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Inequality in Australia 1983-2004: A Stochastic Dominance Approach

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Abstract

In this paper, we employ stochastic dominance analysis on Australian unit records to investigate trends in inequality and relative welfare levels in Australia over the period 1983 to 2004. We find that that when the stochastic dominance tests are applied to income and expenditure distributions for the entire population, net transfers to households do not appear to make any significant difference on the distribution of inequality existing for each year. However, when analysis is applied to particular population subgroups in the economy, the tests show that taxes and transfers do improve existing imbalances in the distribution of welfare. Our group results strong evidence of long-term disparities in the relative welfare levels of male-headed over female-headed households, of households with children over those without, and of couple-parents families over their single-parent counterparts.

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1. Introduction

For a country which prides itself for giving a "fair go" to all and sundry, Australia appears conflicted as evidence of rising inequality mounts in the economic literature. In a most recent study, Nicholas, Ray and Valenzuela (2010) finds anew that the period 1988-2003 was marked by an increase in expenditure inequality and faults the regressive nature of inflation as an aggravating factor. Their results are consistent with those found in earlier works of Johnson and Wilkins (2004), Athanasopolous and Vahid (2003), and Barrett, Crossley and Worswick (2000a) among others, and despite strong reservations expressed by other researchers over the consistency of available data used over a long period of time (see, for example, Atkinson (2008) and Saunders and Hill (2008)). Clear as the trend seems to be, an unambiguous understanding of the reasons for this adverse observation remains elusive. Pendakur (1998) shows, using Canadian data, that fluctuations in both income and consumption inequality is countercyclical – they are high in time of recession and low in times of prosperity. Nicholas, Ray and Valenzuela (2010) point to the inequality increasing effects of inflation as a main cause, while some others (e.g. Harding and Greenwell (2002) and Pappas (2001)) suggest that the greater rate of growth of incomes at the top of end of the distribution is a key contributor. On the influences of demographic change, the findings for Australia are very contradictory. On the one hand, Athanasopolous and Vahid (2003) find increasing inequality among ageing households as a main culprit, while Johnson and Wilkins (2004) find changes in income unit composition over the years (eg growth of single-parent families) as being the major reason for the rising trend. Barrett, Crossley and Worswick (2000a), on the other hand, show exactly the opposite, that is, demographic changes in the population - including ageing households and changing family structures - account for only a minor component of the overall growth in economic inequality in Australia – a result which is much unlike those found for the US and Canada.

All that said, this trend towards greater inequality in Australia over time is in line with those found in other advanced economies in the world[1], but that offers little comfort in terms of identifying factors that help increase the gap between the rich and the poor in the economy. Consequently, identifying proper channels for policy intervention can easily be a speculative

[1]For examples of recent studies in rising inequality in other countries, see Frassdorf, Grabka and Schwarze (2011) for the UK, Germany and the US; Brzozowski et al (2010) for Canada, and Heathcote, Perri and Violante (2010) for the United States.

exercise. Has inequality increased uniformly for all populations groups? Do some groups have a disproportionate share of the inequality burden more than others? How has the government's redistribution policy helped? These are the questions we seek answers to.

In this paper, we revisit this issue of inequality in Australia and examine trends in the distribution of welfare using stochastic dominance analysis. The term stochastic dominance (SD for short) is generally used in decision theory to refer to situations where one outcome (or a probability distribution over outcomes) can be ranked as superior to another. The use of this technique is an important feature and contribution of this paper. Unlike singular measures of inequality, the stochastic dominance approach uses a systematic method for a pairwise comparison of several points in two distinct distributions – so it uses more information, presents a fuller picture of existing inequality level (at all possible points of comparison) and as such avoids the overly narrow cardinalisation of welfare functions as is done by singular inequality indices. Furthermore, singular measures such as the Gini coefficient or the Atkinson Index are known suffer from the lack of universal acceptance of the value judgments of the underlying welfare functions[2] which sometimes result in contradicting conclusions. In contrast, the SD approach ranks welfare situations over very wide classes of welfare functions, and as a result, conclusions drawn are more robust and more useful in the wider policy sense.

In our application, we employ the SD approach to analyse inequality over the entire population. As well, we divide the data into population subgroups along several dimensions and use stochastic dominance tests to analyse significant changes in relative inequality over time. We investigate this trend towards rising inequality using Australian unit record data spanning 20 years, and explore the issue in light of two verifiable facts: (i) that Australia is a welfare state, with strong policies for redistribution, and (ii) that Australia has enjoyed strong and sustained economic growth for over 20 years now. This study, which is also the longest period of study undertaken for Australia in terms of inequality trends for, updates the results obtained for this economy and the SD approach used provides new insights into the nature of the rising inequality trend in the country.

Thus being, this paper has the following structure. After a brief introduction and overview in Section 1, Section 2 introduces and describes some tests of stochastic dominance (describes

[2] See Maasoumi (2000) for an extended discussion.

theory of SD), their distributional characteristics and the bootstrap technique used. Section 3 presents the data, variable definitions and some summary statistics. Section 4 presents the empirical analysis and Section 5 concludes.

2. Tests for Stochastic Dominance

The term stochastic dominance is generally used in decision theory to refer to situations where one outcome (or a probability distribution over outcomes) can be ranked as superior to another. Testing for stochastic dominance of one distribution over another involves a pair-by-pair comparison of the "distances' at a finite number of points or ordinates on the curves. Ranking results are based on preferences (eg a higher value of an outcome is preferred), but require only limited knowledge of preferences with regard to the distribution of outcomes. Several tests for stochastic dominance have been proposed in the literature. In this paper, we employ SD test procedures based on a generalized Kolmogorov-Smirnov test discussed in Linton et.al (2005) and Maasoumi and Hestmati (2000). Alternative implementations of this type of tests have also been examined by several authors including MdFadden (1989), Klecan, McFadden and McFadden (1991) and Barrett and Donald (2003).

