INCOME INEQUALITY, MOBILITY AND ECONOMIC INSECURITY IN AUSTRALIA

Nicholas Rohde*, Kam Ki Tang and Prasada Rao
School of Economics
The University of Queensland
Brisbane, Australia

In this paper we analyze income inequality and mobility using the first six waves of the HILDA (Household Income and Labour Dynamics in Australia) panel survey. The mobility of Australian incomes is measured and our evidence suggests that domestic wages and salaries are slightly less mobile than incomes in some other developed countries. This mobility is investigated in greater detail and it is found that much of the intertemporal variation occurs in the middle and lower end of the income distribution. Lastly we recognize that the mobility of an individual's income may be used as a measure of economic insecurity and we present measures of permanent income inequality that account for this phenomenon. We find that permanent income inequality increases substantially when adjustments to account for aversion to volatility are performed.

ACKNOWLEDGMENT

This paper uses the confidentialised unit record data files from the Household, Income and Labour Dynamics in Australia (HILDA) Survey. The HILDA Survey project was initiated and is funded by the Australian Government Department of Families, Community Services, Housing and Indigenous Affairs (FaCSHIA) and is managed by the Melbourne Institute of Applied Economic and Social Research. The findings and views reported in the paper, however are those of the authors and should not be attributed to either FaCSHIA or the Melbourne Institute.

---

*Address for correspondence: Nicholas Rohde, School of Economics, University of Queensland, Brisbane, Australia or n.rohde@uq.edu.au.

I. INTRODUCTION

Most research on the inequality of income is of the cross sectional variety, measuring the dispersion of incomes at a certain point in time. Although this approach is simple and appealing, a limitation is that incomes are rarely constant over a long time span and therefore the income of an individual at a single moment (or over a brief period) may be a poor reflection of his or her long run welfare. As a result, any inequality measurement taken at a single point will capture differences due to permanent, structural inequalities in incomes which will persist over time, and differences due to transitory fluctuations which will not. This issue is problematic for the interpretation of cross sectional inequality estimates as the welfare effects of permanent income inequality are very different from the welfare effects of fluctuations.

A solution to this problem is to employ longitudinal data sets to obtain inequality measurements that consider intertemporal income dynamics as well as cross sectional inequalities. One simple method is to obtain 'permanent' (long-run average) incomes for each individual. As they are calculated over a long time span, these incomes provide a good reflection of the economic welfare of each person and the inequality between these incomes gives a picture of the time-persistent or ingrained inequality within the economy. Several prominent studies that address this issue include the works of Burkhauser and Poupore (1997), Blundell and Preston (1998) and Gangl (2004) which quantify and compare permanent income inequality in the U.S. and various European countries.

A second method for including the effects of income dynamics into studies of inequality is to address the issue of income mobility. Consider a panel of data where substantial cross sectional inequality exists, and all incomes are perfectly immobile over the time period (i.e. each individual may earn a different income, but the incomes do not change). In this instance there will be no difference between short term static incomes and long run permanent incomes and all inequality measured is of the ingrained, permanent variety. Alternatively a case may exist where identical cross sectional inequality exists at a particular time period, but the incomes are highly mobile such that persons earning a low income in one time period may earn a high income at some subsequent point in time. In this instance there is likely to be a significant difference between static and permanent income inequality measurements due to the averaging out of transitory fluctuations over time. If this averaging process eventually equalizes all incomes, then permanent inequality is non-existent and all cross sectional inequality is of the transitory type.

In reality most income distributions are a combination of these two pictures, where a certain proportion of cross sectional inequality reflects permanent structural differences in earnings, while the remainder is the result of short term fluctuations. As the breakdown of cross sectional inequality into permanent and transitory components depends upon the mobility of incomes, we can incorporate income dynamics into inequality measurement by augmenting static or cross-sectional measurements with estimates of the mobility of incomes. Studies taking this approach include the work of Aaberge et al. (2002) which showed a similarity in income mobility between the United States and Scandinavian countries and other prominent works by Chen (2009), Jarvis and Jenkins (2001) and

Canto (2000) which presented estimates of income mobility in Britain and Spain respectively. Recent research of this kind on Australian data includes work on inter-generational income mobility by Leigh (2007) and a study of mobility and the financial disadvantage of children by Harding (2006). Other prominent papers include the works of Barrett et al. (2000), Breusch and Mitchell (2003) and Headey et al.'s (2005) analysis of poverty and mobility.

In this paper we seek to add to the aforementioned literature by exploring the links between income inequality and mobility using Australian data. Using a set of established techniques we measure mobility and inequality and study the interaction between these concepts. We also use some more progressive methods to examine the mobility of incomes in finer detail. This may be motivated by noting that intertemporal variation at the lower end of the income distribution has a different impact upon welfare than mobility at the higher end; and hence a need exists to distinguish between these cases. The differing impacts arise as low end mobility describes the movements of individuals in and out of the lowest earning income groups, while high end mobility describes the movements of persons between the mid level and higher income groups. As a result of these movements low end mobility tends to compress the long run average incomes of low and middle income earners, while high end mobility reduces permanent income inequality at the middle and higher end.

