Lifecycle Earnings Risk and Insurance: New Evidence from Australia*
Online Technical Appendix

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Abstract

We provide additional information and results in this online technical appendix.

JELL: E24, H24, H31, J31.

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

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A HILDA: Descriptive statistics

We use data from the Household, Income and Labour Dynamics in Australia (HILDA) Survey Restricted Release 20 (2001 – 2020). We report more descriptive statistics of our HILDA data sample in this analysis.

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 A.1: **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 falls into one of these categories, his/her data on income, tax, transfer and other variables of interest is stored prior to being dropped.

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

Table A.2: **Summary statistics of primary earners in financial year 2001**

	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 A.3: **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 A.4: **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.

		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 A.5: **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 A.6: **Cross-tabulation of frequency between education, 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 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.

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 A.7: **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. The figures account for cross-decile mobility over time.

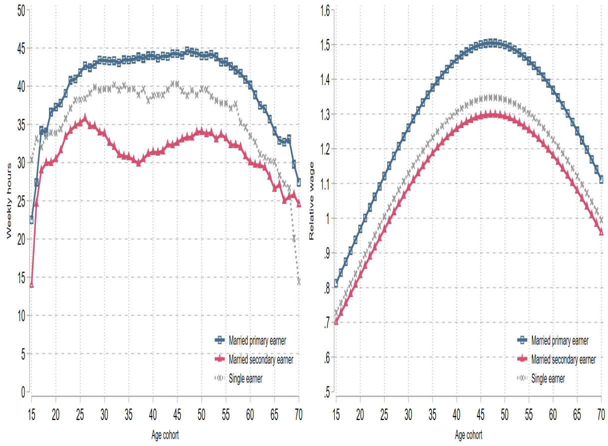

Figure A.1: **Age profiles of weekly work hours and wages**. Wages are normalised to male wage in age 21.

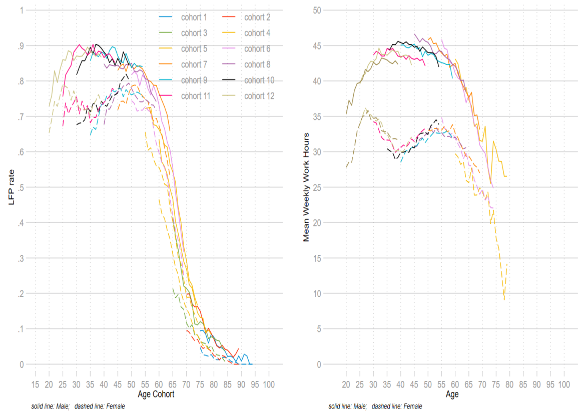

Figure A.2: **Labor force participation and labor supply.** Age-profiles of weekly work hours if employed (left panel) and labour force participation rate (right panel) by age, cohort and gender (2001-2020). The M shape of female labour supply reflects the age-profiles of participation rate and work hour of partnered women. Single women's profiles are hump-shaped, though at a slightly lower level compared to men's.

B Derivations

B.1 Higher-order 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 corresponding equation of change 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.

Second Moment

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

Or, equivalently

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

Third Moment

Following the definition of the standardized third moment,

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

where the first term of the RHS denotes the contributions of Δw and Δh independently to the Pearson skewness of Δy, and the second term of the RHS denotes the contribution of the co-movement of Δw and Δh to the Pearson skewness of Δy.

Fourth Moment

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

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

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 denote the contribution of the co-movement of Δw and Δh to the Pearson kurtosis of Δy.

B.2 Income pooling and added worker effects

Let $f, p,$ and s denote family income, primary earner's earnings and secondary earner's earnings,respectively. Family income is a sum of primary earner's and secondary earner's earnings $f(p(t), s(t)) = p(t) + s(t)$. By total differentiation,

$$
\begin{aligned}
\frac{df}{dt} &= \frac{\partial f}{\partial p}\frac{dp}{dt} + \frac{\partial f}{\partial s}\frac{ds}{dt} \\
df &= dp + ds \\
\frac{df}{f} &= \frac{p}{f}\frac{dp}{p} + \frac{s}{f}\frac{ds}{s}
\end{aligned}
$$

Equivalently, $\%\Delta f = f_p \times \%\Delta p + f_s \times \%\Delta s$, 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 $f_s \in [0, 0.5)$. The expression for the variance of family income changes (or, the second-order family income risk) is then

$$
VAR(\Delta f) = f_p^2 VAR(\Delta p) + \overbrace{f_s^2 VAR(\Delta s)}^{\text{income-pooling effect}} + \overbrace{2 f_p f_s COV(\Delta p, \Delta s)}^{\text{added-worker effect}}.
$$

The first 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, an *income-pooling effect*, which enlarges the variance of family income. The last term $2f_pf_sCOV(\Delta p, \Delta s)$ is the contribution of the covariance. $COV(\Delta p, \Delta s) < 0$ implies an *added-worker effect* which contracts the variance of family income. Adding more second earners (e.g., independent resident children) reduces f_p and leads to a larger combined influence of $VAR(\Delta s)$ of secondary earners.

C Income risk and insurance for the self-employed

Our primary objective is examining moment statistics for employees (i.e., non-family workers in non-own businesses) to obtain risk and insurance estimates comparable to those from the previous studies. For this reason and for the lack of sufficient sample size, income dynamics of the self-employed - including employees of family run businesses - is excluded from the main study. Some other challenges involve the fact that family members working in family-own businesses might be unpaid or report identical income levels (joint income is evenly split), and that the self-employed makes up a trivial fraction of certain demographics of interest (e.g., bottom income decile and/or single mothers). As a guide for future work and a supplementary study for a more complete picture, we conduct two investigations as follows.

We first include the self-employed into our existing sample of employees. This raises the sample size to $179,674$ observations, a 15.77% increase. To address the issue of self-employed couples reporting identical annual market income, we re-define a primary earner as either the person with higher income relative to their partner for at least half the period of observation, or in case of identical income levels, we assign male as the primary earner to be consistent with previous work on male income dynamics. We then re-estimate all the second- and higher-order moments from the main paper. We find no significant difference. This suggests that our results are robust to the inclusion of the self-employed.

Given the relatively small sample size of the self-employed, the findings above are not surprising. Hence, for our second investigation, we study this group in isolation. To accommodate the smaller sample of $26,771$ observations, estimates are re-calculated at a lower resolution by dividing them into income quintile and young/old as opposed to the more finely segmented subgroups done for employees in our main study.

The effort leads to some interesting findings. The risk and insurance experienced by the self-employed and by employees from the main paper exhibit a lot of similarities. For instance, while the sizes of total insurance are similar, the share of government insurance against the second- and third-order risks is larger for the female self-employed primary earners (relative to their male counterparts). Transitory and persistent individual market income risk profiles of the self-employed parents resemble those of non-parents, but the former group benefits substantially more from government insurance. The comparison of partnered with lone self-employed parents yields similar results as discussed in the main paper for the employees. Key differences between the employees and the self-employed primary earners can be summarized in just a few figures.

Figure C.1 shows that although government transfer is still the dominant insurance against the second-order risk for the self-employed primary earners, their family market income insurance is substantial. Notably, because both partner's business earnings tend to move in the same direction (for joint ownership), Figure C.2 below shows that the average changes in spouse's regular earnings tend to move in the same direction as that of the primary earner. However, the second moment statistics show evidence of insurance by spouse against the second-order risk, not captured by the simple average change statistics. There are two lessons here. First, the study of first moment statistics alone might miss the family insurance effect for the self-employed. Second, the observed family market income insurance implies that shocks to earnings of the self-employed heads of households induce secondary earners - who previously jointly owned or were employed by the family business - to search for employment elsewhere in the labour market.

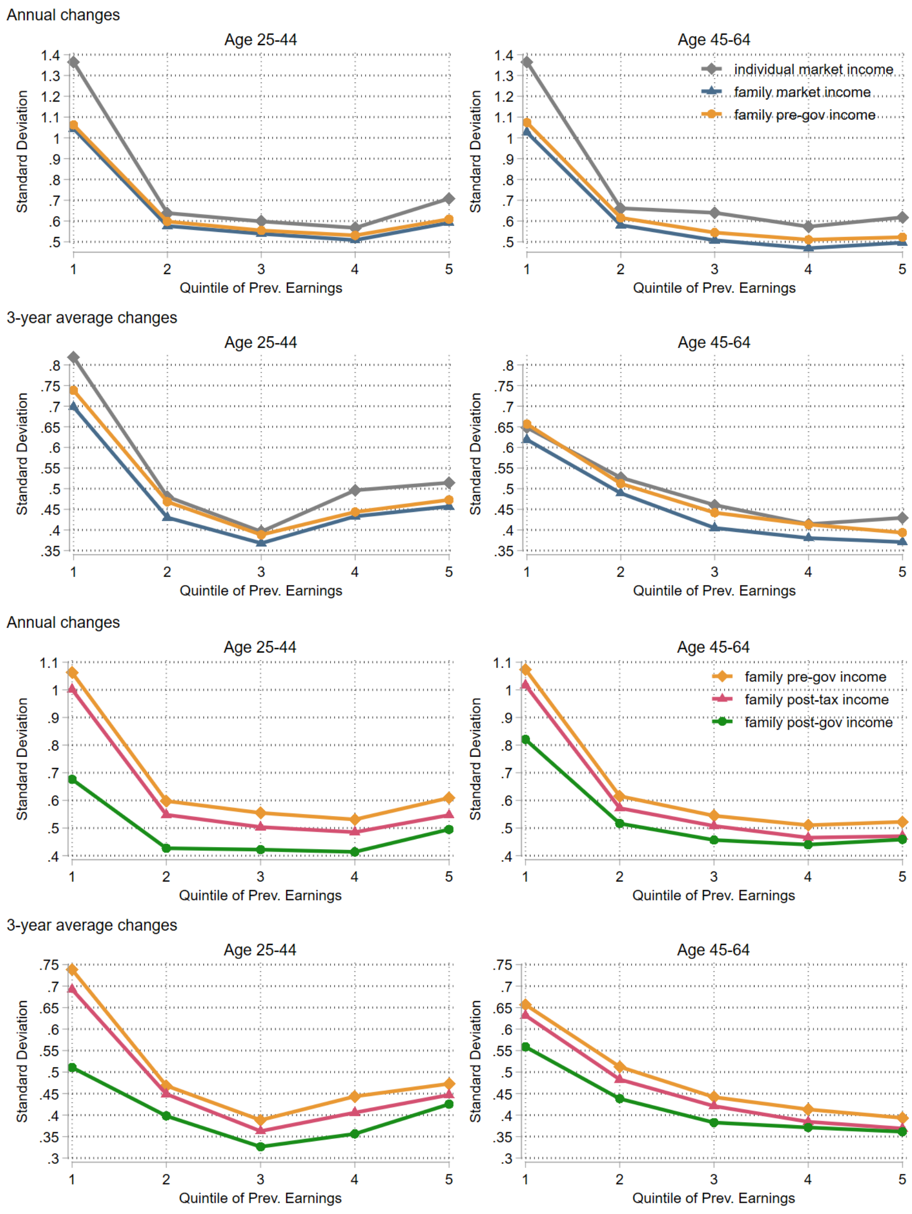

Figure C.1: Family insurance (top two panels) and government insurance (bottom two panels) against second-order risk for the self-employed.

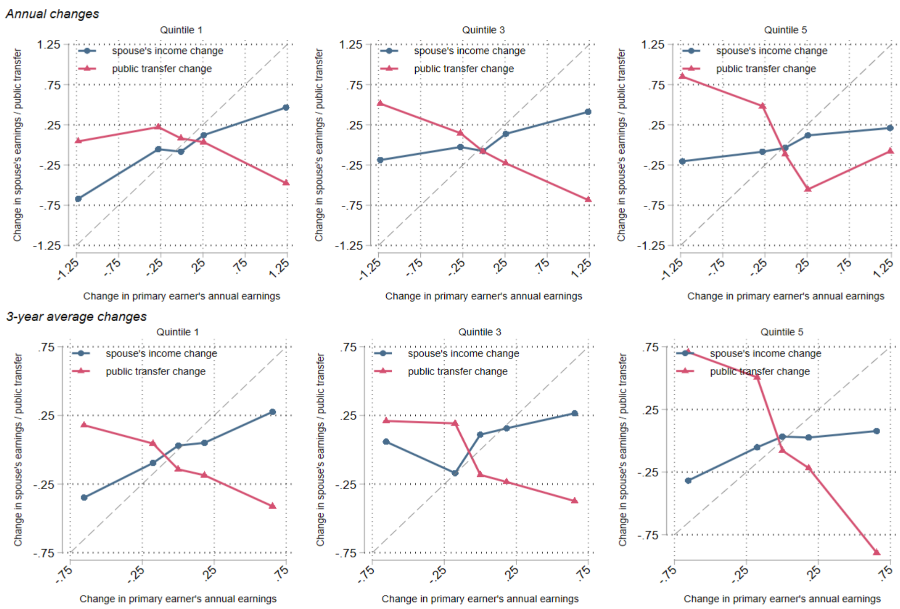

Figure C.2: Spousal versus Government responses to earnings shocks of the self-employed grouped by selected quintiles (Q1, Q3 and Q5).

D Earnings, hour and wage dynamics for permanent and full-time employees

Both the top and bottom panels of figure D.1 confirms our suspicion that the presence of casual and part time employment (not mutually exclusive) is key to understanding the role that hour changes play in driving the second- and high-order earnings risks, especially for the bottom income decile. Removing casual and part time employees results in hours having a much weaker influence on earnings risk. For the second moment statistics, the income profiles of transitory and persistent earnings risks drop in level across the board compared with the second-order risk profiles we report in the paper. What is striking is that the variance of hour changes falls by a huge margin and turns flat, making wage changes the sole driver of the earnings dynamics for the permanent and full-time primary earners, especially for those in the bottom-most past income decile.

For the third- and fourth-order risks, although wage changes now explain a higher proportion of the dynamics of this restricted sample, the magnitude of transitory earnings risk does not diminish. The relative third-order risk between income groups also remains mostly intact. For instance, permanent and full-time employees in the upper bracket still undergo higher third- and fourth-order earnings risks compared to the rest of the group. However, we see the bottom decile permanent and full-time workers experiencing much higher extreme magnitude and probability of positive earnings shocks driven primarily by residual wage growth.

Worth emphasizing is the 3rd-order risk. The evidence here, though incomplete, points in the direction of Lise (2012). The findings suggest that most of the observed third-order earnings risk belongs to permanent and full-time employees. This in turn is driven by wage changes which can be due to job loss (and relocation to a lower paid job), but we cannot rule out other factors such as job switching (voluntary) and health shocks for the older cohort. For Australian permanent and full-time primary earners, in particular, the third-order risk does not appear to be persistent (see the 3-year average statistics for skewness in Figure D.1). The story by Huckfeldt (2018) that workers are entrenched in low-skilled industries does not seem to hold in this case (if we consider wages as signaling low-skilled and high-skilled workplace). On the flip side, it also means that the observed persistent hour and earnings risks is the dynamics of the upper income casual and part time employees. Simply put, their presence in the sample is associated with large third-order persistent earnings risk, which implies that this group experiences the most severe prolonged adverse shocks.

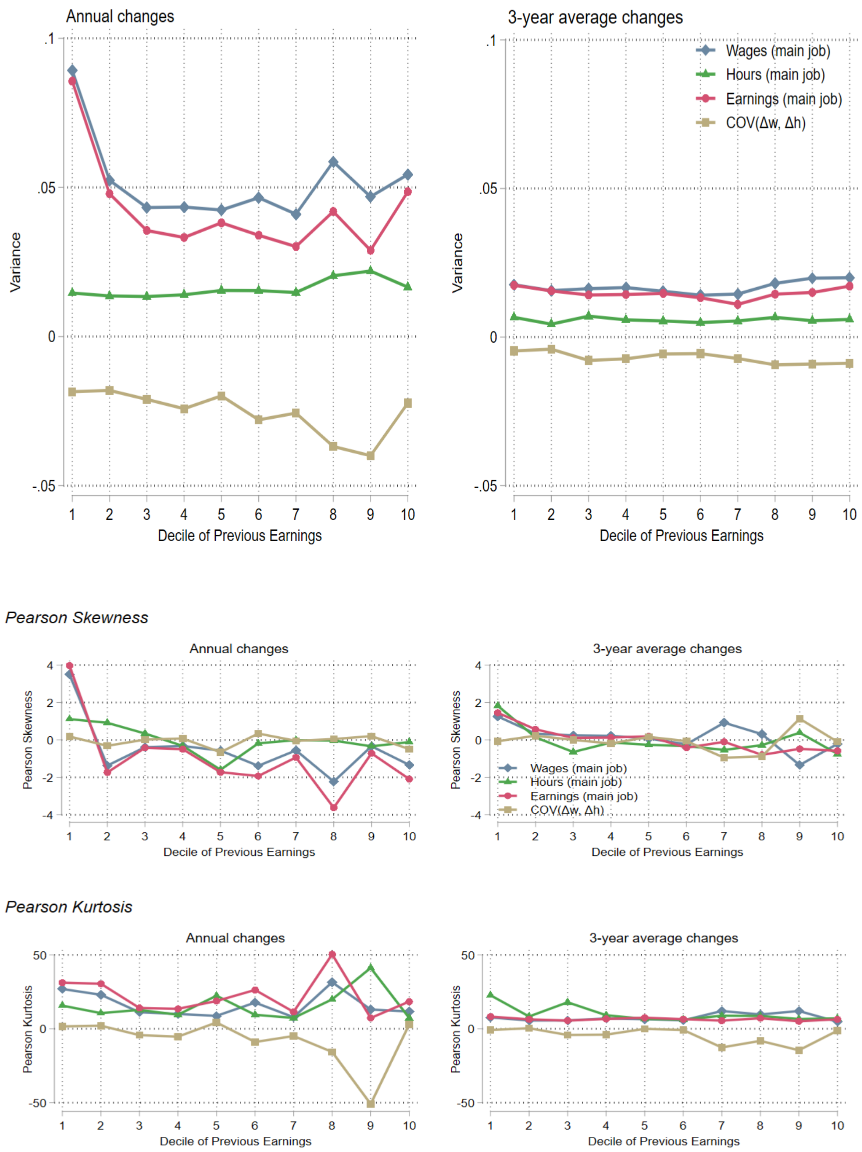

Figure D.1: Decomposition of second-order (top panel) and higher-order (bottom panel) moments of earnings shocks for permanent and full-time employees of non-own and non-family businesses.

Figure D.2 corroborates the above results. It shows that for full time and permanent employees, both negative and positive earnings shocks are driven exclusively by changes in wages. The hour role is silent.

What factors account for this observation is a question not addressed in this study. Still, these findings are informative as they reveal two types of low income workers that exhibit similar earnings dynamics driven by different mechanisms. On the one hand, we have the low income casual and part time employees whose wage and hour growths play equal role in driving their earnings process. On

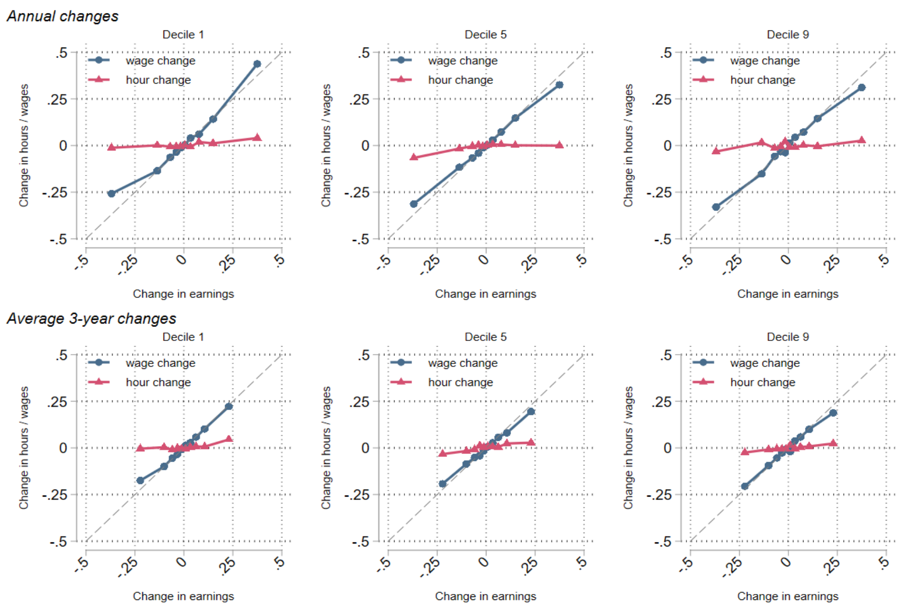

Figure D.2: Average wage and hour changes against decile of earnings shocks by selected (1st, 5th and 9th) decile of past income group of permanent and full-time employees in non-own and non-family businesses.

the other hand, we have the low income permanent and full time employees whose earnings process is driven almost exclusively by wage growth. The same can be said for the rest of the income group, though to a lesser degree. From this preliminary evidence, we speculate that casual and part-time industries could be the reason behind the observed differences between Australia and other OECD nations previously examined by the literature.

Furthermore, as to why wages drive the earnings dynamics for full-time and permanent workers in Australia across income status is another worthwhile research avenue because of its influence on the evolution of inequality over time. If we know more precisely where the labour market rigidity stems from, then loosening the rigidity and allowing hours to take up a greater role could not only change the dynamics of income distribution but perhaps also the output efficiency.

E An estimation of the earnings shock process

In this section, we follow a similar approach as in Guvenen et al. (2021). We first provide a brief description of the benchmark model in Guvenen et al. (2021) and then explore whether their benchmark econometric model can produce a good match for the Australian earnings process.