To describe the tests, we first set the following notation. Let *X* and *Y* be two outcome variables for any two groups or periods. These variables will either be income or expenditures of households, before or after tax incomes, at different points in time or location for some given population. For ease of exposition though, we will simply refer to both as income in this section. We let $X_{(i)}$ and $Y_{(i)}$ denote the i^{th} order statistics, and $F(x)$ and $G(x)$ denote the cumulative distribution functions (cdfs) of *X* and *Y* respectively. Assuming general von Neumann-Morgenstern conditions, we let U_1 denote the class of social welfare functions *u* such that welfare is increasing in income or $u' \geq 0$, and U_2 denote the class of all utility functions in U_1 for which $u'' \leq 0$. This strict concavity assumption represents a strong aversion to higher dispersion of incomes across individuals; in other words, a high concentration of incomes is undesirable. Quantiles $q_x(p)$ and $q_y(p)$ are implicitly defined by $F\left[X \leq q(p)\right] = p$.

Following on from Maasoumi and Heshmati (2000), we define the following key SD conditions. One, *X* First Order Stochastic Dominates (FSD) *Y*, denoted $X \succ_1 Y$, if and only if any one of the following equivalent conditions holds:

(1) $E\left[u(X)\right] \geq E\left[u(Y)\right]$ for all $u \in U_1$, with strict inequality for some *u*.

(2) $F(x) \leq G(x)$ for all *x* in the support of *X*, with strict inequality for some *x*.

(3) $q_x(p) \geq q_y(p)$ for all $0 \leq p \leq 1$.

If $X \succ_1 Y$, then the expected welfare from X is as least as great as that from Y for all increasing welfare functions, with strict inequality holding for some utility function(s) in the class.

Two, X Second Order Stochastic Dominates (SSD) *Y*, denoted $X \succ_2 Y$, if and only if any of the following equivalent conditions holds:

(1) $E\left[u(X)\right] \geq E\left[u(Y)\right]$ for all $u \in U_2$, with strict inequality for some u.

(2) $\int_{-\infty}^{x} F(t)dt \leq \int_{-\infty}^{x} G(t)dt$ for all *x* in the support of *X* and *Y*, with strict inequality for some *x*.

(3) $\int_0^x q_x(t)dt \geq \int_0^x q_y(t)dt$ for all $0 \leq p \leq 1$ with strict inequality for some value(s) *p*.

If $X \succ_2 Y$, then the expected welfare from X is as least as great as that from Y for all increasing and concave utility functions in the class U_2, with strict inequality holding for some utility function(s) in the class.

The tests of FSD and SSD are based on empirical evaluations of conditions (2) or (3) in the above definitions. Mounting tests on conditions (2) requires empirical cdfs and comparisons at a finite number of observed ordinates. Mounting tests on conditions (3) rely on the fact that quantiles are consistently estimated by the corresponding order statistics at a finite number of sample points. FSD implies SSD and higher orders[3].

We then proceed with the KS type tests analysis by first defining a "maximal" sets (originally due to McFadden (1989) and subsequently formalized in Maasoumi and Heshmati (2000)) as follows. Let $\Re = \{X_1, X_2, ..., X_K\}$ be a set of *K* distinct random variables, and let F_K denote the cdf of the k^{th} variable. We define the set $\Re$ as first (second) order maximal if no variable in $\Re$

[3] Higher order dominance rankings (eg third or fourth order) are based on more restricted classes of utility functions which reflect aversion to asymmetry, kurtosis and higher order moments.

is first (second) order weakly dominated by another. Further, let $X_{.n} = (x_{1n}, x_{2n}, ..., x_{Kn}), n = 1, 2, ..., N$ be the observed data. Assume X_n is strictly stationary and $\alpha-$mixing. We assume $F_i(X_i),\ i = 1, 2, \ldots, K$ are exchangeable random variables, so that our resampling of the test statistics converge appropriately. This is a less stringent assumption than independence of income distributions, particularly in our paper, as it will be more often the case that one distribution can be derived from the other (eg before and after tax scenarios). We also assume that F_K is unknown and estimated by the empirical distribution fundtion $F_{kN}(X_k)$. Finally, we adopt the mathematical regularity conditions pertaining to von Neumann-Morgenstern (VNM) utility functions that generally underlie the expected utility maximization paradigm. We also assume that all the expectations involved are finite.

Given the mathematical regularity conditions due to VNM, the first-order stochastically maximal variables in $\Re$ imply that a statistic *d* exists defined by

(1) $d = \min_{i \neq j} \max_x \left[F_i(x) - F_j(x) \right] > 0$ if and only if for each *i* and *j*, there exists a continuous increasing function *u* such that $E\left[u(X_i)\right] > E\left[u(X_j)\right]$.

Similarly, the second order stochastically maximal variables in $\Re$ implies that a statistic *s* exists such that

(2) $s = \min_{i \neq j} \max_x \int_{-\infty}^{x} \left[F_i(\mu) - F_j(\mu) \right] d\mu > 0$ if and only if for each *i* and *j*, there exists a continuous increasing and strictly concave function *u* such that $E\left[u(X_i)\right] > E\left[u(X_j)\right]$.

Now, assuming the stochastic process X_n, *n = 1, 2, ..., N* to be strictly stationary and $\alpha-$mixing with $\alpha(j) = O\left(j^{-\delta}\right)$ for some $\delta > 1$, we have $d_{2N} \to d$ and $s_{2N} \to s$ where d_{2N} and s_{2N} are the empirical versions of the test statistics defined as (Klecan, McFadden and McFadden (1991):

(3) $d_{2N} = \min_{i \neq j} \max_x \left[F_{iN}(x) - F_{jN}(x) \right]$ and

(4) $s_{2N} = \min_{i \neq j} \max_x \int_{-\infty}^{x} \left[F_{iN}(\mu) - F_{jN}(\mu) \right] d\mu$.

