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Deriving Long-Run Inequality Series from Tax Data

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ABSTRACT

Prior to the last three decades, regular surveys on household income were rare or non-existent in many developed countries, making it difficult for economists to develop long-run series on income distribution. Using taxation statistics, which tend to be available over a longer time span, I propose a method for imputing the incomes of non-taxpayers, and deriving the underlying distribution of income. Because taxation statistics are typically disaggregated by gender, it is possible to derive separate income distribution series for men and women in countries where individuals file separately. I show that over the past four decades, the distribution of adult male incomes is a good proxy for the distribution of family incomes. Applying this method to Australia, I develop a new annual series for inequality from 1942-2000. Inequality fell in the 1950s and the 1970s, and rose during the 1980s and 1990s – a pattern similar to the United Kingdom.

Keywords: income distribution, imputation, tax progressivity, Australia

JEL Classification: C81, D31, H23

1. Introduction

In most developed countries, annual income surveys did not appear until the last twenty to thirty years. Prior to this, national statistical agencies frequently changed their definitions of income, while the surveys themselves were conducted intermittently. Consequently, researchers analyzing long-run trends in income distribution tend to find themselves looking through a glass, darkly.

An alternative to survey data is to compute inequality using tabulated statistics from income tax returns. During and immediately after World War II, income taxes in most industrialized nations evolved into mass taxes, payable not only by the very rich, but by ordinary workers as well (Webber and Wildavsky 1986). Decades before annual income surveys came into existence, taxation statistics can potentially provide a picture of earnings across most of the labor force.

Over the past few years, an emerging literature has made use of statistics from taxation returns to measure top income shares in a variety of countries (Atkinson 2002a; Feenberg and Poterba 2000; Piketty 2000; Piketty and Saez 2003; Saez and Veall 2003). Combining taxation statistics with control totals from the national accounts, these studies have calculated the fraction of income that goes to the top 10 percent, 1 percent, 0.1 percent and so on; from the point at which these taxes were first implemented (typically around World War I). However, the conventional wisdom holds that taxation data cannot be used to analyze the whole income distribution. In particular, the necessity of imputing incomes to non-taxpayers is often regarded as a fatal flaw in the use of taxation statistics.

This paper proposes a new method for using taxation statistics to derive a measure of inequality across the entire population, where long-run income distribution statistics are unavailable. The key income distribution measure of interest to economists is the distribution of family incomes (adjusted for family size). I show that this measure is closely proxied by the distribution of incomes among adult males, and that the gap between the two measures has remained constant over the past four decades, despite changes in family composition and the labor force participation of women.

Using gender-disaggregated taxation statistics from Australia, where individuals file separately, I form a measure of income distribution among adult males from 1942-2000. In order to take account of non-taxpayers, I take advantage of the fact that for a number of years, both taxation and census data are available. By subtracting the density function for the distribution of male taxpayers from the density function for all adult males, it is possible to derive a function for the distribution of non-taxpayers, expressed in terms of average income. These functions are then used to impute incomes for non-taxpayers in all years, and produce annual income distribution figures for Australia from 1942 to 2000.

Australia makes a useful case study for calculating income distribution figures because of the paucity of evidence on income distribution in the immediate post-war decades. From the end of World War II until 1968, no official survey asked Australian citizens about their income. By contrast, around 80 percent of Australian men paid tax during this period, making these data a potentially rich source of information on the distribution not only of male income, but also of family income.[1]

The remainder of the paper is organized as follows. Section 1 outlines the methodology for calculating inequality figures from taxation data, and deals with the main problems that arise in this process. Section 2 presents the inequality figures, in the form of the gini coefficient, the 90/50 ratio, and the interquartile range. Section 3 briefly compares these data with what is known about the distribution of household income in Australia in the past two decades, and about long-run trends in inequality in other nations. Section 4 analyzes how progressive taxation affected inequality in Australia, and the final section concludes.

