Inequality, Risk-Sharing and the Crisis: A View From Australia*

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Abstract:

We document the cross-sectional stylized facts of inequality for Australian households between 2001 and 2012 using the Household, Income and Labour Dynamics in Australia (HILDA) survey. Inequality of individual wages, hours worked and earnings remain flat. Household pre-government income and non-durable consumption inequality decline slightly. Household income inequality exceeds non-durable consumption inequality during the global financial crisis, and over the life-cycle, suggesting households partially insure income shocks. The degree of progressivity and private intermediation of risk are high. Both equalized net financial wealth and net total wealth inequality remain relatively flat. Taxes and transfers reduce the variance of permanent shocks.

Keywords: Consumption inequality, income inequality, and wealth inequality; Inequality over the life cycle; Risk-Sharing; Vulnerability

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1. Introduction

Research on inequality has increasingly turned to analyzing the multi-dimensional nature of inequality. For instance, the macroeconomics literature on heterogeneous agents suggests that studying the components of inequality, which link together through the household budget constraint, remains an important task for the future. A recent issue of the Review of Economic Dynamics (RED) presents stylized facts about the joint distribution of wages, hours worked, earnings, consumption, and wealth to understand the multi-dimensional nature of inequality in nine countries.¹ The studies reveal how risks faced by individuals can affect inequality. The studies also show how inequality might arise from the structure of the labor market, decisions over how much to work and save, financial services available to households, as well as official measures taken to change the distribution through taxes and transfers.

We summarize the multi-dimensional nature of inequality by reporting cross-sectional stylized facts using the first twelve waves of the Household, Income and Labour Dynamics in Australia (HILDA) survey. We rely solely on the HILDA survey because the Australian Bureau of Statistics (ABS) surveys can result in misleading conclusions because of underreported income (see Saunders and Bradbury (2006) and references therein) and because the survey methodology and the definitions of some measures have changed over time. For instance, Saunders (2004) finds that surveys before 1990 cannot be compared with those after 1994/95. Similarly, Wilkins (2014) finds that ongoing changes to the ABS survey methodology since then mean that, while the gap is closing, the ABS surveys still likely overstate inequality since 2001. Also, Wilkins (2014) compares income inequality measured using the ABS Survey of Income and Housing (SIH) and HILDA between 2001 and 2010 and finds evidence of rising inequality with the ABS data due to changes in definition of income and method of the survey.

Given the relatively short history of HILDA, our results compare with only part of the samples used in the RED issue, which end no later than 2005, or in Lise et al. (2014), which ends in 2008. Because our sample ends in 2012, as in Perri (2014), we can compare inequality before and after the crisis in Australia. That in mind, while

¹ Countries examined in that issue include the U.S. (Heathcote et al. 2010), Canada (Brzozowski et al. 2010), U.K. (Blundell and Etheridge 2010), Germany (Krueger et al. 2010), Italy (Jappelli and Pistaferri 2010), Spain (Pijoan-Mas and Sánchez-Marcos 2010), Sweden (Domeij and Martin Flodén 2010), Russia (Gorodnichenko et al. 2010), and Mexico (Binelli and Attansio 2010). Lise et al. (2014) also applies the framework to household surveys in Japan, while Yamada (2013) uses the Keio survey in Japan to analyze other aspects of the Japanese data that Lise et al. (2014) do not cover.

Krueger et al. (2010) note that most countries experienced substantial increases in wage and earnings inequality since the mid-1970s, as we discuss below, our post-2000 results show that inequality changed little, resembling findings for countries with post-2000 samples.

In line with the RED methodology, we begin by comparing survey summary statistics with National Income and Product Accounts (NIPA) data. We find that average wages and salaries for individuals as well as the employment to population ratio in the HILDA survey, lie slightly below per capita wages and salaries, and the employment to population estimates from the NIPA data, but do track the respective trends well. Non-durable consumption from the HILDA survey lies below NIPA figures and has a different trend.

Turning to individual inequality, our cross-sectional stylized facts suggest that during the first twelve waves of the HILDA survey wage inequality changed little. While inequality for the college educated and for experienced males remained largely constant, the male gender premium rose slightly throughout the sample. While women have lower inequality of wages than men, they have higher inequality of hours worked, and earnings. Inequality in hours worked for women exceeds that for men, which likely reflects the fact that many women work part-time while most men work full-time, but is converging as labor force participation among women increases.