The null hypothesis tested by these two statistics is that $\Re$ is not first (second) order maximal, i.e., X_i FSD (SSD) X_j for some *i* and *j*. We do not reject the null when the statistics are negative to a statistical degree of confidence. Kaur (1994) and Klecan, McFadden and McFadden (1991) show that when X and Y are independent, tests based on d_{2N} and s_{2N} are consistent. Furthermore, the asymptotic distributions of these statistics are non-degenerate in the least favourable case, being Gaussian.

In this paper, we estimate the empirical distributions by bootstrap methods. We compute d_{2N} and s_{2N} for a finite number *q* of the income (expenditure) ordinates. Bootstrap samples (typically 1000) are generated from which empirical distributions of the differences of the d_{2N} and s_{2N} statistics, and their bootstrap confidence intervals are determined. The bootstrap probability of these statistics being negative and/or falling in these intervals leads to an inference of dominance to a degree of statistical confidence. We implement the foregoing procedures using GAUSS[4], the codes for which we can provide upon request .

3. The Data

The stochastic dominance tests and procedures described in Section 2 are applied to household unit record data from the 1983/84, 1988/89, 1993/94, 1998/99 and 2003/04 Household Expenditure Survey (HES) of the Australian Bureau of Statistics (ABS). These make up a series of surveys designed to obtain details of expenditure, income and a wide range of demographic characteristics of Australian private households on a nationwide basis. The samples of households for each year of the survey are: 4492 for the 1983/84 HES, 7225 for the 1988/89 HES, 8389 for the 1993/94 HES, 6892 for the 1998/99 HES, and 6957 for 2003/04, and each set represents between 5 to 6 million Australian households from all over the country. The information on demographic characteristics, income and infrequent expenditure items (eg vehicle and property purchases, household bills) were recorded by personal interview and details of all other expenditures made by each household member, 15 years old or older, during a two-week period were recorded in personal diaries[5]. The public-use files were representative of the Australian population and the sample of households enumerated evenly over the respective 12-month period.

[4]We are indebted to Professor Maasoumi for providing us the basic GAUSS codes for the algorithm.
[5] Regular but infrequent billsare pro-rated and the expenditure items correspond to average weekly amounts.

The household is the basic unit of our analysis and consists of a person or group of people living together having common provision for food and other essentials of living. They include both adults and children where children are those aged from the very young to 24; those over 18 are considered children as long as they are fully financially dependent on the parent(s) as defined in the survey. Each HES sample is chosen using a stratified procedure, and so it was necessary to use the sampling weights provided to ensure that conclusions drawn from the sample analysis apply to the general population as well. To minimize reporting errors, our estimation sample excludes households classified as multiple family and/or those with negative incomes and negative expenditures. Multiple family households consist mainly of unrelated young adults (as in students sharing a house), and so the income and expenditure information obtained from interviewing one member cannot be simply taken as true for all the others in the house. We also follow the standard practice of excluding households with negative incomes and negative expenditures as these are known to cause large distortions in the results (see, for example, Griffiths and Valenzuela (2004)). All up, we use about 88-90 percent of the full HES sample (depending on the year)[6], and the subsamples for each year are still large and rich enough to allow some hypotheses testing for smaller population groups. The population subgroups we consider here are single v couple parent households, households with and without children, and male-headed v female headed households,

To implement the stochastic dominance analysis in this study, we defined four basic distributions series: (i) Gross or Pre-Tax Income– defined as total household income from all sources; this includes all earned income from employment, own business or self-employment plus unearned income from interest on accounts and financial investments, property rent, worker's compensation, child support and maintenance, superannuation, and scholarships; (ii) Disposable or Post-Tax Income – which is total household income less taxes plus all government benefits; this includes all family allowances and parenting payments, and age, carer and disability pensions. (iii) Total Expenditure (or Exp1) – all non-durable consumption includes all expenditures on Fuel and Power, Food, Alcohol and Tobacco, Clothing and Footwear, Household Furnishings and Equipment, Medical and Health Care, Transport, Recreation and Entertainment and Personal Care. The ABS classification also includes Current Housing Expenditures (rent or mortgage & maintenance costs) but excludes selected other

[6]All up, total household exclusions from the HES data each year ranged from 8.6 percent (1983/94) dataset to 11.7 percent (2003/04).

payments Superannuation and Life Insurance, Mortgage Repayments and Other Capital Housing Costs.; and (iv) Total Expenditure less Housing (or Exp2) - this is Exp1 less Current Housing Expenditures. For expenditures, we focus our analysis on non-durables only to minimize imputation problems association with the consumption of durables. As seen, both series Exp1 and Exp2 pertain to non-durable consumption with the main difference being the exclusion of Current Housing in Exp2. We thus compare Exp1 and Exp2 to determine the effect of Current Housing Expenditures on the distribution of welfare in the economy when welfare is measured via expenditures.

To ensure meaningful analysis of incomes and expenditures over time and space, the four series above were adjusted in the following two ways. First was the application of adult equivalence scales. Equivalence scales are indices that show the relative income (or expenditure) levels required by people in different circumstances to attain the same level of economic well-being. Adjusting incomes/expenditures by an appropriate adult equivalent scale ensures that these incomes and expenditures are comparable across the various types and sizes of households. The adult equivalence scale used was the square-root of family size due to Buhmann, et al (1987). This scale is widely used in empirical studies on inequality and lies near the middles of the range of scales surveyed in that study. The second adjustment needed for the data was the conversion of all nominal values in the raw data sets to 2003 dollars using the national consumer price index[7]. Ideally, we would use state specific CPI values to account for regional variation in the cost of living but this is not possible because the 1988/89 HES does not report state of residence.

Summary statistics on incomes, expenditures and population shares are now presented in the next few tables. Table 1 shows that between 1983/84 and 2003/04, household incomes experienced very slow growth of less than 1 percent per annum or a measly 15 percent over the entire 20 yr period. Mean disposable incomes grew even less, at 13 percent for the entire period. Meanwhile, mean household expenditures grew at a slightly higher rate than both types of incomes – total expenditures increased by 20 percent overall (or about 1 percent per year) or 16 percent total if current housing is excluded.