2. Methodology

At the outset, it is important to consider whether taxation statistics can serve as a workable substitute for survey evidence on income distribution. While there are several disadvantages of using survey data, it should first be noted that taxation statistics do have two advantages. First, taxation statistics provide a more accurate sampling of top incomes, since surveys may under-sample high earners (Moore, Stinson and Welniak 2000), and because surveys that use income "bands" tend to have a cutoff is lower than the top band in tabulated taxation statistics.[2] Second, taxation data are generally available on an annual basis, while censuses are irregular, and comprehensive labor force surveys did not emerge until much later. For example, the United States Current Population

[1] While limited use has been made of taxation statistics to measure Australian income distribution (Brown 1957; Hancock 1971; Berry 1977), I am unaware of any attempt to construct income distribution series for all years since the introduction of the federal income tax. Other studies on inequality in Australia have used information on minimum wages in different industries (Hancock and Moore 1972; Butlin 1983), or returns from censuses conducted during World War I and the Great Depression (Jones 1975; McLean and Richardson 1986). The leading studies of recent trends in Australian inequality include Borland and Wilkins 1996; Harding 1997; Harding and Greenwell 2002.

[2] In the case of Australia, the top income band in the 1996 census was "Over $78,000"; while the top band for taxation statistics in the financial year 1995-96 was "Over $1,000,000".

Survey started in 1962, the British Labour Force Survey began in 1972, and the Australian Employee Earnings and Hours Survey commenced in 1974 (though it was only conducted biennially during the 1980s and 1990s).[3]

However, taxation statistics also have three potential drawbacks. First, in a country where the taxation unit is the individual (such as Australia, or the UK since 1990), measures of income distribution across individuals may not provide a sufficiently precise proxy for income distribution across families or households. Second, because not everyone files a tax return, taxation statistics provide an incomplete picture of income distribution across the population. And third, taxation statistics are broken into differing numbers of bands in successive years, so some correction to the inequality measures is necessary. These issues are discussed in turn below.

2.1 Using the distribution of male incomes to proxy inequality between families

In analyzing inequality in a society, the most commonly used measure is the distribution of incomes across families, which assumes complete income-sharing within the family unit. So as to take account of economies of scale in household expenditures, family incomes are then adjusted by family size. Although complex equivalence scales are sometimes employed, a common method is simply to divide family incomes by the square root of the number of family members (this is the technique used, for example, by the US Census Bureau and the Luxembourg Income Survey). Most inequality measures place equal weights on all individuals, since to weight by families would be to underweight those living in smaller households.

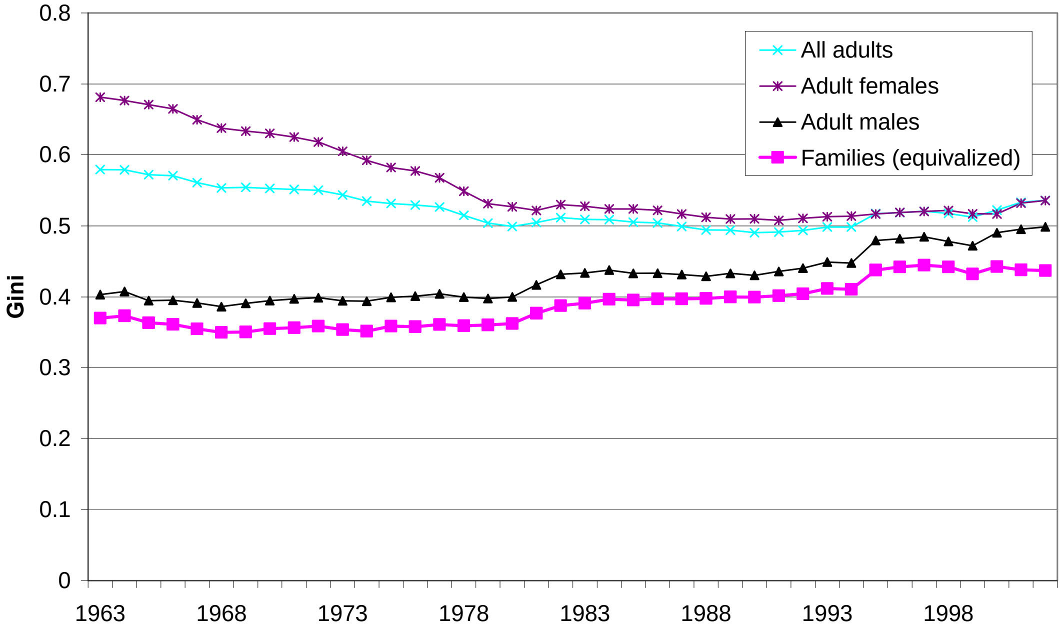
How does this ideal measure of inequality – equivalized family incomes – compare with the distribution of male incomes? In the 1950s and 1960s, when female labor force participation was relatively low, it is reasonable to think that the two measures of income distribution would have been quite close to one another. But changes over the past generation could conceivably have shifted the balance. Rising female labor force participation, greater assortative matching, and changing household composition could conceivably have caused male inequality and family inequality measures to diverge.