Econometric model. The earnings process has a proposed parametric form of $\tilde{Y}_t^i = (1 - \nu_t^i)e^{(g(j)+\alpha^i+\beta^i t+z_t^i+\varepsilon_t^i)}$ for individual i at time t which contains by five key constituents: (i) persistent shock z_t^i, (ii) transitory shock ε_t^i, (iii) nonemployment duration ν_t^i, (iv) individual fixed effects α^iandβ^i, and (v) deterministic age-profile of earnings $g(j)$.[1] Specifically,

(i) the persistent shock z_t^i is governed by an $AR(1)$ process

$$z_t^i = \rho z_{t-1}^i + \eta_t^i$$

[1]For a comprehensive treatment of the subject, we refer the interested readers to Guvenen et al. (2021), page 25-39.

with an initial condition $z_0^i \sim \mathcal{N}(0, \sigma_{z,0})$. The term η_t^i represents normal mixture innovations

$$\eta_t^i \sim \begin{cases} \mathcal{N}_{\eta,1}\left(\mu_{\eta,1}, \sigma_{\eta,1}\right) & \text{with probability } p_z \\ \mathcal{N}_{\eta,2}\left(\mu_{\eta,2}, \sigma_{\eta,2}\right) & \text{withprobability } 1 - p_z \end{cases}$$

where $\mu_{\eta,1}p_z + \mu_{\eta,2}(1 - p_z) = 0$ and $\mu_{\eta,1} < 0$;

(ii) the transitory shock ε_t^i is drawn from mixture of normals

$$\varepsilon_t^i \sim \begin{cases} \mathcal{N}_{\varepsilon,1}\left(\mu_{\varepsilon,1}, \sigma_{\varepsilon,1}\right) & \text{with probability } p_\varepsilon \\ \mathcal{N}_{\varepsilon,2}\left(\mu_{\varepsilon,2}, \sigma_{\varepsilon,2}\right) & \text{withprobability } 1 - p_\varepsilon. \end{cases}$$

where $\mu_{\varepsilon,1}p_\varepsilon + \mu_{\varepsilon,2}(1 - p_\varepsilon) = 0$ and $\mu_{\varepsilon,1} < 0$;

(iii) the nonemployment duration (i.e., the waiting time between employments) ν_t^i acts to scale the income level $\tilde{Y}_t^i$. An agent i at time t faces a time-and-persistent-shock-dependent nonemployment shock probability, $p_\nu(t, z_t^i)$, described by a logistic function. If one falls into a nonemployment spell, the duration of nonemployment ν_t^i is then drawn from an exponential distribution with mean $\frac{1}{\lambda}$ and is capped at 1 (at which point the resultant income $\tilde{Y}_t^i = 0$). That is,

$$\nu_t^i \sim \begin{cases} 0 & \text{with probability } 1 - p_\nu(t, z_t^i) \\ min\{1, exp(\lambda)\} & \text{withprobability } p_\nu(t, z_t^i) \end{cases}$$

The probability of nonemployment shock is $p_\nu(t, z_t^i) = \dfrac{e^{\xi_t^i}}{1 + e^{\xi_t^i}}$ where $\xi_t^i = a + bt + cz_t^i + dz_t^i t$;

(iv) the individual fixed effects α^i and β^i are ex-ante heterogeneity parameters that determine the level and growth rates of earnings. The pair is drawn from a joint normal distribution as follows

$$\begin{bmatrix} \alpha^i \\ \beta^i \end{bmatrix} \sim \mathcal{N}\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} \sigma_\alpha^2 & cov_{\alpha,\beta} \\ cov_{\alpha,\beta} & \sigma_\beta^2 \end{bmatrix} \right); \text{and}$$

(v) the quadratic polynomial of age $g(j) = a_0 + a_1 j + a_2 j^2$ governs the deterministic lifecycle earnings profile common to all individuals where j is age of individual i at time t.

In total, the full-fledged model by Guvenen et al. (2021) requires 21 parameters.

Method of simulated moments. Guvenen et al. (2021) use the Method of Simulated Moments (MSM). They begin the procedure with a simple linear-Gaussian model and incrementally add new features described above. There are five sets of target moments and a weighting matrix that reflects their subjective beliefs on the importance of each set of moments. This piecemeal construction of the benchmark specification allows them to better understand how each component contributes to the dynamics of the simulated earnings process. They find that the MSM provides a good fit to the data at a relatively low computational burden.

We follow Guvenen et al. (2021) and estimate the benchmark specification using the MSM. Due to the different nature of survey data, in our estimation we target four sets of moments:

1. Cross-sectional moments of earnings changes. We target the mean, standard deviation, skewness, and kurtosis of one- and three-year average earnings changes for each of the 4 age cohorts and 10 earnings groups, giving us $4 \times 2 \times 4 \times 10 = 320$ cross-sectional moments,

2. Impulse response moments (i.e., expected k-period future earnings growth for $k = 1, 2, 3, 5$,and 10) by quintile of previous year growth and decile of previous market income, giving us $5 \times 5 \times 10 = 250$ moments,

3. Average years of non-employment by 4 age cohorts and 10 earnings groups, giving us 40 moments, and

4. Variance of log earnings by 4 age cohorts and 10 earnings groups; thus another set of 40 moments.

In the MSM procedure, we estimate the 21 parameters of the benchmark process by minimizing a weighted sum of squared percentage deviations from the target moments. Unlike Guvenen et al. (2021) in which the weighting matrix (W) is based on their belief and experience gained from numerous trials and errors, we employ the iterated variance-covariance method to arrive at an estimate of the optimal weighting matrix, $\hat{W}^*$. We begin by setting the identity matrix as our initial guess of $\hat{W}_0$. Given $\hat{W}_n$, we estimate the parameters of interest and calculate a vector of moment error functions e using percent difference in the vector of simulated moments from the data moments. Then, the vector e is used to construct a variance-covariance matrix whose inverse is our next candidate for $\hat{W}_{n+1}$. This procedure is repeated until some n^{th} iteration when the estimated weighting matrix $\hat{W}$ no longer changes (i.e., $||\hat{W}_n - \hat{W}_{n-1}|| < \varepsilon$ where the norm of choice is the root mean squared relative error or $RMSRE$).

Data limitation. One challenge of the current study is the lack of market earnings and employment data that cover the entire lifespan of individuals. This limitation means that certain informative moments such as those related to earning growth and distribution of total years employed over life cycle are not available. Thus, we do not fit the model to life-cycle earnings growth or non-employment distribution in this attempt. However, we find that the third set of moments, the average years of non-employment by age cohort and income group, is a good compromise and helps us achieve a closer match between the simulated second- and higher-order transitory and persistent risks and those observed in the data.

Another challenge is that the MSM is a moment-matching exercise and therefore relies heavily on accurate data moments. Because the primary objective of the paper is to broadly understand and document earnings dynamics and insurance, HILDA is the dataset of choice as it contains many identifiers and covariates indispensable to the main study. The drawback is that HILDA only has 20 years of observations, which places a restriction on our ability to estimate the earnings shock process via parametric specifications, particularly if the goal is to capture the third- and fourth-order moments of persistent shocks. Since persistent risks rely on some form of temporal aggregates, a 20-period dataset only allows us to compute moments for up to 3-year average shocks instead of 5-year averages as Guvenen et al. (2021) do, or else, we would have to contend with the myriads of issues associated with small sample size. Even then, we see that the fourth-order moments of 3-year average shocks behave more erratically and likely stray from the true patterns, which is a concern for two reasons. First, the output simulated moments can only be as accurate as the input data moments they approximate. Second, parameter estimates associated with persistence can be sensitive to the input data moments. Large fluctuations in the third- and fourth-order moment values thus make it difficult to match the skewness and kurtosis of the residual income shock distribution.[2]

Results. Our estimated results are reported in Table E.1 and Figure E.1.

Parameters		Values	Parameters		Values
Persistent shock	ρ	0.7426	Non-employment	λ	0.0668
	$\sigma_{z,0}$	1.4995		a	-0.2020
	ρ_z	0.9297		b	-0.0889
	$\mu_{\eta,1}$	-0.0049		c	-0.0983
	$\sigma_{\eta,1}$	0.3042		d	-0.0528
	$\sigma_{\eta,2}$	0.1918	Ex-ante heterogeneity	σ^2_α	0.0029
Transitory shock	ρ_ε	0.9498		σ^2_β	0
	$\mu_{\varepsilon,1}$	0.7358		$cov_{\alpha,\beta}$	0.3784
	$\sigma_{\varepsilon,1}$	0.1419	Quadratic polynomial of age	a_1	0.0108
	$\sigma_{\varepsilon,2}$	0.9273		a_2	-0.0001

Table E.1: **Estimated parameters of the benchmark model.** *Notes:* The quadratic polynomial term a_0 is turned off (set to zero). Multiple runs indicates that the inclusion of $a_0$can cause convergence problem.

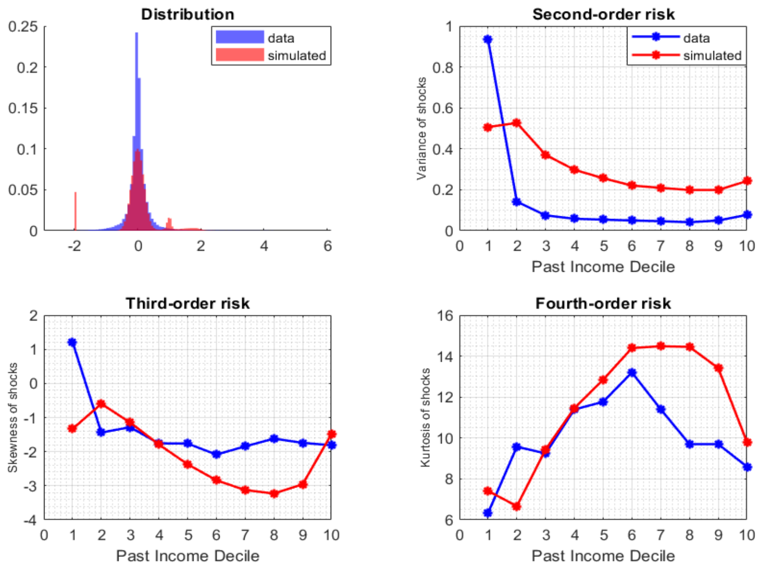

Figure E.1: Actual vs. simulated results

Figure E.1 depicts accomplishments and shortcomings of the current configuration and the available data. Qualitatively, the model does a good job of capturing the non-linear and non-Gaussian features of the market income shock distribution. On the contrary, the current estimation is unable to achieve a close match between the actual and simulated moment values, especially for the second-order moment. The top-left panel of Figure E.1 indicates that the large errors are generated by the lower-peak distribution of simulated shocks (i.e., less dense about the centre) relative to that of the data. We believe this has some connection to the issues raised earlier. First, the less well-behaved skewness and kurtosis statistics from the data might have been problematic. More precisely, the inconsistent

[2]The fact that their qualitative patterns match well with those from the previous studies and remain consistent across settings assures us that they represent the income process in the data. Notwithstanding, this does not tell us about the accuracy of the estimates. The MSM procedure requires more accurate moment estimates from a larger dataset.

third- and fourth-moment values by age and past income subgroups increase the difficulty of producing good matches as some parameters can be sensitive to fluctuating moment values. It might also explain why the model earnings process leads to unusual bumps in the simulated shock distribution in its attempt to capture the L-shaped left skewness and the hump-shaped excess kurtosis over income decile. Second, the absence of life-cycle earnings growth moments from the data to discipline the parameters might have made it possible for the estimation process to generate higher residual shock volatility (top-right panel) at the cost of realistic earnings growth by weighing down estimation errors for the second moment.

Despite the mismatches, the exercise speaks for the capability of the parametric model proposed by Guvenen et al. (2021) in estimating the non-linear and non-Guassian earnings process. We believe improvement is a certainty with more trials and errors and a larger dataset. Another key lesson is that even without substantial knowledge of the data moments and their connection to the parameters that would have permitted one to assign a subjective weight to each set of moments, we were able to operate the MSM procedure by employing the iterated variance-covariance method to arrive at the optimal weighting matrix. On top of convenience, the iterative approach proved to be a useful tool under time constraint and limited computational power by allowing us to more efficiently explore the parameter space, fine-tune our initial guess, and set more informative lower and upper bounds for the optimization routine.

Hence, our estimated model is capable of reproducing the general patterns of the key empirical facts. However, more comprehensive datasets are required for more accurate estimation of earnings dynamics in Australia.

F Additional tables and figures

F.1 Dynamics of earnings, wages and hours

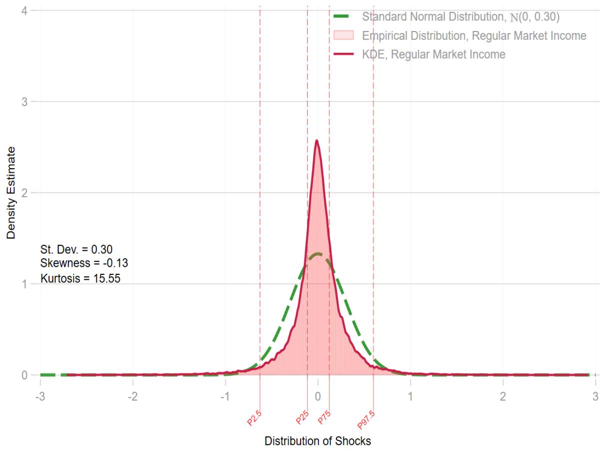

Figure F.1: Empirical distributions of 3-year average growth of individual regular market income for primary earners aged 25-64.

Second moment of regular market earnings shocks by age group via different measures

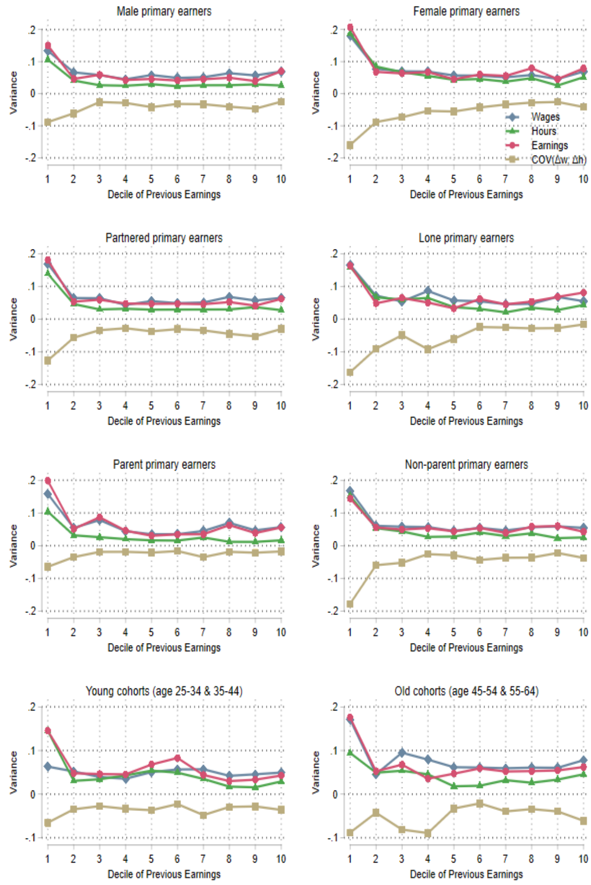

Figure F.2: Variance of annual changes in usual weekly earnings, wages, and hours of selected subsamples (including the tailends of their distributions). The graphs contain observations of selected subsamples and are restricted to individuals who report positive usual weekly earnings (work at least one day per week at or above the minimum wage rate of AU$20 in 2018 value) for at least 18 years. Similar patterns are also observed when minimum employment requirement is set to 0 (unrestricted), 10, 15, or 20 years.

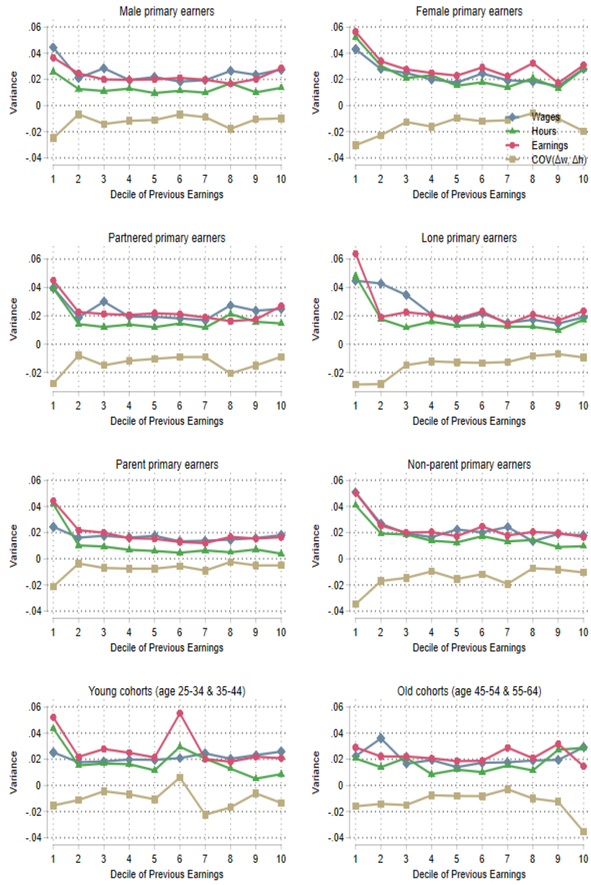

Figure F.3: Variance of 3-year average changes in usual weekly earnings, wages, and hours of selected subsamples (including the tailends of their distributions). The graphs contain observations of selected subsamples and are restricted to individuals who report positive usual weekly earnings (work at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

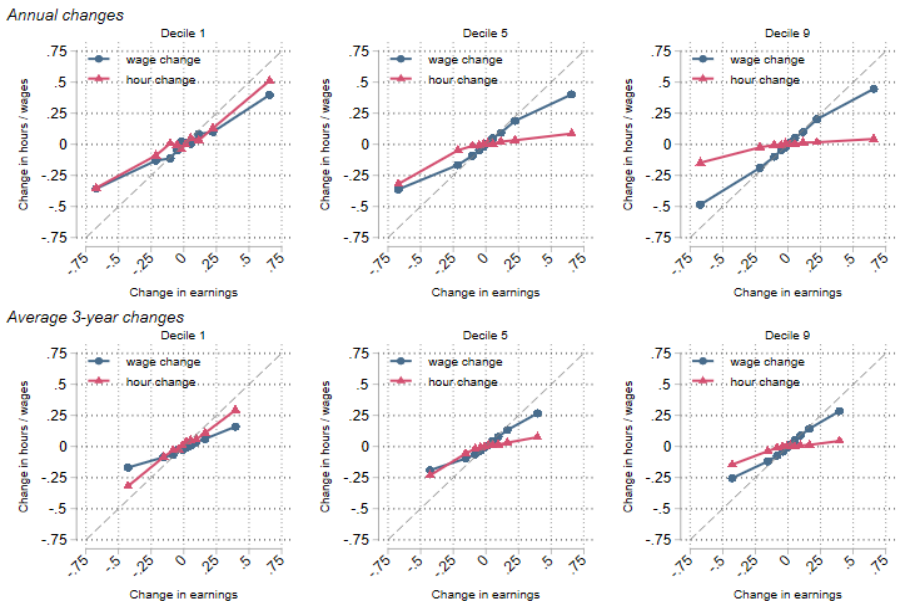

Figure F.4: Changes in residual weekly wages and hours versus decile of changes in residual usual weekly earnings (from main job) for primary earners in the 1st, 5th, and 9th deciles of past usual weekly earnings. The top and bottom panels report annual changes and 3-year average changes, respectively. 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.

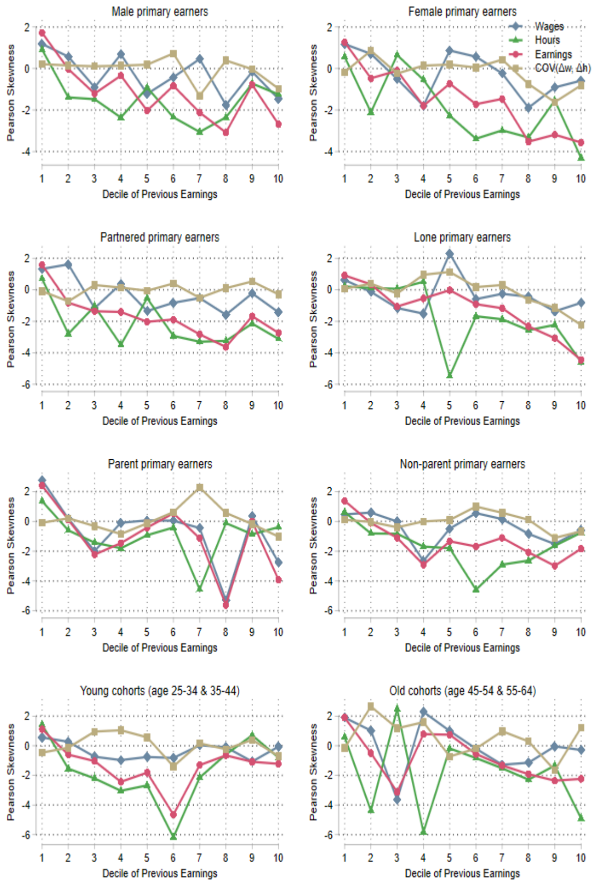

Figure F.5: Pearson skewness of annual average changes in usual weekly earnings, wages, and hours of selected subsamples (including the tailends of their distributions). The graphs contain observations of selected subsamples and are restricted to individuals who report positive usual weekly earnings (work at least one day per week at or above the minimum wage rate of AU$20 in 2018 value) for at least 18 years. Similar patterns are also observed when minimum employment requirement is set to 0 (unrestricted), 10, 15, and 20 years.

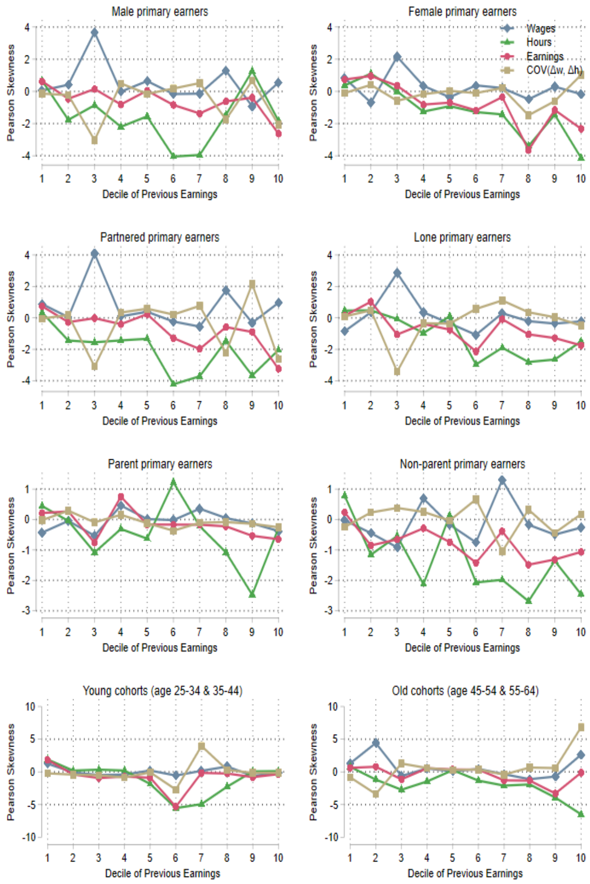

Figure F.6: Pearson skewness of 3-year average changes in usual weekly earnings, wages, and hours of selected subsamples (including the tailends of their distributions). The graphs contain observations of selected subsamples and are restricted to individuals who report positive usual weekly earnings (work at least one day per week at or above the minimum wage rate of AU$20 in 2018 value) for at least 18 years. Similar patterns are also observed when minimum employment requirement is set to 0 (unrestricted), 10, 15, or 20 years.

