Lifecycle Earnings Risk and Insurance: New Evidence from Australia*

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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 2001-2020. 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 the dispersion of earnings shocks (second-order risk), while hours drive the negative skewness and excess kurtosis (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 of earnings changes. Family insurance via income pooling and government insurance embedded in the progressive tax and transfer system play distinct roles in reducing risks over age and by income group. Government transfer is more important in mitigating the dispersion of earning shocks; meanwhile, family transfer is more dominant in mitigating the magnitude and likelihood of extreme and rare earnings shocks. Family insurance interacts with government insurance; however, their joint forces fail to eliminate the non-Gaussian and non-linear features of the distribution. Furthermore, our within-country comparison between groups reveal: (i) the risk equalizing effect of government insurance, and (ii) the persistent nature of risks for certain demographics such as female heads of household and non-parents. Hence, our results sheds new insights into the complexity of earnings dynamics and the 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.

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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 life cycle. Recent developments, including Guvenen et al. (2021), Arellano, Blundell and Bonhomme (2017) and De Nardi et al. (2021) have identified non-Gaussian and non-linearity 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, employing 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 20 (2001-2020), 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 features of income process documented for other countries also apply for Australia; however, there are significant differences in the sources of fluctuations and the insurance roles of family and government.

Specifically, we begin by calculating higher-order moments of earnings shocks, including variance, skewness and kurtosis for primary earners (heads) of households.[1] We uncover rich dynamics of the income shock process that exhibit strong non-linear and non-Gaussian features across household socioeconomic and demographic characteristics. The volatility of earnings shocks (*second-order risk*) 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. Moreover, the distribution of earnings shocks is negatively skewed (*third-order risk*) and leptokurtic (*fourth-order risk*). Indeed, there are significant differences in the degrees of variance, skewness, and kurtosis by age and income history as the previous work suggested..

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. Meanwhile, changes in hours induce the negative skewness and the excess kurtosis. Restricting the sample to workers with consistent employment history or by demographic attributes does not alter this conclusion. In addition, we observe asymmetry between the compositions of negative and positive earnings changes. Earnings changes are associated with substantial wage movement. In contrast, barring those in the bottom decile, the role of hours is limited and only contributes by a relatively lesser degree to negative earnings changes. This asymmetry is likely driven by: (i) the presence of 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

[1] Note that, the terms *shocks* and *changes* are used interchangeably. We use primary earner (male or female) as a measurement unit since a sizeable proportion (39%) of household heads in the HILDA data set is female.

Standards, among others, 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 channels of (external) insurance: *within family responses,* i.e. family market income insurance, and *net public transfers,* i.e. government transfer insurance. To quantify 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 insurance components related to family market earnings and 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 shocks, respectively. In terms of insurance against the second-order risk, family market income insurance is small and 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. Against the third and fourth-order risks, on the other hand, family insurance plays a more dominant role. Overall, family market income and government transfer are vital sources of insurance against lifecycle earnings risks. However, they are not capable of providing full insurance to completely eliminate the non-Gaussian and non-linear elements from the household disposable income dynamics.

As an extension, we further investigate how lifecycle earnings risk is affected by demographic factors. We mainly focus on three attributes: *gender*, *marital* and *parental status* that are prominently embedded in the targeted welfare system in Australia. Our results indicate that the distribution of earnings shocks still displays negative skewness and excess kurtosis even after taking into account these idiosyncracies. There are also pronounced disproportionate effects of government insurance on different household types, partly a result of the differences in income dynamics and the nature of the Australian transfer programs. For instance, lower-income female primary earners and non-parents both confront persistently high income risks, but due to the targetedness of transfer, the former group benefits significantly more from the government insurance. Consequently, the gap in disposable income risks between female and male primary earners shrinks substantially while that between parents and non-parents remains wide. Conversely, family insurance appears to be more important for those not targeted by the means-tested public transfer schemes 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 might explain the M-shaped age-profile of Australian female labour supply and is consistent with the conjecture put forth by De Nardi et al. (2021) based on their comparison of the US and the Netherlands.

Related literature. Our paper contributes to a growing literature that studies non-

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

Gaussian and non-linear 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 (39%) of female headed households in our sample of Australian workers (who are not self-employed). The results point at a strong 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 income and government transfers in insuring households against both transitory and persistent idiosyncratic risks. However, there are some notable 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. 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)). According to Kaygusuz (2015) and Nishiyama (2019), for instance, the US's spousal and survival benefits transfer welfare from two-earner to single-earner households. Our results show that female headed households (typically dual-earner) benefit more than their male counterparts (typically single-earner) from government insurance against earnings risk. Similarly, De Nardi, Fella and Paz-Pardo (2020) show the extent to which the government helps households depends on the risk distribution that they face and their family structure. Therefore, relaxing the Gaussian and linear assumptions to account for more realistic risk structure may have considerable influence on quantitative results.

Our work also contributes directly to the understanding of earning dynamics and inequality in Australia. The early literature studying labour 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 labour earnings is mainly due to residual factors reflecting idiosyncratic wage risks drawn from normal distributions. These studies commonly assume that income shocks follow 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 level. Differently, we focus on the higher-order moments of income changes. In doing so, we uncover the drivers of income risk and the functions and limitations of family and government insurance, which are 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 discusses the main results. Section 4 presents extensions. Section 5 concludes. Appendices report additional results.

2 Data and Methodology

2.1 Data and variable construction

We use data from the Household, Income and Labour Dynamics in Australia Survey (HILDA) Restricted Release 20 ($2001 - 2020$). 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 information on respondents and their family members, including rich demographic data. Compared to the General Release data sets, the Restricted Release also contains details on variables such as income and wealth (not confidentialised via top coding), employment characteristics, and birth dates. This allows for more accurate estimations of total individual and household incomes, and tax payments and transfer benefits.

We include wave 20, which corresponds to the 2019-20 financial year (from 01 July 2019 to 30 June 2020), as a larger sample size enhances the quality of our moment statistics. This means income, tax, and benefit variables are affected to an extent by the COVID-19 pandemic. Nonetheless, our sensitivity tests shows that the findings are robust to the inclusion of wave 20. This could be due to two reasons. First, our investigation into income dynamics controls for time effect. Second, the 2019-20 data includes at most 3 months of the pandemic effect[3].

Our core unit of measurement is an adult individual who legally pays taxes in Australia. After excluding dependent children and students, we arrive at $302,355$ observations. Restricting the sample further to include only employees (i.e., not self employed), we retain $152,903$ observations. Family is another core 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.[4]

At the annual level, the estimate of family income encompasses all individual regular market income flows that comprise all market sources of earnings such as wage and salary, business income, investment income, and regular private pension accruing to the sampling unit. Thus, it may contain additional regular market earnings by spouse, independent children, and other family members of the same family unit. Jointly with private transfer, this makes up family pre-government income (i.e., family income before tax and transfer)..

At the weekly level, the HILDA survey reports usual weekly earnings and usual work hours. Our measures of weekly wage rates are derived from these two figures. A caveat is that these

[3]Australian borders were not closed to non-residents until 20 March 2020. Many non-pharmaceutical interventions (e.g., mandatory social distancing and stay at home orders) and strict inter-state border control were enacted in or after late March 2020.

[4]The current sample involves single and partnered (married or in de facto relationship) primary earners distinguished by their unique family unit identifiers. 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 elementary 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. Note that parents and their dependent children belong to the same income unit.

variables are reported annually and do not capture interim unemployment spells and other short-term hour changes within a year. The estimates of earnings dynamics and its constituents at the usual weekly level are thus subject to measurement errors that likely result in an underestimation of the role of hours.[5] 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 one day or more per week for at least 18 periods (years) of observation and received at least the minimum hourly wage of AUD20 (in 2018 dollar). We relax this requirement, by setting the cutoff work duration to 10 years, for certain subgroups (e.g., non-parents) to allow sufficient sample size and ensure reliability of the moment estimates. Regardless, because the differences found in our study between the roles of wages and hours in explaining the transitory and persistent earnings changes are large, we believe the true patterns are unlikely to 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 work history. The reason is major welfare programs in Australia 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 government insurance demands that we do not drop those who temporarily exited the workforce. Moreover, the measurement error problem is of less 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 and lead to high clustering of hours that inevitably emerges as a consequence of omitting information on changes during the year. HILDA eases this constraint by collecting annual income, tax, and transfer information on a completed financial year preceding the date of interview, which permits more accuracy in imputing tax, transfer, and gross and disposable income at the annual level. 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).[6]

Since the annual data captures more within-year variation, the annual income variables are examined separately from the weekly variables. Besides, because tax and benefit are reported annually[7], it is through the annual variables that the effects of government insurance are estimated.

More precisely, the schema is as follows:

Weekly income variables:

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

Annual income variables:

[5] 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.

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

[7] We work with annual data and thus lack information on benefits or components of benefits that accrue at a higher frequency (e.g., 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 one of the eligibility criteria for major transfer programs is means testing combined family income (e.g., gross adjusted taxable family income) as opposed to individual income. Particularly, 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 construct various family income definitions which are then used to calculate social benefits and their related supplements. For convenience, 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. 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.[8]

Table 1 presents descriptive statistics of some of the main variables at individual and family levels in 2020. The values of income, tax liabilities and transfers are expressed in 2018 AUD.

Table 1: Summary statistics of primary earners in financial year 2020

Primary Earner		N	Mean	Median	SD	Min	Max
Age	Individual	5,064	41.62	40	11.42	25	64
	Family	5,064	-	-	-	-	-
Weekly hours	Individual	5,064	38.39	40	12.17	0	137
	Family	5,064	53.17	48	30.83	0	227
Weekly wage	Individual	5,064	1,602.68	1,407.68	994.18	0.00	13,106.03
	Family	5,064	2,366.64	2,135.80	1,479.03	0.00	15,752.48
Labour Income	Individual	5,064	85,855.68	75,723.73	56,891.76	0.00	970,817.13
	Family	5,064	129,099.10	114,556.42	85,839.93	0.00	1.13e+06
Market income	Individual	5,064	88,836.96	77,665.37	60,488.81	-42,502.38	970,817.13
	Family	5,064	139,555.66	121,949.19	102,986.36	-42,016.96	2.74e+06
Private transfer	Individual	5,064	446.73	0.00	3,197.68	0.00	132,911.66
	Family	5,064	809.84	0.00	5,273.85	0.00	168,922.17
Total income tax	Individual	5,064	20,926.39	15,641.81	23,154.97	-2,259.09	413,873.91
	Family	5,064	31,058.35	23,178.26	37,202.65	-7,960.70	1.16e+06
Public transfer	Individual	5,064	2,133.53	0.00	5,764.68	0.00	72,231.70
	Family	5,064	5,205.20	0.00	10,679.92	0.00	97,191.41

[8] 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 risks. We use similar metrics as in De Nardi et al. (2021) to measure the family and government insurance. Accordingly, the terms "*insurance*" is defined as 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. The current practice involves comparisons of moment properties between distributions of shocks at different income layers 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 $n = 1$, $\Delta^1_{\widehat{\mu}_{i,t}}$ is the annual growth rate of the income residuals. We refer to these 'residual' income changes as *income shocks*. 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 ($n = 1$) and 3-year ($n = 3$) average residual changes. Without knowledge of the nature of measurement errors in the survey data, the former contains both transitory shocks and measurement errors. By partially removing the transitory component, the latter's statistics thus achieve two objectives. First, they capture the more persistent element of shocks. Second, they help reduce the influence of measurement errors. Figure 1 reports an empirical distribution of annual residual income shocks.

Group-specific income shocks. Individual income shocks are subsequently grouped by (*i*) *age cohort* and (*ii*) *income history*. There are four age cohorts, namely $\{25-34,\ 35-44,\ 45-54,\ 55-64\}$. Income history, measured by either past usual weekly wages or past regular annual market income[9], is divided into deciles. Then, for every group conditioning on (i) and (ii), we study their respective empirical distributions.

To better understand the dynamics of income process, consider a parsimonious permanent and transitory component model for the residual income shocks 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

[9]When $n = 1$, previous period income refers to last year income. When $n = 3$, previous period income refers to average income of the past 3 years.

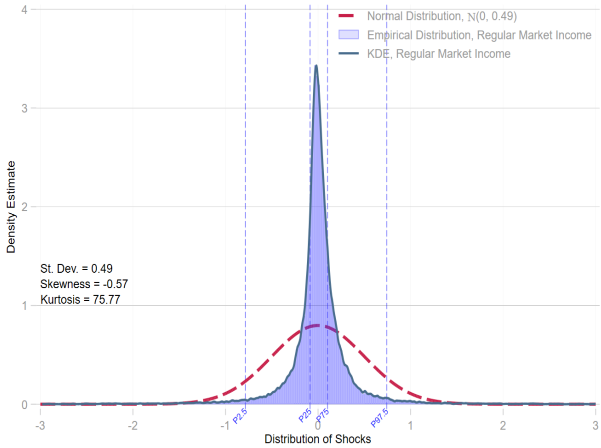

Figure 1: Empirical distribution of annual growth of individual regular market income of primary earners aged $25-64$. See Figure 20 in the appendix for a corresponding distribution of 3-year average income growth (when $n=3$).

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

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

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 $\varDelta^n_{\widehat{\mu}_{i,t}}$ analytically

$$\sigma^2_{\varDelta^n_{\widehat{\mu}_{i,t}}} = n\sigma_\eta^2 + 2\sigma_\epsilon^2$$

$$S_{\varDelta^n_{\widehat{\mu}_{i,t}}} = \frac{n \times \sigma_\eta^3}{\left(n \times \sigma_\eta^2 + 2 \times \sigma_\epsilon^2\right)^{\frac{3}{2}}} S_\eta$$

$$K_{\varDelta^n_{\widehat{\mu}_{i,t}}} = \frac{n \times \sigma_\eta^4}{\left(n \times \sigma_\eta^2 + 2 \times \sigma_\epsilon^2\right)^2} K_\eta + \frac{2 \times \sigma_\epsilon^4}{\left(n \times \sigma_\eta^2 + 2 \times \sigma_\epsilon^2\right)^2} K_\epsilon$$

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 $\varDelta^n_{\widehat{\mu}_{i,t}}$ follows a normal distribution $N_{\varDelta^n_{\hat{\mu}_{i,t}}} \sim \left(0, n\sigma_\eta^2 + 2\sigma_\epsilon^2\right)$. For example, Chatterjee, Singh and Stone (2016) employs this approach to 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 $\sigma_{\varDelta^n_{\widehat{\mu}_{i,t}}}$, $S_{\varDelta^n_{\hat{\mu}_{i,t}}}$, and $K_{\varDelta^n_{\hat{\mu}_{i,t}}}$.

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 and linear shock distribution assumptions are valid. This approach is also more flexible and allows us to identify the sources behind the non-normalities and non-linearities.

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

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

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 a sufficient sample size. In the subsequent subsection, we discuss the role of family and government in insuring primary earners against earnings risks by comparing 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.

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 common features. 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 a similar pattern is still observed for the 3-year average changes, though to a much smaller extent, suggests that the poorest primary earners face higher second-order risks 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 brackets is trivial. The fact that casual and part-time employment is more flexible might account for the persistently higher variance of the bottom decile's hour changes since a large proportion of part-time (≈%50) and casual (≈%30) workers in the sample belongs to this group. Second, wage changes play a markedly greater role in explaining earnings fluctuations, except for the bottom decile where changes in hour and wage 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 primary earners encountering adverse wage shocks make up for the loss by significantly increasing their work hours.[10]

[10] We report more dispersion statistics in the appendix. Figure 21 and 22 report second-moment statistics

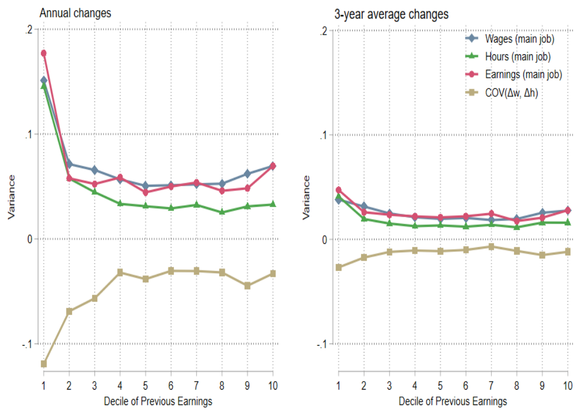

Figure 2: Variances of annual and 3-year average changes in usual weekly earnings, wages, and hours of primary earners.

There are also notable differences between the annual and 3-year average change statistics. The latter's variance undergoes a substantial decline, most strikingly for those in the bottom-most past income decile. As a result, together with their relatively larger covariance, the second-order persistent earnings risk (associated with the 3-year statistics) falls precipitously for the lowest 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, which could explain the more persistent dispersion of wage and hour changes. For the rest of the income group, the variance of hour changes diminishes by a lesser extent compared to that of wage changes, but wage changes are still the dominant contributor to the fluctuations of the 3-year average earnings changes.. In addition, despite the fall in wage and hour dispersion, the right panel shows that the second-order persistent earnings risk decreases by less than proportional the decrease in the corresponding wage-related risk. This outcome can be ascribed to the accompanying shrinkage of income effect as reflected by the lesser covariance magnitude. In other words, while 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 results in the later subsections point to public support as a major reason.

Figure 3 complements the above findings by juxtaposing the average changes in wages and hours with the average earnings changes for selected deciles 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 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 the bottom decile, wages contribute substantially more to the movement in earnings, whereas the contribution by hours is 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 to that of wage changes. In contrast, for the poorest, hour changes contribute about as much as wage changes do to large

of annual and 3-year average earnings, wage, and hour changes by selected subsamples. Table 5 and 6 reports statistics on part-time and casual employment by age cohort and past decile of weekly main wages.

earnings fluctuation.

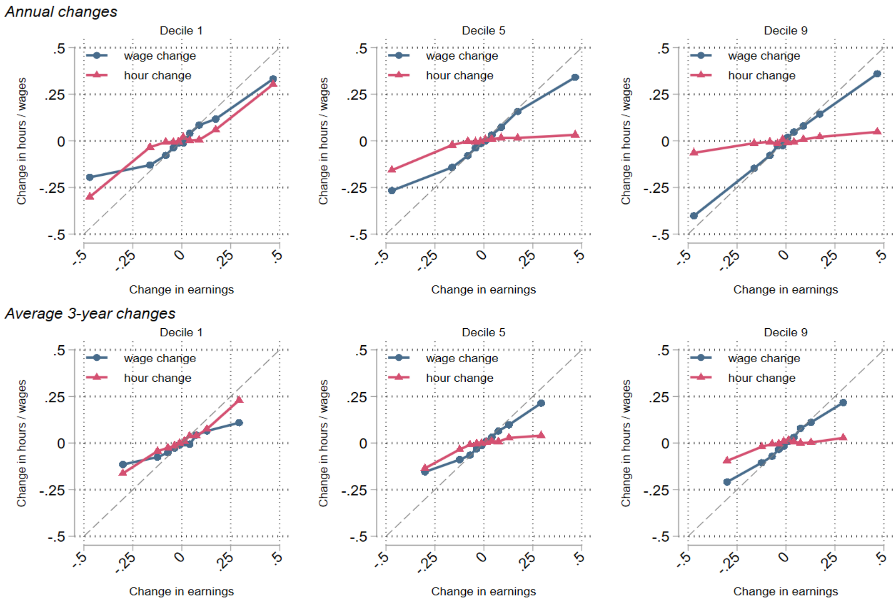

Figure 3: Average changes in residual usual weekly wages and hours versus average changes in residual usual weekly earnings (from main job) for primary earners in the 1st, 5th, and 9th deciles of past usual weekly earnings. The top and bottom panels report annual changes and 3-year average changes, respectively. We only consider primary earners who report positive earnings at or above the minimum wage cutoff for at least 18 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. 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 (-0.18) and 0.125 (-0.12) 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 regards to the relative shares of hour and wage changes in explaining earnings changes of the two income 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).[11] 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

[11]See Table 5 and 6 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).[12] 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 when hours fall due to, for instance, early retirement, health shock, and unemployment spells that are less constrained by the hour cap or the institutional friction. 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 usual work hours may still involve some information on the extensive margin.[13] These factors help rationalize the larger role of hours in driving their earnings changes. Lastly, job and career mobility - voluntary or involuntary - may play a role in raising the influence of wages on earnings growth. This would be consistent with the rising variance of log hourly wage and persistent component of wage shocks over time and over life cycle as documented in Chatterjee, Singh and Stone (2016); Kaplan, Cava and Stone (2018); Freestone (2018). However, cross-country evidence on job mobility is scarce. Although a recent report by the Australian Bureau of Statistics (ABS) suggests a declining mobility[14] in Australia, a study by Azzopardi et al. (2020) also shows a declining trend in the US. Therefore, further exploration along this direction should shed more light on the observed dynamics.

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 a year of observation. The exclusion of workers with inconsistent employment history helps 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 therefore applies mostly to the intensive margin of labour supply. That said, assuming independent measurement errors, the errors would have to be large to explain away the observed pronounced differences in hour and wage contributions to earnings changes across deciles. Note that relaxing the sampling restriction brings about a greater relationship between negative hour and negative earnings changes, and increases the role of hours in explaining the dispersion of earnings shocks. Nonetheless, it does not change the results in any significant manner with regards to the non-existent impact of hours on positive earnings changes, nor does it alter the fact that wage changes play the biggest role in producing the second-order earnings risk.[15] On this ground, 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 negative earnings changes, but it should not affect our main results.

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

[13] 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.

[14] See report on job mobility by the ABS.

[15] See Figure 23 in the appendix.

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 its magnitude being an increasing function of past weekly earnings. In more colloquial terms, negative skewness means extreme negative earnings shocks are more severe compared to positive ones. The corresponding 3-year average changes are more symmetric although primary earners in the upper four deciles still experience a relatively high negative skewness. Thus, upper income individuals are affected by more extreme persistent adverse shocks to their earnings.

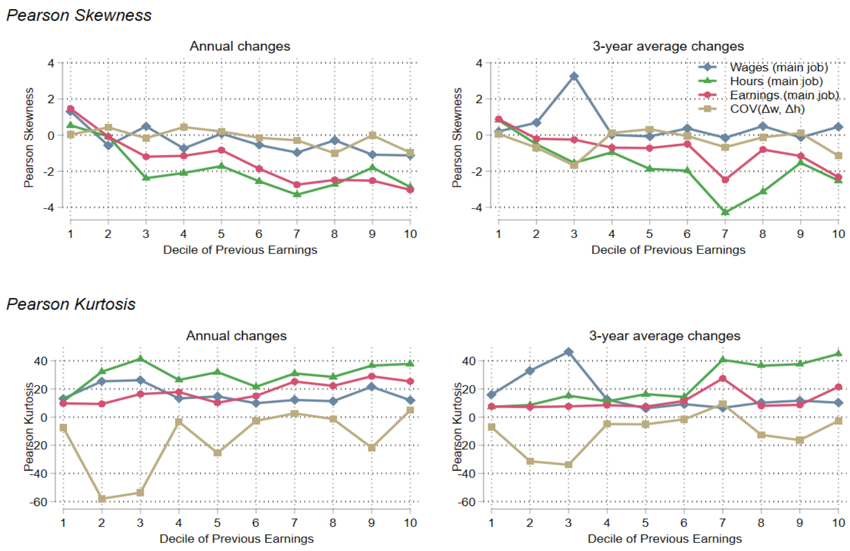

Figure 4: Pearson Skewness and Pearson Kurtosis of annual and 3-year average changes in usual weekly earnings, wages, and hours of main job of primary earners.

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.[16] These estimates demonstrate that the third-order earnings risk is driven by hours. In addition, we see that co-skewness of the annual changes hovers around zero, whereas the co-skewness of the 3-year average changes is more 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. In this regard, negative co-skewness means large fluctuations in wages are often 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 hours.

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 restraints, naturally places a hard upper bound on hours. Prior quantitative inves-

[16]Results are consistent across the various household characteristics. See Figure 24 and 25 in the appendix for the third-moment statistics of annual and 3-year average earnings, wage, and hour changes by selected subsamples.

tigations suggest the nature of job ladder as a strong candidate explaining the role of hours in driving the third-order earnings risk. In particular, Lise (2012) shows how workers at the top of the wage distribution faces job-loss risk while those at the bottom climb the ladder slowly with the arrival of job opportunities and the incremental wage gains. Similarly, Huckfeldt (2018) finds that job loss leads to occupation displacement for some workers as they are forced to search in the lower skilled labour market. In Australia specifically, workers experiencing job loss could be absorbed and become entrenched in its large part-time and casual employment industries. These factors help account for the relatively higher and more persistent third-order risk of the upper income earners.

The bottom panel of Figure 4 depicts excess kurtosis (leptokurtic) of the earnings shock distribution. Statistically, a leptokurtic distribution is denser around the centre (high peakedness) and thicker at the tails than the standard Gaussian distribution. Large kurtosis thus implies that changes in earnings are rare and most are small, but at the extreme, they occur more frequently. To put it differently, most breadwinners seldom encounter any large changes to their earnings, but the probability of experiencing drastic earnings changes is greater than otherwise prescribed by the standard Gaussian distribution. The figure further shows that this high fourth-order earnings risk 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 excess kurtosis of annual earnings changes, the contribution by hour changes is approximately twice as much.

The impact of hours on the fourth-order earnings risk is dampened to an extent by the negative co-kurtosis, a counterbalancing force. Co-kurtosis between two random variables captures the relationship between the extreme changes 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. The negative co-kurtosis thus suggests that an extreme decrease (*increase*) in wages tends to be offset by an increase (*decrease*) in work hours. This interaction reduces the otherwise high density at the centre and tailends of the distribution of annual earnings shocks, thereby mitigating the fourth-order earnings risk to a relatively moderate level. For more persistent earnings changes (bottom-right panel), the size of the effect of hours shrinks for the lower six deciles, though 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 driving 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 earnings risks. Results concerning the role of wages and hours in accounting for 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 its two subsections 3.2.1 and 3.2.2, beginning with a brief comparison of the second-order earnings risks faced by different age cohorts.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 their employment history.[17] We consider robust moment statistics 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 chose to present the P1-P99 figures in the main paper for ease of interpretation, conciseness, 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.[18] 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 have U-shaped income profiles for all age cohorts with the greatest dispersion for primary earners whose past regular market income lies in the lowest decile. Top earners also experience a relatively strong fluctuation, but the magnitude is considerably smaller than those of the bottom decile. The high share of low income earners employed in part-time and casual jobs that entail more irregular hours, seasonality, and risk of layoff is one potential reason.

There are notable differences between the two panels. First, excluding the bottom decile, we see a small but non-uniform decrease in the second-order earnings risk associated with the 3-year statistics for all cohorts. Second, for workers in the bottom-most decile in particular, the standard deviations of their 3-year average market earnings shocks are substantially lower compared to those of their annual changes. The drop is even 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 prevalent 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 compared to those of the youngest and the oldest. A rationale is that these two latter age groups are more likely to undergo changes in their market earnings for the reasons stated previously. 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, or have already accumulated

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

[18] 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.

sufficient wealth (in case of the oldest cohort). In turn, compared to the oldest, the youngest sees higher transitory and persistent fluctuations associated with their earnings changes, especially if they happen to be below the median past income distribution. This implies that the process that drives the second-order earnings risk for the youngest group is more potent and persistent in comparison to those for the oldest group. For instance, early career horizontal and vertical job mobility and other family-related decisions can result in either adverse or favourable earnings growth and therefore more variation, whereas health shocks and early retirement in later life cycle only lead to a unidirectional change (decline) in market earnings and thus less variation. Similar results are observed across the different measures of second-order risk.[19]

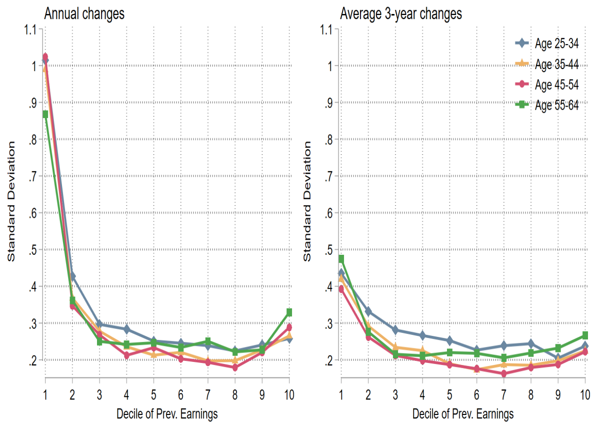

Figure 5: Standard deviation of the distribution of regular market earnings shocks for primary earner (P1-P99).

A logical follow-up to the prior discussion is examining the extent to which family income insures primary earners against their market earnings risks. 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 the second-order risk, 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 those situated in the bottom past income decile, and only family market income matters while the addition of private transfer marginally raises the level of dispersion. Even this small effect of family market income insurance for the poorest dissipates completely when we consider the more persistent 3-year average shocks in the bottom panel. In this case, family earnings and private transfer actually elevate the second-order risk. The absence of family insurance implies dominance of the *income-pooling effect* of family as opposed

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

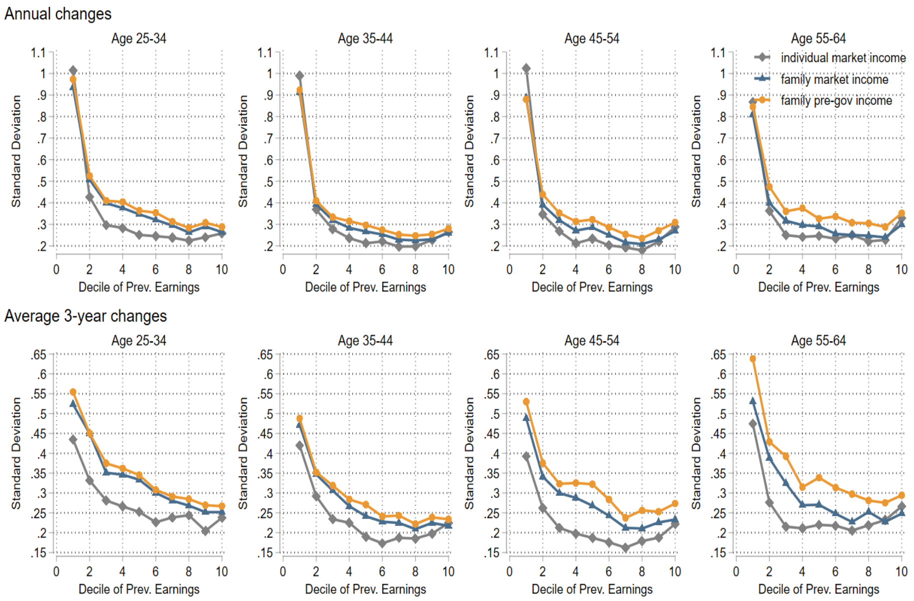

Figure 6: Standard deviation of the distribution of annual and 3-year average changes of family income (P1-P99) at different levels. The figure captures the relative contribution of family market income and private transfer to the second-order risk of pre-government family income.

to the *added-worker effect*.[20] That is, family members do not actively adjust their market activities (e.g., labour supply) in response to primary earner's earnings shocks. As a result, individual members' earnings tend to increase variance of the combined family market income.

