grows weaker in the longer run. Likely candidates accounting for this lack of self-insurance on the part of primary earners could be either spousal labour supply response, public income support, or some combination of both. Our result provided in the subsequent sections points to public income support as a major reason.

Figure 3 complements the above findings by juxtaposing average changes in wages and hours with average earnings changes for selected deciles of the distribution of past weekly earnings. Immediately apparent are that: (i) wage changes constitute the main driving force of earnings changes, with few exceptions, and (ii) there exists an asymmetry between positive and negative earnings changes with respect to their contributing factors.

The annual statistics on the top panel of Figure 3 show that, apart from primary earners in the bottom decile, wages contribute substantially more to the movement in earnings, whereas the contribution by hours tends to be either small or absent. For the fifth and ninth deciles, hour changes contribute mainly to negative earnings changes, though their role is still limited relative

statistics of annual and 3-year average earnings, wage, and hour changes by selected subsamples.

to that of wage changes. In contrast, for those in the first decile, hour changes contribute about as much as wage changes do to large earnings fluctuation.

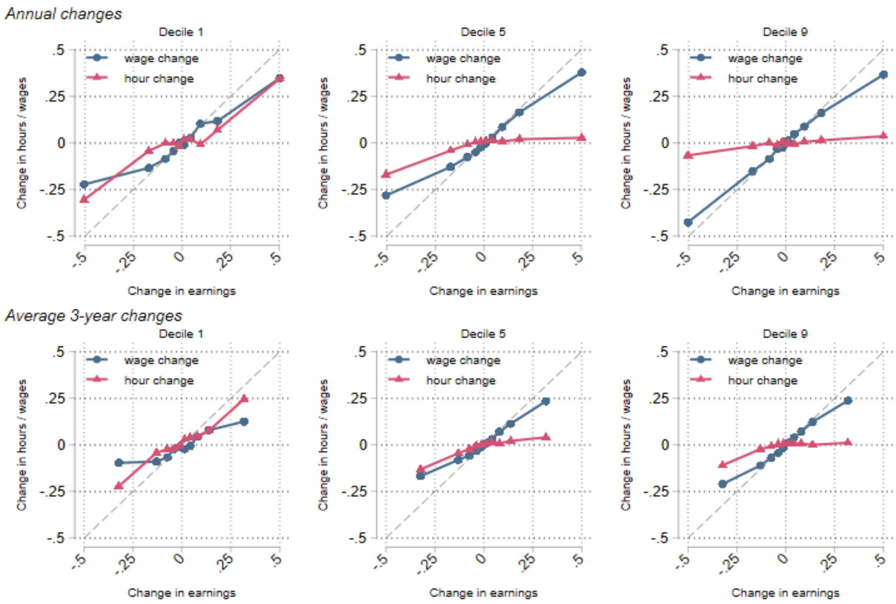

Figure 3: Changes in residual weekly wages and hours versus decile of changes in residual usual weekly earnings (from main job) for primary earners in the 1st, 5th, and 9th deciles of past usual weekly earnings. The top and bottom panels report annual changes and 3-year average changes, respectively. Note that, we only consider primary earners who report positive earnings during the 15 years of observation.

A critical distinguishing factor between the annual (top panel) and the 3-year (bottom panel) statistics in Figure 3, aside from the smaller extremes, is the stronger earnings-hour correlation of the latter. As depicted in the bottom-left graph, hour changes are the main driver behind extreme persistent earnings changes on both ends for primary earners in the bottom-most decile of past earnings. For example, at their highest positive (*negative*) earnings changes of 0.35 (-0.35) log points, the corresponding average hour and wage changes are around 0.25 (-0.23) and 0.125 (-0.1) log points, respectively. Likewise, for the median and top income earners (bottom-middle and bottom-right graphs), their 3-year average changes in hours now explain a greater proportion of the fall in their earnings, particularly at the extreme. On the positive side, however, the top and the bottom panels show almost no difference with respect to the relative shares of hour and wage changes in driving earnings changes of the two groups.

The results above demonstrate that for the middle and upper income primary earners, transitory and persistent earnings changes are largely determined by wage changes. The role of hours is negligible on the positive side, but it does account for a small to moderate fraction of large negative changes in their earnings. One explanation is that these better off individuals mostly comprise full-time employees who face a natural upper bound of weekly work hours (e.g., due to fatigue and preference for work-life balance).[9] Another potential cause is the institutional structure in Australia. The laws and regulations surrounding wages and work hours, e.g., the National Minimum Wage law and the National Employment Standards (NES), might generate rigidity along the intensive margin of labour supply, making it hard for both employers and employees to adjust non-casual hours up. More specific examples are the high

[9]See Table 4 and 5 in the appendix.

extra remuneration for overtime work and the legal arrangement that permits annual leave to be accrued on overtime hours (abolished in 2009).[10] In consequence, it is unlikely that primary earners can increase their earnings by working longer hours than they already do. On the other hand, there are fewer barriers for hours to fall due to, for instance, early retirement, health shock, and unemployment spells that are neither constrained by the hour cap nor the institutional friction. This further suggests that full-time workers in Australia might find it difficult to smooth consumption via intensive margin adjustment (e.g., before the arrival of a child). On the contrary, the earnings dynamics of workers in the bottom decile behave quite differently. As a large portion of this group works in casual and/or part-time employment, they are subject to fewer regulations and have a greater degree of freedom to adjust their hours. This group is also more likely to be unemployed or underemployed temporarily, which implies that the perceived changes in hours may still involve some information on the extensive margin.[11] These factors help rationalize the larger role of hours in driving their earnings changes.

Some caveats apply in interpreting the results. As wages are derived from usual weekly work hours and earnings, measurement errors arise because of the loss of information pertaining to short-term unemployment spells and other irregularities associated with work hours that may have occurred within each year of observation. The exclusion of workers with inconsistent employment history can help alleviate the problem, but the strict sample selection criteria, in conjunction with the use of log transformation, still comes at some cost of information on the extensive margin. This finding thus applies mostly to the intensive margin of labour supply. That said, assuming independent measurement errors, the pronounced differences in hour and wage contributions to earnings changes across deciles suggest that the measurement errors would have to be very large to explain away the observed statistics. Furthermore, relaxing our sampling restriction does not seem to change the results in any significant manner with regards to the contribution of hours to positive earnings changes, though it does bring about a greater relationship between negative hour and negative earnings changes.[12] Therefore, we expect the inclusion of more extensive margin information (e.g., with high-frequency administrative data) to reduce the measurement errors and expand the role of hours in explaining earnings changes.

3.1.2 Skewness and Kurtosis

As is evident in the top panel of Figure 4, except for workers in the bottom decile, the distribution of usual weekly earnings shocks is highly left skewed with the magnitude of its negative skewness being an increasing function of past weekly earnings. The corresponding 3-year average changes are moderately left skewed, but primary earners in the upper four deciles still experience a relatively high negative skewness. Thus, upper income individuals tend to be more affected by extreme persistent adverse shocks to their earnings.

It is also apparent that both the distributions of annual and 3-year average hour changes are considerably more left skewed than those of earnings changes while the opposite is the case of wage changes.[13] These estimates demonstrate that the third-order earnings risk is driven

[10]More information on overtime pay in Australia can be found on FairWork Ombudsman's website.

[11]We only have access to report on their employment status at the annual frequency. Even with the stricter sample selection criterion on work history, it is highly improbable that we are able to fully exclude those unemployed over a short time span within a year.

[12]See Figure 23 in the appendix.

[13]Results are consistent across the various household characteristics. See Figure 24 and 25 in the appendix

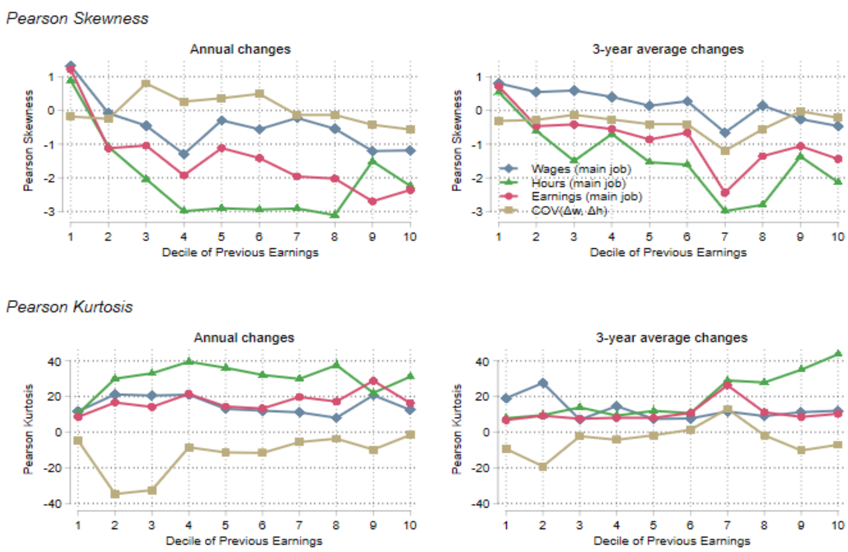

Figure 4: Pearson Skewness and Pearson Kurtosis of annual and 3-year average changes in usual weekly earnings, wages, and hours of main job of primary earners.

by hours. In addition, we see that co-skewness of the annual earnings changes hovers around zero, staying positive for workers at or below the sixth decile and turning slightly below zero for the upper four deciles, whereas the co-skewness of the 3-year average changes is exclusively on the negative side. Negative co-skewness reflects the interaction between wage and hour changes, that a fluctuation in one tends to be accompanied by a decrease of the other. Since the second-order risk associated with wages is relatively high, the volatility of wage changes is the primary determinant of co-skewness. Thus, a negative co-skewness means large fluctuations in wages are usually associated with declines in hours, which add to the adverse earnings shocks. This explains why the co-skewness in Figure 4 moves in tandem with the skewness of earnings changes, though its influence is small compared to that of hour changes.

The findings thereby conform to our earlier understanding. Earnings shocks have more room downward than upward. Being in full-time employment, to say nothing of the various institutional limits, naturally places a hard upper bound on hours. Consequently, a fall in earnings for upper income primary earners can be more extreme since a downward hour movement is less restricted, which could be the reason why the the annual and 3-year average earnings distributions of the upper income earners are highly left skewed. Note that, the use of log changes might be conducive to estimation bias of the contributions of wages and hours to earnings changes due to the loss of information at 0. However, comparing the current output to arc percent change measures shows that there is no significant deviation in the patterns observed.

The bottom panel of Figure 4 depicts excess kurtosis (leptokurtic) of the earnings change distribution. Statistically, a leptokurtic distribution is denser around the centre and thicker at the tails than the standard Gaussian distribution. This implies that changes in earnings are rare and most are small, but at the extreme, they occur more frequently. To put it differently, most Australian primary earners unlikely experience any large shocks to their earnings, but for those

for the third-moment statistics of annual and 3-year average earnings, wage, and hour changes by selected subsamples.

who do, the probability of severe earnings shocks is greater than what the standard Gaussian distribution prescribes. The figure further shows that the leptokurtic distribution of earnings changes is driven mostly by the large positive kurtosis of hour changes. As an example, barring those in the lowest decile, although both wage and hour kurtoses contribute positively to the kurtosis of annual earnings changes, the contribution by hour changes is approximately twice as much.

The impact of hours on the kurtosis of annual earnings changes is dampened to a certain extent by the negative co-kurtosis, a counterbalancing force. Co-kurtosis between two random variables captures the relationship between the extreme changes (or skewness) of one variable and the deviation of the other. They can also be understood as the likelihood that two random variables undergo either positive and negative drastic changes together. In other words, the negative co-kurtosis suggests that an extreme decrease (*increase*) in wages tends to be offset by an increase (*decreases*) in work hours. This interaction reduces the otherwise high density at the centre and tailends of the distribution of annual earnings changes, thus mitigating the fourth-order earnings risk to a relatively more moderate level. For persistent earnings changes (bottom-right panel), the size of the effect of each element shrinks and the role of hours becomes less visible, particularly for the lower six deciles of past earnings. However, the contribution of hours to the fourth-order earnings risk remains strong for the upper four deciles.

In short, despite the dominance of wage changes in producing the second-order earnings risk, our third and fourth moment estimates in Figure 4 show that hour changes constitute the principal source behind the higher-order risks. The results concerning the role of wages and hours in accounting for the earnings dynamics thus far are qualitatively robust across the different household characteristics examined. This consistency seems to suggest institutionally induced frictions, rather than choices or behaviours peculiar to certain household types, as agents behind the dynamics of wage, hour, and earnings changes in Australia.

3.2 Insurance against earnings shocks

This section reports family and government insurance in the first two subsections 3.2.1 and 3.2.2. Motivated by the targetedness of the Australian transfer system, the remaining subsections discuss the differential effects of family and government insurance on household types varied by selected demographic and socioeconomic characteristics, namely: *income, age, gender, marital status, and parenthood.*

Because major transfer programs such as the Family Tax Benefit part A and part B are not conditioned on labour market participation, a comprehensive analysis on the impact of the Australian social security scheme requires that we relax the previous section's sampling restriction and include all employees regardless of the consistency of their employment history.[14] We consider robust moment stastistics P1-P99, P5-P95, and P10-P90 to address potential outliers that may arise due to the broader sampling criteria. Nonetheless, the non-robust and robust statistics only differ quantitatively while the qualitative patterns persist across settings. We choose to present the P1-P99 figures in the main paper for ease of interpretation, conciseness,

[14]Eligibility and size of benefits receivable depends on income (means test on annual family adjusted taxable income) and number and age of qualifying children (dependend children). In case of divorcees, the amount of time spent taking care of one's children is also factored in to calculate the amount claimable.

and aesthetic. For higher-order moments, the discussion revolves around the pearson measures of skewness and kurtosis (standardized third and fourth moments) of the P1-P99 income change distributions instead of the quantile-based robust (Kelley's) skewness and (Crow-Siddiqui) kurtosis.[15] This is to ensure an acceptable degree of robustness without sacrificing too many observations at the tails of the shock distributions which contain information crucial for understanding the role of family and government insurance against higher-order risks.

3.2.1 Family Insurance

Figure 5 displays standard deviation statistics of the shock distributions for annual (left panel) and 3-year (right panel) average regular market income changes, both of which display U-shaped income profiles with the greatest dispersion for primary earners with the lowest past regular market income. The top decile also experiences a relatively strong fluctuation, but the magnitude is significantly smaller than that of the bottom decile. The relatively high share of low income earners employed in part-time and casual jobs that entail more irregular hours, seasonlity, and risk of layoff is a potential reason.

There are notable differences between the two panels. First, excluding the bottom decile, we see a small but non-uniform decrease in earnings risk associated with the 3-year statistics for the younger three cohorts. The change is less visible for the oldest cohort, except for those belonging to the top decile whose 3-year average shock dispersion is markedly smaller than their corresponding annual level. Second, for workers in the bottom-most decile in particular, their standard deviations of 3-year average market earnings changes are substantially lower compared to those of their annual changes. The drop is more drastic for the younger cohorts. Job switching and pursuit of higher education are some possible causes of the more volatile transitory shocks for the young. Health shock and early retirement are more pre-dominant among members of the oldest cohort ($55-64$), and given the enduring nature of these events, they might explain why the poorest old cohort's persistent shocks still possess a relatively high variation.

A closer inspection shows that the distributions of earnings shocks of the two middle age cohorts ($35-44$ and $45-54$) are predominantly less dispersed relative to those of the youngest and the oldest cohorts. A rationale is that these two latter age groups are more likely to undergo changes in their market earnings for reasons stated previously such as job switching, education, bad health, and early retirement. On average, there are also fewer reasons hampering them from taking greater risks (e.g., change one's career path, start a new business venture, etc), reducing their labour supply, or exiting the labour force provided that they either have not started a family, do not have dependents (e.g., dependent children), or have already accumulated sufficient wealth (in case of the oldest cohort). In turn, compared to the oldest, the youngest sees a higher variation associated with their earnings changes, particularly if they happen to be below the median past income distribution. This implies that the processes that drive earnings fluctuations for the youngest group are more potent and persistent in comparison to those for the oldest group. For instance, horizontal and vertical job mobility in early career and other family-related decisions can result in either adverse or favourable market earnings growth and

[15] For comparability with the literature, Kelley's and Crow Siddiqui figures are included in the main section of the paper, though not elaborated. P5-P95 statistics are reported in the appendix. We do not present P10-P90 due to space constraints.

therefore more variation, whereas health shocks and early retirement in later life cycle only lead to a unidirectional change (decline) in market earnings and therefore less variation. Similar results are observed across the different measures of second moment.[16]

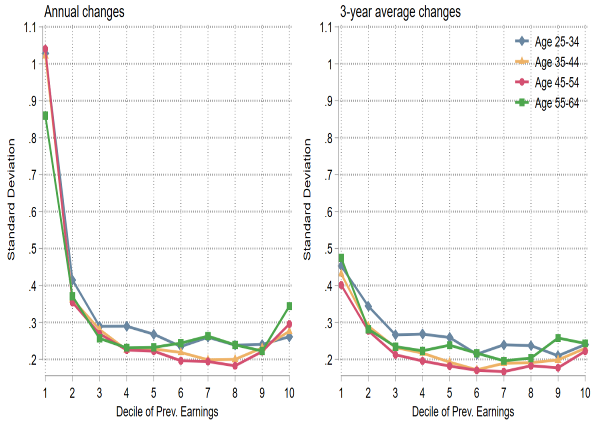

Figure 5: Standard deviation of the distribution of changes in regular market earnings for primary earner (P1-P99)

A logical follow-up to the prior discussion is examining the extent to which family income insure primary earners against their market earnings risk. To learn about insurance against the second-order risk, we first compare the standard deviation of individual market income with that of their family market income to capture *family market income insurance.* Then, private transfers from non-resident family members are added to family market income to derive total family pre-government income. We define the extent by which the standard deviation of this new measure falls below that of the family market income as *family private transfer insurance.* Repeating the procedure for each income and age group of interest gives rise to Figure 6. Similarly, to learn about family insurance against the higher-order risks, we perform the same pairwise comparison on the skewnesses and kurtoses of the distributions of primary earner's own market income, family market income, and family pre-government income as exhibited in Figure 7.

Against shock dispersion, it is evident in Figure 6 that the insurance effect of family market income and private transfer is little to none. The top panel demonstrates that family insurance only applies to the younger three cohorts at the bottom past income decile. Among these three groups, only family market income matters while the addition of private transfer marginally raises the level of dispersion. The effect of family market income insurance is small, and it dissipates completely, even for the poorest, when we consider more persistent shocks. The 3-year average statistics in the bottom panel further shows that family earnings and transfer actually elevate the second-order family pre-government income risk. The absence of family insurance implies the dominance of *income-pooling effect* of family market earnings as opposed to the *added-worker effect.*[17] That is, family members do not actively adjust their market activities (e.g., labour supply) in response to shocks to primary earner's earnings. As a result, individual members' earnings only increase the variance of the combined family market income.

[16] See Figure 28 and 29 in the appendix for further detail.

[17] See subsection A.2 of the appendix for formula and explanation of the variance of income changes of a two-earner family.

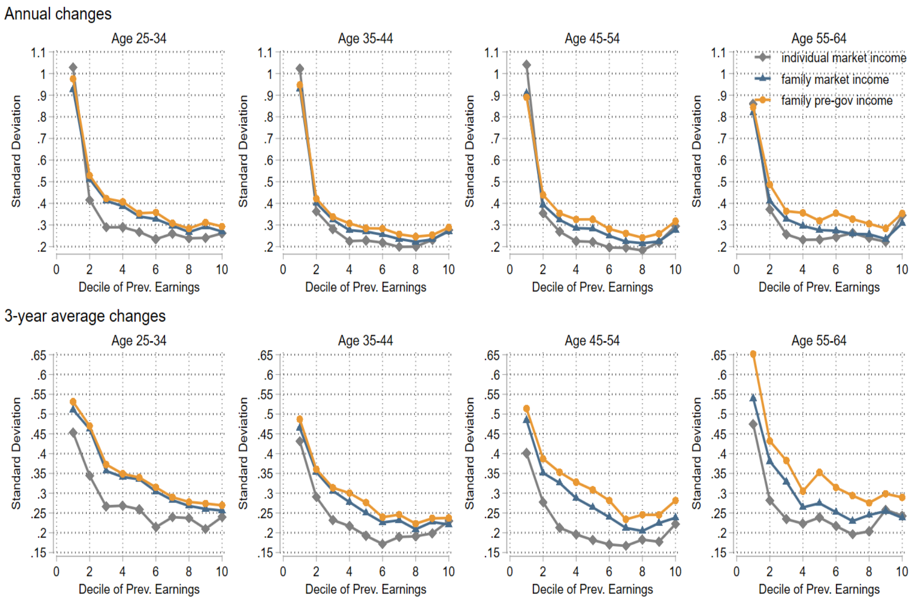

Figure 6: Standard deviation of the distribution of annual and 3-year average changes of family income (P1-P99) at different levels. The figure captures the relative contribution of family market income and private transfer to the second-order risk of pre-government family income.

The next figure conveys more revealing information about the earnings dynamics of primary earners and their households. As it turns out, the above passiveness of family members seems to only apply to small and moderate shocks. Figure 7 suggests that family insurance has a pronounced effect on the skewness and kurtosis of the distribution of individual regular market earnings shocks. To rephrase it, family members do respond to extreme adverse earnings shocks. [18]

The top panel of Figure 7 shows large negative skewness (between -1.5 and -2.5) for primary earners in the upper nine deciles of the past income distribution across all age groups. Evidence from Figure 4 points to hours changes as the main driver. The single exception is those situated in the bottom decile whose skewness is highly positive. The relatively high proportion of this group in part-time and casual jobs suggests more flexibility for upward movement of work hours and wages, especially when considering their initial wages and hours. In this casee, family market income provides substantial insurance, resulting in a remarkably lower negative skewness (ranging between -0.5 and -1) compared with that of the individual market income shocks. The effect is relatively small for richer households in the top two deciles of the $45-54$ and $55-64$ cohorts and might be due to family members being less responsive to extreme negative earnings shocks of the richer and older primary earners. Rather, these households benefit from moderate private transfer insurance, making up for the lack of market income adjustment by their members. For the oldest cohort in particular, the family private transfer insurance extends to all upper middle income primary earners. In fact, the presence of family transfer allows the third-order risk of family pre-government income of the richer seniors to arrive at a similar level as those of the other three cohorts who rely almost exclusively on their family market earnings insurance.

[18]The observed effect tends to be consistent over all the subsamples analyzed. Thus, we report only the annual statistics and leave the rest in the appendix.

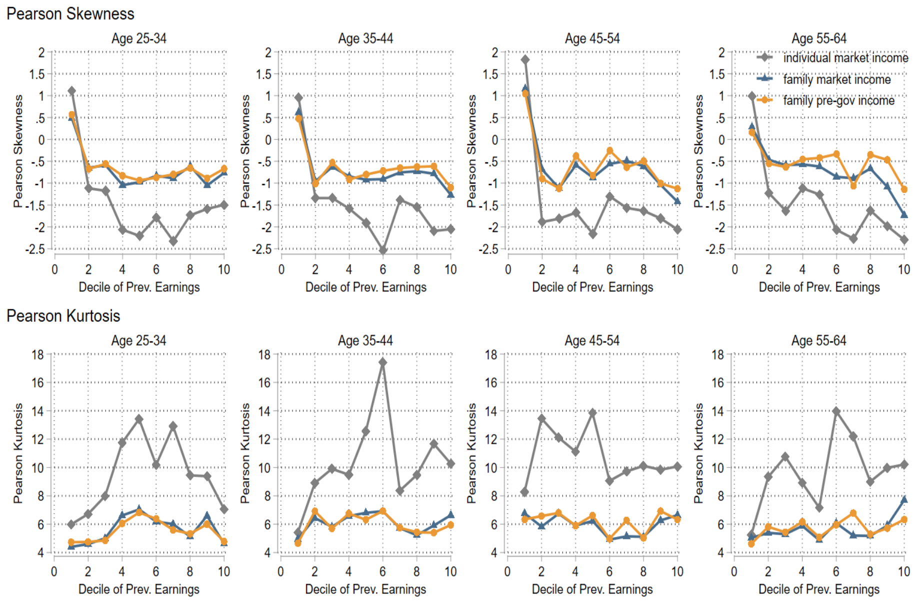

Figure 7: Skewness and kurtosis of the distribution of annual changes of family income (P1-P99) at different levels. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of pre-government family income. Corresponding moment statistics for 3-year average changes show similar patterns and are provided in subsection A.6 of the appendix.

Kurtosis of the distribution of earnings shocks also manifests a non-Gaussian property. According to the lower panel of Figure 7, kurtosis is highly positive (leptokurtic) with a somewhat hump-shaped income-profile for all age cohorts. Its minimum is around 5 which is still well above the standard normal kurtosis value of 3. The observed excess kurtosis implies that while most primary earners in Australia experience little or no earnings shocks, there are more of those who encounter extreme shocks than otherwise suggested by the standard Gaussian assumption. Like skewness, the statistics on kurtosis in Figure 4 suggests hours to be the main explanatory factor, and since this section studies annual level earnings, we expect short-term unemployment spells to further augment the influence of hour changes on earnings changes. Along the same line, the ability to adjust one's hours for casual and part-time employees in response to wage shocks could help explain the smaller kurtosis levels of those in the lower past income deciles in relation to others.

As illustrated in Figure 7, the mitigating effect of family market income on the fourth-order individual earnings risk is pronounced, enough to reduce the kurtosis of the family pre-government income shock distributions to a comparable degree (between 5 and 7) for all households. The single exception is for the bottom decile primary earners whose kurtosis is already low to begin with.

Measures of kelley's skewness and crow-siddiqui kurtosis from Figure 30 to Figure 44 in the appendix show the corresponding P1-P99 and P5-P95 standardized and quantile-based statistics of the annual and 3-year average changes calculated using (i) the standard method from equation 1, and (ii) the Arc-Percentage Change method. The patterns associated with crow-siddiqui kurtosis behave more erratically, making it difficult to interpret. In contrast, kelley's skewness exhibits more consistent patterns across the different measures. First, it demonstrates that once enough extreme shocks at the tailends have been excluded, the distribution of shocks of the remaining lower income earners is positively skewed, whereas the upper deciles still face a small to moderate level of left skewness. Second, this drastic change in the dynamics of individual market earnings also entails a change in family behaviour. For richer households, kelley's skewness suggests that when an adverse shock is large but not too extreme, family insurance becomes either small or insignificant. On the other hand, the shock distribution of family pre-government income for those below the median of past income decile is either more symmetric or negatively skewed than that of the individual market earnings. That is, family market income and private transfer add to the absolute size of the negative skewness or the excess kurtosis, which seems to imply that members respond to large positive earnings shocks of primary earners by cutting back their own market activities.

In a nutshell, extreme shocks induce responses from family. For a typical primary earner in Australia, family market income serves as a crucial source of insurance against the third- and fourth-order risks even if it does not mitigate the dispersion of the primary earner's market earnings. Notwithstanding, we should pay special attention to the interpretation of kurtosis because a smaller kurtosis can originate from either: (i) the contraction of probability mass about the mean of the shock distribution, i.e., more households experiencing moderate or extreme shocks, or (ii) the contraction of mass at the tailends, i.e., fewer households experiencing extreme shocks. While (ii) constitutes a positive effect on households, (i) does not. If one is concerned with welfare, then the outcome ultimately depends on which of the two processes dominates. A more detailed discussion is provided in subsection 3.2.2.

3.2.2 Government Insurance

This subsection discusses two distinct types of government insurance - *government tax insurance* and *government transfer insurance* - against the second and higher-order risks of family pre-government income. For our purpose, government tax insurance is defined as the extent to which income tax reduces the size of standard deviation, skewness, and kurtosis of the distribution of family pre-government income shocks. Analogously, government transfer insurance is the degree to which public transfers can fulfill the same task. We capture the former by the gap between moment statistics of family pre-government income and post-tax (pre-transfer) income, and the latter by that between family post-tax income and family post-government income.

We first turn our attention towards the role of government insurance in mitigating the dispersion of shocks (or second-order risk) as depicted in Figure 8. Based on annual change statistics in the top panel, though tax insurance is insignificant, government transfer considerably reduces the second-order risk of family pre-government income for primary earners at or below the median of past regular market income distribution.[19] The insurance is at its largest for the poorest households and declines rapidly as one moves up the income hierarchy. Another interesting observation is the fact that relative to the annual statistics, transfer insurance against persistent second-order risk remains significant with its magnitude well-preserved (bottom panel of Figure 8). For the bottom decile, the magnitude of insurance may have decreased in the absolute terms but not in relation to its mitigating effect on the second-order risk of family income. This is most likely a product of the targeted and means tested welfare programs

[19]This occurs because by construction, public transfer and family pre-government income move in opposite direction. That is, $COV(income, transfer) < 0$.

in Australia such as the family-oriented social securities from which families receive pecuniary support with large maximum and base payments conditional on the number of dependent children and the combined family income test. Thus, government insurance is effective against both transitory and persistent family income shock dispersion, but this may also be a worrying sign that households rely too heavily on public transfer.[20]

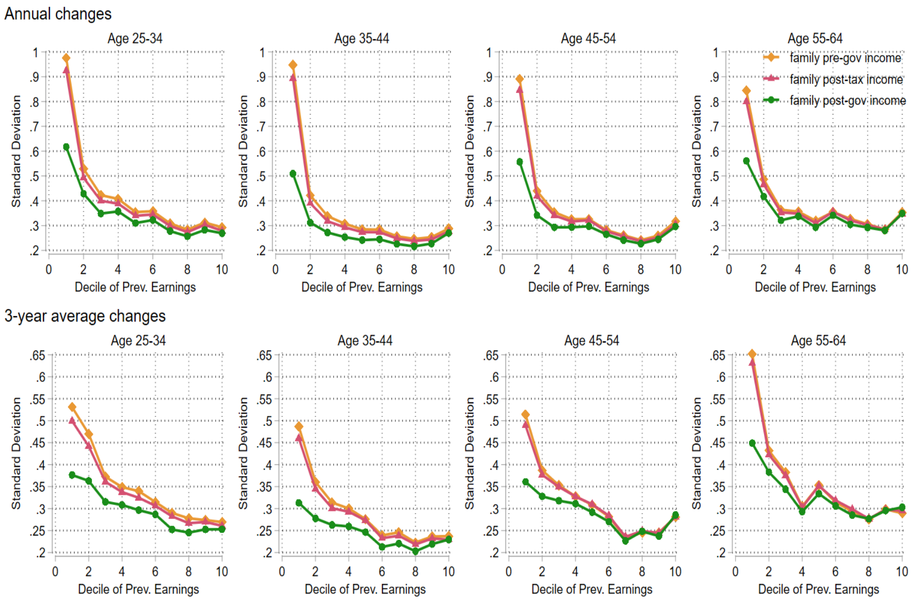

Figure 8: Standard deviation of the distribution of annual and 3-year average changes of post-tax and disposable (or post-government) family income (P1-P99) at different levels. The figure captures the relative contribution of tax and transfer to the second-order risk of disposable family income.

Next, we report the P1-P99 standardized skewness and kurtosis of pre- and post-government household income. Figure 9 shows the relative contributions of tax and transfer to the third-order risk of the annual (top panel) and 3-year (bottom panel) average family disposable income changes. At the annual level, government transfer insurance is visible for most in the $45-54$ and $55-64$ age cohorts. Though small relative to family market income insurance, it is non-trivial. For the 3-year average changes, however, the insurance remains sizeable for the youngest but largely disappears for the older cohorts.

Lastly, we examine the impact of government insurance on the fourth-order risk of family disposable income exhibited in Figure 10. The annual level statistics on the top panel reveals that tax and transfer insurance against the fourth-order risk is generally absent. Similarly for the 3-year average changes on the bottom panel, government tax and transfer play no insurance role; on the contrary, they lead to more excess kurtosis for the majority of households.[21]

Yet, a higher kurtosis level does not readily imply households are worse off. Kurtosis changes either due to changes in probability mass around the mean or at the tails of the shock distribution. On that account, the larger kurtosis induced by tax and transfer is not necessarily an

[20]See Figure 45 to Figure 47 in subsection A.7 of the appendix for the corresponding P1-P99 and P5-P95 second moment statistics of the annual and 3-year average changes calculated using (i) the standard method in equation 1, and (ii) the Arc-Percentage Change method.