The idea that mobility varies over the distribution to further effect by using it to study economic insecurity. Like Jarvis and Jenkins (2001) and Hacker (2004) we acknowledge that while income mobility has a 'good' aspect in that it tends to reduce structural inequality, it also has a 'bad' aspect in that it may be seen as an undesirable source of anxiety. This issue is addressed by following authors such as Allanson (2008) by factoring in disutility from income volatility into our study. This is done by employing a concave, monotonic utility function to determine a risk free income level for each individual that yields the same utility as each original income stream. By calculating the inequality between these 'risk adjusted' incomes we can determine the effect of economic insecurity upon long run inequality. As we are able to determine a mobility based 'risk premium' for each individual this method also provides some further innovative techniques for investigating the location of mobility over the distribution of income more thoroughly.

The paper is organized as follows: In Section 2 the data set is introduced and the processes of organizing and preconditioning the data are described. In Section 3 we begin by comparing cross sectional inequality estimates with measurements based on permanent incomes to show that there is dynamic mobility within our dataset. This mobility is measured using several methods in Section 4 and some cross national comparisons are provided to place the estimates for Australia in context. In Section 5 our focus turns to investigating where the mobility in Australian incomes occur across the distribution. Section 6 builds on this concept by presenting measurements of inequality adjusted for the economic insecurity due to income volatility and presents some further evidence on the location of Australian income mobility.

II. DATA

Our data comes from the first six waves of the Australian HILDA data panel which presents the results of a series of annual surveys starting in 2001. Though a number of income related variables are available we use the imputed series _WSCEI throughout the paper. This variable contains the average weekly wage and salary incomes of over 20,000 Australian individuals accruing from all forms of paid employment over the time period. The incomes used are reported before taxation and governmental transfers take effect and hence the results we obtain are slightly different to those obtained in comparable studies (such as by Chen (2009), Jarvis and Jenkins (2001) and Canto (2000)) where data representing after tax and transfer incomes are used. We use this more basic data series as we are interested in examining the effects of earnings volatility upon inequality; and as market income is more exposed to changing labour market conditions and other factors than net income it makes a more appropriate vehicle for our analysis. We anticipate that the inequality and mobility within this data set would be slightly higher than if net incomes were used due to the smoothing and redistributive effects of taxation and transfers.

As estimates of income mobility are typically sensitive to persons entering and leaving labour markets we condition our data upon labour force participation to filter out these effects. This is done as the entry of persons into the labour force creates substantial upward mobility as their market earnings increase from zero, while persons leaving the labour market due to retirement, maternity etc typically see their wage/salary fall back to zero. As these changes are not representative of dynamic mobility within the distribution (rather they involve movement in and out of the sample) they are removed, allowing our results to reflect mobility and inequality within the continuing labour force. Thus employed and unemployed workers are included in the sample but persons who drop out of the labour force are omitted for the period of their absence. Furthermore, as we are interested in dynamic changes in income we require that each individual reports participation in the labour force for at least two of the six surveyed years such that a basis for intertemporal comparison exists. Such a restriction is rather undemanding however and we note that the majority of participants' record incomes for either five or six of the six time periods, and that omitting these observations still leaves a final sample of 9000 individuals. Lastly we removed the effects of inflation and economic growth from our data as these factors, even if they occurred in a uniform fashion, would influence our estimates of income volatility. This was done by scaling the incomes from each wave such that the mean income levels were equivalised at the 2002 level and the transformation does not affect the estimation of inequality or mobility statistics.

III. CROSS SECTIONAL AND PERMANENT INCOME INEQUALITY

Suppose we have the set of n incomes across k time periods $X = \{x : x_{it} \in \Re \wedge \geq 0\}$ where x_{it} is the income of individual i in time period t. There are a large number of inequality indices that may be used to measure the dispersion of incomes at cross section t. Here we select two practical measures, the Gini coefficient and half the square of the

Coefficient of Variation to estimate the inequality at each cross section. The Gini coefficient is chosen as it satisfies important axiomatic criteria such as the transfer principle and is frequently employed in empirical studies on the distribution of income. Half the squared Coefficient of Variation is another popular axiomatically sound index and is a member of the Generalized Entropy (GE) class of measure (see Cowell, 1981). Both measures can handle distributions that contain incomes of zero and make a useful pairing as the Gini coefficient is more sensitive to income changes around the mean of the distribution while half the squared Coefficient of Variation is more sensitive at the extremities.

The Gini coefficient at cross section *t* is

$$G(x_{it};t)=\frac{1}{2n_t^{\,2}\mu}\sum_{i=1}^{n}\sum_{j=1}^{n}\left|x_{it}-x_{jt}\right| \tag{1}$$

where μ is the mean income level as equalized across all time periods. Similarly half the square of the Coefficient of Variation is given as

$$\frac{1}{2}CV^2(x_{it};t)=\frac{\sum_{i=1}^{n}(x_{it}-\mu)^2}{2n_t\mu^2} \tag{2}$$

Calculating inequality between $x_1 \ldots x_n$ at $t=1\ldots k$ (from 2002-2007) using these measures gives the figures in the following table.