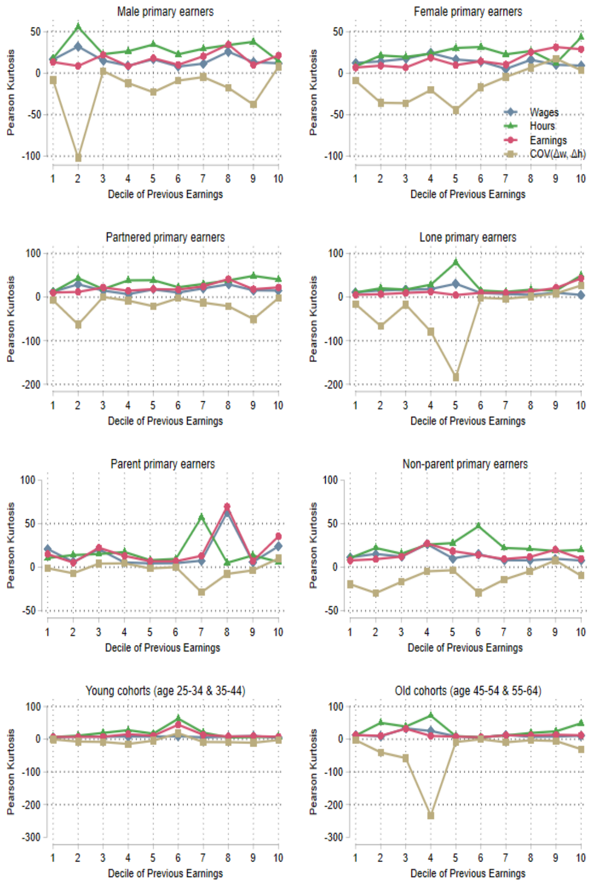

Figure F.7: Pearson kurtosis of annual changes in usual weekly earnings, wages, and hours of selected subsamples (including the tailends of their distributions). The graphs contain observations of selected subsamples and are restricted to individuals who report positive usual weekly earnings (work at least one day per week at or above the minimum wage rate of AU$ 20 in 2018 value) for at least 18 years. Similar patterns are also observed when minimum employment requirement is set to 0 (unrestricted), 10, 15, or 20 years.

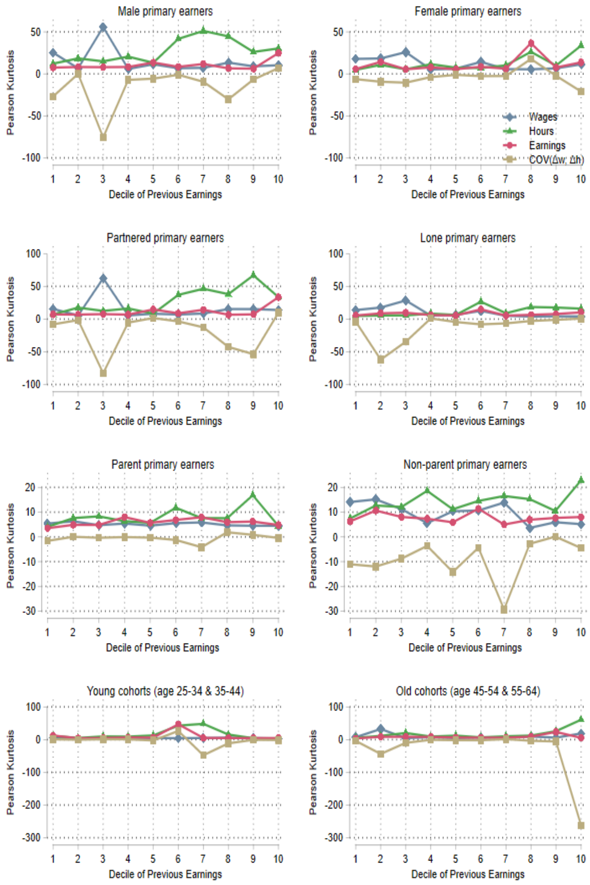

Figure F.8: Pearson kurtosis of 3-year average changes in usual weekly earnings, wages, and hours of selected subsamples. The graphs contain observations of selected subsamples and are restricted to individuals who report positive usual weekly earnings (work at least one day per week at or above the minimum wage rate of AU$20 in 2018 value) for at least 18 years. Similar patterns are also observed when minimum employment requirement is set to 0 (unrestricted), 10, 15, or 20 years.

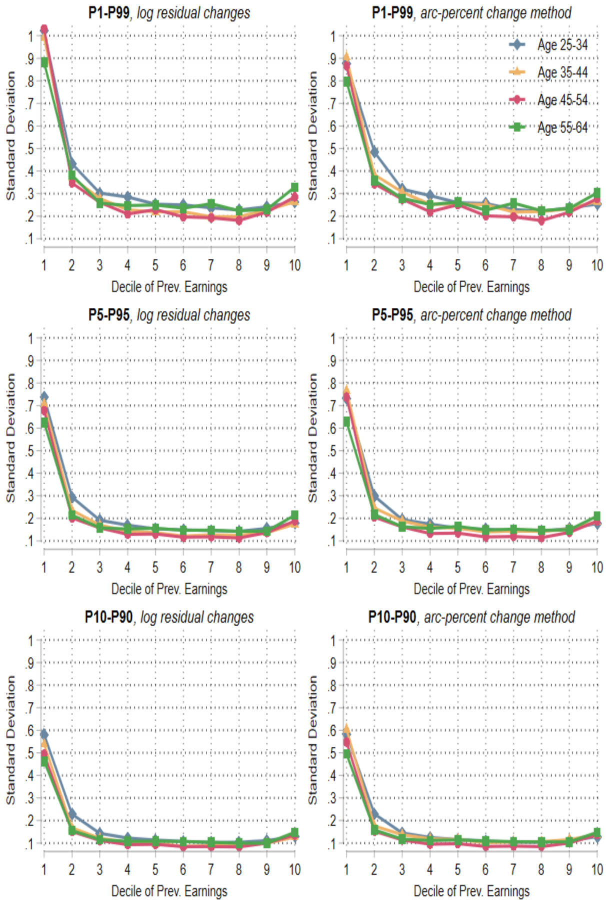

Figure F.9: Second moment statistics measured at $P1-P99$, $P5-P95$, and $P10-P90$ of the annual regular market earnings change distributions of primary earners. The left panel's annual figures are statistics of the changes in log of residual income. The right panel's annual figures are statistics obtained via *Arc-Percent Change method* (i.e., statistics of mid-point averages of changes in the income-to-group-means ratio).

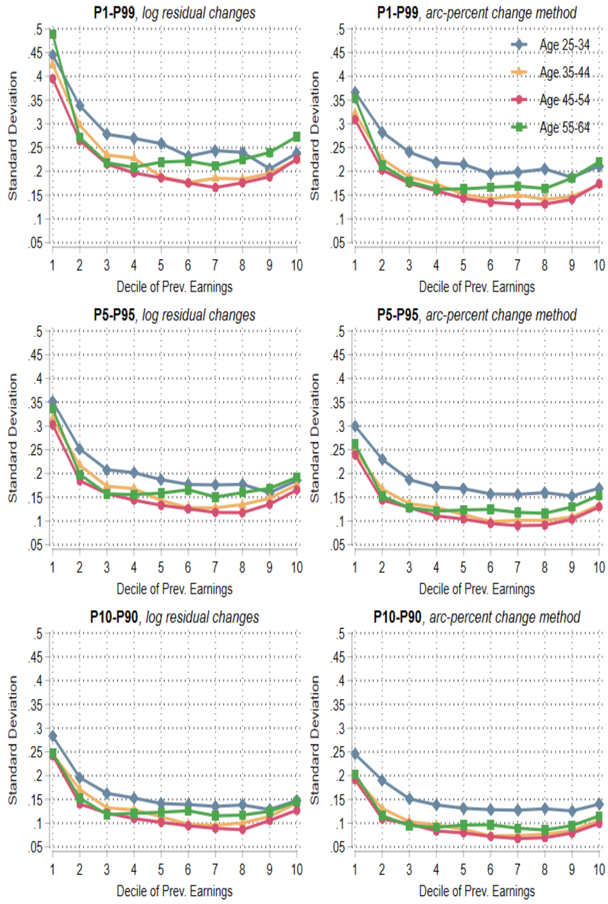

Figure F.10: Second moment statistics measured at $P1-P99$, $P5-P95$, and $P10-P90$ of the 3-year average regular market earnings change distributions of primary earners. The left panel's annual figures are statistics of the changes in log of residual income. The right panel's annual figures are statistics obtained via *Arc-Percent Change method* (i.e., statistics of mid-point averages of changes in the income-to-group-means ratio).

F.2 Family insurance: Standardized and quantile-based measures

P1-P99

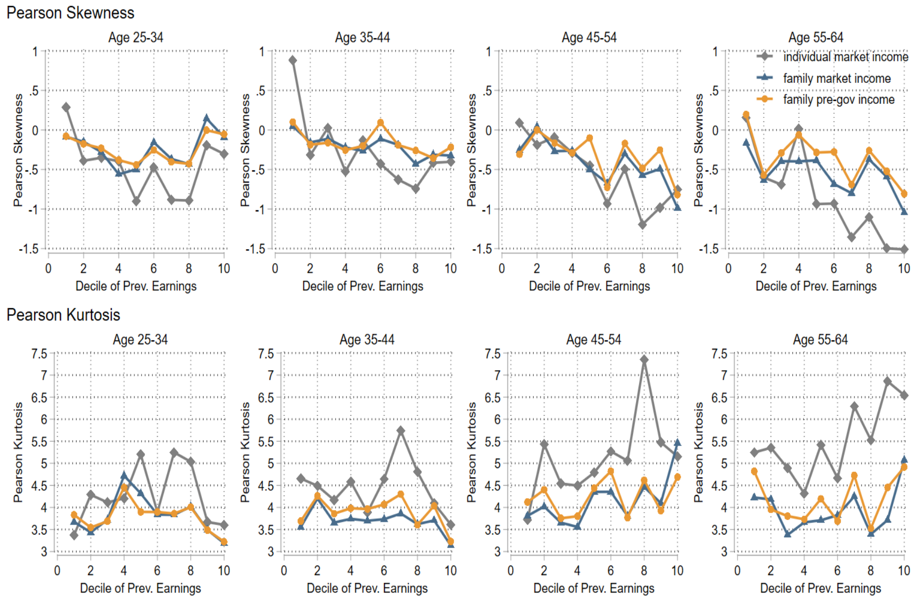

Figure F.11: Skewness and Kurtosis of the distribution of 3-year average changes of family income (P1-P99) at different levels. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of pre-government family income.

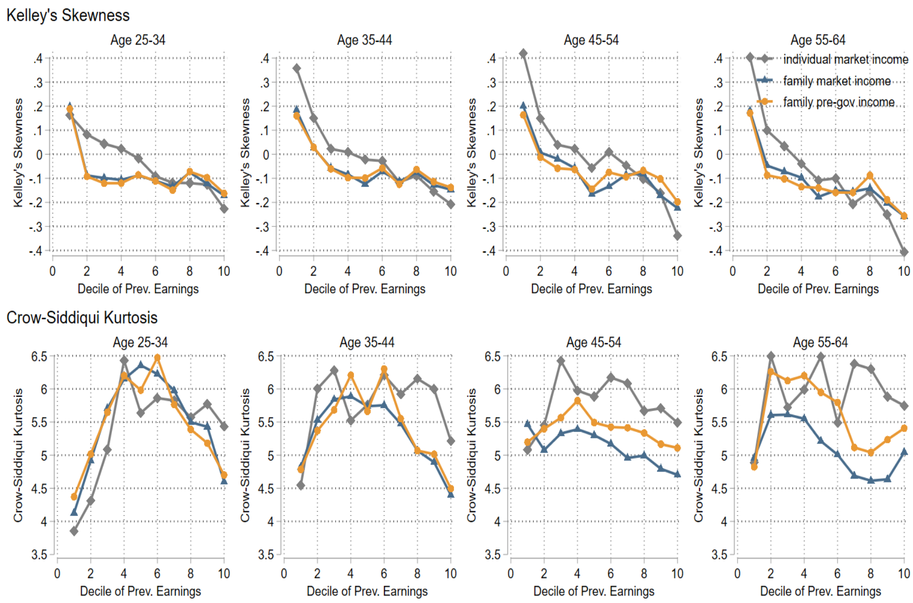

Figure F.12: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of annual changes of family income (P1-P99) at different levels. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of family pre-government income.

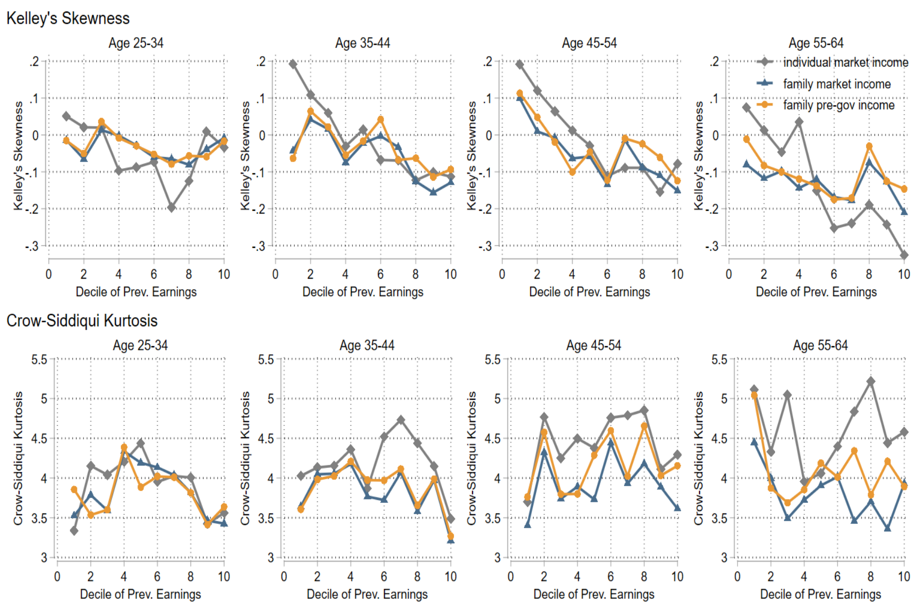

Figure F.13: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of 3-year average changes of family income (P1-P99) at different levels. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of family pre-government income.

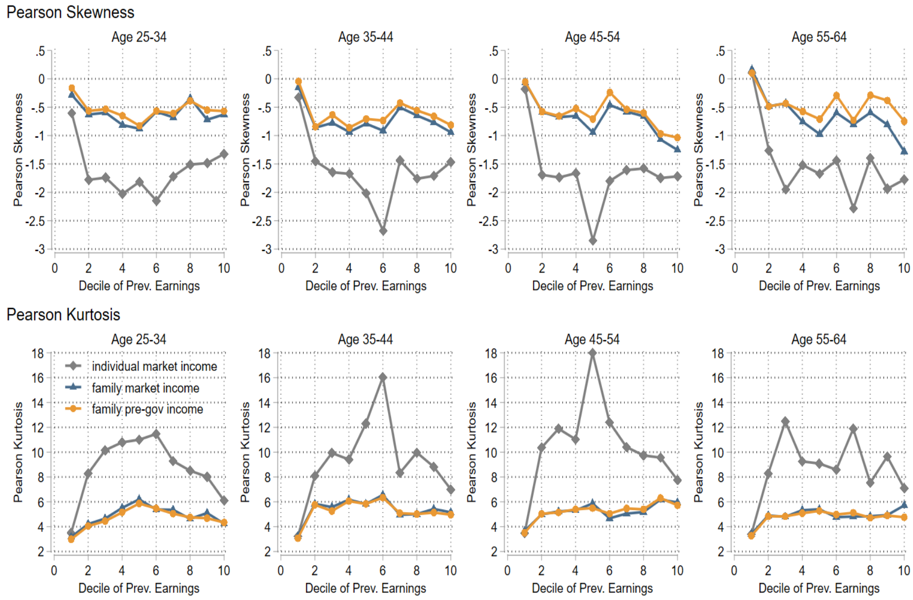

Figure F.14: Skewness and Kurtosis of the distribution of annual changes of family income (P1-P99) at different levels calculated via *Arc-Percent Change method*. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of pre-government family income.

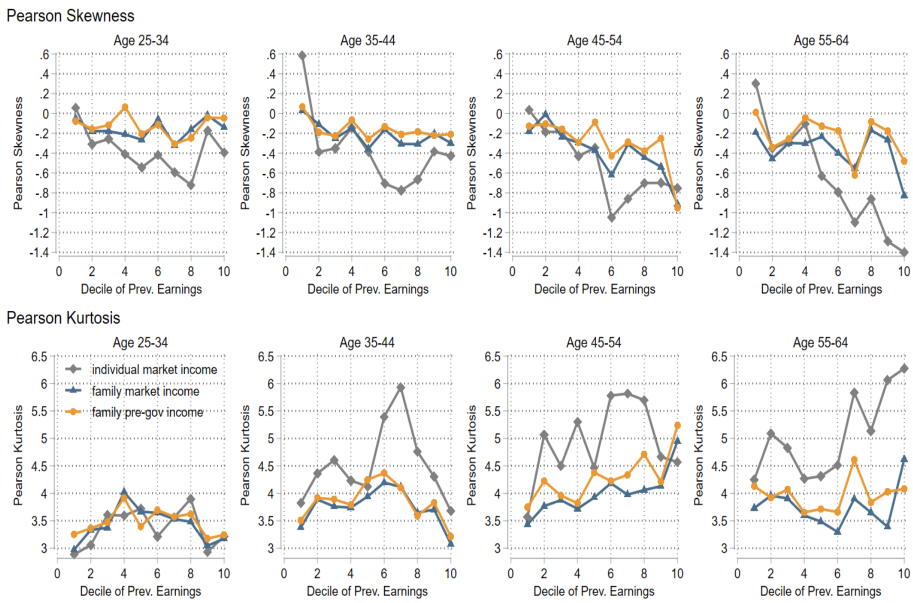

Figure F.15: Skewness and Kurtosis of the distribution of 3-year average changes of family income (P1-P99) at different levels calculated via *Arc-Percent Change method*. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of pre-government family income.

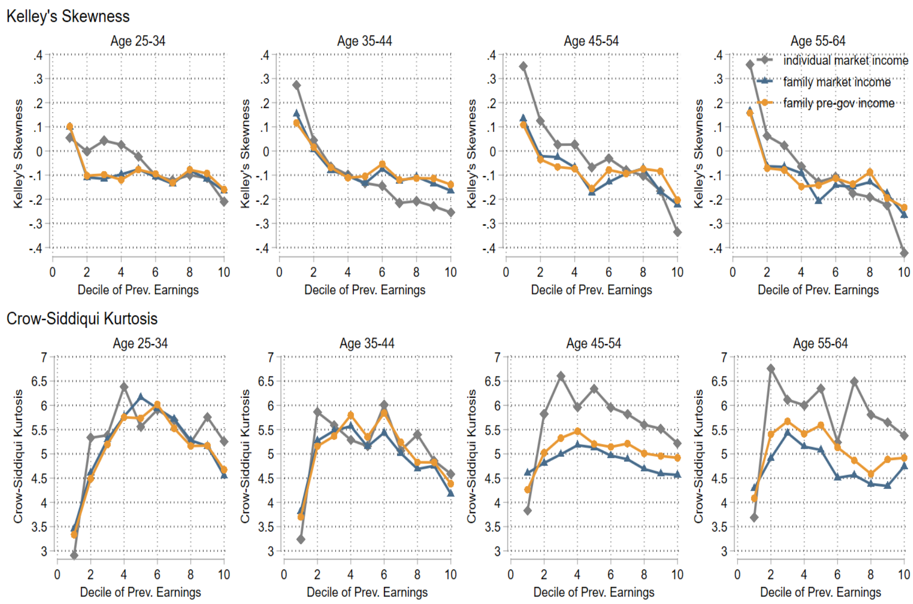

Figure F.16: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of annual changes of family income (P1-P99) at different levels calculated via *Arc-Percent Change method*. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of pre-government family income.

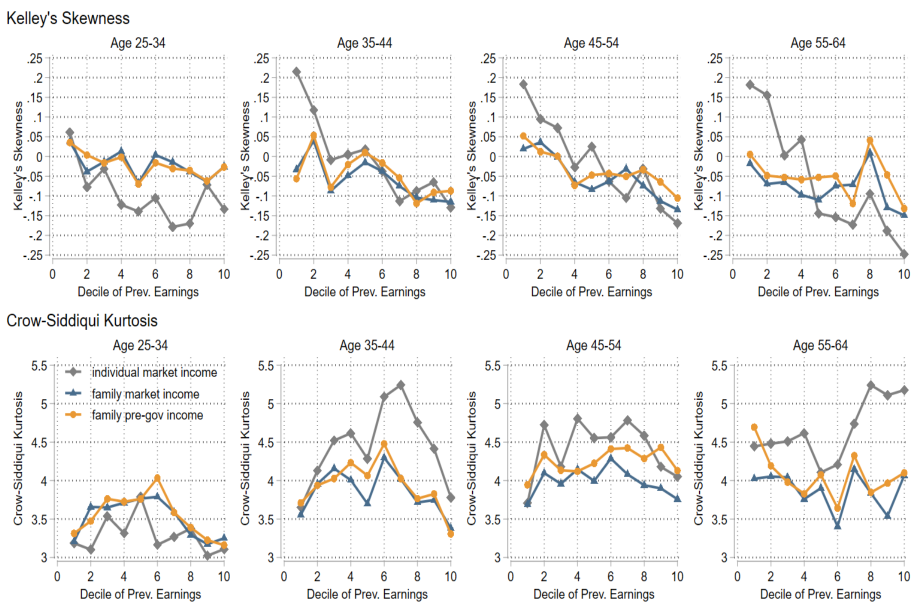

Figure F.17: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of 3-year average changes of family income (P1-P99) at different levels calculated via *Arc-Percent Change method*. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of pre-government family income.