[21]See Figure 48 to Figure 63 in subsection A.7 of the appendix for the corresponding P1-P99 and P5-P95 third and fourth moment statistics of the annual and 3-year average changes calculated using (i) the standard method in equation 1, and (ii) the Arc-Percentage Change method, which show generally consistent results with the findings in this subsection.

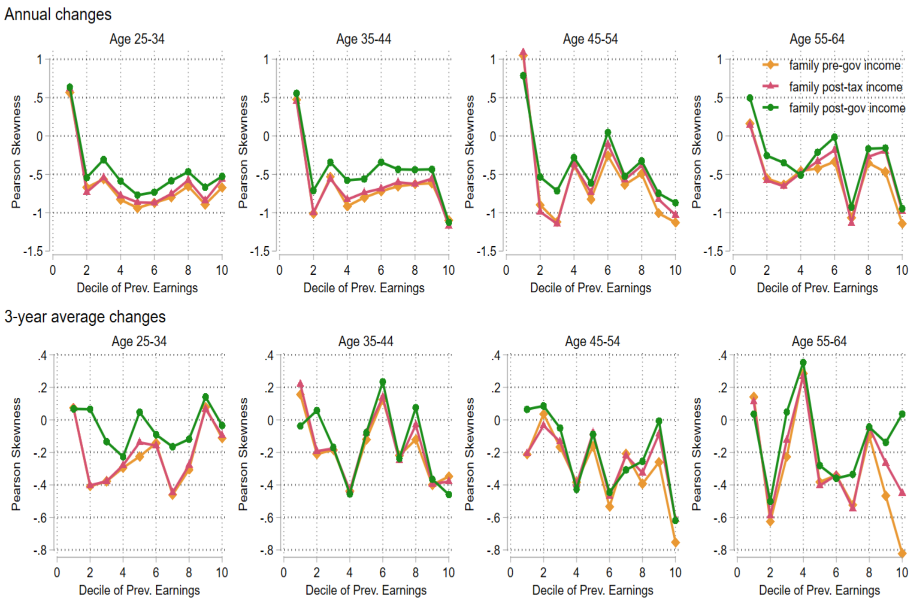

Figure 9: Skewness of the distribution of annual and 3-year average changes of post-tax and disposable (or post-government) family income (P1-P99) at different levels. The figure captures the relative contribution of tax and transfer to the third-order risk of disposable family income.

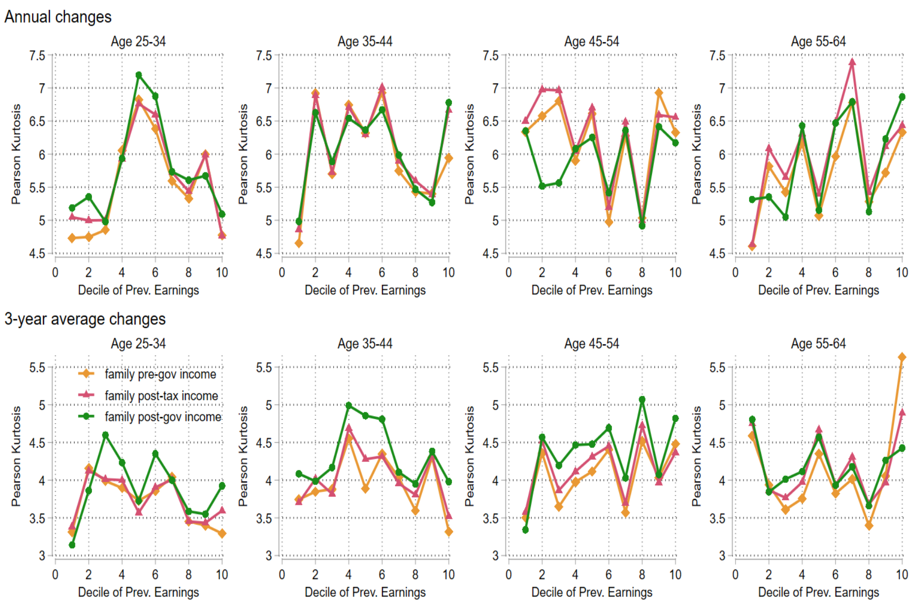

Figure 10: Kurtosis of the distribution of annual and 3-year average changes of post-tax and disposable (or post-government) family income (P1-P99) at different levels. The figure captures the relative contribution of tax and transfer to the fourth-order risk of disposable family income.

adverse outcome. If the growth reflects an increase in the proportion of households experiencing small or no disposable income shocks (i.e., greater peakedness of the shock distribution), then the greater kurtosis actually conveys the effectiveness of government tax and transfer. Conversely, if the growth is brought about by an increase in the probability of extreme income shocks (i.e., mass expansion at the tails), then it suggests that tax and transfer insurance is inefficacious, if not detrimental. Therefore, a careful examination into the empirical distributions of shocks from income sources, namely, own regular market income, family market income, and family disposable income is required.

Changes in income shock distributions and their implication on kurtosis

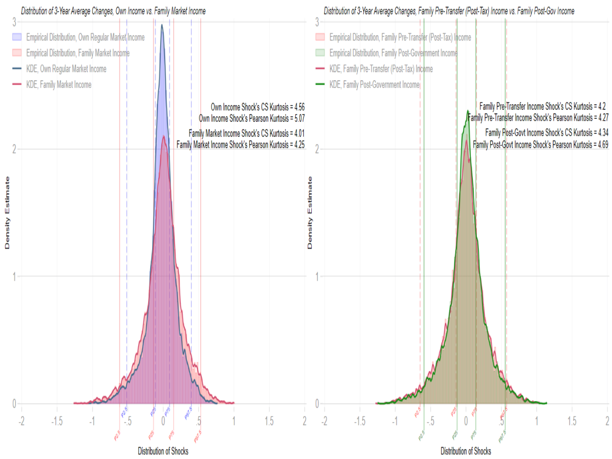

Figure 11: Comparison of empirical distributions of 3-year average shocks: individual market income vs. family market income (left panel), and family pre-transfer (post-tax) income vs. family post-government income (right panel). All density estimates use epanechnikov kernel function with bandwidth of 0.01.

To learn more about the fourth moment, we construct and compare empirical distributions of 3-year average income changes and their respective kernel density estimates across four income layers as displayed in Figure 11. The selected sample contains working-age primary earners belonging to the younger three cohorts.[22] The bottom and top deciles of the past income distribution are excluded because their higher-order moments often behave quite differently from those of the other groups. We report the P2.5, P25, P75, and P97.5 percentiles - used to calculate crow-siddqui kurtosis - in order to highlight the effects that each step of the distributional changes has on the quantile-based kurtosis value and its interpretation.

The left panel of Figure 11 contrasts the distribution of regular market income shocks of primary earners with that of their family market income. The comparison reveals important information about the observed kurtosis changes in the previous subsections. First, both the quantile-based and standardized measures of kurtosis of the family income shock distribution are

[22]Similar comparison between distributions of shocks at the annual level and for the oldest working-age cohort (55-64) are presented in the appendix. The distributions of annual changes for the younger cohorts in Figure 64 are more disperse about the mean with elongated tails but it tells the same story as Figure 11 does. The annual (Figure 65) and 3-year (Figure 66) average shocks of the oldest working cohort show a similar family market income role in driving down kurtosis by virtue of the lower peakedness of its shock distribution, but a negligible effect of public transfer on the distribution of post-government income changes. This again partly reflects the targeted family welfare system in Australia which transfers large benefits to parents of dependent children. Note that breaking down the sample by income decile does not result in any significant changes in the observed pattern and neither does using the arc percent change method.

smaller than those of the individual shocks despite the former's greater probability mass below the 25-th and above the 75-th percentiles. The chief reason is the contraction of mass about the mean of the former distribution which more than offsets its larger tail mass. This allows the distribution of family income shocks to assume a more Gaussian shape with the net result being the reduction in kurtosis. Hence, additional market earnings from family members do not necessarily mitigate the extreme shock probability; on the contrary, they add to the probability of moderate and large shocks. Whether this is a favourable or adverse outcome also depends on where the density in the region of moderate shocks originates from. If a greater proportion represents households whose primary earners were initially in the tails (i.e., experiencing ex-ante extreme shocks), then that signifies an improvement. On the other hand, if it represents those who were previously at the mean of the shock distribution (i.e., those experiencing small to no ex-ante shocks to their personal market income), then the increase in moderate shocks tells us that family market activities increase the overall risk. Although Figure 11 shows clearly that family income increases density around the tailends, the picture is not as obvious in some other cases. This question complicates the analysis of kurtosis and is not addressed in our current work.

The right panel displays a similar juxtaposition of family pre-transfer (post-tax) income and family disposable income shock distributions, which demonstrates that the higher kurtosis associated with family disposable income is a consequence of higher peakedness as opposed to thicker tails. That is, what drives the kurtosis up is the fact that the post-government income shocks are more clustered around the centre of the distribution. Indeed, the probability of extreme disposable income shocks remains small at both ends, and the P2.5 and P97.5 percentiles actually move inward relative to those of the pre-transfer income. Despite these positive effects, the crow-siddiqui kurtosis computed increases from 4.2 to 4.34, and in a similar manner, the standardized kurtosis increases moderately from 4.27 to 4.69. Depending on kurtosis to inform about insurance effects against the fourth-order risks can thus be misleading.

In essence, the above finding provides evidence of instances when the fourth-order risk is driven mainly by a process that alters the central density of the shock distribution as opposed to one that affects the tail density. It counters the notion that a lower fourth-order risk is equivalent to a decreased probability of extreme shocks and therefore an improvement in individual and household welfare. Kurtosis contains rich information, albeit its interpretation should be exercised and treated with caution. Therefore, without a more indepth analysis of the processes behind the changes in kurtosis, variance and skewness are perhaps more reliable standalone measures of insurance against risk and its implication on welfare.

We demonstrate that the roles of family and government insurance generally do not overlap. Against the third-order risk, family market income is a major source of insurance, and government transfer insurance is comparatively small. However, family market income does not insure primary earners against the second-order risk. Furthermore, the decrease in kurtosis of the shock distribution associated with family market income does not readily translate into positive insurance effects against the probability of extreme adverse income shocks.[23]

[23]If one defines the fourth-order risk as representing the fourth moment of shocks, then by virtue of lower kurtosis alone, it is technically correct to conclude that family market income mitigates the fourth-order risk. However, its welfare implication is ambiguous. It implies neither (i) that the probability of extreme shocks has been reduced, nor (ii) that the effect is welfare improving.

Conversely, government transfer serves as an effective tool insuring against the dispersion of earnings shocks of primary earners below the median past income, especially for the younger cohorts, as seen in Figure 8. On the contrary, its impact on the third-order risk is small compared to the family market income insurance effect. With regards to its effect against the fourth-order risk, investigating the shock density estimates allows us to show precisely that the rise in kurtosis does not mean that the government insurance is absent or that the public transfer induces a higher probability of extreme shocks. The relatively larger mass about the mean of the disposable income change distribution produces a moderate increase in its pearson and crow-siddqui kurtoses even though its tail regions appear to be less dense than those of the distribution of family pre-transfer income changes. In effect, the government transfer insurance mitigates the relative probability of large shocks, an outcome not apparent via the fourth moment statistics alone.

3.2.3 Spousal Response versus Public Transfer

Results from the analysis of moments demonstrate that for the average breadwinners in Australia, government transfer better insures them and their households against the volatility of income shocks while family market income insurance is most potent against extreme adverse shocks. We construct two complementary figures (aggregated over age) to learn more about primary earner's past income shocks and their correlations with changes in spouse's market earnings and public transfer.

Figure 12 plots spouse's average weekly wage and hour changes against changes in primary earner's past weekly earnings. We see that changes in work hours and wages of spouse (or secondary earner) in response to shocks to primary earner's earnings are largely absent. Because Figure 12 is based on usual weekly work hours and weekly wage rates, some fluctuations within a year such as temporary unemployment of primary earners and employment of their partners are likely omitted, which could explain the absence of spousal response. However, the fact that the 3-year average statistics (the bottom panel) also show no sign of any sizeable or consistent spousal response corroborates our earlier hypothesis that market activity adjustment on the part of spouse is indeed lacking.

Next, because we lack information on government transfer to households on a weekly basis, the subsequent Figure 13 compares changes in spousal earnings and public transfer conditional on changes in primary earner's past regular market earnings. Partly, this allows us to address the aforementioned shortcomings and capture more information at the extensive margin. Nonetheless, the figure depicts an almost identical result on spousal responses to that of the weekly statistics. Evidently, spousal responses to both negative and positive changes in primary earner's annual earnings are generally trivial. Though we do see some movement in spouse's earnings, they are inconsistent and do not suggest a conscious counteraction made by spouses to changes in their partner's income. Perhaps more striking is the strong negative correlation between changes in public transfer and primary earner's income. At the extreme of negative annual changes for the median income primary earners (top-middle graph in Figure 13), for instance, a decrease (increase) in their previous annual earnings by -0.8 (0.8) log points corresponds to an increase (decrease) of 0.3 (-0.5) log points in public transfer. Responses from the transfer system are even greater for richer households in the 9th decile, plausibly owing to the

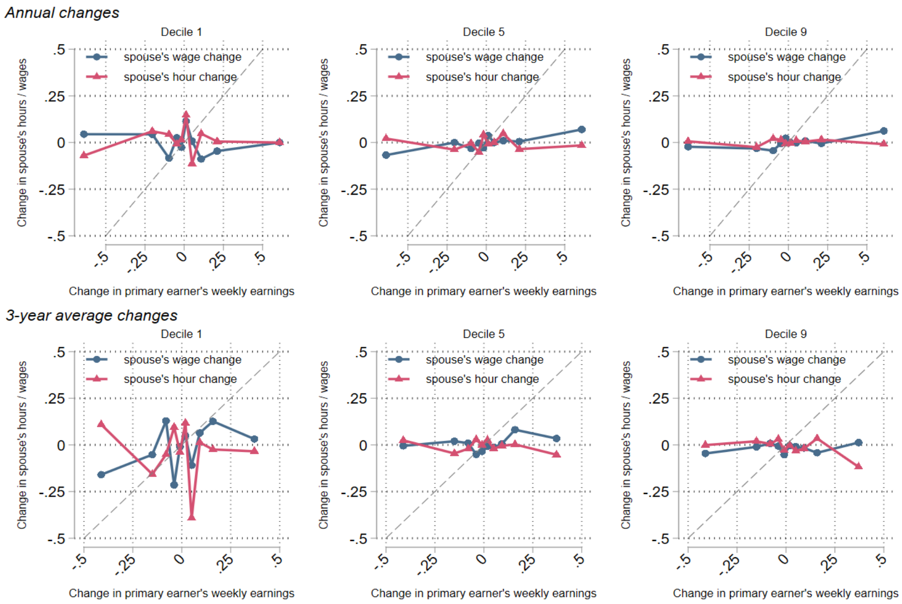

Figure 12: Changes in usual weekly wages and hours of spouse versus decile of changes in usual weekly earnings (main job) of primary earners in the 1st, 5th, and 9th deciles of past weekly earnings. The top and bottom panels report annual and 3-year average changes, respectively.

means test on combined family income. Likewise, the 3-year average change statistics on the bottom panel convey a matching story.

Although they are unable to capture moment properties of the shock distributions, Figure 12 and 13 offer a new perspective and make comparison possible between different directions and degrees of changes. What has become transparent is that, on average, the greatest response to individual earnings changes comes from the public transfer. The adjustment in spouse's earnings tends to be either insignificant or inconsistent. Interestingly, though the sign is weak, it appears that spousal and government responses move in opposite direction, which implies that government insurance may have crowded out family insurance. How much of the currently observed spousal behaviour stems from the presence of large government transfer insurance against the primary earner's earnings risk is a subject worth inquiring into, and we leave it to future research.

4 Further analysis

The similarities and differences in demographic structure across households raise questions about the extent to which households can self-insure and the role of government insurance. In this section we extend our analysis further to consider some key demographic factors including gender, marital status and parenthood.

4.1 Gender

Households with female primary earners, a.k.a female headed households, account for approximately 30% of our pooled sample of single and partnered employees. 45% of the female headed households in the sample are partnered households. Figure 14 compares moment properties of the distributions of income shocks of male (left panel) and female (right panel) headed house-

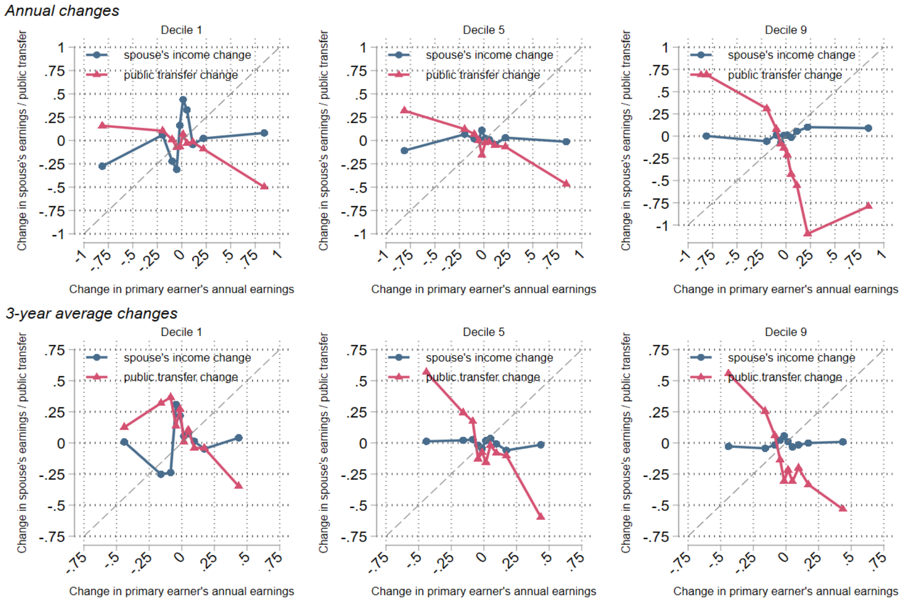

Figure 13: Changes in spousal earnings and public transfers versus decile of changes in past market earnings of primary earners in the 1st, 5th, and 9th deciles of past regular market income. The top and bottom panels report annual and 3-year average changes, respectively.

holds aggregated over age. For both genders, the standardized moments show that government transfer provides substantial insurance against the dispersion of shocks, particularly for the bottom decile and relatively small insurance against the negative skewness. Conversely, family market income greatly reduces the negative skewness and kurtosis of shocks, but its dispersion mitigating role is largely absent.

At the same time, there are notable differences. First, the second-order risk of the pre-transfer (post-tax) income of female headed households tends to be larger than those of their male counterparts - especially for the lower three deciles. This is primarily driven by the relatively high individual market earnings shock variance of female primary earners themselves. A likely secondary cause is the higher share of labour hours and earnings of male secondary earners (in female headed households) as displayed in Table 2.[24] Higher income share of male secondary earners then translates to higher positive influence of their income changes on the variance of family income shocks (i.e., income-pooling effect).[25] Regardless, we expect this effect to be small since the gap between the standard deviations of individual income and family market income for both male and female primary earners are roughly equal in size. Due to these individual and household gross earnings dynamics, government transfer has a stronger insurance effect against the second-order earnings risk of female headed households situated below the median of past regular market income, whereas only the poorest male headed households benefit from the transfer insurance. Second, concerning the skewness of individual market earnings shocks, those of female primary earners are on the whole greater in magnitude. Consequently, in terms of its insurance role against the third-order risks, family market income

[24]The substantial fraction of matching between higher income male and lower income female (appendix: Table 6) might account for the lower earnings of female secondary earners. Note that the lower female secondary earnings is not simply an ex-post marriage adjustment since we also observe educational attainment gap associated with couples (appendix: Table 7), which is also reflected by the lower weekly wages of female secondary earners relative to those of male secondary earners as evident in Table 2.

[25]We provide an explicit formula and discussion in the appendix A.2

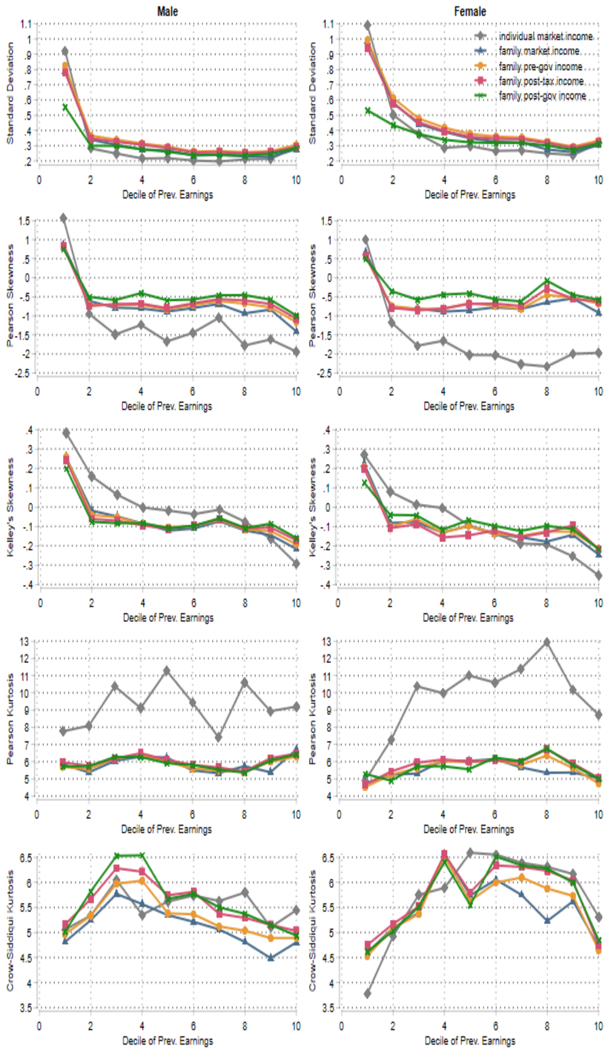

Figure 14: Moment properties of the distributions of annual income shocks of male (left panel) and female (right panel) primary earners (P1-P99 pearson statistics).

insurance is greater for female primary earners. This is further corroborated by the statistics in Table 2 which show that male secondary earners bring home substantially more income than their female counterparts do. Similarly, while the government insurance effect is small, there are signs of comparatively larger government insurance for lower income female headed households. As for the fourth-order risk, family market income appears to be the sole insurance and the role of government insurance is completely absent for both male and female heads.

Secondary Earner		Age	Higher Education	Weekly Hours	Weekly Wage	Annual Market Income	Annual Govt Transfer
1	Male	34.3	44%	29.7	$574	$21,417	$9,352.15
	Female	34.7	47%	25.2	$563	$20,372	$9,935.98
2	Male	37.5	56%	35.6	$809	$39,519	$4,021.98
	Female	36.4	53%	26.6	$651	$28,760	$5,636.72
3	Male	40.7	66%	38.4	$949	$48,841	$2,474.55
	Female	38.7	58%	29.4	$759	$37,230	$3,362.50
4	Male	42.5	73%	40.3	$1,185	$64,725	$1,454.20
	Female	40.2	66%	32.0	$943	$49,256	$1,432.93
5	Male	45.8	81%	41.9	$1,651	$100,803	$872.83
	Female	42.9	75%	33.6	$1,253	$72,570	$994.40

Table 2: Average 18-year statistics for male and female secondary earners by family market income quintile. All income and transfer values are stated in 2018 Australian dollar. As the naming suggests, female secondary earners belong to male headed households, and male secondary earners belong to female headed households.

Male and female primary earners diverge further with respect to their persistent income risks. From moment properties of the 3-year average income changes in Figure 15, at both the individual and household levels, income shocks on the female side continue to be more volatile than those of their male counterpart, particularly if they are below the median past earnings. Compared to the annual statistics in Figure 14, a marked difference occurs at the bottom-most decile where we see a substantial decline in the standard deviation of male primary earners relative to the rest of their group, whereas the improvement, though of significant magnitude in the absolute sense, still leaves the lowest income women worse off than their male and higher income female counterparts. The persistent shock process of female primary earners and their households may be influenced by motherhood and the entailing social security benefits that distort incentive. The institutionally induced rigidity in the labour market can further prevent labour supply adjustment for mothers. Precise answers to these questions, however, require a more sophisticated economic model beyond the scope of this study. What is clearly laid out in this case is that government transfer maintains its status as the crucial source of insurance against the persistent income shock dispersion for female headed households even when its insurance effect becomes almost trivial for male headed households. Furthermore, unlike transitory risks, more persistent adverse risks are harder to insure through self-insurance mechanisms such as savings and borrowings. This has important implications for structural models of Australian households and optimal tax and transfer system.

Next, we compare pearson skewness and kurtosis between the two types of households. The skewness and kurtosis exhibited in Figure 15 contain some distinct patterns from those of the annual statistics in Figure 14. On skewness, the distribution of female primary earner's income shocks remains more negatively skewed compared to that of male heads. Family market income

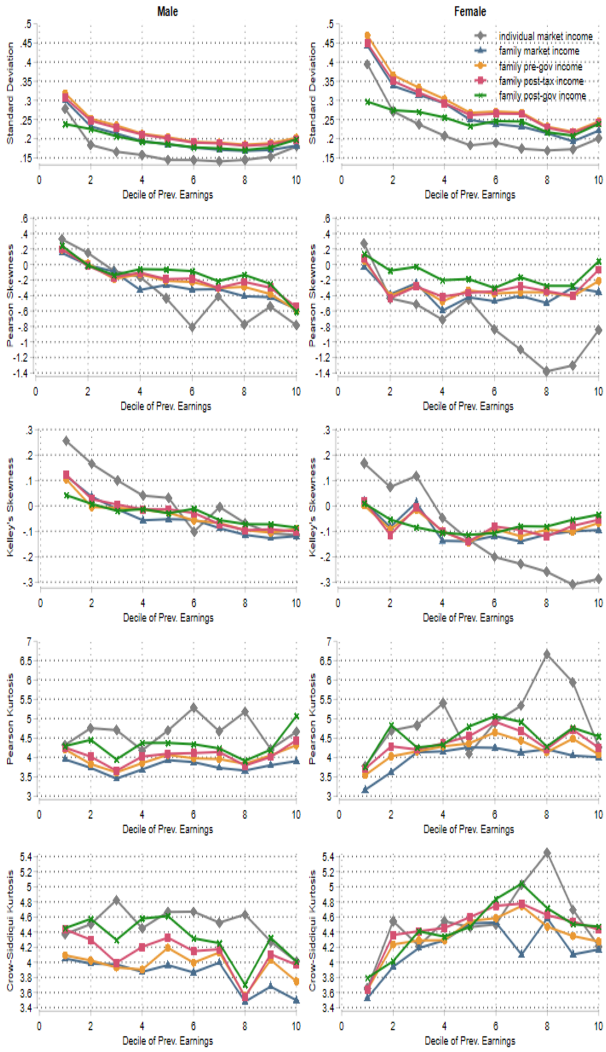

Figure 15: Moment properties of the distributions of 3-year average income shocks of male (*left panel*) and female (*right panel*) primary earners (P1-P99 pearson statistics)

insurance still exerts a strong third-order risk mitigating effect for women, particularly for those in the upper past income deciles. Conversely, female heads below the median benefit significantly more from government transfer insurance, especially in relation to their male counterparts. On kurtosis, male and female primary earners experience a sharp decrease in the fourth-order risk compared to their corresponding annual statistics, though that of female heads in the upper deciles remains relatively high. Family market income does reduce the kurtosis level in this case, but the effect is much less pronounced. On the other hand, government transfer causes small increases in kurtosis for both groups. Inspecting their empirical density distributions (figures not included) suggests that the increase in kurtosis is due to higher peakedness of the household disposable income shock distribution as opposed to thicker tails. Because male headed households (with female secondary earners) obtain larger public transfers on average (last column in Table 2), this may cause their household disposable income shocks to be more clustered about the mean of the distribution and helps explain the result.

Figure 14 and 15 show significant differences in income dynamics and insurance between male and female headed households in Australia. More importantly, we see that government transfer equalizes the risk outcome between male and female headed households. This further implies that examining income level and the first moment alone does not allow one to fully grasp the role of family and government transfers across socioeconomic and demographic groups. The supplementary statistics on average government transfer in Table 2, as an example, report larger transfers to male headed households even though their female counterpart has been found to persistently benefit more from government insurance against risks. In this manner, the first moment metrics agree with Kaygusuz (2015) and Nishiyama (2019) whose quantitative investigation into the impact of the US's social security system, particularly spousal and survival benefits, on American households finds that the schemes transfer welfare from two-earner (with both male and female spouses working) to single-earner (with male primary earners) households. Given that 45% of the female primary earners in our Australian sample is married or in de facto relationship, our results indicate that two-earner households benefit considerably from the progressive tax and transfer system. Note that, the strength of government insurance effect for female headed households, particularly against the third-order risk, weakens when single households are excluded, but the overall pattern remains. This implies that allowing for rich income dynamics and heterogeneity in gender and family structure is important for properly evaluating the social insurance effects. De Nardi, Fella and Paz-Pardo (2020) make a similiar point using the case study from the UK.

4.2 Marriage and Parenthood

Following the previous discussion, the central theme in this subsection is concerned with how family and government insurance differs among households varied by marital and parental status.[26] One reason is that the weight of parenthood (i.e., child-bearing and child-rearing responsibilities) tends to fall more heavily on mothers and consequently increases the earnings risk of female headed households. This might explain the persistently greater fluctuation of income changes and the government insurance effect for this group given that family support

[26]We count those married or in de factor relationship as married. Only parents of dependent children are counted as parents.

programs are strongly tied to the presence of dependent children; hence, the focus on parenthood in the first segment. Another reason is that women constitute the majority (87%) of lone parents in our sample, which might also explain the strong government insurance effect on female headed households. Thus, in the second segment, we examine the effects of family and government insurance on partnered and lone parent households.

Parent and Non-Parent Primary Earners

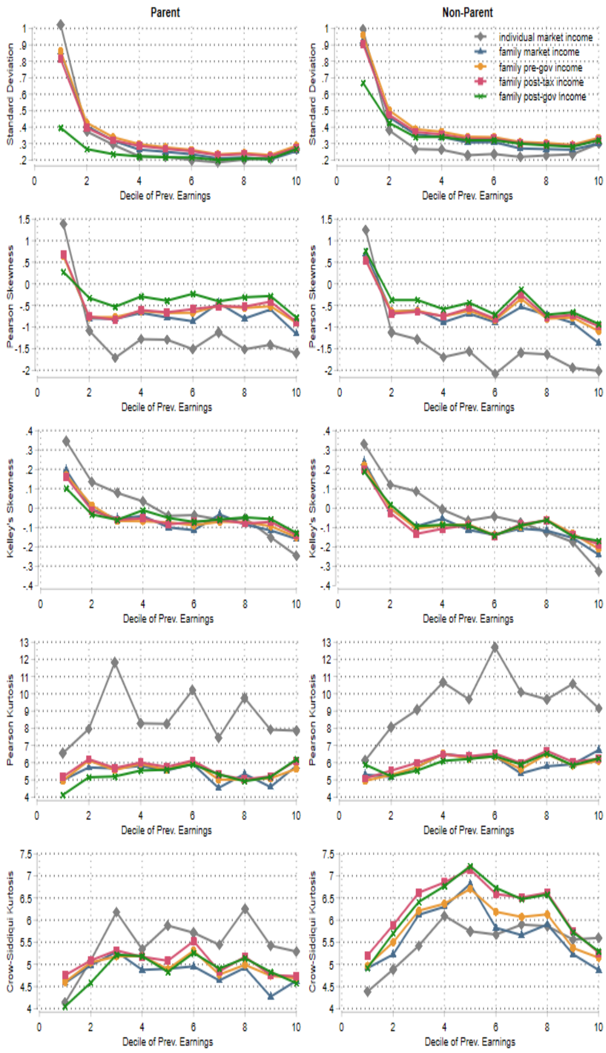

Figure 16: Moment properties of the distributions of annual income shocks of parent (*left panel*) and non-parent (*right panel*) primary earners (P1-P99 pearson statistics)

Apparent in Figure 16 is the difference between the insurance effects against the second- and third-order annual income risks faced by parents (left panel) and non-parents (right panel). Beginning with the standard deviation statistics, family market income behaves as insurance mitigating the income shock dispersion for parents in the bottom decile but not for non-parents. Government transfer insurance is visible for all parents below the median of past income distribution, whereas for non-parents, it is limited to the poorest households. To both household types, the magnitude of government insurance is the largest for the bottom decile although it is smaller for non-parents.