Table 1. Income inequality estimates for Australia 2002-2007

Year	Gini	$\frac{1}{2}CV^2$
2001	0.415295	*0.357434*
2002	0.409930	*0.348875*
2003	0.408777	*0.341132*
2004	0.408014	*0.352275*
2005	0.405966	*0.352989*
2006	*0.397624*	*0.311870*

The figures in Table 1 show a slight but steady decline in cross sectional inequality over the time period, however as we have noted these static estimates do not provide a full picture of Australian inequality if there is a degree of income mobility within our distribution. To counter this problem we use permanent incomes averaged across multiple time periods in place of simple cross sectional observations. Though our data do not extend sufficiently into the past to determine true permanent incomes of each individual we may generate an estimate of each person's long run income simply by averaging yearly incomes over time. If individual i earns the incomes $x_{i1}, x_{i2,} ... x_{ik}$ over k time periods then we define the estimate of the permanent income of person i as

$$x_i^* = \frac{1}{k}\sum_{t=1}^{k} x_{ik} \tag{3}$$

where x_i^* is an estimate of the permanent income of individual i. The inequality between the permanent incomes x^* is calculatable using standard inequality indices and is measured at $G(x^*) = 0.3678$ for the Gini coefficient and $\frac{1}{2}CV^2(x^*) = 0.2765$ for half the squared Coefficient of Variation. As these indices are substantially lower than the static inequality estimates provided in Table 1, we note that a degree of income mobility within our distribution is implied from the partial convergence of long run incomes. This mobility is investigated in further detail in the next few sections using a variety of techniques to provide a detailed representation of income dynamics and inequality.

IV. MEASURES OF INCOME MOBILITY

A formal treatment of intra-distributional income mobility can be provided using the inequality based R measure from Shorrocks (1978, 1981). The R index measures the extent to which permanent incomes are equalized as the time period over which they are measured increases. Calculated as the ratio of long run inequality to a weighed average of static measures over some time period, the index has a simple interpretation as the proportion of cross sectional inequality that persists over an extending accounting period. The index lies between zero and one, where higher values indicate greater levels of rigidity of incomes through time. This concept is well illustrated by recalling the two examples of mobility and immobility given in the introduction. In both instances we considered cases where substantial cross sectional inequalities existed, however in the first scenario the incomes were immobile while in the second, all short term inequality was the result of transitory fluctuations which were eventually averaged out over time. Applying Shorrocks' R to these distributions would yield a persistent value of one for the first instance as there is no scope for reductions in long run inequality due to mobility, while in the second case the Shorrocks' R would diminish from one to zero rather quickly due to the offsetting effects of transitory income movements.

The R measure may be calculated using the equation

$$R = \frac{I(X)}{\sum_t w_t I(x_t)} \tag{4}$$

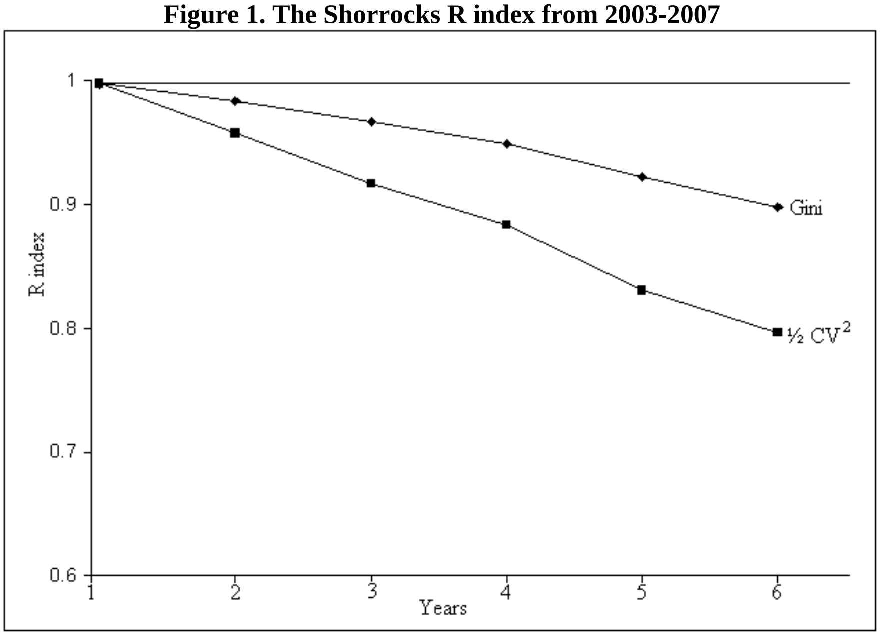
where $I(X)$ is the inequality of permanent incomes from 1...t time periods, w_t is the ratio of income in time period t to the average income level i.e. $w_t = (\mu_t / \mu)$ and $I(x_t)$ is the inequality at cross section t. The evolution of the R index for Australia from 2003-2007 is given below for our two inequality measures.

Table 2. The Shorrocks R index for Australia from 2002-2006

Measure	R Wave I-II	R Wave I-III	R Wave I-IV	R Wave I-V	R Wave I-VI
Gini	0.986129	0.969785	0.9523	0.924266	0.899772
½ CV^2	0.960073	0.91848	0.885935	0.832373	0.798473

As evident in Table 4 and Figure 1 below, the choice of income inequality metric has a substantial impact on the Shorrocks R index. Statistics calculated using the Gini coefficient usually give higher values for R than for other inequality measures (Jarvis and Jenkins, 2001) that place greater weights on the extremities of the income distribution. Thus for a meaningful cross national comparison to be made we need to ensure that (i) the same inequality measure is used across both studies and (ii) that the measure is taken over a time period of equal length. Estimates of R for the U.S. using the Gini coefficient are placed at 0.97 for a one year accounting period (Burkhauser and Poupoure, 1997) while Jarvis and Jenkins (2001) estimate the same figure for Britain to be 0.95. This figure is also estimated at 0.95 for Spanish data by Canto (2000). Our estimate of 0.986 (see Table 4) for Australia indicates that 98.6% of the cross sectional inequality as measured by the Gini coefficient persists over a one year period. This figure suggests a lower level of income mobility than for the three other countries.