Determining how well male inequality proxies family inequality is ultimately an empirical question. To answer it requires data on both male and family incomes over a

[3] Australia has also had a monthly Labour Force Survey since 1978. But unlike its US and UK counterparts, the survey does not ask respondents about their incomes.

generation or more. I therefore briefly turn away from Australia, and instead use data from the US – another country which has experienced many of the same demographic shifts as Australia over recent decades (eg. rising female labor force participation, high immigration rates, and changing family composition). Using microdata from the US Current Population Survey from 1963 to 2002, I calculate the "ideal" measure of inequality – equivalized family income.[4] I then calculate three possible proxies – inequality among adult males (those aged 20 or over), inequality among adult females, and inequality among all adults. These four series are plotted in Figure 1.

Figure 1: How Closely Do Measures of Inequality Track One Another? (Using US CPS data)



As this chart shows, the gap between male inequality and family inequality is smaller than that between female inequality and family inequality, or between individual inequality and family inequality. Over the 40 year time span, male inequality is on average 4 gini points above family inequality, and the gap between the two varies very little (the standard deviation of the difference is just 0.6 gini points). Regressing family income on male inequality returns a coefficient of 0.92 (se=0.04), with an insignificant constant. By contrast, both female inequality and individual inequality are considerably

[4] Family income is equivalized by dividing by the square root of the number of family members. All figures are person-weighted, and all negative and zero incomes are recoded to $1 (since most inequality measures can only be calculated from positive incomes). The inequality measure used here is the gini coefficient, but the results are comparable if other measures of inequality, such as the Atkinson indices or the coefficient of variation, are used instead. I discard data from the March 1963 Current Population Survey (for incomes in 1962), since it appears to be contaminated by an unrealistically number of high incomes.

further away from family inequality, and the standard deviation of either gap is an order of magnitude higher. Of course, it is possible that the pattern that holds true over the past 40 years does not hold for full post-war period, or that the pattern which holds true for the US does not hold true for Australia. But the evidence from US inequality measures does seem to suggest that during the period in question, adult male inequality will be a good proxy for family inequality; and a considerably better proxy than any other measure of individual inequality.