P5-P99

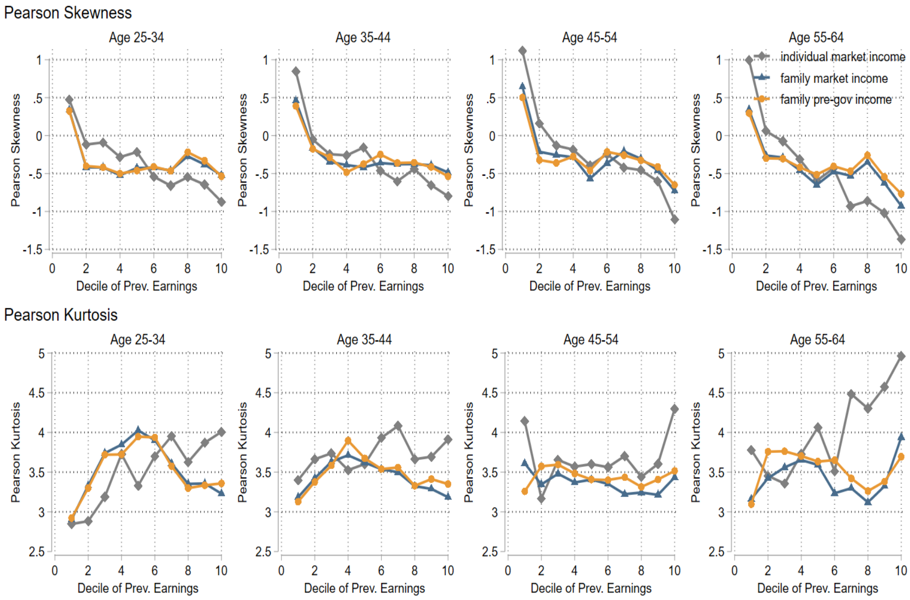

Figure F.18: Skewness and Kurtosis of the distribution of annual changes of family income (P5-P95) at different levels. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of pre-government family income.

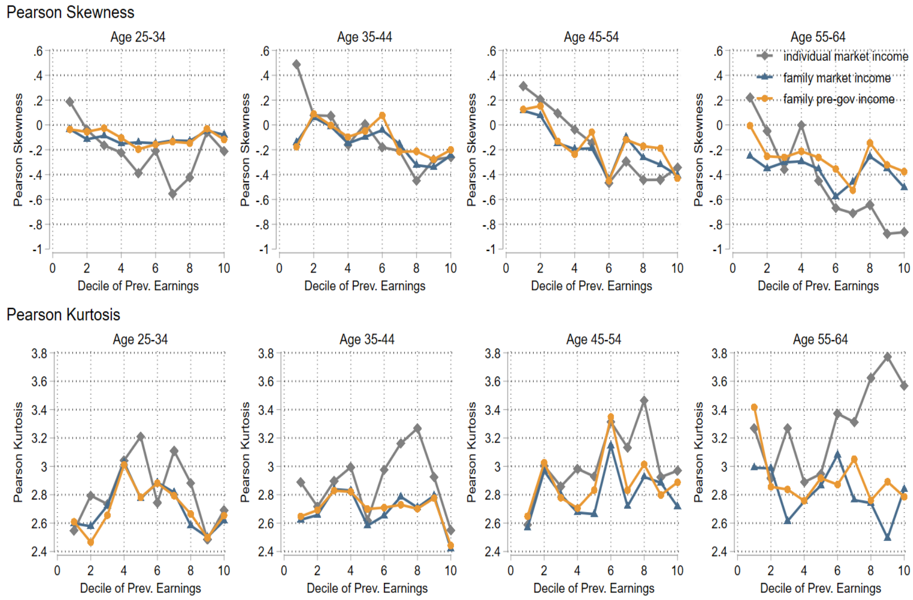

Figure F.19: Skewness and Kurtosis of the distribution of 3-year average changes of family income (P5-P95) at different levels. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of pre-government family income.

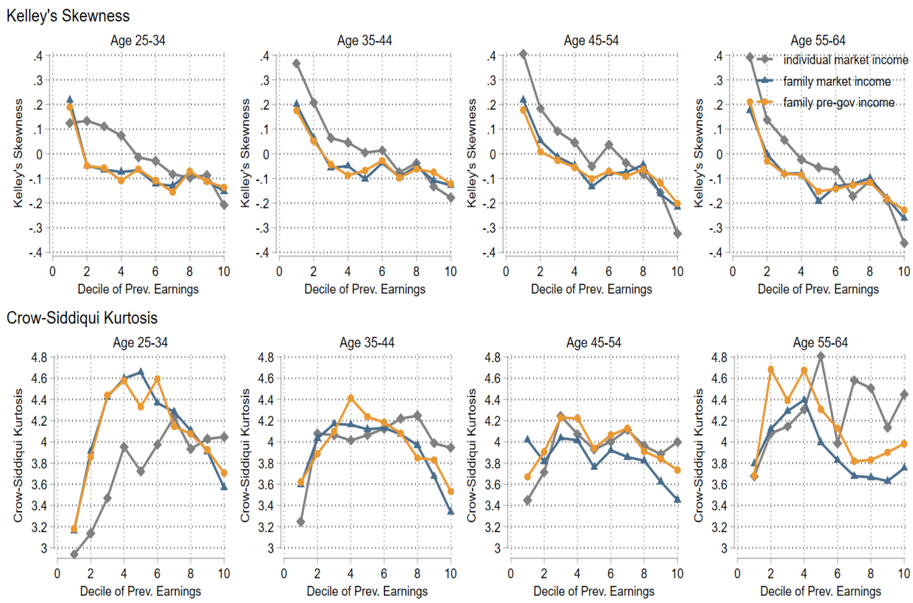

Figure F.20: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of annual changes of family income (P5-P95) at different levels. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of family pre-government income.

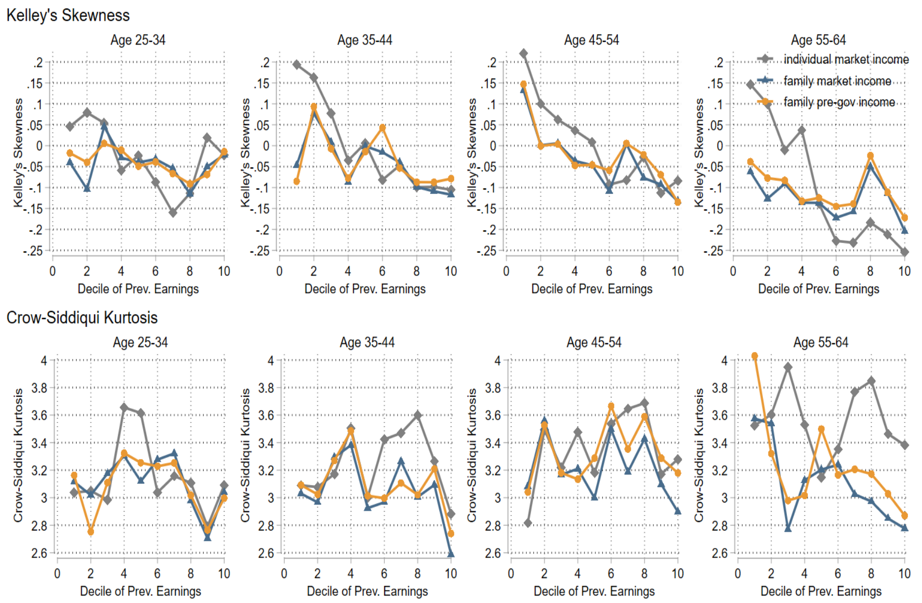

Figure F.21: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of 3-year average changes of family income (P5-P95) at different levels. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of family pre-government income.

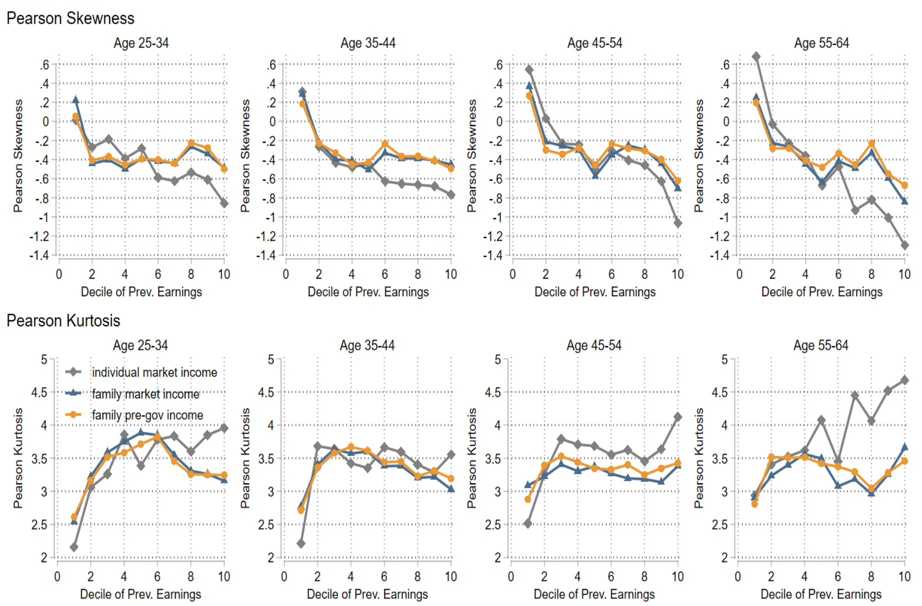

Figure F.22: Skewness and Kurtosis of the distribution of annual changes of family income (P5-P95) at different levels calculated via *Arc-Percent Change method*. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of pre-government family income.

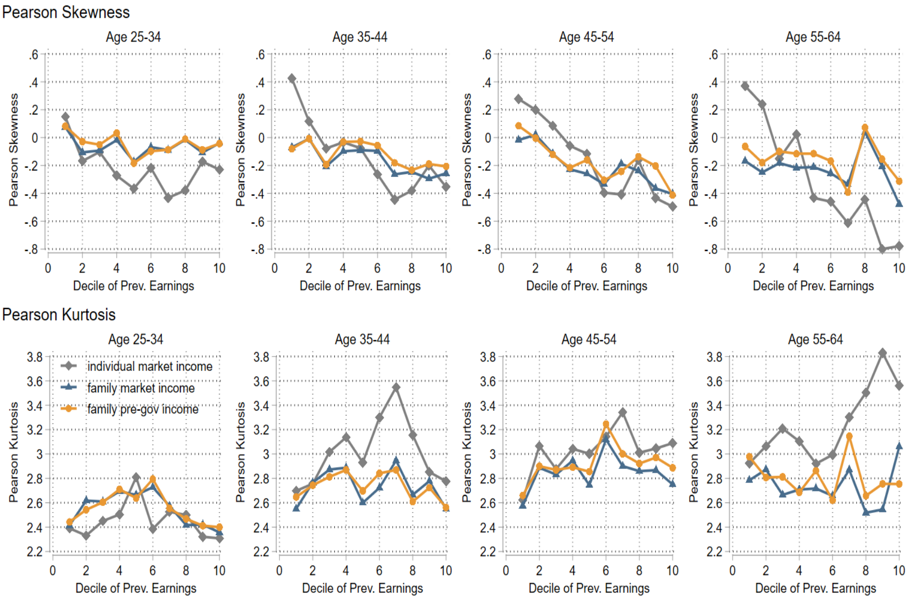

Figure F.23: Skewness and Kurtosis of the distribution of 3-year average changes of family income (P5-P95) at different levels calculated via *Arc-Percent Change method*. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of pre-government family income.

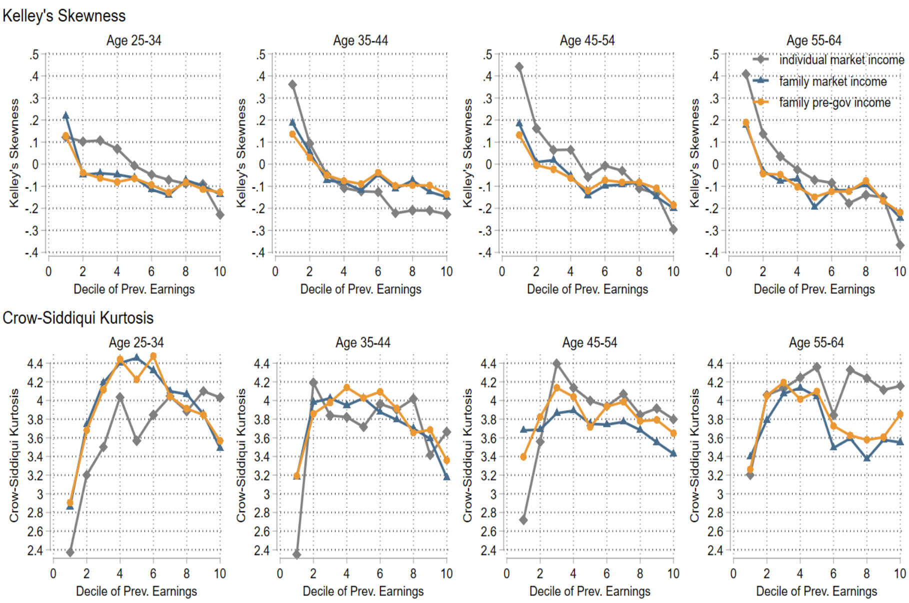

Figure F.24: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of annual changes of family income (P5-P95) at different levels calculated via *Arc-Percent Change method*. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of pre-government family income.

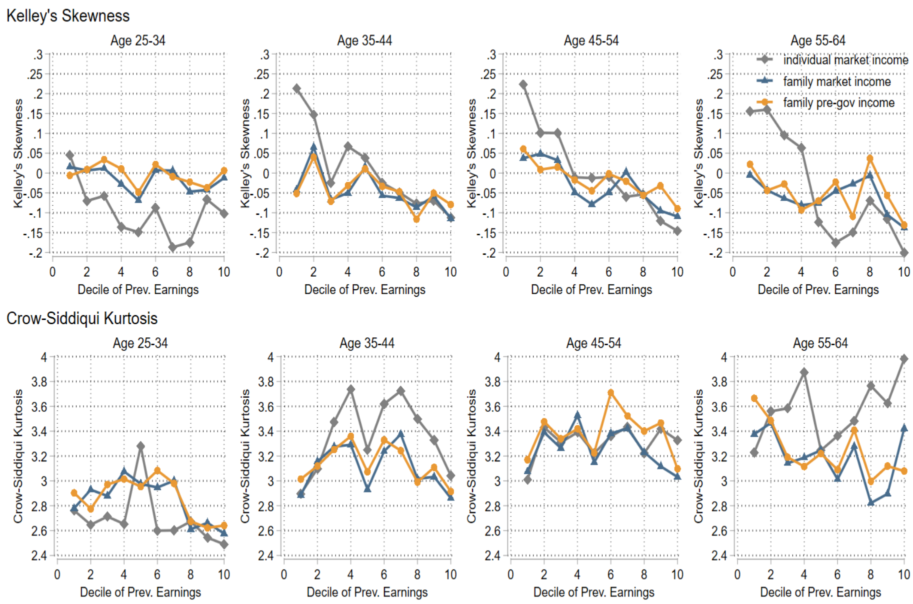

Figure F.25: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of 3-year average changes of family income (P5-P95) at different levels calculated via *Arc-Percent Change method*. The figure captures the relative contribution of family market income and private transfer to the third- and fourth-order risks of pre-government family income.

F.3 Government insurance: Standardized and quantile-based measures

Second moment (P1-P99)

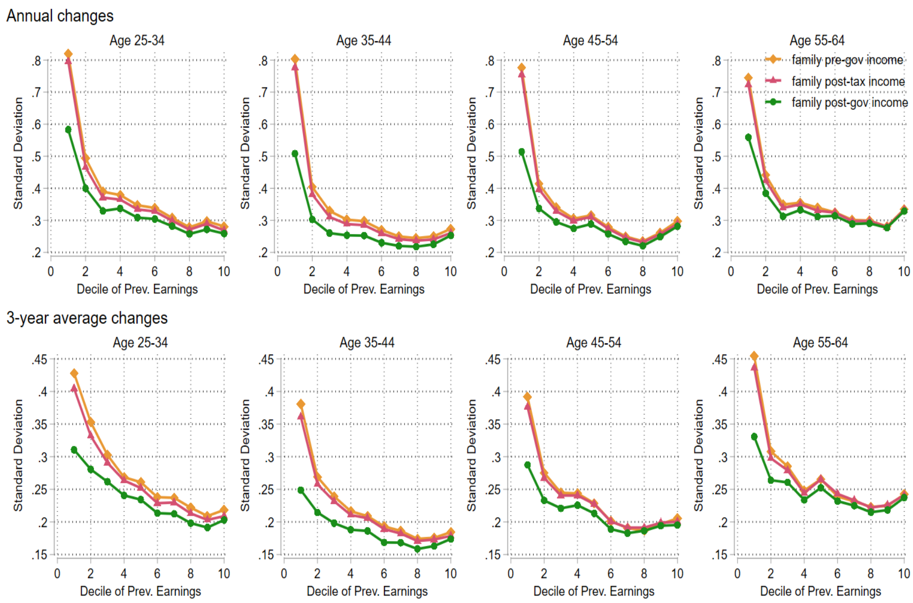

Figure F.26: Standard deviation of the distribution of annual and 3-year average changes of family income (P1-P99) at different levels calculated via *Arc-Percent Change method*. The figure captures the relative contribution of tax and transfer to the second-order risk of disposable family income.

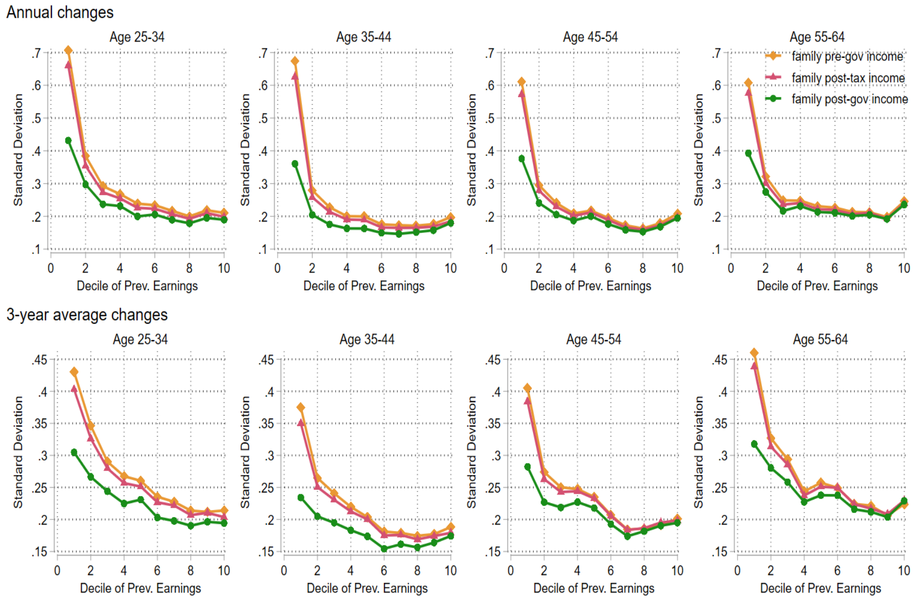

Figure F.27: Standard deviation of the distribution of annual and 3-year average changes of family income (P5-P95) at different levels. The figure captures the relative contribution of tax and transfer to the second-order risk of disposable family income.

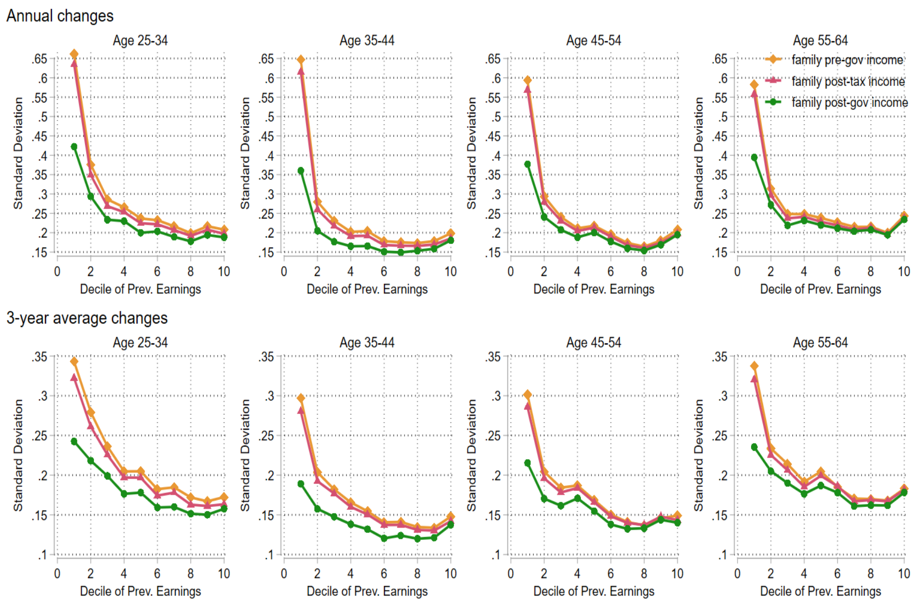

Figure F.28: Standard deviation of the distribution of annual and 3-year average changes of family income (P5-P95) at different levels calculated via *Arc-Percent Change method*. The figure captures the relative contribution of tax and transfer to the second-order risk of disposable family income.