The next figure conveys more revealing information. As it turns out, the above passiveness of family members seems to only apply to small and moderate shocks. Figure 7 suggests that family income is paramount to insuring against the third- and fourth-order risks of individual regular market earnings. To rephrase, family members do respond to extreme adverse earnings shocks.[21]

The top panel of Figure 7 shows large negative skewnesses (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. In this scenario, family market income provides substantial insurance, resulting in remarkably lower negative skewnesses (ranging between -0.5 and -1.5) compared with those of the individual market income shocks. Better off households at or above the median past earnings of the oldest ($55-64$) age cohort also benefit from moderate private transfer insurance, supplementing the market income adjustment by their members. In fact, the presence of family transfer allows the third-order pre-government income risk of the richer seniors to arrive at a similar level as those of the younger two cohorts who rely exclusively on their family market income insurance. The single outlier in the described pre-fiscal earnings dynamics and insurance thus far is primary earners in the bottom decile whose skewness is strongly positive. As aforementioned, the relatively high proportion of this group in part-time and casual jobs suggests more flexibility and therefore opportunities for upward movement of hours and wages.

Kurtosis of the earnings shock distribution also manifests non-Gaussian and non-linear prop-

[20] See subsection A.2 of the appendix for related formula and further explanation.

[21] The observed insurance effect against higher-order earnings risks is generally consistent across all the sub-samples analyzed. Thus, we report only the annual statistics and leave the rest in the appendix.

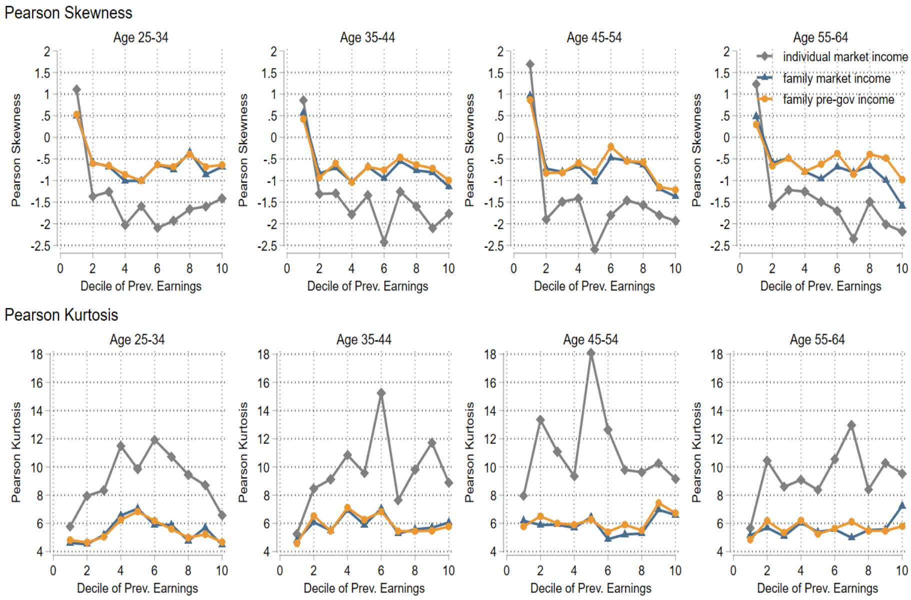

Figure 7: Skewness and Kurtosis of the distribution of annual changes of family income (P1-P99) at different levels. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of pre-government family income. Corresponding moment statistics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

erties. 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. Like skewness, the statistics on kurtosis in Figure 4 suggests hours to be the main explanatory factor. Since we study annual level earnings, we expect short-term unemployment spells to further augment the influence of hours on earnings changes. Along the same line, the ability to adjust one's hours for casual and part-time employees in response to 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 significant, enough to reduce the kurtosis levels to comparable degrees (between 5 and 7) for all households. Again, the only 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 Crow-Siddiqui kurtosis behaves erratically, making it difficult to interpret. In contrast, Kelley's skewness exhibits more consistent patterns across the different measures. It demonstrates that once enough extreme shocks at the tailends have been excluded, the distributions of shocks of the first half of the past income distribution are positively skewed, whereas the upper deciles still face a moderate to high level of left skewness. Additionally, it highlights the fact that extreme shocks in either direction (i.e., adverse or favourable) bring about family responses. That is, not only do family members increase their market activities in response to severe downward shocks, the Kelley's skewness statistics indicates that they also react to large positive shocks 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 earnings risks even if it does not mitigate the second-order risk. 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 combined family income taxes reduce the magnitude of standard deviation, skewness, and kurtosis of the distribution of family pre-government income shocks. Analogously, government transfer insurance is the extent 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 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 trivial, government transfer considerably reduces the second-order risk associated with family pre-government income for primary earners below the median past regular market income.[22] The insurance is at its largest for the poorest households and declines rapidly as one moves up the income hierarchy. Another noteworthy observation is that relative to the annual statistics, transfer insurance against persistent second-order risk remains significant with its magnitude mostly well-preserved (bottom panel of Figure 8). For the bottom decile, the magnitude of insurance may have decreased but not in a relative sense. This is most likely a product of the targeted and means tested welfare programs 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 second-order risks, but this may also be a worrying sign that households rely too heavily on public transfers.[23]

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-

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

[23] 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.

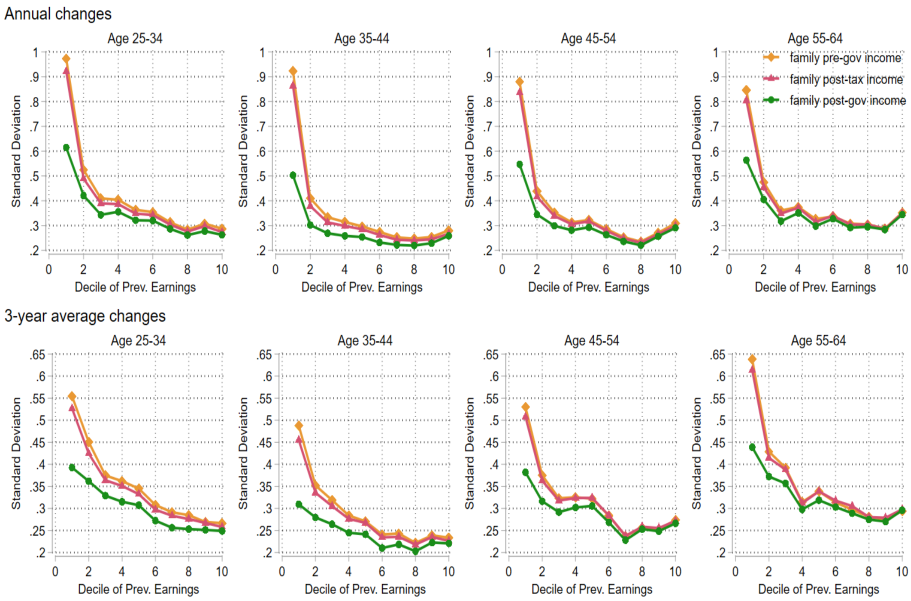

Figure 8: Standard deviation of the distribution of annual and 3-year average changes of family income (P1-P99) at different levels. The figure captures the relative contribution of tax and transfer to the second-order risk of disposable family income.

order risks of the annual (*top panel*) and 3-year (*bottom panel*) average family disposable income. Given the large family insurance against extreme shocks, it is to be expected that the government insurance is relatively small. Still, government transfer insurance against the third-order risk at the annual level is visible and non-trivial for poorer households and most in the younger two cohorts. For the 3-year average changes, however, the insurance remains sizeable for the youngest but largely disappears for the older cohorts. The impact of government insurance on the fourth-order risk of family disposable income in Figure 10 exhibits similar results. The annual level statistics on the top panel reveals that tax and transfer insurance against the fourth-order risk is generally absent. Likewise for the 3-year average changes on the bottom panel, government tax and transfer play no insurance role; on the contrary, they could lead to more excess kurtosis for some households.[24]

Yet, a higher kurtosis level does not readily imply a welfare deteriorating effect on households. 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 adverse outcome. If the growth reflects an increase in the proportion of households experiencing small or no disposable income shocks (i.e., higer peakedness of the shock distribution), then the greater kurtosis actually conveys the effectiveness of government tax and transfer insurance. 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 is required.

[24]See Figure 48 to Figure 63 in subsection A.7 of the appendix for 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 mostly consistent results with the findings in this subsection.

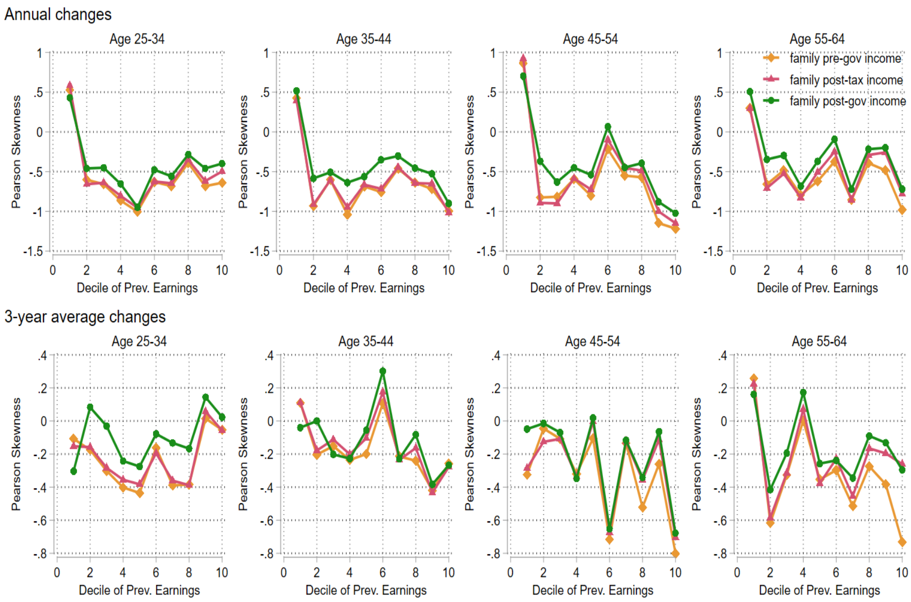

Figure 9: Skewness of the distribution of annual and 3-year average changes of family income (P1-P99) at different levels. The figure captures the relative contribution of tax and transfer to the third-order risk of disposable family income.

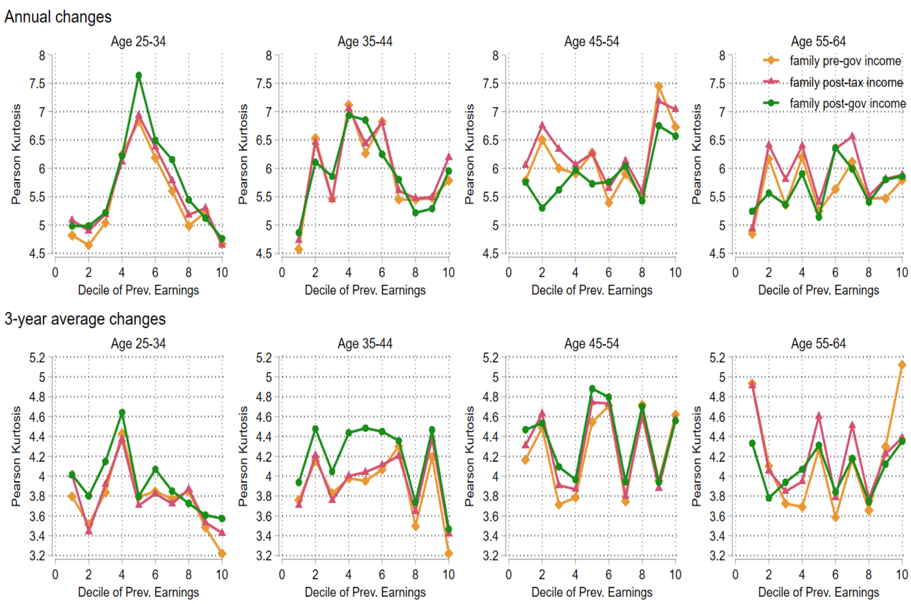

Figure 10: Kurtosis of the distribution of annual and 3-year average changes of family income (P1-P99) at different levels. The figure captures the relative contribution of tax and transfer to the fourth-order risk of disposable family income.

Changes in income shock distributions and their implication on kurtosis

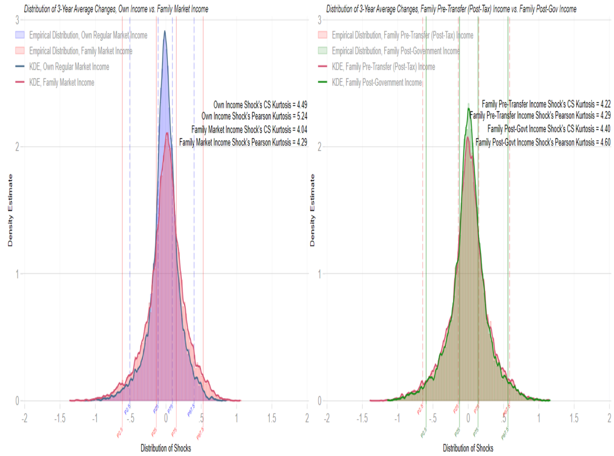

Figure 11: Comparison of empirical distributions of 3-year average shocks: individual market income vs. family market income (left panel), and family pre-transfer (post-tax) income vs. family post-government income (right panel). All density estimates use epanechnikov kernel function with bandwidth of 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.[25] The bottom and top deciles of the past income distribution are excluded because their higher-order moments often behave quite differently. We report the *P2.5*, *P25*, *P75*, and *P97.5* percentiles - used to calculate Crow-Siddiqui kurtosis - in order to emphasize the effect that each step of the distributional changes has on the quantile-based kurtosis value and its interpretation.

The left panel of Figure 11 contrasts regular market income and family market income shock distributions of primary earners. The comparison reveals important information about the observed kurtosis changes in the earlier subsections. First, both the quantile-based and standardized measures of kurtosis of the family income shock distribution are smaller than those of the individual shock distribution 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 around 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. Under this scenario, additional market earnings from family members do not mitigate extreme shock probabilities; on the contrary, they add to the probabilities of moderate and large shocks.

The right panel displays a similar juxtaposition of family pre-transfer (post-tax) income and disposable income shock distributions, which demonstrates that the higher kurtosis associated

[25] Similar comparisons 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 concentrated about the mean with elongated tails but they tell the same story as Figure 11 does. The annual (Figure 65) and 3-year average (Figure 66) 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. This again reflects the family targeting welfare system in Australia which transfers large benefits to parents of dependent children. Note that grouping the observations by income decile does not result in any significant changes in the observed pattern and neither does using the arc percent change method.

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 at 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. In effect, the government transfer insurance mitigates the probability of large shocks, an outcome not apparent via the fourth moment statistics alone. On the contrary, the Crow-Siddiqui kurtosis computed actually increases from 4.22 to 4.40, and in a similar manner, the standardized kurtosis increases moderately from 4.29 to 4.60.

In essence, Figure 11 serves as an example when depending on kurtosis to inform about insurance effects against the fourth-order risks is misleading. Specifically, it provides evidence of an instance when the fourth-order risk is driven mainly by a process that alters the central density of the shock distribution, and as a result, a lower fourth-order risk is not equivalent to a decreased probability of extreme shocks. The picture is not as obvious in some other cases. Because this question complicates the analysis of kurtosis beyond the scope of our study, it is not addressed in the current work.

Hence, kurtosis contains rich information, albeit its interpretation should be exercised and treated with caution. Without a more in-depth analysis of the processes behind the changes in kurtosis, variance and skewness are perhaps more reliable standalone measures of insurance against risks and its welfare implication.

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 income shock volatility while family market income insurance is most potent against extreme shocks. We construct two complementary figures (aggregated over age) to learn more about primary earner's earnings 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 weekly earnings for primary earners grouped by their past income rank. In the top panel, we see that annual changes in work hours and wages of spouse (or secondary earner) in response to primary earner's earnings shocks are largely absent. As Figure 12 is based on usual weekly work hours and wage rates, one may argue that some fluctuations within a year such as temporary unemployment of primary earners and employment of their partners are omitted, which could explain the absence of spousal response. However, the fact that the 3-year average statistics (the bottom panel) still 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.

The subsequent Figure 13 compares changes in annual spousal earnings and public transfer against changes in primary earner's annual 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 response 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

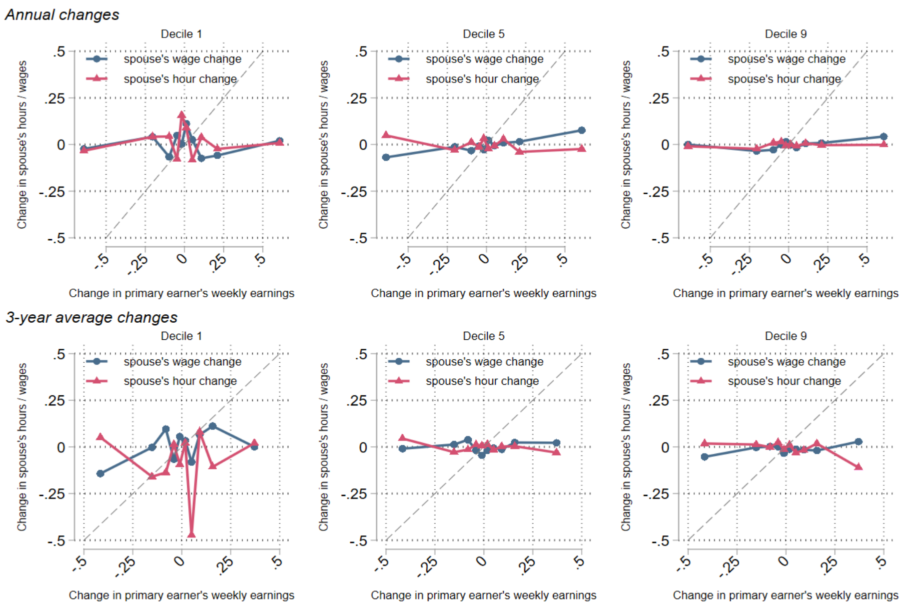

Figure 12: Changes in usual weekly wages and hours of spouse versus decile of changes in usual weekly earnings (main job) of primary earners in the 1st, 5th, and 9th deciles of past weekly earnings. The top and bottom panels report annual and 3-year average changes, respectively.

earnings, they are inconsistent and do not suggest a conscious counteraction made by the spouse to changes in their partner's income. Perhaps equally striking, though anticipated, is the strong negative correlation between changes in public transfer and primary earner's income. At the extreme of annual changes for the median income primary earners (top-middle graph in Figure 13), for example, a decrease (*increase*) in their previous annual earnings by -0.8 (0.8) log points corresponds to an increase (*decrease*) of 0.35 (-0.5) log points in public transfer. Response from the transfer system is even greater for richer households in the 9th decile, plausibly owing to the means test on combined family income. The 3-year average change statistics on the bottom panel convey a matching story.

In summary, section 3.2 demonstrates that the roles of family and government insurance generally do not overlap. Family market income does not insure against the second-order risk; however, against the third-order risk, it is a major source of insurance. Conversely, government transfer serves as an effective tool insuring against the second-order risk, especially for young and low income households, but its impact on the third-order risk is comparatively small. With regards to insurance against the fourth-order risk, investigating the shock density estimates allows us to show precisely that the decrease in kurtosis of the shock distribution associated with family market income does not readily translate into a positive insurance effect.[26] Likewise, the rise in kurtosis does not necessarily mean that the government insurance is absent or that the public transfer induces a higher probability of extreme shocks. Additionally, 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 side. The adjustment in spouse's earnings tends to

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

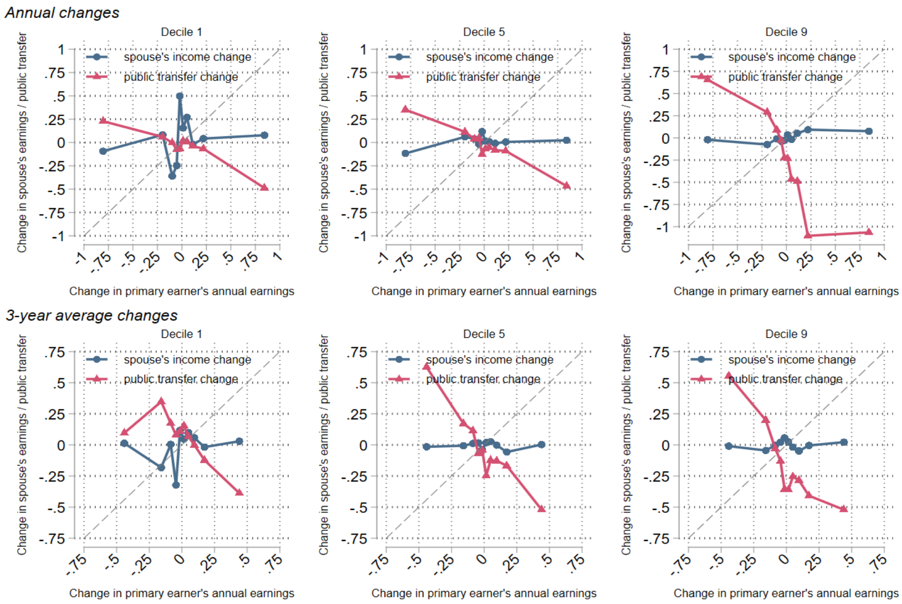

Figure 13: Changes in spousal earnings and public transfers versus decile of changes in past market earnings of primary earners in the 1st, 5th, and 9th deciles of past regular market income. The top and bottom panels report annual and 3-year average changes, respectively.

be either insignificant or inconsistent. Interestingly, though the sign is weak, it appears that spousal and government responses move in opposite direction. Since government insurance may have crowded out family insurance, how much of the observed spousal behaviour stems from the presence of large government transfer insurance is therefore a subject worth inquiring into. We leave this to future research.

4 Further analysis

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

4.1 Gender

Households with female primary earners, a.k.a female headed households, account for approximately 39% of our pooled sample of single and partnered employees (46.37% of whom live in partnered households). Figure 14 compares moment properties of the income shock distributions of male (*left panel*) and female (*right panel*) headed households aggregated over age. For both genders, 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 rela-

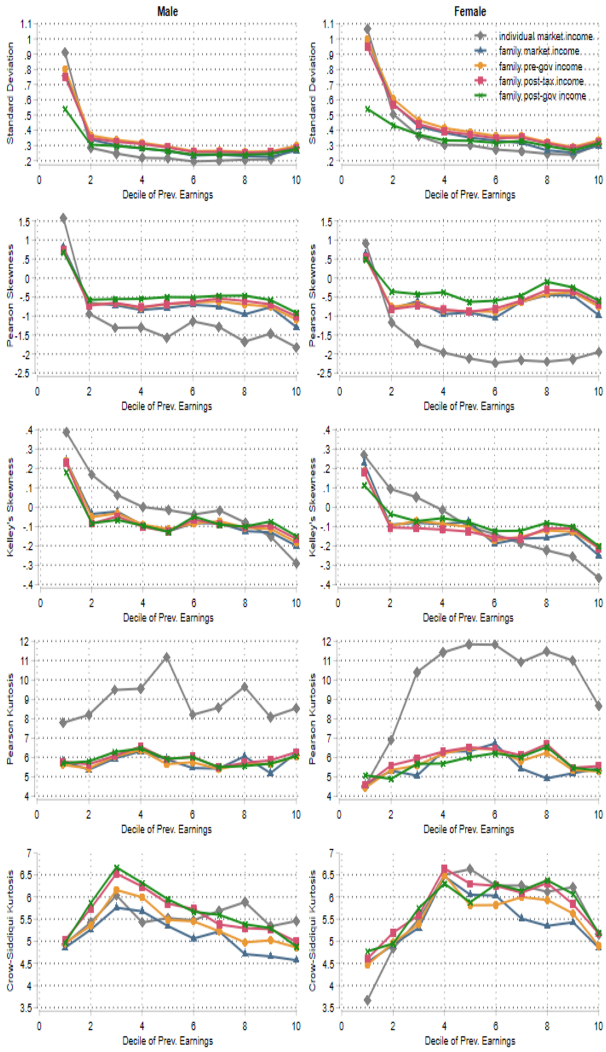

Figure 14: Moment properties of the distributions of annual income shocks of male (left panel) and female (right panel) primary earners and their households (P1-P99 Pearson statistics).

tively higher individual earnings shock variance of female heads themselves. A likely secondary cause is the larger share of labour hours and earnings of male secondary earners (in female headed households) as displayed in Table 2.[27] Higher income share of male secondary earners then translates to higher positive influence of shocks to their income on the variance of family income shocks (i.e., income-pooling effect).[28] 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 on the second-order earnings risk of female headed households below the median past 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. Coupled with the fact that male secondary earners bring home substantially more income than their female counterparts do, this helps explain why family market income insurance is greater for female primary earners in terms of its insurance role against the third-order risk. For similar reasons, while the government insurance against the third-order risk is small, there is sign of comparatively larger government insurance for female headed households. Concerning the fourth-order risk, family market income appears to be the sole insurance and its effect is in overall larger for female heads.

Secondary Earner		Age	Higher Education	Weekly Hours	Weekly Wage	Annual Market Income	Annual Govt Transfe
1	Male	36	47%	29.9	$619.43	$19,554.41	$10,633.3
	Female	34.4	47%	25.3	$566.46	$21,166.45	$11,822.0
2	Male	38.3	57%	35	$823.47	$40,572.98	$5,065.0
	Female	36.3	54%	26.6	$664.96	$29,604.74	$6,705.7
3	Male	40.7	65%	38	$959.69	$49,668.30	$3,046.4
	Female	38.6	58%	29.6	$775.35	$38,089.68	$3,708.1
4	Male	42.3	73%	40	$1,201.26	$65,238.51	$1,729.3
	Female	40	67%	31.9	$958.34	$50,298.72	$1,670.6
5	Male	46.1	82%	41.5	$1,670.71	$104,266.79	$885.9
	Female	42.9	76%	33.9	$1,281.75	$74,134.83	$1,114.5

Table 2: Average 20-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 in Figure 15, at both the individual and household levels, shocks on the female side continue to be more volatile than those of their male counterpart, particularly if they happen to be below the median. 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 second-order risk of male primary earners, whereas the improvement, though sizeable in the absolute sense, still leaves the lowest income women worse off than their male and higher

[27]The substantial fraction of matching between higher income male and lower income female (appendix: Table 7) 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 8) which is also reflected by the smaller weekly wages of female secondary earners relative to those of male secondary earners as evident in Table 2.

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

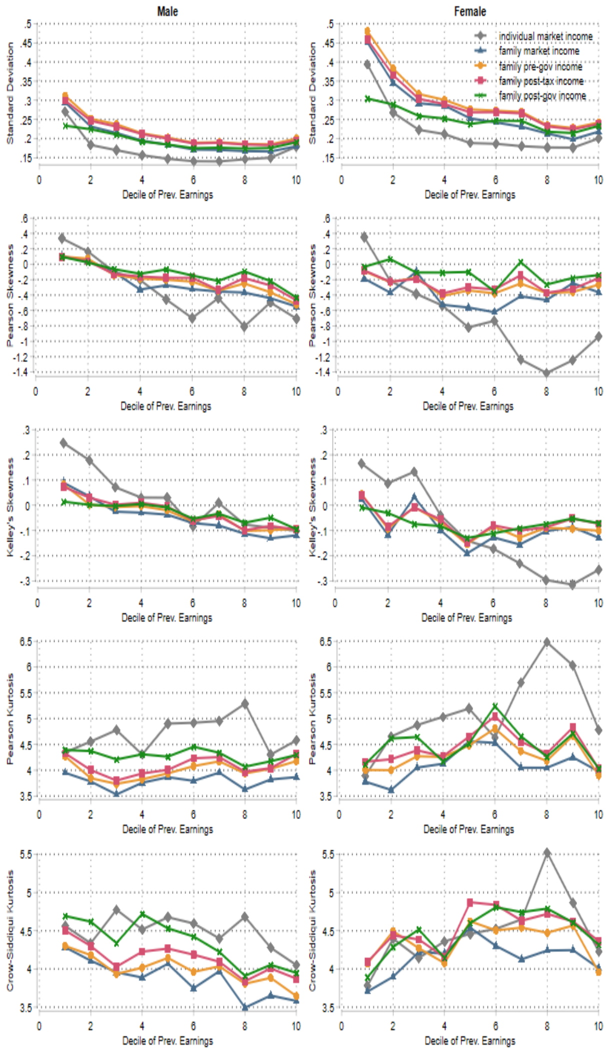

Figure 15: Moment properties of the distributions of 3-year average income shocks of male (left panel) and female (right panel) primary earners (P1-P99 Pearson statistics).