2.2 Incorporating incomes of non-taxpayers

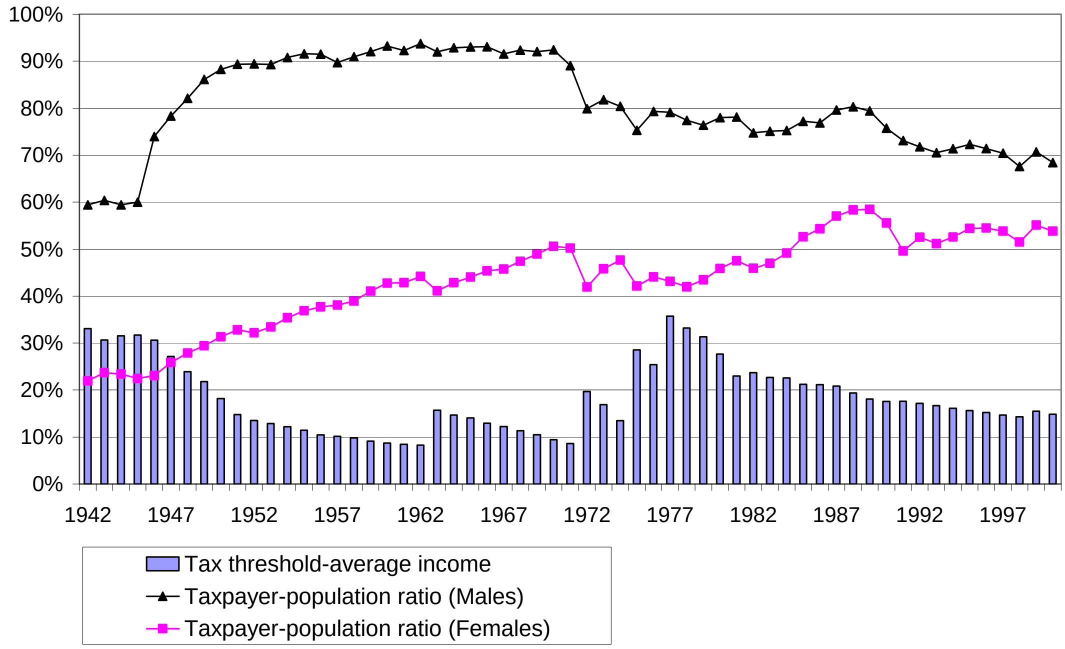
In calculating measures of inequality, some assumptions must be made about the accuracy of tax returns as a measure of actual income. Taxation statistics suffer from underreporting of incomes and from outright avoidance (those who earn more than the taxable threshold, but do not file a return). In addition, some people are not required to file a return, since their incomes fall below the taxable threshold (since Australia has no earned income tax credit, and over-withholding is minimal, there are few incentives for those below the threshold to file a return).

Unfortunately, there is little relevant Australian evidence on the extent of underreporting and tax avoidance in Australia. In the US, Bloomquist (2003) estimates that underreporting of income during the period 1980-2000 amounted to approximately 3-5 percent of total income, and that underreporting as a fraction of total income decreased slightly as income rises. Christian (1994) also finds a non-trivial degree of over-reporting of incomes, which suggests that this may partially offset the underreporting bias.

With regard to those who are not required to file, it is possible to be somewhat more precise. Since the introduction of a federal income tax in 1941, all Australians citizens and residents with incomes over the taxable threshold have been required to file income tax returns.[5] Annual tabulations of these returns have been published, with a one or two year lag, by the Commissioner of Taxation (see Appendix 1 for details).

[5] The Australian taxation year runs from July 1 to June 30, so for simplicity I will refer to the financial year 1941-42 simply as 1941.

Figure 2: Taxpayers in Australia



Notes to Figure 2: Population is those aged 20 and over. Average male income for 1941-42 to 1944-45 is average earnings in manufacturing (Withers, Enders and Perry 1985); 1945-46 to 1980-81 is average earnings per employed male (Withers, Enders and Perry 1985); 1981-82 to 1983-84 from Reserve Bank Economic Statistics, Table 4.18; and 1984-85 onwards is from Australian Bureau of Statistics 6302.0.