Figure 1. The Shorrocks R index from 2003-2007



The longer term trends in R indices may be examined using Figure 1 which shows a slow but egalitarian trend using both measures. For instance we note that the Gini coefficient declines by around 10% over a six year period, while half the squared Coefficient of Variation is reduced by approximately double this amount over the same length of time. The more substantial reduction in inequality as measured by half the squared Coefficient of Variation relative to the Gini coefficient is likely to be the result of the strong sensitivity the measure exhibits to changes in incomes at the high end of the distribution.

Comparable longer term results for R using the Gini coefficient were calculated by Burkhauser and Poupoure (1997) using data from the U.S. and Germany, though the data used represents incomes sampled in the 1980s. Their estimates place the R statistic at 0.787 and 0.880 respectively for these countries over a six year period. Both estimates are lower than the figure of 0.899 we estimate for Australia and suggest that Australian income inequality is more persistent than in the US or Germany two decades ago.

The results for Australia generated using the R index may be supported using other methods for measuring income mobility. Though somewhat ad hoc in nature the mobility estimates provided here are commonly calculated and are thus useful for cross national comparisons. These income mobility statistics work by measuring the degree of change as distribution $x_{t-1} = (x_{1,t-1}, x_{2,t-1}, \ldots x_{n,t-1})$ is transformed to distribution $x_t = (x_{1,t}, x_{2,t}, \ldots x_{n,t})$ over accounting period $t-(t-1)$. If each $x_{it-1} = x_{it}$ then there is said to be perfect income immobility or rigidity over the time period $t-1 \rightarrow t$, while an income mobility measure will take on non-zero values when a degree of difference between x_{t-1} and x_t occurs. As with the R index, the length of the accounting period will affect the measure of mobility as a short time period gives little opportunity for incomes to deviate. A commonly used measure of income mobility between two points in time is Hart's (1978) index, which can be calculated as

$$H = 1 - \rho(\ln x_{t-1}, \ln x_t) \qquad (5)$$

where ρ is the Pearson correlation coefficient. A simple measure of *im*mobility that is frequently quoted alongside Hart's index is the correlation between x_{t-1} and x_t. We present Hart's measure and the correlation coefficient for the mobility of incomes between our time periods in the table below.

Table 3. Australian income immobility and mobility indices

Waves	Correlation *(ρ)*	Hart's index
I-II	0.776364	0.192097
II-III	0.753326	0.184030
III-IV	0.771555	0.139528
IV-V	0.746114	0.146935
V-VI	0.759795	0.171575

The results may be compared to similar estimates provided by the Jarvis and Jenkins study of British mobility and Canto's equivalent study on Spain. Correlations between yearly income data for Britain lie between 0.56 and 0.69 while estimates for Spanish data are 0.705 and 0.867, depending on the sampling technique used. Estimates of Hart's measure for Spain are 0.225 and 0.096 under alternative assumptions. The results are consistent with our initial finding that Australian incomes are less mobile than their British counterparts; and are perhaps more similar to those described by Spanish data, despite the use of market income rather than net income for the Australian estimates. Combining these findings with those derived using the Shorrocks index encourages us to conclude that the transitory component of Australian inequality is relatively low compared to several other developed countries.

V. MOBILITY OVER THE DISTRIBUTION OF INCOME

Although the mobility indices estimated in the previous section provide a representation of intertemporal income movements over the entire distribution, they are silent on where this mobility occurs. For instance it is important to distinguish between distributions where volatility is concentrated at the lower, middle or higher end of the income scale. Mobility solely at the lower end of the income distribution enables lower income earners to increase their long run welfare by progressing upwards, but provides little chance for a low income earner to reach the top end in the future. Conversely mobility at the top of the distribution implies that the chances of an individual progressing to the top of the income distribution are quite good; providing they did not start at the lower end of the income scale where earnings are rigid.

In this section we characterize Australian income mobility in this manner using several more mobility measures. A simple technique for roughly locating intertemporal mobility is to give the correlation coefficient and Hart's index for the lower and upper 50% of the distribution where incomes are ranked according to x^*. The correlation coefficient for incomes between waves is noticeably higher for the upper 50% of the income distribution (denoted U in the table) than the lower 50% (denoted L). This figure varies between around 0.3 and 0.5 at the lower end, and 0.6-0.7 at the higher end of the distribution, indicating a greater level of dynamic stability for higher income earners, though the finding is not supported by estimates of Hart's index where the use of logarithms suppresses correlation at the upper end of the distribution but increases correlation at the lower end.

Table 4. Correlation coefficient and Hart's index for lower and upper 50%

Waves	Correlation *(ρ) L*	Correlation *(ρ) U*	Hart's index *L*	Hart's index *U*
I-II	0.499560	0.703468	0.336053	0.353176
II-III	0.330104	0.678576	0.328900	0.356565
III-IV	0.398698	0.700592	0.304025	0.236946
IV-V	0.407170	0.663191	0.281056	0.266082
V-VI	0.526415	0.665210	0.292227	0.308963

Though the truncated correlation coefficients and estimates of Hart's index provide a guide to the location of the bulk of mobility within the distribution, the trend can be explored in further detail by using the transition matrix given below. The matrix is constructed by defining five pentile groups; each of which consists of 20% of the total population where incomes are ordered from the lowest to the highest such that pentile I contains the lowest earning 20% and pentile V has the highest earning 20%. This is done for two time periods of three years in length, P1 and P2 (P1 is from 2001-2003, P2 from 2004-2006) where membership to a particular pentile is based on the average income of each individual over each three year period. In instances where several individuals earned the same average income and spanned a population cutoff they were assigned to pentile groups proportionately, though alternative groupings of these individuals exist that are as feasible as the allocation used. This is not expected to have a significant effect on the interpretation of the table however as such instances were small and infrequent.