[7]Barrett , Crossley and Worswick (2000a) notes that using a single price index to deflate expenditures of all households, irrespective of the actual consumption bundle is appropriate only if preferences are homothetic.

Household incomes and expenditures however rarely grow in a linear fashion. A more realistic picture is that both series fluctuate in the in-between years and this important insight is often not seen by just looking at overall growth figures. In the case of Australia – incomes and expenditure changes were certainly not uniform across the years. During the recession-affected years of 1988/89 and 1993/94, average pre-tax household incomes dropped 6.7 percent while disposable income dropped slightly less, by 3.5 percent. Notwithstanding, household expenditures continued to increase, albeit at a marginal rate of around 0.85 percent per annum.

Mean incomes and mean expenditures however grew very strongly in the next four years. Between 1993/94 and 1998/99 survey years, mean gross incomes grew by as much as 13.18 percent and the equivalent figure for disposable income is 8.92 percent. This strong growth continued on in the next 4 years to 2003/04; but this time, disposable incomes grew faster than gross incomes. Expenditures are observed to also have grown very strongly between the 1998/99 and 2003/04 survey years, indicating full recovery of households from the recession years and successfully surviving the Asian financial crisis of 1998 and the dot.com bubble of 2001.

Table 2 shows some figures for male-headed and female-headed households, that is, MHH and FHH. Notice first that the proportion of female-headed households in the population mor than doubled in the last 20 years, increasing from under just 18 percent in 1983/84 to 39 percent in 2003/04. Further, their average pre-tax incomes have also increased significantly – in 1983/84, FHHs had an average income of just $273, which was just 44% of the average income earned by MHHs. By 2003/04, FHH's average income has grown to $484 and is now 66% of the average incomes of their male counterparts. This trend is observed alongside the noticeable increased in female labour force participation rates in the last 20 years, with new entrants first taking part-time appointments and slowly easing their way in to full time work in due course.

From Table 3, it appears that preferences for having children have also changed dramatically over the last 20 years. In 1983/84, the proportion of households with no children was recorded at 48 percent of total households; by 2003/04, this has dramatically increased to 58 percent overall. Indeed, according to ABS statistics, the fastest growing household type in Australia is the lone person household, growing by an average of 2.2 percent per year; while couples without children are the fastest growing family type, with a projected 1.4 million additional

households falling in this category between the period 2006-2013 period (ABS 2010). There is clearly increased propensity for couples to remain childless, but the ageing of the population is also a primary contributor to the growth of both lone households and households with no children types.

Now, despite the promised lifestyle and purported 'savings' that can be derived from having no children in the household, the income and expenditure data above indicate the opposite. First, the pre-tax incomes of households without children are less than those with children, albeit slightly. Additionally, this income shortfall appears to be increasing over time. On average, we find that households WITHOUT children (HWOC) earned $14 less in 1983/84 compared to their WITH Children counterpart (HWC), and this has dropped further back to $27 less in 2003/04. It is a different story with disposable incomes however. At $52 a week difference, the mean disposable income differential between HWOCs and HWCs was substantial in 1983/84 in favour of those without children and this gap has narrowed over time. As for expenditures, we see no significant difference in the observed levels of weekly expenditures for HWOCs and HWCs.

Lastly, from Table 4, it is seen that the proportion of single-parent households has dramatically risen between 1983/84 and 2003/04. At the beginning of the study period, single-parent households comprised 13 percent of all households with children; this figure gradually increased over the years to reach 19 percent share by 2003/04. Further, in 1983/84, pre-tax incomes of single parents were just 33 percent that of couple-parents on average, but this has increased to as much as 64 percent at the end of the period. On levels, both mean gross and disposable incomes of single-parent households have increased much more than those of couple-parents, and much more than the increase in their own expenditures. We also note that it is only in this household group that we see mean disposable incomes being consistently higher than mean gross income for each survey year between 1983/84 and 2003/04 inclusive.

4. **Empirical Analysis**

The tables in this section present the results of our stochastic dominance (SD) analysis for pairwise income and expenditure distributions across households in Australia. All of these are from 1000 bootstrap samples. Given distributions X and Y, the expression $X >_1 Y$ denotes "X first order stochastic dominance over Y" and $X >_2 Y$ denotes "X second order stochastic

dominance over Y". In the discussion, we sometimes refer to these as FSD and SSD of X over Y, respectively. Where evidence of stochastic dominance appears, the number in brackets show the probability of the test being negative. No SD means that the two distributions are unrankable.

Gross and Disposable incomes over time

Table 5 tabulates the SD results for the gross and disposable income series. The first panel pertains to Between-Years comparisons of the same series, and the second panel presents the Within-Year results comparing the two series. From row 1, the gross v gross income comparisons show first-order stochastic dominance of the 2003/04 series over each of those in the other years. That is, the 2003/04 gross income distribution was strongly welfare superior (or more equally distributed) when compared to the distributions in every other survey year i.e. it is maximal. The 1983/84 and 1988/89 comparison did not show stochastic dominance either way, but both these 80s distributions were more equally distributed compared to the two in the 90s. Between 1993/94 and 1998/99, no SD was detected.

In terms of disposable incomes, the SD test results in row 2 show that the 2003/04 series also strongly dominated each of the other disposable income series from all of the other years. But unlike earlier results for gross incomes, the 1998/99 distribution appears to be more equal now compared to the distributions of the 1983/84, 1988/89 and 1993/94. And of these last three series, the 1988/89 distribution appears to be the most unequal of the lot. From Row 3, we observe no stochastic dominance in the gross and disposable incomes within same the years, except for the 1988/89 result which showed first and second order stochastic dominance of gross over disposable incomes.