Higher-order moments (P1-P99)

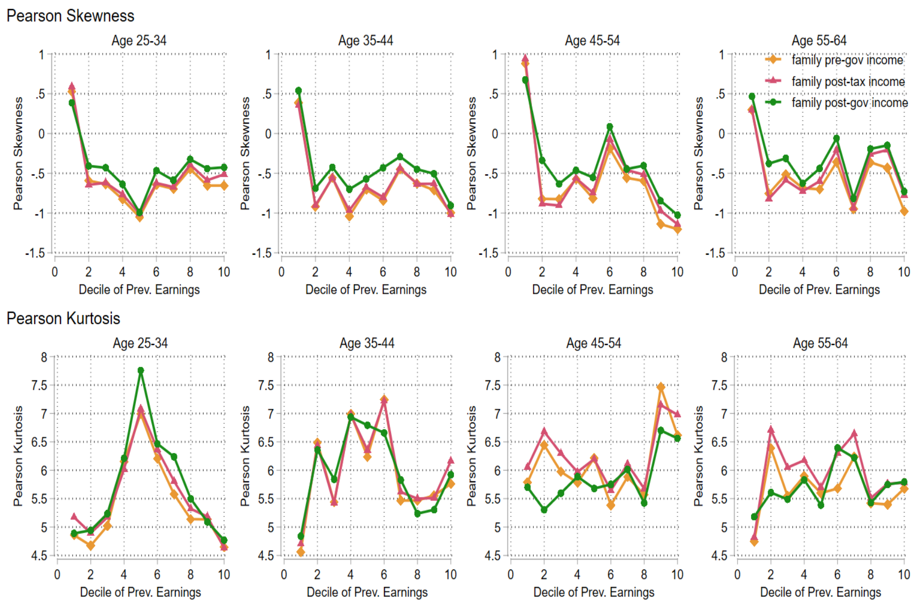

Figure F.29: Skewness and Kurtosis of the distribution of annual changes of family income (P1-P99) at different levels. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable family income.

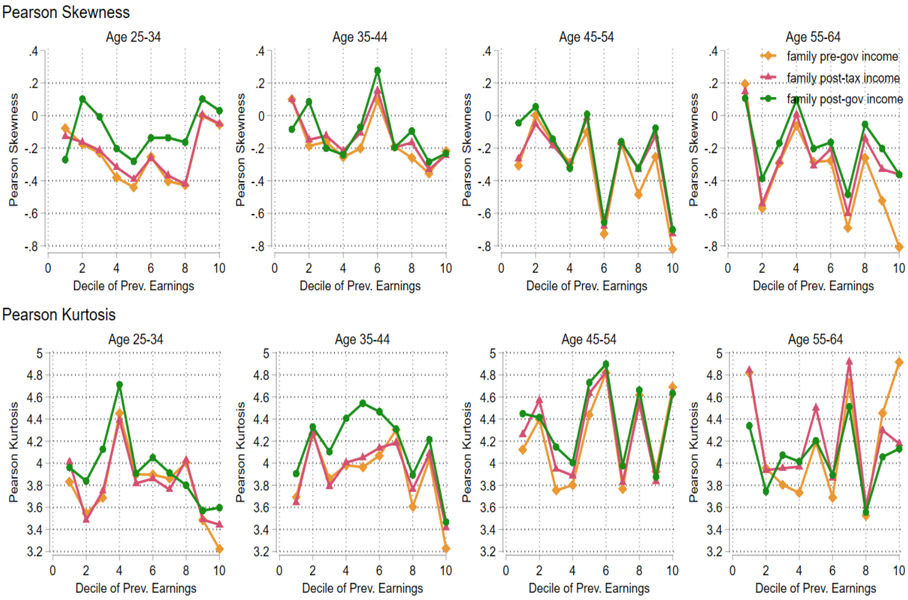

Figure F.30: Skewness and Kurtosis of the distribution of 3-year average changes of family income (P1-P99) at different levels. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable family income.

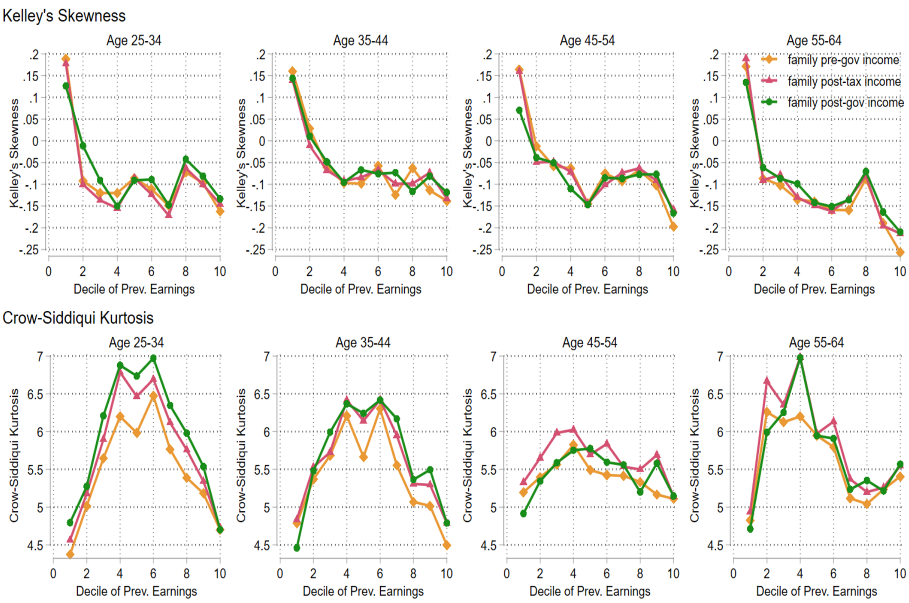

Figure F.31: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of annual changes of family income (P1-P99) at different levels. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable family income.

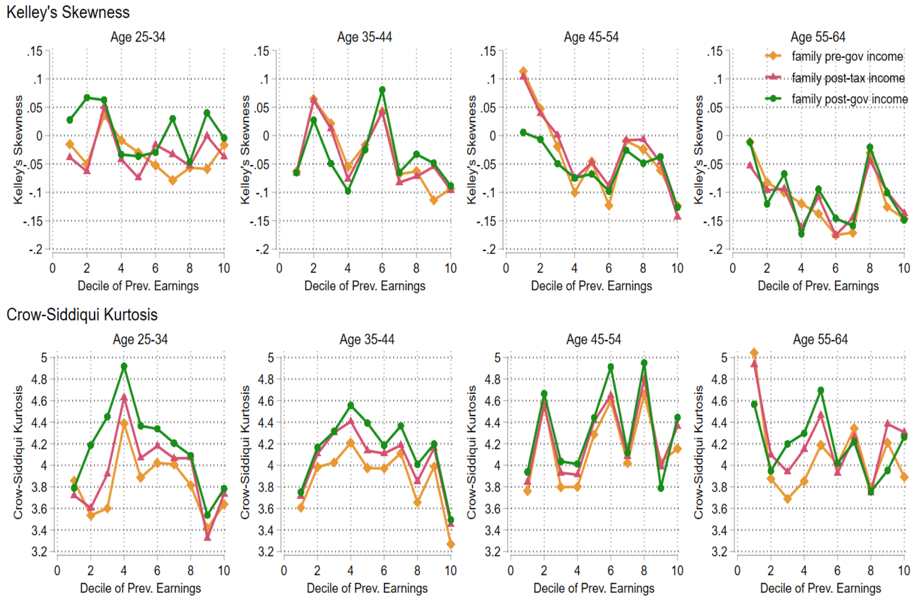

Figure F.32: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of 3-year average changes of family income (P1-P99) at different levels. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable family income.

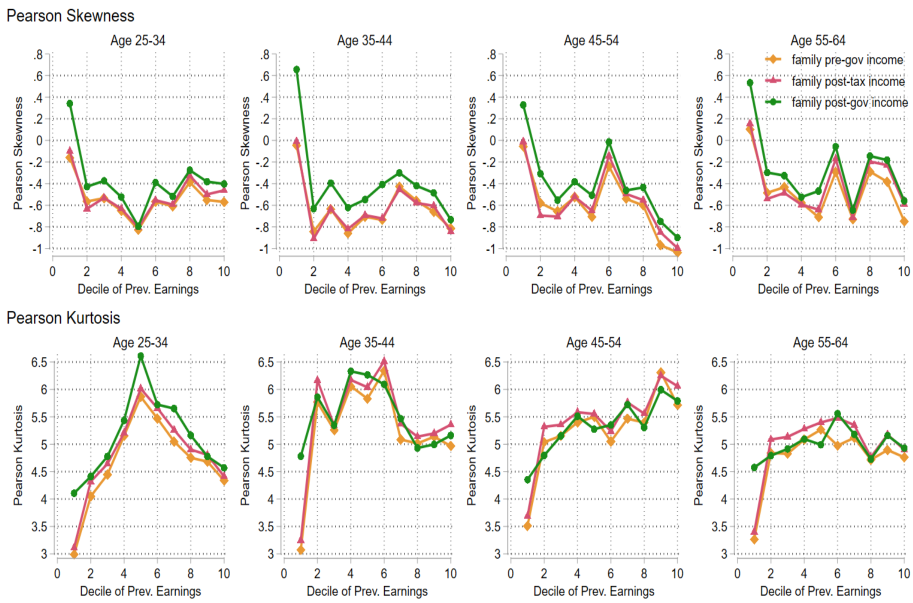

Figure F.33: Skewness and kurtosis of the distribution of annual changes of family income (P1-P99) at different levels calculated via *Arc-Percent Change method*. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable family income.

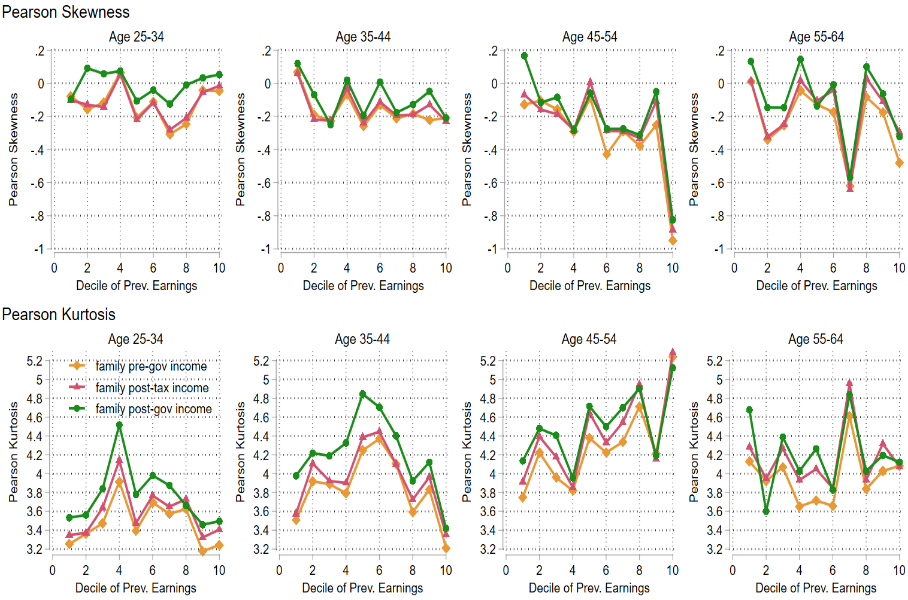

Figure F.34: Skewness and kurtosis of the distribution of 3-year average changes of family income (P1-P99) at different levels calculated via *Arc-Percent Change method*. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable family income.

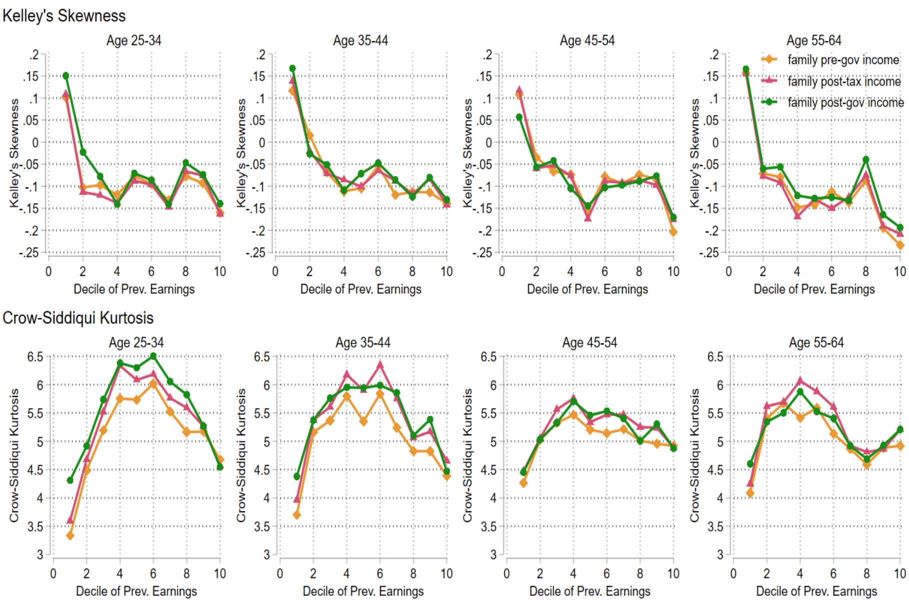

Figure F.35: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of annual changes of family income (P1-P99) at different levels calculated via *Arc-Percent Change method*. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable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

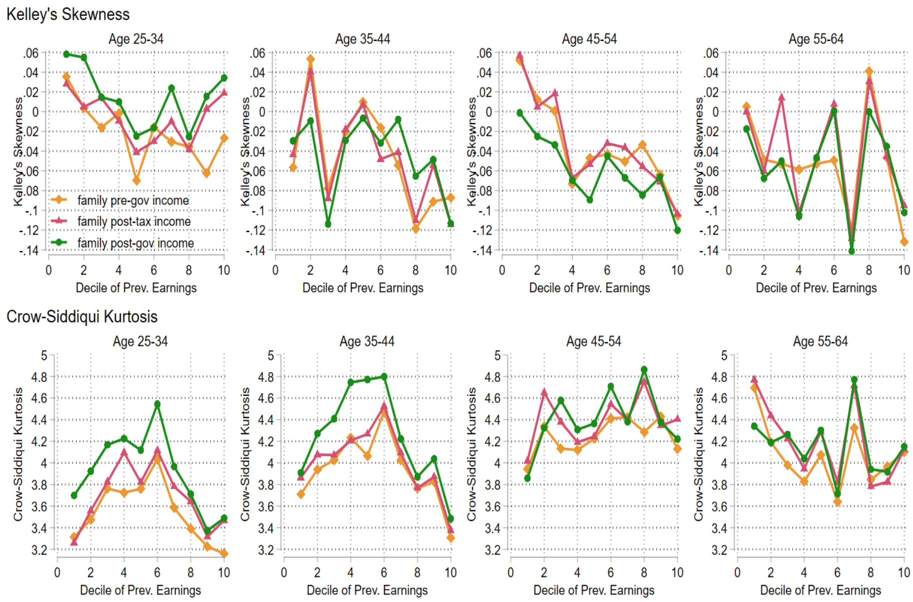

Figure F.36: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of 3-year average changes of family income (P1-P99) at different levels calculated via *Arc-Percent Change method*. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable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

Higher-order moments (P5-P95)

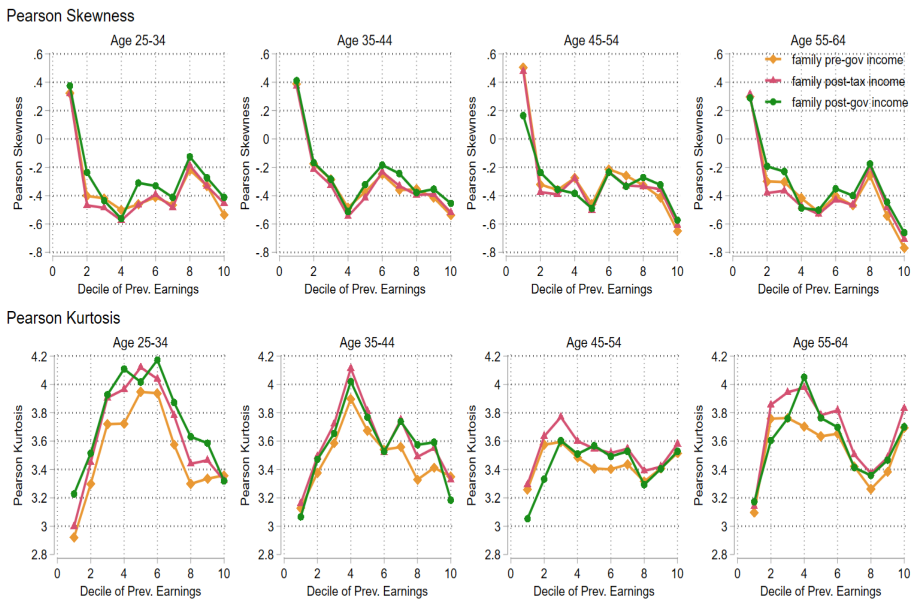

Figure F.37: Skewness and Kurtosis of the distribution of annual changes of family income (P5-P95) at different levels. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable family income.

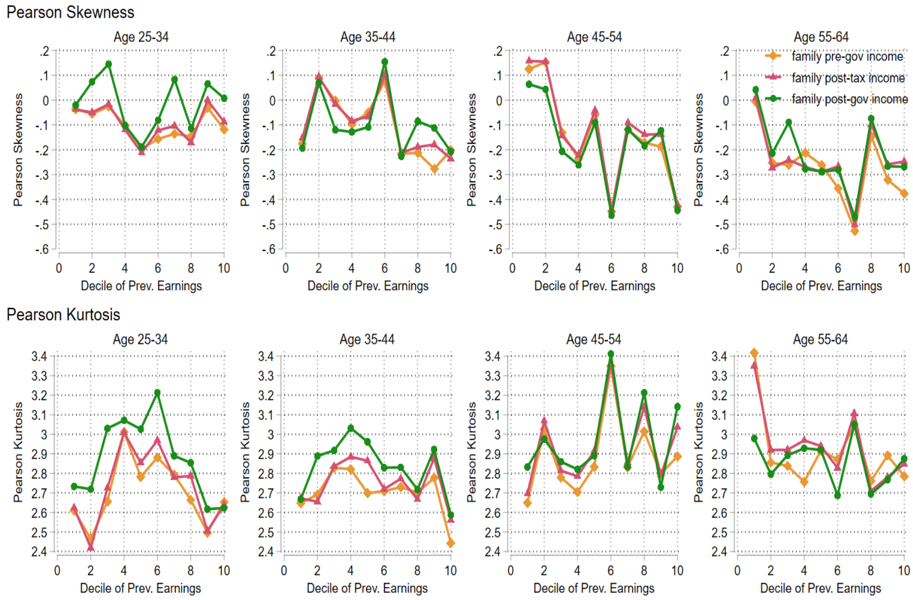

Figure F.38: Skewness and Kurtosis of the distribution of 3-year average changes of family income (P5-P95) at different levels. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable family income.

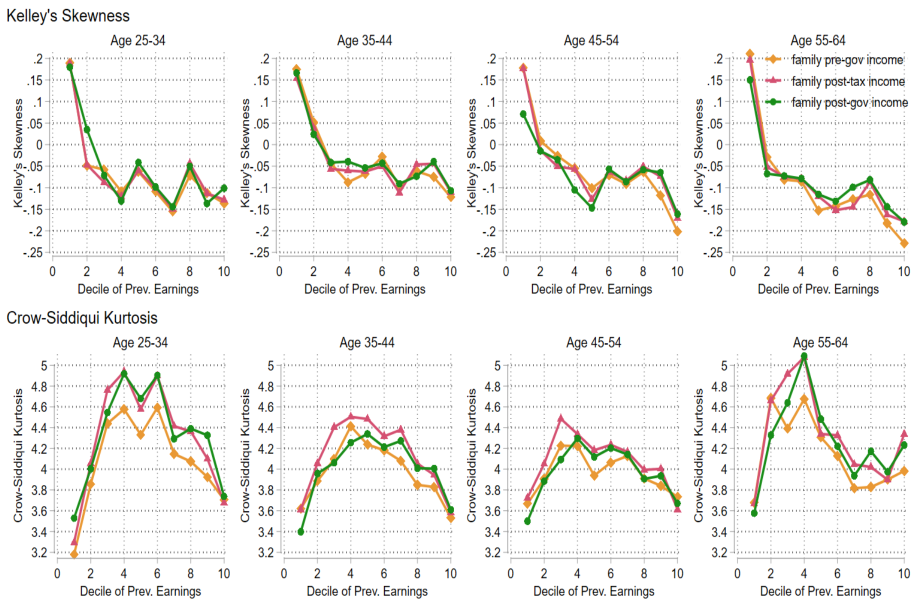

Figure F.39: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of annual changes of family income (P5-P95) at different levels. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable family income.

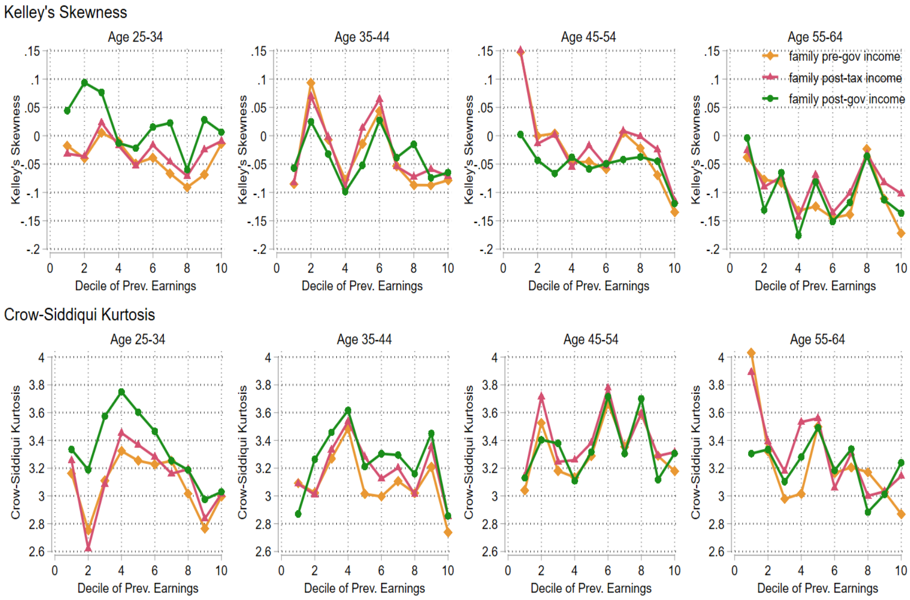

Figure F.40: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of 3-year average changes of family income (P5-P95) at different levels. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable family income.