The corresponding statistics on 3-year average income changes in Figure 17 demonstrate the persistence of government insurance for parent households when family insurance completely vanishes. For non-parents, government transfer continues to serve as an important source of insurance but only for the poorest. For parent households, on the other hand, government transfer insurance effect remains substantial and extends even to those in the upper two deciles above the median past income.

Turning to pearson skewness of shocks in the second row of Figure 16, we see that family insurance is present for both parent and non-parent households, though it tends to be larger for non-parents. To both, the role of government transfer insurance in dampening the transitory third-order risk is small compared to that of family insurance. However, the government transfer insurance appears to be more widespread and represents a larger proportion of the total insurance for parent households.[27] This observation matches skewness statistics of the 3-year average changes in Figure 17 which show that for the most part, government insurance for parent households is relatively sizeable across income status. Additionally, it indicates that family market income is still the only major source of insurance against the third-order risk for non-parents at or above the median past income, whereas for parents within the same income bracket, their family market income, private transfer, and government transfer make up roughly equal shares of the total insurance.

As discussed in subsection 3.2.2, kurtosis is less straightforward to interpret. The pearson kurtosis measures in the fourth row of Figure 16 and Figure 17 illustrate that family market income significantly reduces the fourth-order earnings risk for parent and non-parent primary earners alike while government transfer plays virtually no role in the annual statistics and even generates more excess kurtosis in the 3-year average statistics. The question then is whether the higher (lower) clustering of shocks around the mean or the increased (decreased) density at the tails drives the increase (decrease) in the kurtosis level. Further inspection (see Figure 67 and 68 in appendix) indicates that the former effect usually prevails. That is, the fall in kurtosis associated with the distribution of family market income changes arises from the contraction of probability mass about the mean even when the tail mass increases (or sometimes remains unchanged). In other words, most primary earners undergo small or no earnings shocks, but additional income generating market activities from family members cause more households to experience moderate pre-government income shocks. Unlike family market income, however, government transfer creates a larger cluster around the mean, causing the peak of the shock distribution of the household disposable income to increase relative to that of the pre-transfer income. This process more than offsets the smaller decline in the tail density. Ultimately, the greater peakedness decides the direction of changes in the fourth moment. In layman's terms, government transfer leads to more households experiencing small or no shocks to their disposable income. The seemingly non-existent government insurance effect against the fourth-order risk of household disposable income is therefore not a sign of ineffectiveness of the social security system in lowering the likelihood of extreme shocks as one might otherwise be led to believe when reading the fourth moment statistics.

We can draw a few critical points from the above discussion. First, the existence of means-

[27] The non-robust moment statistics (containing all datapoints at the tails of the shock distributions) of Figure 79 in the appendix show decisively larger government insurance for parents relatively to that of their non-parent counterpart.

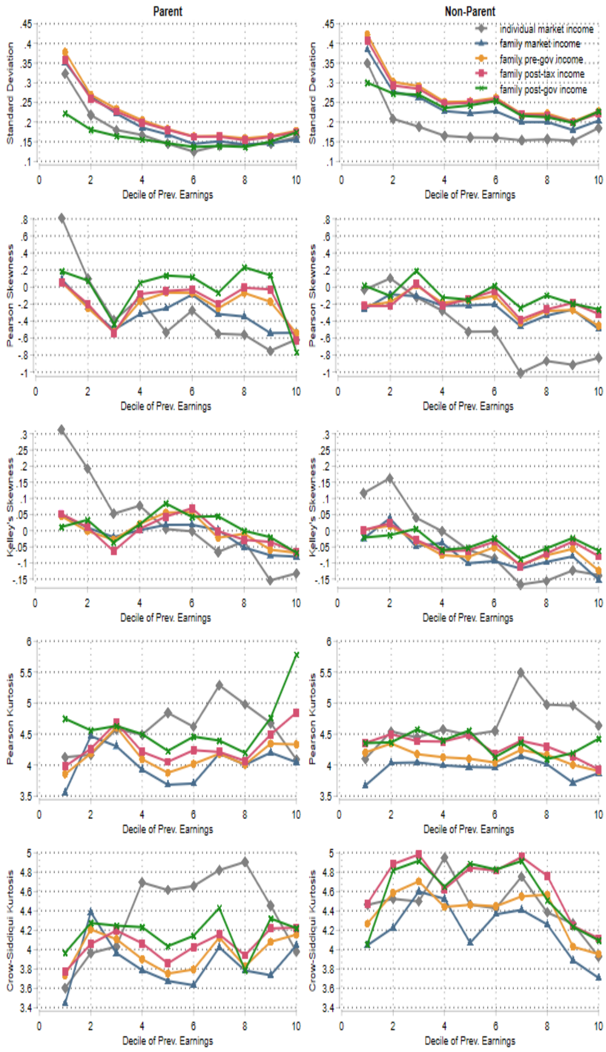

Figure 17: Moment properties of the distributions of 3-year average income shocks of parent (*left panel*) and non-parent (*right panel*) primary earners (P1-P99 pearson statistics)

tested benefits (independent of labour market participation) targeting parents might help explain the dissimilarities in lifecycle earnings risk and insurance between parents and non-parents. Second, the results are ex-post statistical measures and do not allow us to infer behavioural responses of households to the incentive (or disincentive) to work and save induced by the transfer system. It is possible that family insurance effect would change substantially were the government insurance absent. Third, in spite of the limitation stated, the inter-group comparison provides a hint of the behavioural responses to the presence of government support programs. Assuming that parents have at least as strong an incentive to insure their households against income shocks as non-parents do, then the smaller family insurance for parents relative to that of non-parents might suggest a crowding-out effect of government insurance on family insurance (i.e., work disincentive effect on secondary earners).[28] This would be aligned with our earlier results in subsection 3.2.3 and the findings by De Nardi et al. (2021) that family insurance effect is stronger in the US than that in the Netherlands, the latter of which has a bigger and more pervasive welfare system. The authors also point to the potential crowding-out effect of government insurance.

Partnered and Lone Parents

The analysis in the prior subsection reveals that parenthood, to a large extent, determines the size of government transfer insurance against transitory and persistent income shocks in Australia. Provided that the majority of lone parents are female and that female headed households benefit the most from government insurance, we dedicate this segment to an extended examination along the dimension of marital status.

The lack of sufficient sample size for lone parents means that 3-year average statistics are less reliable; thus, we limit our investigation to moments of the annual income shock distribution in Figure 18. The standard deviation measures in the top panel display a stark contrast between the insurance effects for partnered and lone parent households. Lone parents usually face a significantly greater second-order risk when compared to partnered parents within the same bracket. More interestingly, while family insurance against the second-order risk is missing for lone parents, their government insurance is large, especially for the bottom three deciles. In fact, the insurance magnitude is sufficient to close the initial gap between partnered and lone parents such that their household disposable income shock distributions end up at virtually the same level of dispersion. Its effect on partnered parents, on the other hand, is significant only for the poorest who benefit equally from family market income and government transfer insurance.

Pearson skewness statistics in the second row of Figure 18 yields a similar conclusion. The left panel shows that the dominant insurance against the third-order risk for partnered parents is family market income, whereas their government insurance is relatively small and intermittent. In contrast, for most of the lone parent households, a large fraction of insurance stems from the government transfer. This group does benefit from a relatively sizeable family market income insurance, but it applies to only a small subset around the median of the past income distribution. Therefore, in terms of insurance against the third-order risk, the main beneficiary of the government transfer programs is the lone parent households, which is an anticipated

[28] In fact, it is more plausible that parents have a stronger incentive to do so.

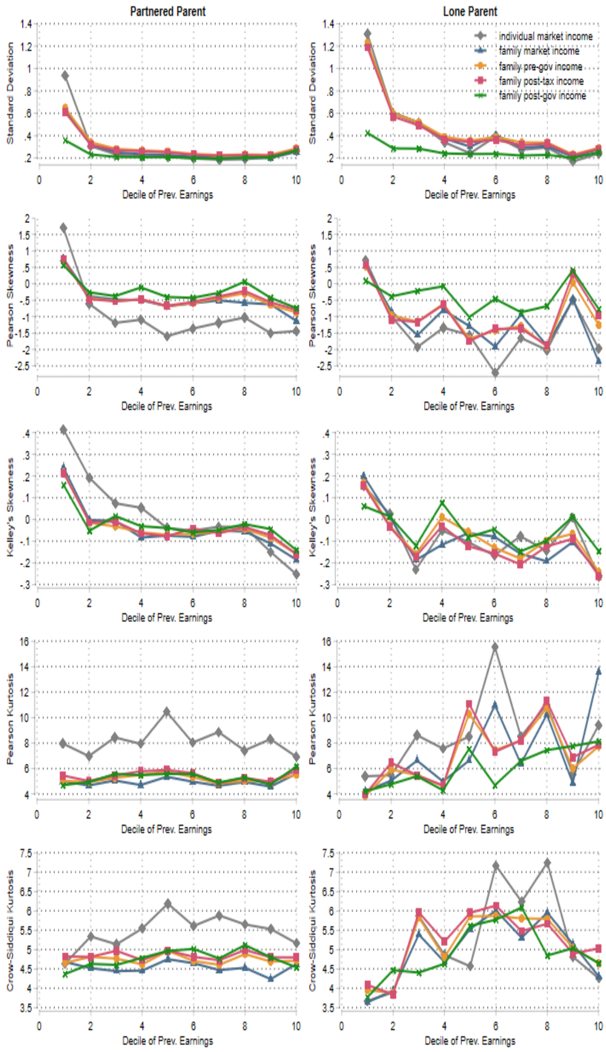

Figure 18: Moment properties of the distributions of annual income shocks of partnered parent (left panel) and lone parent (right panel) primary earners (P1-P99 pearson statistics)

outcome based on earlier results.

Looking at pearson kurtosis, we observe that government transfer does not lead to any changes in the kurtosis of pre-transfer income shock distribution for partnered parents. While it appears to reduce kurtosis for some lone parent households, the irregular pattern (likely caused by the small sample size of lone parents) does not allow us to establish a good baseline for comparison. The only reliable message emerging from the statistics of both household types is that family market income is the dominant kurtosis mitigating factor. Further examination into the empirical distribution of shocks once again suggests this result is driven by the lower peakedness of the distribution of family market income shocks relative to that of primary earner's market income. Simply speaking, while family market income does reduce the thickness of the tails to a certain degree, it simultaneously introduces a larger probability of moderate shocks.

In overall, our findings indicate that parent households benefit the most from the Australian government transfer programs in terms of their total insurance effect against the second-order and higher-order risks, and the bulk of benefits goes to lone parents. This in turn equalizes risk outcomes between partnered and lone parents as reflected by the comparability between the their disposable income risks despite the fact that the latter group's pre-government income shock distribution begins with much higher dispersion and skewness. What is also interesting is that the government transfer insurance extends to the upper income lone parents, perhaps a result of the means-tested transfers. Furthermore, because female lone parents constitute the majority of this group, the public transfer insurance affects them the most. This can deteriorate human capital of the existing and potential female workforce by increasing the proportion of mothers, especially those young and unskilled, choosing to exit the labour force. However, the insurance also potentially improves the well-being of children and the lone mothers themselves. The positives and negatives of the transfer programs can only be ascertained with more sophisticated quantitative models that capture the behavioral responses to such policies and their welfare implication. Using the current work for guidance, this subject is explored in our forthcoming paper.

5 Conclusion

This paper provides evidence of the non-linear and non-Gaussian features of the income dynamics in Australia. Similar to other studies on the OECD countries, the earnings risk of working-age Australian primary earners and their households vary over age and income. For instance, though the shock distribution of the majority is left skewed and leptokurtic with small to moderate variance, the income processes of specific groups such as the poorest, richest, youngest, and oldest exhibit distinct dynamics from those commonly observed. Differently, our findings reveal different roles of hours and wages in accounting for the earnings risk process. In lieu of hour changes, wages drive the second-order risk. Hours, on the contrary, contribute significantly more to the third- and fourth-order risks. Wage changes also constitute the main factor explaining the upward and downward movements of earnings changes, while the contribution by hour changes is relatively small. The single exception is for workers in the bottom income decile whose rises and falls in earnings are driven primarily by hour changes. We believe institutional differences to be behind these cross-country dissimilarities.

Another point of departure in this paper is concerned with family and government insurance against earnings risk. In general, we find that family income and government transfer are major sources of insurance as the previous studies do. However, government insurance is an important mechanism insuring primary earners against the second-order risk (or shock dispersion), whereas family insurance is the dominant insurance against the third- and fourth-order risks (or the magnitude and probability of adverse extreme shocks). A crucial caveat is, as we have demonstrated, a smaller kurtosis of the post-government income does not directly imply a better risk sharing arrangement. Therefore, interpreting the fourth moment of shocks should be done with caution.

We also extend the previous work on income dynamics by analyzing demographic characteristics and their role in determining earnings risk and insurance. First, we find that against higher-order risks, the family insurance effect is generally larger for non-parents, and the government insurance effect tends to be more pronounced for parents. Along the same line, we highlight the passiveness on the part of spouses and the strong response from public transfers to primary earners' earnings shocks. Given the family-oriented nature of the Australian transfer schemes, these point to the crowding-out effect of government insurance on family insurance. Second, although the social security system seems to redistribute resources from female headed households to male headed households (who typically represent two-earner and single-earner households, respectively) according to first moment income statistics, the narrative may change when one account for the government insurance effect against the second and higher-order risks. More specifically, female headed households benefit substantially more from the public transfer insurance such that, despite facing higher risks initially, the measures of their transitory and persistent disposable income risks are at the same level as those of their male counterpart. We observe a similar equalization effect between partnered and lone parents. In contrast, because government transfer leaves non-parents' household disposable income with more volatility and more extreme adverse shocks relative to those of parent households, the induced inequality by the transfer programs in Australia from the viewpoint of earnings risk, is perhaps between these two groups. Third, certain demographics in Australia such as female heads of households and non-parents (both are not mutually exclusive) experience income risks that are quite persistent and thus more difficult to self-insure. De Nardi, Fella and Paz-Pardo (2020) shows how incorporating this element of earnings dynamics into structural economic models can therefore affect resultant optimal policy recommendations in a significant way.

Lastly, we limit our sample to primary earners and therefore exclude retirees and the largest transfer program in Australia, the Age Pension. Accounting for Age Pension may enlarge the role of government insurance. Moreover, as we set out to document the dynamics of income process in Australia, we inevitably leave out consumption risk. An analysis of consumption contains crucial economic elements of family and government, namely, consumption equivalence scale, non-cash transfer, and indirect taxes, among others. We leave this question for future research.

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A Appendix

A.1 Derivations of moments

We have:

$$
\begin{aligned}
y_{t,t} &= w_{i,t} \times h_{i,t} \\
log(y_{i,t}) &= log(w_{i,t}) + log(h_{i,t}) \\
\frac{d \log(y_{i,t})}{dt} &= \frac{d \log(w_{i,t})}{dt} + \frac{d \log(h_{i,t})}{dt} \\
\frac{\Delta y_{i,t}}{dt} &= \frac{\Delta w_{i,t}}{dt} + \frac{\Delta h_{i,t}}{dt}
\end{aligned}
$$

This is an equation of changes per unit time. We suppress the subscript and write as:

$$\Delta y = \Delta w + \Delta h$$

Let $\tilde{\mu}_z^k := \mathbb{E}\left(\frac{z-\mu_z}{\sigma_z}\right)^k$ be the k^{th} standardized moment of a random variable z, where

- $\mu_z := \mathbb{E}_z$, and
- $\sigma_z := \sqrt{var(z)} = \sqrt{E(z-\mu_z)^2}$.

We can then derive and decompose the second, third, and fourth moments.

A.1.1 Second Moment

$$
\begin{aligned}
var(\Delta y) &= var(\Delta w + \Delta h) \\
&= var(\Delta w) + var(\Delta h) + 2cov(\Delta w, \Delta h)
\end{aligned}
$$

Or, equivalently

$$\sigma_{\Delta y}^2 = \sigma_{\Delta w}^2 + \sigma_{\Delta h}^2 - 2cov(\Delta w, \Delta h)$$

A.1.2 Third Moment

Following the definition of a standardized third moment,

$$
\begin{aligned}
\tilde{\mu}^3_{\Delta y} &= \mathbb{E}\left(\frac{\Delta y - \mu_{\Delta y}}{\sigma_{\Delta y}}\right)^3 \\
&= \frac{1}{\sigma^3_{\Delta y}}\mathbb{E}\left[\Delta y^3 - 3\Delta y^2 \mu_{\Delta y} + 3\Delta y \mu^2_{\Delta y} - \mu^3_{\Delta y}\right] \\
&= \frac{1}{\sigma^3_{\Delta y}}\mathbb{E}\left[(\Delta w + \Delta h)^3 - 3(\Delta w + \Delta h)^2(\mu_{\Delta w} + \mu_{\Delta h}) + 3(\Delta w + \Delta h)(\mu_{\Delta w} + \mu_{\Delta h})^2 - (\mu_{\Delta w} + \mu_{\Delta h})^3\right] \\
&= \frac{1}{\sigma^3_{\Delta y}}\mathbb{E}[\Delta w^3 + 3\Delta w^2 \Delta h + 3\Delta w \Delta h^2 + \Delta h^3 \\
&\qquad -3(\Delta w^2 + 2\Delta w \Delta h + \Delta h^2)(\mu_{\Delta w} + \mu_{\Delta h}) \\
&\quad +3(\Delta w + \Delta h)(\mu^2_{\Delta w} + 2\mu_{\Delta w}\mu_{\Delta h} + \mu^2_{\Delta h}) \\
&\qquad -(\mu^3_{\Delta w} + 3\mu^2_{\Delta w}\mu_{\Delta h} + 3\mu_{\Delta w}\mu^2_{\Delta h} + \mu^2_{\Delta h})] \\
&= \frac{1}{\sigma^3_{\Delta y}}\mathbb{E}[\Delta w^3 + 3\Delta w^2 \Delta h + 3\Delta w \Delta h^2 + \Delta h^3 \\
&\qquad -3(\Delta w^2 \mu_{\Delta w} + 2\Delta w \Delta h \mu_{\Delta w} + \Delta h^2 \mu_{\Delta w} + \Delta w^2 \mu_{\Delta h} + 2\Delta w \Delta h \mu_{\Delta h} + \Delta h^2 \mu_{\Delta h}) \\
&\quad +3(\Delta w \mu^2_{\Delta w} + 2\Delta w \mu_{\Delta w}\mu_{\Delta h} + \Delta w \mu^2_{\Delta h} + \Delta h \mu^2_{\Delta w} + 2\Delta h \mu_{\Delta w}\mu_{\Delta h} + \Delta h \mu^2_{\Delta h}) \\
&\qquad -(\mu^3_{\Delta w} + 3\mu^2_{\Delta w}\mu_{\Delta h} + 3\mu_{\Delta w}\mu^2_{\Delta h} + \mu^2_{\Delta h})] \\
&= \frac{1}{\sigma^3_{\Delta y}}\left[\mathbb{E}(\Delta w - \mu_{\Delta w})^3 + \mathbb{E}(\Delta h - \mu_{\Delta h})^3\right] \\
&\qquad + \frac{3}{\sigma^3_{\Delta y}}\mathbb{E}(\Delta w \Delta h^2 - \Delta h^2 \mu_{\Delta w} - 2\Delta h \Delta w \mu_{\Delta h} + 2\mu_{\Delta w}\mu_{\Delta h}\Delta h + \mu^2_{\Delta h}\Delta w - \mu^2_{\Delta h}\mu_{\Delta w}) \\
&\quad + \frac{3}{\sigma^3_{\Delta y}}\mathbb{E}(\Delta w^2 \Delta h - \Delta w^2 \mu_{\Delta h} - 2\Delta w \Delta h \mu_{\Delta w} + 2\mu_{\Delta w}\mu_{\Delta h}\Delta w + \Delta h \mu^2_{\Delta w} - \mu^2_{\Delta w}\mu_{\Delta h}) \\
&= \frac{1}{\sigma^3_{\Delta y}}\left[\mathbb{E}(\Delta w - \mu_{\Delta w})^3 + \mathbb{E}(\Delta h - \mu_{\Delta h})^3\right] \\
&\qquad + \frac{3}{\sigma^3_{\Delta y}}\mathbb{E}\left[\Delta h^2(\Delta w - \mu_{\Delta w}) - 2\Delta h \mu_{\Delta h}(\Delta w - \mu_{\Delta w}) + \mu^2_{\Delta h}(\Delta w - \mu_{\Delta w})\right] \\
&\quad + \frac{3}{\sigma^3_{\Delta y}}\mathbb{E}\left[\Delta w^2(\Delta h - \mu_{\Delta h}) - 2\Delta w \mu_{\Delta w}(\Delta h - \mu_{\Delta h}) + \mu^2_{\Delta w}(\Delta h - \mu_{\Delta h})\right] \\
&= \frac{1}{\sigma^3_{\Delta y}}\left[\mathbb{E}(\Delta w - \mu_{\Delta w})^3 + \mathbb{E}(\Delta h - \mu_{\Delta h})^3\right] \\
&\qquad + \frac{3}{\sigma^3_{\Delta y}}\mathbb{E}\left[(\Delta h - \mu_{\Delta h})^2(\Delta w - \mu_{\Delta w})\right] \\
&\quad + \frac{3}{\sigma^3_{\Delta y}}\mathbb{E}\left[(\Delta w - \mu_{\Delta w})^2(\Delta h - \mu_{\Delta h})\right] \\
&= \frac{1}{\sigma^3_{\Delta y}}\left[\sigma^3_{\Delta w}\tilde{\mu}^3_{\Delta w} + \sigma^3_{\Delta h}\tilde{\mu}^3_{\Delta h}\right] \\
&\qquad + \frac{3}{\sigma^3_{\Delta y}}\left[\mathbb{E}(\Delta h - \mu_{\Delta h})^2(\Delta w - \mu_{\Delta w}) + \mathbb{E}(\Delta w - \mu_{\Delta w})^2(\Delta h - \mu_{\Delta h})\right]
\end{aligned}
$$

Where

- The first term of the RHS denotes the contributions of Δw and Δh independently to the skewness of Δy, and
- The second and third terms of the RHS denotes the contribution of the co-movement of

Δw and Δh to the skewness of Δy.

A.1.3 Fourth Moment

We follow a similar procedure to arrive at the below expression of the standardized fourth moment (kurtosis) of income changes:

$$
\begin{aligned}
\tilde{\mu}^4_{\Delta y} &= \mathbb{E}\left(\frac{\Delta y - \mu_{\Delta y}}{\sigma_{\Delta y}}\right)^4 \\
&= \frac{1}{\sigma^4_{\Delta y}}\left[\mathbb{E}(\Delta w - \mu_{\Delta w})^4 + \mathbb{E}(\Delta h - \mu_{\Delta h})^4\right] \\
&\qquad + \frac{4}{\sigma^4_{\Delta y}}\mathbb{E}\left[(\Delta h - \mu_{\Delta h})^3(\Delta w - \mu_{\Delta w})\right] + \frac{4}{\sigma^4_{\Delta y}}\mathbb{E}\left[(\Delta w - \mu_{\Delta w})^3(\Delta h - \mu_{\Delta h})\right] \\
&\quad + \frac{6}{\sigma^4_{\Delta y}}\mathbb{E}\left[(\Delta w - \mu_{\Delta w})^2(\Delta h - \mu_{\Delta h})^2\right] \\
&= \frac{1}{\sigma^4_{\Delta y}}\left[\sigma^4_{\Delta w}\tilde{\mu}^4_{\Delta w} + \sigma^4_{\Delta h}\tilde{\mu}^4_{\Delta h}\right] \\
&\qquad + \frac{4}{\sigma^4_{\Delta y}}\mathbb{E}\left[(\Delta h - \mu_{\Delta h})^3(\Delta w - \mu_{\Delta w})\right] + \frac{4}{\sigma^4_{\Delta y}}\mathbb{E}\left[(\Delta w - \mu_{\Delta w})^3(\Delta h - \mu_{\Delta h})\right] \\
&\quad + \frac{6}{\sigma^4_{\Delta y}}\mathbb{E}\left[(\Delta w - \mu_{\Delta w})^2(\Delta h - \mu_{\Delta h})^2\right] \\
\tilde{\mu}^4_{\Delta y} &= \frac{1}{\sigma^4_{\Delta y}}\left[\sigma^4_{\Delta w}\tilde{\mu}^4_{\Delta w} + \sigma^4_{\Delta h}\tilde{\mu}^4_{\Delta h}\right] \\
&\qquad + \frac{4}{\sigma^4_{\Delta y}}\mathbb{E}\left[(\Delta h - \mu_{\Delta h})^3(\Delta w - \mu_{\Delta w}) + (\Delta w - \mu_{\Delta w})^3(\Delta h - \mu_{\Delta h})\right] \\
&\quad + \frac{6}{\sigma^4_{\Delta y}}\mathbb{E}\left[(\Delta w - \mu_{\Delta w})^2(\Delta h - \mu_{\Delta h})^2\right]
\end{aligned}
$$

As in the previous case,

- The first term of the RHS denotes the contributions of Δw and Δh independently to the kurtosis of Δy, and
- The second and third terms of the RHS denotes the contribution of the co-movement of Δw and Δh to the kurtosis of Δy.

A.2 Income Pooling versus Added Worker Effects

Assuming that family income is a sum of primary earner and secondary earner's earnings, let:

- $f := family\ income$
- $p := primary\ earner's\ earnings$
- $s := secondary\ earner's\ earnings$

Therefore,

$$f(p, s) = p + s$$

By total differentiation,

$$\begin{aligned}
\frac{df}{dt} &= \frac{df}{dp}\frac{dp}{dt} + \frac{df}{ds}\frac{ds}{dt} \\
df &= dp + ds \\
\frac{df}{f} &= \frac{dp}{p}\frac{p}{f} + \frac{ds}{s}\frac{s}{f} \\
equivalently,\ \%\Delta f &= \%\Delta p \times f_p + \%\Delta s \times f_s
\end{aligned}$$

Where $f_p$denotes the family income share of the primary earner's earnings and $f_s$denotes the family income share of the secondary earner's earnings such that $f_p + f_s = 1$. Note that $f_p > f_s$ by our definition of primary earner, which implies $f_s \in [0, 0.5)$. We drop any observation with $f_p = f_s$.

We can then derive the expression of the variance of family income as:

$$VAR(\Delta f) = f_p^2 VAR(\Delta p) + f_s^2 VAR(\Delta s) + 2 f_p f_s COV(\Delta p, \Delta s)$$

On the RHS, the terms $f_p^2 VAR(\Delta p)$ denotes the contribution of primary earner's shock variance to the variance of family income changes. The second terms $f_s^2 VAR(\Delta s)$ denotes the contribution of secondary earner's shock variance, known as the *income-pooling effect*, which enlarges the variance of family income. The last terms $2 f_p f_s COV(\Delta p, \Delta s)$ is the contribution of the covariance of the two earners. $COV(\Delta p, \Delta s) < 0$ implies the *added-worker effect* which contracts the variance of family income. Note that adding more family members (e.g., resident independent children) may also reduce f_p and leads to a larger influence of $VAR(\Delta s)$.

A.3 HILDA: Descriptive statistics

Financial year	Individual	Household	Family (excl. lone person)	Family (incl. lone person)
2000-01	14,191	7,682	5,611	8,065
2001-02	13,115	7,245	5,187	7,540
2002-03	12,719	7,096	5,031	7,363
2003-04	12,454	6,987	4,909	7,237
2004-05	12,670	7,125	4,985	7,383
2005-06	12,722	7,139	4,991	7,420
2006-07	12,658	7,063	4,955	7,318
2007-08	12,642	7,066	4,937	7,303
2008-09	13,003	7,234	5,061	7,529
2009-10	13,229	7,317	5,154	7,614
2010-11	17,317	9,543	6,806	9,990
2011-12	17,216	9,537	6,734	9,920
2012-13	17,255	9,555	6,793	9,963
2013-14	17,144	9,538	6,746	9,920
2014-15	17,351	9,631	6,857	9,976
2015-16	17,499	9,750	6,885	10,086
2016-17	17,454	9,742	6,873	10,037
2017-18	17,324	9,639	6,818	9,950

Table 3: Sample size by year and unit of observation. The sample excludes dependent children and students but includes retirees, non-working students, and those with full-time domestic duties.

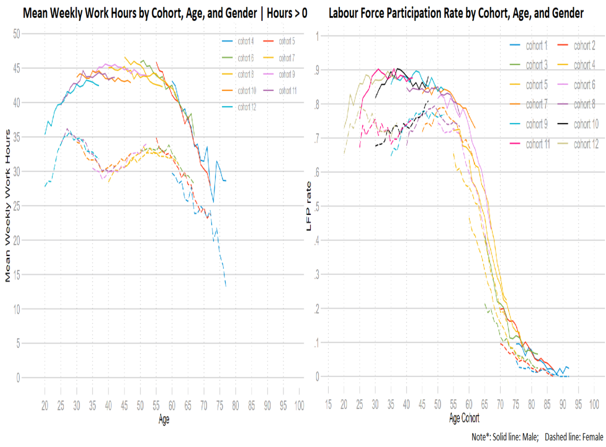

Figure 19: Age-profile of work hours and labour force participation rate by age, cohort, and gender (2001-2018)

	Age 25-34		Age 35-44		Age 45-54		Age 55-64		
Past decile	Part-time	Full-time	Part-time	Full-time	Part-time	Full-time	Part-time	Full-time	Total
1	231	294	497	309	519	319	396	124	2,689
	50.55%	6.42%	47.93%	3.82%	46.55%	3.85%	46.48%	3.46%	9.61%
	8.59%	10.93%	18.48%	11.49%	19.30%	11.86%	14.73%	4.61%	100.00%
2	66	556	195	688	184	694	125	292	2,800
	14.44%	12.15%	18.80%	8.51%	16.50%	8.38%	14.67%	8.15%	10.00%
	2.36%	19.86%	6.96%	24.57%	6.57%	24.79%	4.46%	10.43%	100.00%
3	51	598	78	789	98	783	95	350	2,842
	11.16%	13.06%	7.52%	9.76%	8.79%	9.45%	11.15%	9.77%	10.15%
	1.79%	21.04%	2.74%	27.76%	3.45%	27.55%	3.34%	12.32%	100.00%
4	34	554	65	782	83	821	54	380	2,773
	7.44%	12.10%	6.27%	9.67%	7.44%	9.91%	6.34%	10.61%	9.91%
	1.23%	19.98%	2.34%	28.20%	2.99%	29.61%	1.95%	13.70%	100.00%
5	21	614	56	871	82	775	66	352	2,837
	4.60%	13.41%	5.40%	10.77%	7.35%	9.36%	7.75%	9.83%	10.14%
	0.74%	21.64%	1.97%	30.70%	2.89%	27.32%	2.33%	12.41%	100.00%
6	20	454	48	967	36	874	48	340	2,787
	4.38%	9.92%	4.63%	11.96%	3.23%	10.55%	5.63%	9.49%	9.96%
	0.72%	16.29%	1.72%	34.70%	1.29%	31.36%	1.72%	12.20%	100.00%
7	16	420	38	889	47	992	23	424	2,849
	3.50%	9.17%	3.66%	11.00%	4.22%	11.98%	2.70%	11.84%	10.18%
	0.56%	14.74%	1.33%	31.20%	1.65%	34.82%	0.81%	14.88%	100.00%
8	10	393	27	911	27	982	19	409	2,778
	2.19%	8.58%	2.60%	11.27%	2.42%	11.86%	2.23%	11.42%	9.93%
	0.36%	14.15%	0.97%	32.79%	0.97%	35.35%	0.68%	14.72%	100.00%
9	4	359	24	916	30	1,064	15	415	2,827
	0.88%	7.84%	2.31%	11.33%	2.69%	12.85%	1.76%	11.59%	10.10%
	0.14%	12.70%	0.85%	32.40%	1.06%	37.64%	0.53%	14.68%	100.00%
10	4	336	9	963	9	978	11	495	2,805
	0.88%	7.34%	0.87%	11.91%	0.81%	11.81%	1.29%	13.82%	10.02%
	0.14%	11.98%	0.32%	34.33%	0.32%	34.87%	0.39%	17.65%	100.00%
Total	457	4,578	1,037	8,085	1,115	8,282	852	3,581	27,987
	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
	1.63%	16.36%	3.71%	28.89%	3.98%	29.59%	3.04%	12.80%	100.00%

Table 4: Proportion of primary earners in part-time employment by decile of usual weekly wages from main job. The subsample contains primary earners who report positive usual weekly labour earnings for at least 15 years of observation.