The foregoing clearly points to a significant improvement in the distribution of welfare across the entire set of households in our sample between 1983/84 and 2003/2004. This is a positive result indicating a substantial reduction in the gap of living standards between the haves and the have-nots in Australia over the course of this 20 year period. Further, the results hold for welfare that is measured by gross incomes, and also true when welfare is measured by disposable incomes.

At first glance, one might note that this finding runs in contrast to the finding of increased inequality in Australia that is found in previous work (for example, Barrett, Crossley and Worswick (2000), Athanasopolous and Vahid (2003) and Nicholas, Ray & Valenzuela (2010)). A careful comparison will however reveal that each of these previous studies cover a much shorter period[8], and that all use singular measures of inequality, and so this particular finding e may not be strictly comparable to theirs.

To further put our results in perspective, we look at changes in inequality for each 4-year block. Our pairwise SD analysis shows that the overall improvement in inequality did not happen in a linear, uniform fashion over the 20 years. In terms of gross incomes, inequality levels were steady in the years leading to the recession (between 1983/84 and 1988/89), after which a worsening was observed between 1988/89 and 1993/94. This rise in inequality levels continued in the late 90s, despite the strong growth of incomes during that time. It was only during the early 2000s that inequality of gross incomes improved significantly. In terms of disposable incomes, inequality levels worsened much earlier in the pre-recession years of the 80s, compared to gross incomes. At the same time however, a turn-around also came much earlier. Thereafter, disposable incomes became consistently more equal relative to gross incomes, through the last ten years, between 1993/94 and 2003/04. The overall picture that emerges from all these is that the distribution of gross incomes have declined in the first 10 years of this study period, alongside a slow-growth or contracting economy; further, we only see a small and delayed improvement in the distribution in gross incomes even whilst the economy was in strong growth stage once again. In contrast, the distribution of disposable incomes is observed to have improved very quickly alongside periods of rapid economic growth. This effectively implies that the tax and transfer scheme in place were effective in improving household welfare overall through the growth years.

The Distribution of Expenditures Over Time

The first panel of Table 6 tabulates the results of the SD tests between the two expenditure series, Exp1 and Exp2. The two distributions both refer to all non-durable expenditures of the household - with Exp1 including Current Housing Expenditures (CHE) and Exp2 excluding it.

[8] Barrett, Crossley and Worswick (2000) tracks inequality between 1975 to 1994, while Athanasopolous and Vahid (2003) compares just two years 1993and 1998, and Nicholas, Ray & Valenzuela (2010) covers a later period from 1988 to 2003.

In the analysis, it will be useful to remember that CHE includes such costs as rent or mortgage, council rates, house insurances, plus all other maintenance costs such as repainting, electrical work, plumbing and materials thereof.

In row (1), the SD test shows first order statistical dominance of the 2003/04 Exp1 distribution over each of the other Exp1 distributions in the set. The 1998/99 distribution was also found first order stochastic dominant over each of the other 4 years, while the 1983/84 series was found weakly stochastic dominant (2^{nd} order) compared to both the 1988/89 and the 1993/94 series. And between these last two, the 1993/94 distribution was found to be first order stochastic dominant over that of the 1988/89.

If current housing expenditures are excluded in the expenditure basket, we see in row (2) that a similar dominance pattern is evident. That is, the Exp2 distribution for 2003/04 is first-order stochastic dominant over each of the other Exp2 series. Further, the Exp2 for 1998/99 also strongly dominates the remaining others, then 1983/84 is weakly dominant (2^{nd} order) over both 1993/94 and 1988/89, and between these last two series, the former strongly dominated the other.

In the second panel of Table 6, we find the Within-Year Comparison between Exp1 and Exp2. The SD results show consistent first order stochastic dominance of Exp1 over Exp2 over time. That means that if current housing expenditures are excluded in the expenditure basket, expenditure inequality becomes worse or becomes more highly unequal. Put differently, current housing outlays appear to make expenditure distribution more even across Australian households. This finding aligns well with those of Nicholas, Ray and Valenzuela (2010).

These results for the expenditure series bear two main points. First, the clear ordering of the expenditure series over time – with later years bearing stochastic dominance over earlier ones – show a steady improvement in the level of inequality and relative welfare over the 20 years covered. Further, the finding for the years 1988/89 and 1993/94 series of having the worst levels are not surprising - that they had the least equal distributions compared to the other years may have to do with the fact that they bookend the 1990-1991 recession period. In any case, the finding of an overall improvement in the distribution of expenditures over time is good news to hear/positive outcome.

Second, the consistently strong welfare ordering between Exp1 and Exp2 highlights the importance of current housing expenditure in the welfare stakes. In the short term, housing expenditures are shown to improve the distribution of welfare across households. In other words, including housing in the expenditure basket makes for a more equal distribution of economic well-being and this is found true for all the years covered. And if we note that having a mortgage also increases the net worth of an individual/household over the long haul, then current housing expenditures not only alleviates inequality among households not just today, but also tomorrow since the accumulation of such an asset makes for greater financial security for many in the future and is especially relevant for an aging population.

SD Results by Population Groups

We now break up the population into various groups and apply the tests to determine relative inequality levels existing within each group. Results for stochastic dominance tests comparing distributions for male and female headed households (MHH v FHH) are shown in Table 4. We find strong differences in the inequality levels by gender. Gross income distributions among MHHs are shown to first and second orders stochastically dominate those of FHHs in all the years. This is also observed for disposable incomes and for both types of expenditure series in the post recession years, but not before.

The foregoing basically implies that welfare levels, whether measured by income or by expenditures, are better distributed among male-headed households than they are for female-headed households. The smaller p-values indicate some periodic improvement in the relative distribution but the order of dominance has not changed. For the entire study period, the SD tests did not indicate any reversals in this pattern of relationship, and so income and expenditure distributions among female-headed households remained relatively worse all through the period.