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. Institutionally induced rigidities in the labour market can further prevent labour supply adjustment for mothers. Precise answers to these questions, however, require a more sophisticated economic model. What is clearly laid out in this case is that government transfer maintains its status as a crucial source of insurance against the persistent second-order risk for female headed households even when its insurance effect becomes almost trivial for male heads. This has important implications for structural models of Australian households and optimal policies because unlike transitory risks, more persistent adverse risks impact lifetime wealth and are harder to insure through self-insurance mechanisms such as savings and borrowings.

Next, we compare standardized 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 insurance still exerts a strong third-order risk mitigating effect for women, particularly for those in the upper past income deciles. Conversely, in relation to their male counterparts, female heads below the median benefit significantly more from government transfer insurance. On kurtosis, male and female primary earners experience a sharp decrease in their fourth-order risks compared to the corresponding annual statistics, though that of female heads in the upper deciles remains relatively high. Family market income does reduce kurtosis in this case, but the effect is much less consequential. On the other hand, public and private transfers cause a small increase in kurtosis for both groups. Inspecting their empirical density distributions (figures not included) suggests that the increase in kurtosis stems from higher peakedness of the household disposable income shock distributions as opposed to thicker tails. Transfers may cause changes in their household disposable income to be more clustered about the mean of the shock distribution and thus helps explain the result.

Figure 14 and 15 show significant differences in income dynamics and insurance between male and female headed households. More interestingly, we see that government transfer equalizes the risk outcome between these two household types. An important implication is that examining income level and first moment alone might not allow one to fully grasp the role of family and government insurance across socioeconomic and demographic groups. The supplementary statistics on mean government transfer in Table 2, as an example, report a larger average transfer 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 previous quantitative works; for instance, Kaygusuz (2015) and Nishiyama (2019) whose 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 (typically with both male and female spouses working) to single-earner (typically with male primary earners) households. Given that 46.37% of the female primary earners in our Australian sample is married or in de facto relationship, our results suggest that two-earner households may also benefit from the transfer system, though these say nothing about the aggregate efficiency and welfare effect. Note that, the strength of government insurance effect for female headed households, especially against the third-order risk, weakens when single households are excluded, but the overall pattern remains. Allowing for rich income dynamics and heterogeneities in family structure is thus important for evaluating social insurance effects. De Nardi, Fella and Paz-Pardo (2020) make a similar point using the UK case study.

4.2 Marriage and Parenthood

Following the previous discussion, the central theme in this subsection is concerned with how family and government insurance effects differ among households varied by marital and parental status.[29] 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 large government insurance for this group as family support 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 (87.21%) of lone parents in our sample, which might also explain the strong government transfer insurance effect for 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

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*). Family market income behaves as a moderate insurance mitigating the individual shock dispersion for parents in the bottom decile but the effect is barely discernible for non-parents. Government transfer insurance is visible for all parents below the median, whereas for non-parents, the insurance is limited to the poorest households. The transfer insurance is at its largest for parents in the bottom decile, more than double that for non-parents.

The corresponding 3-year average income statistics in Figure 17 demonstrate the persistence of government insurance for parent households even as family insurance has completely vanished. For this group, government transfer insurance effect remains substantial and extends to those in the upper brackets above the median past income. For non-parents, on the other hand, government transfer continues to serve as a vital source of insurance but only for the lowest decile.

Turning to Pearson skewness in the second row of Figure 16, we see that family insurance is present for both parents and non-parents, though it is generally larger for latter. 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 transfer insurance appears to be more widespread and represents a larger fraction of the total insurance for parent households.[30] 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 larger

[29] We count those legally married or in de factor relationship as married or partnered. Only parents of dependent children are counted as parents. By these definitions, parents account for 39.29% of the $152,884$ observations. Partnered primary earners comprise 89.07% of parents and 53.99% of non-parents.

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

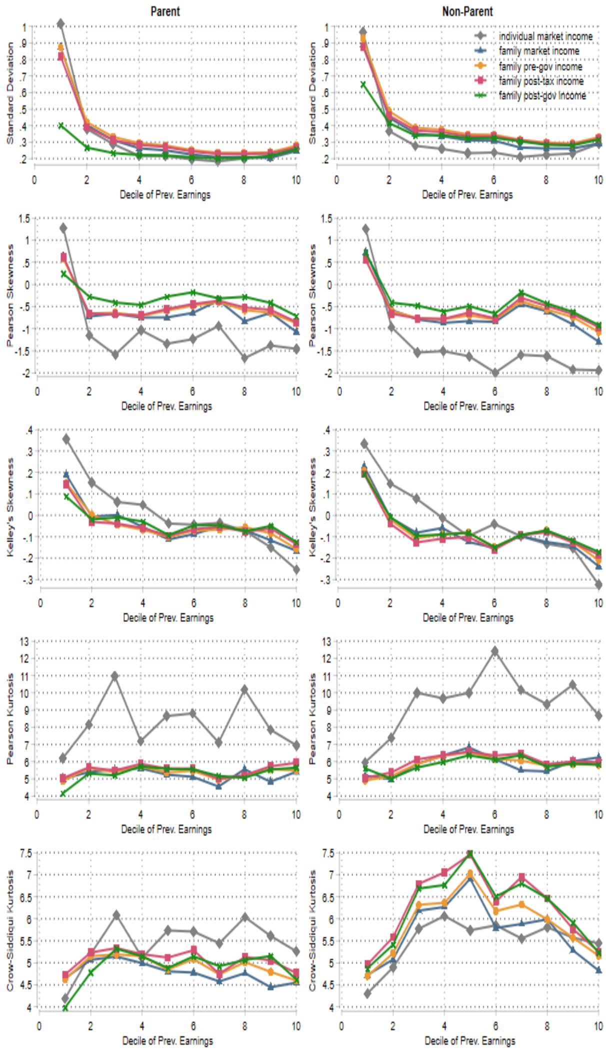

Figure 16: Moment properties of the distributions of annual income shocks of parent (left panel) and non-parent (right panel) primary earners (P1-P99 Pearson statistics).

across income status. Additionally, the figure indicates that family market income is still the only primary source of insurance against the third-order risk for non-parents above the median income, whereas for parents within the same past income bracket, their family market income, private transfer, and government transfer make up roughly equal shares of the total insurance.

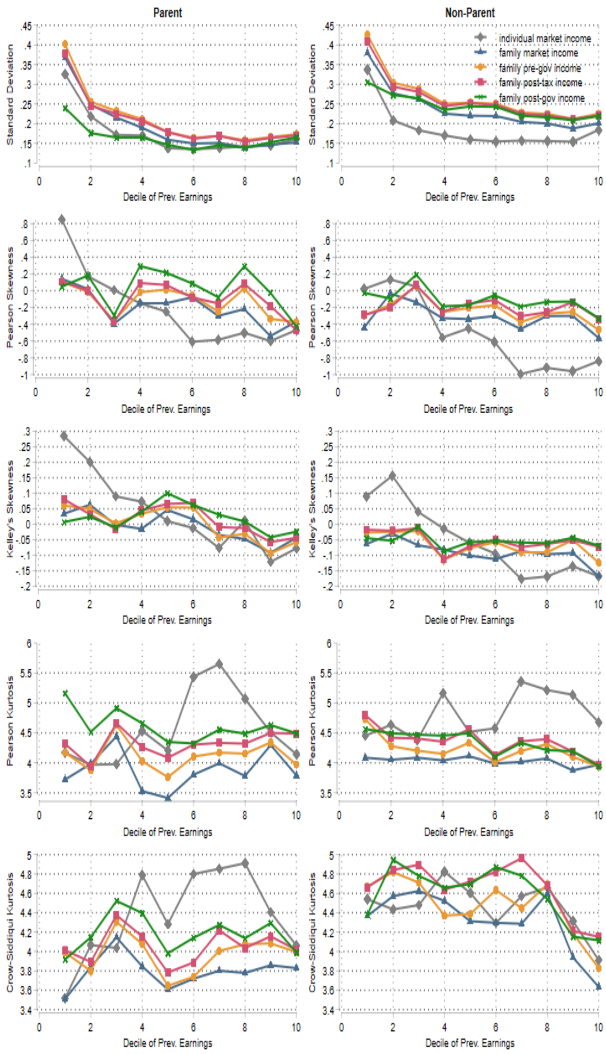

Figure 17: Moment properties of the distributions of 3-year average income shocks of parent (left panel) and non-parent (right panel) primary earners (P1-P99 Pearson statistics).

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 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 process usually prevails. 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, government transfer creates a larger cluster around the mean, causing the peak of the shock distribution of 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.

We can draw a few critical points from the above discussion. First, the existence of means-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 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 market income insurance for parents, despite the large proportion of partnered households within their composition (89.07%), relative to that of non-parents suggests a crowding-out effect of government insurance on family insurance (i.e., work disincentive effect on secondary earners).[31] 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 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 prior subsection reveals that parenthood, to a considerable extent, determines the size of government transfer insurance against transitory and persistent income risks in Australia. Provided that the majority of lone parents are female and that female headed households benefit greatly from government insurance, we dedicate this segment to an extended examination along the dimension of marital status.

The small sample size for lone parents makes the 3-year average statistics less reliable; thus, we restrict our investigation to moments of the annual income shocks 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 confront a significantly greater second-order risk than partnered parents within the same bracket do. More interestingly, while family insurance against the second-order risk is missing for lone parents, their government insurance is strikingly large, especially for poorer households. In fact, the insurance magnitude is sufficient to close the initial disparity in pre-fiscal risks 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 bottom decile 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.

[31] In fact, it is more plausible that parents have a stronger incentive to insure their households against shocks.

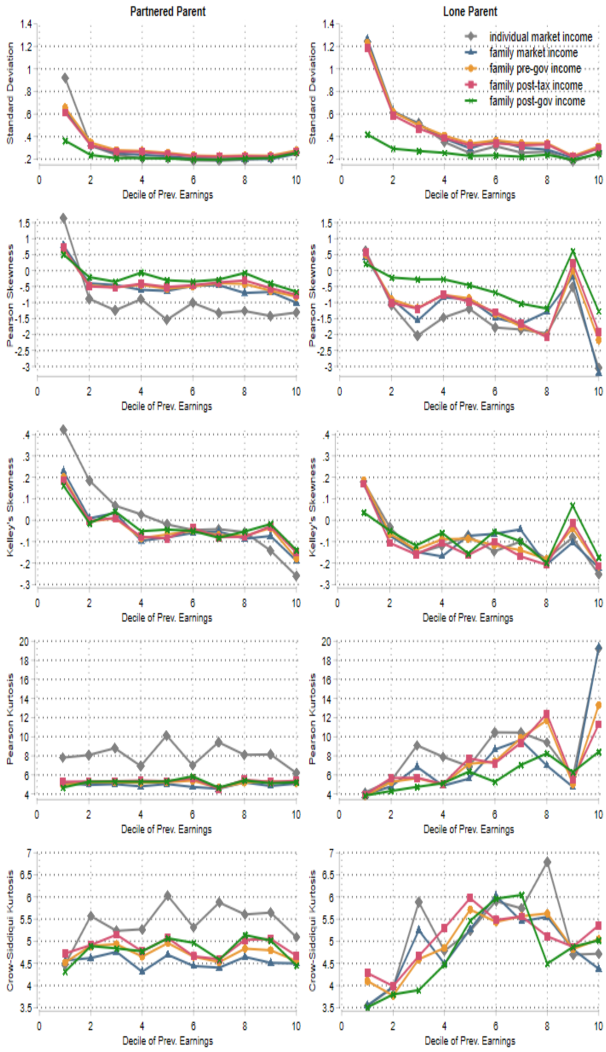

Figure 18: Moment properties of the distributions of annual income shocks of partnered parent (left panel) and lone parent (right panel) primary earners (P1-P99 Pearson statistics).

In contrast, for most lone parent households, a large portion of insurance stems from government transfers. Therefore, in terms of insurance against the third-order risk, the main beneficiary of the government transfer programs is the lone parent households.

Looking at Pearson kurtosis, we observe that government transfers do 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 due to the small sample size of lone parents) does not allow us to establish a good baseline for comparison. The more reliable message 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 risks, and the bulk of the benefits goes to lone parents. This in turn equalizes the risk outcomes between partnered and lone parents as manifested by the comparability between their disposable income risks despite the fact that the latter group starts off with much higher dispersion and skewness of pre-transfer income shocks. What is equally intriguing 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 the group, the public transfer insurance should affect them the most. This can deteriorate human capital of the existing and potential female workforce by increasing the proportion of mothers exiting the labour force. However, the insurance also potentially improves the well-being of children and lone mothers themselves. The pros and cons of the transfer programs can be ascertained with quantitative models that capture 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 income dynamics in Australia. Similar to other studies on the OECD countries, the earnings risk varies over age and income history. Moreover, the income processes of specific groups such as the poorest, richest, youngest, and oldest exhibit distinct dynamics. Differently, our findings reveal different roles of hours and wages. In lieu of hour changes, wages drive the second-order earnings 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 primary earners in the bottom past income decile whose rises and falls in earnings are driven by both hour and wage changes. We believe job mobility and institutional differences are be behind these cross-country dissimilarities.

Another point of departure in this study is concerned with insurance against earnings risk. In general, we find that family market income and government transfer are major sources of insurance as the previous studies do. However, government transfer is the dominant mechanism insuring against the second-order risk, whereas family market income insurance is more effective against the third- and fourth-order risks. A caveat is, as we have demonstrated, a smaller kurtosis does not immediately imply a better risk sharing arrangement.

Our paper also extends the previous work on income dynamics by analyzing demographic characteristics and their role in determining risk and insurance. First, we find that against higher-order earnings risks, family insurance is generally larger for non-parents and government insurance 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 a crowding-out effect of government insurance on family insurance. Second, although the social security system seems to redistribute resources from female to male headed households (who typically represent two-earner and single-earner households, respectively) based on first moment statistics, our results show that the former group does benefit substantially from the public transfer insurance such that despite facing greater pre-government income risks, the measures of their transitory and persistent disposable income risks are at comparable levels with those of their male counterpart. We observe a similar equalization effect between partnered and lone parents, which leads us to believe that the narrative may change if one incorporates insurance effects against risks into economic models. In contrast, because government transfer leaves non-parent households' disposable income with more volatility and severe adverse shocks relative to those of parent households, the induced inequality by the transfer programs from the viewpoint of earnings risk in Australia is perhaps between these two household types. Third, groups such as female heads and non-parents (not mutually exclusive) experience quite persistent risks that are difficult to self-insure. De Nardi, Fella and Paz-Pardo (2020) demonstrates how integrating this element of earnings dynamics into structural models can change the resultant optimal policy recommendations. However, the question remains to be answered is whether the persistence of risks is an inherent feature of the income process of certain demographics or an outcome induced by the presence of large government transfers. The former case would elevate the importance of government insurance, but the latter would introduce more ambiguity and complexity due to the interaction between household behaviour and government insurance. Addressing this question therefore requires a more sophisticated quantitative study.

Lastly, we restrict our sample to primary earners and consequently exclude retirees and the largest transfer program in Australia, the Age Pension. Accounting for the Age Pension may enlarge the role of government insurance. We also condition the moment statistics on past income as we lack annual frequency data on wealth. Conditioning on wealth can further enrich our understanding. Furthermore, as we set out to document the dynamics of income in Australia, we inevitably leave out consumption risk. An analysis of consumption contains crucial economic elements pertaining to family and government, namely, consumption equivalence scale, non-cash transfers, and indirect taxes, among others. We leave this question for future research.

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A Appendix

A.1 Derivations of moments

Let y,w, and h denote earnings, wages, and hours of work, respectively. For each individual i at time t, we have

$$y_{i,t} = w_{i,t} \times h_{i,t}$$

Which can be transformed into an equation of changes per unit time. Suppressing the subscripts, the equation can be written 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
- $\sigma_z := \sqrt{var(z)} = \sqrt{\mathbb{E}(z-\mu_z)^2}$.

We then derive and decompose the second, third, and fourth moments of earning changes, Δy.

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

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

A.1.2 Third Moment

Following the definition of the 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 Pearson skewness of Δy, and
- The second terms of the RHS denotes the contribution of the co-movement of Δw and

Δh to the Pearson skewness of Δy.

A.1.3 Fourth Moment

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

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

As in the previous case,

- The first term of the RHS denotes the contributions of Δw and Δh independently to the Pearson 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 Pearson kurtosis of Δy.

A.2 Income Pooling and Added Worker Effects

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

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

Therefore,

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

By total differentiation,

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

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 $f_p = f_s$.

The expression of the variance of family income changes (or, second-order family income risk) is then

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

On the RHS, the term $f_p^2 VAR(\Delta p)$ denotes the contribution of primary earner's earnings shock variance to the second-order risk of family income. The second term $f_s^2 VAR(\Delta s)$ denotes the contribution of secondary earner's shock variance, known as the *income-pooling effect*, which enlarges the variance of family income. The last term $2 f_p f_s COV(\Delta p, \Delta s)$ is the contribution of the covariance. $COV(\Delta p, \Delta s) < 0$ implies the *added-worker effect* which contracts the variance of family income. Adding more second earners (e.g., resident independent children) reduces f_p and may lead 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	6,360	4,396	3,495	4,531
2001-02	6,143	4,296	3,363	4,404
2002-03	6,103	4,257	3,305	4,358
2003-04	5,955	4,167	3,192	4,255
2004-05	6,277	4,334	3,307	4,446
2005-06	6,415	4,425	3,376	4,555
2006-07	6,461	4,434	3,396	4,530
2007-08	6,542	4,474	3,406	4,574
2008-09	6,641	4,543	3,508	4,656
2009-10	6,787	4,605	3,572	4,724
2010-11	8,768	6,012	4,717	6,186
2011-12	8,688	5,956	4,661	6,105
2012-13	8,613	5,926	4,628	6,079
2013-14	8,703	5,966	4,659	6,122
2014-15	8,748	5,992	4,748	6,127
2015-16	8,748	6,016	4,739	6,137
2016-17	8,839	6,018	4,741	6,147
2017-18	8,915	6,044	4,776	6,180
2018-19	8,885	6,031	4,762	6,162
2019-20	8,405	5,794	4,621	5,898
Total	150,996	103,686	80,972	106,176

Table 3: Sample size by year and unit of observation. The sample excludes employer/self-employed, unpaid family worker, dependent children and students, retirees, non-working students, and those with full-time domestic duties. For partnered individuals, if their partner fall into one of these categories, his/her data on income, tax, transfer and other variables of interest is stored prior to being dropped.

Table 4: Summary statistics of primary earners in financial year 2001

Primary Earner		N	Mean	Median	SD	Min	Max
Age	Individual	3,872	40.82	40	9.73	25	64
	Family	3,872	-	-	-	-	-
Weekly hours	Individual	3,872	40.09	40	13.09	0	120
	Family	3,872	53.01	47	32.39	0	201
Weekly wage	Individual	3,872	1,292.20	1,144.11	833.72	0.00	14,189.97
	Family	3,872	1,854.35	1,629.21	1,195.40	0.00	14,189.97
Labour Income	Individual	3,872	66,296.91	59,623.97	47,176.12	0.00	915,285.31
	Family	3,872	96,419.84	84,933.90	65,805.50	0.00	915,285.31
Market income	Individual	3,872	68,764.74	61,171.57	48,541.73	-53,391.64	916,353.19
	Family	3,872	103,635.25	91,527.77	73,219.05	-28,221.30	1.51e+06
Private transfer	Individual	3,872	414.57	0.00	2,450.85	0.00	36,611.41
	Family	3,872	605.10	0.00	3,016.12	0.00	44,543.89
Total income tax	Individual	3,872	16,818.29	12,684.33	18,900.91	-3,252.31	391,345.50
	Family	3,872	23,958.07	17,950.27	26,017.05	-8,808.10	637,691.50
Public transfer	Individual	3,872	2,366.43	0.00	5,257.32	0.00	47,440.77
	Family	3,872	5,276.89	0.00	8,855.15	0.00	69,825.59

	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	188	231	418	247	389	276	320	143	2,212
	53.56%	6.90%	48.21%	3.64%	44.20%	3.81%	45.58%	4.40%	9.44%
	8.50%	10.44%	18.90%	11.17%	17.59%	12.48%	14.47%	6.46%	100.00%
2	51	419	177	593	137	604	96	268	2,345
	14.53%	12.51%	20.42%	8.73%	15.57%	8.34%	13.68%	8.24%	10.01%
	2.17%	17.87%	7.55%	25.29%	5.84%	25.76%	4.09%	11.43%	100.00%
3	35	450	54	630	78	684	77	340	2,348
	9.97%	13.43%	6.23%	9.28%	8.86%	9.44%	10.97%	10.45%	10.02%
	1.49%	19.17%	2.30%	26.83%	3.32%	29.13%	3.28%	14.48%	100.00%
4	27	407	58	681	80	708	55	332	2,348
	7.69%	12.15%	6.69%	10.03%	9.09%	9.77%	7.83%	10.21%	10.02%
	1.15%	17.33%	2.47%	29.00%	3.41%	30.15%	2.34%	14.14%	100.00%
5	15	445	41	753	66	708	46	298	2,372
	4.27%	13.28%	4.73%	11.09%	7.50%	9.77%	6.55%	9.16%	10.12%
	0.63%	18.76%	1.73%	31.75%	2.78%	29.85%	1.94%	12.56%	100.00%
6	14	324	36	847	38	783	42	268	2,352
	3.99%	9.67%	4.15%	12.47%	4.32%	10.81%	5.98%	8.24%	10.03%
	0.60%	13.78%	1.53%	36.01%	1.62%	33.29%	1.79%	11.39%	100.00%
7	13	311	35	771	39	842	19	343	2,373
	3.70%	9.28%	4.04%	11.35%	4.43%	11.62%	2.71%	10.54%	10.12%
	0.55%	13.11%	1.47%	32.49%	1.64%	35.48%	0.80%	14.45%	100.00%
8	5	292	26	724	22	886	15	389	2,359
	1.42%	8.72%	3.00%	10.66%	2.50%	12.23%	2.14%	11.96%	10.06%
	0.21%	12.38%	1.10%	30.69%	0.93%	37.56%	0.64%	16.49%	100.00%
9	3	252	11	749	28	897	18	408	2,366
	0.85%	7.52%	1.27%	11.03%	3.18%	12.38%	2.56%	12.54%	10.09%
	0.13%	10.65%	0.46%	31.66%	1.18%	37.91%	0.76%	17.24%	100.00%
10	0	219	11	795	3	857	14	464	2,363
	0.00%	6.54%	1.27%	11.71%	0.34%	11.83%	1.99%	14.26%	10.08%
	0.00%	9.27%	0.47%	33.64%	0.13%	36.27%	0.59%	19.64%	100.00%
Total	351	3,350	867	6,790	880	7,245	702	3,253	23,438
	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
	1.50%	14.29%	3.70%	28.97%	3.75%	30.91%	3.00%	13.88%	100.00%

Table 5: 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 18 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	113	306	130	535	135	532	116	347	2,214
	31.92%	9.15%	30.23%	7.40%	33.33%	6.89%	37.54%	9.52%	9.45%
	5.10%	13.82%	5.87%	24.16%	6.10%	24.03%	5.24%	15.67%	100.00%
2	51	419	58	713	64	677	51	313	2,346
	14.41%	12.52%	13.49%	9.86%	15.80%	8.77%	16.50%	8.58%	10.01%
	2.17%	17.86%	2.47%	30.39%	2.73%	28.86%	2.17%	13.34%	100.00%
3	52	433	51	633	47	715	36	381	2,348
	14.69%	12.94%	11.86%	8.76%	11.60%	9.26%	11.65%	10.45%	10.02%
	2.21%	18.44%	2.17%	26.96%	2.00%	30.45%	1.53%	16.23%	100.00%
4	26	408	35	705	38	750	20	367	2,349
	7.34%	12.19%	8.14%	9.75%	9.38%	9.71%	6.47%	10.07%	10.02%
	1.11%	17.37%	1.49%	30.01%	1.62%	31.93%	0.85%	15.62%	100.00%
5	23	437	23	770	24	750	14	330	2,371
	6.50%	13.06%	5.35%	10.65%	5.93%	9.71%	4.53%	9.05%	10.12%
	0.97%	18.43%	0.97%	32.48%	1.01%	31.63%	0.59%	13.92%	100.00%
6	15	323	26	857	16	805	14	296	2,352
	4.24%	9.65%	6.05%	11.86%	3.95%	10.42%	4.53%	8.12%	10.03%
	0.64%	13.73%	1.11%	36.44%	0.68%	34.23%	0.60%	12.59%	100.00%
7	15	309	16	790	16	865	17	345	2,373
	4.24%	9.23%	3.72%	10.93%	3.95%	11.20%	5.50%	9.46%	10.12%
	0.63%	13.02%	0.67%	33.29%	0.67%	36.45%	0.72%	14.54%	100.00%
8	15	282	21	729	15	893	7	397	2,359
	4.24%	8.43%	4.88%	10.09%	3.70%	11.56%	2.27%	10.89%	10.06%
	0.64%	11.95%	0.89%	30.90%	0.64%	37.86%	0.30%	16.83%	100.00%
9	26	228	19	741	20	905	9	417	2,365
	7.34%	6.81%	4.42%	10.25%	4.94%	11.72%	2.91%	11.44%	10.09%
	1.10%	9.64%	0.80%	31.33%	0.85%	38.27%	0.38%	17.63%	100.00%
10	18	201	51	755	30	830	25	453	2,363
	5.08%	6.01%	11.86%	10.45%	7.41%	10.75%	8.09%	12.42%	10.08%
	0.76%	8.51%	2.16%	31.95%	1.27%	35.12%	1.06%	19.17%	100.00%
Total	354	3,346	430	7,228	405	7,722	309	3,646	23,440
	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
	1.51%	14.27%	1.83%	30.84%	1.73%	32.94%	1.32%	15.55%	100.00%

Table 6: 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 18 years of observation.

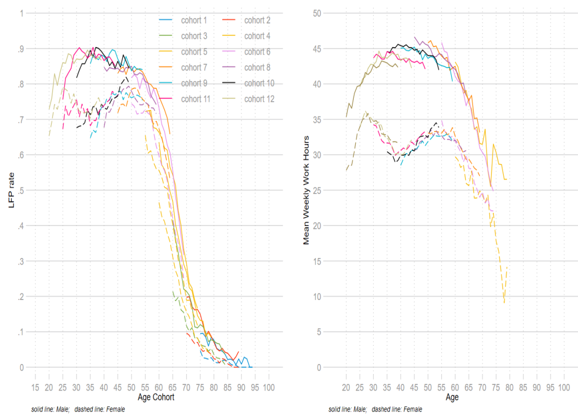

Figure 19: Age-profile of weekly work hours if employed (left panel) and labour force participation rate (right panel) by age, cohort and gender (2001-2020). The M shape of female labour supply reflects the age-profiles of paraticipation rate and work hour of partnered women. Single women's profiles are hump-shaped, though at a slighly lower level compared to men's.

		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 7: 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 8: 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 the survey, partly due to attrition and the inclusion of new and younger households.

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

Income Decile	N	Individual Labour Income	Individual Market Income	Household Pre-gov't Income	Household Disposable Income
1	10,965	58.64%	56.27%	29.11%	16.23%
2	10,964	5.86%	5.97%	4.17%	0.22%
3	10,950	-0.88%	-0.24%	2.54%	-0.01%
4	10,940	-3.20%	-3.20%	-0.56%	-1.42%
5	10,982	-4.45%	-4.03%	-1.73%	1.00%
6	10,930	-4.86%	-4.82%	-2.49%	-1.85%
7	10,950	-4.51%	-4.79%	-2.31%	-1.90%
8	10,947	-4.17%	-4.84%	-3.95%	-1.89%
9	10,953	-5.39%	-6.17%	-3.60%	-2.82%
10	10,948	-7.80%	-10.00%	-7.16%	-5.83%

Table 9: Average Annual Residual Income Growth (2001-2020) 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.

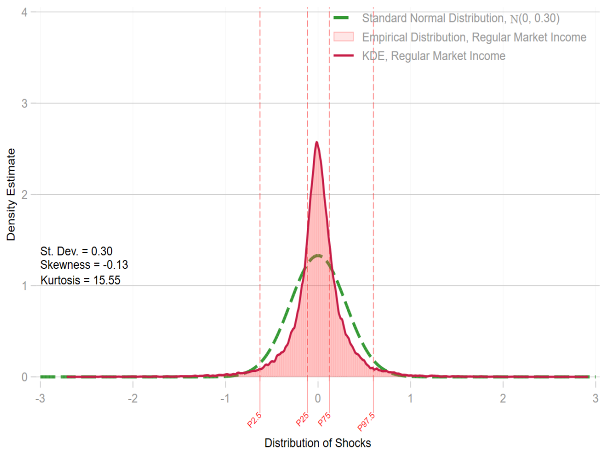

Figure 20: Empirical distributions of 3-year average growth of individual regular market income of primary earners aged 25-64.