As per the description, the matrix shows the flow of individuals between pentiles from time period P1 to time period P2 and hence provides a detailed picture of mobility within the distribution. An examination of the first row reveals that 56.75% of persons in the lowest income group during P1 were also in the lowest pentile for P2, while 27% of these low income earners had progressed to pentile II over this period. Remarkably only 1.6% of persons in the lowest income group from 2001-2003 found themselves in the highest income group in 2004-2006.

Table 5. Transition matrix for Australian income pentiles from 2001-2003 to 2004-2006

P1/P2	I	II	III	IV	V
I	56.75%	27.07%	9.76%	4.81%	1.60%
II	25.94%	42.85%	21.19%	8.09%	2.21%
III	10.03%	21.79%	43.38%	20.05%	4.88%
IV	5.08%	5.75%	20.25%	51.00%	18.05%
V	2.74%	2.87%	5.08%	16.18%	73.06%

A notable feature of this table is the stability of the highest earning income group. Around 73% of persons in this pentile remained present after three years, which is the highest of all five income groups. The next most stable group is the lowest 20% while the most unstable is group the second lowest 20%. Together these results paint a picture of the Australian income distribution where the incomes of both low and high end earners are persistent while there is a reasonable degree of volatility in the middle and lower middle of the income distribution.

Two further interesting properties of the matrix include the heavily diagonal nature and the remarkable level of symmetry on the off-diagonal elements. The large values down the main diagonal reveal that in all cases the pentile an individual occupied in P1 is the best predictor of his or her income group in P2, and that this trend is especially strong at the extremities of the distribution. The symmetry over the off diagonal elements indicates that movements from one pentile to another are largely offset by movements in the opposite direction. For example, 9.76% of persons in pentile I moved into pentile III over the time period, while 10.03% of persons moved from pentile III down to pentile I.

VI. MOBILITY AND ECONOMIC INSECURITY

Throughout this article it has been somewhat implicit that income mobility is regarded as an attractive characteristic for a distribution of income to exhibit. This notion is usually tied in with worthy ideals of fairness and equal opportunity, however a flip side to these desirable characteristics is that for the individual, income mobility may represent economic insecurity (Hacker, 2006; Jarvis and Jenkins, 2001). A mobile income stream may be considered undesirable due to risk associated with income uncertainty (e.g. a volatile income may be perceived as more risky than a stable income, especially if the fluctuations are unanticipated) or a tendency for persons earning volatile incomes to over-consume in some periods and under-consume in others.

As the rationale for using permanent incomes over static measurements is that the permanent measure more accurately captures the welfare of the individual, it seems sensible to also consider the welfare effect of a volatile or unstable income. In this section we seek to include this factor in our analysis by modeling economic insecurity as an increasing function of the mobility of each individual. The approach we use has two advantages; firstly it allows us to standardize for economic insecurity across individuals such that a more complete measurement of inequality may be achieved, and secondly, as the economic insecurity estimated for each person gives a measurement of the mobility of that individual's income, the methodology employed gives a novel method for understanding the nature of mobility across the distribution.

Suppose individual *i*'s income stream $x_{i1}, x_{i2,} ... x_{ik}$ is fairly volatile over the period $t = 1...k$. If there are insufficient mechanisms in place to smooth the incomes stream through time, it is likely that this individual may prefer to accept some slightly lower average income if the new income level could be fixed without fluctuations. As this implies that volatile long run incomes are less desirable than steady incomes, we proceed by adjusting estimates of the permanent income of each individual to account for this disutility.

To capture this aversion to volatility we use the following utility function

$$U(x) = \frac{x^{1-\gamma}}{1-\gamma} \qquad 0 \le \gamma < 1 \tag{6}$$

where γ is a measure of risk. Choosing a value of zero for γ implies no aversion towards income volatility for the individual such that he or she would be indifferent between any two income streams of the same average monetary amount, while positive values for γ introduce an element of concavity to the utility function and a corresponding degree of aversion to income volatility. Once a choice for γ has been made, an immobile, 'risk free' income level for each individual that yields the same utility as income stream $x_{i1}, x_{i2,} ... x_{ik}$ may be determined. This income represents an alternative to the original income stream and is fixed throughout time such that an individual earning this income level is free of the economic insecurity from income volatility. This income level may be calculated as

$$x_i^{EDE}(\gamma)=\left[\left(\frac{1}{k}\sum_{t=1}^{k}U(x_{it})\right)(1-\gamma)\right]^{\frac{1}{1-\gamma}} \tag{7}$$

where x_i^{EDE} is the 'risk free' or Equally Distributed Equivalent (EDE) income (Atkinson, 1970) that provides the same utility as the original income stream. The EDE income will match the risk free permanent income when incomes are constant through time (i.e. $x_i^{EDE}=x_i^*$ if $x_{i1}=x_{i2}=...x_{ij}$). If there is a degree of volatility through time however (e.g. $x_{i1}\neq x_{i2}$) then the EDE income will be less than the average level (i.e. $x_i^{EDE}<x_i^*$), reflecting the reduction utility due to the risky nature of the income stream.