From Table 8 we find second-order stochastic dominance of gross incomes of households with children (HWC) over those without children (HWOC), pointing to a relatively worse level of income dispersion among households with no children. SD test results for disposable incomes

show some leveling of welfare, but this was not enough to eliminate or change the order of the SD relationship between the two types of households. As for expenditures, the distributions for households with children are found second order stochastic dominant over those for households without children. Further, excluding housing costs in the expenditure series appears to worsen the welfare gap between HWC and HWOC.

In Table 9, SD test results show that that the gross income distribution of couple-parent households (CPH) first and second-order dominate the distribution for single-parent households (SPH) for the entire period of study. This indicates greater equality in welfare levels among couple-parent households compared to those among single-parent households. However, when the SD tests are applied to disposable incomes, the CPH and SPH distributions do not show any stochastic dominance either way, that is, no one distribution is better than the other - except for the 1993/94 series where the series for CPHs dominance remained dominant. But even for this year, the smaller p-values indicate a much improved distribution of welfare for the SPHs, all pointing to an improvement in welfare distribution after the redistribution of incomes through taxes and social transfers.

In terms of expenditures, SD tests reveal unrankable distributions of Exp1 for single- and couple-parent households for all years except for one. Welfare distributions across these two family groups are thus comparable, save for the 1993/94 series where the CPH distribution first order dominated the SPH distribution – a result that appears to follow from the SD results for disposable incomes. In terms of Exp2, which excludes the Current Housing Expenditure, test results show first and second order stochastic dominance of CPH distributions over SPH distributions in the last three survey years. In other words, the distribution of welfare among couple-parent households became much more equal than those of single-parent households during these years. This implies that relatively high level of inequality exists in the distribution of expenditures on non-durables of single parent households and that SPHs are worse off in this way compared to CPHs. From a policy perspective, this suggests that expenditures on current housing serve as an effective tool for equalizing the distributions between single-parent and couple-parent households. It is therefore an effective tool for intervention – that is, subsidizing current housing expenditures of single-parent households go a long way in them catch up in the living standards of couple-parent households.

5. **Conclusion**

In this paper, we employ stochastic dominance analysis on Australian unit records to investigate trends in inequality and relative welfare levels in Australia over the period 1983 to 2004. We find that that when stochastic dominance tests are applied to income and expenditure distributions for the entire population, net transfers to households do not make any significant improvement on the distribution of welfare for each year. However, when analysis is applied to particular population subgroups in the economy, the SD tests show that taxes and transfers do improve existing imbalances within and between the groups. Results of our SD analysis for selected segments Australia show strong evidence of long-term disparities in the relative welfare levels of male-headed over female-headed households, of households with children over those without, and of couple-parents families over their single-parent counterparts.

More specifically, our group-specific findings suggest a number of important items for policy concern. First, we find that the welfare distribution among male-headed households – whether it be gross, disposable incomes, or non-durable expenditures – strongly and consistently dominate those of female-headed households. In other words, there is so much more inequality existing among female-headed households than male-headed households. Second, our results show that income distributions of households with children are more evenly spread compared to those without children. This is both an expected and a desirable outcome. This is expected in the sense that households without children are less homogenous in their abilities and capacities to earn and expend; indeed, we expect a greater range of incomes and expenditures associated with households without children. Meanwhile, households with children tend to have more fixed incomes and tend to expend resources in more predictable ways (as dictated by relatively well-defined needs of children). This result is also desirable because we do not want large disparities in welfare levels among those households with children; by implication, we conclude that children in these households enjoy good living standards which are comparable across the range of the income and/or expenditures distributions.

Lastly, our findings suggest that expenditures on current housing serve as an effective tool for equalizing the distributions of expenditures among households in the national economy. This is true for all households in general, but particularly very relevant for bridging existing welfare differentials between single-parent and couple-parent households. That is, subsidizing current

housing expenditures of single-parent households go a long way in helping them catch up with the welfare of couple-parent households, which is both higher in terms of living standards and also more equally distributed.

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Table 1 Mean Incomes & Expenditures (adult equivalent, all households)

	1983/84	1988/89	1993/94	1998/99	2003/04
Sample Size n	**4087**	**6288**	**7357**	**6097**	**6268**
Taxable Income	**553**	**553**	**516**	**584**	**636**
	(482)	(503)	(530)	**(551)**	(637)
Disposable Income	**516**	**498**	**482**	**525**	**588**
	(324)	(337)	(312)	**(325)**	(394)
Expenditure 1	**567**	**563**	**568**	**620**	**678**
	(355)	**(372)**	(396)	**(419)**	**(473)**
Expenditure 2	**502**	**492**	**496**	**544**	**584**
	(335)	**(349)**	(371)	**(396)**	**(435)**

Note: standard errors are in brackets

Table 2 Mean Incomes & Expenditures (adult equivalent, Male & Female Headed Households)

			Male Head		
	1983/84	**1988/89**	**1993/94**	**1998/99**	**2003/04**
% share to total	**82%**	**80%**	**64%**	**62%**	**61%**
Taxable Income	**615**	**611**	**598**	**688**	**733**
	(479)	(493)	(545)	(567)	(682)
Disposable Income	**550**	**530**	**526**	**581**	**643**
	(331)	(339)	(323)	(336)	(427)
Expenditure 1	**604**	**599**	**616**	**679**	**738**
	(356)	(366)	(407)	(439)	(494)
Expenditure 2	**538**	**527**	**543**	**602**	**642**
	(336)	(344)	(383)	(415)	(458)
			Female Head		
	1983/84	**1988/89**	**1993/94**	**1998/99**	**2003/04**
% share to total	**18%**	**20%**	**36%**	**38%**	**39%**
Taxable Income	**273**	**322**	**373**	**418**	**484**
	(384)	(475)	(471)	(480)	(524)
Disposable Income	**359**	**369**	**405**	**436**	**500**
	(228)	(293)	(274)	(285)	(317)
Expenditure 1	**395**	**418**	**482**	**525**	**583**
	(300)	(362)	(359)	(365)	(420)
Expenditure 2	**335**	**352**	**413**	**452**	**493**
	(275)	(333)	(334)	(344)	(379)

Note: Standard errors are in parentheses.