At the household level, inequality of pre-government earnings exceed that of post-government earnings, which would be consistent with a progressive system of taxes and transfers, as Krueger et al. (2010) observe that progressive taxes and transfers tend to compress inequality. We estimate the degree of progressivity, as in Heathcote et al. (2014a, 2014b) and find it quite high at roughly 0.5, more than twice as high as estimates for the U.S. With the exception of the crisis years between 2008-2010, pre-government earnings inequality declines throughout the sample. This finding appears associated with the bottom end of the distribution, measured by the 50th percentile relative to the 10th percentile (p_{50}/p_{10}) rather than with the top end of the distribution, measured by the 90th percentile relative to the 50th percentile (p_{90}/p_{50}) where inequality is flat.

We also find that non-durable consumption inequality lies below income inequality, which in turn lies below wealth inequality. As Krueger et al. (2010) argue, this can be interpreted as evidence that households insure against income shocks, and is consistent with recent findings in Miller (2014) for Australia, before, during and

after the recent crisis. This also may suggest that consumption provides a better measure of inequality than income or wealth for Australia, as Harding (1997) and Barrett et al. (2000) suggest.

Finally, while most of the studies were finalized before the Great Recession, Perri (2014) extends a subset of Heathcote et al.'s (2010) findings to examine what happened with inequality in the U.S. before, during and after the 2007-2009 crisis. He finds that the consumption inequality remained largely flat, even as some measures of inequality increased, and that taxes and transfers helped mitigate the increased inequality during and after the crisis. Similarly, we find consumption inequality lies below disposable income inequality, and the gap falls during the crisis, which is consistent with Miller's (2014) finding that the sensitivity of consumption to negative income shocks rose slightly during the crisis. We also measure total, government and private intermediation of risk and find that private intermediation comprises the bulk of total intermediation of risk. Overall, these findings indicate households withstood the crisis.

2. Methodology and Data

2.1. Framework

The basic framework that Krueger et al. (2010) describe draws from an intertemporal household budget constraint. The framework either specifies the labor supply exogenously by aggregating income across earning members of the housing, or endogenously by breaking down income into hours worked and wages earned per hour. Using their notation, Krueger et al. (2010) write the intertemporal budget constraint with an exogenous labor supply as

$$c + a' = y^L + a + y^A + b + T, \quad (1)$$

where consumption (c) can be financed by the growth in assets between now and the next period (a'), current labor income (y^L), an existing stock of assets (a), the income earned from those assets through dividends (y^A), through private transfers and bequests (b), and public transfers net of taxes (T). By specifying the labor supply endogenously, the intertemporal budget constraint becomes

$$c + a' = \underbrace{(w_f l_f + w_m l_m)}_{y^L} + a + y^A + b + T, \quad (2)$$

where in addition to the variables specified in (1), we can account for hourly wages earned by female and male earners (w_f, w_m) and hours worked by female and male earners (l_f, l_m). They also examine pre-government income defined as the sum of labor income, asset income and private transfers ($y^L + y^A + b$), and disposable income defined as pre-government income plus net transfers ($y^L + y^A + b + T$).

The RED guidelines call for computing time series of the variance of the natural logs for wages, hours worked, labor earnings, market and disposable income, consumption and wealth. We also report other traditional measures of inequality, including the Gini coefficient, p50/p10 and p90/p50 percentile ratios.

2.2. The HILDA Data

Our empirical results make use of the HILDA survey, which is a nationally representative, longitudinal survey of households, stratified across all seven states and territories in Australia. The survey is undertaken annually and the first wave of the survey consists of 7,682 households, with an additional 2,153 households added in 2011 (wave 11).

In the early years, the primary focus of the HILDA surveys was the collection of information about household income and labor market activities. As Miller (2014) discusses, information about expenditures was limited to monthly housing expenditures, but waves 1, 3 and 4 recorded information about household food expenditures, including groceries and meals eaten outside the home.

The survey broadened its coverage in wave 5 by including a self-completed questionnaire asking households to report their expenditures on a wider range of non-durable goods and services, though some non-durable categories changed in wave 6. Also new for wave 6 were durable consumption expenditure categories such as new and used cars, computers, audio-visual equipment, home appliances, and furniture. Therefore, while we use the earlier waves for other variables, for consumption we use waves 6-12. The consumption subcategories include groceries, dining out, alcohol,

cigarettes, petrol, shoes and clothes, utilities, public transportation, phone and internet, home repairs, auto repairs, and holidays.

In line with the RED methodology, to compute real, adult-equivalent, consumption and income we deflate the nominal measures by the Australian Bureau of Statistics' all cities consumer price index (CPI). To equalize consumption and income figures, we use the OECD equivalence scale, which gives the household head a weight equal to 1, all adults other than the household head a weight equal to 0.7, and all children aged 16 and under, a weight of 0.5.