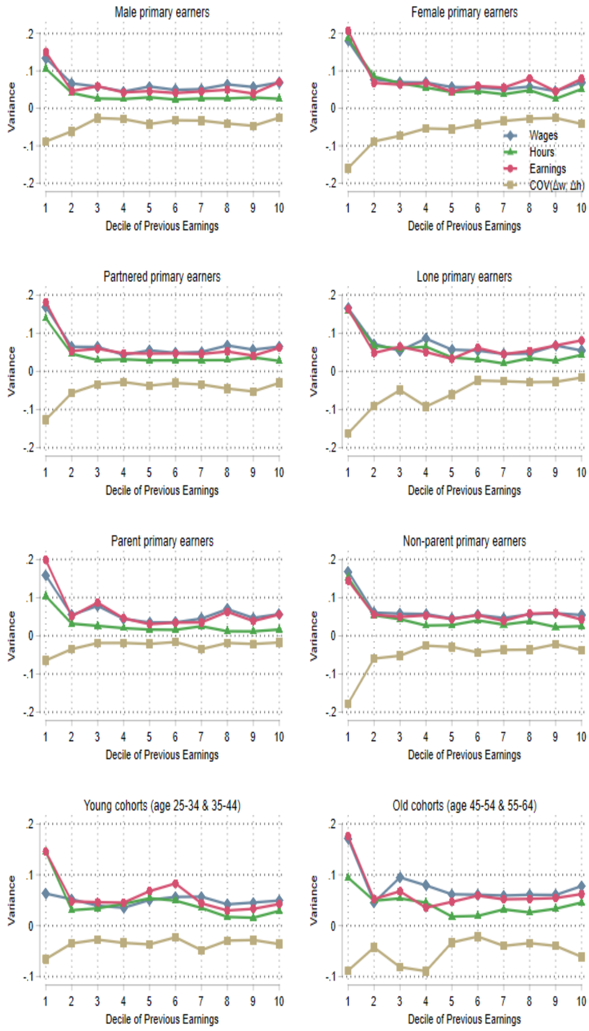

Figure 21: Variance of annual changes in usual weekly earnings, wages, and hours of selected subsamples (including the tailends of their distributions). The graphs contain observations of selected subsamples and are restricted to individuals who report positive usual weekly earnings (work at least one day per week at or above the minimum wage rate of AU$20 in 2018 dollar) for at least 18 years. Similar patterns are also observed when minimum employment requirement is set to 0 (unrestricted), 10, 15, or 20 years.

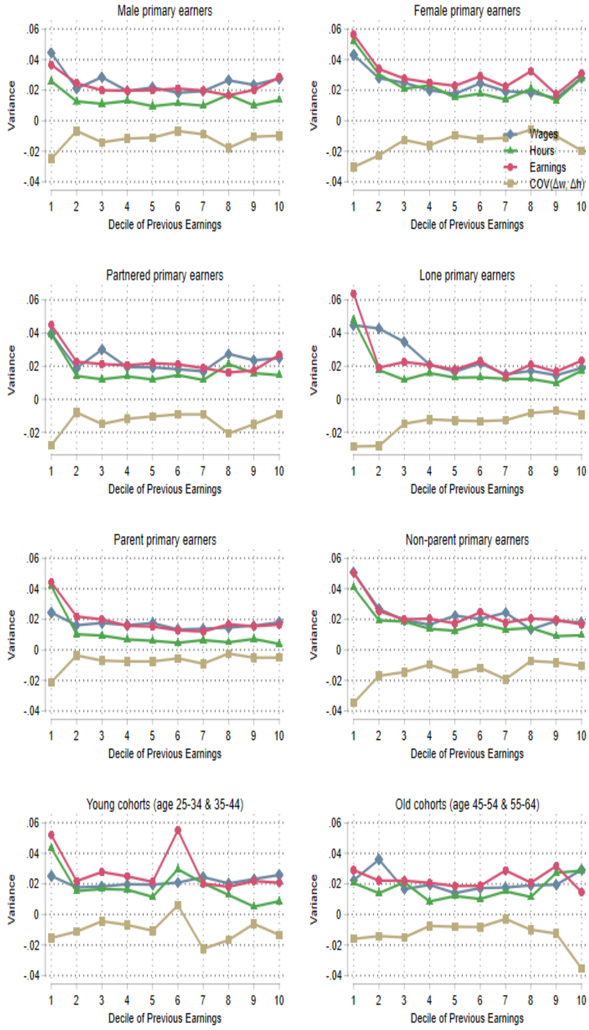

Figure 22: Variance of 3-year average changes in usual weekly earnings, wages, and hours of selected subsamples (including the tailends of their distributions). The graphs contain observations of selected subsamples and are restricted to individuals who report positive usual weekly earnings (work at least one day per week at or above the minimum wage rate of AU$20 in 2018 dollar) for at least 18 years. Similar patterns are also observed when minimum employment requirement is set to 0 (unrestricted), 10, 15, or 20 years.

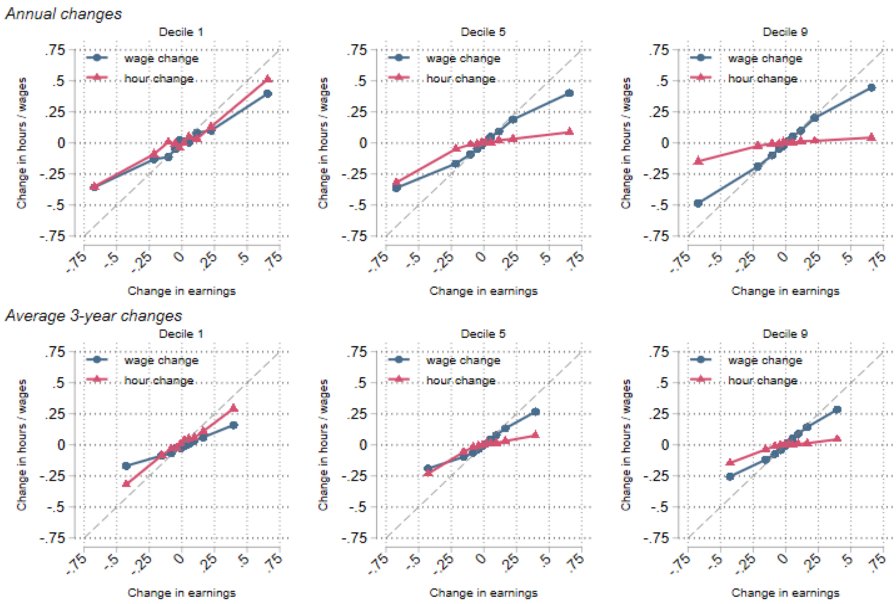

Figure 23: Changes in residual weekly wages and hours versus decile of changes in residual usual weekly earnings (from main job) for primary earners in the 1st, 5th, and 9th deciles of past usual weekly earnings. The top and bottom panels report annual changes and 3-year average changes, respectively. We consider all primary earners regardless of their work history. Similar patterns are also observed when minimum employment requirement is set to 0 (unrestricted), 10, 15, or 20 years.

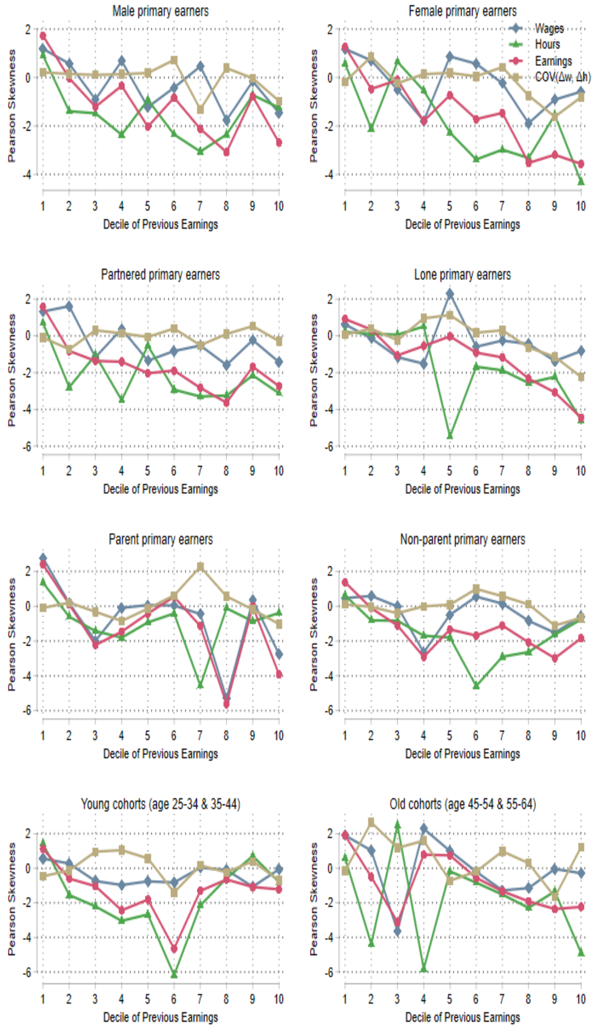

Figure 24: Pearson skewness of annual average changes in usual weekly earnings, wages, and hours of selected subsamples (including the tailends of their distributions). The graphs contain observations of selected subsamples and are restricted to individuals who report positive usual weekly earnings (work at least one day per week at or above the minimum wage rate of AU$20 in 2018 dollar) for at least 18 years. Similar patterns are also observed when minimum employment requirement is set to 0 (unrestricted), 10, 15, and 20 years.

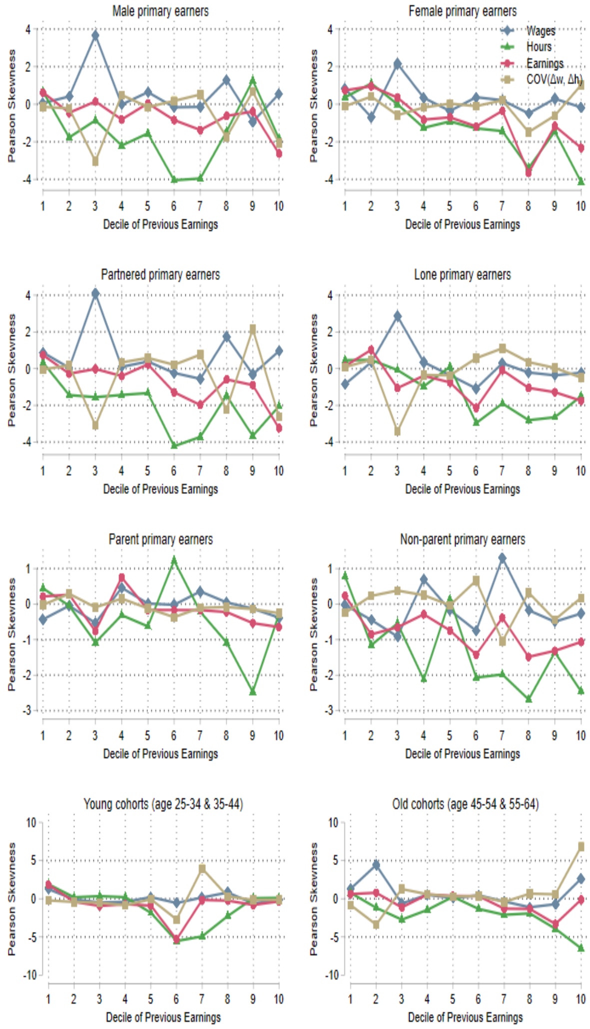

Figure 25: Pearson skewness of 3-year average changes in usual weekly earnings, wages, and hours of selected subsamples (including the tailends of their distributions). The graphs contain observations of selected subsamples and are restricted to individuals who report positive usual weekly earnings (work at least one day per week at or above the minimum wage rate of AU$20 in 2018 dollar) for at least 18 years. Similar patterns are also observed when minimum employment requirement is set to 0 (unrestricted), 10, 15, or 20 years.

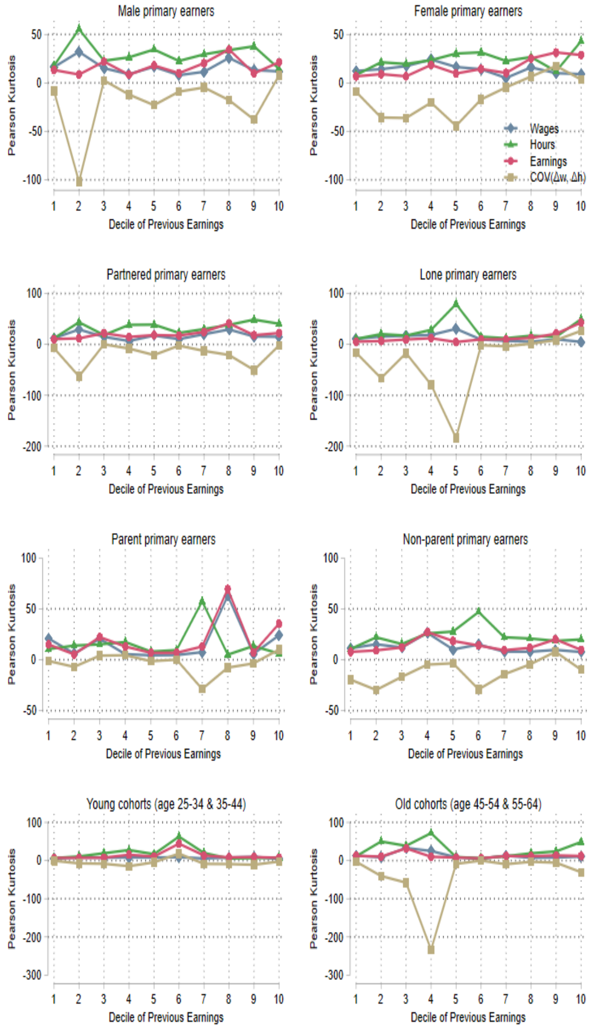

Figure 26: Pearson kurtosis of annual changes in usual weekly earnings, wages, and hours of selected subsamples (including the tailends of their distributions). The graphs contain observations of selected subsamples and are restricted to individuals who report positive usual weekly earnings (work at least one day per week at or above the minimum wage rate of AU$20 in 2018 dollar) for at least 18 years. Similar patterns are also observed when minimum employment requirement is set to 0 (unrestricted), 10, 15, or 20 years.

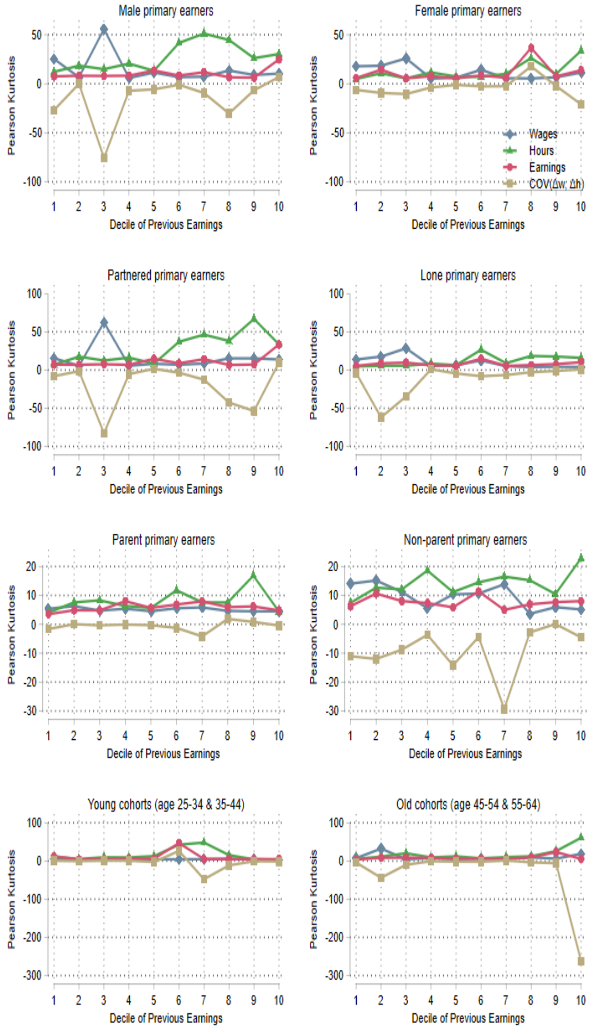

Figure 27: Pearson kurtosis of 3-year average changes in usual weekly earnings, wages, and hours of selected subsamples. The graphs contain observations of selected subsamples and are restricted to individuals who report positive usual weekly earnings (work at least one day per week at or above the minimum wage rate of AU$20 in 2018 dollar) for at least 18 years. Similar patterns are also observed when minimum employment requirement is set to 0 (unrestricted), 10, 15, or 20 years.

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

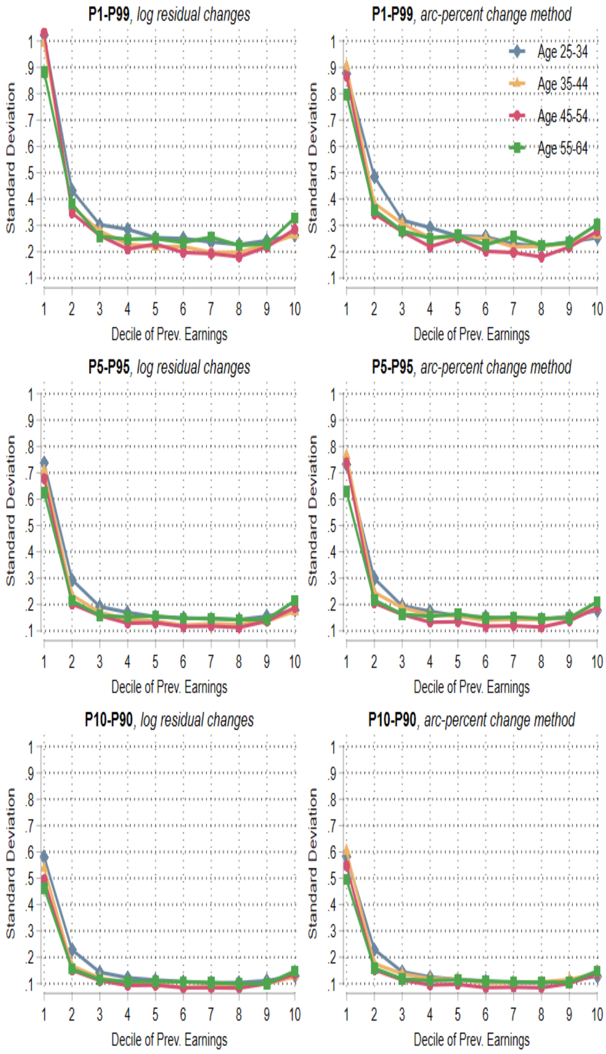

Figure 28: Second moment statistics measured at $P1-P99$, $P5-P95$, and $P10-P90$ of the annual regular market earnings change distributions of primary earners. The left panel's annual figures are statistics of the changes in log of residual income as described in equation 1. The right panel's annual 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).

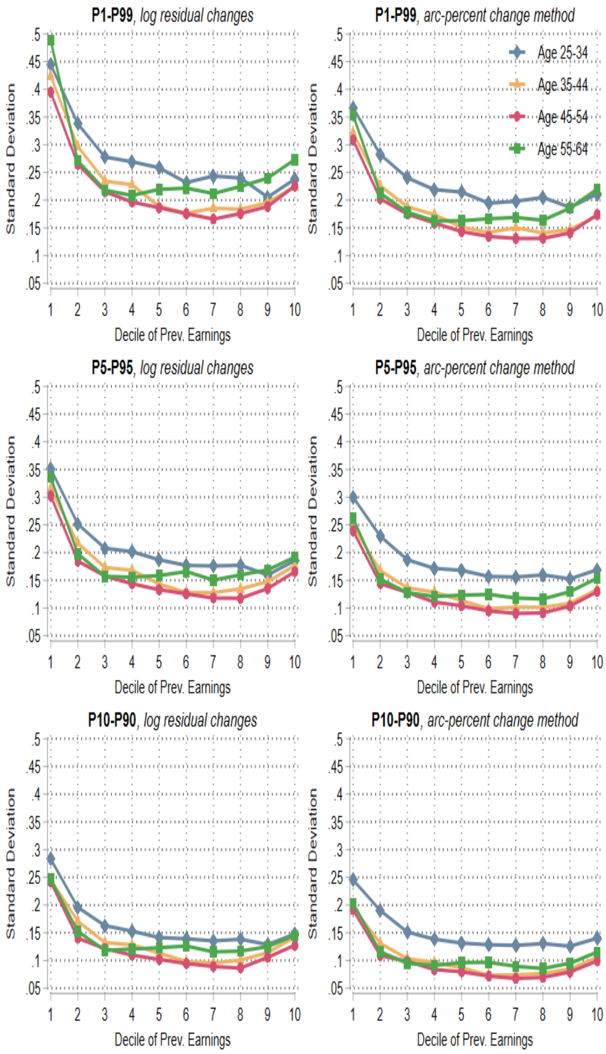

Figure 29: Second moment statistics measured at $P1-P99$, $P5-P95$, and $P10-P90$ of the 3-year average regular market earnings change distributions of primary earners. The left panel's annual figures are statistics of the changes in log of residual income as described in equation 1. The right panel's 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

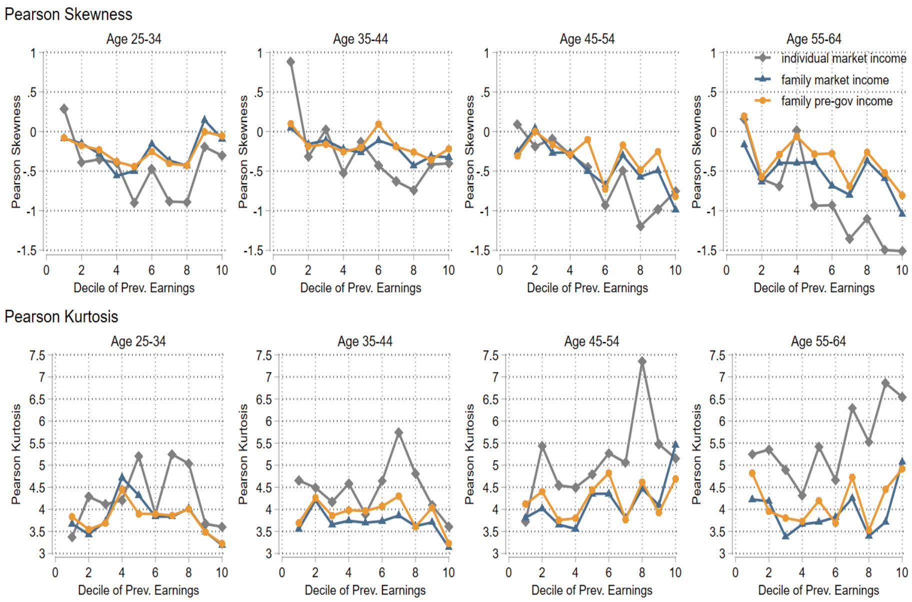

Figure 30: Skewness and Kurtosis of the distribution of 3-year average changes of family income (P1-P99) at different levels. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of pre-government family income.

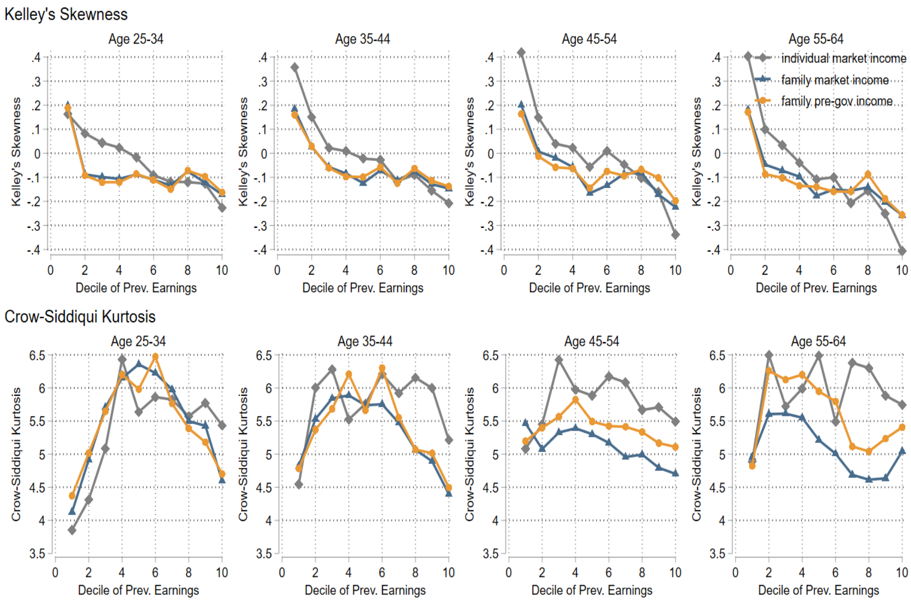

Figure 31: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of annual changes of family income (P1-P99) at different levels. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of family pre-government income.

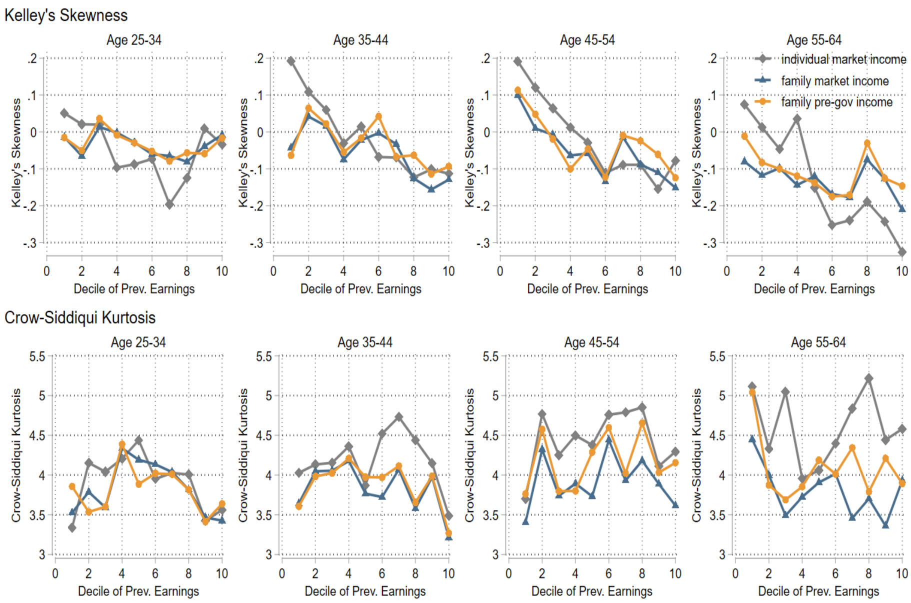

Figure 32: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of 3-year average changes of family income (P1-P99) at different levels. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of family pre-government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

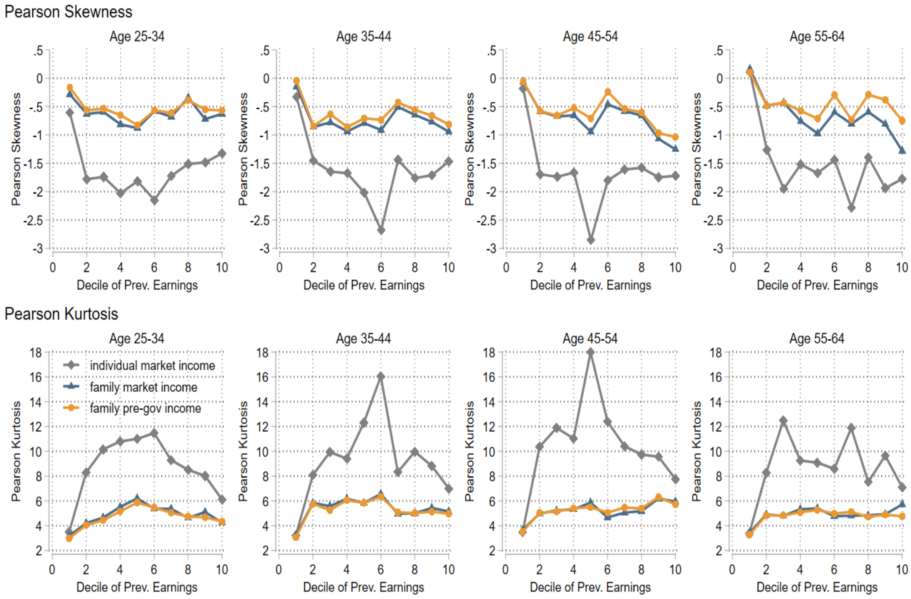

Figure 33: Skewness and Kurtosis of the distribution of annual changes of family income (P1-P99) at different levels calculated via *Arc-Percent Change method*. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of pre-government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

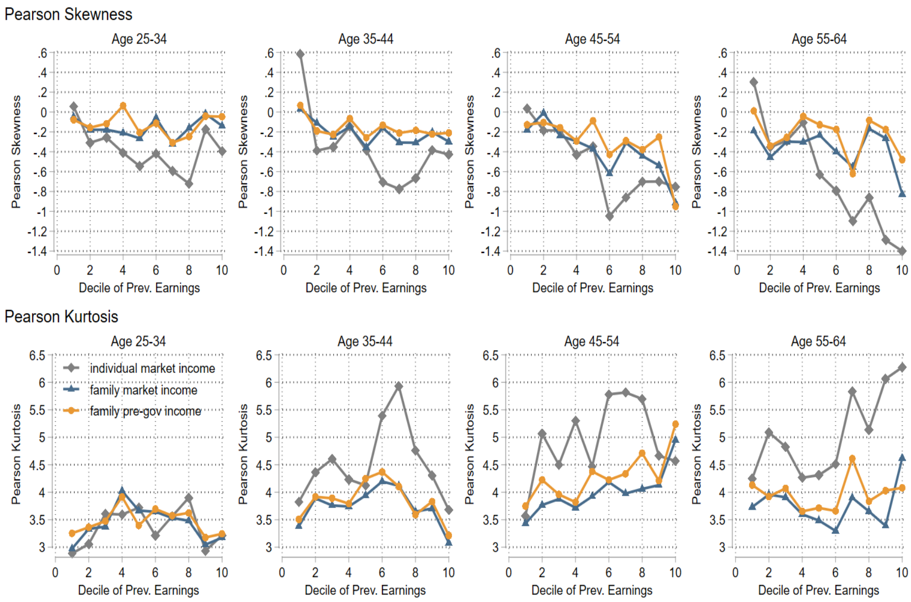

Figure 34: Skewness and Kurtosis of the distribution of 3-year average changes of family income (P1-P99) at different levels calculated via *Arc-Percent Change method*. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of pre-government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