From the EDE income we also define a 'risk premium' for individual *i* as $r_i=x_i^*-x_i^{EDE}$. This provides a measure of the burden of the risk borne by the individual in dollar terms and may be interpreted as the maximum amount the person is willing to pay per year to make his or her income stable over time period $t=1...k$. The greater the risk premium r_i, the greater the mobility of the income stream $x_{i1}, x_{i2,}...x_{ik}$ and the greater the economic insecurity faced by the individual. Thus the variable r_i serves a dual purpose for us as it allows us to identify both mobility and economic insecurity within our distribution.

By subtracting this value from each individual's permanent incomes (working with x_i^{EDE}) we standardize for economic insecurity across agents for the basis of making inequality comparisons. The Gini coefficient for inequality between the EDE incomes becomes

$$G(x;\gamma)=\frac{1}{2n^2\mu^{EDE}}\sum_{i=1}^{n}\sum_{j=1}^{n}\left|x_i^{EDE}-x_j^{EDE}\right| \tag{8}$$

where μ^{EDE} is the mean EDE income level, while half the square of the Coefficient of Variation is given as

$$\frac{1}{2}CV^2(x;\gamma)=\frac{\sum_{i=1}^{n}\left(x_i^{EDE}-\mu^{EDE}\right)^2}{2n\mu^{EDE\,2}} \tag{9}$$

The estimates of inequality between the EDE incomes are a function of the data and the risk aversion parameter γ. For a given positive value of γ, how $G(\gamma)$ differs from G (and similar for $\frac{1}{2}CV^2(\gamma)$ and $\frac{1}{2}CV^2$) depends on the distribution of r_i relative to that of x_i^*.

If r_i maintains a stable ratio to x_i^* throughout the whole income distribution, then $G(\gamma)$ will be quantitatively comparable to *G*. If r_i is negatively related to x_i^*, i.e. lower income earners bear a bigger income risk in proportional terms than the rich, then $G(\gamma)$ will be greater than *G*, and the gap between the two measures will enlarge as the value of γ increases. The opposite is true if the rich bears bigger income risk than the poor. The findings are given in Table 6.

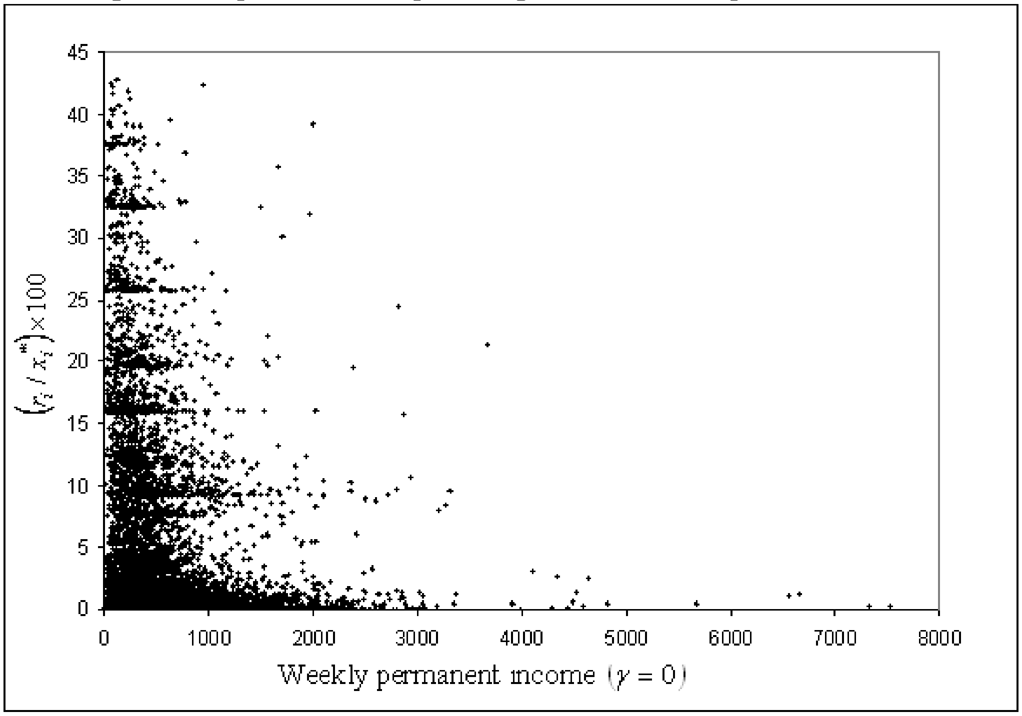
Table 6. Permanent inequality estimates accounting for volatility

γ	$Gini^{EDE}$	$\frac{1}{2}\, CV^{2\ EDE}$
0	0.367814	0.276534
0.1	0.370714	0.279923
0.2	0.374221	0.284174
0.3	0.378548	0.289601
0.4	0.384028	0.296686
0.5	0.391193	0.306204
0.6	0.400915	0.319464
0.7	0.414688	0.338796
0.8	0.435147	0.368448
0.9	0.464995	0.413406

The first entries where $\gamma = 0$ is associated with the set of incomes where $x_i^{EDE} = x^*$ and hence the estimates are equal to the measurements of permanent income inequality given in Section 3. For higher values of γ the results show an unambiguous increasing relationship between risk aversion and permanent income inequality for both sets of indices, indicating that lower income earners bear a proportionally higher share of mobility risk than higher income earners.