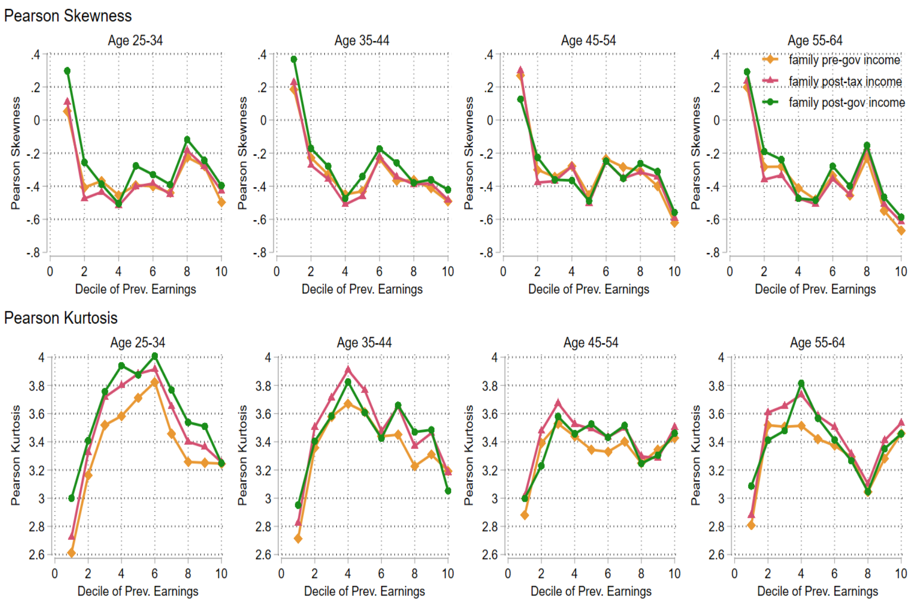

Figure F.41: Skewness and Kurtosis of the distribution of annual changes of family income (P5-P95) at different levels calculated via *Arc-Percent Change method*. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable family income.

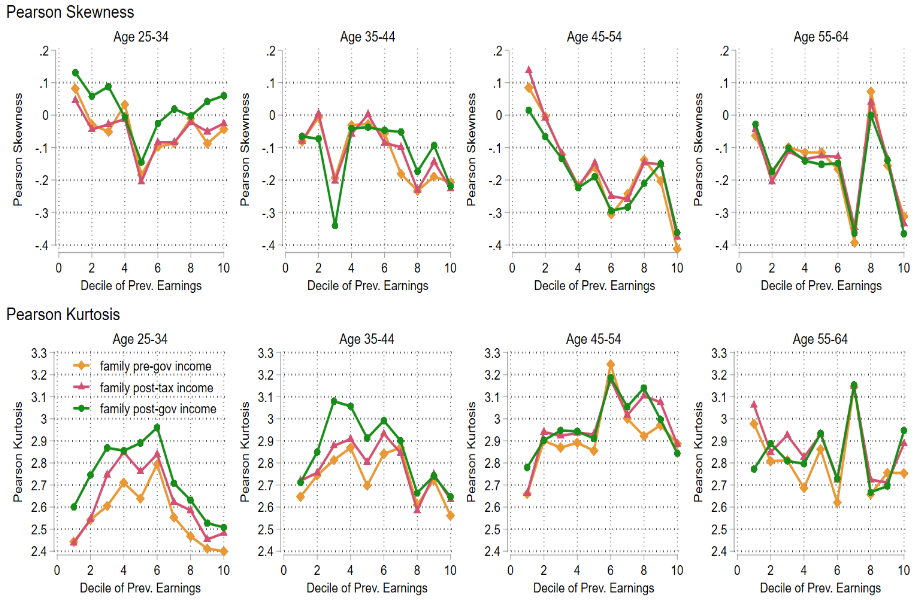

Figure F.42: Skewness and Kurtosis of the distribution of 3-year average changes of family income (P5-P95) at different levels calculated via *Arc-Percent Change method*. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable family income.

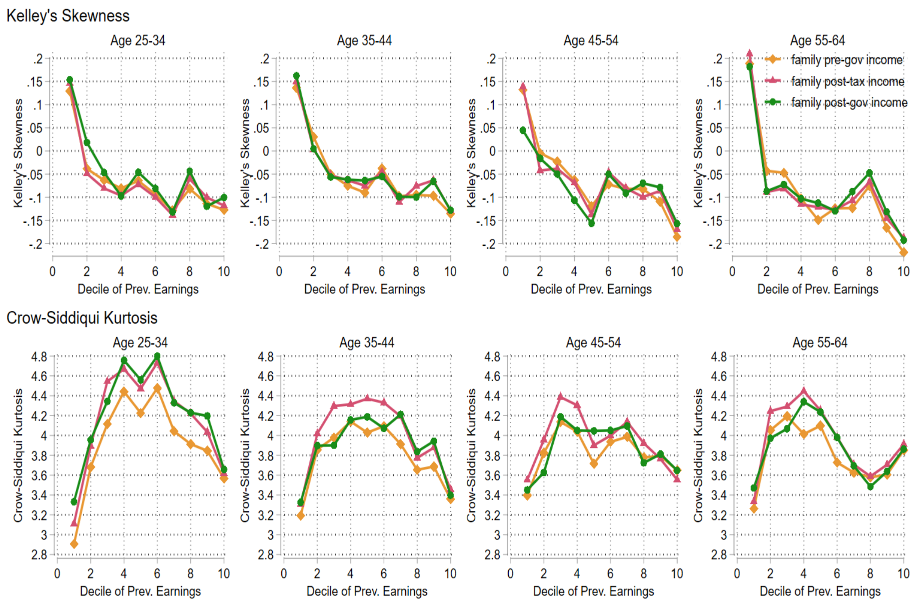

Figure F.43: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of annual changes of family income (P5-P95) at different levels calculated via *Arc-Percent Change method*. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable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

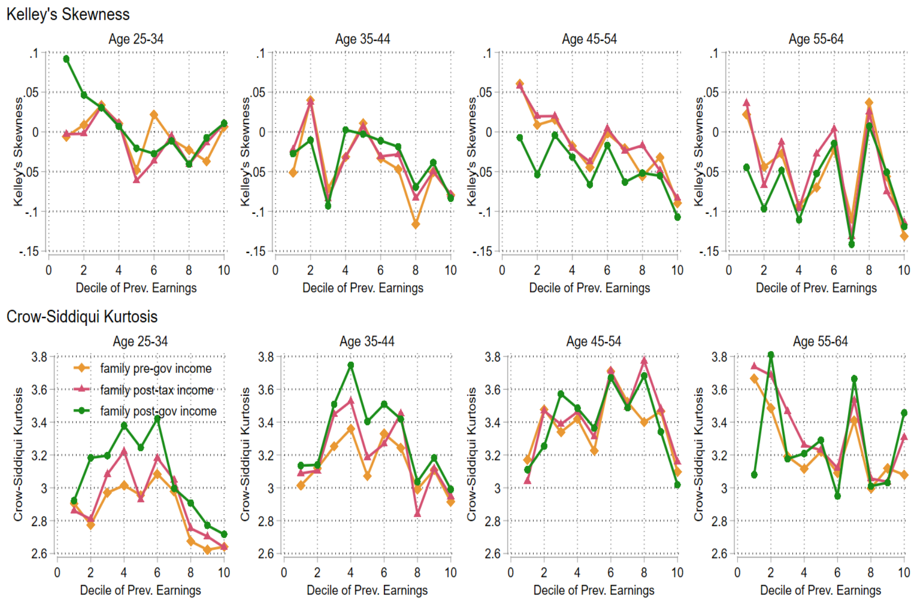

Figure F.44: Kelley's Skewness and Crow-Siddiqui Kurtosis of the distribution of 3-year average changes of family income (P5-P95) at different levels calculated via *Arc-Percent Change method*. The figure captures the relative contribution of tax and transfer to the third- and fourth-order risks of disposable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

F.4 Empirical distributions of shocks and their KDEs

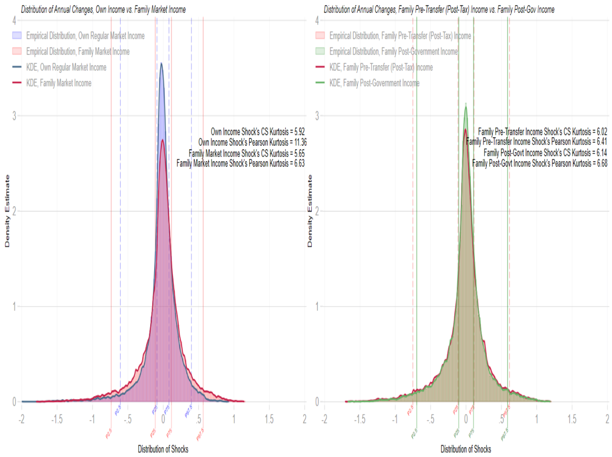

Figure F.45: Comparison of empirical distributions of annual shocks: individual market income vs. family market income (left panel), and family pre-transfer (post-tax) income vs. family post-government income (right panel).

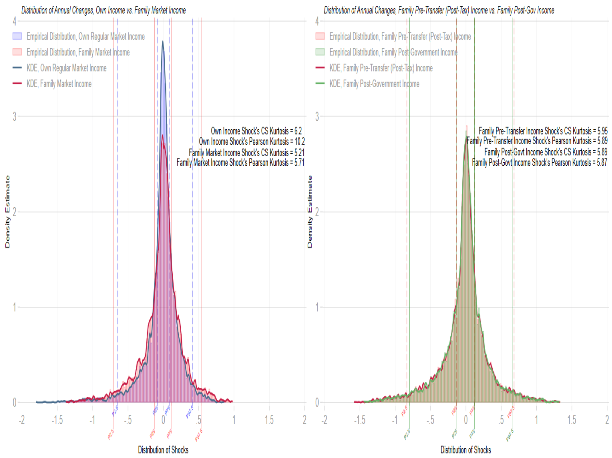

Figure F.46: Comparison of empirical distributions of annual shocks of the working-age cohort aged 55-64: individual market income vs. family market income (left panel), and family pre-transfer (post-tax) income vs. family post-government income (right panel).

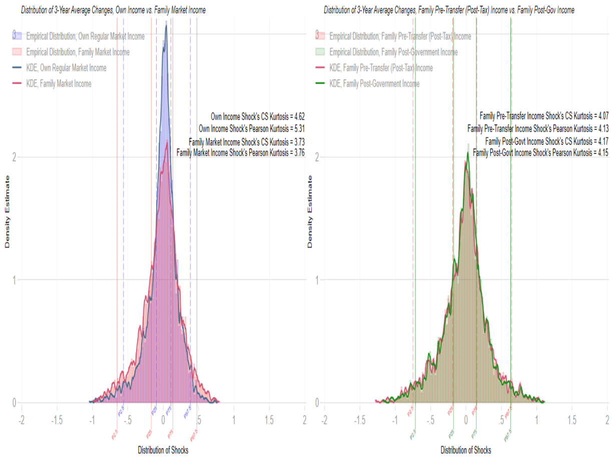

Figure F.47: Comparison of empirical distributions of 3-year average shocks of the working-age cohort aged 55-64: individual market income vs. family market income (left panel), and family pre-transfer (post-tax) income vs. family post-government income (right panel).

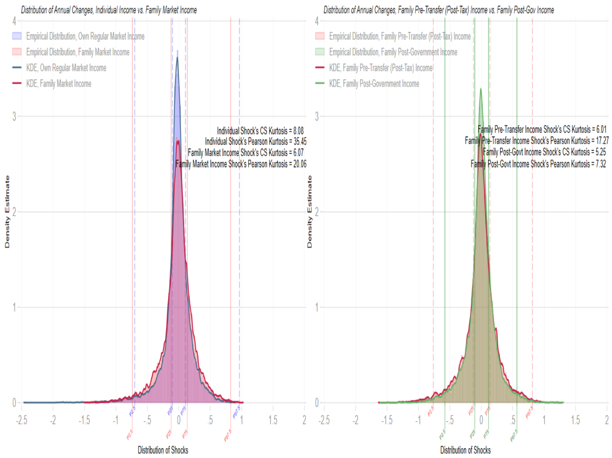

Figure F.48: Comparison of empirical distributions of anual average shocks of lower and upper middle income parents (decile 3 to decile 8): individual market income vs. family market income (left panel), and family pre-transfer (post-tax) income vs. family post-government income (right panel).

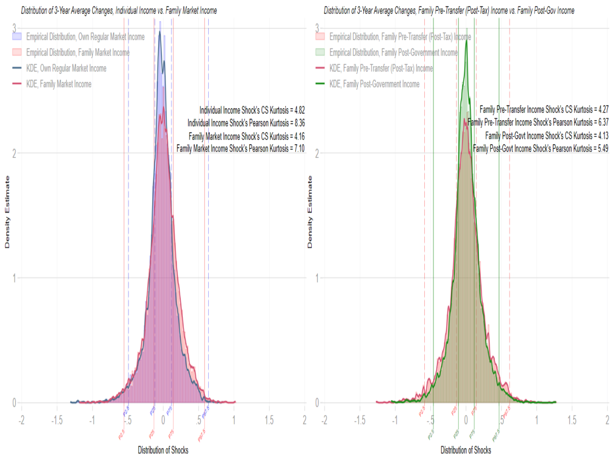

Figure F.49: Comparison of empirical distributions of 3-year average shocks of lower and upper middle income parents (decile 3 to decile 8): individual market income vs. family market income (left panel), and family pre-transfer (post-tax) income vs. family post-government income (right panel).

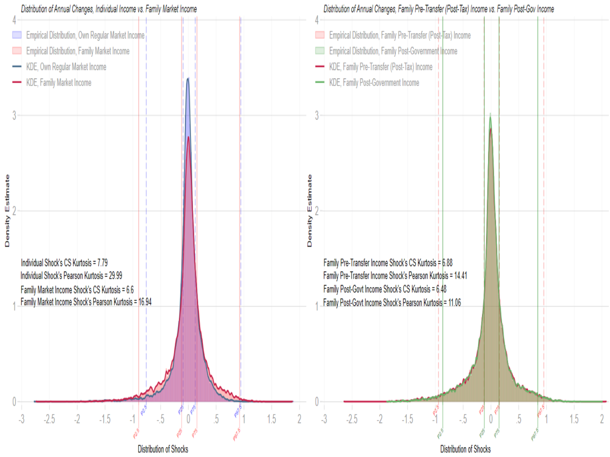

Figure F.50: Comparison of empirical distributions of anual average shocks of lower and upper middle income non-parents (decile 3 to decile 8): individual market income vs. family market income (left panel), and family pre-transfer (post-tax) income vs. family post-government income (right panel).

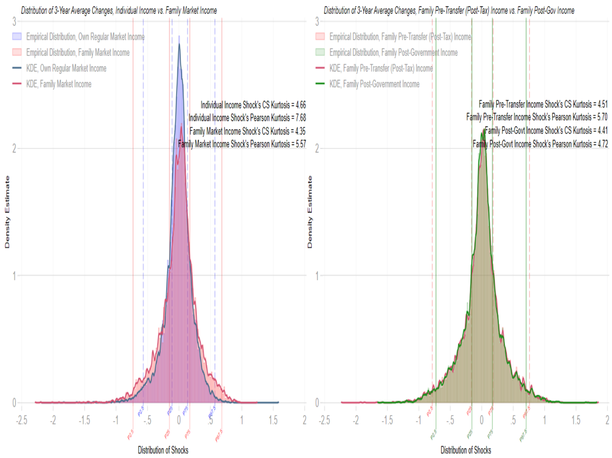

Figure F.51: Comparison of empirical distributions of 3-year average shocks of lower and upper middle income non-parents (decile 3 to decile 8): individual market income vs. family market income (left panel), and family pre-transfer (post-tax) income vs. family post-government income (right panel).

F.5 Higher-order moments: Male vs. female

P1-P99

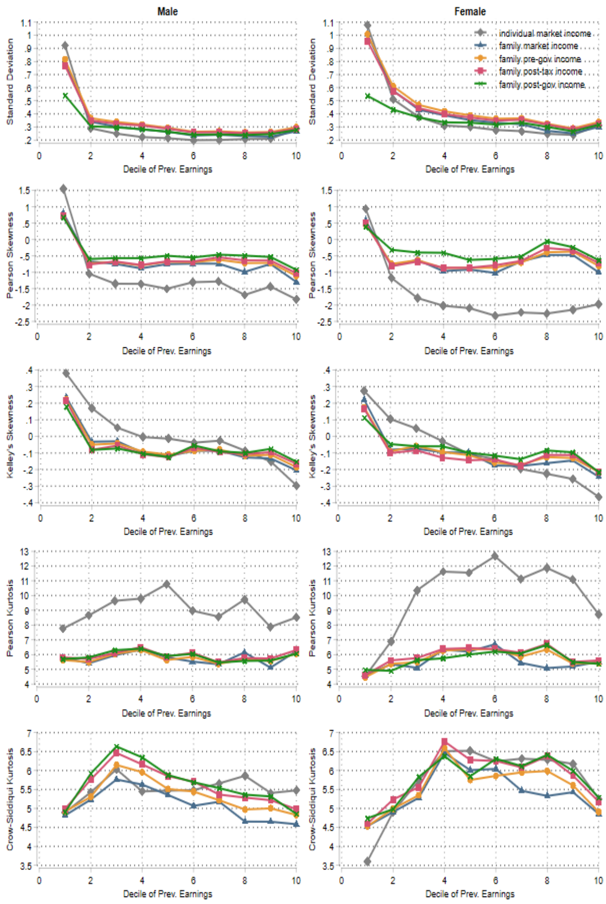

Figure F.52: Second- and higher-order moments of the distributions of annual income shocks (P1-P99) of male (left panel) and female (right panel) primary earners.

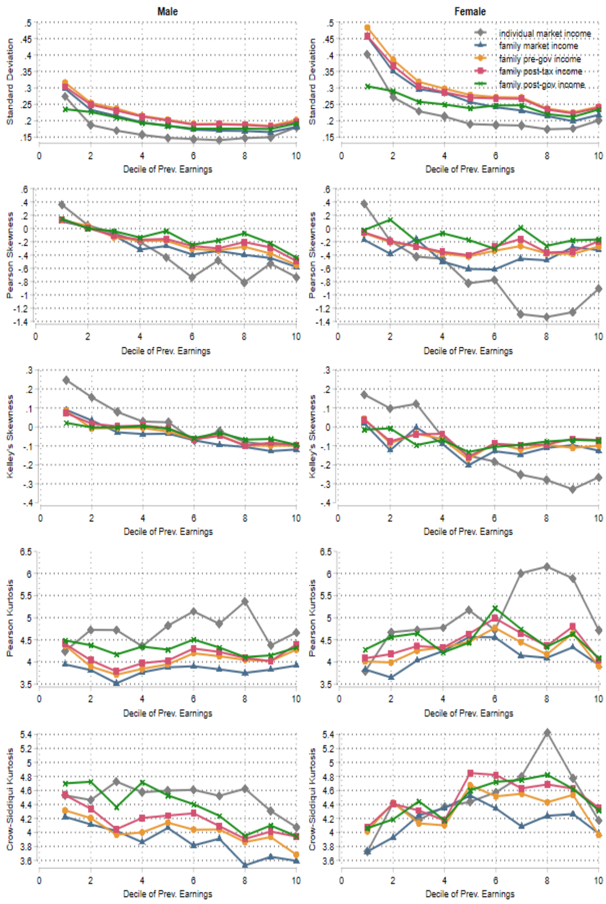

Figure F.53: Second- and higher-order moments of the distributions of 3-year average income shocks (P1-P99) of male (left panel) and female (right panel) primary earners.

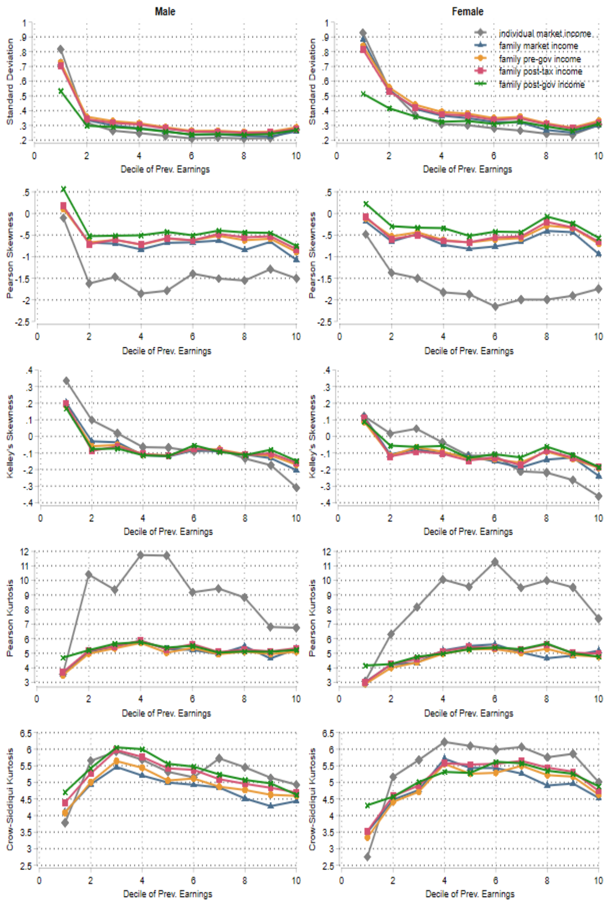

Figure F.54: Second- and higher-order moments of the distributions of annual income shocks (P1-P99) of male (left panel) and female (right panel) primary earners calculated via *Arc-Percent Change method*.