Figure 2 shows taxpayer to population ratios for males and females aged 20 or over. By the end of World War II, over half of Australian men filed a tax return, and three-quarters did by the end of the 1940s.[6] This figure remained above 90 percent until 1970, and has fluctuated around 70-80 percent since. (By contrast, the fraction of adult women who paid tax only rose above 50 percent in the mid-1980s, making it unfeasible to impute incomes to non-taxpaying women.) Figure 2 also shows the taxable threshold as a fraction of average male income. In 1942, the threshold was 33 percent of average male income (down from 70 percent the year before). Since then, the taxable threshold has remained at about this level or below.[7] Note that over the past few decades, the fraction of adult males paying tax has declined, despite the fact that the taxable threshold as a fraction of average income has moved downwards. This suggests that the assumption that all non-taxpayers have incomes below the taxable threshold is probably not sustainable.

[6] Prior to 1941, taxation statistics can be used to measure the distribution of top incomes (see Atkinson and Leigh 2003), but not the distribution as a whole.
[7] For more detail on the history of income taxation in Australia, see Smith (1993, 2001).

I now embark upon imputing incomes to those males who do not pay tax. To gauge the distribution of non-taxpayers, I compare the distribution of male income in taxation statistics with those from seven official surveys – income distribution surveys carried out in 1968-69 and 1973-74, and censuses from 1976, 1981, 1986, 1996 and 2001.[8] In each of the seven surveys, the definition of income is essentially the same as that published in the taxation statistics, leading one Australian Bureau of Statistics report to conclude that "both sets of data are relatively comparable" (Gibbs and Knight 2000, 14).[9]

To determine the income distribution of non-taxpayers, a kernel density function is estimated for the seven surveys and their corresponding tax years (eg. the 2001 census and the 2000-01 tax year). The function is estimated at 21 points – starting at zero, and continuing in 10 percent intervals to twice average male income. Since the top income band in the income surveys is around twice the average income, it is not possible to reliably estimate the kernel density functions beyond this point.[10]

By normalizing the area under the kernel density function to 1, and multiplying by the relevant population, it is possible to obtain an estimate for the number of males at zero earnings, 10 percent of average earnings, 20 percent of average earnings, and so on up to 200 percent of average earnings. By comparing the number of males under the tax distribution with the number of males under the survey distribution, I can estimate the distribution of non-taxpayers in a given year.

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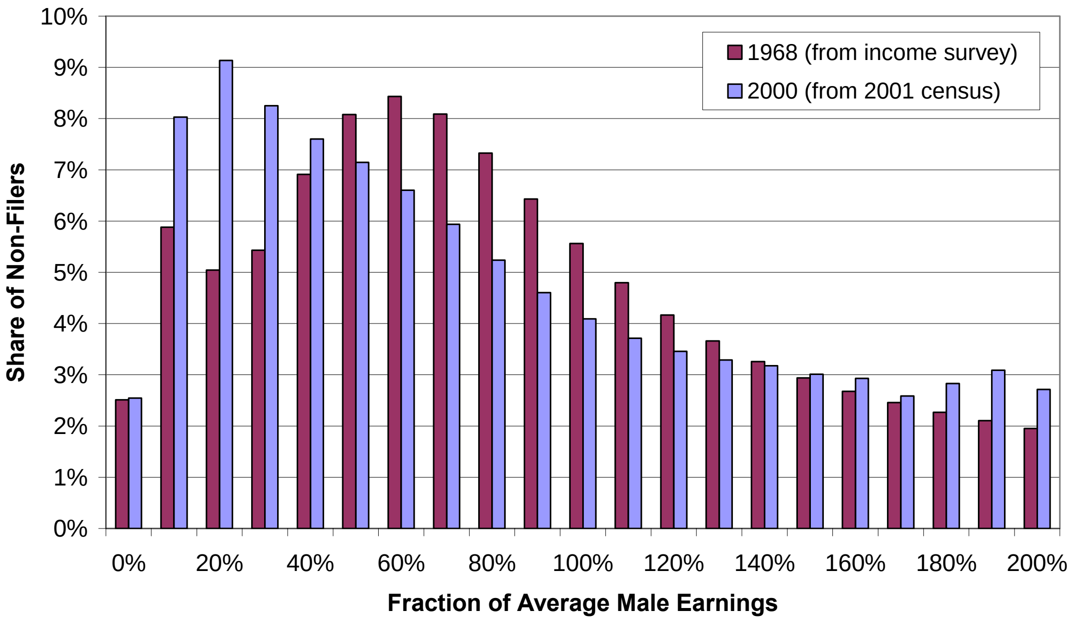
[8] These surveys asked for all income, including transfers. Income ranges were typically defined by both weekly and annual earnings (with the annual range being 52 times the weekly range). The 1991 census is excluded because it did not include an option to either record nil income (as did other censuses), or a near-zero income (the 1968-69 and 1973-74 surveys both had bottom bands equivalent to 0-3 percent of average male earnings, while the lowest band in the 1991 census was substantially higher: 0-10 percent of average earnings).