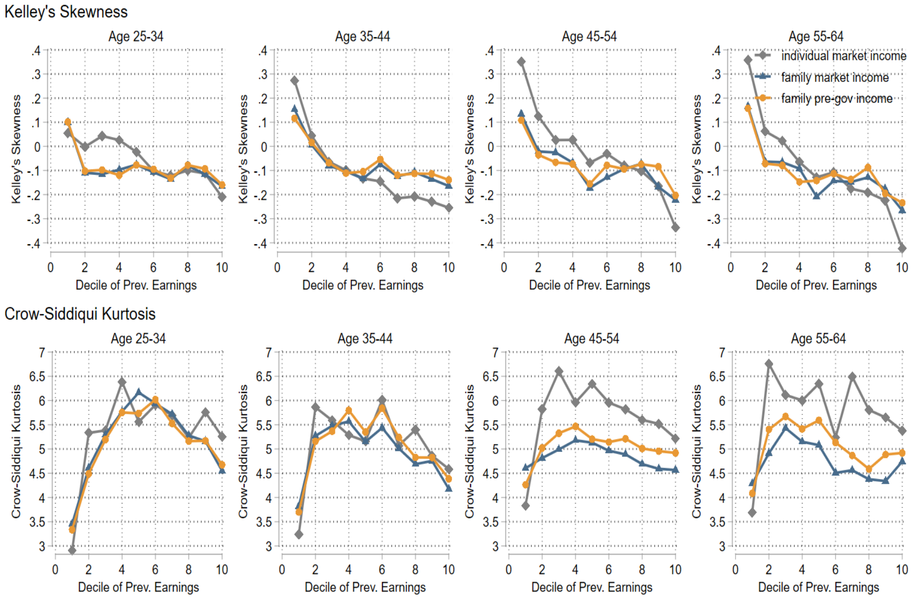

Figure 35: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of annual changes of family income (P1-P99) at different levels calculated via *Arc-Percent Change method*. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order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

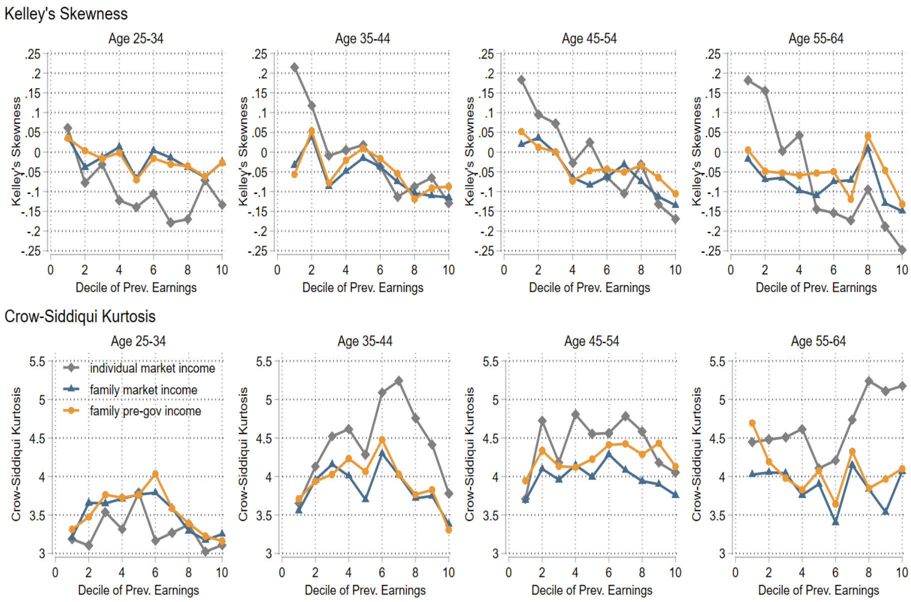

Figure 36: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of 3-year average changes of family income (P1-P99) at different levels calculated via *Arc-Percent Change method*. The figure captures the relative contribution of family market income and private transfer to the third- and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

A.6.2 P5-P99

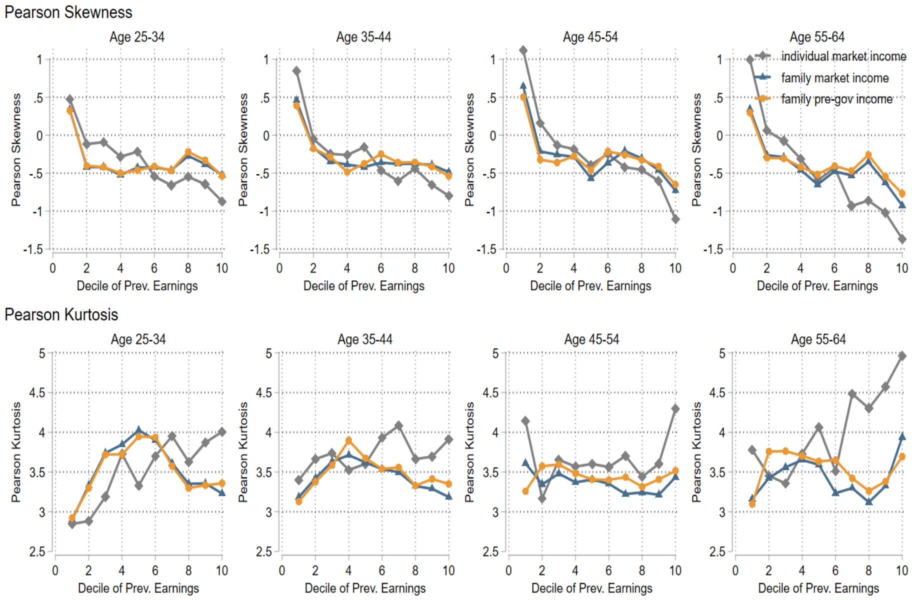

Figure 37: Skewness and Kurtosis of the distribution of annual changes of family income (P5-P95) at different levels. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of pre-government family income.

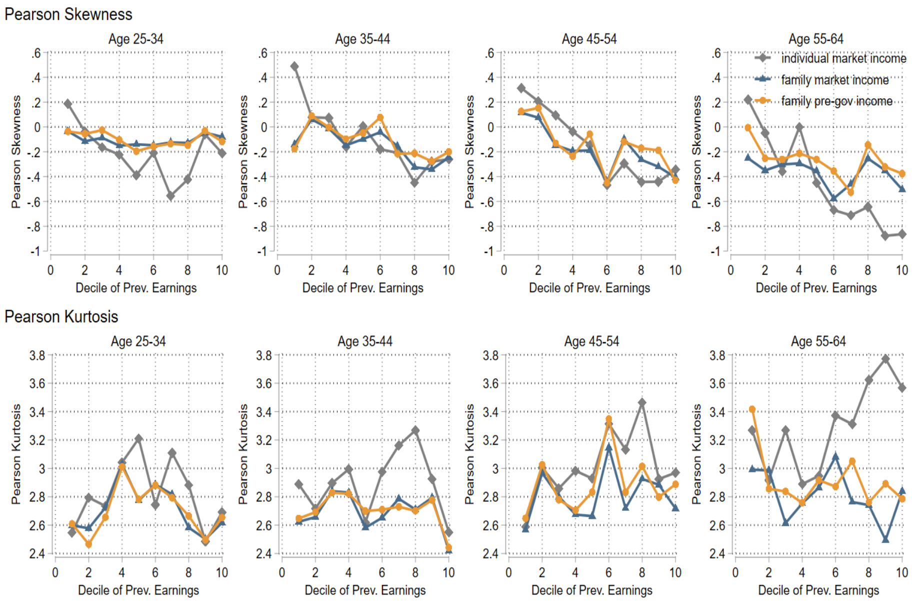

Figure 38: Skewness and Kurtosis of the distribution of 3-year average changes of family income (P5-P95) at different levels. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of pre-government family income.

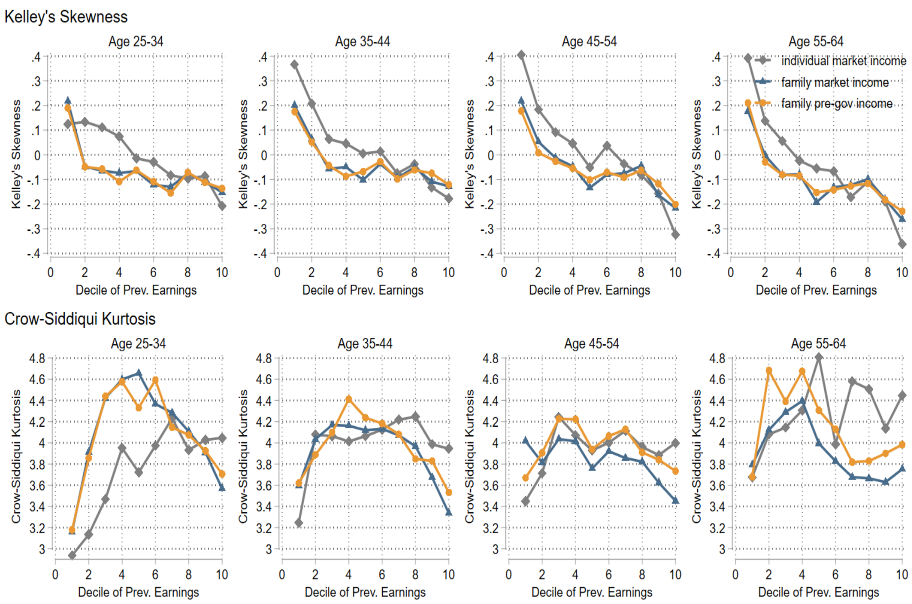

Figure 39: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of annual changes of family income (P5-P95) at different levels. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of family pre-government income.

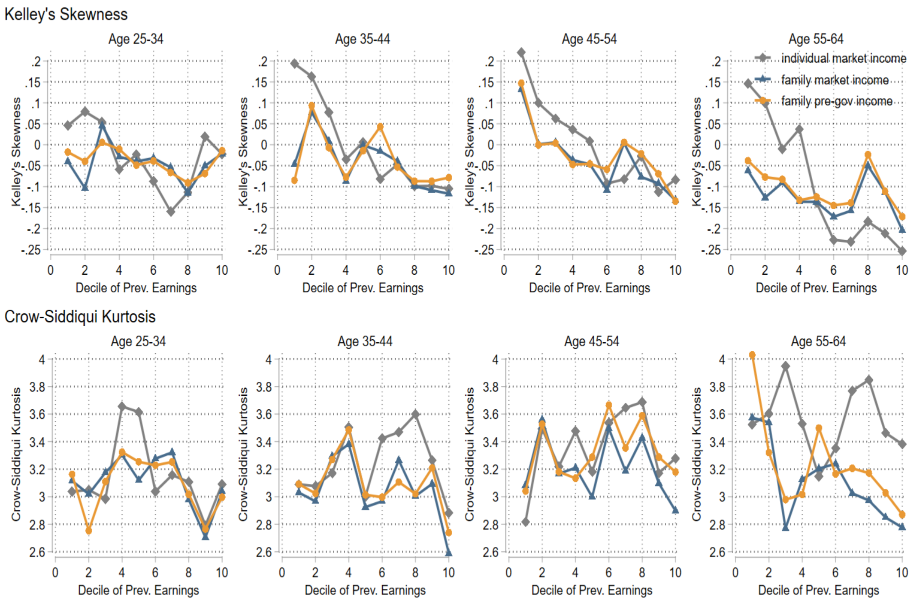

Figure 40: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of 3-year average changes of family income (P5-P95) at different levels. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of family pre-government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

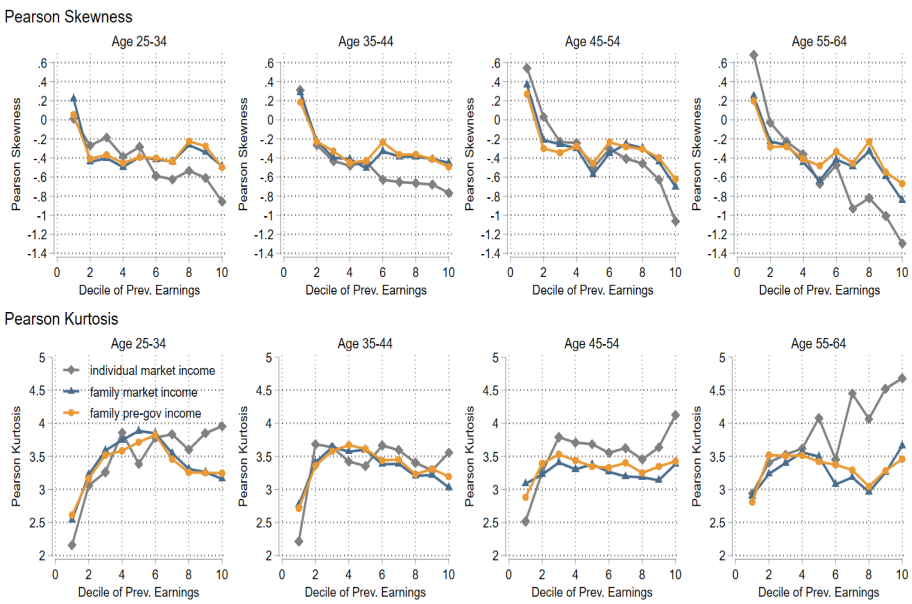

Figure 41: Skewness and Kurtosis of the distribution of annual changes of family income (P5-P95) at different levels calculated via *Arc-Percent Change method*. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of pre-government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

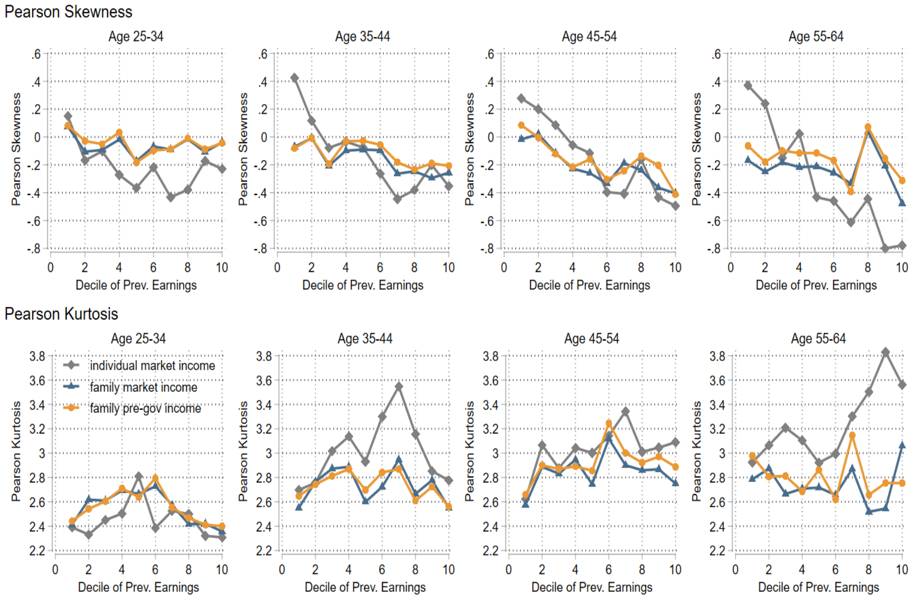

Figure 42: Skewness and Kurtosis of the distribution of 3-year average changes of family income (P5-P95) at different levels calculated via *Arc-Percent Change method*. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of pre-government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

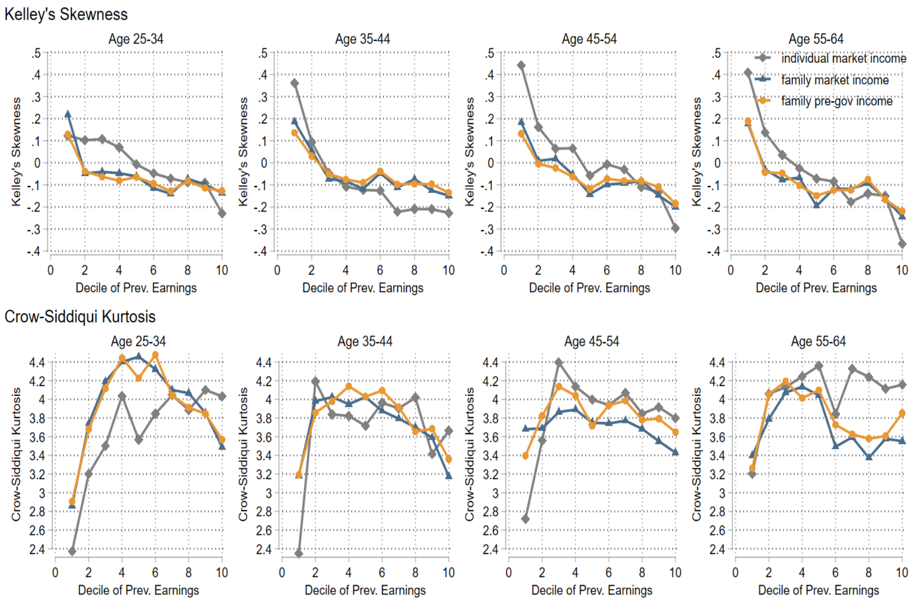

Figure 43: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of annual changes of family income (P5-P95) at different levels calculated via *Arc-Percent Change method*. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order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

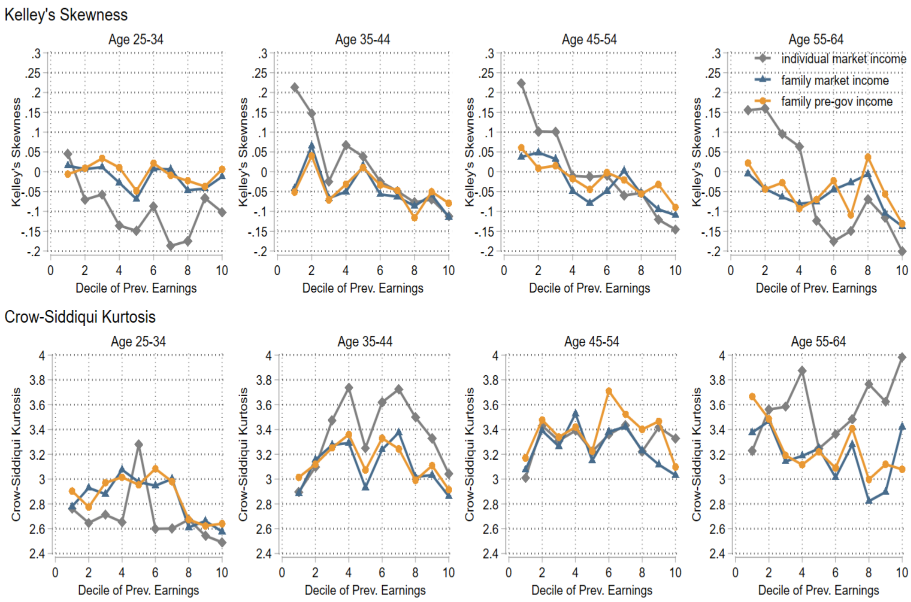

Figure 44: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of 3-year average changes of family income (P5-P95) at different levels calculated via *Arc-Percent Change method*. The figure captures the relative contribution of family market income and private transfer to the third- and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

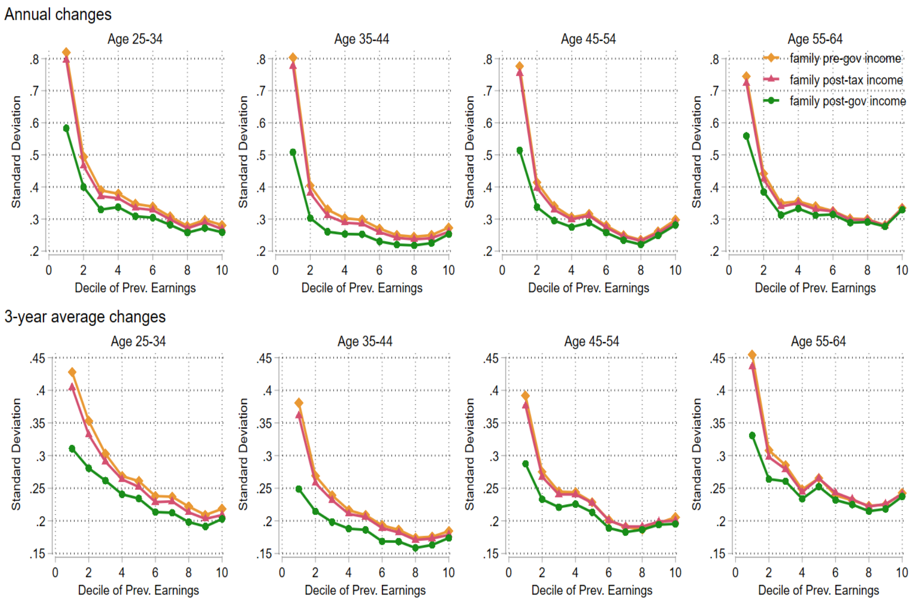

Figure 45: Standard deviation of the distribution of annual and 3-year average changes of family income (P1-P99) at different levels calculated via *Arc-Percent Change method*. The figure captures the relative contribution of tax and transfer to the second-order risk of disposable family income.

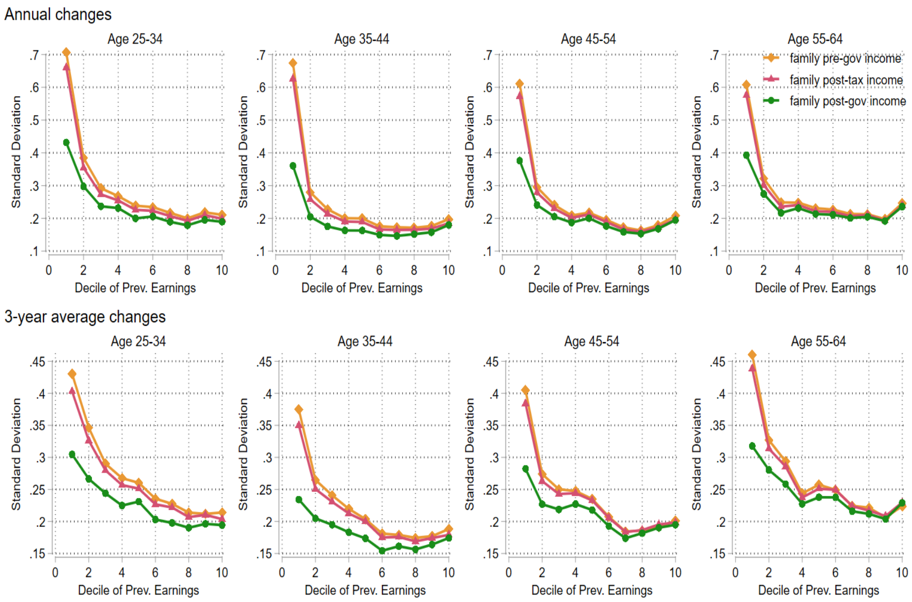

Figure 46: Standard deviation of the distribution of annual and 3-year average changes of family income (P5-P95) at different levels. The figure captures the relative contribution of tax and transfer to the second-order risk of disposable family income.

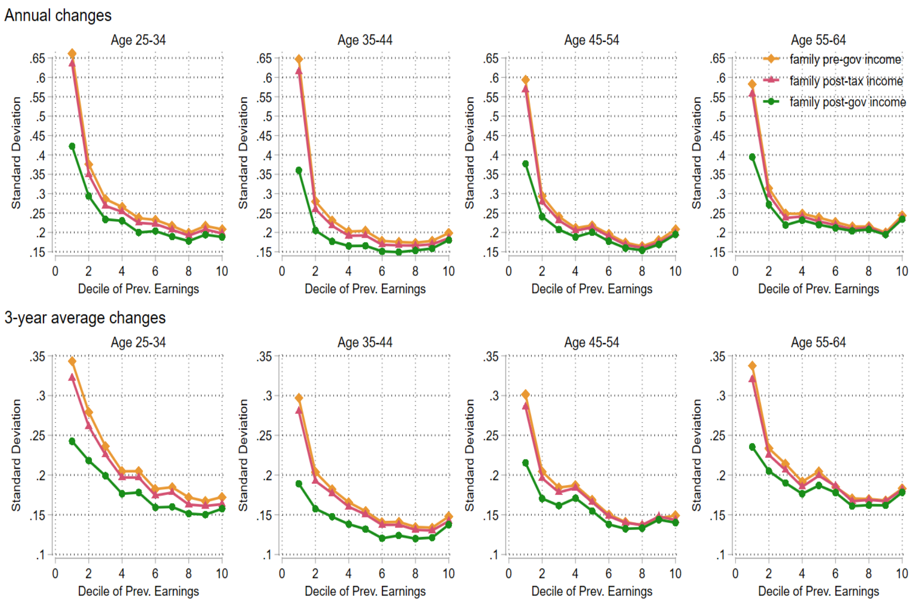

Figure 47: Standard deviation of the distribution of annual and 3-year average changes of family income (P5-P95) at different levels calculated via *Arc-Percent Change method*. The figure captures the relative contribution of tax and transfer to the second-order risk of disposable family income.

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

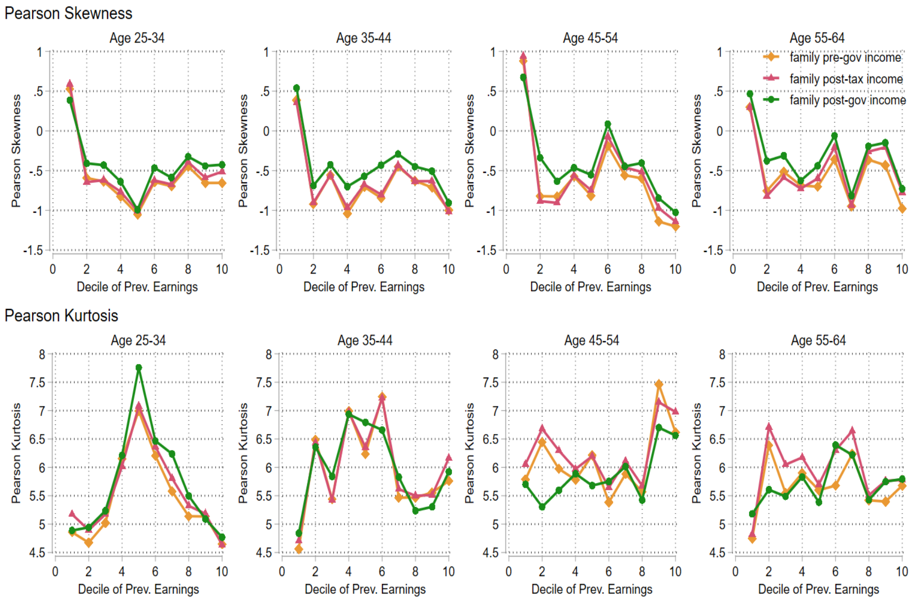

Figure 48: Skewness and kurtosis of the distribution of annual changes of family income (P1-P99) at different levels. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable family income.

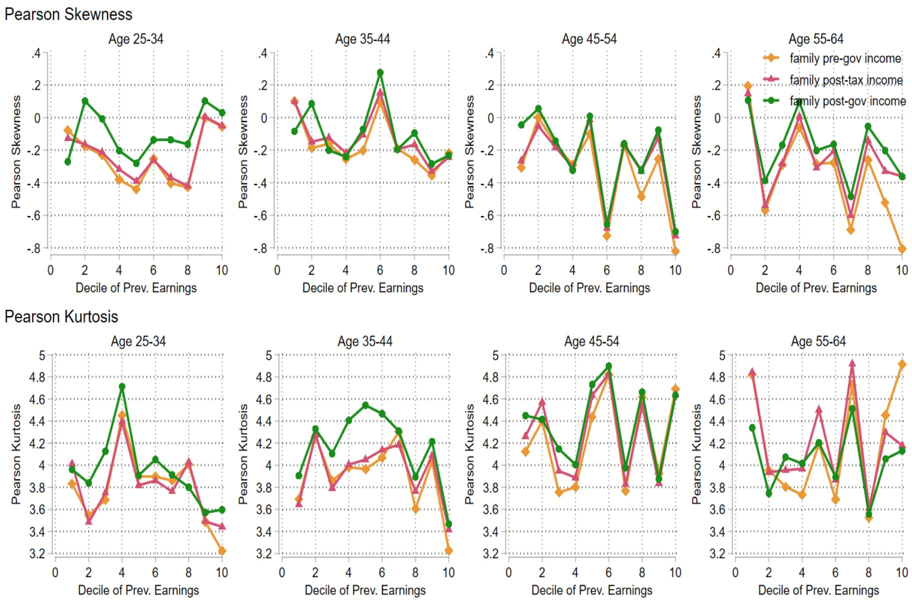

Figure 49: Skewness and kurtosis of the distribution of 3-year average changes of family income (P1-P99) at different levels. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable family income.

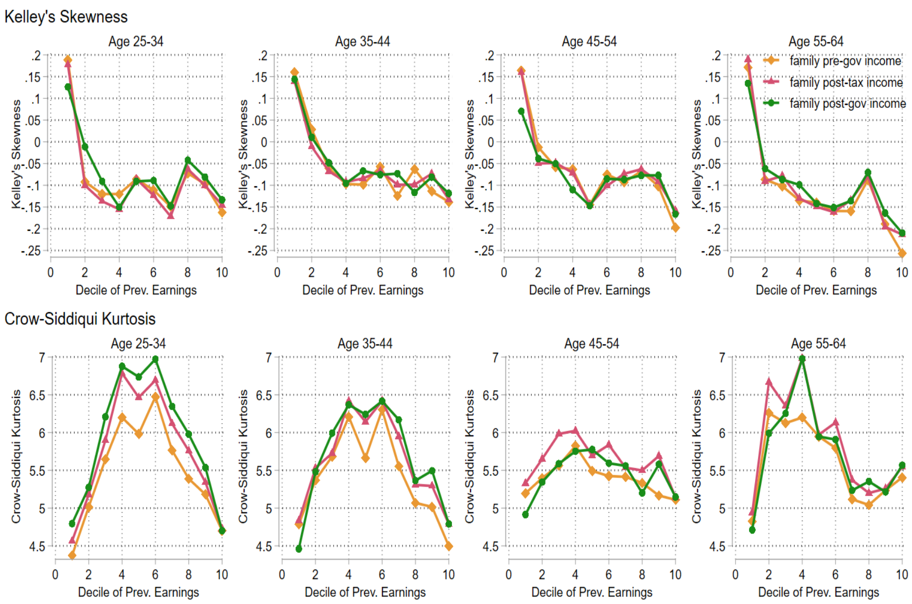

Figure 50: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of annual changes of family income (P1-P99) at different levels. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable family income.