Again this result is consistent with our previous assertion that much of Australian income mobility lies at the lower end of the distribution and we may use the concept of the risk premium to examine this in further detail. The two graphs given below are particularly illustrative for this purpose. The first is a scatter diagram of each individual's risk premium (where $\gamma = 0.3$) as a proportion of total permanent income, plotted against risk neutral income. Though couched in terms of the risk premia, the values on the *y* axis are proportional to $\left(x_i^* - x_i^{EDE}\right)/\,x_i^*$ which is an expression for Atkinson's (1970) inequality metric for the measurement of intertemporal inequality for individual *i*, while the *x* axis gives permanent income inequality x_i^*.

Figure 2. Proportionate risk premia against risk neutral permanent income



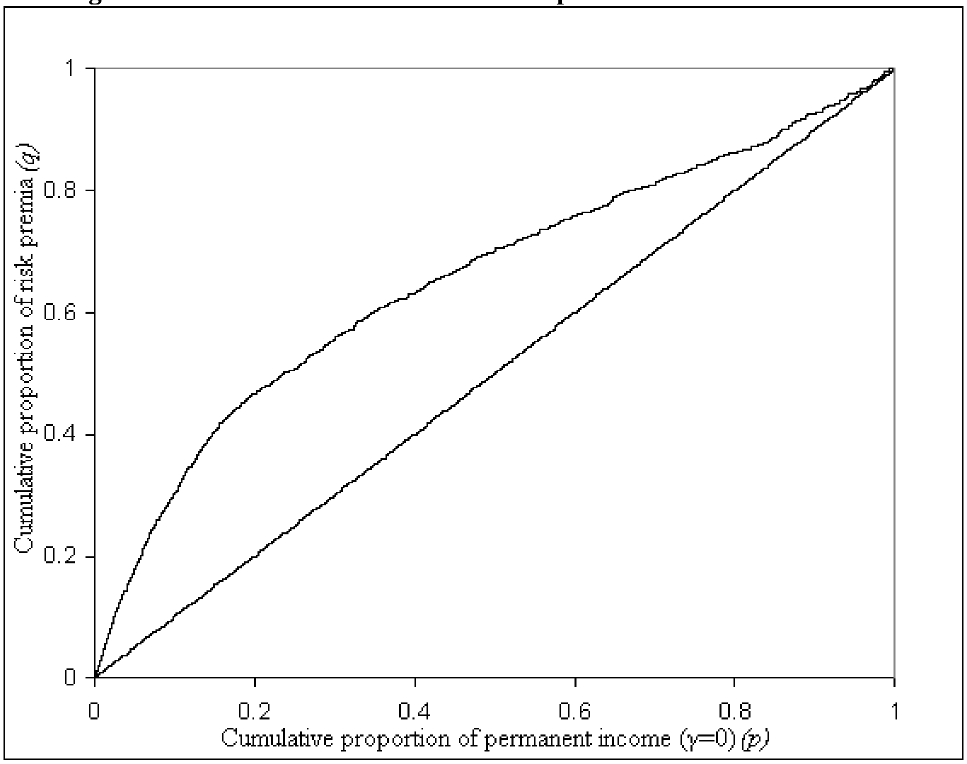
Two features of Figure 2 stand out in particular. The first is the distinctly higher welfare loss due to inequality for lower income earners than higher income earners and the finding is in keeping with our observation that mobility is greater at the lower end of the income distribution. The second feature worth commenting on is the existence of rather curious 'bands' of observations concentrated at certain levels of proportional risk premia. This phenomenon indicates that income volatilities tend to congregate quite strongly around certain levels, and the pattern persists for different choices of γ. While a clear explanation of this trend defies explanation from the authors, homogeneity of volatility within certain industries could be a possible cause.

The distribution of the risk premia may be further examined using Figure 3, which is a concentration curve for the risk premium as plotted against permanent income where the curve is constructed from incomes ordered from lowest to highest. The variable on the x-axis, *p*, is generated by expressing the cumulative total of permanent incomes accruing to the lowest earning *p* percentage as a proportion of total cumulative permanent income. The variable on the y-axis, *q*, gives the cumulative proportion of risk premia constructed. Again, $\gamma = 0.3$ is used in the figure though other choices for γ produce near identical results. The variables *p* and *q* are hence calculated as

$$p_z = \frac{\sum_{i=1}^{z} x_i^*}{\sum_{i=1}^{n} x_i^*} \qquad\qquad q_z = \frac{\sum_{i=1}^{z} r_i}{\sum_{i=1}^{n} r_i} \tag{11}$$

where $x_1^* \leq x_2^* \leq ... x_n^*$.

Figure 3. The concentration of income risk premia in Australia 2002-2007



We can observe the distribution of risk premia by comparing the plotted curve to the 45º line. If the risk premium increases proportionally with permanent income across the income distribution, the concentration curve will be close to the diagonal line, with the only perturbations being the result of random noise. Instead we note a substantial positive bias in risk premia for lower income earners. The lowest 10% earners bear over 30% of total volatility risk within this distribution and the lowest 20% earners account for 46% of the lost utility due to income uncertainty. This is also reflected in the fact that the slope of the concentration curve turns from over 45% to below 45% at around $p = 0.2$. Furthermore it may be observed that the concentration curve lies above the 45º line for the entire distribution, indicating that at no point does the lowest earning *p*% of the population bear less than the proportional *p*% of the economic burden of income insecurity.