2.3. The RED Sample Selection Strategy

We use a sample of 77,912 household across the first twelve waves, as summarized in Table 1. For the sake of comparison, the RED studies adopt common guidelines for sample selection that we apply as well.² The selection strategy calls for using only households in which the reference person or head of household is at least 25 and not more than 60 years old. HILDA uses the term *reference person* instead of *household head*. The reference person has a clear interpretation for single households. For mixed sex couples, defined with either a reference person, along with a spouse, the male gets treated as the reference and the female as the spouse, while with same sex couples, the oldest get treated as the reference person. For non-couple households the oldest working age male gets identified as the reference person, unless none exists, in which case, the oldest female becomes the reference person.

[Table 1]

We now turn to our analysis comparing basic means from the HILDA data with the associated NIPA figures.

3. NIPA Data vs. HILDA Means

The measures we compare include per capita wages and salaries, non-durable consumption, as well as the employment to population ratio. In Table 2, we update Table 2 in Krueger et al. (2010) and summarize our findings as well as results from Lise et al. (2014) for Japan. While most studies report mixed results when using

² See <https://www.economicdynamics.org/guidelines.pdf>.

household survey data to corroborate NIPA income and consumption data in levels, they do corroborate NIPA income and consumption growth rates. While the HILDA data generates income levels and growth rates that are comparable with the NIPA figures, the consumption levels and growth rates do not corroborate the NIPA figures.

[Table 2]

Wages and Salaries. Figure 1 depicts HILDA mean Wages and Salaries against NIPA per capita wage income. Figure 1 shows that the HILDA series lies just below the NIPA series, and the trend for the HILDA series generally follows the NIPA series. The two series exhibit similar volatility. This finding is consistent with those in Canada, Britain, Germany, Russia and Japan where typically the NIPA figures lie above the survey figures, or in the U.S. and Italy, where they closely follow each other. In Sweden, the survey figures lie above the NIPA figures.

[Figure 1]

Consumption. Figure 2 depicts non-durable consumption expenditures. While the HILDA series lies below and has a different trend from the NIPA series, the cyclicalities are similar. In terms of the HILDA figures, the decline in non-durable consumption expenditures in 2009 has been observed in Miller (2014), reflecting the effects of the Global Financial Crisis on household consumption. Since then, however, non-durable consumption expenditures have fallen. As in Australia, the NIPA series exceed survey series for the U.S., Canada, Sweden, and Japan, unlike in Britain, Germany, Italy and Russia, where the series track each other closely.

[Figure 2]

Employment-to-Population. In Figure 3 we see that the employment to population ratio in HILDA tracks the NIPA quite closely. This stylized fact is consistent with results for Canada and Russia. The decline since 2008 could be consistent with the effects of the Global Financial Crisis: even though the Australian economy weathered the turmoil initially, the labor market after 2008 worsened.

[Figure 3]

4. Inequality

Taken as a whole, we show that inequality in Australia changed little between 2001 and 2012, especially income and consumption, overall and at both the top and bottom of the distribution. There were notable changes in the distribution of hours worked and especially earnings. We begin with summaries of individual level inequality before turning to household level inequality.

4.1. Individual Level Inequality

Basic Inequality in Wages. In Figure 4, the variance of the log of wages exhibits no general pattern. In terms of levels, Krueger et al. (2010) observe that countries with more significant labor market restrictions might exhibit less wage inequality. To the extent that the Australian labor market features more restrictions with minimum wages and high unionization rates, this may explain the relatively lower wage inequality measured by the variance of the natural log of wages, which equals roughly 0.2.³ This value lies closer to those reported for Italy, Spain, and Sweden, and about half the nine-country average of 0.38 for the year 2000 reported in Krueger et al. (2010). Inequality is much lower than in Canada, the U.S., Britain, and Germany. We observe the similar stylized facts for the Gini coefficient.

The p90/p50 ratio is higher than the p50/p10 ratio, suggesting that higher inequality exists at the top end of the distribution. The p50/p10 measure of inequality had been declining through 2004, but has been stable since then through 2012. Also, the p90/p50 measure declined through 2003, but since then has been higher. While the variance of log wages is slightly higher, the p90/p50 and p50/p10 measures resemble those in Italy.

[Figure 4]

³ Real minimum wage data adjusted using purchasing power parities in 2014 US dollars from the OECD indicates that the Australian hourly minimum wage in 2014 was \$10.80; among OECD countries, only France and Luxembourg have higher real minimum wages. In addition, although Australia has seen a dramatic decline in union membership rates over the past two decades like other countries, the average trade union density, measuring the fraction of the work force that belonged to a trade union, still exceeds the OECD average (source: <https://stats.oecd.org>).