	Age 25-34		Age 35-44		Age 45-54		Age 55-64		
Past decile	Casual	Permanent	Casual	Permanent	Casual	Permanent	Casual	Permanent	Total
1	157	368	209	597	236	603	138	382	2,690
	29.96%	8.16%	33.02%	7.03%	37.64%	6.87%	35.57%	9.44%	9.61%
	5.84%	13.68%	7.77%	22.19%	8.77%	22.42%	5.13%	14.20%	100.00%
2	79	543	83	801	96	783	58	359	2,802
	15.08%	12.04%	13.11%	9.43%	15.31%	8.93%	14.95%	8.88%	10.01%
	2.82%	19.38%	2.96%	28.59%	3.43%	27.94%	2.07%	12.81%	100.00%
3	77	572	77	790	74	807	38	407	2,842
	14.69%	12.68%	12.16%	9.31%	11.80%	9.20%	9.79%	10.06%	10.15%
	2.71%	20.13%	2.71%	27.80%	2.60%	28.40%	1.34%	14.32%	100.00%
4	48	540	47	800	50	854	27	407	2,773
	9.16%	11.97%	7.42%	9.42%	7.97%	9.73%	6.96%	10.06%	9.91%
	1.73%	19.47%	1.69%	28.85%	1.80%	30.80%	0.97%	14.68%	100.00%
5	35	600	34	893	28	829	30	388	2,837
	6.68%	13.30%	5.37%	10.52%	4.47%	9.45%	7.73%	9.59%	10.14%
	1.23%	21.15%	1.20%	31.48%	0.99%	29.22%	1.06%	13.68%	100.00%
6	20	454	37	978	24	887	25	363	2,788
	3.82%	10.06%	5.85%	11.52%	3.83%	10.11%	6.44%	8.97%	9.96%
	0.72%	16.28%	1.33%	35.08%	0.86%	31.81%	0.90%	13.02%	100.00%
7	24	412	26	901	23	1,016	19	428	2,849
	4.58%	9.13%	4.11%	10.61%	3.67%	11.58%	4.90%	10.58%	10.18%
	0.84%	14.46%	0.91%	31.63%	0.81%	35.66%	0.67%	15.02%	100.00%
8	19	384	30	908	20	989	12	416	2,778
	3.63%	8.51%	4.74%	10.69%	3.19%	11.27%	3.09%	10.28%	9.92%
	0.68%	13.82%	1.08%	32.69%	0.72%	35.60%	0.43%	14.97%	100.00%
9	30	332	28	912	25	1,070	16	414	2,827
	5.73%	7.36%	4.42%	10.74%	3.99%	12.20%	4.12%	10.23%	10.10%
	1.06%	11.74%	0.99%	32.26%	0.88%	37.85%	0.57%	14.64%	100.00%
10	35	306	62	910	51	935	25	481	2,805
	6.68%	6.78%	9.79%	10.72%	8.13%	10.66%	6.44%	11.89%	10.02%
	1.25%	10.91%	2.21%	32.44%	1.82%	33.33%	0.89%	17.15%	100.00%
Total	524	4,511	633	8,490	627	8,773	388	4,045	27,991
	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
	1.87%	16.12%	2.26%	30.33%	2.24%	31.34%	1.39%	14.45%	100.00%

Table 5: Proportion of primary earners in casual employment by decile of usual weekly wages from main job. The subsample contains primary earners who report positive usual weekly labour earnings for at least 15 years of observation.

		Married		Single		
Income Quintile	Parenthood	Male	Female	Male	Female	Total
Q1	Non-parent	143	455	238	177	1,013
		4.34%	12.14%	21.38%	19.39%	11.17%
		14.12%	44.92%	23.49%	17.47%	100.00%
	Parent	167	809	12	117	1,105
		5.07%	21.58%	1.08%	12.81%	12.18%
		15.11%	73.21%	1.09%	10.59%	100.00%
Q2	Non-parent	200	407	319	217	1,143
		6.07%	10.86%	28.66%	23.77%	12.60%
		17.50%	35.61%	27.91%	18.99%	100.00%
	Parent	234	597	1	32	864
		7.10%	15.93%	0.09%	3.50%	9.53%
		27.08%	69.10%	0.12%	3.70%	100.00%
Q3	Non-parent	327	379	261	179	1,146
		9.92%	10.11%	23.45%	19.61%	12.64%
		28.53%	33.07%	22.77%	15.62%	100.00%
	Parent	399	386	2	19	806
		12.11%	10.30%	0.18%	2.08%	8.89%
		49.50%	47.89%	0.25%	2.36%	100.00%
Q4	Non-parent	361	255	165	120	901
		10.95%	6.80%	14.82%	13.14%	9.93%
		40.07%	28.30%	18.31%	13.32%	100.00%
	Parent	548	219	2	1	770
		16.63%	5.84%	0.18%	0.11%	8.49%
		71.17%	28.44%	0.26%	0.13%	100.00%
Q5	Non-parent	349	129	111	51	640
		10.59%	3.44%	9.97%	5.59%	7.06%
		54.53%	20.16%	17.34%	7.97%	100.00%
	Parent	568	112	2	0	682
		17.23%	2.99%	0.18%	0.00%	7.52%
		83.28%	16.42%	0.29%	0.00%	100.00%
	Total	3,296	3,748	1,113	913	9,070
	%	100.00%	100.00%	100.00%	100.00%	100.00%
	%	36.34%	41.32%	12.27%	10.07%	100.00%

Table 6: Cross-tabulation of frequencies between parenthood, marital status and gender. Since HILDA tracks individuals and their households over time, we present a snapshot of the first cohort entering the survey in 2001. The table suggests a negative assortative matching (or matching of unlike) between higher income males and lower income females.

	Married		Single		
Highest education attained	Male	Female	Male	Female	Total
High school or lower	1,226	2,227	639	494	4,586
	37.20%	59.45%	57.41%	54.11%	50.57%
	26.73%	48.56%	13.93%	10.77%	100.00%
Above high school,	1,741	1,221	424	350	3,736
at most bachelor's degree	52.82%	32.59%	38.10%	38.34%	41.20%
	46.60%	32.68%	11.35%	9.37%	100.00%
Above bachelor's degree,	329	298	50	69	746
at most post-graduate degree	9.98%	7.96%	4.49%	7.56%	8.23%
	44.10%	39.95%	6.70%	9.25%	100.00%
Total	3,296	3,746	1,113	913	9,068
%	100.00%	100.00%	100.00%	100.00%	100.00%
%	36.35%	41.31%	12.27%	10.07%	100.00%

Table 7: Cross-tabulation of frequency between education, marial status, and gender. Since HILDA tracks individuals and their households over time, we present a snapshot of the first cohort entering the survey in 2001. The table suggests a negative assortative matching (or matching of unlike) between higher education males and lower education females. The observed pattern becomes less pronounced in later years of survey, partly due to attrition and the inclusion of new and younger households in the survey.

A.4 Additional results: Dynamics of earnings, wages, and hours across selected subsamples

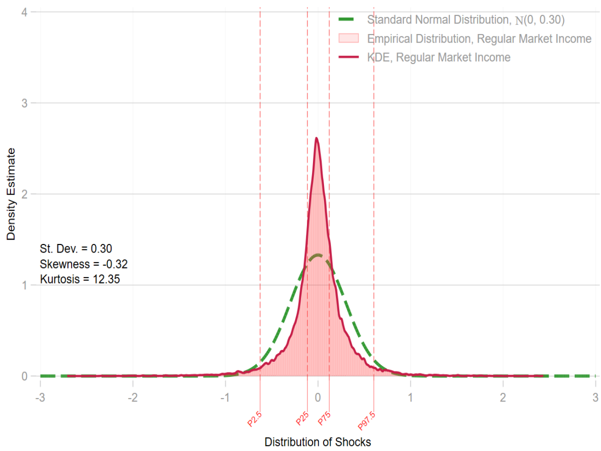

Figure 20: Empirical distributions of 3-year average growth of individual regular market income of primary earners aged 25-64.

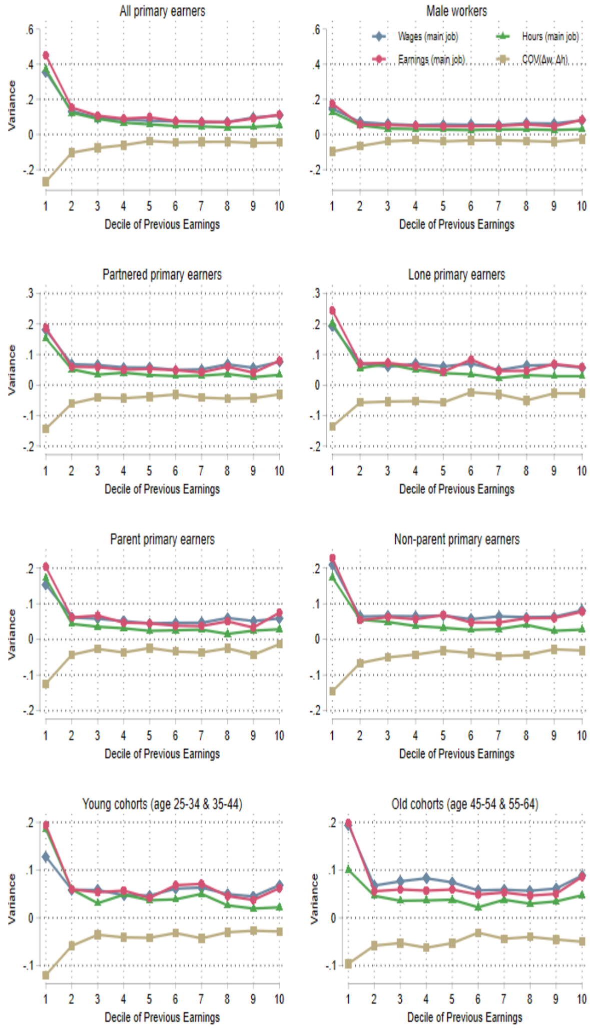

Figure 21: Variance of annual changes in usual weekly earnings, wages, and hours of selected subsamples. The top-left graph contains observations of all primary earners regardless of their employment history. For the remaining graphs, all selected subsamples are restricted to individuals who report positive usual weekly earnings (work at least one day per week at or above the minimum wage rate of AU$20 in 2018 dollar) for at least 15 years.

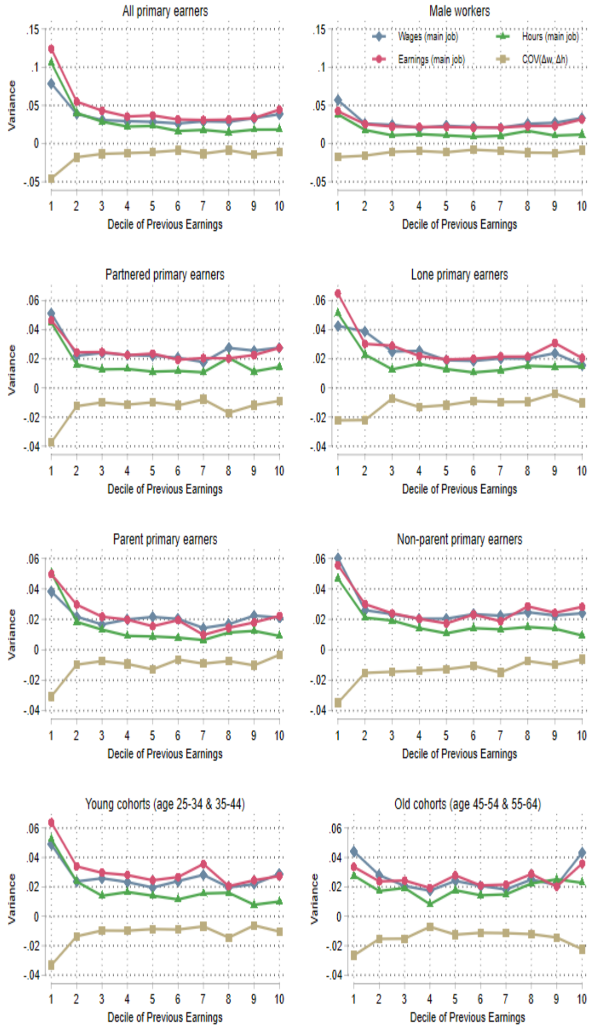

Figure 22: Variance of 3-year average changes in usual weekly earnings, wages, and hours of selected subsamples. The top-left graph contains observations of all primary earners regardless of their employment history. For the remaining graphs, all selected subsamples are restricted to individuals who report positive usual weekly earnings (work at least one day per week at or above the minimum wage rate of AU$20 in 2018 dollar) for at least 15 years.

Income Decile	N	Individual Labour Income	Individual Market Income	Household Pre-gov't Income	Household Disposable Income
1	9,544	59.75%	56.73%	27.54%	31.35%
2	9,559	6.41%	6.22%	4.05%	2.75%
3	9,541	-0.83%	-0.14%	0.42%	0.28%
4	9,556	-3.12%	-2.60%	-0.37%	-0.55%
5	9,524	-4.50%	-4.06%	-1.33%	1.83%
6	9,571	-4.76%	-4.75%	-2.53%	-1.86%
7	9,509	-4.53%	-4.95%	-2.04%	-1.6%
8	9,564	-3.98%	-4.58%	-1.98%	-1.52%
9	9,526	-5.34%	-6.38%	-3.76%	-2.92%
10	9,534	-7.70%	-10.12%	-7.34%	-5.94%

Table 8: Average Annual Residual Income Growth (2001-2018) of Employees. The growth statistics shown are for employees (not self-employed) age 25-64. The residual changes are obtained from controlling for time and age effects (see equation 1). The figures account for cross-decile mobility over time.

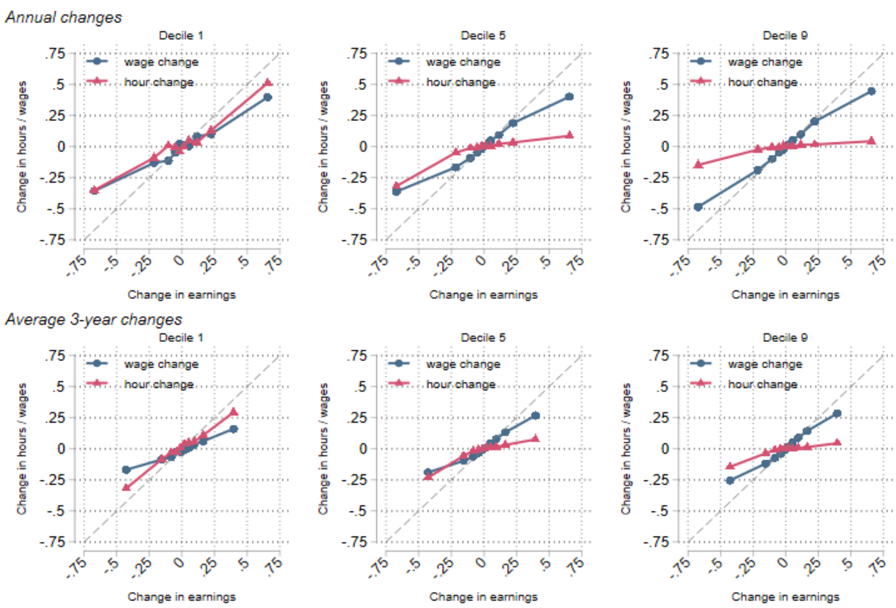

Figure 23: Changes in residual weekly wages and hours versus decile of changes in residual usual weekly earnings (from main job) for primary earners in the 1st, 5th, and 9th deciles of past usual weekly earnings. The top and bottom panels report annual changes and 3-year average changes, respectively. We consider all primary earners regardless of their work history.

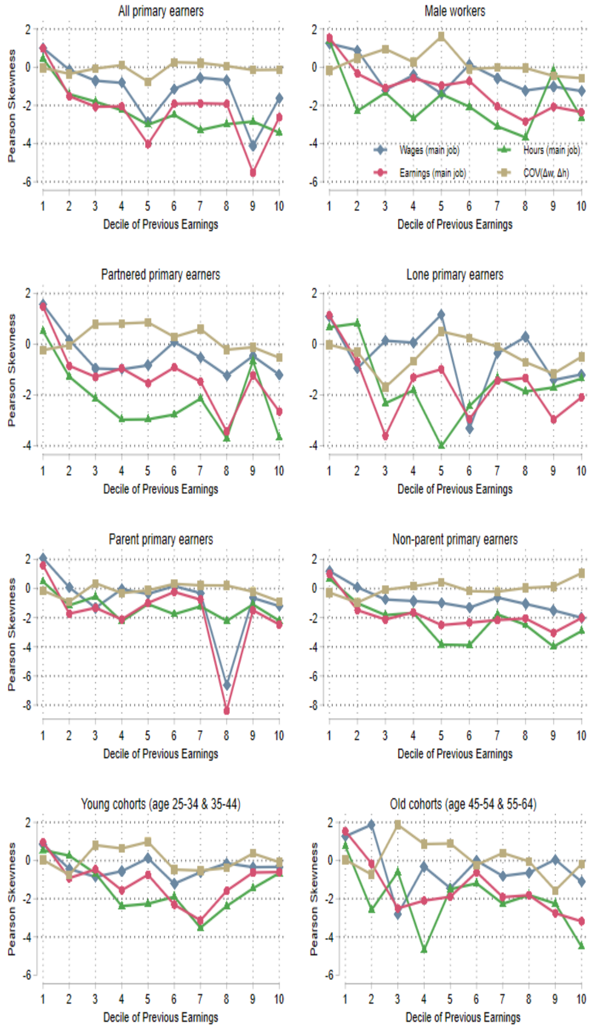

Figure 24: Pearson skewness of annual average changes in usual weekly earnings, wages, and hours of selected subsamples. The top-left graph contains observations of all primary earners regardless of their employment history. For the remaining graphs, all selected subsamples are restricted to individuals who report positive usual weekly earnings (work at least one day per week at or above the minimum wage rate of AU$20 in 2018 dollar) for at least 15 years.

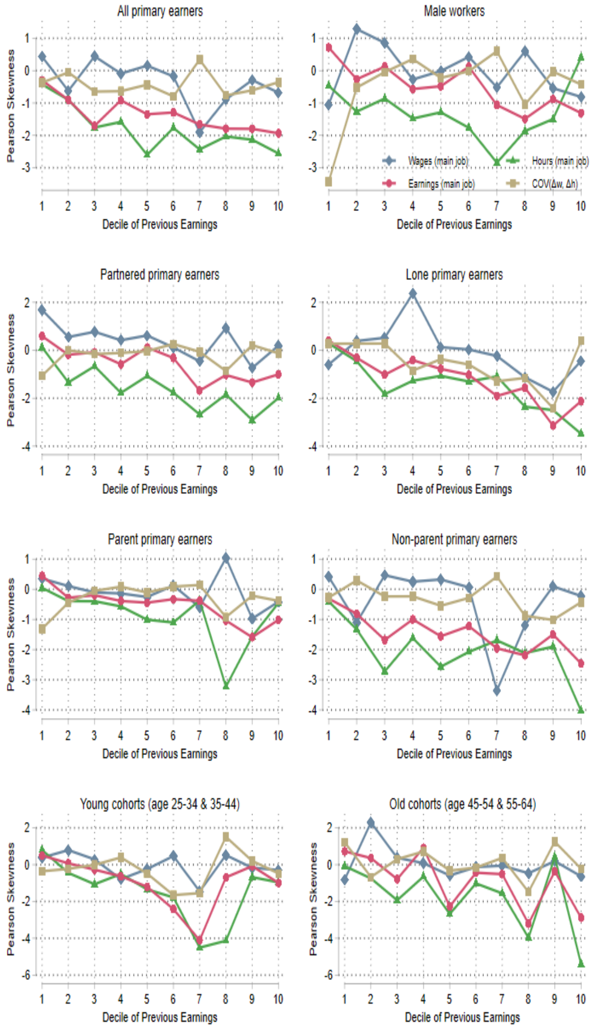

Figure 25: Pearson skewness of 3-year average changes in usual weekly earnings, wages, and hours of selected subsamples. The top-left graph contains observations of all primary earners regardless of their employment history. For the remaining graphs, all selected subsamples are restricted to individuals who report positive usual weekly earnings (work at least one day per week at or above the minimum wage rate of AU$20 in 2018 dollar) for at least 15 years.

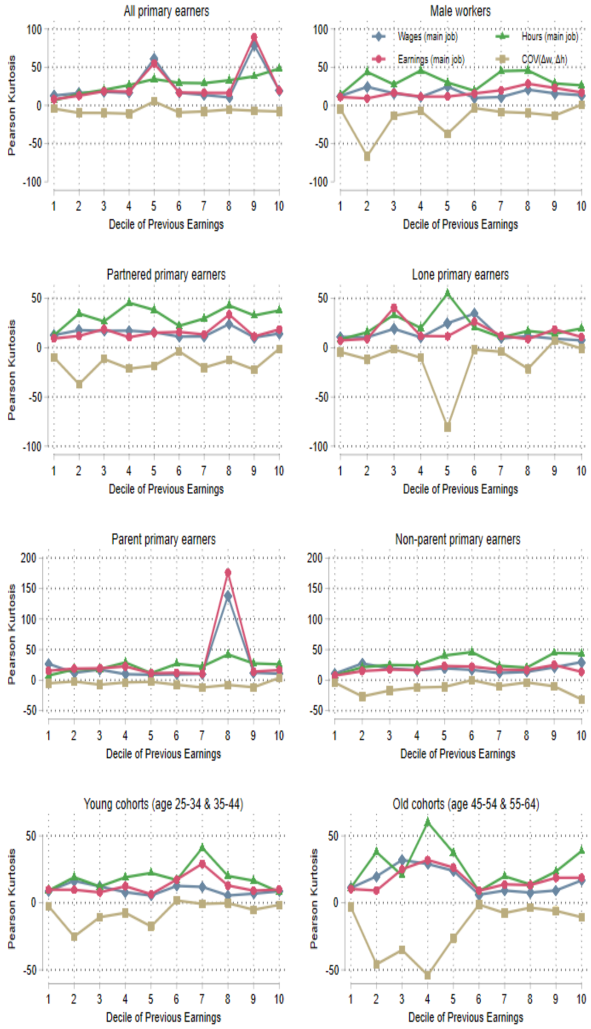

Figure 26: Pearson kurtosis of annual changes in usual weekly earnings, wages, and hours of selected subsamples. The top-left graph contains observations of all primary earners regardless of their employment history. For the remaining graphs, all selected subsamples are restricted to individuals who report positive usual weekly earnings (work at least one day per week at or above the minimum wage rate of AU$20 in 2018 dollar) for at least 15 years.

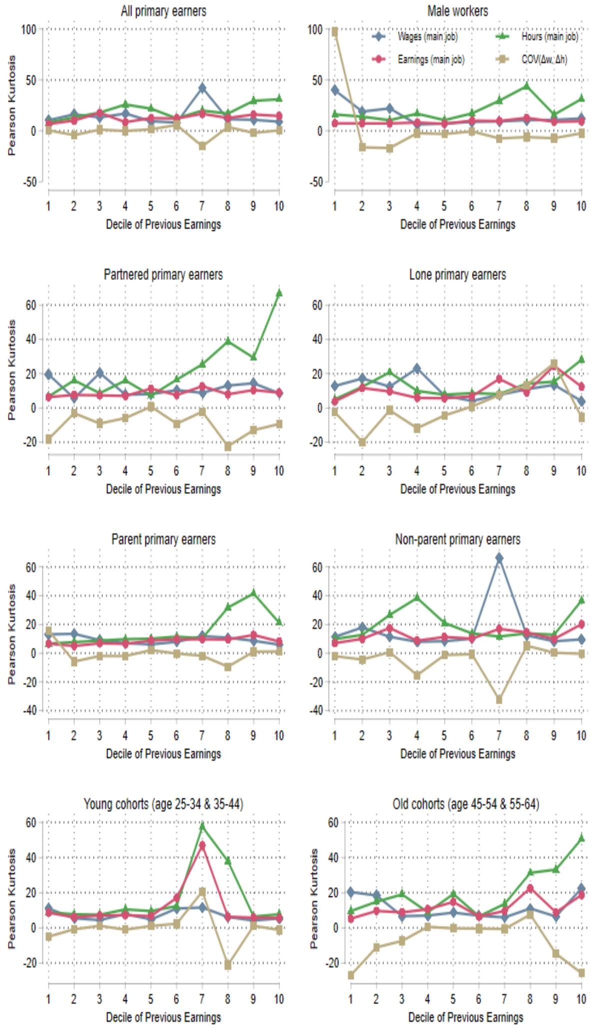

Figure 27: Pearson kurtosis of 3-year average changes in usual weekly earnings, wages, and hours of selected subsamples. The top-left graph contains observations of all primary earners regardless of their employment history. For the remaining graphs, all selected subsamples are restricted to individuals who report positive usual weekly earnings (work at least one day per week at or above the minimum wage rate of AU$20 in 2018 dollar) for at least 15 years.

A.5 Additional results: Second moment statistics of regular market earnings shocks by age group via different measures

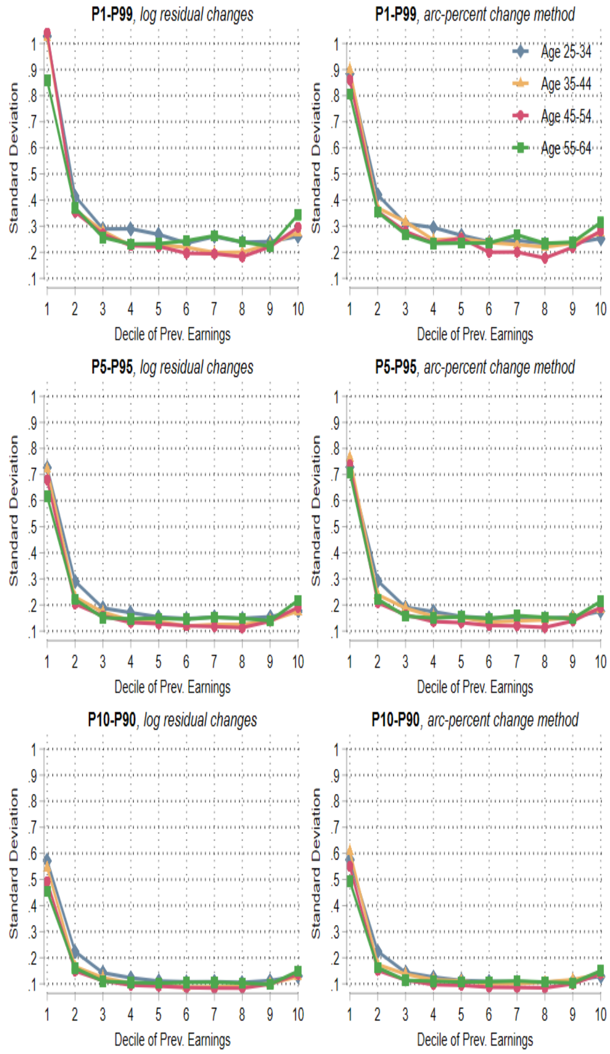

Figure 28: Second moment statistics measured at P1-P99, P5-P95, and P10-P90 of the annual regular market earnings change distributions of primary earners. The left panel's annual figures are statistics of the changes in log of residual income as described in equation 1. The right panel's annual figures are statistics obtained via arc-percent change method (i.e., statistics of mid-point averages of changes in the income-to-group-means ratio).

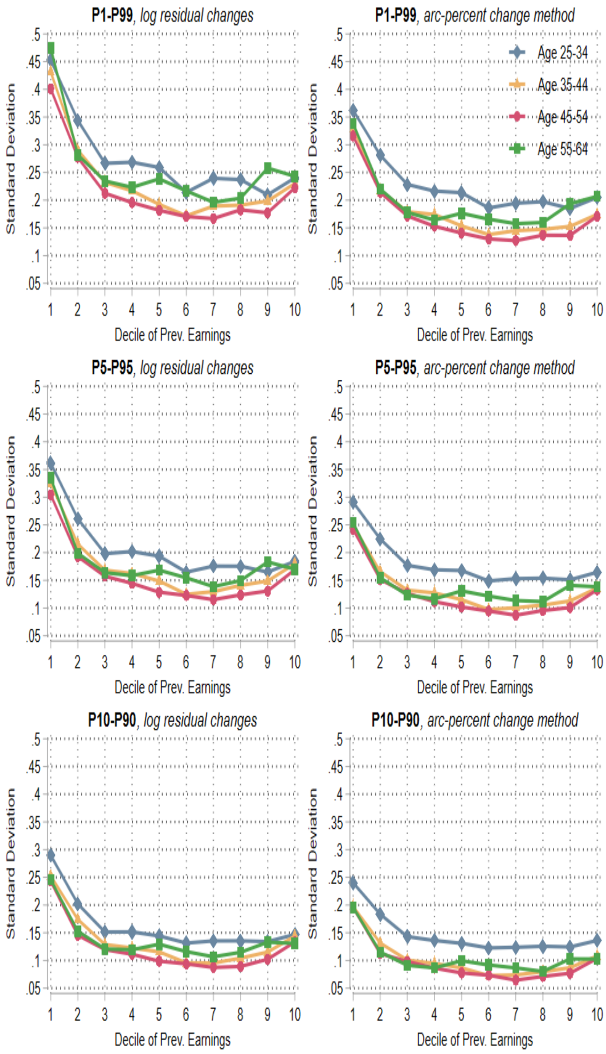

Figure 29: Second moment statistics measured at $P1-P99$, $P5-P95$, and $P10-P90$ of the 3-year average regular market earnings change distributions of primary earners. The left panel's annual figures are statistics of the changes in log of residual income as described in equation 1. The right panel's annual figures are statistics obtained via arc-percent change method (i.e., statistics of mid-point averages of changes in the income-to-group-means ratio).