Table 3 Mean Incomes & Expenditures (adult equivalent, Households WITH & WITHOUT children)

	1983/84	1988/89	1993/94	1998/99	2003/04
Households with Children					
Sample Size n	**47%**	**44%**	**40%**	**40%**	**36%**
Taxable Income	**545**	**563**	**525**	**596**	653
	(393)	(458)	(478)	(487)	(594)
Disposable Income	**486**	**478**	**463**	**517**	580
	(272)	(322)	(279)	(282)	(368)
Expenditure 1	**552**	**568**	**563**	**624**	**687**
	(307)	(337)	(356)	(378)	(428)
Expenditure 2	**486**	**496**	**493**	**550**	**595**
	(293)	(321)	(339)	(364)	(401)
Households Without Children					
Sample Size n	**53%**	**56%**	**60%**	**60%**	**64%**
Taxable Income	**561**	**545**	**511**	**576**	626
	(548)	(535)	**(561)**	**(590)**	(660)
Disposable Income	**542**	**514**	**495**	**531**	592
	(362)	(347)	**(330)**	**(352)**	(409)
Expenditure 1	**580**	**559**	**571**	**617**	**673**
	(393)	**(397)**	**(419)**	**(444)**	**(496)**
Expenditure 2	**515**	**488**	**498**	**540**	**578**
	(369)	**(369)**	**(391)**	**(416)**	**(453)**

Note: Standard errors are in parentheses.

Table 4 Mean Incomes & Expenditures (adult equivalent, Single & Couple Parent Households)

	1983/84	1988/89	1993/94	1998/99	2003/04
Couple Parent Households					
Sample Size n	**87%**	**88%**	**85%**	**83%**	**81%**
Taxable Income	**595**	**616**	**585**	**674**	**743**
	(386)	(456)	(483)	(482)	(606)
Disposable Income	**510**	**506**	**492**	**556**	626
	(277)	(330)	(288)	(285)	(381)
Expenditure 1	**578**	**601**	**600**	**674**	**747**
	(308)	(338)	(361)	(382)	(435)
Expenditure 2	**512**	**527**	531	**600**	**652**
	(293)	(323)	(343)	(366)	(407)
Single Parent Households					
Sample Size n	**13%**	**12%**	**15%**	**17%**	**19%**
Taxable Income	**215**	**181**	**188**	**218**	272
	(255)	(243)	(251)	(299)	(342)
Disposable Income	**328**	**276**	**299**	**326**	387
	(169)	(131)	(137)	(164)	(214)
Expenditure 1	**380**	**328**	**350**	**384**	**431**
	(243)	(204)	(228)	(247)	(280)
Expenditure 2	**319**	**270**	281	**308**	**255**
	(223)	(191)	(217)	(232)	(350)

Note: Standard errors are in parentheses.

Table 5. Stochastic Dominance Results for all households: Gross and Disposable Incomes

Row #	Between YRS Comparisons	1983/84 vs. 1988/89	1983/84 vs. 1993/94	1983/84 vs. 1998/99	1983/84 vs. 2003/04	1988/89 vs. 1993/94	1988/89 vs. 1998/99	1988/89 vs. 2003/04	1993/94 vs. 1998/99	1993/94 vs. 2003/04	1998/99 vs. 2003/04
(1)	Gross v Gross Income	No SD	No SD	83 $>_2$ 98 (0.012)	03 $>_1$ 83 (0.101) 03 $>_2$ 83 (0.307)	88 $>_1$ 93 (0.002) 88 $>_2$ 93 (0.789)	88 $>_2$ 98 (0.006)	03 $>_1$ 88 (0.018) 03 $>_2$ 88 (0.045)	No SD	03 $>_1$ 93 (0.013) 03 $>_2$ 93 (0.187)	03 $>_1$ 98 (0.321) 03 $>_2$ 98 (1.000)
(2)	Disposable v Disposable Income	83 $>_2$ 88 (0.622)	No SD	No SD	03 $>_1$ 83 (0.169) 03 $>_2$ 83 (0.627)	93 $>_2$ 88 (0.005)	98 $>_2$ 88 (0.645)	03 $>_1$ 88 (0.206) 03 $>_2$ 88 (0.621)	98 $>_2$ 93 (0.123)	03 $>_1$ 93 (0.064) 03 $>_2$ 93 (0.872)	03 $>_1$ 98 (0.344) 03 $>_2$ 98 (0.979)
	Within YRS Comparison	**1983/84**		**1988/89**		**1993/94**		**1998/99**		**2003/04**	
(3)	Gross vs. Disposable Income	No SD		G $>_1$ D (0.156) G $>_2$ D (0.647)		No SD		No SD		No SD	

Table 6. Stochastic Dominance Results for all households: Expenditure Series, Over Time