For comparison, many of the country studies report that inequality generally increased during the full sample. However, in studies that report results through 2005, like Australia, the trend appears flat in the U.S., Canada, Germany, Italy, and Japan, while it declined in Britain and Russia.

We also examine basic inequality for males and females. Figure 5 suggests that in terms of levels, male inequality appears to be much higher than female wage inequality, overall, at the top of the distribution (p90/p50), and at the bottom of the distribution (p50/p10). In terms of trends, while male wage inequality remains flat, female wage inequality declines slightly, although this finding does not appear at the top (p90/p50) or bottom (p50/p10) ends of the distribution.

[Figure 5]

The flat and declining wage inequality for males and females, respectively, contrasts with the patterns observed elsewhere. In the U.S., after 2000, male wage inequality remained flat, while female wage inequality rose. In Canada after 2000, male wage inequality rose slightly, while for females that remained flat. In Britain and Russia, wage inequality fell for males and females. In Italy, wage inequality remained flat for males and females after 2000. In Japan, wage inequality rose for males and declined for females.

Wage Premia. Figure 6 depicts wage premia in terms of the education premium (the average wage of college educated males divided by that of non college-educated males), the gender premium (the average wage of males relative to that of females), and the experience premium (the average wage of males aged 45-55 relative to that of males aged 25-35), as well as the variance of residuals from a regression of wages against demographic factors:

$$\ln y_{it} = x'_{it} \beta_t + \varepsilon_{it}^y, \quad (3)$$

where x_{it} includes indicator variables for each state and each year, indicator variables for families with a single parent and children or other dependents, couples without children, and couples with children, and the age and age-squared, as well as indicator

variables capturing differences in educational attainment for the reference person.⁴ The coefficients vary over time.

[Figure 6]

In terms of levels, the education premium on average equals 1.38 and lies toward the bottom end of the college premium reported in Krueger et al. (2010), which averaged 1.62 across all countries in the year 2000. The flat post-2000 trend for the education premium in Australia resembles that Germany and Italy, and differs from the declining trend observed in Canada, Britain, and Russia, and the rising trend in the U.S. and Japan. The experience premium varies little, and lies well below the values reported in Krueger et al. (2010), exceeding only that for Russia, which lies close to par. The gender premium rises slightly from 2003 onward, but lies well below the average for 2000 reported by Krueger et al. (2010), resembling the levels observed in Italy. The slight rise in the gender premium contrasts with the declining trend observed in the U.S., Canada, Germany, Japan and to a lesser extent in Russia. The flat experience premium in Australia resembles that in Russia and Japan, and contrasts with the rising trend observed in the U.S., Canada, and Germany, and the declining trend in Italy.

Finally, the pattern for the variance of the log wage regression residuals estimated after controlling for demographic factors also exhibits no trend after the decline from 2001 through 2004. The initial decline in the regression residual resembles that in Britain, Italy and Russia, although the levels in Britain and Russia are more than twice as high as in Australia and Italy. Comparing the variance of log wage residuals with the variance of log wages in Figure 4 suggests that much of the inequality in wages arises from unobserved factors rather than observable characteristics, such as demographic composition and education.

Inequality in Labor Supply. Figure 7 depicts inequality of wages as in Figure 5, together with inequality of hours worked, the correlation between wages and hours worked, and inequality of individual earnings for men and women. While women have lower inequality of wages, they have higher inequality of hours worked relative

⁴ Educational attainment is defined as “highest level of education” and coded as follows: “Degree,” “Certificate or Diploma,” “Year 12,” and “Year 11 or below.”

to men across years. Like in Canada, the U.S. and Russia, inequality of hours worked in Australia remained roughly flat for males and declined slightly for females.

In addition, the correlation between wages and hours worked has been negative throughout the sample for men and women, but has trended toward zero, resembling that observed in Canada, where they also approached zero.⁵ While Krueger et al. (2010) argue that such a finding would be consistent with the basic neoclassical theory of labor where the income effect dominates the substitution effect, contrary to other studies, as in Canada the correlation is closer to zero for men than women.

[Figure 7]

The higher inequality of hours worked among women also mirrors the higher inequality of earnings among women compared to men. Only two other studies report earnings inequality for men and women. For the U.S., Heathcote et al. (2010) show that earnings inequality for men and women is similar, while in Japan, Lise et al. (2014) show that earnings inequality is higher for women than men, as in Australia. Heathcote et al. (2010) and Lise et al. (2014) also show that the log variance of individual earnings has been rising for men and women after 2000 in the U.S. and Japan, respectively, which contrasts with the flat earnings inequality pattern for men and declining pattern for women in Australia.