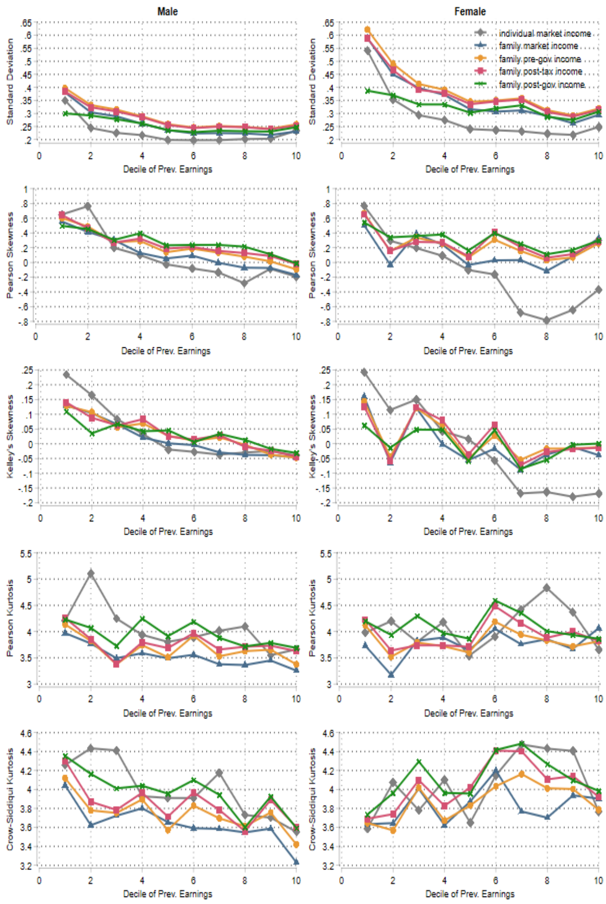

Figure F.55: Second- and higher-order moments of the distributions of annual income shocks (P1-P99) of male (left panel) and female (right panel) primary earners calculated via *Arc-Percent Change method.*

P5-P95

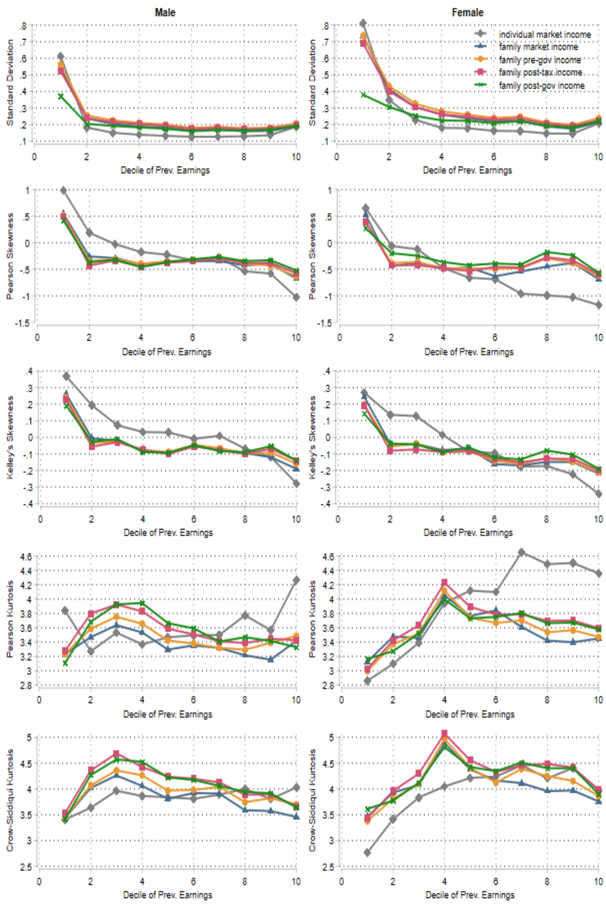

Figure F.56: Second- and higher-order moments of the distributions of annual income shocks (P5-P95) of male (left panel) and female (right panel) primary earners.

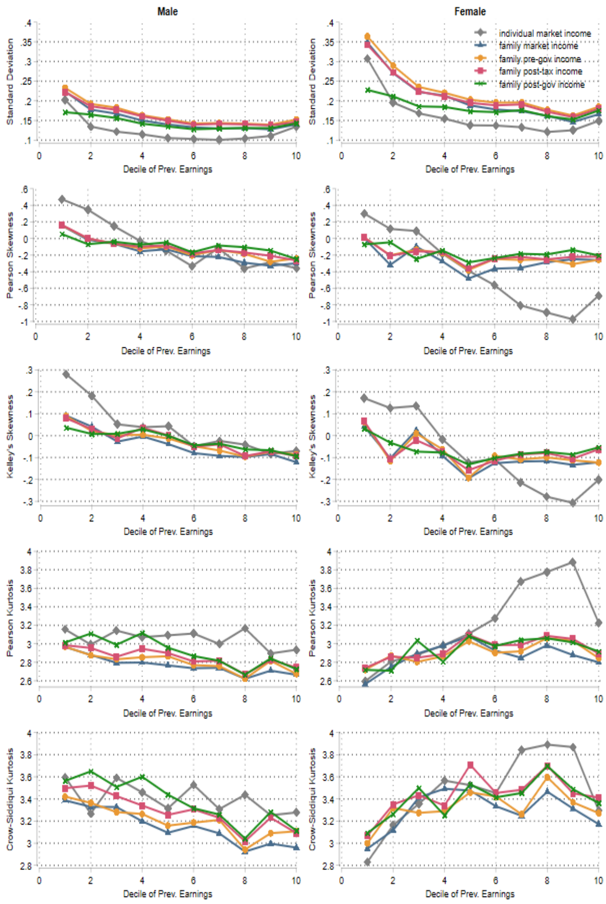

Figure F.57: Second- and higher-order moments of the distributions of 3-year average income shocks (P5-P95) of male (left panel) and female (right panel) primary earners.

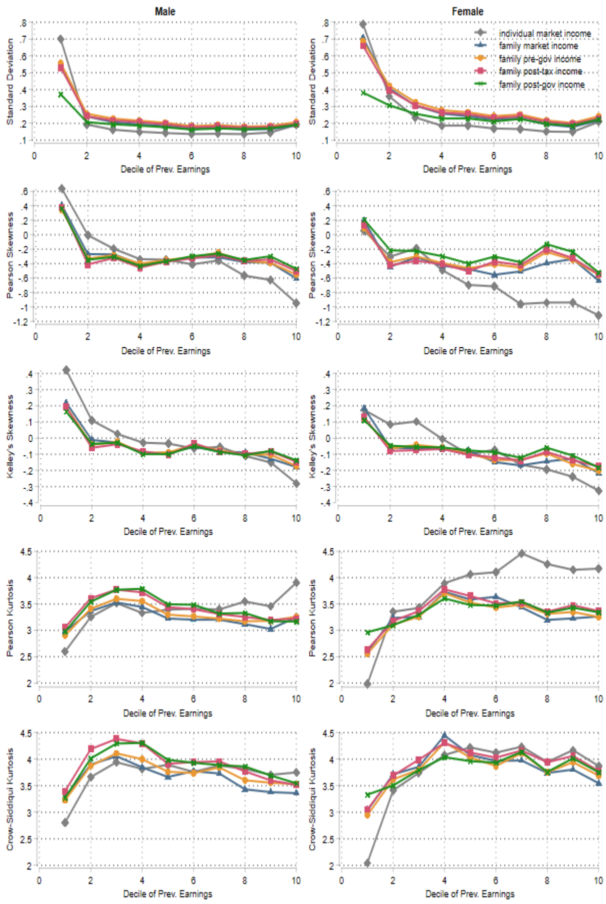

Figure F.58: Second- and higher-order moments of the distributions of annual income shocks (P5-P95) of male (left panel) and female (right panel) primary earners calculated via *Arc-Percent Change method*.

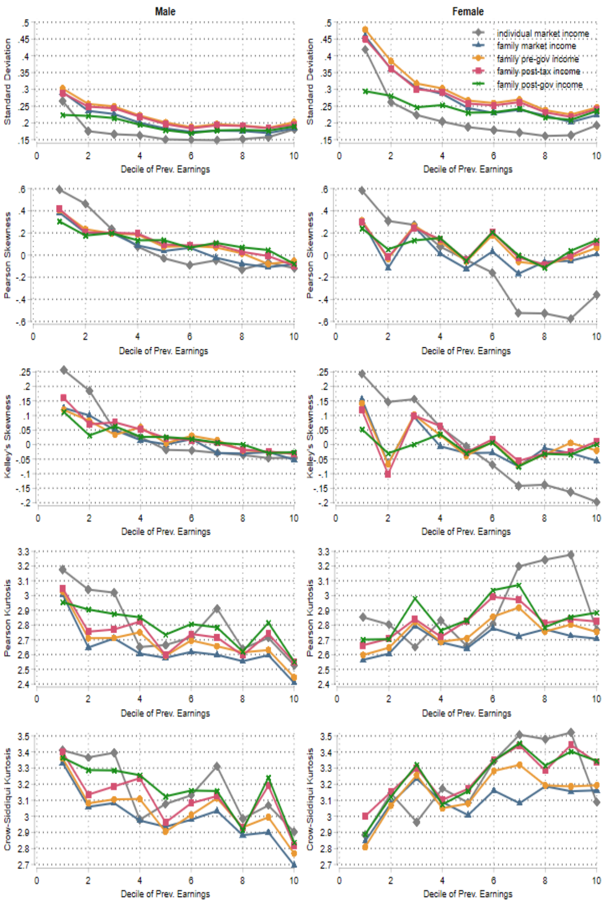

Figure F.59: Second- and higher-order moments of the distributions of annual income shocks (P5-P95) of male (left panel) and female (right panel) primary earners calculated via *Arc-Percent Change method*.

F.6 Higher-order moments: Parent vs. non-parent

Non-robust

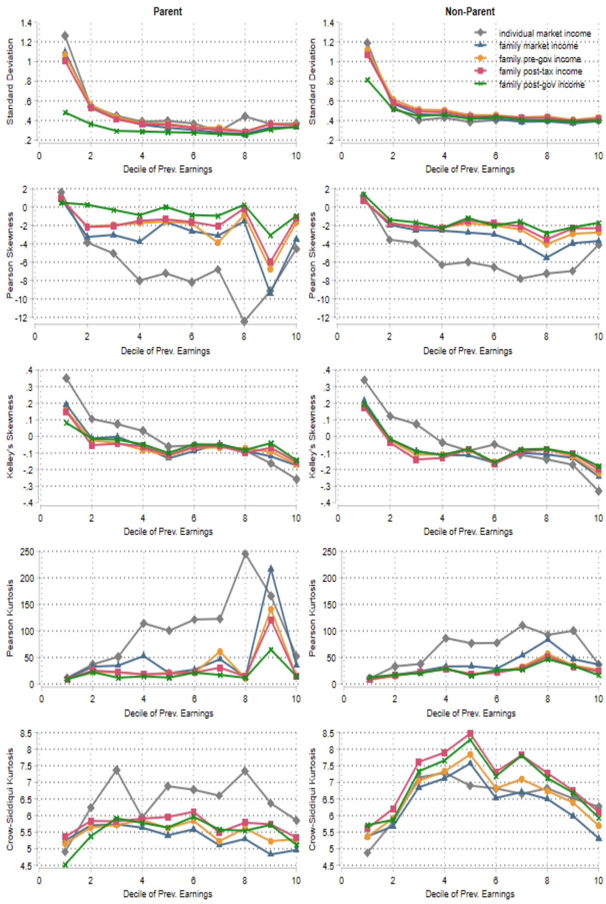

Figure F.60: Non-robust second- and higher-order moments of the distributions of annual income shocks of parent (left panel) and non-parent (right panel) primary earners.

P1-P99

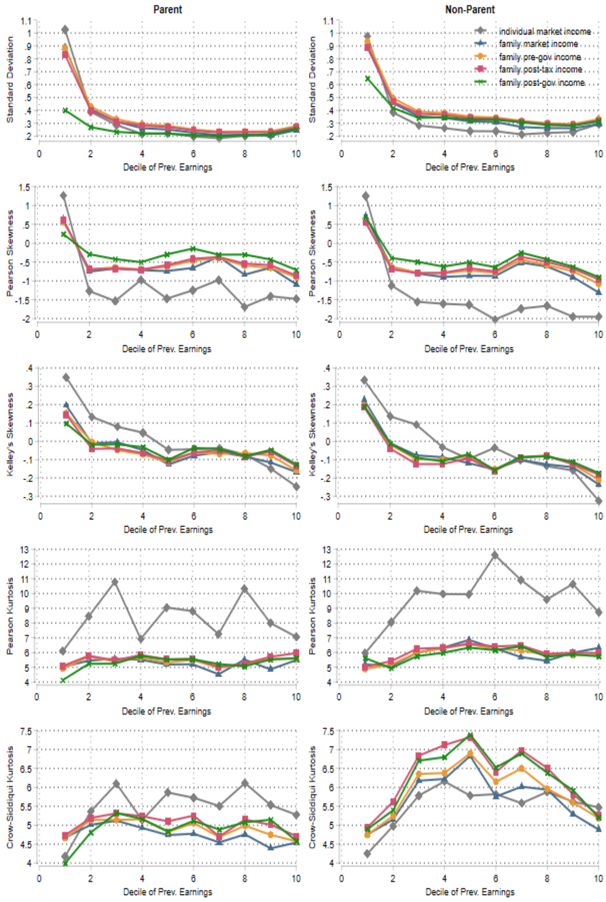

Figure F.61: Second- and higher-order moments of the distributions of annual income shocks (P1-P99) of parent (left panel) and non-parent (right panel) primary earners.

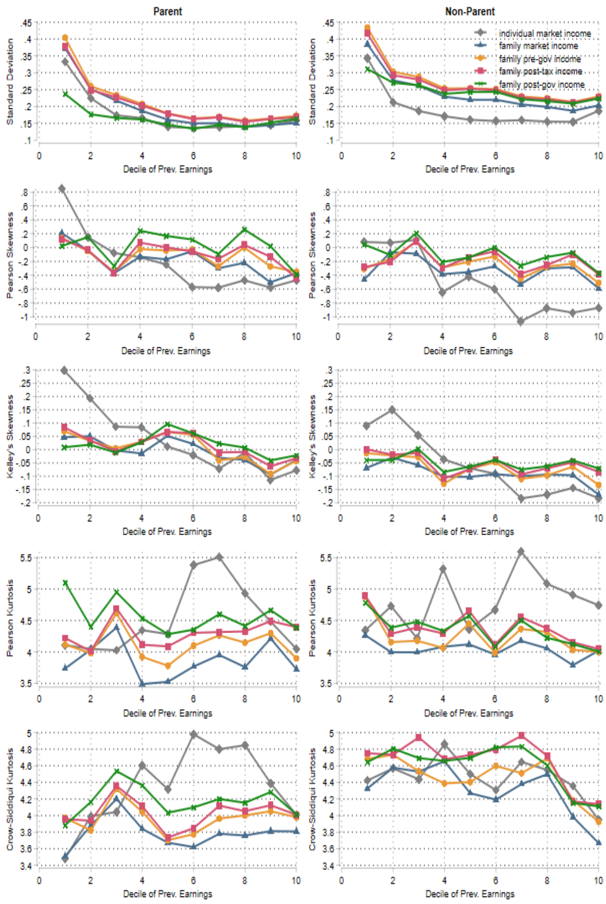

Figure F.62: Second- and higher-order moments of the distributions of 3-year average income shocks (P1-P99) of parent (left panel) and non-parent (right panel) primary earners.

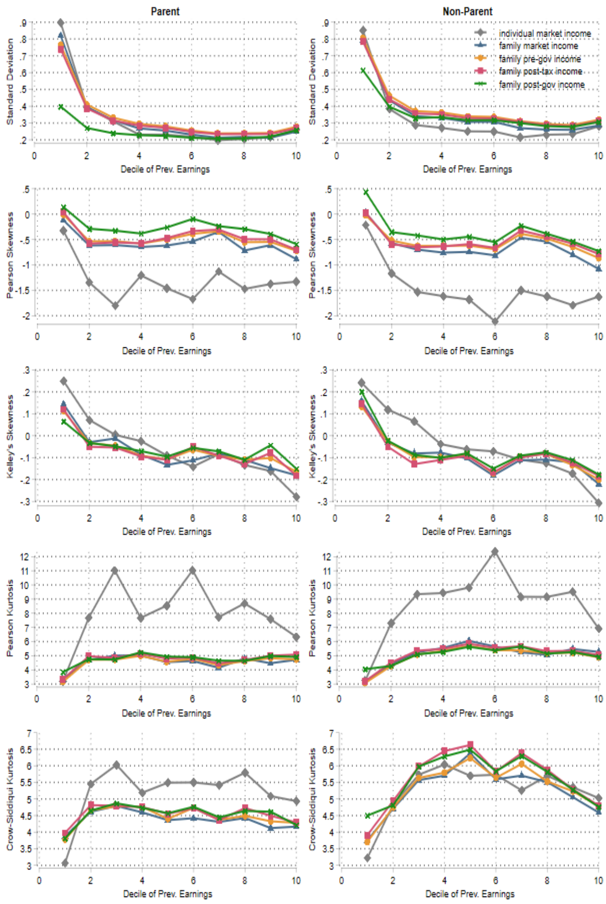

Figure F.63: Second- and higher-order moments of the distributions of annual income shocks (P1-P99) of parent (left panel) and non-parent (right panel) primary earners calculated via *Arc-Percent Change method*.

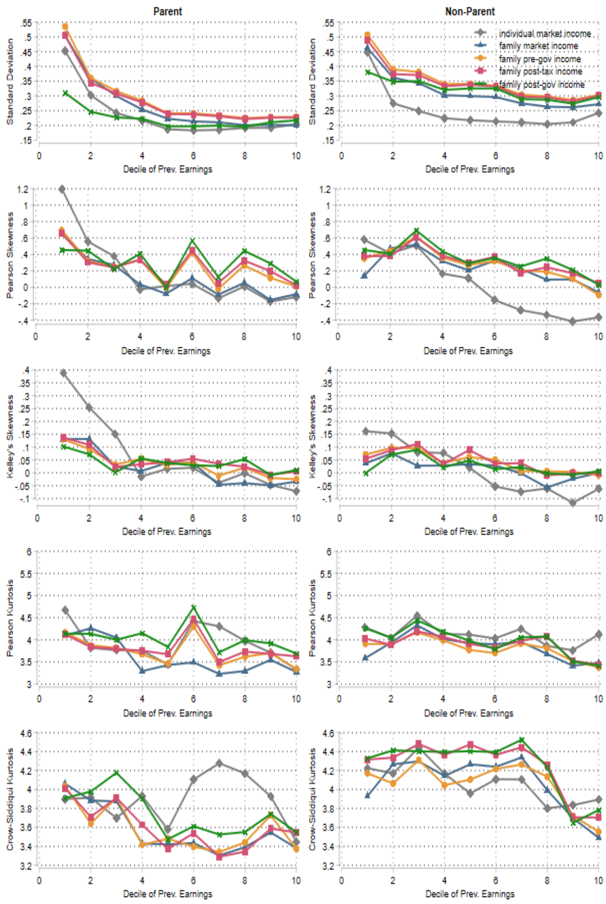

Figure F.64: Second- and higher-order moments of the distributions of annual income shocks (P1-P99) of parent (left panel) and non-parent (right panel) primary earners calculated via *Arc-Percent Change method*.

P5-P95

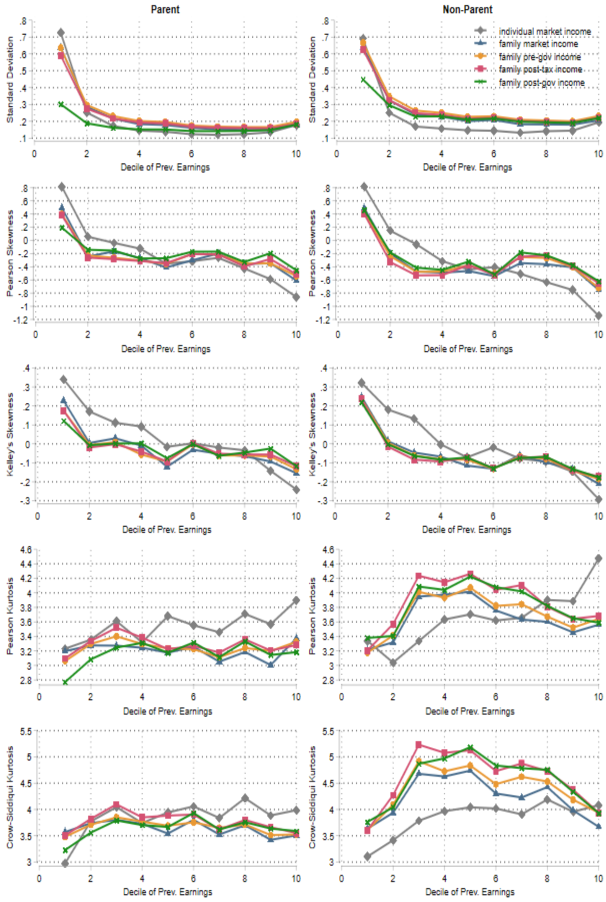

Figure F.65: Second- and higher-order moments of the distributions of annual income shocks (P5-P95) of parent (left panel) and non-parent (right panel) primary earners.

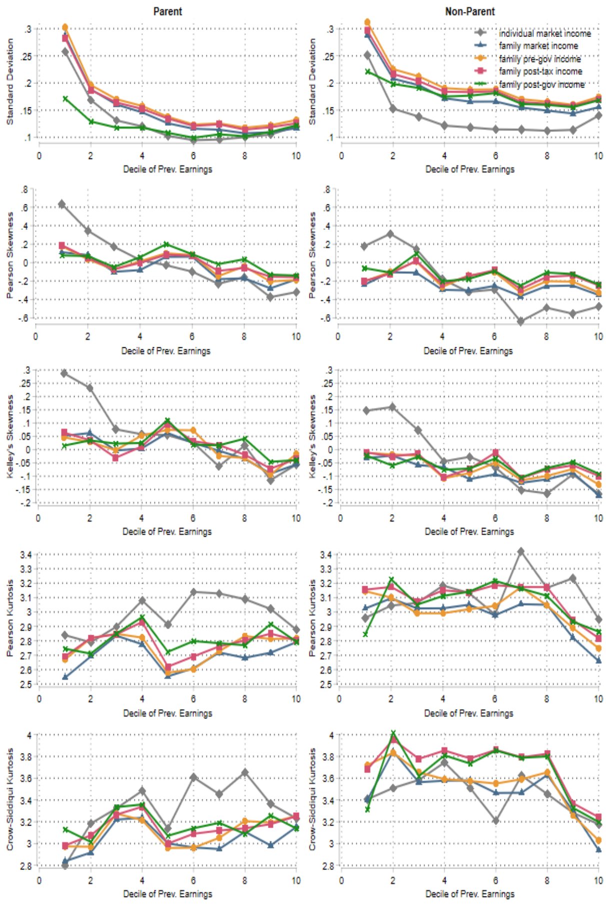

Figure F.66: Second- and higher-order moments of the distributions of 3-year average income shocks (P5-P95) of parent (left panel) and non-parent (right panel) primary earners.