A.6 Additional results: Family Insurance according to standardized and quantile-based measures of higher moments at P1-P99 and P5-P95 of the distributions of shocks at different income levels

A.6.1 P1-P99

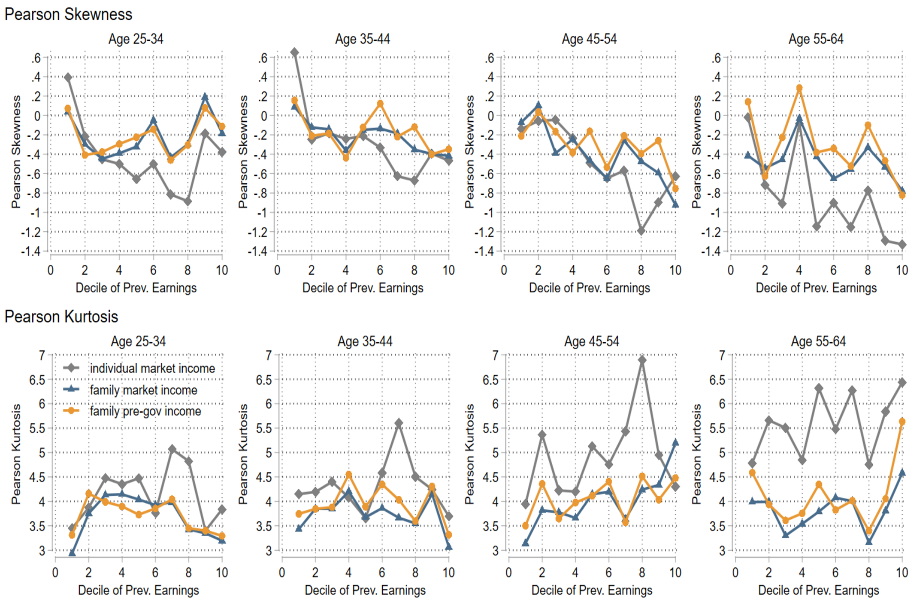

Figure 30: Skewness and kurtosis of the distribution of 3-year average changes of family income (P1-P99) at different levels. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of pre-government family income.

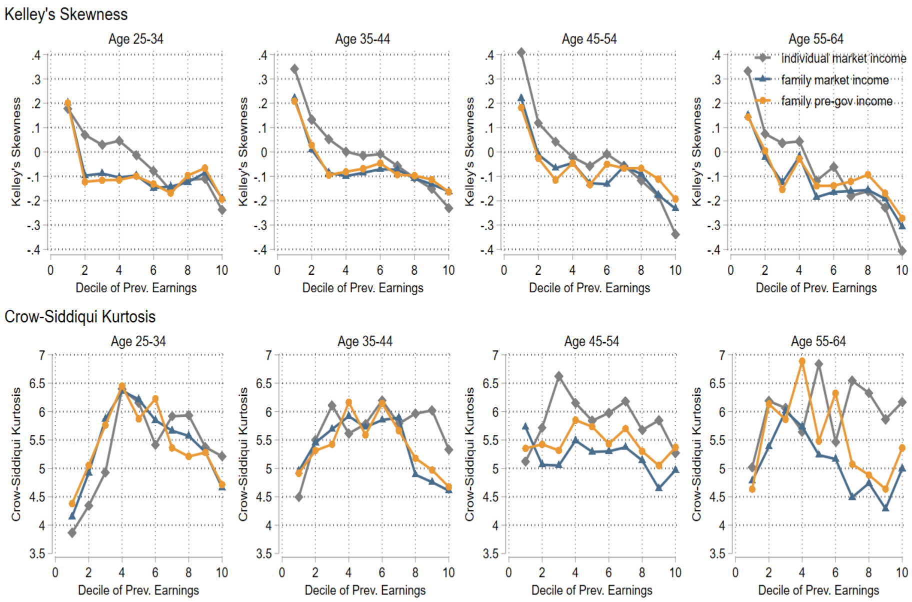

Figure 31: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of annual changes of family income (P1-P99) at different levels. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of family pre-government income.

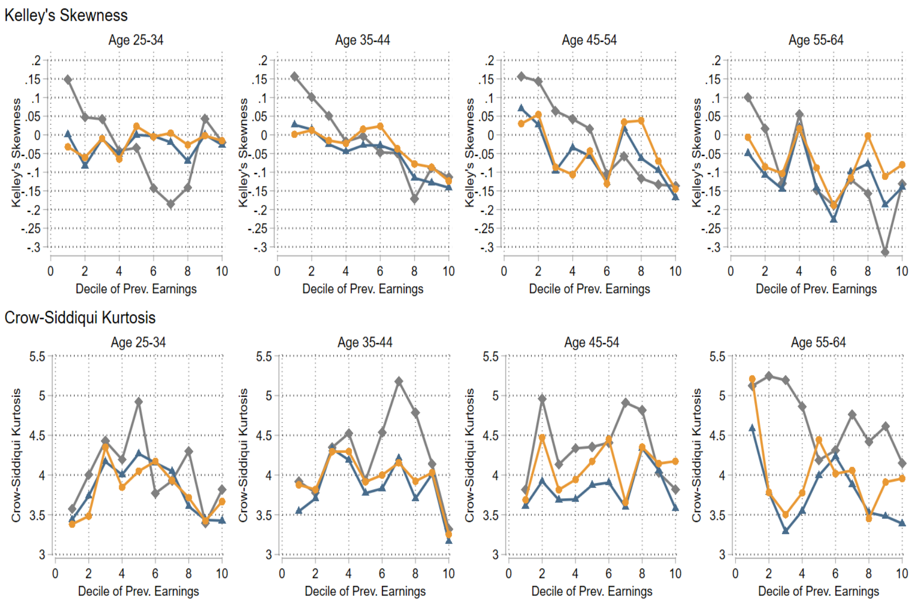

Figure 32: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of 3-year average changes of family income (P1-P99) at different levels. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of family pre-government income.

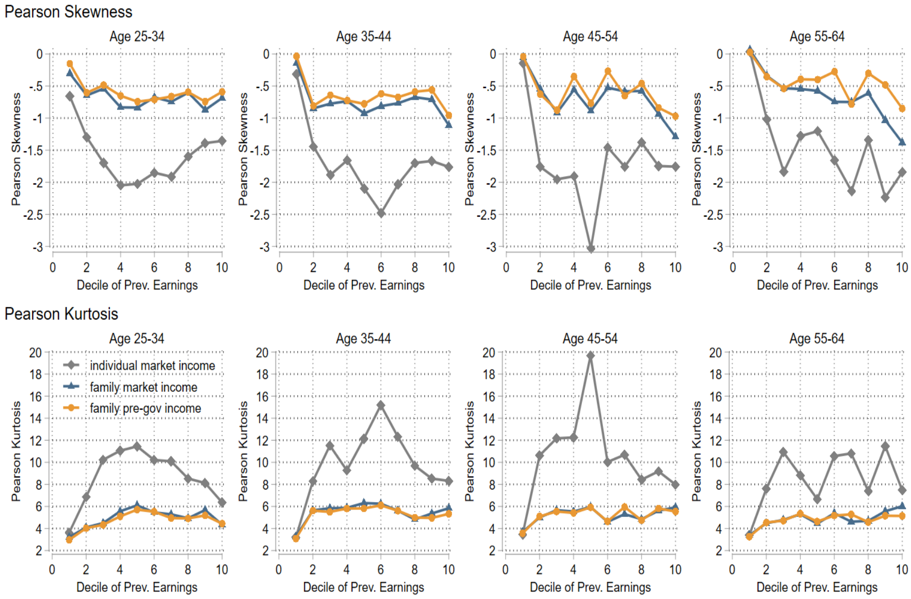

Figure 33: Skewness and kurtosis of the distribution of annual changes of family income (P1-P99) at different levels calculated via Arc-Percent Change method. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of pre-government family income.

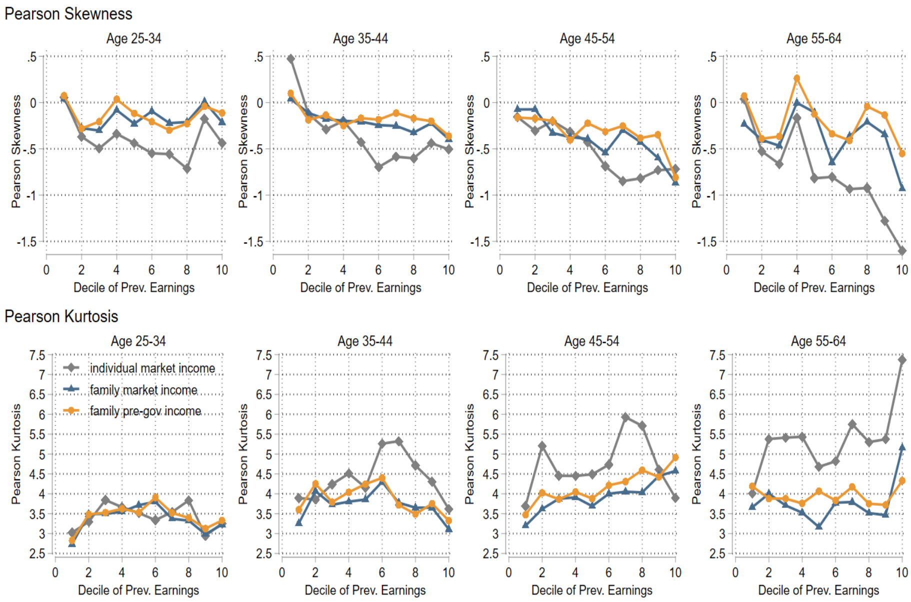

Figure 34: Skewness and kurtosis of the distribution of 3-year average changes of family income (P1-P99) at different levels calculated via Arc-Percent Change method. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of pre-government family income.

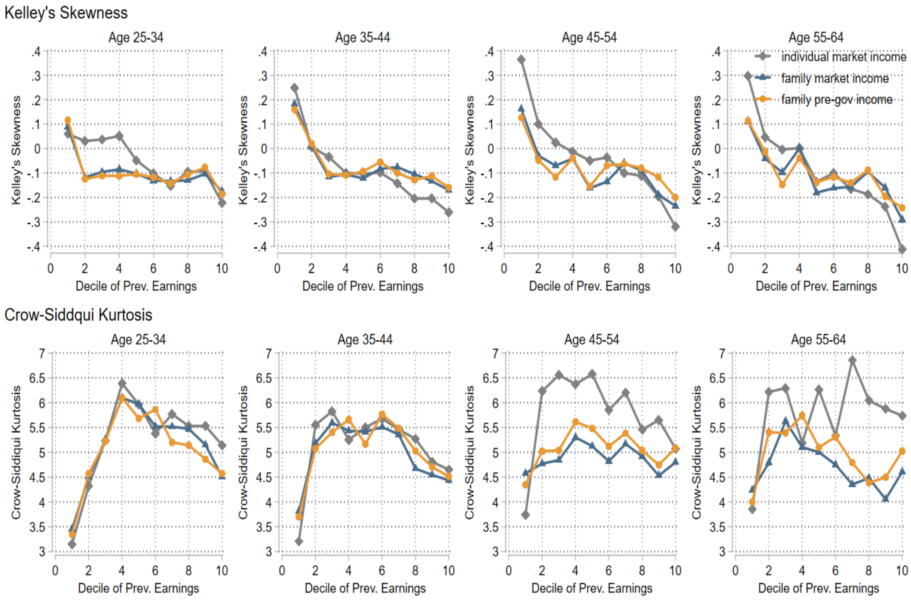

Figure 35: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of annual changes of family income (P1-P99) at different levels calculated via Arc-Percent Change method. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of pre-government family income.

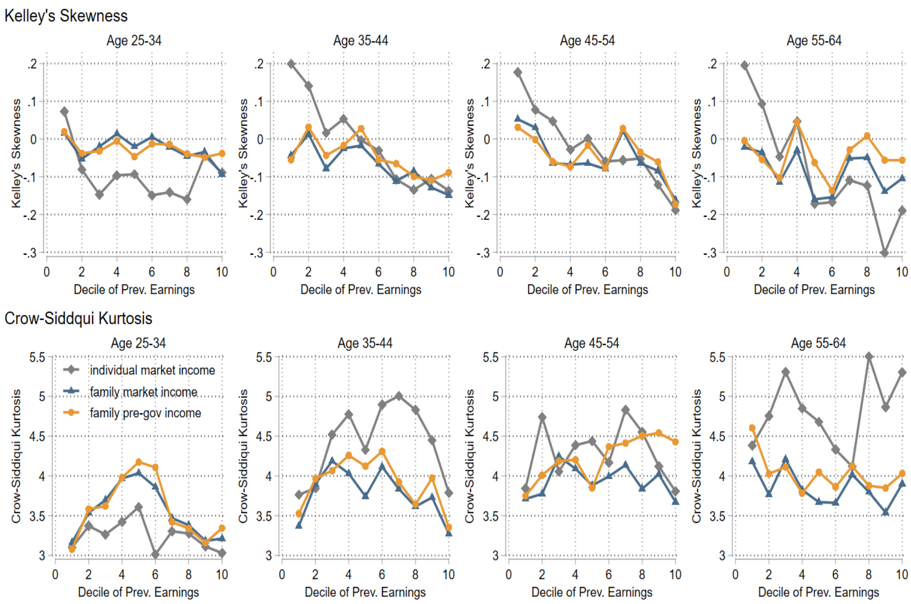

Figure 36: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of 3-year average changes of family income (P1-P99) at different levels calculated via Arc-Percent Change method. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of pre-government family income.

A.6.2 P5-P99

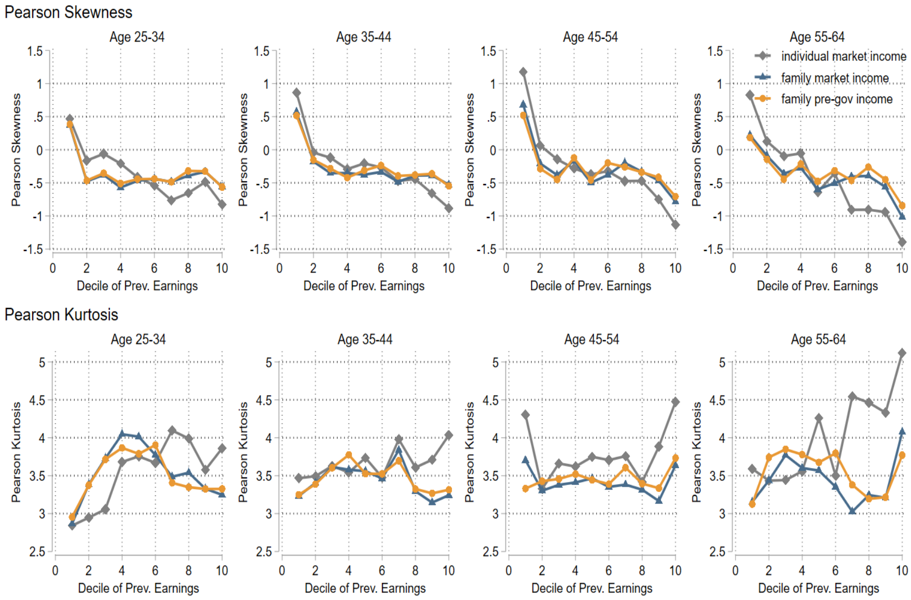

Figure 37: Skewness and kurtosis of the distribution of annual changes of family income (P5-P95) at different levels. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of pre-government family income.

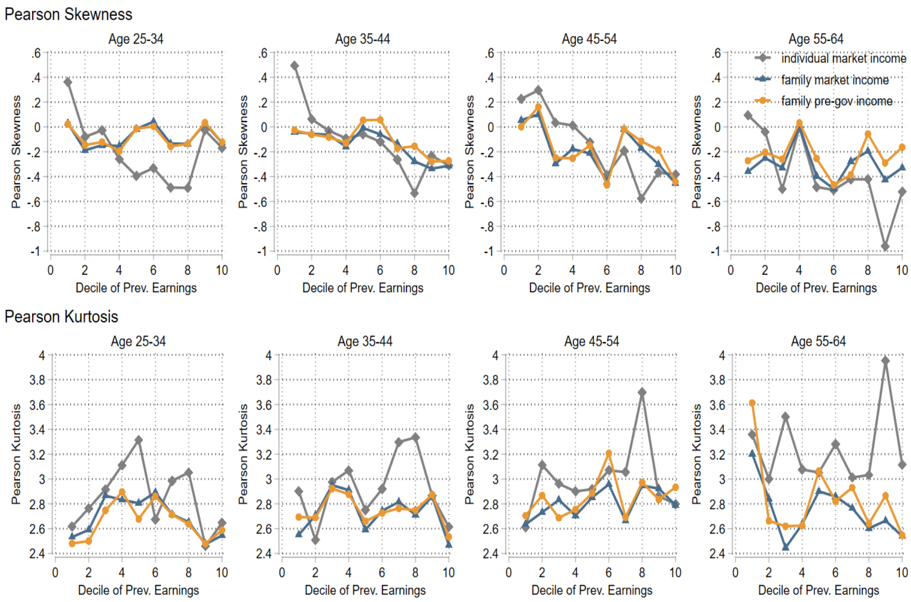

Figure 38: Skewness and kurtosis of the distribution of 3-year average changes of family income (P5-P95) at different levels. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of pre-government family income.

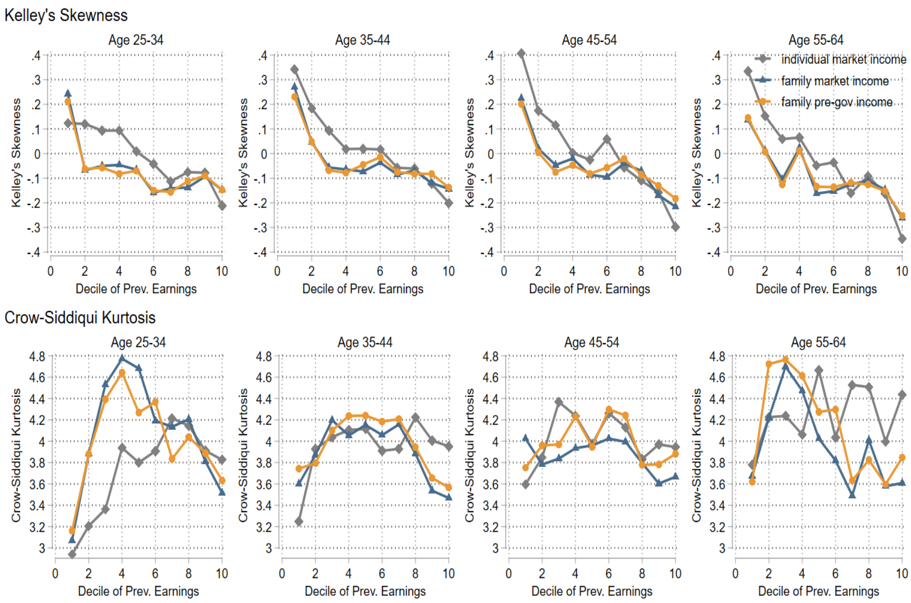

Figure 39: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of annual changes of family income (P5-P95) at different levels. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of family pre-government income.

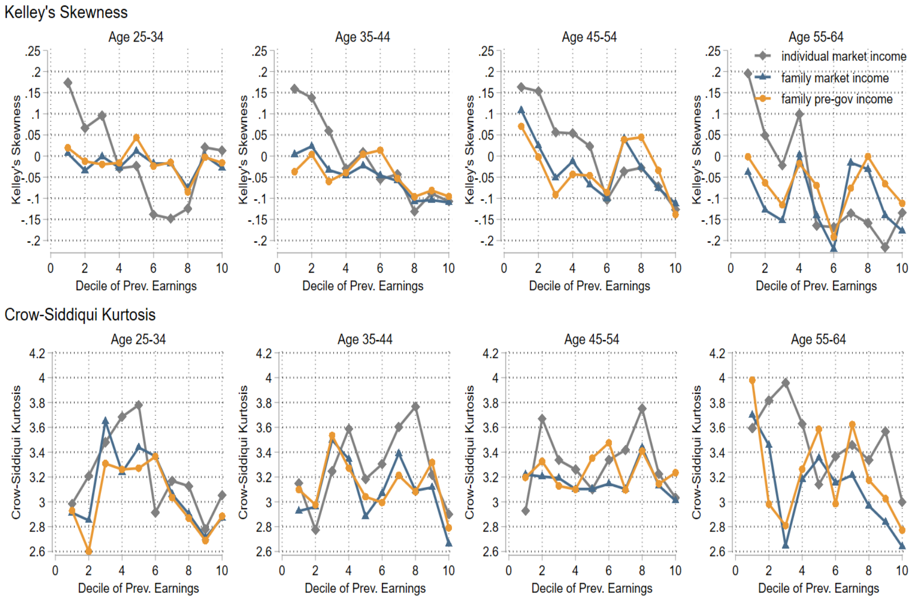

Figure 40: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of 3-year average changes of family income (P5-P95) at different levels. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of family pre-government income.

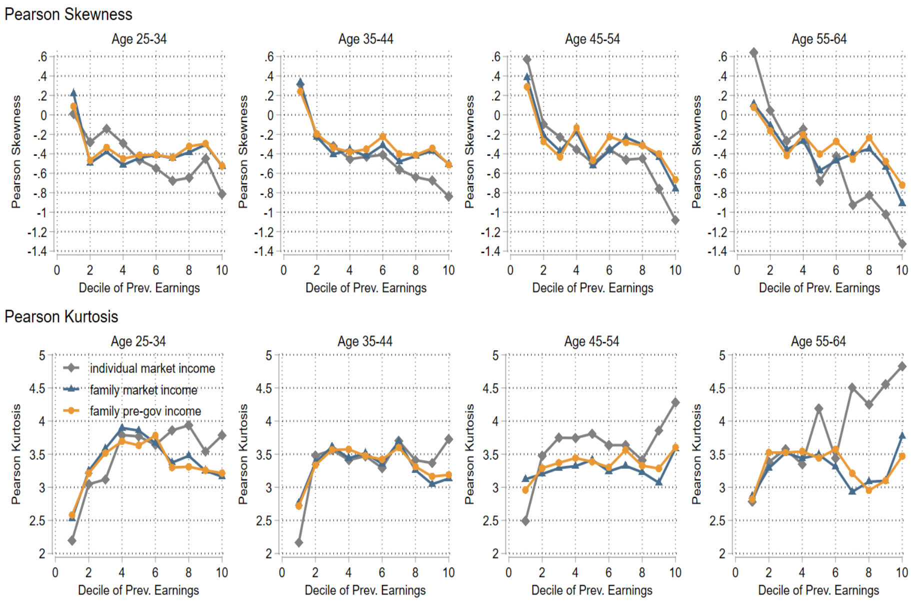

Figure 41: Skewness and kurtosis of the distribution of annual changes of family income (P5-P95) at different levels calculated via Arc-Percent Change method. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of pre-government family income.

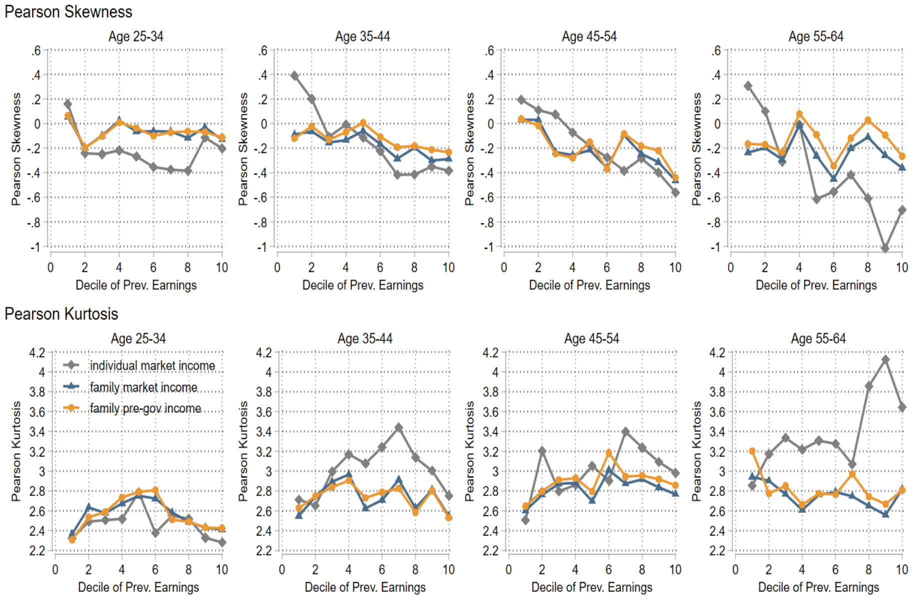

Figure 42: Skewness and kurtosis of the distribution of 3-year average changes of family income (P5-P95) at different levels calculated via Arc-Percent Change method. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of pre-government family income.

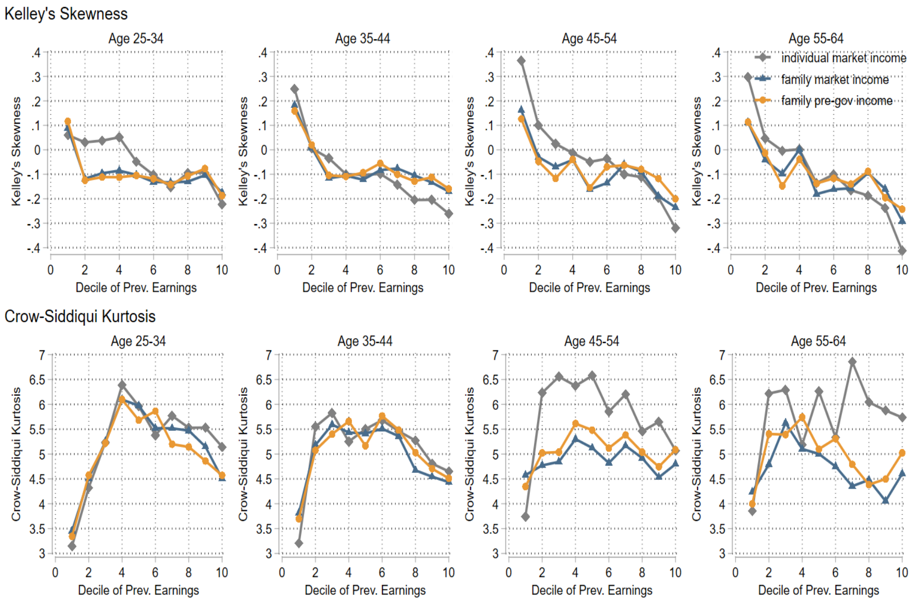

Figure 43: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of annual changes of family income (P5-P95) at different levels calculated via Arc-Percent Change method. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of pre-government family income.

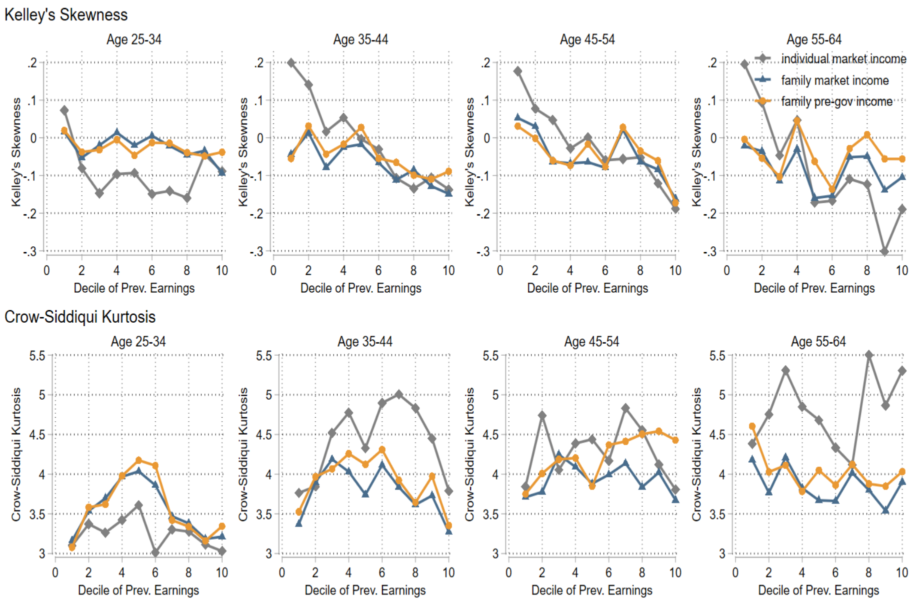

Figure 44: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of 3-year average changes of family income (P5-P95) at different levels calculated via Arc-Percent Change method. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of pre-government family income.

A.7 Additional results: Government Insurance according to standardized and quantile-based measures of moments at P1-P99 and P5-P95 of the distributions of shocks at different income levels

A.7.1 Second moment

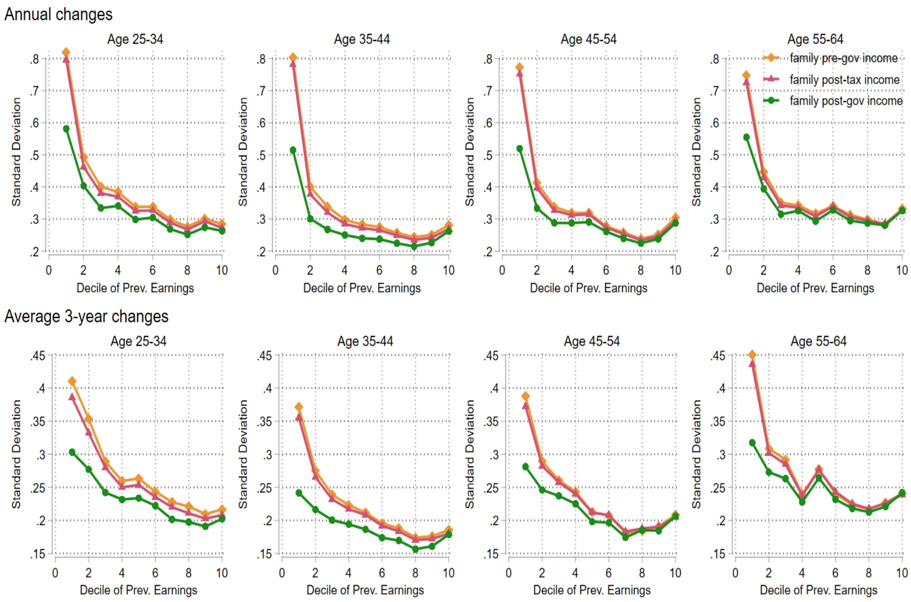

Figure 45: Standard deviation of the distribution of annual and 3-year average changes of post-tax and disposable (or post-government) family income (P1-P99) at different levels calculated via Arc-Percent Change method. The figure captures the relative contribution of tax and transfer to the second-order risk of disposable family income.

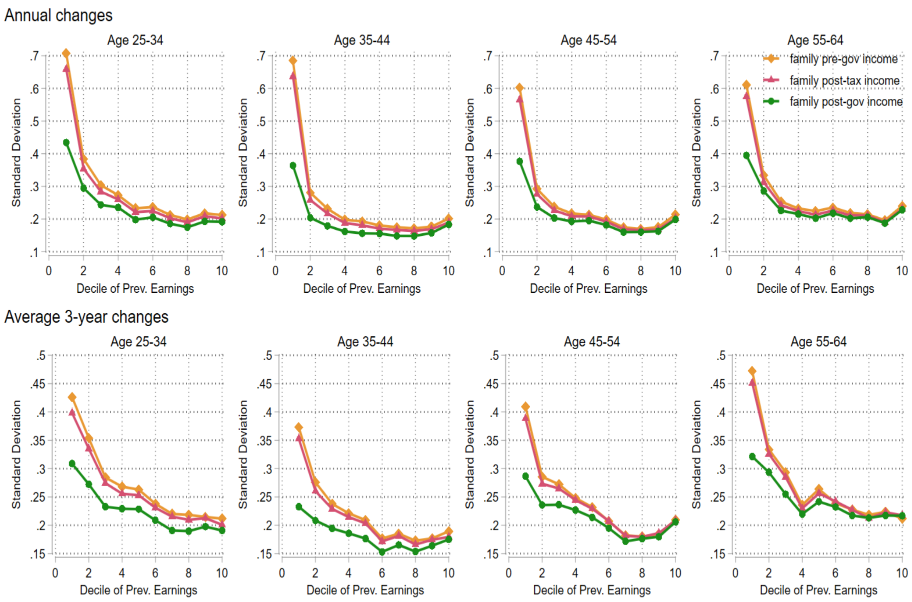

Figure 46: Standard deviation of the distribution of annual and 3-year average changes of post-tax and disposable (or post-government) family income (P5-P95) at different levels. The figure captures the relative contribution of tax and transfer to the second-order risk of disposable family income.