Figures 2 and 3 suggest that mobility risk is highest at the very bottom end of the distribution, which is not instantly reconcilable with the results from Table 5 which shows that the lowest pentile is the second most stable income group. We note however, that Table 5 gives the flows of persons between pentiles and does not consider the mobility of incomes within pentile groups. Therefore, the results from these differing approaches are consistent if there is significant mobility within pentile I but that much of the mobility is insufficient to push persons into higher income groups.

The central implication of the results from the transition matrix and the risk premia is that if we do view income volatility as a suitable measure for income insecurity we see that lower income earners face further disadvantages than diminished earnings would suggest. As studies on permanent income inequality are primarily concerned with the welfare of the constitute individuals the inclusion of this effect appears to be a reasonable development.

VI. CONCLUSION

This paper analyzes recent data on Australian income inequality, mobility and insecurity. Our results suggest that overall Australian income mobility is lower than figures reported for several developed countries including Britain, the U.S. and Germany. Certain caveats concerning differences in variables analyzed and the differing windows in time over which the results are drawn do however apply. Using a variety of techniques we study Australian income mobility in greater detail and show that much of the mobility occurs at the middle and lower end of the distribution while high incomes tend to be relatively stable through time. The results collectively suggest that most of the income mobility in Australia could be the result of income churning amongst persons in the middle and lower income brackets There are three main conclusions that may be drawn from these findings: (i) volatility for lower incomes suggests ingrained poverty is lower than a standard cross sectional study would suggest, (ii) lower income earners face greater levels of economic insecurity than higher income earners, and (iii) few low income earners appeared to progress to the higher end of the distribution. We also find that by adjusting an individual's income stream to account for economic insecurity reveals a higher level of inequality as the burden of this volatility lies disproportionately upon lower income earners.

REFERENCES

Aaberge, R.., Bjorklund, A., Jantti, M., Palme, M., Pederson, P., Smith, N, and Wennemo, T. (2002), 'Income Inequality and Income Mobility in Scandinavian Countries Compared to the United States' *Review of Income and Wealth*, 48, 1-27.

Allanson, P. (2008), 'On the characterisation and measurement of the welfare effects of income mobility from an ex-ante perspective' *Dundee Discussion Papers in Economics*, No 219.

Atkinson, A.B. (1970), 'On the Measurement of Inequality' *Journal of Economic Theory*, 2, 244-236.

Barrett, G., Crossely., T and Worswick, C (2007), 'Consumption and Income Inequality in Australia' *Economic Record* 76, 223, 116-138.

Blundell, R. and Preston, I. (1998), 'Consumption Inequality and Income Uncertainty' *Quarterly Journal of Economics* 113, 2, 603-640.

Breusch, T. and Mitchell, D. (2003), 'Australian Family Income Dynamics: Preliminary Evidence from the NLC Project, 1997 & 2000'. *Negotiating the Life Course Discussion Paper Series* Australian National University.

Burkhauser, R. and Poupore, J. (1997), 'A Cross National Comparison of Permanent Inequality in the United States and Germany' In *The Distribution of Household Welfare and Household Production* (eds. S Jenkins, A Kapteyn and B. van Praage) Cambridge University Press.

Canto, O. (2000), 'Income Mobility in Spain: How much is there?' *Review of Income and Wealth* 46, 85-102.

Chen, H. (2009), 'Cross National Differences in Income Mobility: Evidence from Canada, The United Stats, Great Britain and Germany' *Review of Income and Wealth* 55,1, 75-100.

Cowell, F. and Kuga, K. (1981), 'Inequality Measurement: An Axiomatic Approach' *European Economic Review*, 15, 287-305.

Gangl, M. (2005), 'Income Inequality, Permanent Income and Income Dynamics' *Work and Occupations*, 32, 2, 140-162.

Hacker, J., (2006) 'The Great Risk Shift: The Assault on American Jobs, Families, Health Care, and Retirement, and How You Can Fight Back' *Oxford University Press*

Hart, P. (1978), 'The Comparative Statics and Dynamics of Income Distributions' *Journal of the Royal Statistical Society* 139:1 108-125.

Harding, A. (1997), 'The Suffering Middle: Trends in Income Inequality in Australia, 1982 to 1993-94 *The Australian Economic Review* 30, 341-358.

Headey, B. Marks. G and Wooden, M. (2006), 'The dynamics of income poverty in Australia: Evidence from the first three waves of the HILDA Survey' *The Australian Journal of Social Issues* 40, 541-552.

Jarvis, S. and Jenkins, P. (1998) 'How Much Income Mobility is the in Britain?' *The Economic Journal* 108 428-442.

Leigh, A (2007) 'Intergenerational Mobility in Australia' *The B.E Journal of Economic Analysis and Policy* 7:2.

Shorrocks, A. (1978), 'Income Inequality and Income Mobility' *Journal of Economic Theory* 19 376-393.

Shorrocks, A. (1981), 'Income Mobility in the United States' in N.A. Klevemarken and J.A. Lybeck (eds) *The Statistics and Dynamics of Income* Tieto.