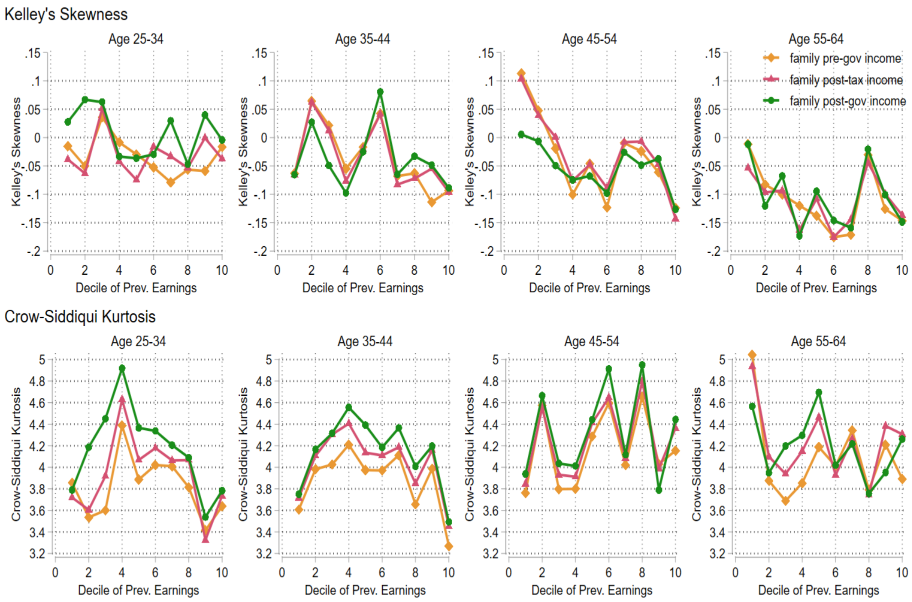

Figure 51: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of 3-year average changes of family income (P1-P99) at different levels. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable family income.

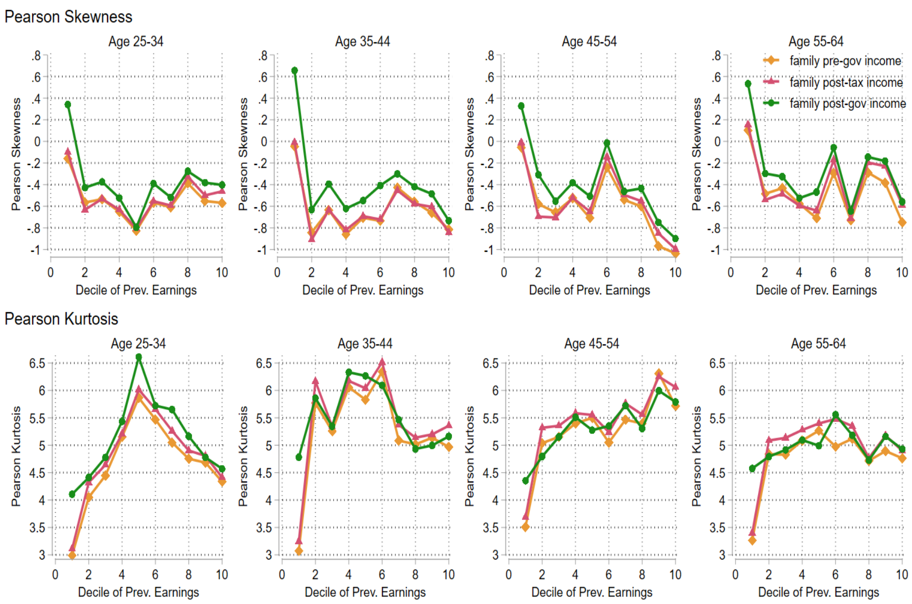

Figure 52: Skewness and kurtosis of the distribution of annual changes of family income (P1-P99) at different levels calculated via *Arc-Percent Change method*. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable family income.

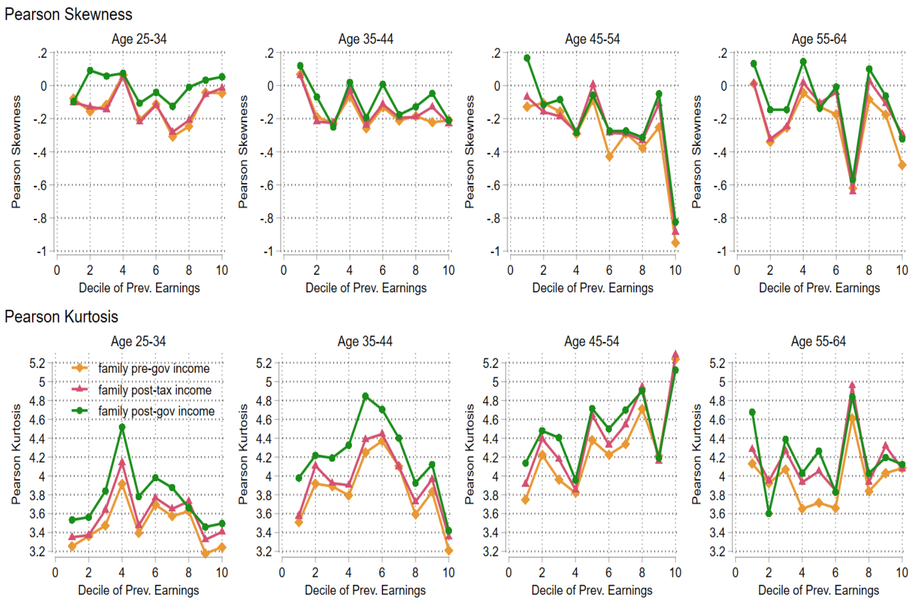

Figure 53: Skewness and kurtosis of the distribution of 3-year average changes of family income (P1-P99) at different levels calculated via *Arc-Percent Change method*. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable family income.

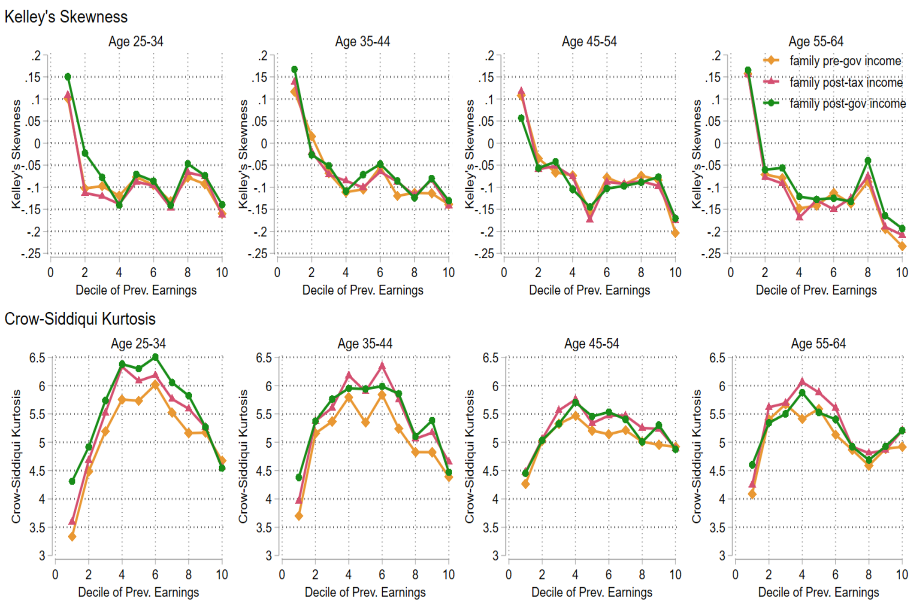

Figure 54: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of annual changes of family income (P1-P99) at different levels calculated via *Arc-Percent Change method*. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable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

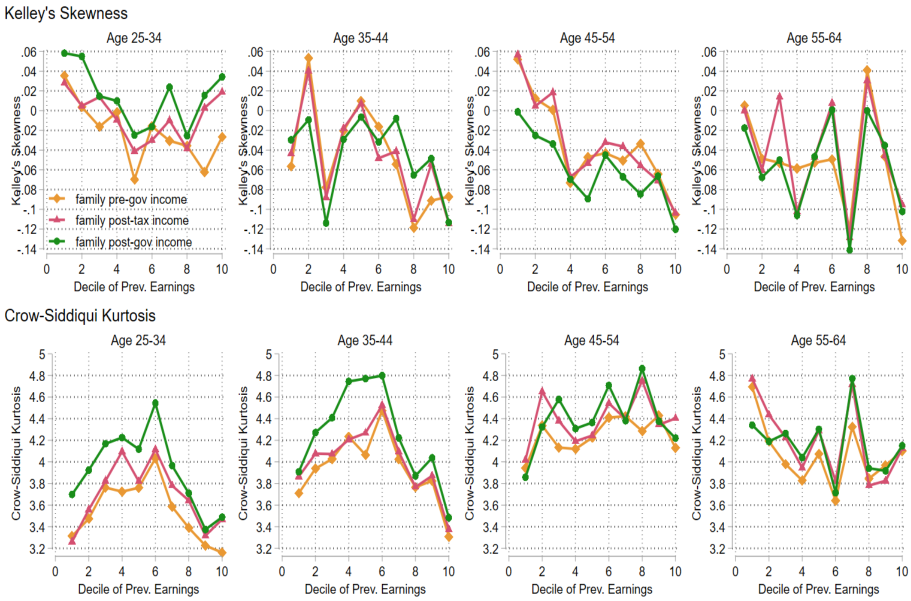

Figure 55: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of 3-year average changes of family income (P1-P99) at different levels calculated via *Arc-Percent Change method*. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable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

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

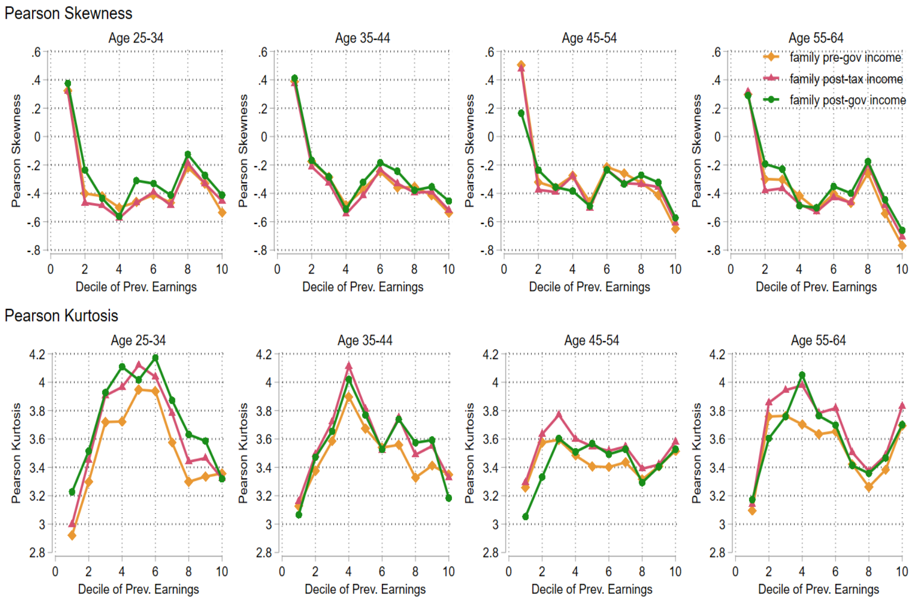

Figure 56: Skewness and kurtosis of the distribution of annual changes of family income (P5-P95) at different levels. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable family income.

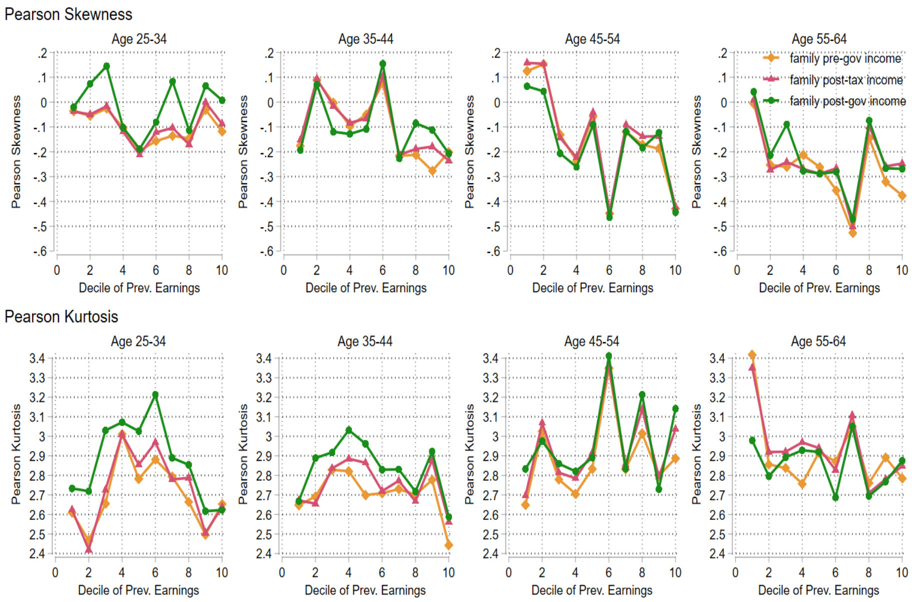

Figure 57: Skewness and Kurtosis of the distribution of 3-year average changes of family income (P5-P95) at different levels. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable family income.

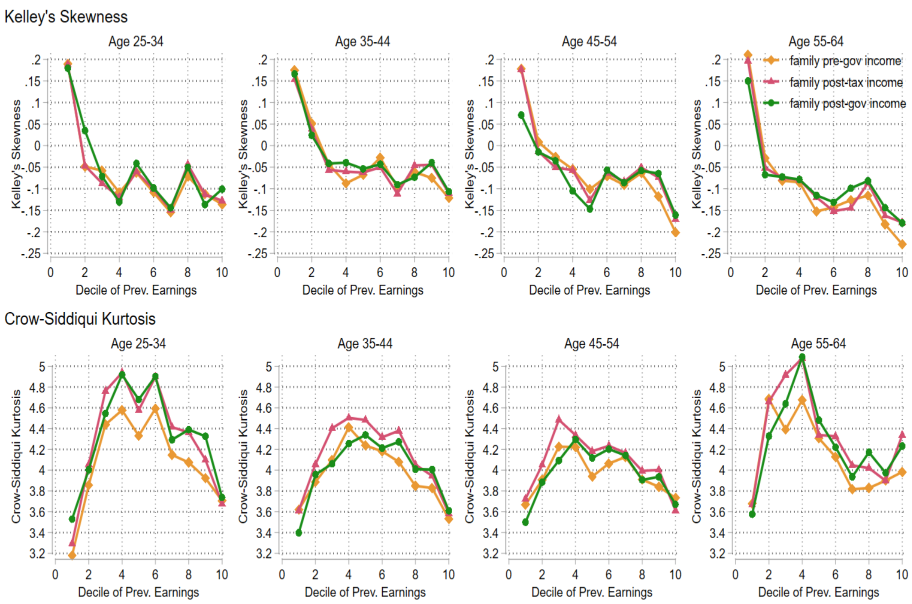

Figure 58: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of annual changes of family income (P5-P95) at different levels. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable family income.

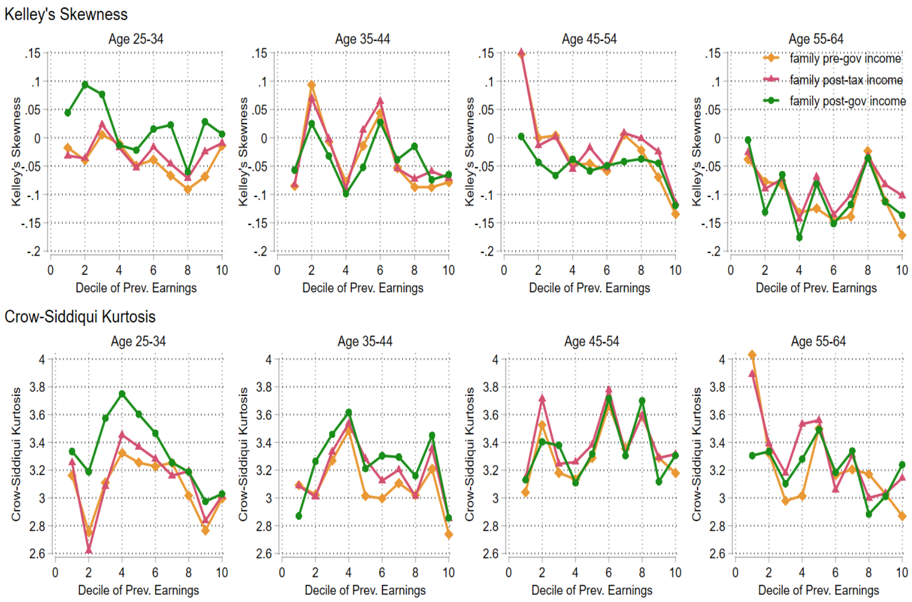

Figure 59: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of 3-year average changes of family income (P5-P95) at different levels. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable family income.

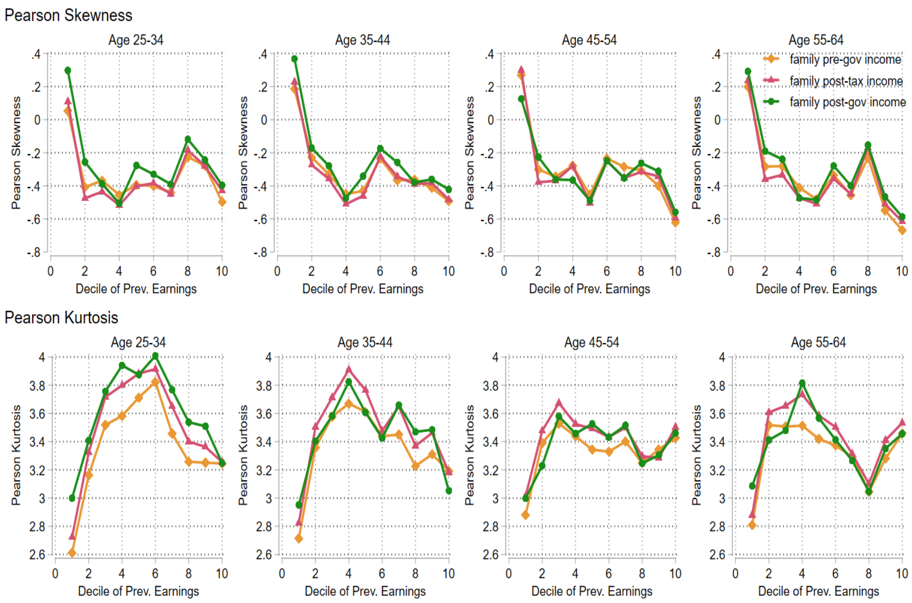

Figure 60: Skewness and Kurtosis of the distribution of annual changes of family income (P5-P95) at different levels calculated via *Arc-Percent Change method*. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable family income.

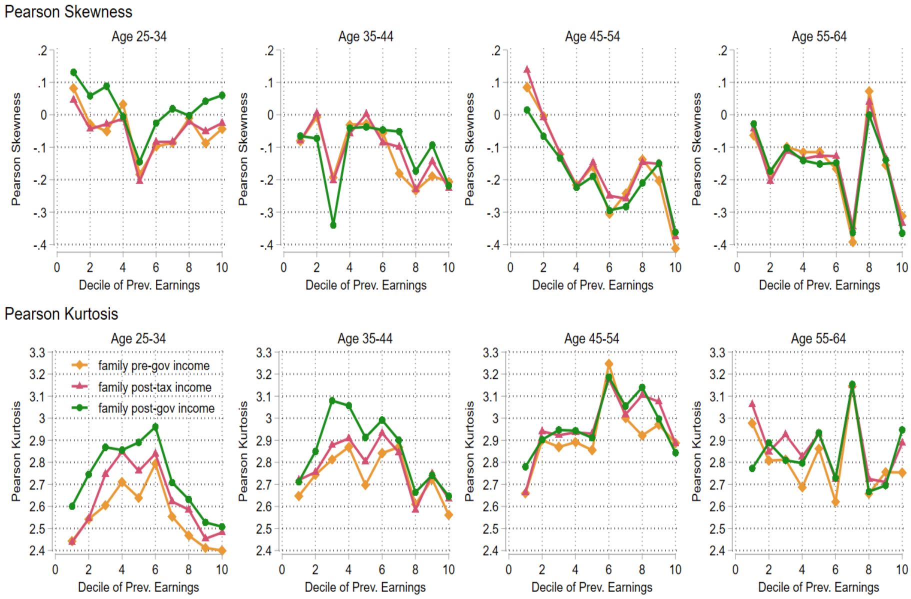

Figure 61: Skewness and Kurtosis of the distribution of 3-year average changes of family income (P5-P95) at different levels calculated via *Arc-Percent Change method*. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable family income.

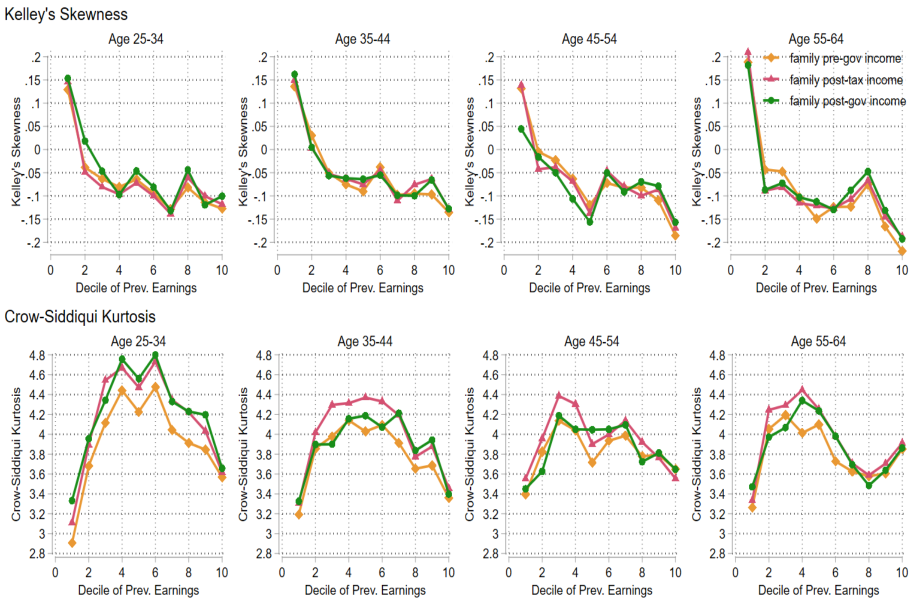

Figure 62: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of annual changes of family income (P5-P95) at different levels calculated via *Arc-Percent Change method*. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable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

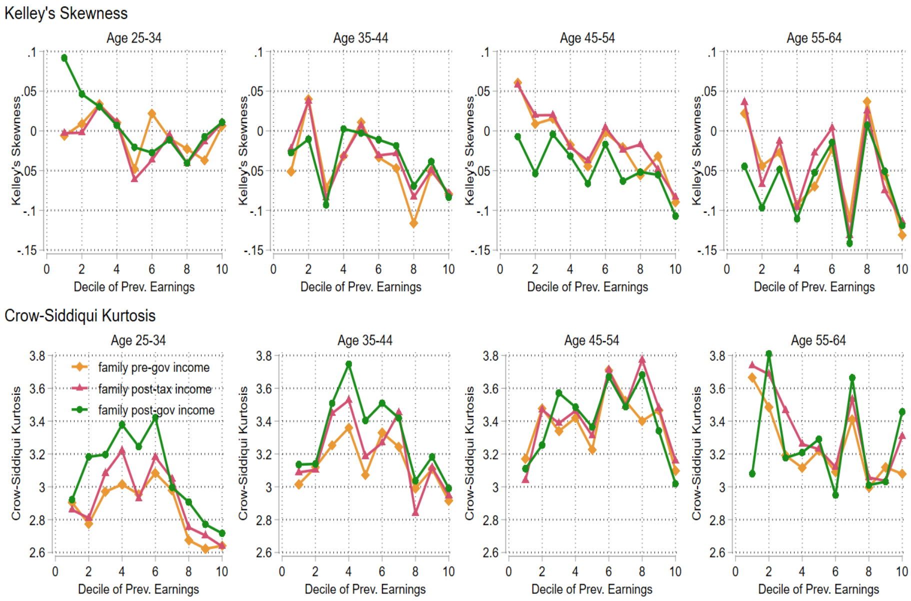

Figure 63: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of 3-year average changes of family income (P5-P95) at different levels calculated via *Arc-Percent Change method*. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable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

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

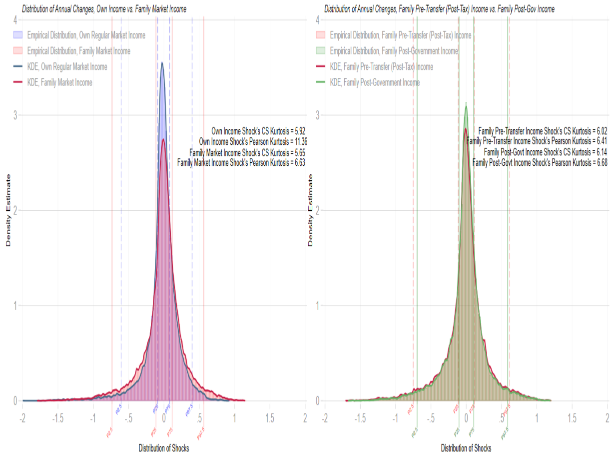

Figure 64: Comparison of empirical distributions of annual shocks: individual market income vs. family market income (left panel), and family pre-transfer (post-tax) income vs. family post-government income (right panel).

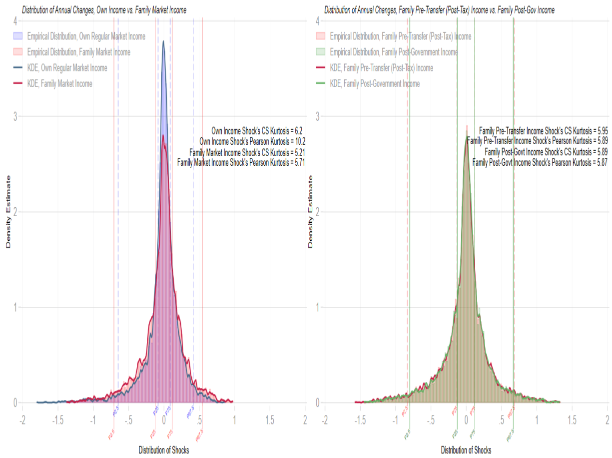

Figure 65: Comparison of empirical distributions of annual shocks of the working-age cohort aged 55-64: individual market income vs. family market income (left panel), and family pre-transfer (post-tax) income vs. family post-government income (right panel).

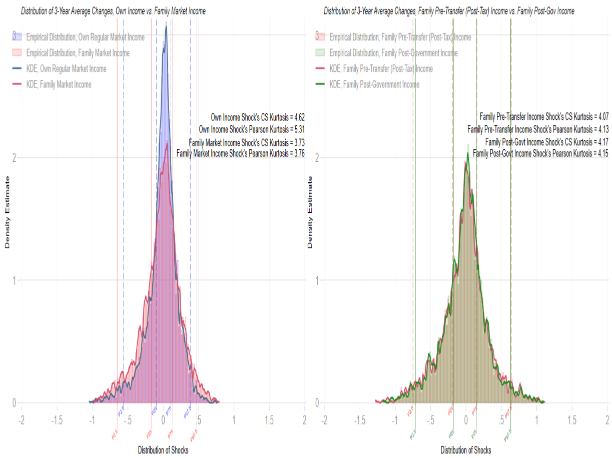

Figure 66: Comparison of empirical distributions of 3-year average shocks of the working-age cohort aged 55-64: individual market income vs. family market income (left panel), and family pre-transfer (post-tax) income vs. family post-government income (right panel).

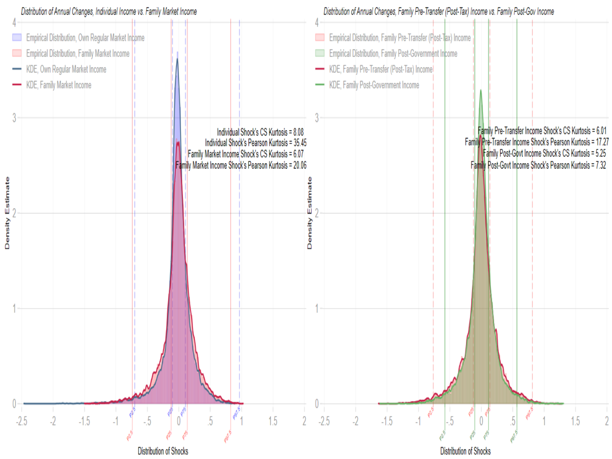

Figure 67: Comparison of empirical distributions of anual average shocks of lower and upper middle income parents (decile 3 to decile 8): individual market income vs. family market income (left panel), and family pre-transfer (post-tax) income vs. family post-government income (right panel).

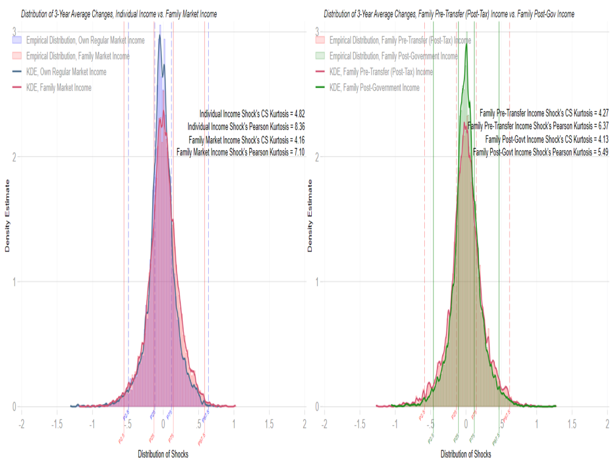

Figure 68: Comparison of empirical distributions of 3-year average shocks of lower and upper middle income parents (decile 3 to decile 8): individual market income vs. family market income (left panel), and family pre-transfer (post-tax) income vs. family post-government income (right panel).