Row #	Between YRS Comparisons	1983/84 vs. 1988/89	1983/84 vs. 1993/94	1983/84 vs. 1998/99	1983/84 vs. 2003/04	1988/89 vs. 1993/94	1988/89 vs. 1998/99	1988/89 vs. 2003/04	1993/94 vs. 1998/99	1993/94 vs. 2003/04	1998/99 vs. 2003/04
(1)	EXP1 v EXP1 series	83 $>_2$ 88 (0.334)	83 $>_2$ 93 (0.316)	98 $>_1$ 83 (0.022) 98 $>_2$ 83 (0.588)	03 $>_1$ 83 (0.110) 03 $>_2$ 83 (0.624)	93 $>_1$ 88 (0.023) 93 $>_2$ 88 (0.208)	98 $>_1$ 88 (0.143) 98 $>_2$ 88 (0.645)	03 $>_1$ 88 (0.401) 03 $>_2$ 88 (0.621)	98 $>_1$ 93 (0.004) 98 $>_2$ 93 (0.633)	03 $>_1$ 93 (0.071) 03 $>_2$ 93 (0.648)	03 $>_1$ 98 (0.050) 03 $>_2$ 98 (0.503)
(2)	EXP2 v EXP2 series	83 $>_1$ 88 (0.001) 83 $>_2$ 88 (0.569)	83 $>_2$ 93 (0.595)	98 $>_1$ 83 (0.006) 98 $>_2$ 83 (0.157)	03 $>_1$ 83 (0.121) 03 $>_2$ 83 (0.577)	93 $>_1$ 88 (0.029) 93 $>_2$ 88 (0.313)	98 $>_1$ 88 (0.122) 98 $>_2$ 88 (0.644)	03 $>_1$ 88 (0.316) 03 $>_2$ 88 (0.621)	98 $>_1$ 93 (0.003) 98 $>_2$ 93 (0.633)	03 $>_1$ 93 (0.047) 03 $>_2$ 93 (0.648)	03 $>_1$ 98 (0.044) 03 $>_2$ 98 (0.509)
	Within YRS Comparison	**1983/84**		**1988/89**		**1993/94**		**1998/99**		**2003/04**	
(3)	EXP1 v EXP2 series	Exp1 $>_1$ Exp2 (0.055) Exp1 $>_2$ Exp2 (0.353)		Exp1 $>_1$ Exp2 (0.087) Exp1 $>_2$ Exp2 (0.531)		Exp1 $>_1$ Exp2 (0.053) Exp1 $>_2$ Exp2 (0.450)		Exp1 $>_1$ Exp2 (0.063) Exp1 $>_2$ Exp 2 (0.651)		Exp1 $>_1$ Exp2 (0.070) Exp1 $>_2$ Exp2 (0.654)	

a) EXP1 – total expenditure for all non-durables b) **EXP2** – total expenditures for all non-durables (EXP1) less Current Housing Costs.

Table 7: SD Results by Male v Female Headed Households

	Gross Income	Disposable Income	Non Durable Expenditure INCLUDING Housing Costs (EXP1)	Non Durable Expenditure EXCLUDING Housing Costs (EXP2)
1983/84	M $>_1$ F (0.683) M $>_2$ F (1.000)	No SD	No SD	No SD
1988/89	M $>_1$ F (0.419) M $>_2$ F (1.000)	No SD	No SD	No SD
1993/94	M $>_1$ F(0.049) M $>_2$ F(1.000)	M $>_1$ F(0.050) M $>_2$ F(0.335)	M $>_1$ F (0.027) M $>_2$ F (0.616)	M $>_1$ F(0.042) M $>_2$ F (0.620)
1998/99	M $>_1$ F(0.833) M $>_2$ F(1.000)	M $>_1$ F (0.094) M $>_2$ F (0.352)	M $>_1$ F (0.204) M $>_2$ F (0.620)	M $>_1$ F (0.201) M $>_2$ F (0.609)
2003/04	M $>_1$ F(0.180) M $>_2$ F(1.000)	M $>_1$ F (0.048) M $>_2$ F (0.321)	No SD	M $>_1$ F (0.138) M $>_2$ F (0.625)

Note: X $>_1$ Y means X first-order stochastic dominance Y; X $>_2$ Y means X second-order stochastic dominance Y;
No SD means no stochastic dominance between X and Y. The number in parentheses is the probability of SD statistics being negative.

Table 8: SD Results by households with v without children

	Gross Income	Disposable Income	Non Durable Expenditure INCLUDING Housing Costs (EXP1)	Non Durable Expenditure EXCLUDING Housing Costs (EXP2)
1983/84	w/ child $>_2$ no child (0.098)	No SD	No SD	w/ child $>_2$ no child (0.001)
1988/89	w/ child $>_2$ no child (0.430)	No SD	w/ child $>_2$ no child (0.581)	w/ child $>_2$ no child (0.627)
1993/94	w/ child $>_2$ no child (0.041)	w/ child $>_2$ no child (0.001)	w/ child $>_2$ no child (0.219)	w/ child $>_2$ no child (0.231)
1998/99	w/ child $>_2$ no child (0.942)	w/ child $>_2$ no child (0.025)	w/ child $>_2$ no child (0.526)	w/ child $>_2$ no child (0.507)
2003/04	w/ child $>_2$ no child (0.891)	w/ child $>_2$ no child (0.363)	w/ child $>_2$ no child (0.605)	w/ child $>_2$ no child (0.627)

Note: $X >_1 Y$ means X first-order stochastic dominance Y; $X >_2 Y$ means X second-order stochastic dominance Y;
No SD means no stochastic dominance between X and Y. The number in parentheses is the probability of SD statistics being negative.

Table 9: SD Results by Single-Parent (S) v Couple-Parent (C) Households

	Gross Income	Disposable Income	Non Durable Expenditure INCLUDING Housing Costs (EXP1)	Non Durable Expenditure EXCLUDING Housing Costs (EXP2)
983/84	C $>_1$ S (0.319) C $>_2$ S (1.000)	No SD	No SD	No SD
1988/89	C $>_1$ S (0.178) C $>_2$ S (1.000)	No SD	No SD	No SD
1993/94	C $>_1$ S (0.296) C $>_2$ S (1.000)	C $>_1$ S (0.197) C $>_2$ S (0.643)	C $>_1$ S (0.213) C $>_2$ S (0.643)	C $>_1$ S (0.090) C $>_2$ S (0.643)
1998/99	C $>_1$ S (0.922) C $>_2$ S (1.000)	No SD	No SD	C $>_1$ S (0.353) C $>_2$ S (0.630)
2003/04	C $>_1$ S (0.620) C $>_2$ S (1.000)	No SD	No SD	C $>_1$ S (0.153) C $>_2$ S (0.616)

Note: X $>_1$ Y means X first-order stochastic dominance Y; X $>_2$ Y means X second-order stochastic dominance Y;
No SD means no stochastic dominance between X and Y. The number in parentheses is the probability of SD statistics being negative.