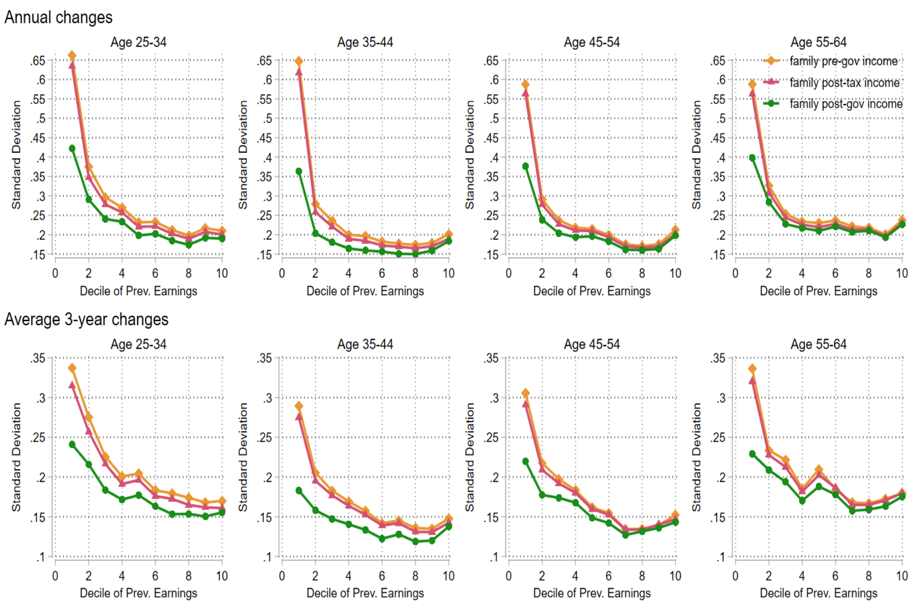

Figure 47: Standard deviation of the distribution of annual and 3-year average changes of post-tax and disposable (or post-government) family income (P5-P95) at different levels calculated via Arc-Percent Change method. The figure captures the relative contribution of tax and transfer to the second-order risk of disposable family income.

A.7.2 Higher-order moments (P1-P99)

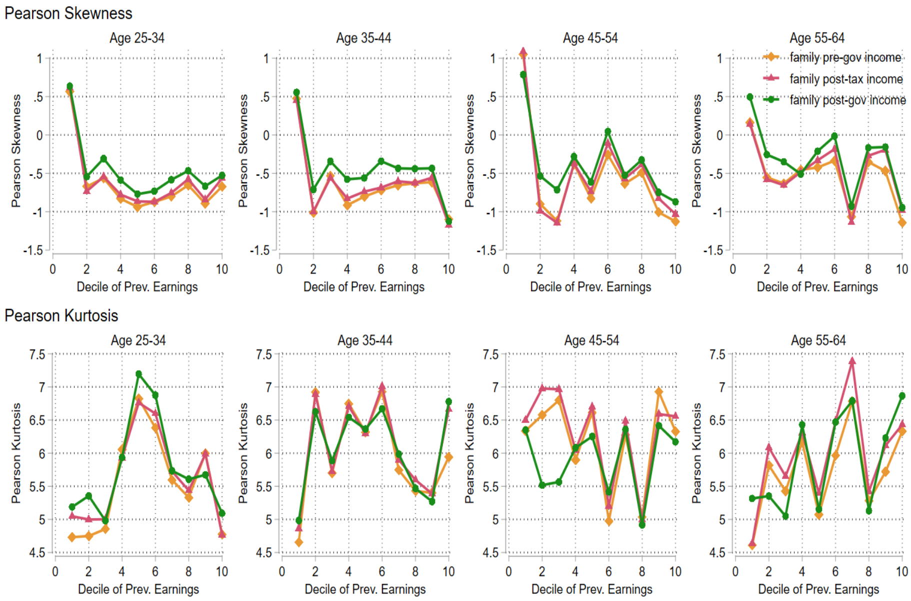

Figure 48: Skewness and kurtosis of the distribution of annual changes of post-tax and disposable (or post-government) family income (P1-P99) at different levels. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable family income.

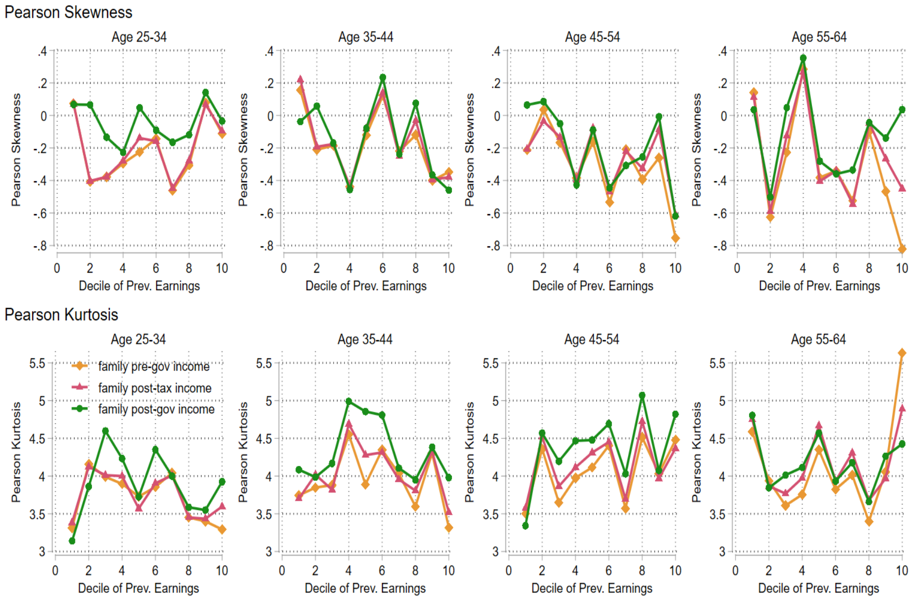

Figure 49: Skewness and kurtosis of the distribution of 3-year average changes of post-tax and disposable (or post-government) family income (P1-P99) at different levels. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable family income.

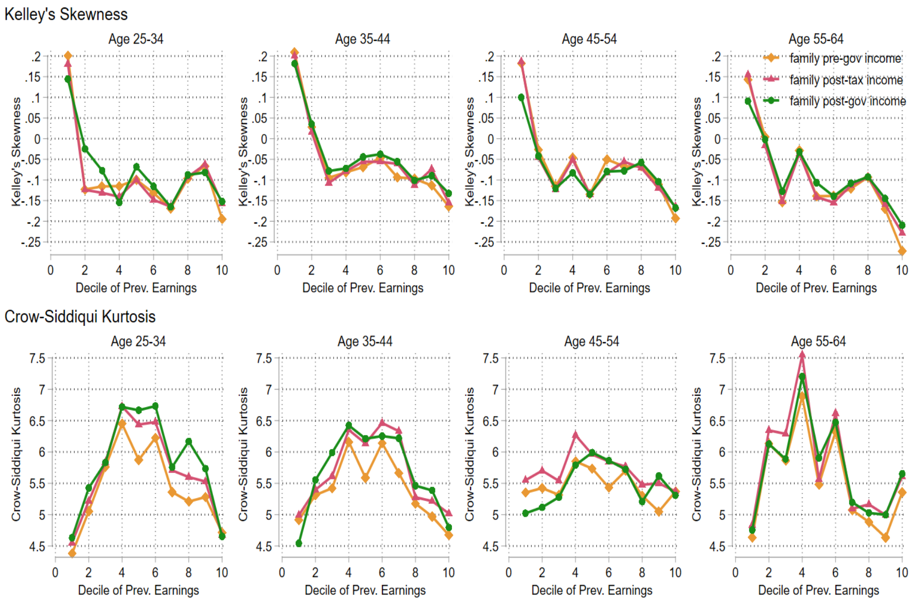

Figure 50: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of annual changes of post-tax and disposable (or post-government) family income (P1-P99) at different levels. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable family income.

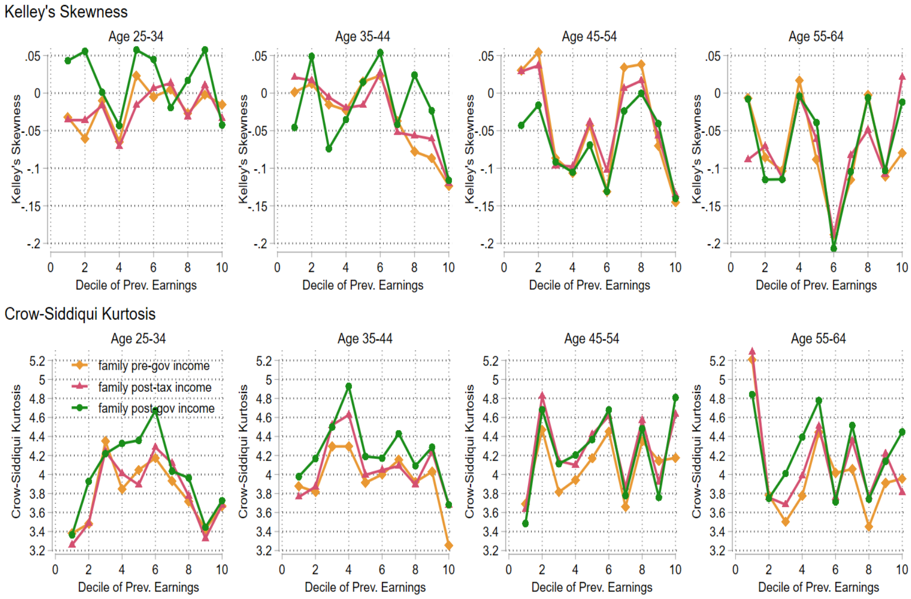

Figure 51: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of 3-year average changes of post-tax and disposable (or post-government) family income (P1-P99) at different levels. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable family income.

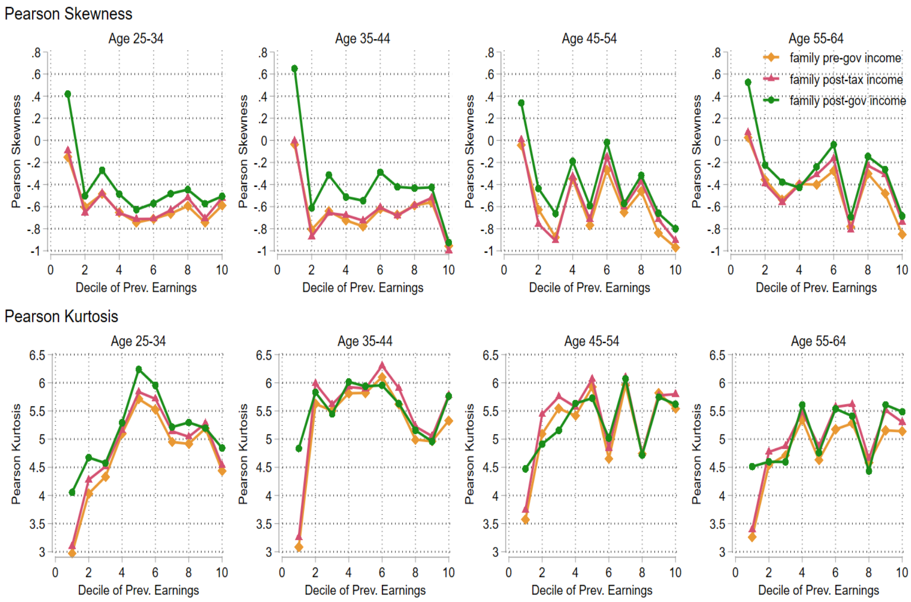

Figure 52: Skewness and kurtosis of the distribution of annual changes of post-tax and disposable (or post-government) family income (P1-P99) at different levels calculated via Arc-Percent Change method. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable family income.

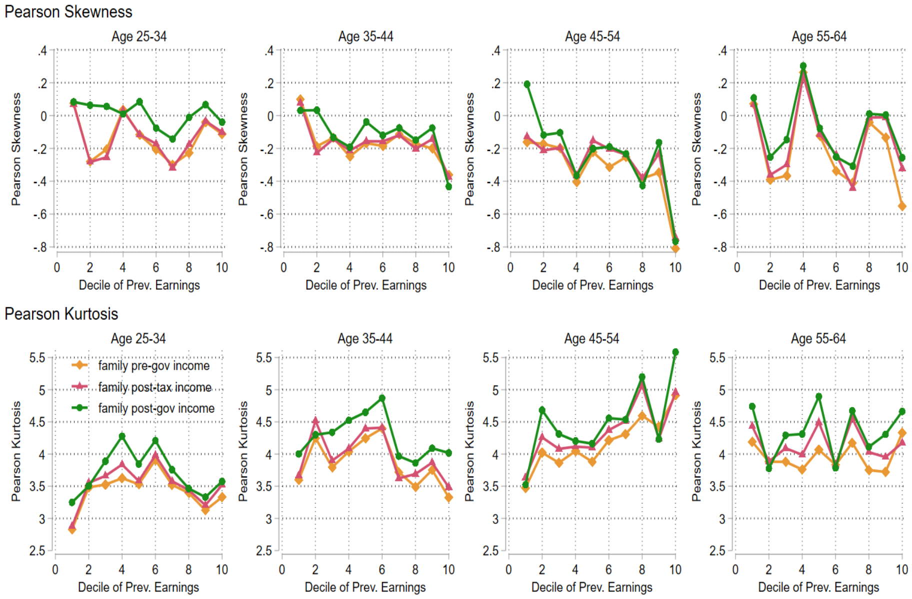

Figure 53: Skewness and kurtosis of the distribution of 3-year average changes of post-tax and disposable (or post-government) family income (P1-P99) at different levels calculated via Arc-Percent Change method. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable family income.

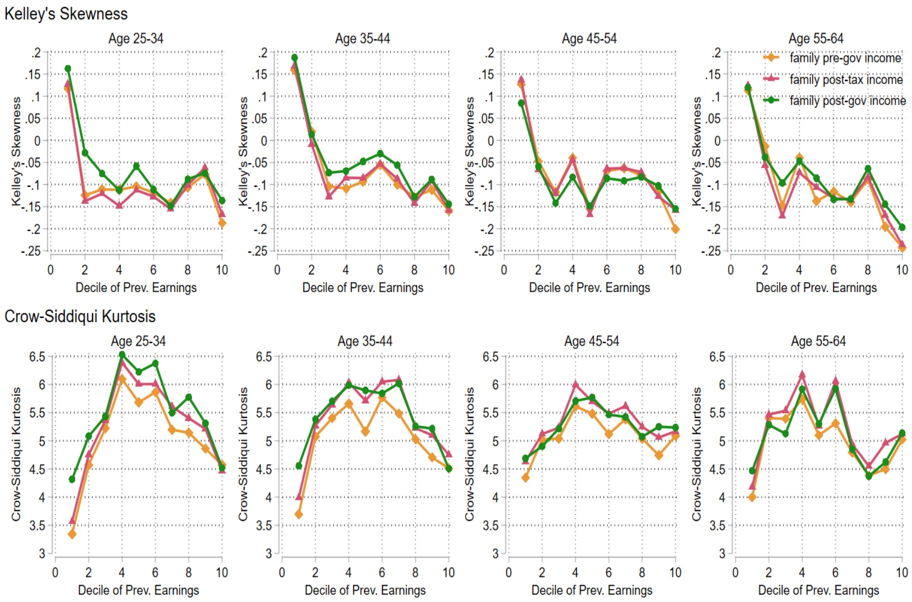

Figure 54: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of annual changes of post-tax and disposable (or post-government) family income (P1-P99) at different levels calculated via Arc-Percent Change method. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable family income.

Figure 55: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of 3-year average changes of post-tax and disposable (or post-government) family income (P1-P99) at different levels calculated via Arc-Percent Change method. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable family income.

A.7.3 Higher-order moments (P5-P95)

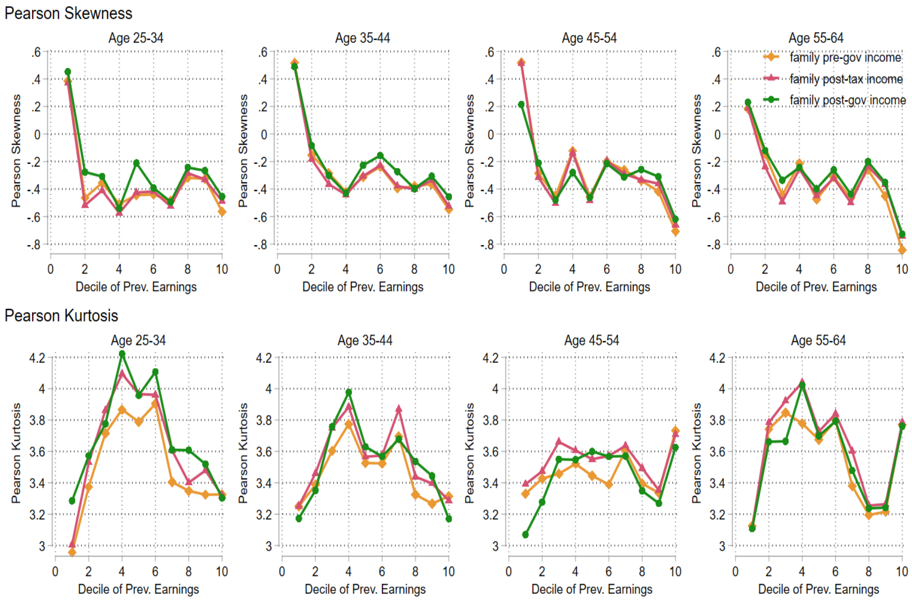

Figure 56: Skewness and kurtosis of the distribution of annual changes of post-tax and disposable (or post-government) family income (P5-P95) at different levels. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable family income.

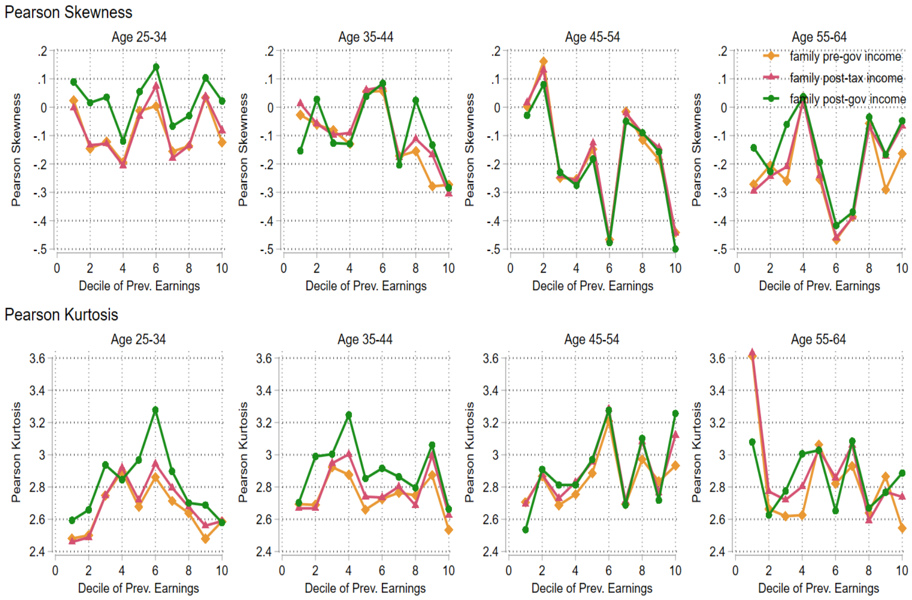

Figure 57: Skewness and kurtosis of the distribution of 3-year average changes of post-tax and disposable (or post-government) family income (P5-P95) at different levels. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable family income.

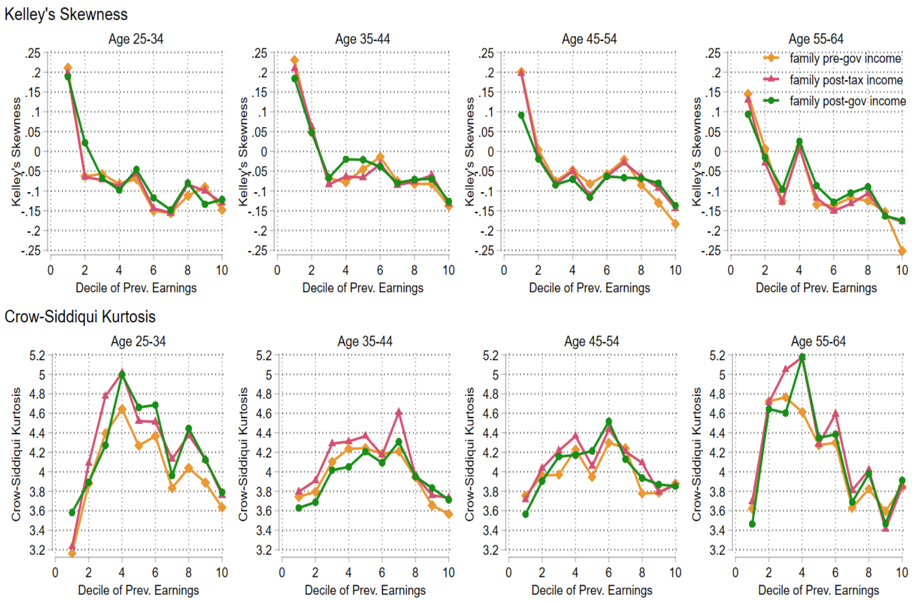

Figure 58: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of annual changes of post-tax and disposable (or post-government) family income (P5-P95) at different levels. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable family income.

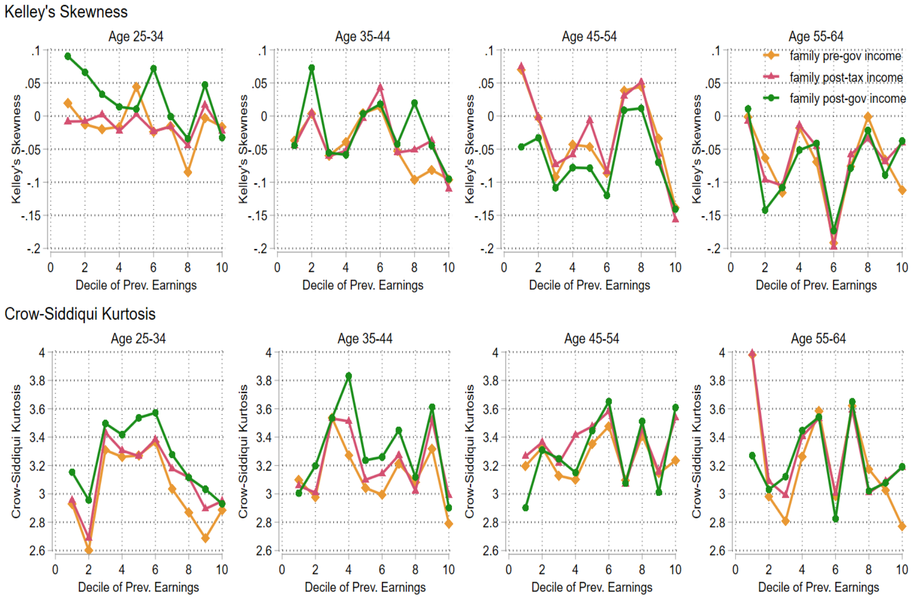

Figure 59: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of 3-year average changes of post-tax and disposable (or post-government) family income (P5-P95) at different levels. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable family income.

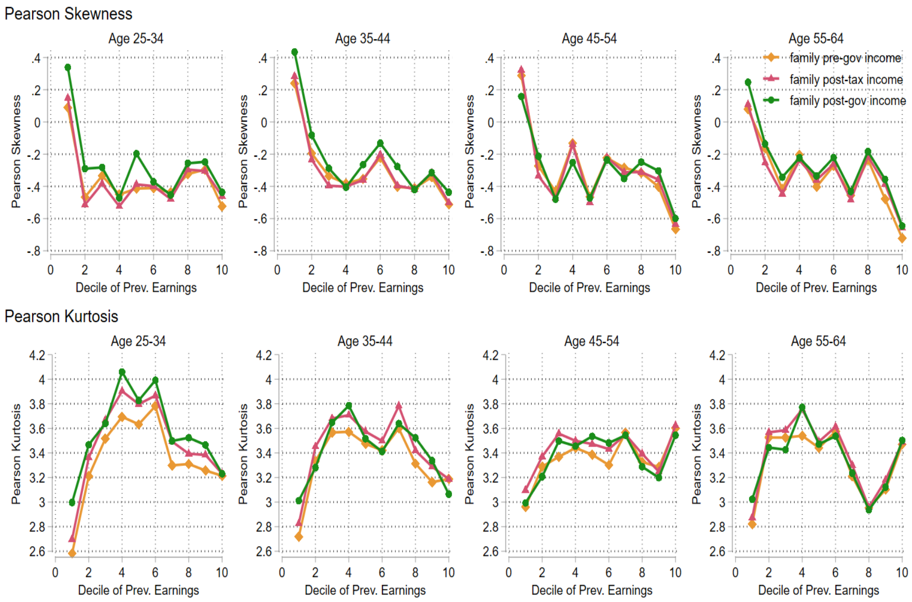

Figure 60: Skewness and kurtosis of the distribution of annual changes of post-tax and disposable (or post-government) family income (P5-P95) at different levels calculated via Arc-Percent Change method. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable family income.

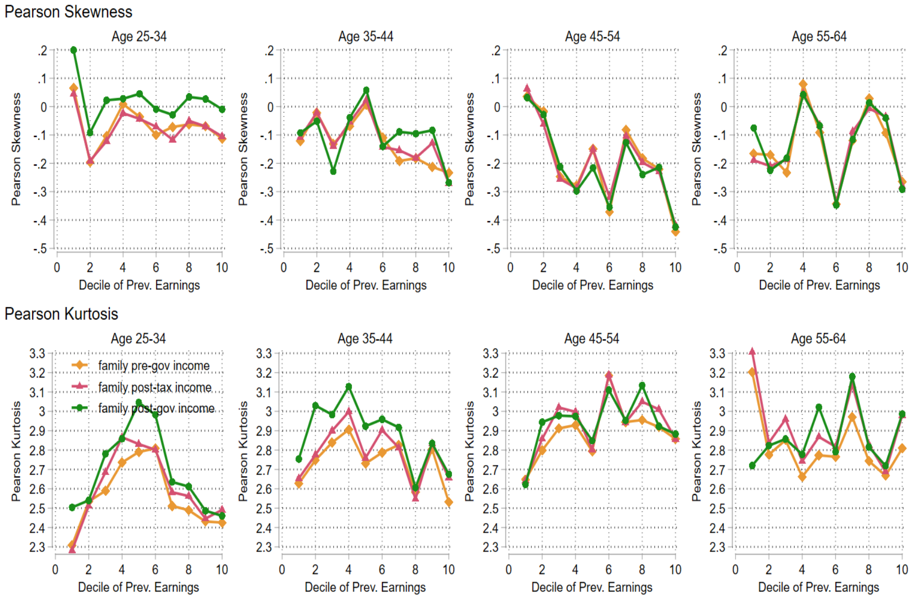

Figure 61: Skewness and kurtosis of the distribution of 3-year average changes of post-tax and disposable (or post-government) family income (P5-P95) at different levels calculated via Arc-Percent Change method. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable family income.

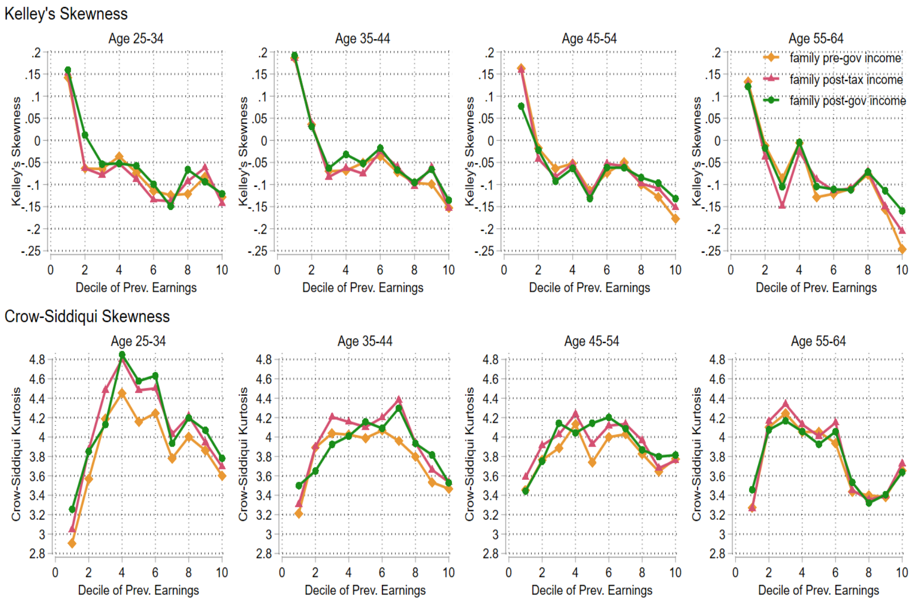

Figure 62: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of annual changes of post-tax and disposable (or post-government) family income (P5-P95) at different levels calculated via Arc-Percent Change method. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable family income.

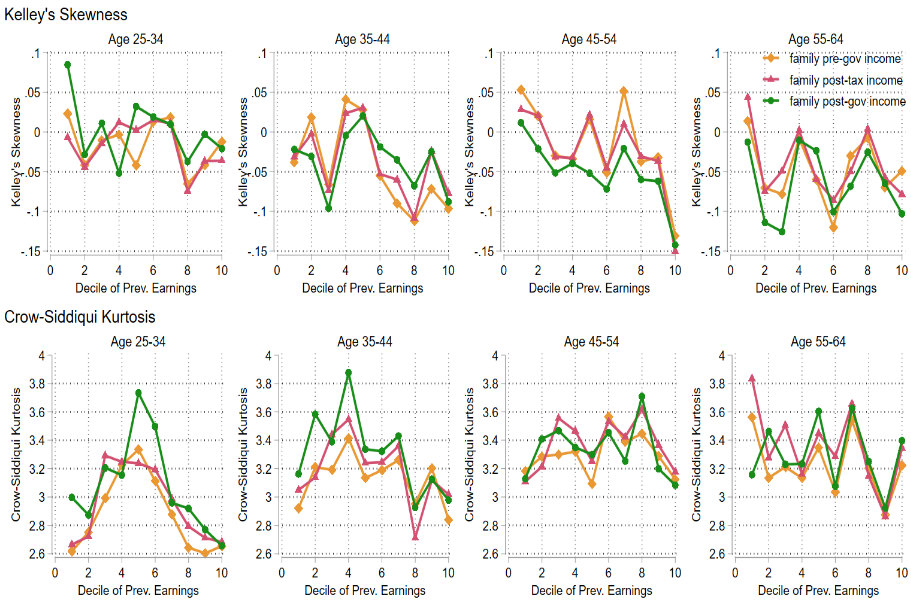

Figure 63: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of 3-year average changes of post-tax and disposable (or post-government) family income (P5-P95) at different levels calculated via Arc-Percent Change method. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable family income.

A.8 Additional results: Empirical distributions of shocks and their KDEs

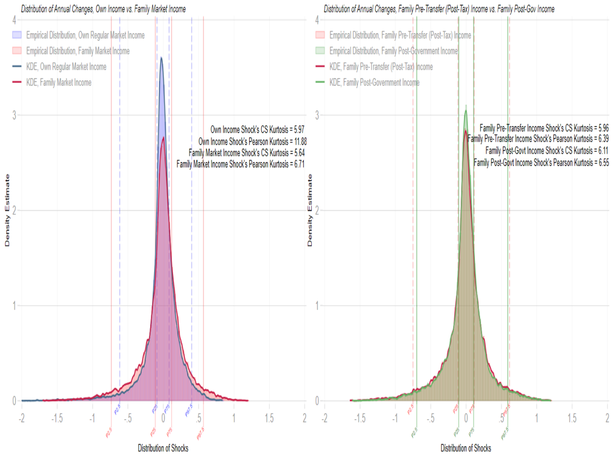

Figure 64: Comparison of empirical distributions of annual shocks: individual market income vs. family market income (left panel), and family pre-transfer (post-tax) income vs. family post-government income (right panel).