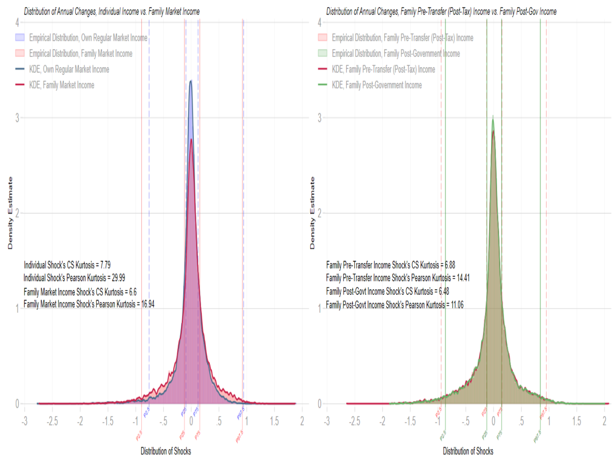

Figure 69: Comparison of empirical distributions of anual average shocks of lower and upper middle income non-parents (decile 3 to decile 8): individual market income vs. family market income (left panel), and family pre-transfer (post-tax) income vs. family post-government income (right panel).

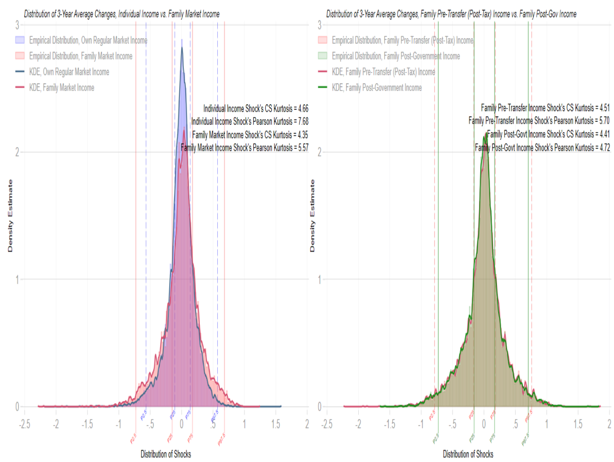

Figure 70: Comparison of empirical distributions of 3-year average shocks of lower and upper middle income non-parents (decile 3 to decile 8): individual market income vs. family market income (left panel), and family pre-transfer (post-tax) income vs. family post-government income (right panel).

A.9 Family and government insurance effects by gender

A.9.1 P1-P99

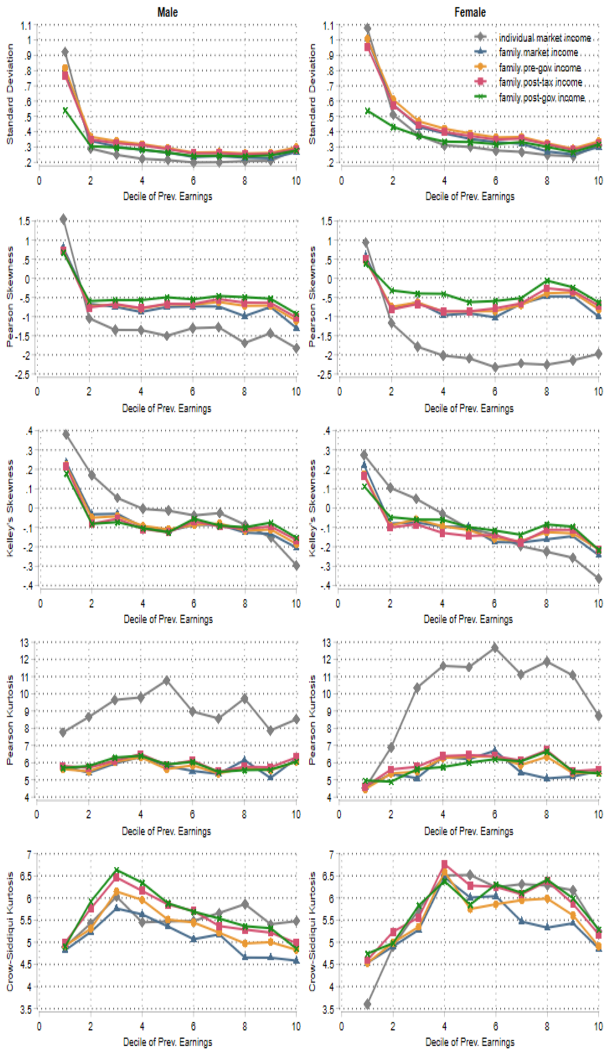

Figure 71: Moment properties of the distributions of annual income shocks (P1-P99) of male (left panel) and female (right panel) primary earners.

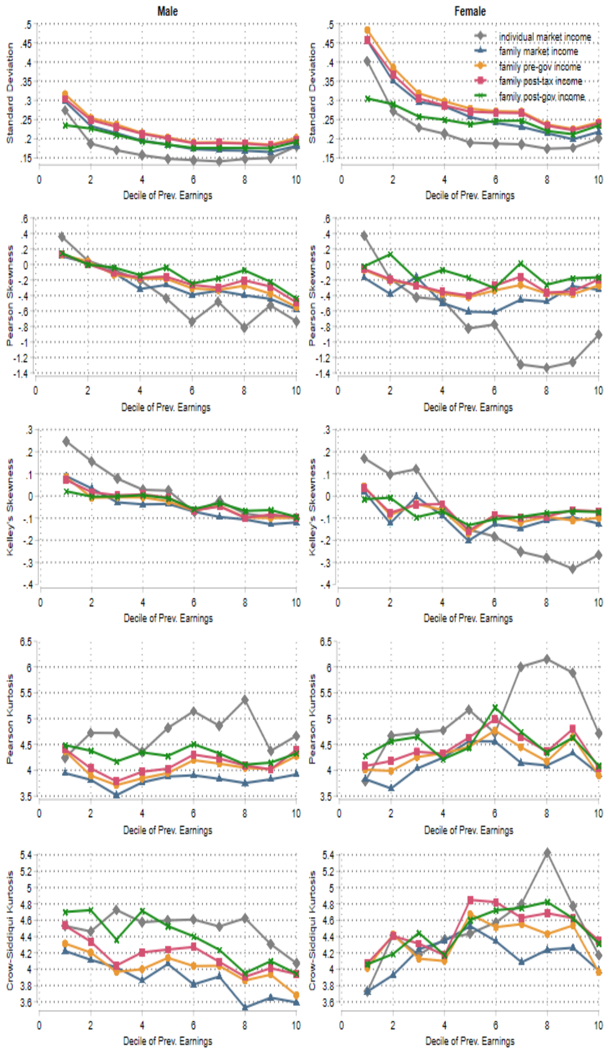

Figure 72: Moment properties of the distributions of 3-year average income shocks (P1-P99) of male (left panel) and female (right panel) primary earners.

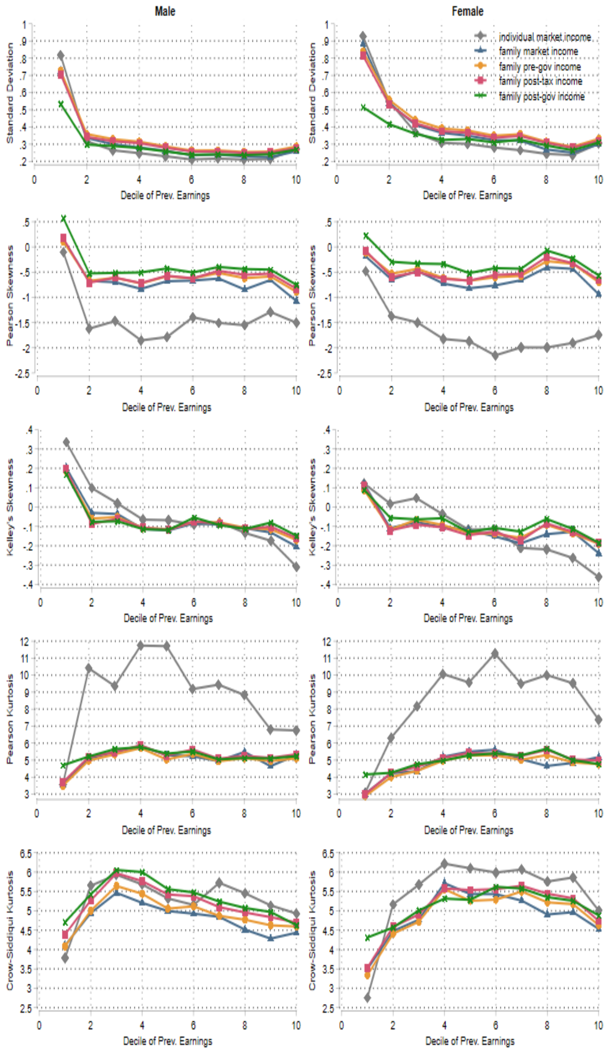

Figure 73: Moment properties of the distributions of annual income shocks (P1-P99) of male (left panel) and female (right panel) primary earners calculated via *Arc-Percent Change method*.

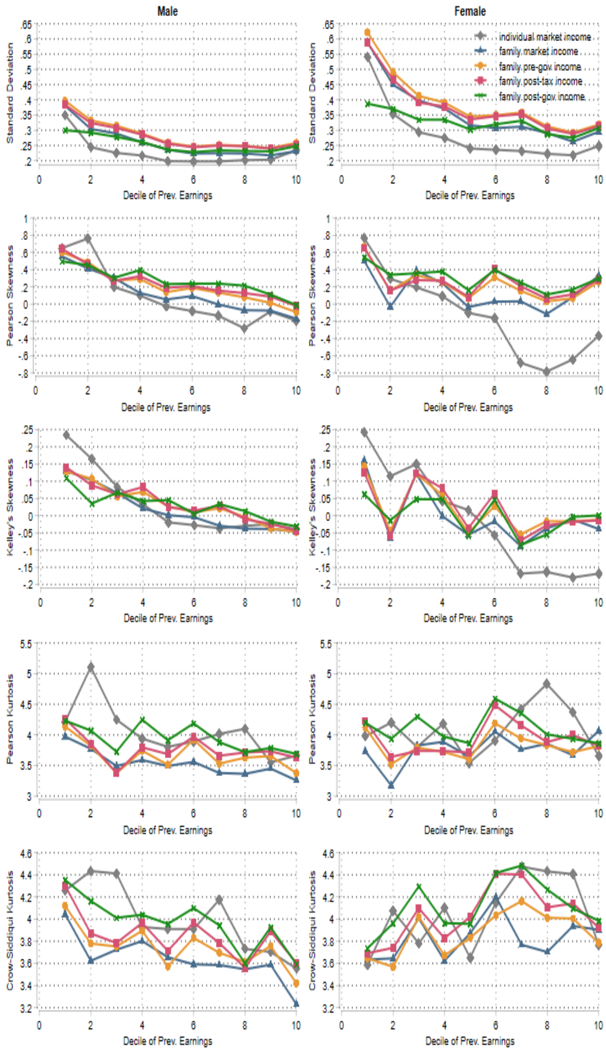

Figure 74: Moment properties of the distributions of annual income shocks (P1-P99) of male (left panel) and female (right panel) primary earners calculated via *Arc-Percent Change method*.

A.9.2 P5-P95

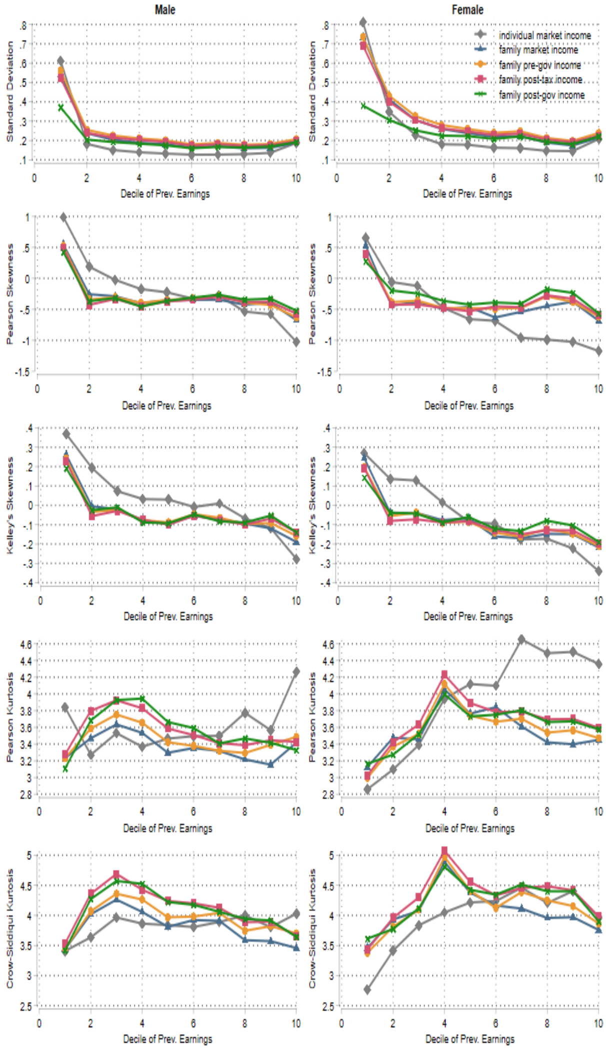

Figure 75: Moment properties of the distributions of annual income shocks (P5-P95) of male (left panel) and female (right panel) primary earners.

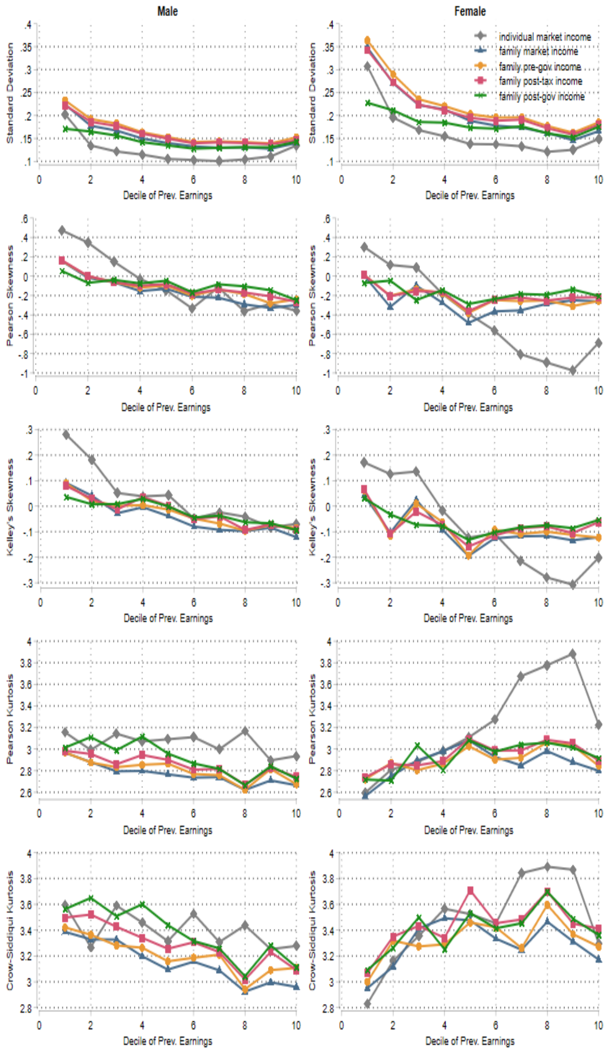

Figure 76: Moment properties of the distributions of 3-year average income shocks (P5-P95) of male (left panel) and female (right panel) primary earners.

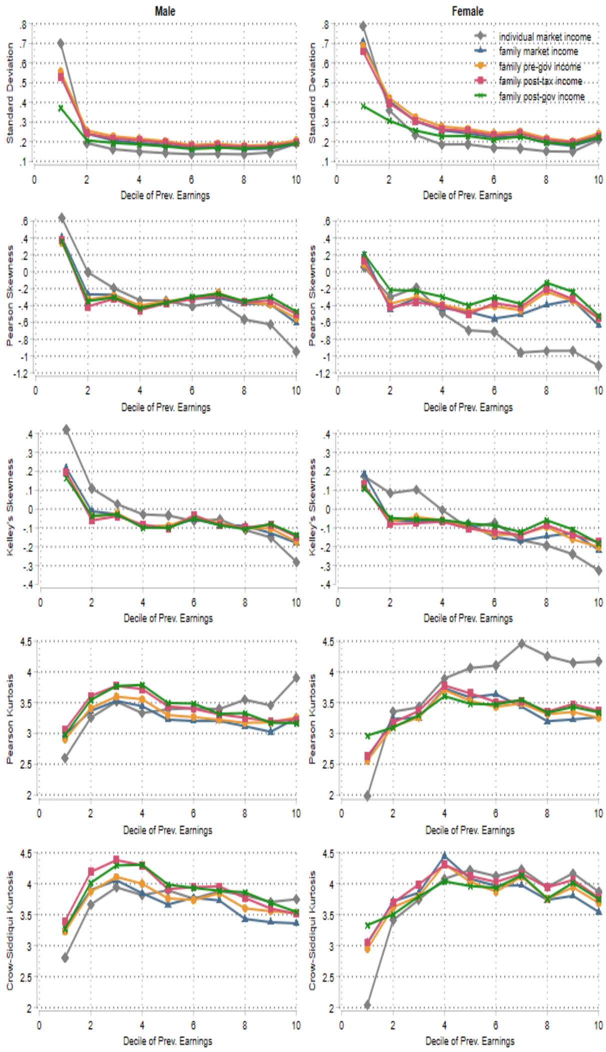

Figure 77: Moment properties of the distributions of annual income shocks (P5-P95) of male (left panel) and female (right panel) primary earners calculated via *Arc-Percent Change method*.

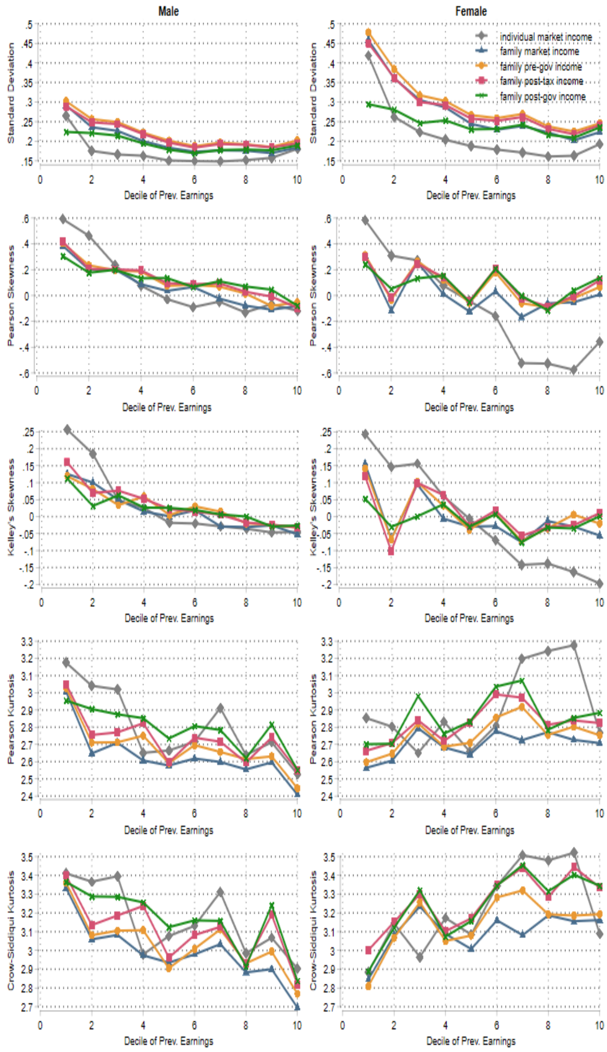

Figure 78: Moment properties of the distributions of annual income shocks (P5-P95) of male (left panel) and female (right panel) primary earners calculated via *Arc-Percent Change method*.

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

A.10.1 Non-robust

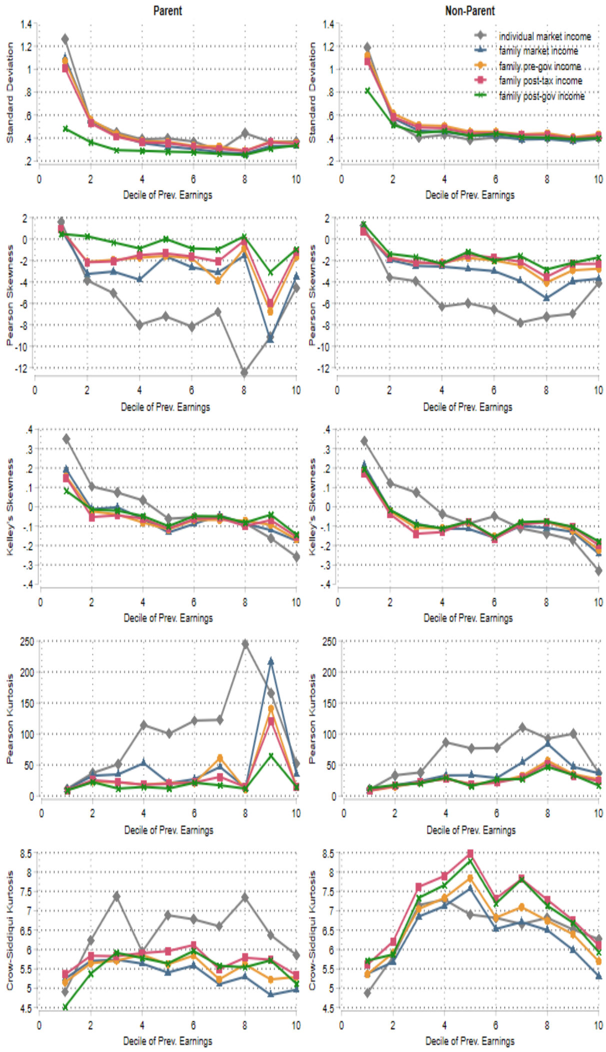

Figure 79: Non-robust moment properties of the distributions of annual income shocks of parent (left panel) and non-parent (right panel) primary earners.

A.10.2 P1-P99

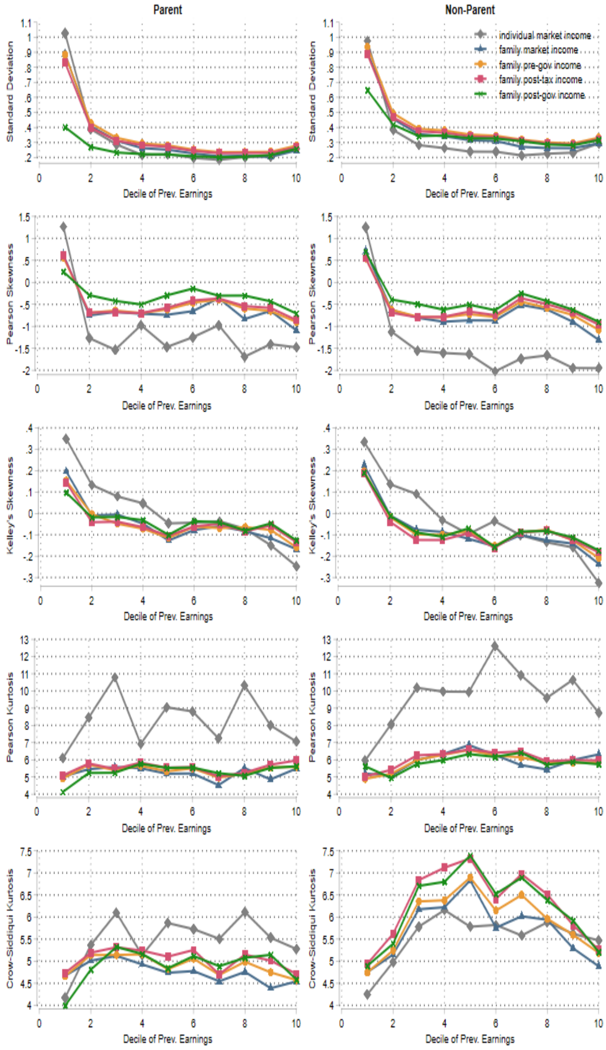

Figure 80: Moment properties of the distributions of annual income shocks (P1-P99) of parent (left panel) and non-parent (right panel) primary earners.

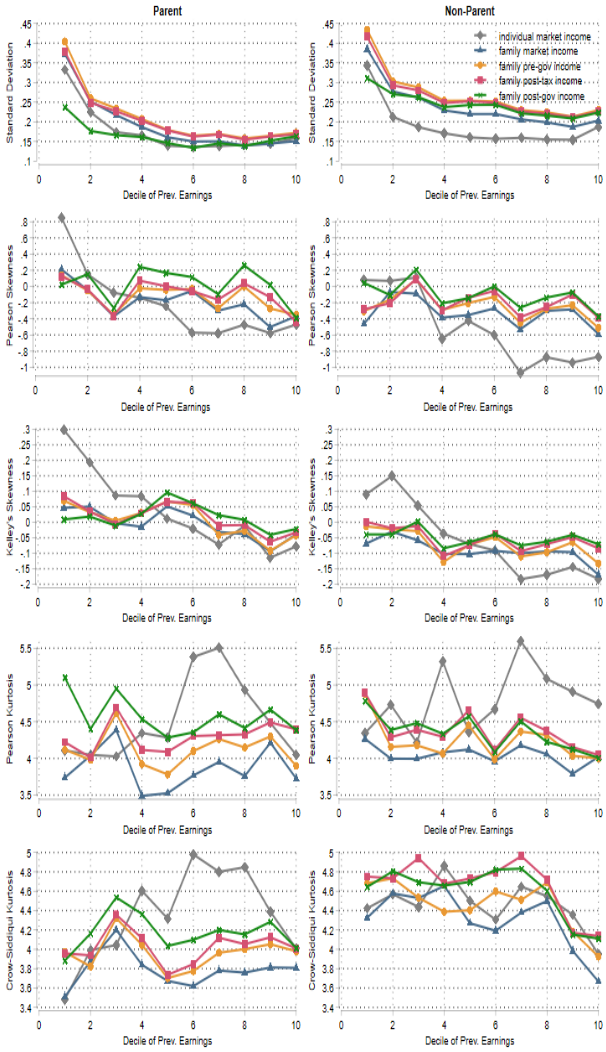

Figure 81: Moment properties of the distributions of 3-year average income shocks (P1-P99) of parent (left panel) and non-parent (right panel) primary earners.

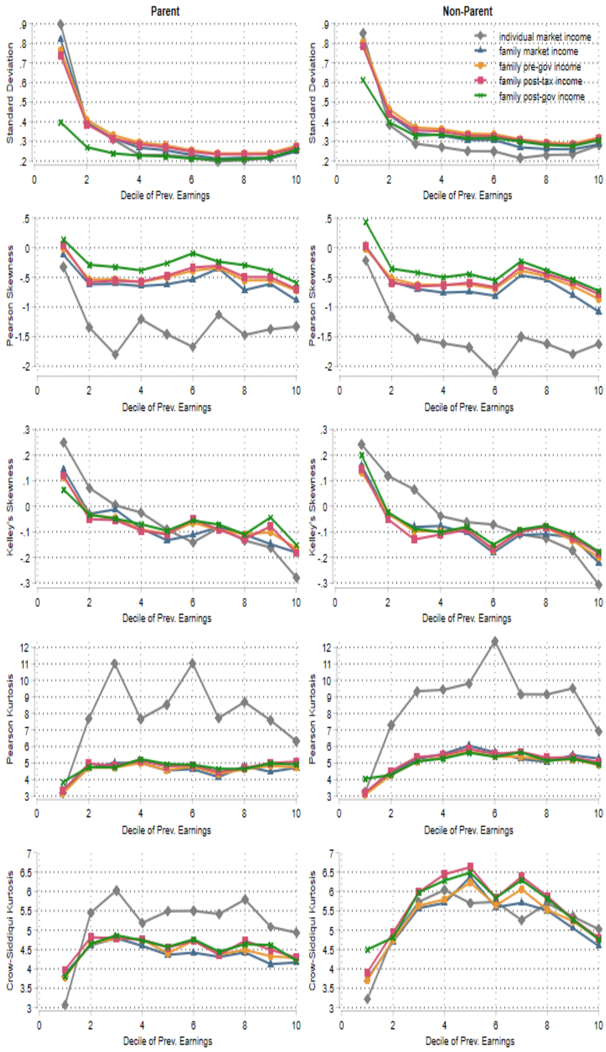

Figure 82: Moment properties of the distributions of annual income shocks (P1-P99) of parent (left panel) and non-parent (right panel) primary earners calculated via *Arc-Percent Change method*.