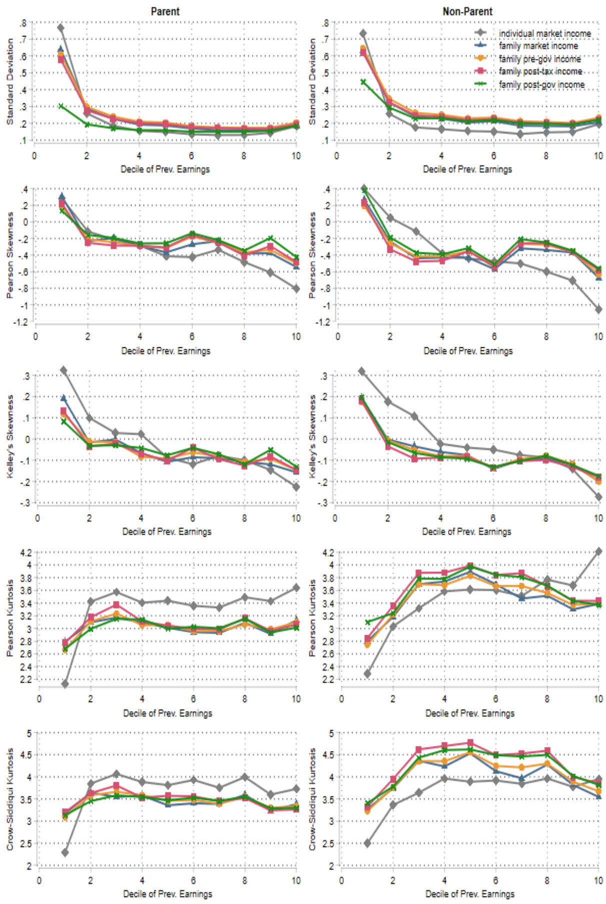

Figure F.67: Second- and higher-order moments of the distributions of annual income shocks (P5-P95) of parent (left panel) and non-parent (right panel) primary earners calculated via *Arc-Percent Change method*.

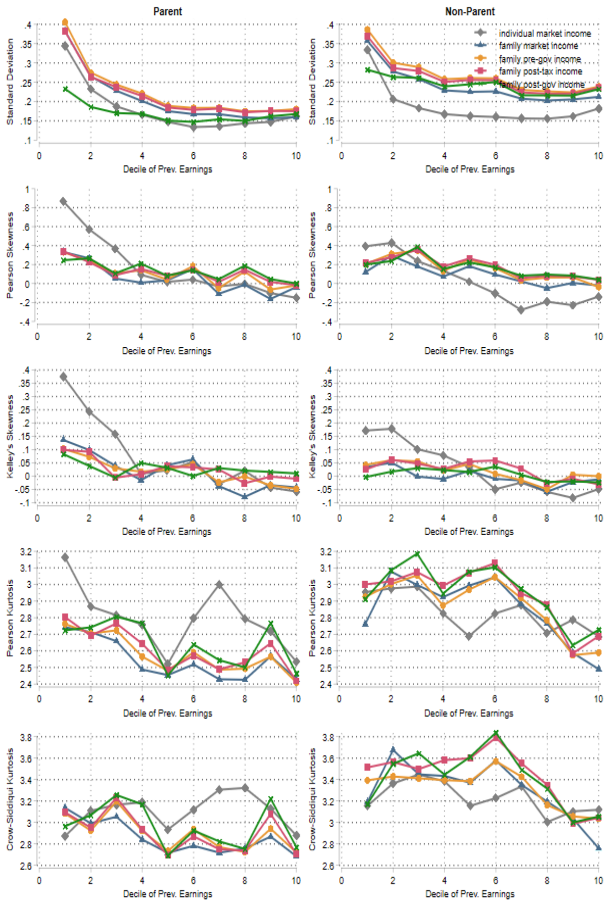

Figure F.68: Second- and higher-order moments of the distributions of annual income shocks (P5-P95) of parent (left panel) and non-parent (right panel) primary earners calculated via *Arc-Percent Change method*.

F.7 Higher-order moments: Partnered vs. lone parents

P1-P99

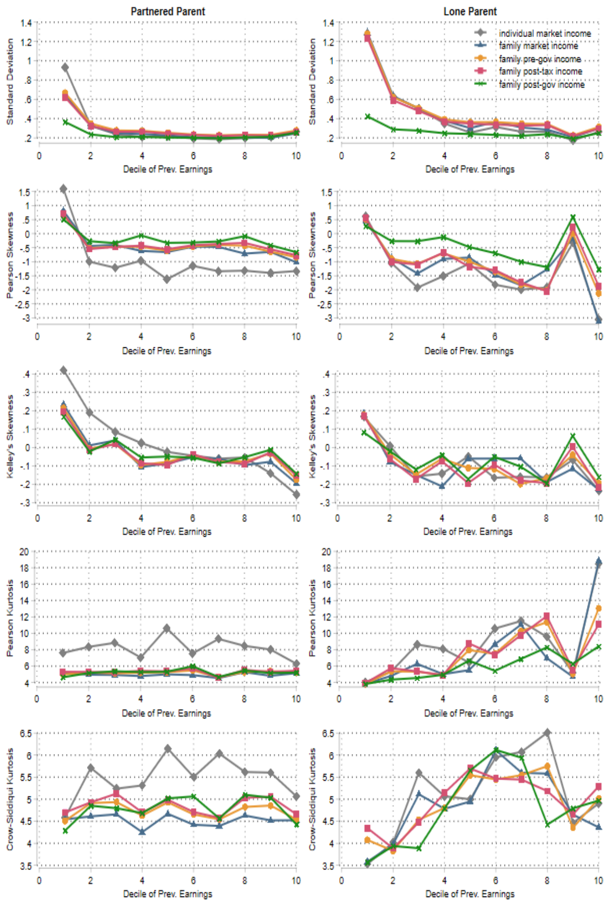

Figure F.69: Second- and higher-order moments of the distributions of annual income shocks (P1-P99) of partnered parent (left panel) and lone parent (right panel) primary earners.

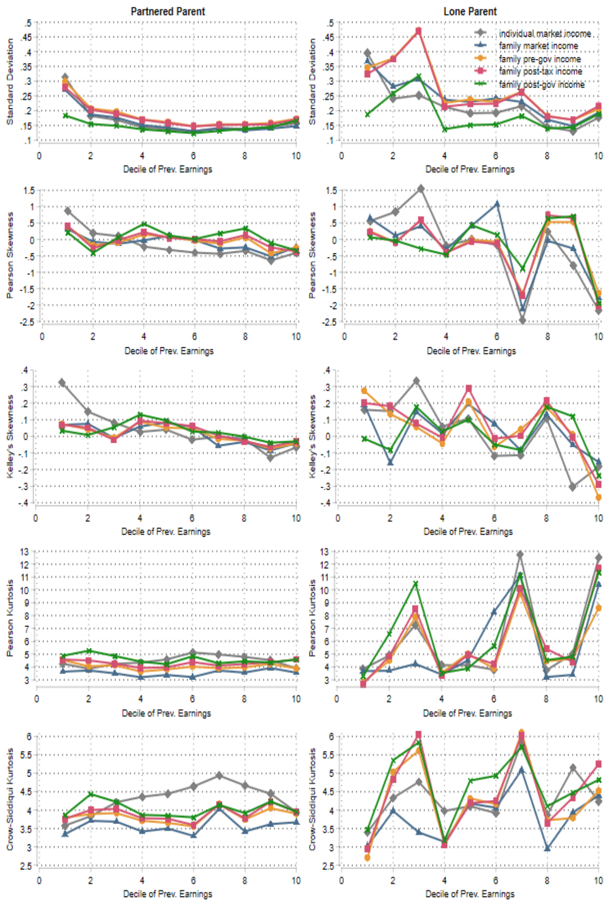

Figure F.70: Second- and higher-order moments of the distributions of 3-year average income shocks (P1-P99) of partnered parent (left panel) and lone parent (right panel) primary earners.

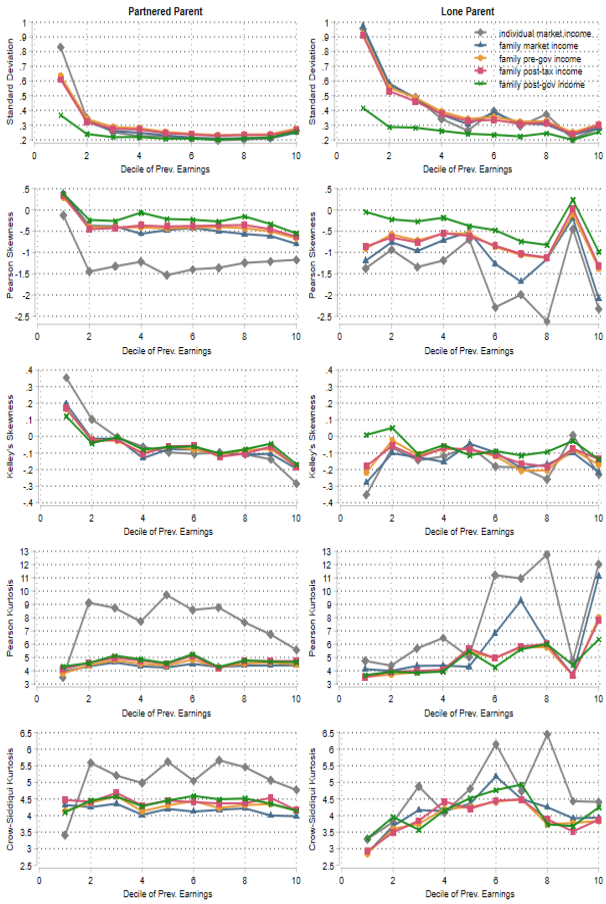

Figure F.71: Second- and higher-order moment of the distributions of annual income shocks (P1-P99) of partnered parent (left panel) and lone parent (right panel) primary earners calculated via *Arc-Percent Change method*.

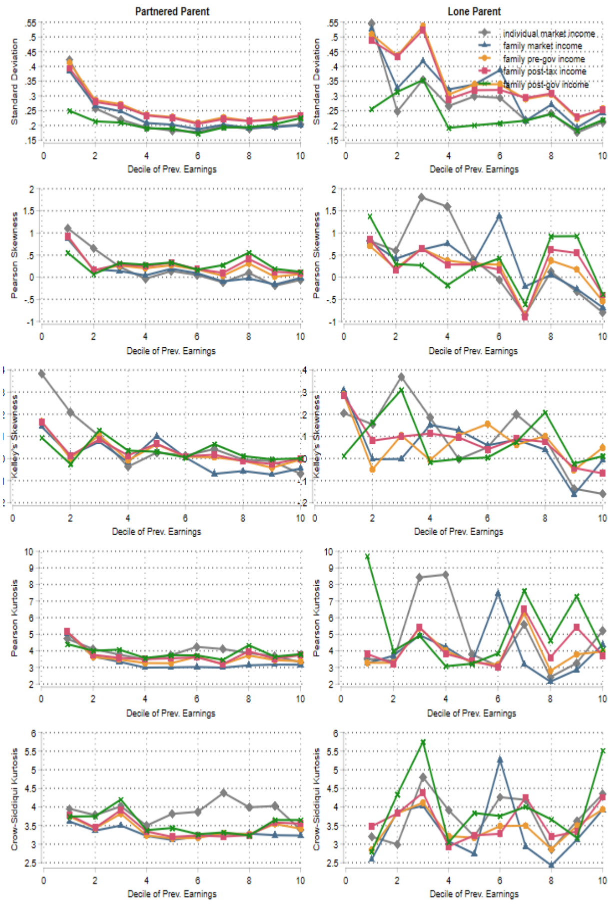

Figure F.72: Second- and higher-order moments of the distributions of annual income shocks (P1-P99) of partnered parent (left panel) and lone parent (right panel) primary earners calculated via *Arc-Percent Change method*.

P5-P95

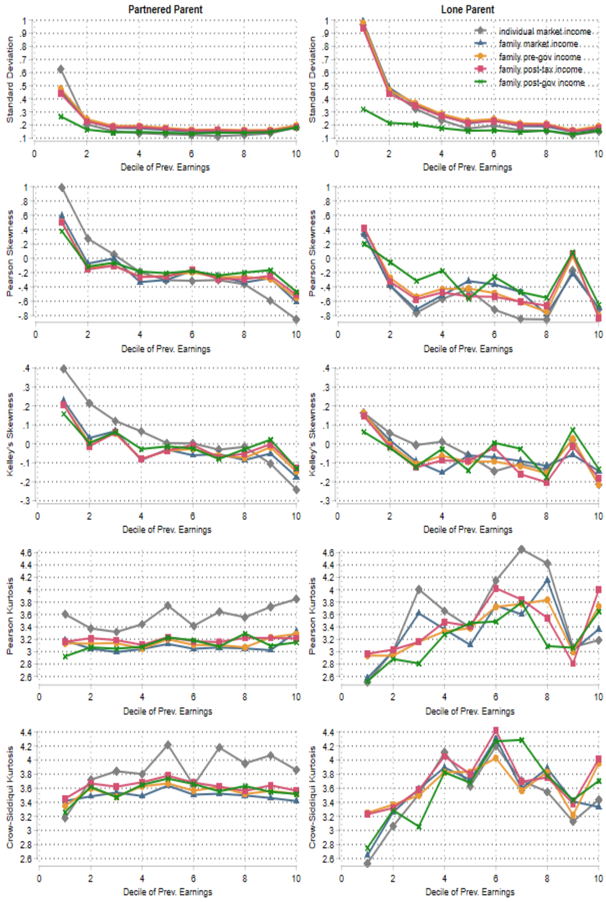

Figure F.73: Second- and higher-order moments of the distributions of annual income shocks (P5-P95) of partnered parent (left panel) and lone parent (right panel) primary earners.

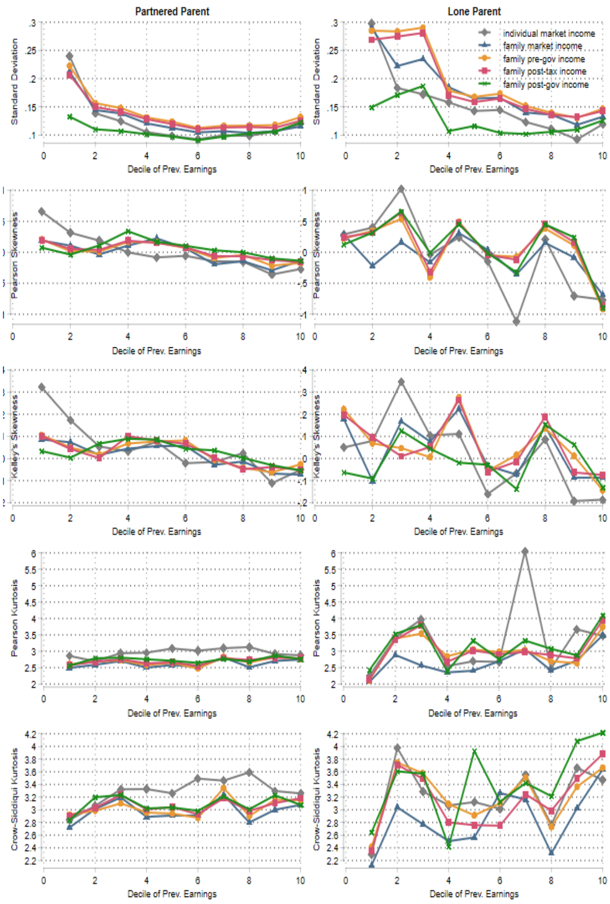

Figure F.74: Second- and higher-order moments of the distributions of 3-year average income shocks (P5-P95) of partnered parent (left panel) and lone parent (right panel) primary earners.

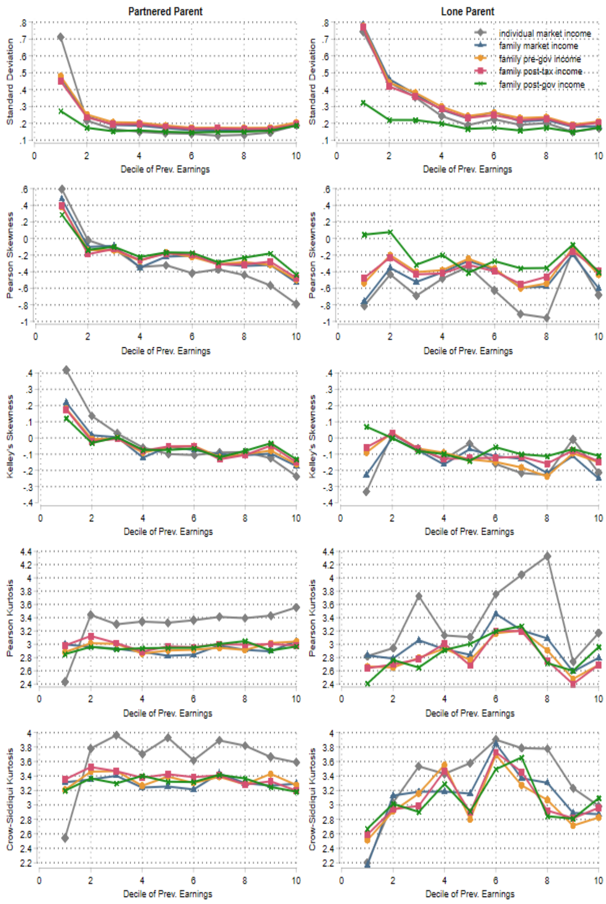

Figure F.75: Second- and higher-order moments of the distributions of annual income shocks (P5-P95) of partnered parent (left panel) and lone parent (right panel) primary earners calculated via *Arc-Percent Change method*.

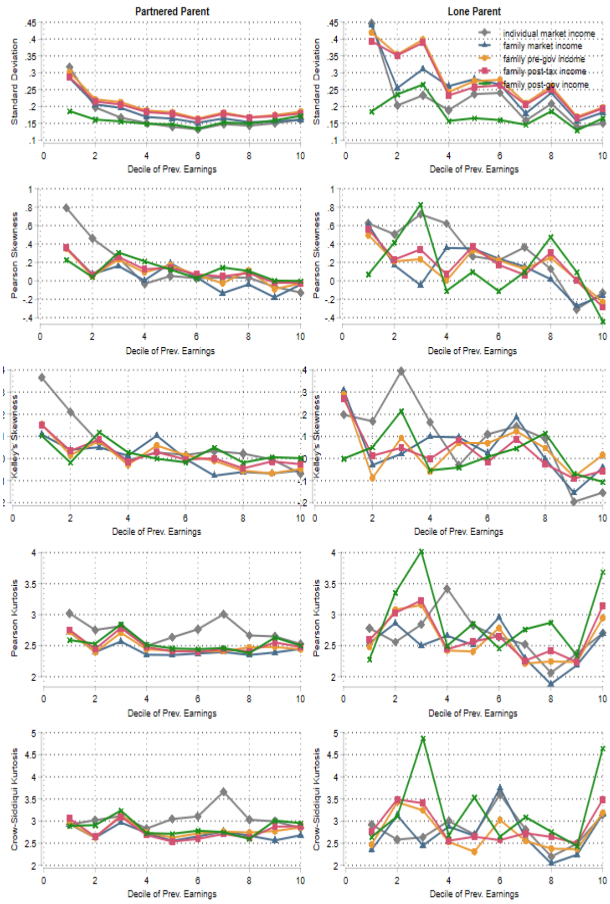

Figure F.76: Second- and higher-order moments of the distributions of annual income shocks (P5-P95) of partnered parent (left panel) and lone parent (right panel) primary earners calculated via *Arc-Percent Change method*.

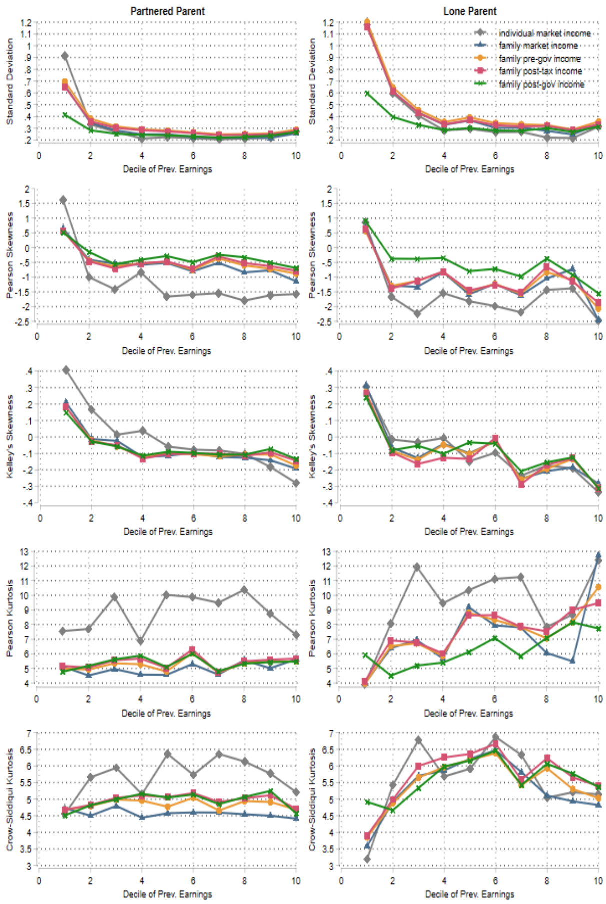

Figure F.77: Second- and higher-order moments of the distributions of annual income shocks of partnered parent (left panel) and lone parent (right panel) primary earners (P11-P99) Pearson statistics.

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