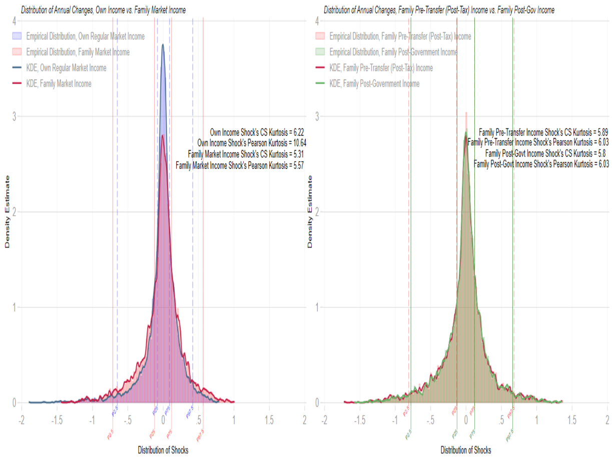

Figure 65: Comparison of empirical distributions of annual shocks of the working-age cohort aged 55-64: individual market income vs. family market income (left panel), and family pre-transfer (post-tax) income vs. family post-government income (right panel).

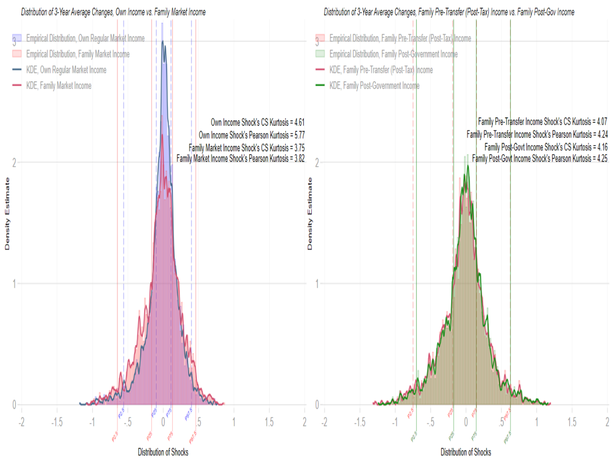

Figure 66: Comparison of empirical distributions of 3-year average shocks of the working-age cohort aged 55-64: individual market income vs. family market income (left panel), and family pre-transfer (post-tax) income vs. family post-government income (right panel).

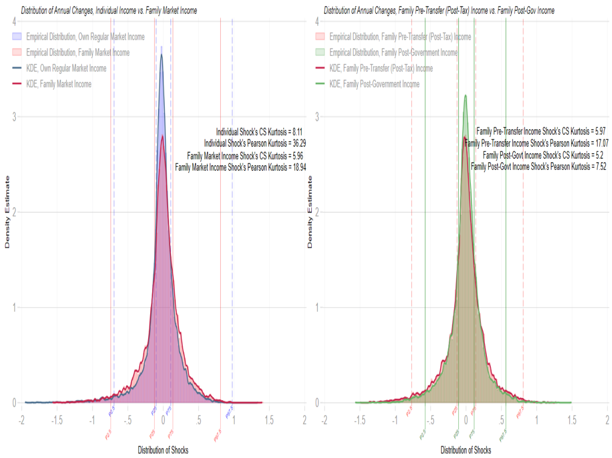

Figure 67: Comparison of empirical distributions of anual average shocks of lower and upper middle income parents (decile 3 to decile 8): individual market income vs. family market income (left panel), and family pre-transfer (post-tax) income vs. family post-government income (right panel).

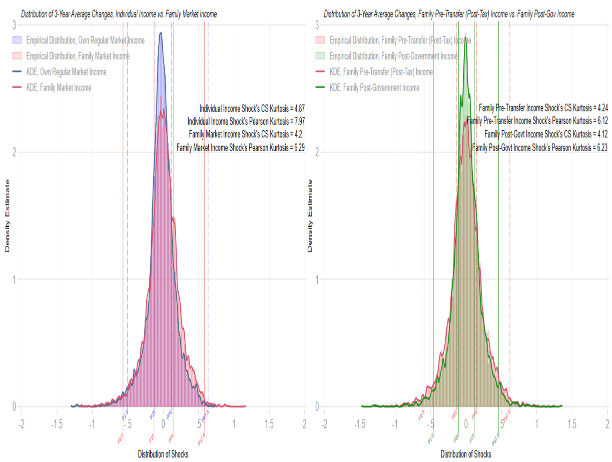

Figure 68: Comparison of empirical distributions of 3-year average shocks of lower and upper middle income parents (decile 3 to decile 8): individual market income vs. family market income (left panel), and family pre-transfer (post-tax) income vs. family post-government income (right panel).

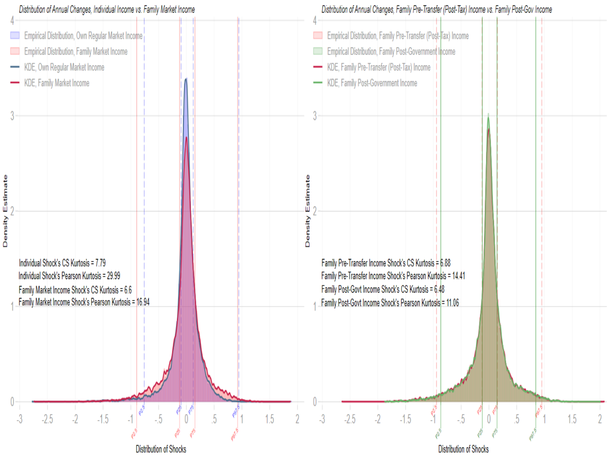

Figure 69: Comparison of empirical distributions of anual average shocks of lower and upper middle income non-parents (decile 3 to decile 8): individual market income vs. family market income (left panel), and family pre-transfer (post-tax) income vs. family post-government income (right panel).

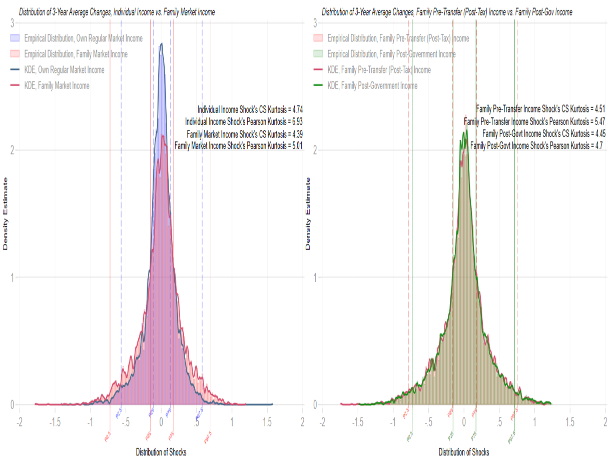

Figure 70: Comparison of empirical distributions of 3-year average shocks of lower and upper middle income non-parents (decile 3 to decile 8): individual market income vs. family market income (left panel), and family pre-transfer (post-tax) income vs. family post-government income (right panel).

A.9 Family and government insurance effects by gender

A.9.1 P1-P99

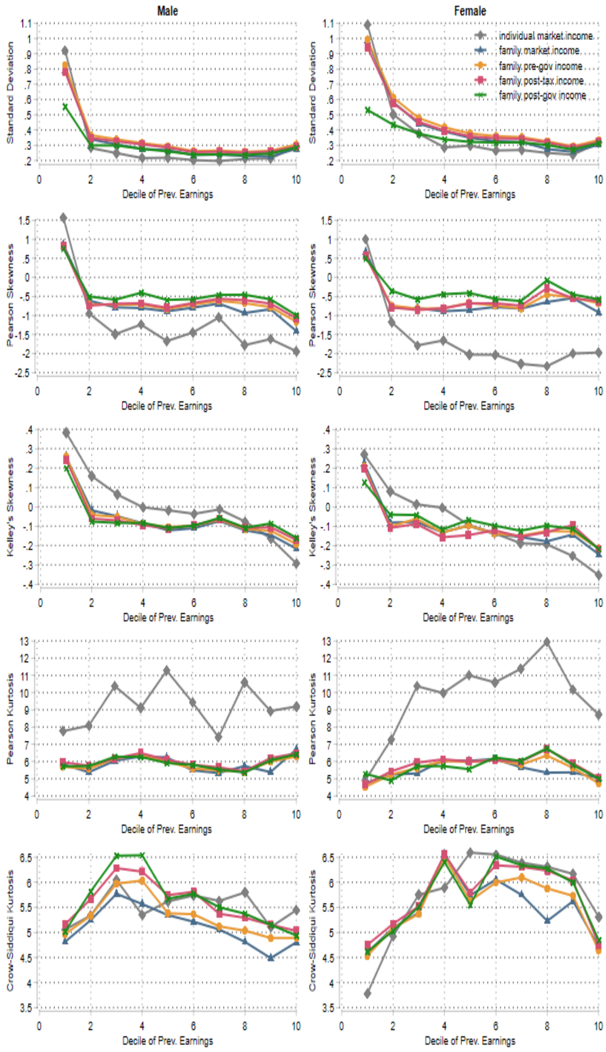

Figure 71: Moment properties of the distributions of annual income shocks (P1-P99) of male (left panel) and female (right panel) primary earners

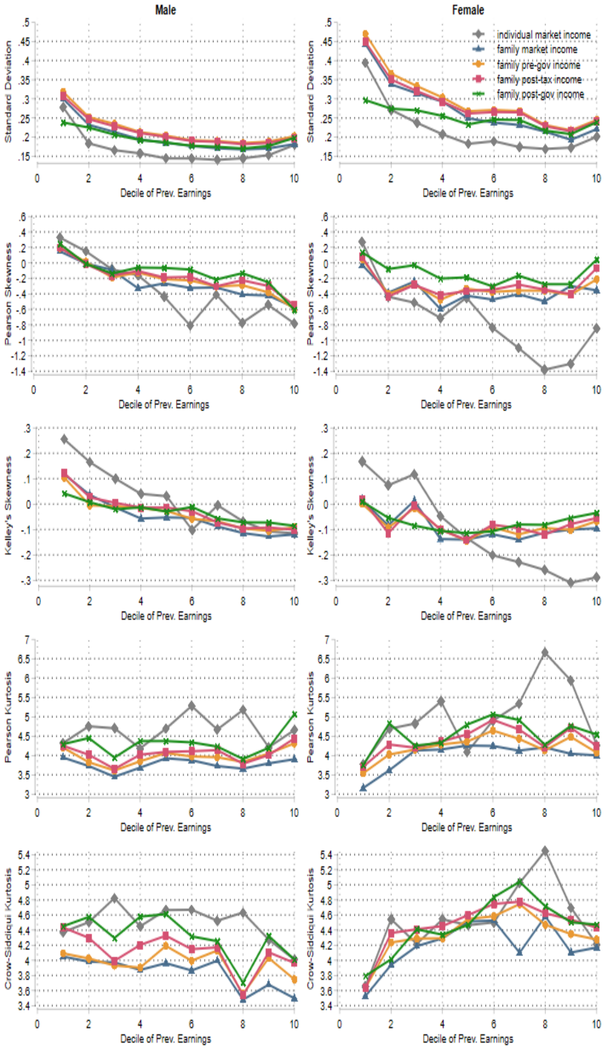

Figure 72: Moment properties of the distributions of 3-year average income shocks (P1-P99) of male (left panel) and female (right panel) primary earners

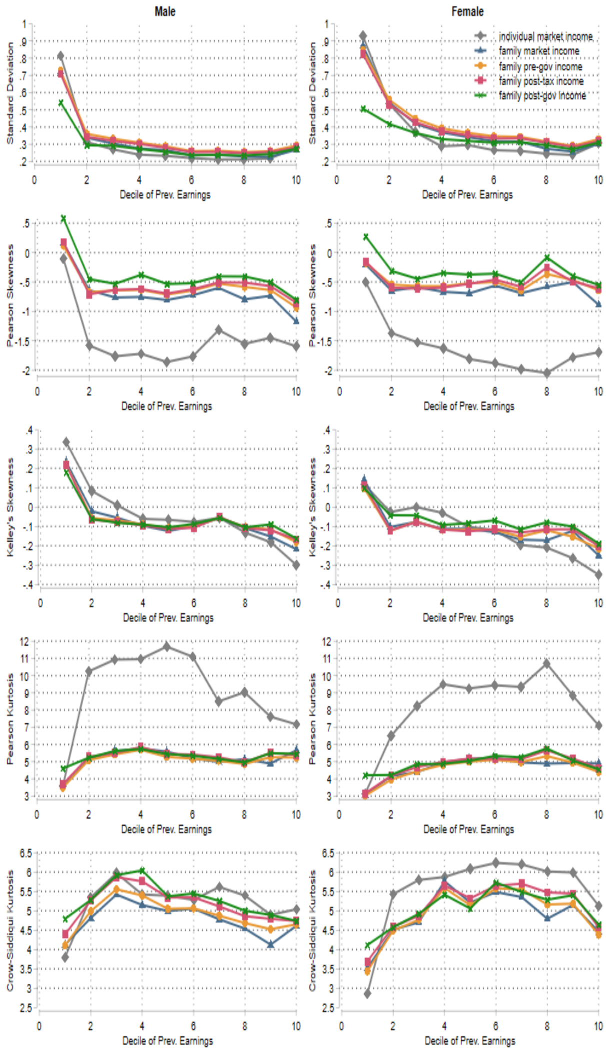

Figure 73: Moment properties of the distributions of annual income shocks (P1-P99) of male (left panel) and female (right panel) primary earners calculated via Arc-Percent Change method

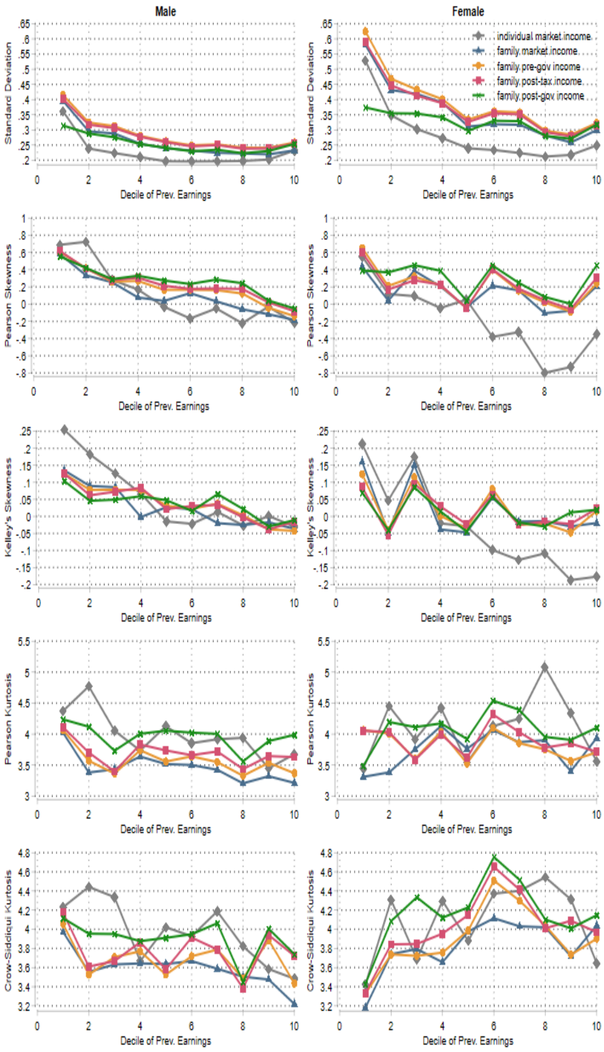

Figure 74: Moment properties of the distributions of annual income shocks (P1-P99) of male (left panel) and female (right panel) primary earners calculated via Arc-Percent Change method

A.9.2 P5-P95

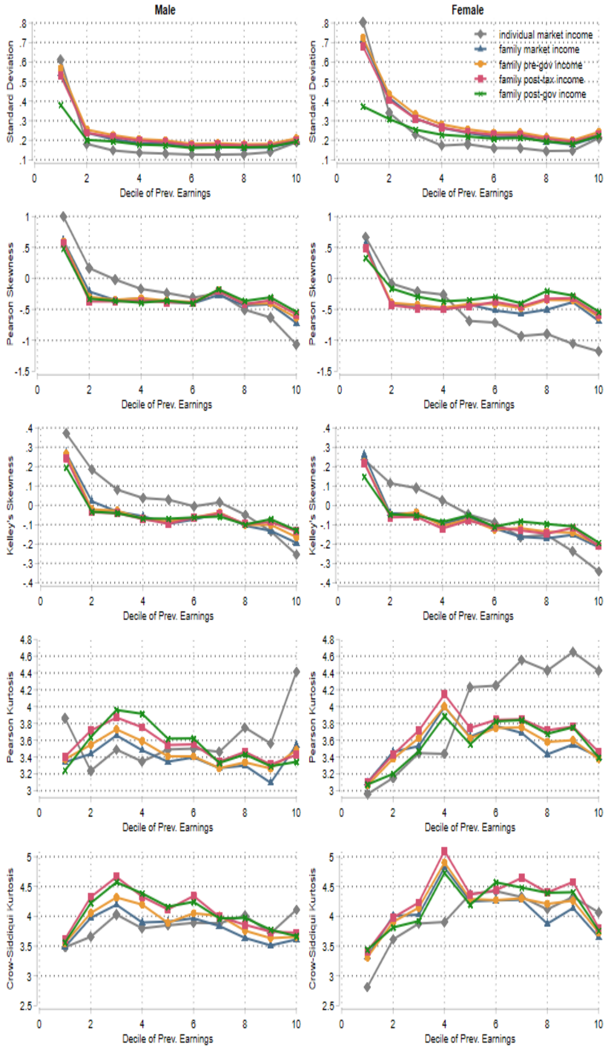

Figure 75: Moment properties of the distributions of annual income shocks (P5-P95) of male (left panel) and female (right panel) primary earners

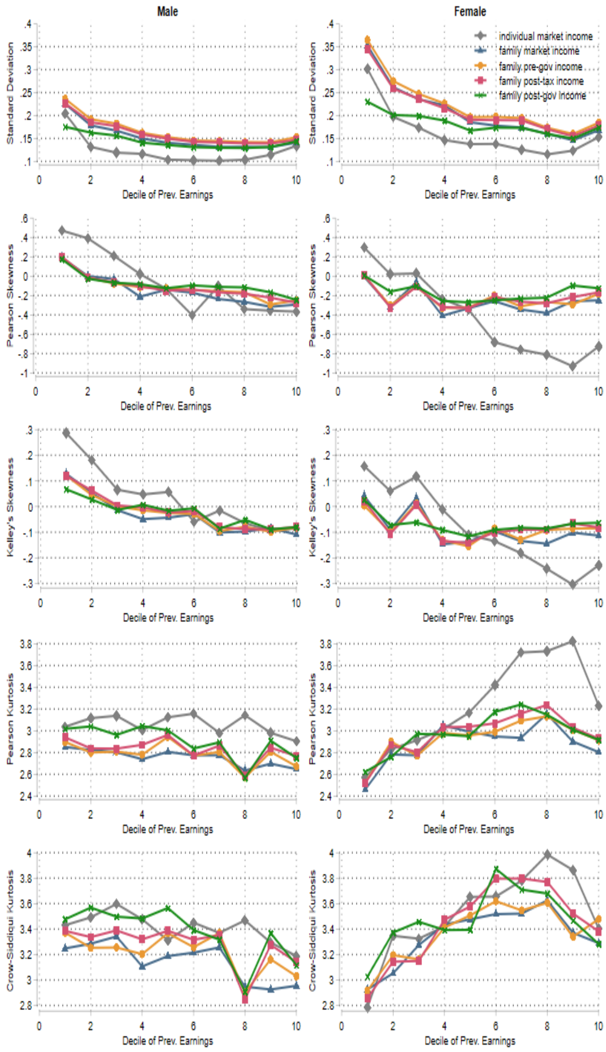

Figure 76: Moment properties of the distributions of 3-year average income shocks (P5-P95) of male (left panel) and female (right panel) primary earners

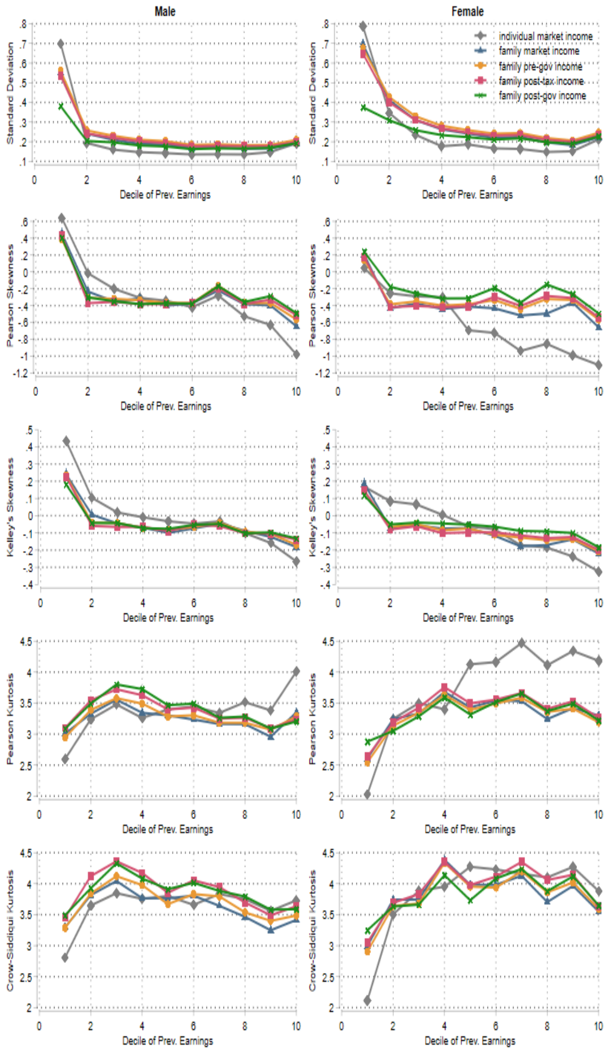

Figure 77: Moment properties of the distributions of annual income shocks (P5-P95) of male (left panel) and female (right panel) primary earners calculated via Arc-Percent Change method

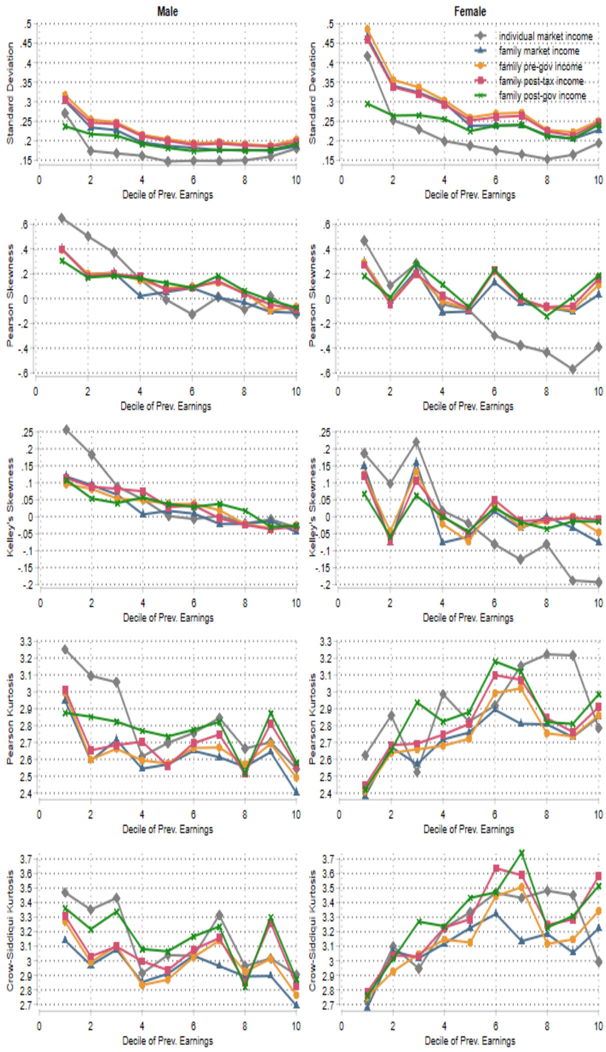

Figure 78: Moment properties of the distributions of annual income shocks (P5-P95) of male (left panel) and female (right panel) primary earners calculated via Arc-Percent Change method

A.10 Family and government insurance effects by parenthood (of dependent children)

A.10.1 Non-robust

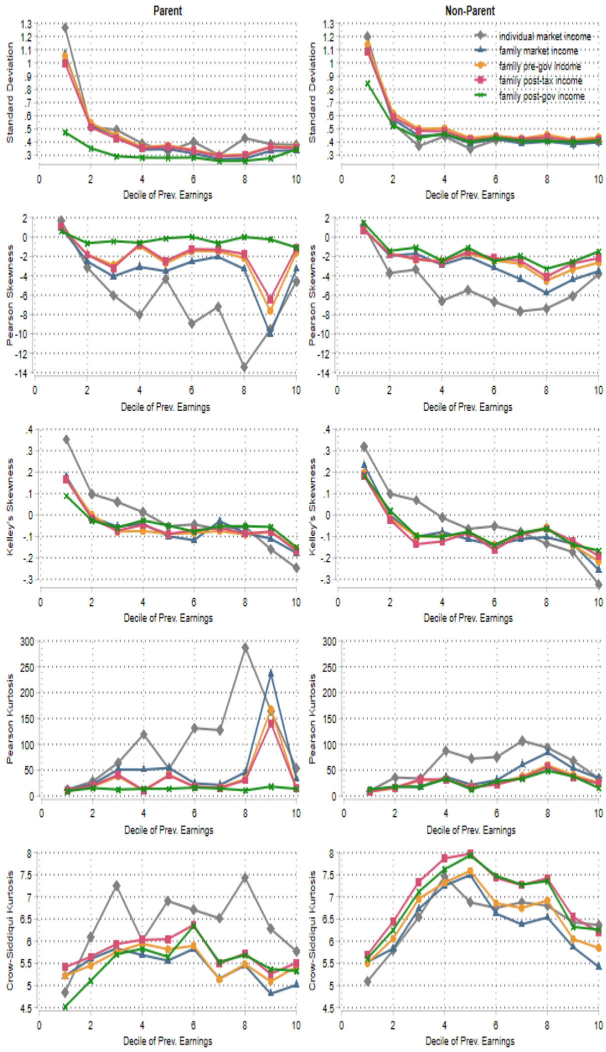

Figure 79: Non-robust moment properties of the distributions of annual income shocks of parent (left panel) and non-parent (right panel) primary earners

A.10.2 P1-P99

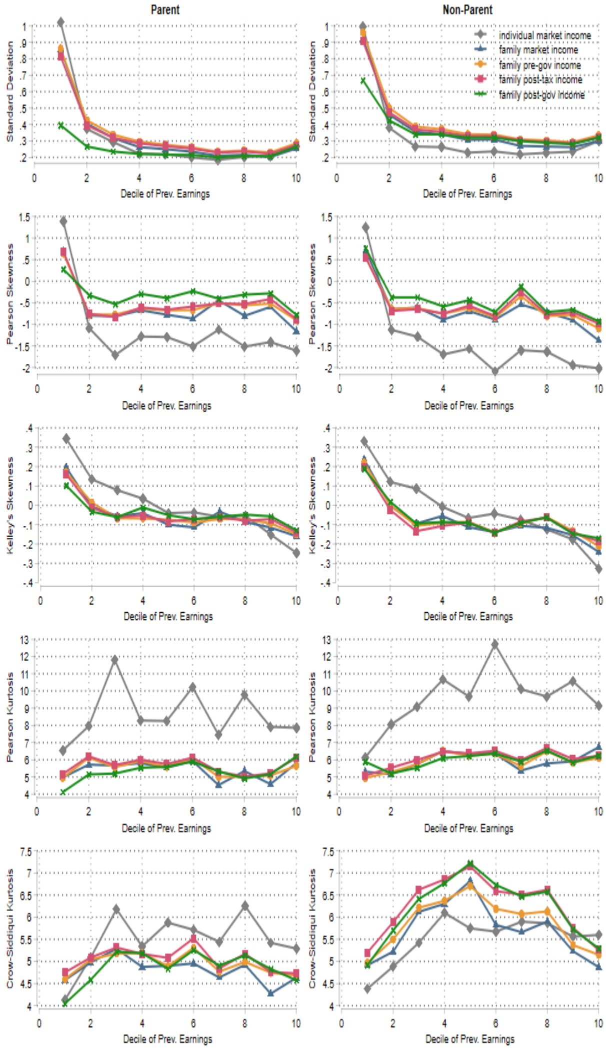

Figure 80: Moment properties of the distributions of annual income shocks (P1-P99) of parent (left panel) and non-parent (right panel) primary earners

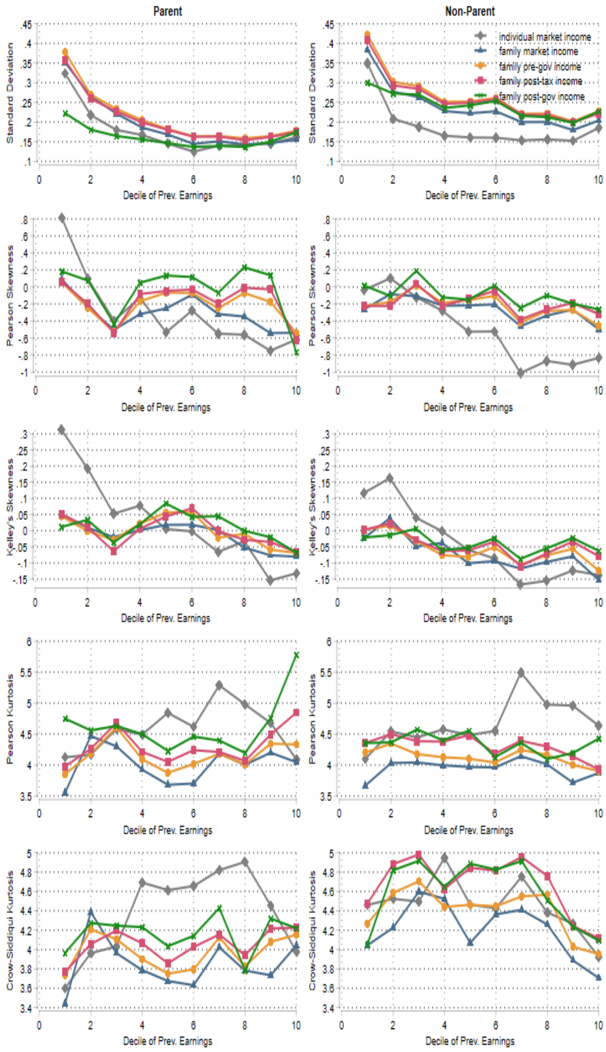

Figure 81: Moment properties of the distributions of 3-year average income shocks (P1-P99) of parent (left panel) and non-parent (right panel) primary earners