Also, the convergence between inequality of hours worked for women relative to men is consistent with a market in which female labor force participation rises. To examine this in more detail, Figure 8 depicts labor supply for part-time workers, full-time workers, as well as the usual reported hours worked per week and labor force participation. One possible explanation for higher inequality of hours worked for women is that women are more likely to work part-time rather than full-time: around 25% of women in the workforce work part-time, while about 5% of men work part-time (Figure 8). Female labor force participation rapidly increased until the crisis in 2008 and then declined as shown in Figure 8. For men, labor force participation increased slightly until 2009, and has since declined slightly.

⁵ Hourly wages are calculated as earnings divided by hours worked, and thus measurement error in reported hours worked might lower the correlation (Krueger et al. 2010).

[Figure 8]

4.2. Household Inequality

Earnings Inequality. We examine household earnings inequality for the raw series, the equivalized series, and also the residual from equation (3). Figure 9 shows that household earnings inequality declines through 2008, but rises in 2009 and 2010 during the recent crisis. The rise in earnings inequality during the crisis is consistent with the finding that earnings inequality rises during recessions (e.g., Krueger et al. (2010)). The size and the trend of the residual in the left hand panel of Figure 9 indicates that the observables including age and education of the household reference person, the region in which the household lives, and type of family explain relatively little of the variation in earnings. Comparing Figures 9 and 10 we observe that aside from a spike in 2004, household and equivalized earnings inequality falls through 2008, then it increases through 2010, before falling again. Also, equivalized earnings inequality slightly exceeds raw earnings inequality, as in Germany, Italy and Spain.

[Figure 9]

[Figure 10]

In terms of the trend in Figure 9, early in the sample, as in Russia, all measures of earnings inequality exhibit a slight decline. This contrasts with results in Canada, where all reported measures rise, and in Britain, where all measures remain largely flat. In terms of the decomposition, the pattern and order of each component resembles that in Canada, with family type being more important than education, which exceeds both age and regional factors.

Figure 10 depicts the four measures of household earnings inequality. The trend for household inequality differs from the trend for individuals shown in Figure 4. While individual earnings inequality has been mostly flat, household earnings inequality generally shows a declining trend until 2008, rises during the crisis and drops again after the crisis.

We observe this pattern for the variance of log earnings, the Gini coefficient, and the p50/p10 ratio but not the p90/p50 ratio. The earnings inequality measure at the bottom of the distribution (p50/p10) is much higher than at the top end of the distribution (p90/p50), indicating that the bottom 10th percentile of the household

earnings distribution has fared worse than the median, resulting in a ratio for earnings between 3.5 and 4. This ratio is much larger than the relative earnings of the top 10th percentile relative to the median (p90/p50), which is slightly higher than 2.

Inequality at the household level is much higher in all four measures of inequality compared to the individual level of inequality. This could be due to assortative mating, which refers to a positive association between the values of the traits such as education and income among the couple. Using data from the U.S. Census Bureau, Greenwood et al. (2014) find that there has been a rise in assortative mating and assortative mating worsens household income inequality. Their analysis suggests that the Gini coefficient in 2005 would have fallen from the observed 0.43 to 0.34, had the matching between husbands and wives been random.

From Wages to Disposable Income. Figure 11 depicts the log variance of equivalized pre-government household earnings (y^{L+}), pre-government non-financial income (y^L), and total disposable (post-government) income of the household (y^D). As in Australia, in the U.S., Canada, Britain, Germany and Japan, disposable income inequality rose slightly after 2000. However, unlike in other countries where pre-government income inequality tended to rise, in Australia pre-government income inequality fell slightly. The differences between pre-government and post-government equivalized income inequality reflect the extent of progressivity in the Australian system of taxes and transfers.

[Figure 11]

To estimate the degree of progressivity in the tax system, we start with the mapping between disposable post-government earnings and pre-government earnings used by Heathcote et al. (2014a, 2014b):

$$y^D = \lambda(y^{L+})^{1-\tau}, \quad (4)$$

where λ measures the average level of taxation and $(1 - \tau)$ measures the elasticity of post-government income to pre-government income, and τ measures the degree of progressivity in the tax system. We estimate τ by regressing the log of household

post-government income against a constant and the log of household pre-government income by year.

The estimate of the progressivity parameter ranges from 0.51 to 0.53 prior to crisis years and dips to 0.47 during the crisis 2008 and 2009, while the constant ranges between 5.7 to 6.2 before the crisis but falls to 5.2 to 5.3 during the crisis (all estimated parameters are statistically significant at the 1 percent level and R^2 ranges between 0.53 and 0.66 throughout the sample period). Figure 12 plots the estimates for progressivity parameter and constant term for each year. These findings suggest that the average degree of progressivity decreased during the crisis years, and that the average level of taxation also fell during the crisis. Given that Heathcote et al. (2014a, 2014b) report the range of 0.151 to 0.185, the Australian tax and transfer system appears more progressive than those in the U.S. However, unlike Congressional Budget Office figures reported by Heathcote et al. (2014b), which suggest the degree of progressivity increased slightly in the U.S during the 2008-2010 period, our estimates suggest they fell.