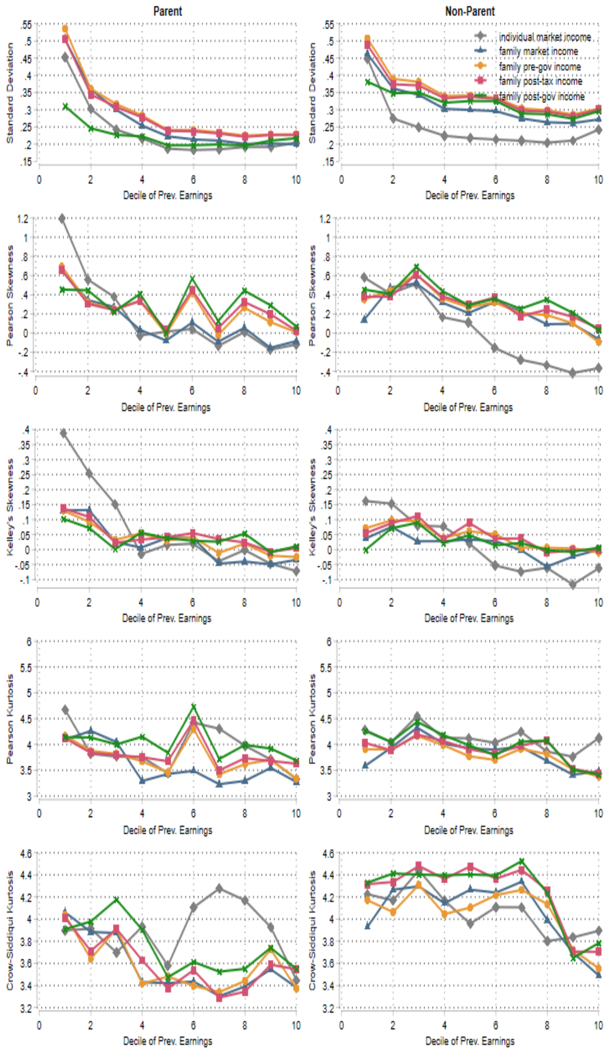

Figure 83: Moment properties of the distributions of annual income shocks (P1-P99) of parent (left panel) and non-parent (right panel) primary earners calculated via *Arc-Percent Change method*.

A.10.3 P5-P95

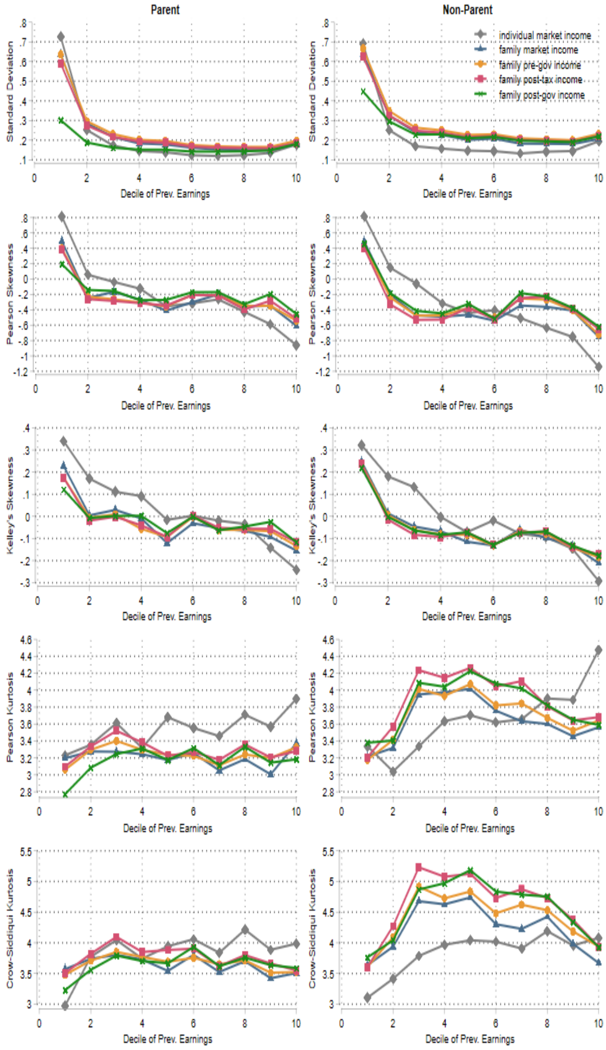

Figure 84: Moment properties of the distributions of annual income shocks (P5-P95) of parent (left panel) and non-parent (right panel) primary earners.

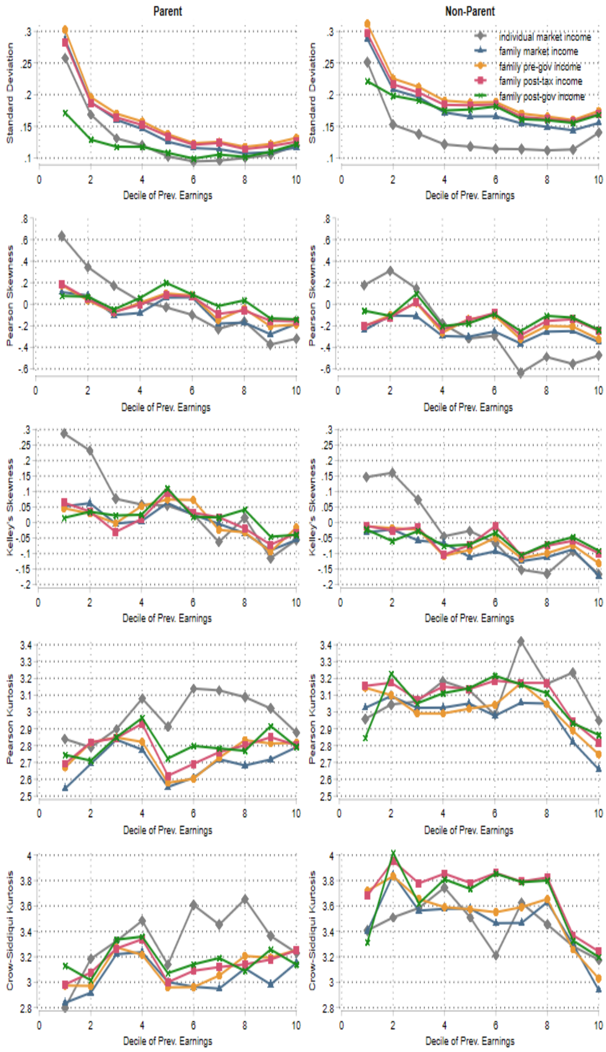

Figure 85: Moment properties of the distributions of 3-year average income shocks (P5-P95) of parent (left panel) and non-parent (right panel) primary earners.

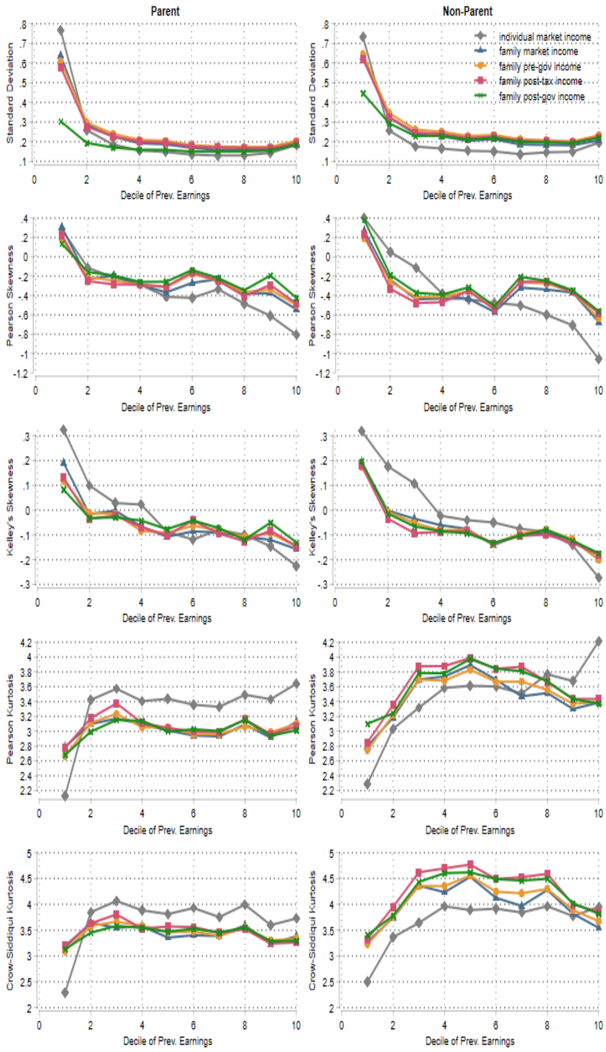

Figure 86: Moment properties of the distributions of annual income shocks (P5-P95) of parent (left panel) and non-parent (right panel) primary earners calculated via *Arc-Percent Change method*.

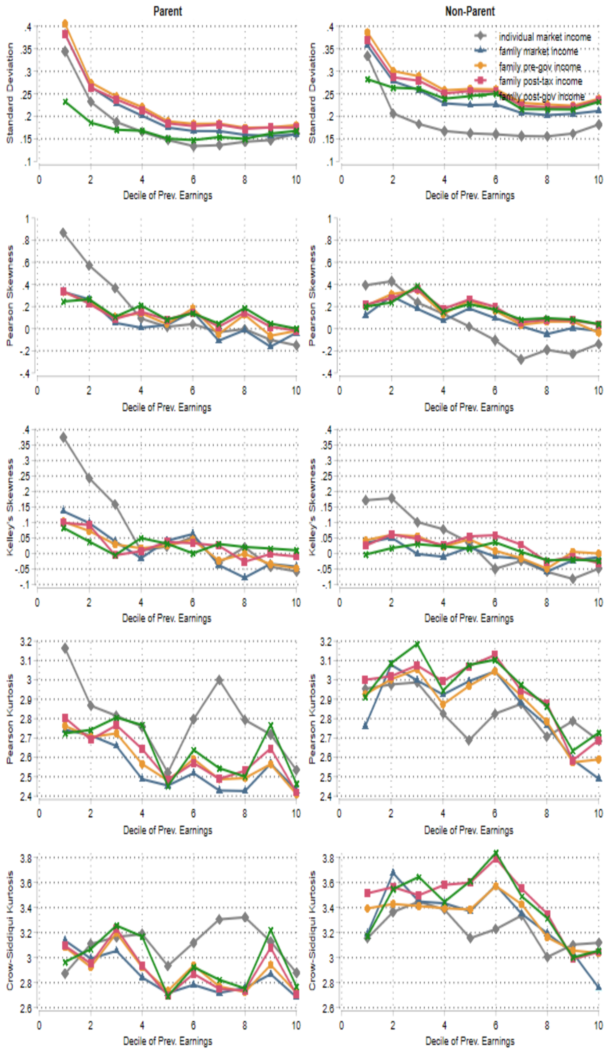

Figure 87: Moment properties of the distributions of annual income shocks (P5-P95) of parent (left panel) and non-parent (right panel) primary earners calculated via *Arc-Percent Change method*.

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

A.11.1 P1-P99

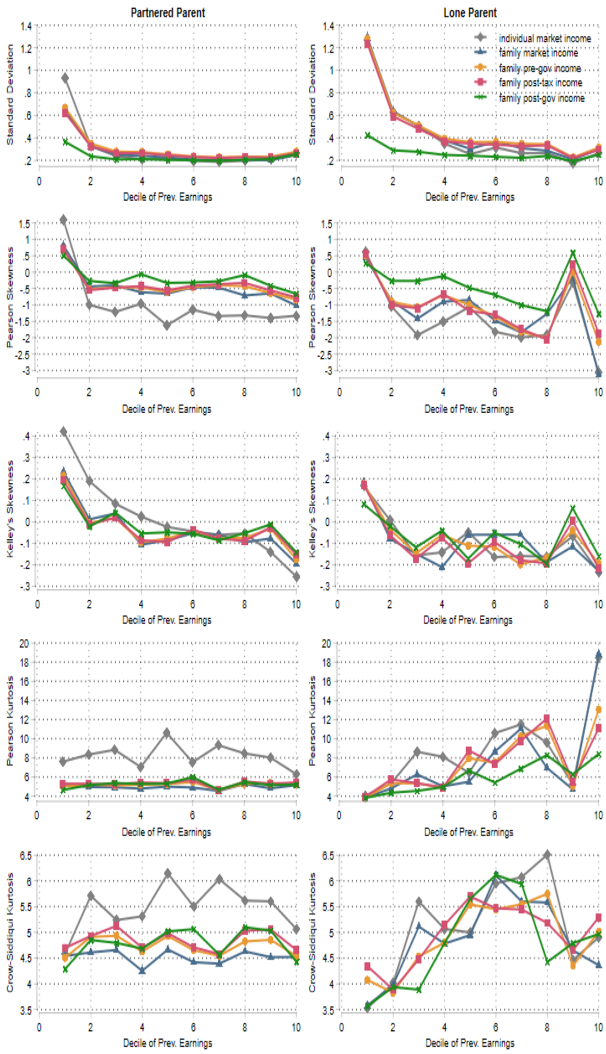

Figure 88: Moment properties of the distributions of annual income shocks (P1-P99) of partnered parent (left panel) and lone parent (right panel) primary earners.

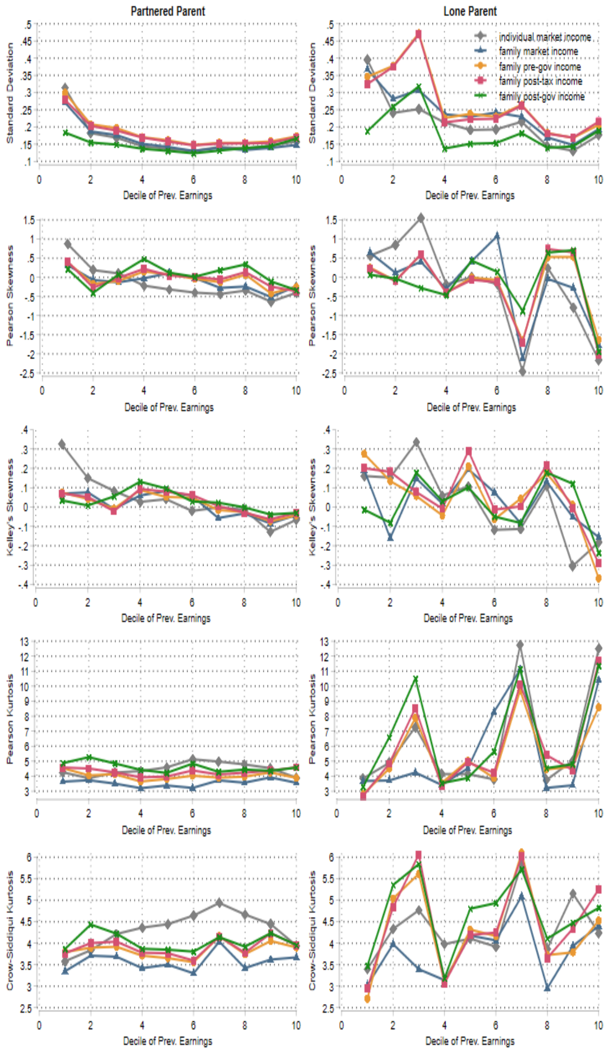

Figure 89: Moment properties of the distributions of 3-year average income shocks (P1-P99) of partnered parent (left panel) and lone parent (right panel) primary earners.

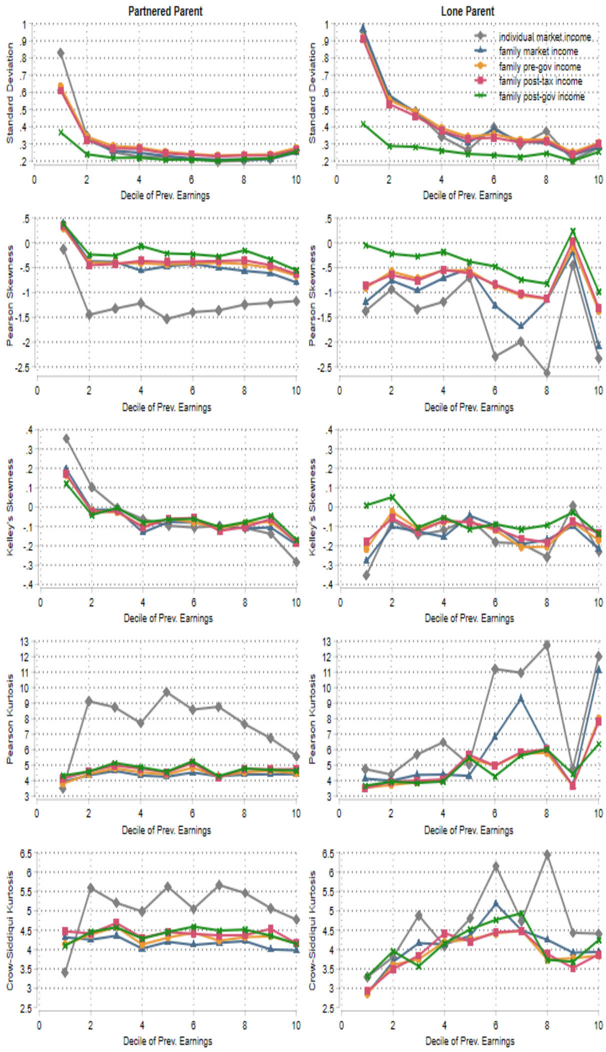

Figure 90: Moment properties of the distributions of annual income shocks (P1-P99) of partnered parent (left panel) and lone parent (right panel) primary earners calculated via *Arc-Percent Change method*.

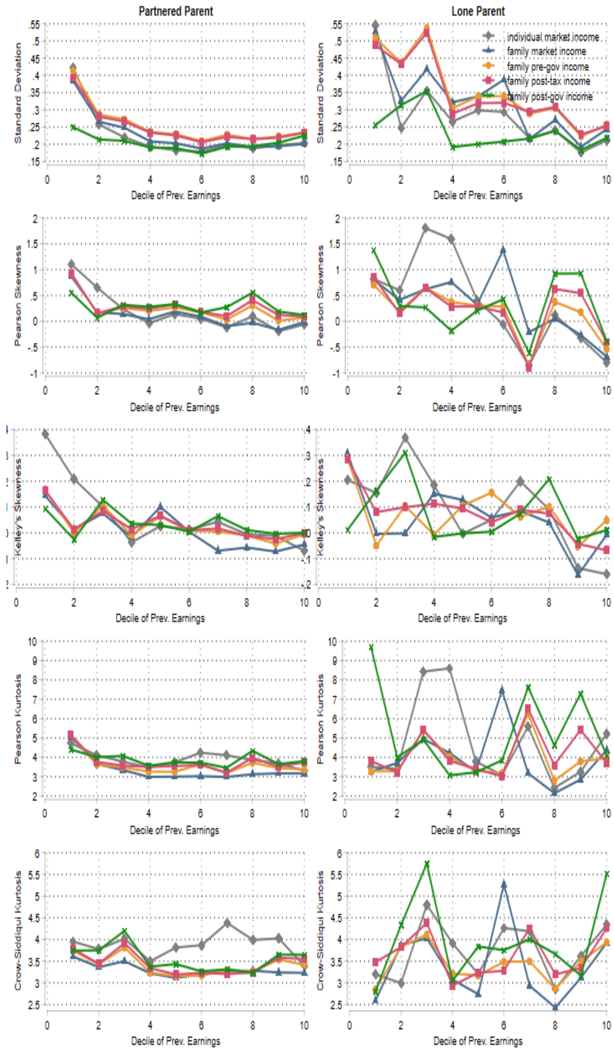

Figure 91: Moment properties of the distributions of annual income shocks (P1-P99) of partnered parent (left panel) and lone parent (right panel) primary earners calculated via *Arc-Percent Change method*.

A.11.2 P5-P95

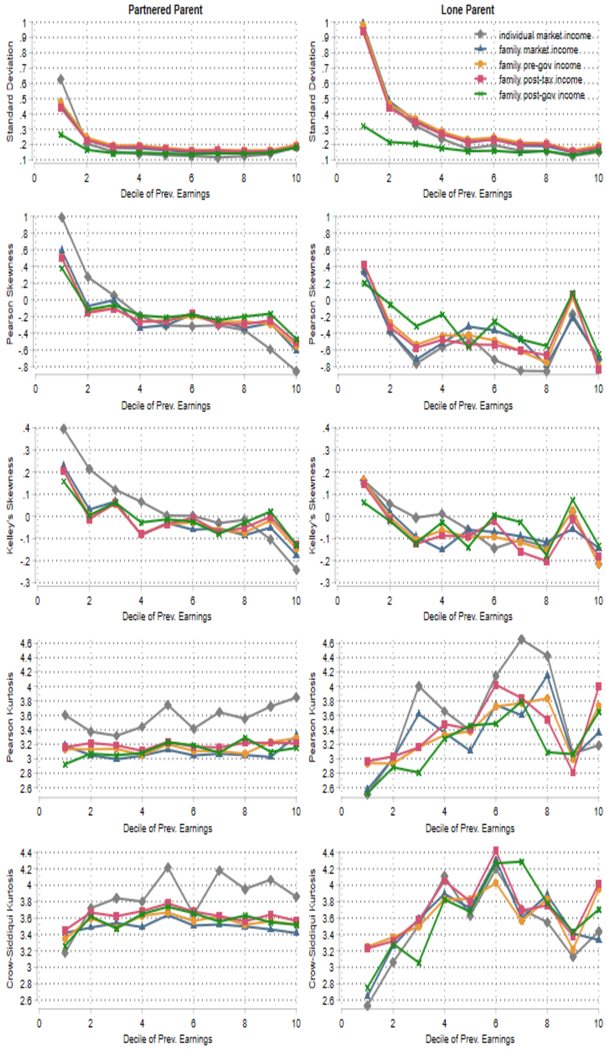

Figure 92: Moment properties of the distributions of annual income shocks (P5-P95) of partnered parent (left panel) and lone parent (right panel) primary earners.

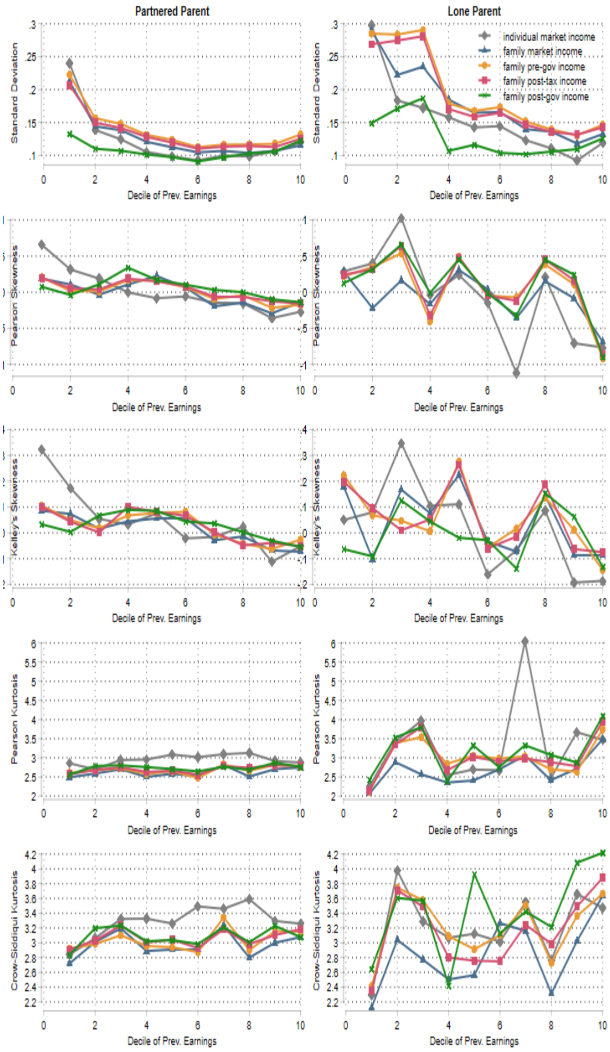

Figure 93: Moment properties of the distributions of 3-year average income shocks (P5-P95) of partnered parent (left panel) and lone parent (right panel) primary earners.

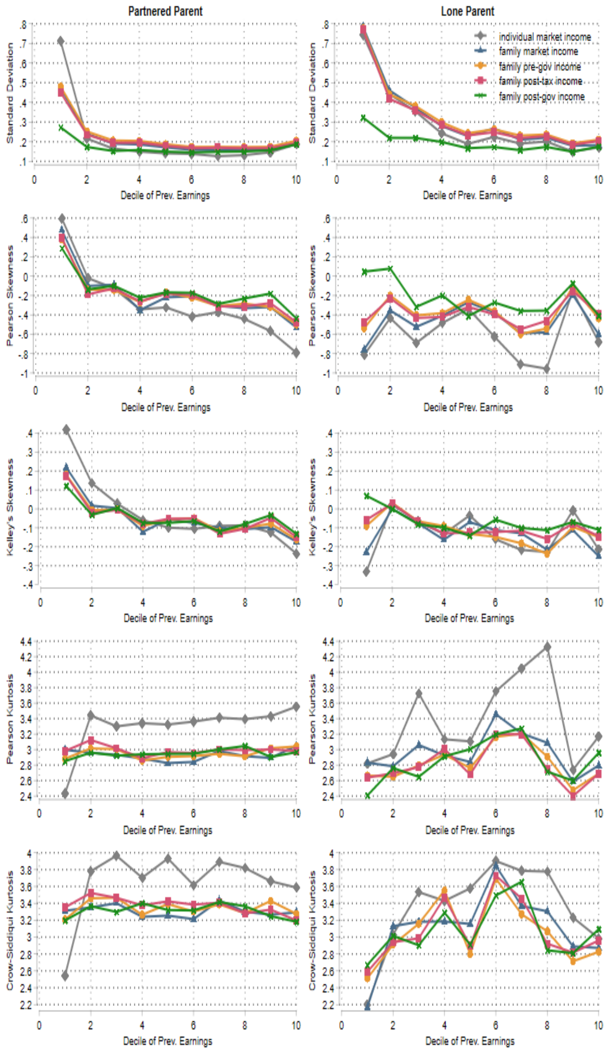

Figure 94: Moment properties of the distributions of annual income shocks (P5-P95) of partnered parent (left panel) and lone parent (right panel) primary earners calculated via *Arc-Percent Change method*.

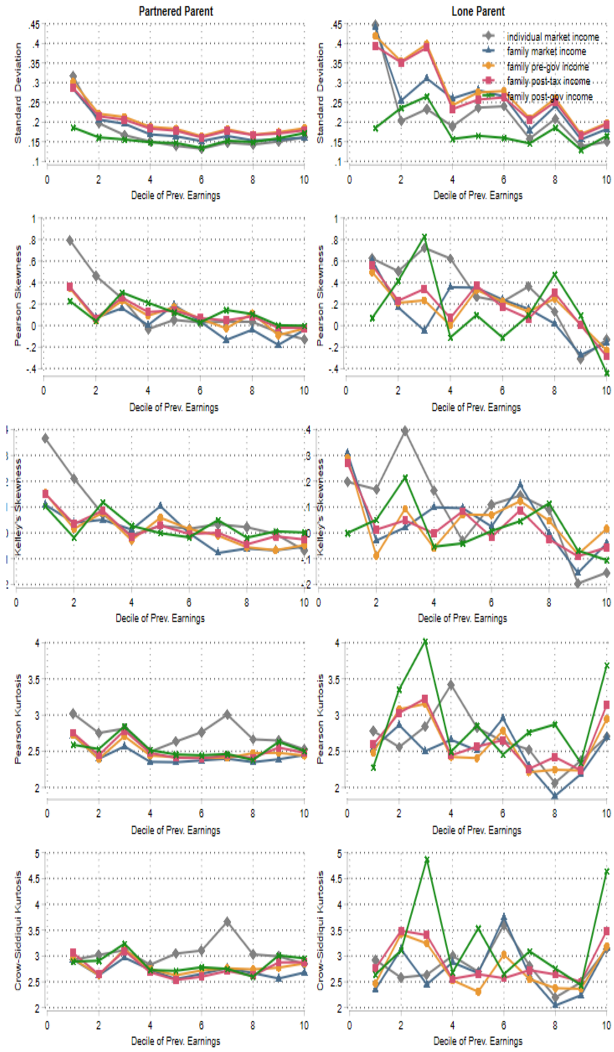

Figure 95: Moment properties of the distributions of annual income shocks (P5-P95) of partnered parent (left panel) and lone parent (right panel) primary earners calculated via *Arc-Percent Change method*.

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

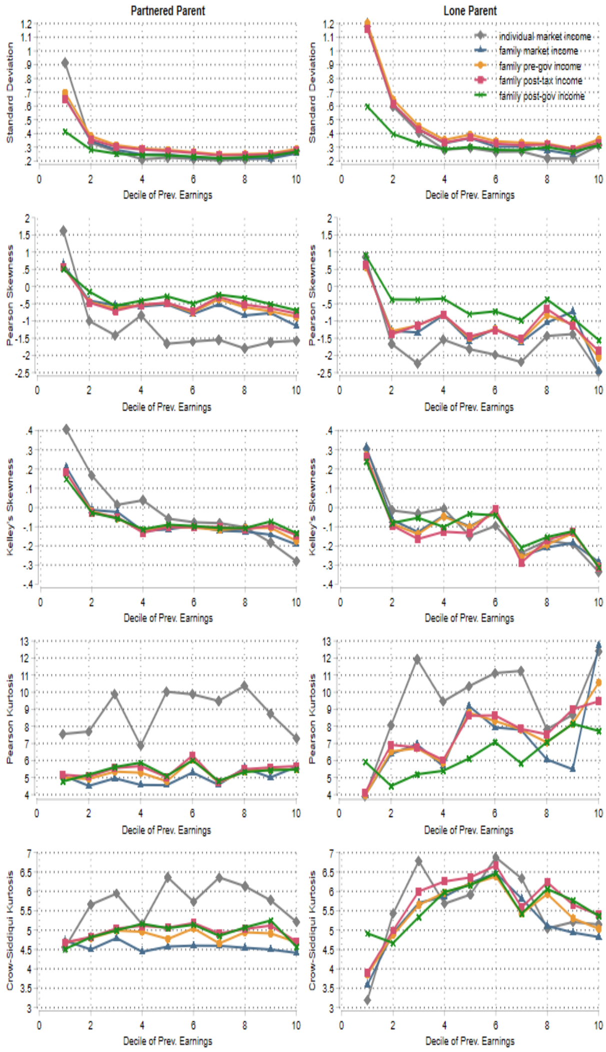

Figure 96: Moment properties of the distributions of annual income shocks of partnered parent (left panel) and lone parent (right panel) primary earners (P11-P99) Pearson statistics.