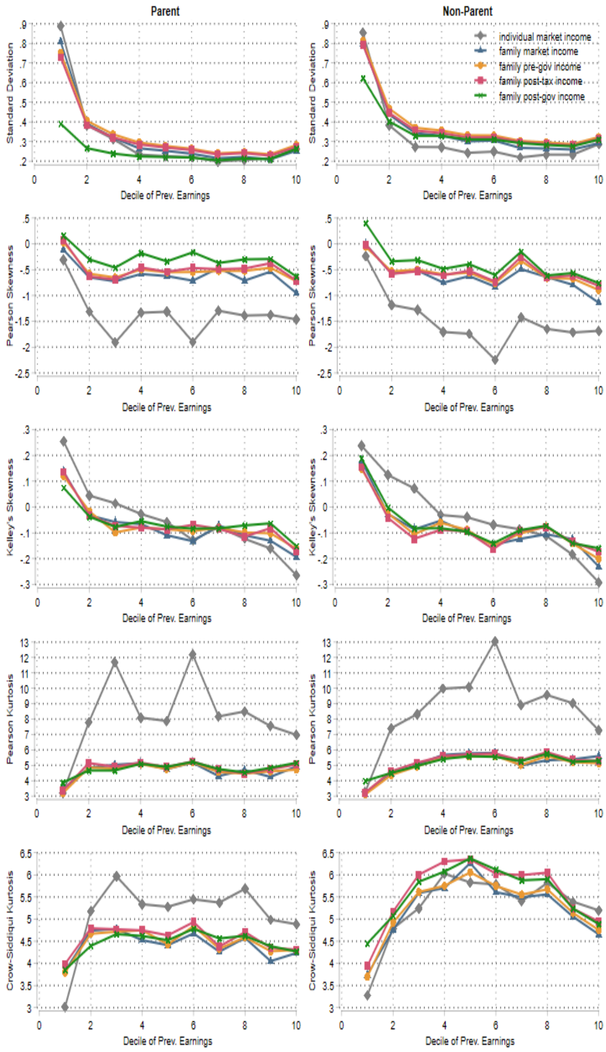

Figure 82: Moment properties of the distributions of annual income shocks (P1-P99) of parent (left panel) and non-parent (right panel) primary earners calculated via Arc-Percent Change method

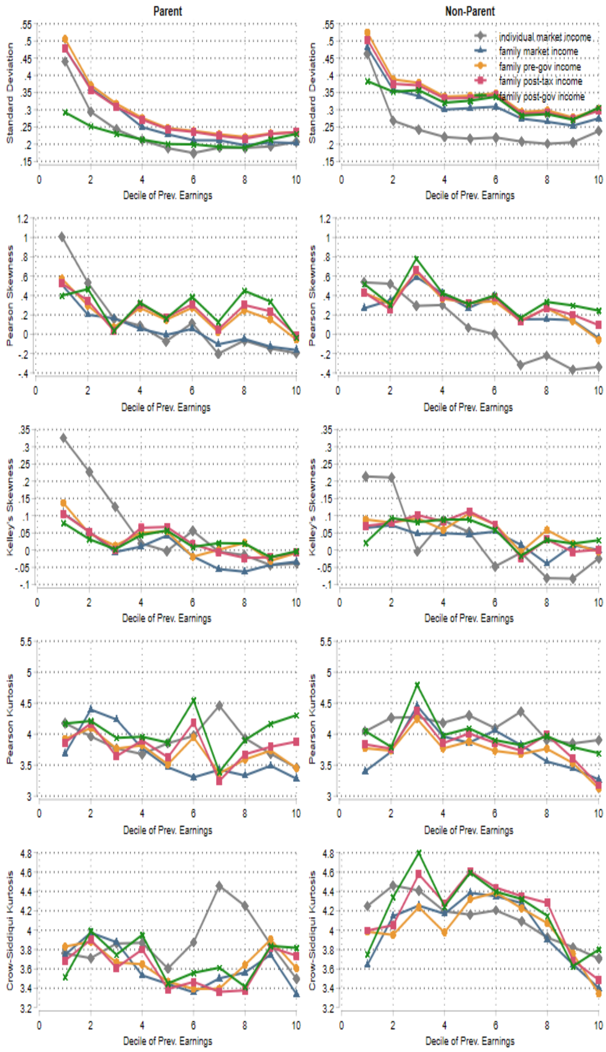

Figure 83: Moment properties of the distributions of annual income shocks (P1-P99) of parent (left panel) and non-parent (right panel) primary earners calculated via Arc-Percent Change method

A.10.3 P5-P95

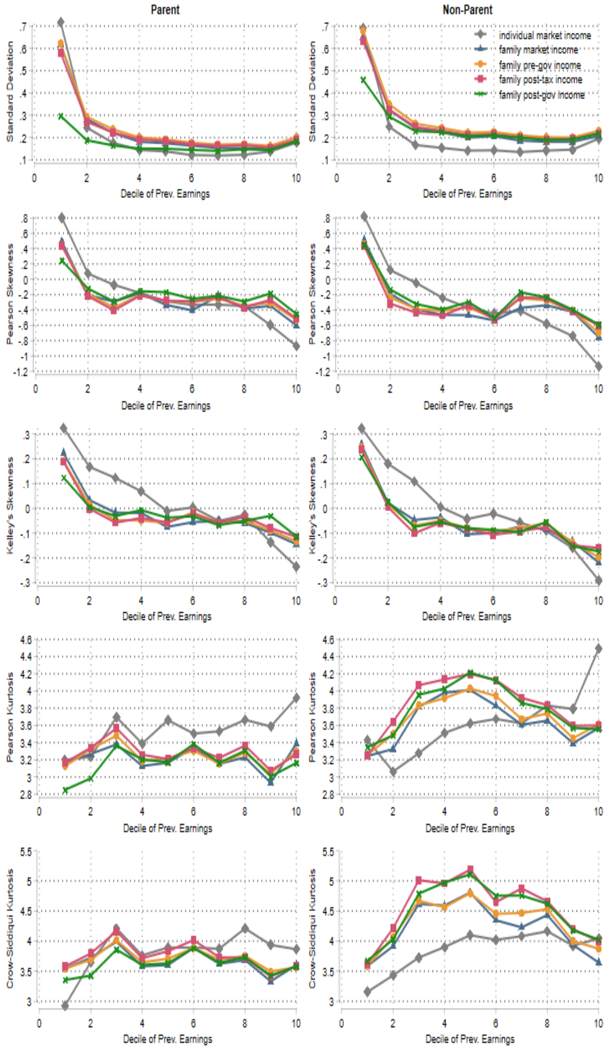

Figure 84: Moment properties of the distributions of annual income shocks (P5-P95) of parent (left panel) and non-parent (right panel) primary earners

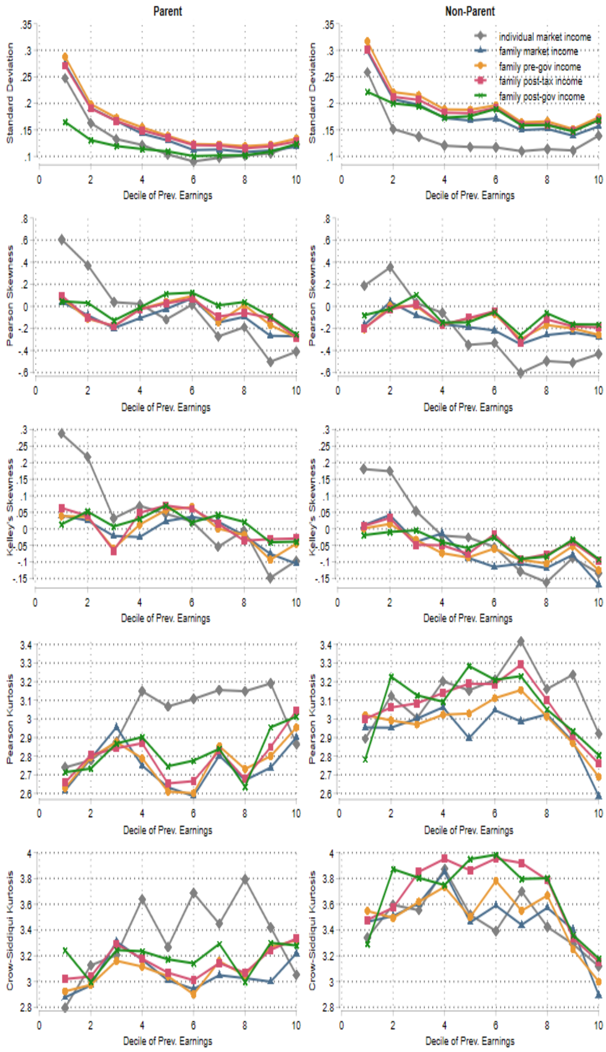

Figure 85: Moment properties of the distributions of 3-year average income shocks (P5-P95) of parent (left panel) and non-parent (right panel) primary earners

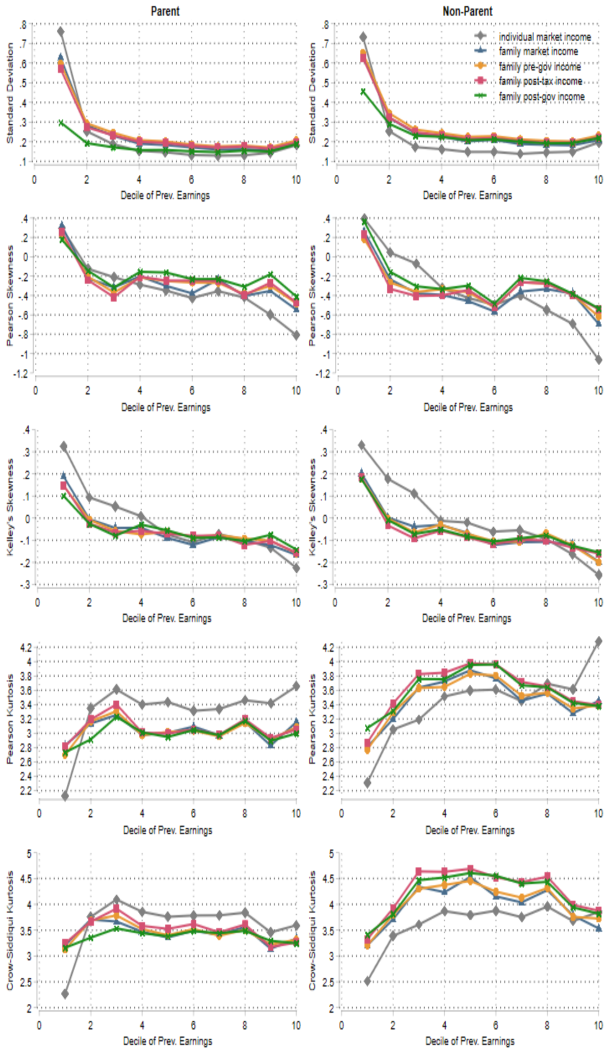

Figure 86: Moment properties of the distributions of annual income shocks (P5-P95) of parent (left panel) and non-parent (right panel) primary earners calculated via Arc-Percent Change method

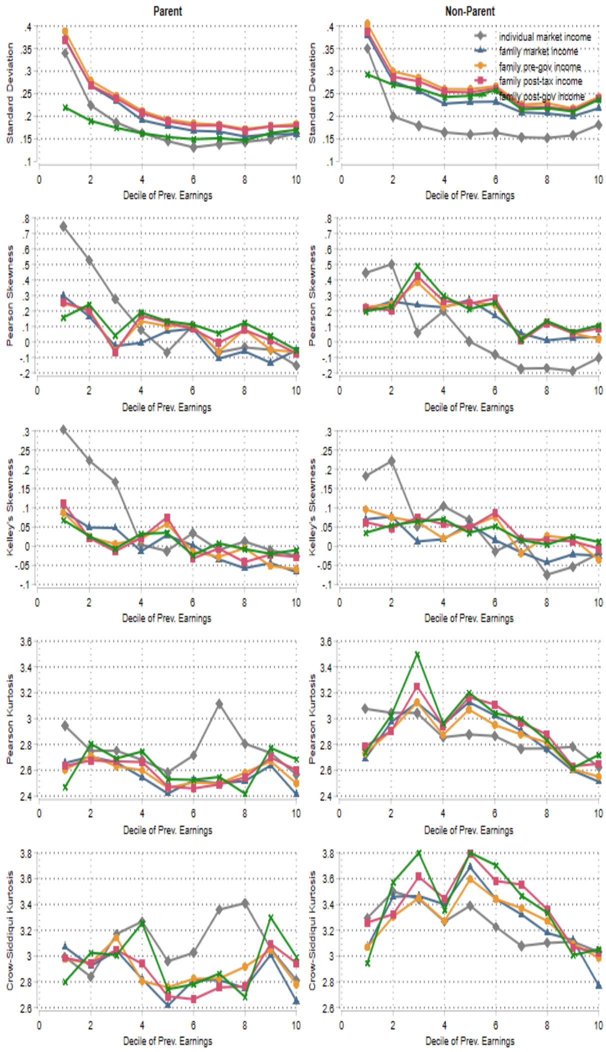

Figure 87: Moment properties of the distributions of annual income shocks (P5-P95) of parent (left panel) and non-parent (right panel) primary earners calculated via Arc-Percent Change method

A.11 Family and government insurance effects by marital status and parenthood (of dependent children)

A.11.1 P1-P99

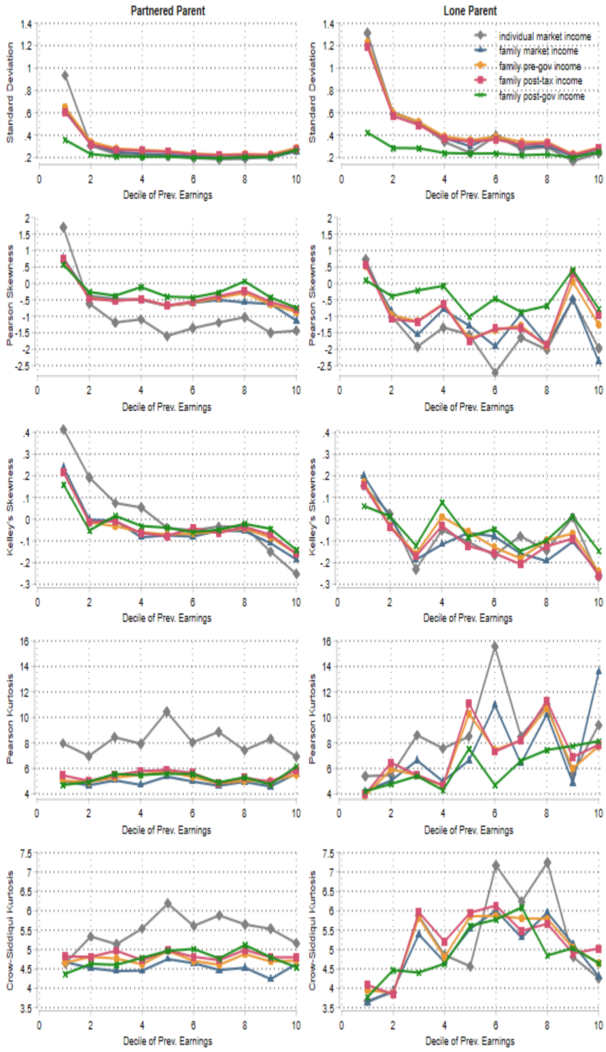

Figure 88: Moment properties of the distributions of annual income shocks (P1-P99) of partnered parent (left panel) and lone parent (right panel) primary earners

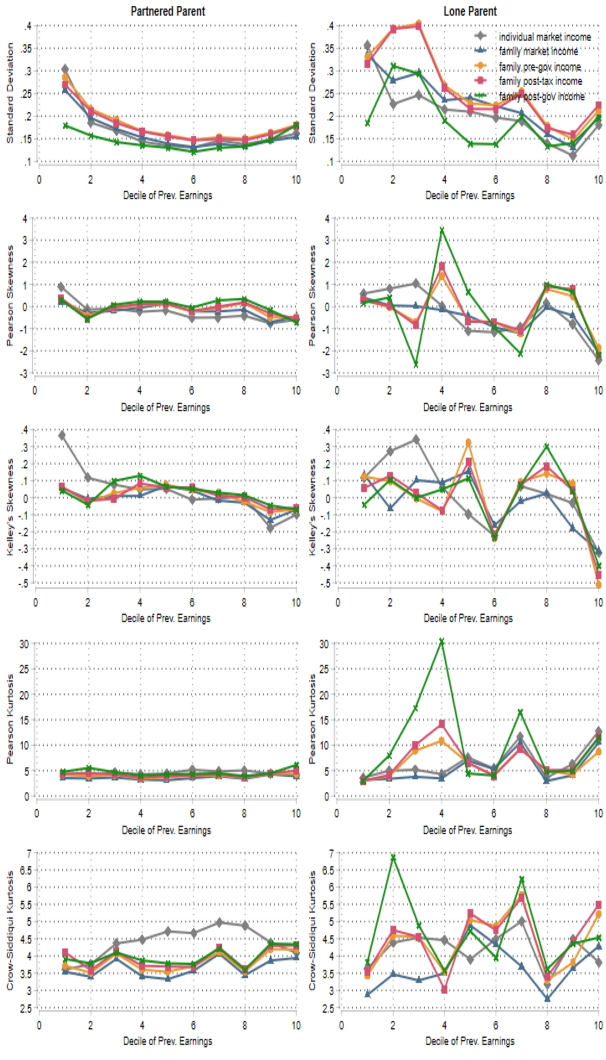

Figure 89: Moment properties of the distributions of 3-year average income shocks (P1-P99) of partnered parent (left panel) and lone parent (right panel) primary earners

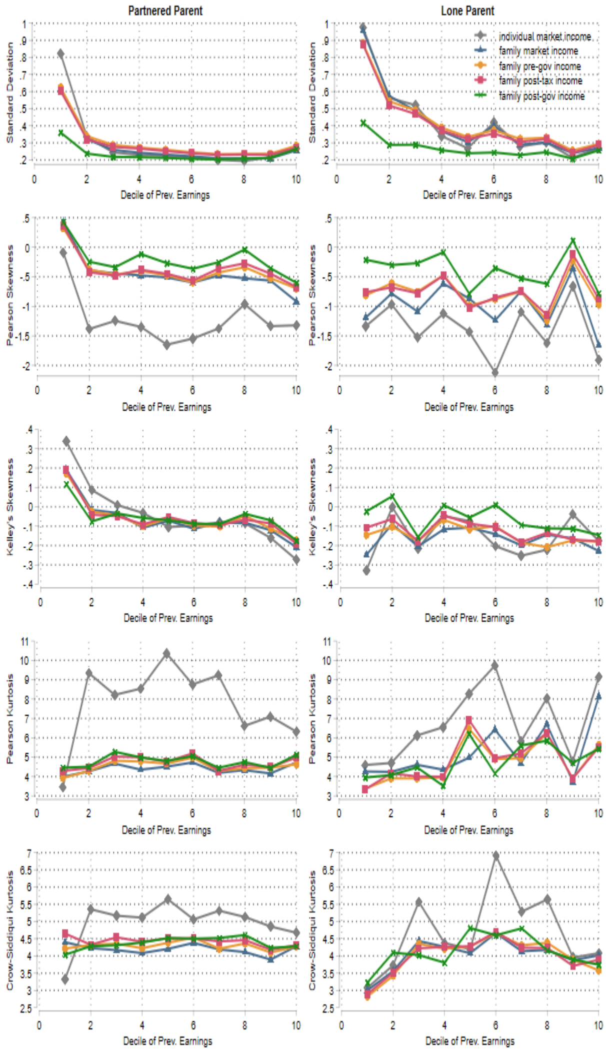

Figure 90: Moment properties of the distributions of annual income shocks (P1-P99) of partnered parent (left panel) and lone parent (right panel) primary earners calculated via Arc-Percent Change method

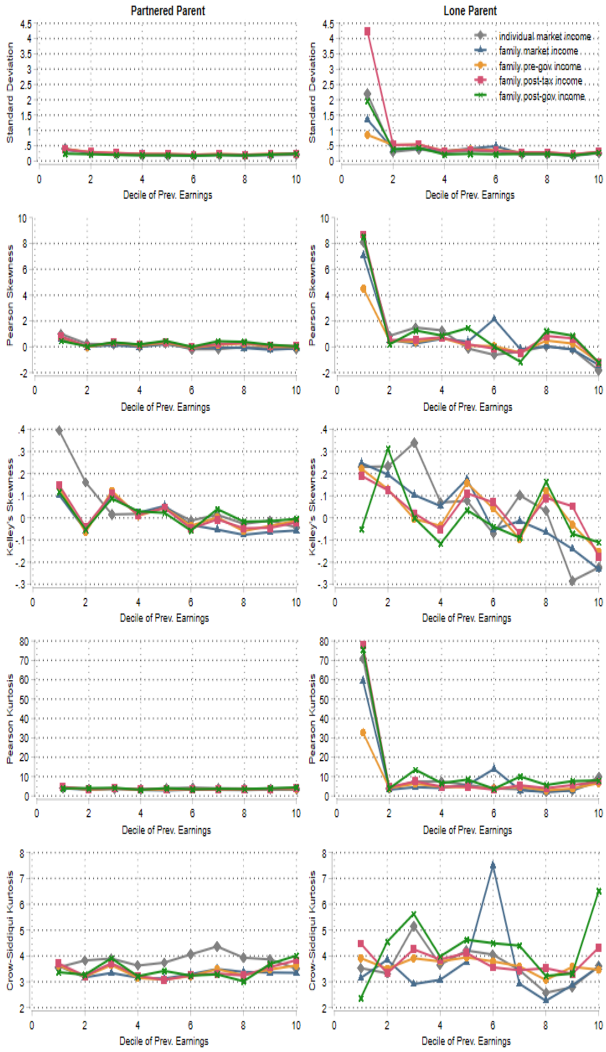

Figure 91: Moment properties of the distributions of annual income shocks (P1-P99) of partnered parent (left panel) and lone parent (right panel) primary earners calculated via Arc-Percent Change method

A.11.2 P5-P95

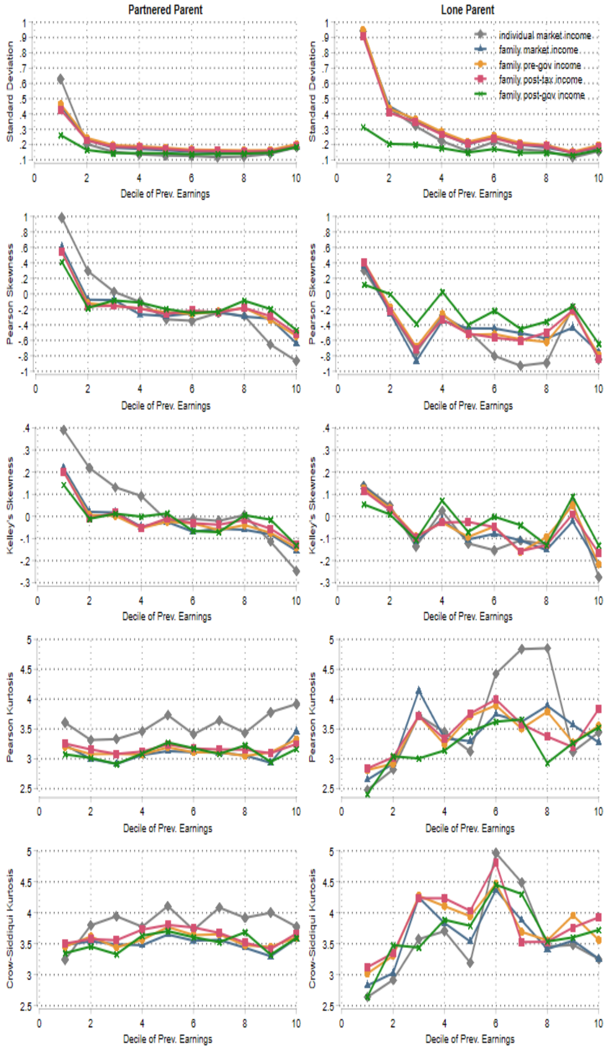

Figure 92: Moment properties of the distributions of annual income shocks (P5-P95) of partnered parent (left panel) and lone parent (right panel) primary earners

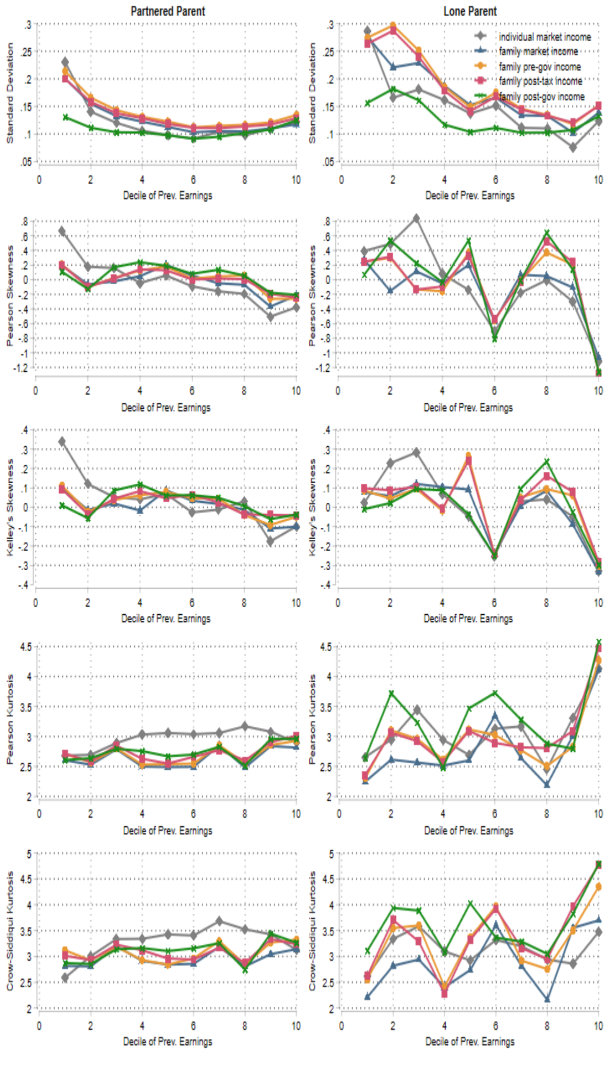

Figure 93: Moment properties of the distributions of 3-year average income shocks (P5-P95) of partnered parent (left panel) and lone parent (right panel) primary earners

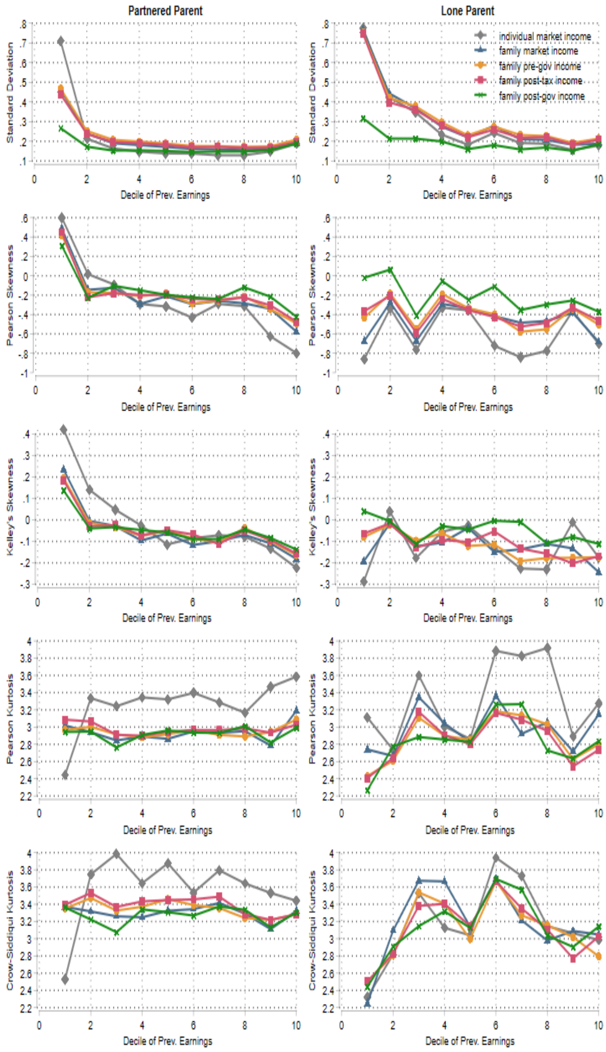

Figure 94: Moment properties of the distributions of annual income shocks (P5-P95) of partnered parent (left panel) and lone parent (right panel) primary earners calculated via Arc-Percent Change method

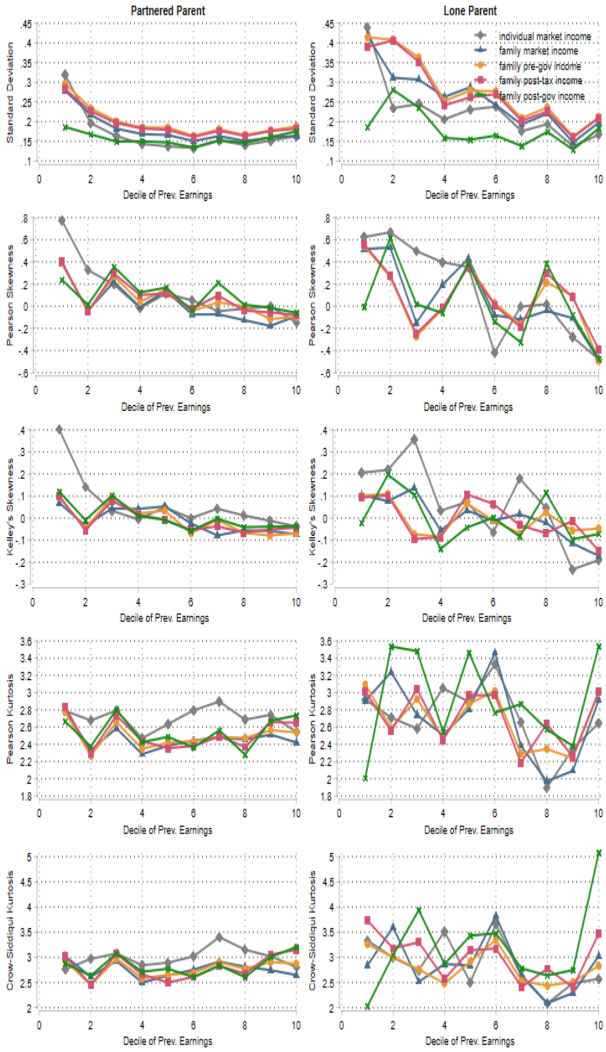

Figure 95: Moment properties of the distributions of annual income shocks (P5-P95) of partnered parent (left panel) and lone parent (right panel) primary earners calculated via Arc-Percent Change method

A.12 Family and government insurance effects by marital status and parenthood (of dependent and independent children)

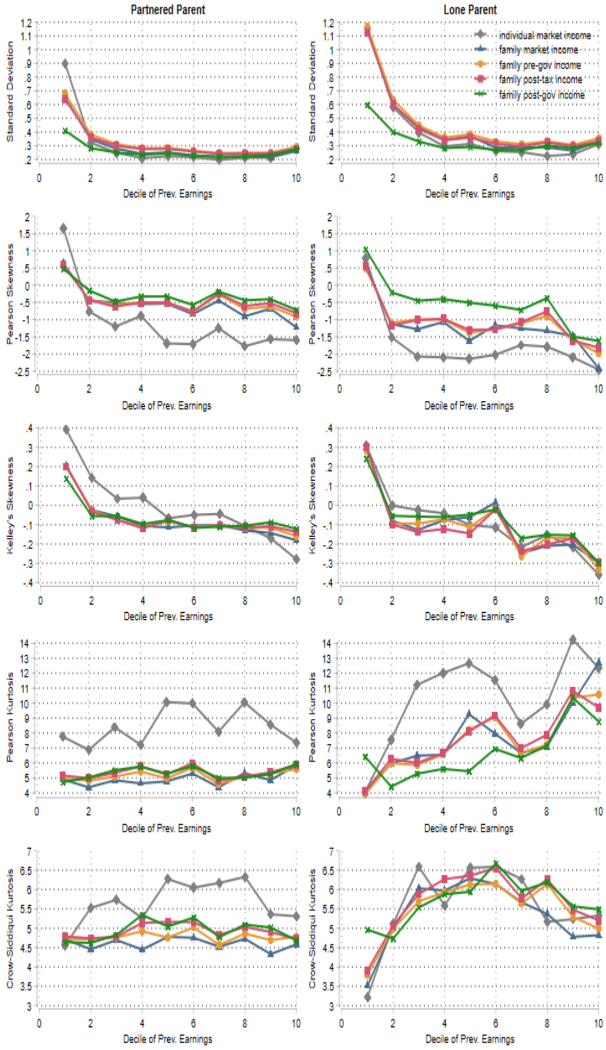

Figure 96: Moment properties of the distributions of annual income shocks of partnered parent (left panel) and lone parent (right panel) primary earners (P11-P99) pearson statistics)