[Figure 12]

Consumption Inequality. Figure 13 shows that inequality of the raw, equivalized, and residual non-durable consumption, estimated using equation (3), was low and fell slightly throughout the sample. This indicates that vulnerability declined slightly. Moreover, much of non-durable consumption inequality remains unexplained by demographic factors. As with earnings inequality, family type has the most explanatory power, although inequality still lies close to zero.

[Figure 13]

From Disposable Income to Consumption. Figure 14 compares equivalized disposable income and consumption inequality from 2006 through 2012. Little difference exists between disposable income and consumption inequality at the top end of the distribution, although a much larger difference exists at the bottom of the distribution. This pattern is also repeated in the U.S., Canada, Britain, Germany, and Italy through 2005. Heathcote et al. (2010) suggest that one reason for this finding

could be that temporary income shocks, which are only partially transmitted to consumption, are more likely to affect the bottom of the distribution than the top.

[Figure 14]

The distribution of consumption appears symmetric given the similarity in the bottom two panels of Figure 14 depicting the p50/p10 and p90/p50 ratios. This is in contrast to household earnings inequality, where the p50/p10 ratio far exceeds the p90/p50 ratio, as we observed for Figure 10. Comparing across panels, the log-variance of disposable income rises while the log variance of consumption declines slightly. For all other measures, both disposable income and consumption inequality decline. Overall, these measures indicate that before, during and after the crisis, households insure against income shocks, corroborating evidence presented in Miller (2014). We can also examine the extent of risk sharing through the intermediation of risk.

Krueger and Perri (2011) propose measures of the degree of risk intermediation to examine whether public income insurance can improve upon private sector income insurance under incomplete risk sharing. For the purpose of accounting for risk sharing, total, government and private intermediation ratios are defined as follows:

$$\text{Total intermediation of risk} = 1 - \frac{\text{SD}(\text{consumption})}{\text{SD}(\text{pre-government income})}, \quad (5a)$$

$$\text{Government intermediation of risk} = 1 - \frac{\text{SD}(\text{post-government income})}{\text{SD}(\text{pre-government income})}, \quad (5b)$$

$$\text{Private intermediation of risk} = 1 - \frac{\text{SD}(\text{consumption})}{\text{SD}(\text{post-government income})}, \quad (5c)$$

where $\text{SD}(\cdot)$ is the standard deviation operator, consumption is nondurable expenditures, and pre-government income includes private transfers, while post-government income adjusts for taxes and government transfers. Under perfect risk sharing, where the standard deviation of consumption equals zero, total intermediation equals one and coincides with private intermediation. Similarly, under

perfect private income risk sharing, private intermediation is same as total intermediation and equals one. For government intermediation, we report the empirical version, rather than that for an assumed tax function as in Krueger and Perri (2011). Government intermediation, however, could reflect the progressivity of the tax system nonetheless, since it measures the extent to which pre-government income inequality exceeds post-government income inequality as a fraction of pre-government income inequality. We report all three measures for each wave in Figure 15.

[Figure 15]

The results indicate that total intermediation of risk has ranged from 60 to 70%, and that private intermediation has accounted for much of that intermediated risk. Government intermediation of risk, to the extent that it reflects progressivity of the tax and transfer system, suggests that progressivity has declined slightly through 2009 and has since increased slightly.

Earlier we reported that our estimate of the degree of progressivity fell during the crisis relative to non-crisis years. Figure 15 also confirms this as government intermediation of risk prior to the crisis was higher than during the 2008-2010 period. Since Krueger and Perri's (2011) measure of government intermediation also equals their measure of the degree of progressivity, then the decline in progressivity during the crisis could reflect the smaller gap between the standard deviation of pre- and post-government income.

Inequality over the Life Cycle I and II. Deaton and Paxson (1994) show that the age profile present in income and consumption inequality can reflect the ability of households to insure against risk over time. Given the findings in the previous section that households appear to share risk, we examine the extent to which this holds true over the life-cycle.

To get a picture of inequality over the life-cycle, we estimate the following regressions, to determine the age profile of inequality, controlling for either time as in equation (6a) or cohorts as in equation (6b):

$$M_{at} = \delta_{0,t} + \sum_{a=1}^A \delta_a \text{agegroup}_a + \sum_{t=1}^T \delta_t \text{year}_t + \varepsilon_{at}, \quad (6a)$$

$$M_{ak} = \delta_{0,t} + \sum_{a=1}^A \delta_a \text{agegroup}_a + \sum_{k=1}^K \delta_k \text{cohort}_k + \varepsilon_{ak}, \quad (6b)$$

where M_{at} measures the variance of log for either wages, earnings, disposable income or non-durable consumption, agegroup_a is a set of indicator variables for age groups $a = 25-29, \dots, 50-54$, and 55 or older, year_t is a set of indicator variables for years 2002 through 2012, and cohort_k is a set of indicator variables for age cohorts $k =$ born before 1950, between 1950 and 1959, between 1960 and 1969, between 1970 and 1979, and after 1980. As Heathcote et al. (2010) point out, the linear dependence between age, cohort and year effects means that we cannot determine whether cohort or year effects explain observed inequality.

In Figure 16 we report the results controlling for time effects as in equation (6a), while in Figure 17 we report the results controlling for cohort effects as in equation (6b). Figures 16 and 17 show that over the life-cycle, earnings inequality exceeds wage inequality and non-durable consumption inequality. Building on our earlier findings, the results indicate that households share risk over the life cycle as well.

[Figure 16]

[Figure 17]

Also, Storesletten et al. (2004) find that linearity (non-linearity/concavity) of the age profile of inequality shocks suggests a unit root (less than a unit root). With complete markets, consumption inequality would be flat over the life cycle, while under autarky, consumption inequality would mirror that for earnings. Our findings suggest that the behavior of Australian households conforms to those predicted by Storesletten et al. (2004) as wages, as well as earnings from ages 30-45, exhibit a concave life-cycle profile, whether we adjust for time or cohort effects, which could indicate the series exhibit less than a unit root. The convexity of the earnings profile outside of the ages 30-45 could reflect heterogeneity for younger adults, as well as

increasing dispersion in hours worked among those nearing retirement. Consumption has a linear profile suggesting a unit root process could characterize the series.

Figure 18 depicts the raw and equivalized household earnings controlling for time and cohort effects to compare the changes aligned along a common scale. Figure 18 shows that equivalizing tends to tilt the earnings profile, increasing it especially for younger households, while decreasing it slightly for older households, which would be consistent with Heathcote et al.'s (2010) observation that equivalization magnifies inequality for younger families. Also, since the profiles in the left panel are steeper than those in the right panel, earnings inequality in Australia appears due more to greater within-cohort inequality rather than a general increase in earnings inequality for successive cohorts.

[Figure 18]

Wealth. The HILDA survey has included a wealth component every fourth wave since Wave 2. Figure 19 depicts the ratio of net financial wealth to disposable income across all households, the Gini coefficient for net financial wealth, the ratio of net total wealth to disposable income across all households, and the Gini coefficient for net total wealth.

[Figure 19]

While the ratio of total net financial wealth to total disposable income dipped in 2006, the ratio of total net total wealth to total disposable income has increased across the three waves from three to eight to almost twelve. One possible explanation for the dip in net financial wealth could be that households appear to have switched out of equity investments and into housing even though the stock market was still rising in 2006 (see Kecmanovic and Wilkins (2013)). At the same time, home prices continued to rise throughout the sample (see Wilkins (2013)). In terms of inequality the Gini coefficients for net financial and net total wealth are roughly twice as high as the Gini disposable income, and non-durable consumption, and both measures of inequality suggest that wealth inequality remained flat during the sample.

Stochastic Wage and Income Process. Given that the calibration and estimation of heterogeneous agent models often make use of parameters estimated using structural models of income dynamics from panel data, we estimate the following model:

$$\ln y_{i,t} = x'_{i,t} \beta_t + \beta_{0,t} + \varepsilon_{i,t}^y, \quad \text{with} \quad \varepsilon_{i,t}^y \sim N(0, \sigma_{\varepsilon^y,t}^2) \quad (7a)$$

$$\beta_{0,t} = \beta_{0,t-1} + \varepsilon_{i,t}^\beta, \quad \text{with} \quad \varepsilon_{i,t}^\beta \sim N(0, \sigma_{\varepsilon^\beta,t}^2), \quad (7b)$$

where $x_{i,t}$ includes age and age-squared, indicator variables capturing differences in educational attainment, regional location, and family, with coefficient estimates β_t varying over time, and $\beta_{0,t}$ captures the permanent component of the process, while $\varepsilon_{i,t}^y$ captures the transitory component of the process. We assume the errors in (7a) and (7b) are i.i.d. across households, uncorrelated over time, and allow the variance of the errors to vary over time.

Figure 20 plots the variance of the permanent and transitory shocks for wage, pre-government income, both excluding and including financial income, and disposable income. For each measure, the variances of the permanent and transitory shocks are similar in all cases. Wage shocks exhibit the lowest and least volatile variances, followed by disposable income shocks. Pre-government income shocks are the highest and exhibit the most volatility. Moreover, the differences between the variances of the permanent shocks for pre-government income and disposable income exceed those for the transitory shocks. This suggests that the system of taxes and transfers in Australia does reduce the variance of permanent shocks, rather than transitory shocks.

[Figure 20]

5. Conclusions

Inequality, across most measures from individual wages and earnings to household non-durable consumption and wealth in Australia for the most part remained flat between 2001 and 2012. Unions and minimum wage policies may push inequality down. The progressivity of the tax and transfer system in Australia, appears quite high. Still, taxes and transfers seem to reduce the variances of permanent

income shocks, rather than transitory income shocks, such that taxes and transfers may help households manage permanent shocks.

More importantly, wealth inequality exceeds disposable income inequality, which exceeds non-durable consumption inequality. Non-durable consumption inequality varies little over time. Much of total intermediated risk appears to be intermediated through private channels. Moreover, households also appear to insure against income shocks over the life-cycle. These findings suggest that on average households appear year-to-year to insure against wealth and income shocks, even during the recent crisis.

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Table 1. Sample Selection for wage variable used in Figures 4-6

	Original	Dropped	Remaining
wave 1	19914	13308	6606
wave 2	18295	12104	6191
wave 3	17690	11648	6042
wave 4	17209	11333	5876
wave 5	17468	11354	6114
wave 6	17453	11291	6162
wave 7	17280	11171	6109
wave 8	17144	11033	6111
wave 9	17630	11403	6227
wave 10	17855	11588	6267
wave 11	23414	15245	8169
wave 12	23180	15142	8038
Total	224532	146620	77912
Due to age restriction (keeping $25 \leq \text{age} \leq 60$)		117017	
Due to trimming top and bottom 0.25 percentiles		338	
Due to keeping non-zero work hours ^a		28252	
Due to keeping wage $> 0.5 \times$ minimum wage		1013	

Notes: ^a Non-zero work hours constitute (1) non-responding person (N=6406); (2) implausible value, refused, don't know, 0 (N=158); (3) not asked (N=21688).

Table 2. Comparing HILDA and NIPA Figures for Income and Consumption Levels and Growth

	Levels		Growth	
	Income	Consumption	Income	Consumption
Australia	Yes	No	Yes	No
Canada	No	No	Yes	Yes
Germany	No	Yes	Yes	Yes
Italy	No	No	Yes	Yes
Japan	No	No	Yes	Yes
Mexico	No	No	Yes	Yes
Russia	No	Yes	Yes	Yes
Spain	No	No	Yes	Yes
Sweden	Yes	No	Yes	Yes
UK	No	No	Yes	No
USA	No	No	Yes	No

Note: Table 2 reproduces Table 2 in Krueger et al. (2010), with results from Lise et al. (2014) for Japan added.

Figure 1. Comparison with NIPA I (Wages and Salaries)

Figure 2. Comparison with NIPA II (Non-durable Consumption Expenditures)

Figure 3. Comparison with NIPA III (Employment to Population Ratio, Population 15-64)

Figure 4. Basic Inequality in Wages

Figure 5. Basic Inequality for Male and Female Wages

Figure 6. Wage Premia

Figure 7. Inequality in Labor Supply

Figure 8. Female and Male Labor Supply

Figure 9. Household Earnings Inequality and Its Decomposition

Figure 10. Basic Inequality in Equivalized Household Earnings

Figure 11. Inequality from Wages to Disposable Income

Note: Each graph depicts the log variance of the following series (equivalized). yL: pre-government non-financial income; yL+: pre-government household earnings including financial income; yD: total disposable (post-government) income of the household.

Figure 12. Progressivity and Average Level of Taxation, 2001-2012

Figure 13. Consumption Inequality and Its Decomposition

Figure 14. Inequality from Disposable Income to Consumption

Figure 15. Total, Private and Government Intermediation of Risk

Figure 16. Inequality over the Life Cycle I (Time Effects)

Figure 17. Inequality over the Life Cycle II (Cohort Effects)

Figure 18. Raw vs. Equivalized Earnings (Left: Controlling for Time Effect, Right: Controlling for Cohort Effect)

Figure 19. Wealth

Figure 20. Estimated Coefficients of the Stochastic Wage and Income Process

Note: yL: pre-government income excluding financial income; yL+: pre-government income including including financial income; yD: disposable income.