[9] In particular, both the income surveys and taxation statistics include transfers and self-employment income. One potential difference could arise from the wording of the census income question in the 1980s and 1990s. In these years, the census asked for the "the gross income (including pensions and allowances) that the person usually receives each week from all sources". Although the income ranges are given in both weekly and annual amounts, individuals might interpret this question as asking for median weekly income, not mean weekly income. In this case, an individual with "lumpy" income might report a lower figure in the census than on their tax return.

[10] A gaussian kernel density function is used, though results do not vary significantly with an Epanechnikov kernel function. The most important decision in using a kernel density function is the bandwidth. The standard formula for the optimal bandwidth is $w=0.9*sd*n^{-0.2}$, where *sd* is the standard deviation of log income, and *n* is the number of bands. Sala-i-Martin (2002) reports that *sd* is 0.6 in most European countries, and 0.9 in the US. Given that Australian income inequality is somewhat below that of the US, sd=0.8 is assumed. The number of income bands in the different surveys and corresponding tax tables varies between 14 and 38, and averages 25, so I set n=25. This results in a bandwidth of 0.37.

Figure 3 shows the distribution of non-taxpaying males, relative to average income, for the first and last surveys: 1968 and 2000. Because the taxable threshold was lower (as a fraction of average income) in 1968 than 2000, it is not surprising that the typical non-taxpayer is also richer (as a fraction of average income) in 1968. In each case, the distribution of non-taxpayers is approximately lognormal. In both years, only about 2 percent of non-taxpaying males actually report zero incomes – indicating that setting the incomes of non-taxpayers to zero would substantially overstate the extent of inequality.

Figure 3: Distribution of Non-Filers
Based on Difference Between Taxation and Census Data



From 1968 onwards, I impute incomes to non-taxpayers using the survey that is closest in time to the tax year in question. For example, the distribution of non-taxpayers derived from combining the 2001 census with the 2000-01 tax statistics is used to impute incomes for non-taxpayers not only in 2000-01, but also in 1998-99 and 1999-2000. Because no official income surveys were conducted from World War II to 1968, I use the "non-taxpayer function" from 1968 to estimate the income distribution of non-taxpayers in prior years. While this is the only available option, there is indeed a potential for bias if the income distribution of non-taxpayers was markedly different in earlier years. While there is no way of determining the extent of such bias, it is limited by the fact that there is less imputation to be done in the 1950s and 1960s – since nine out of ten male adults paid tax during these decades.

Based on this distribution, I impute earnings for non-taxpayers in all years. For example, in 1950-51, there were 2,731,100 males aged 20 or over in Australia, but only 2,410,836 male taxpayers. Using the average annual male income in 1950-51 ($576), and the distribution of non-taxpayers from the 1968 income survey, the 320,264 non-taxpaying males were allocated incomes between zero and $1152 (twice average male income).

Some readers of an earlier version of this paper have queried whether it would not be better to assume a small level of tax avoidance, and then that all non-taxpayers had incomes at or below the taxable threshold. To test this, Appendix 2 presents three variants on this approach. In each of the three alternative specifications, I assume that 5 percent of adult males do not pay tax, and then variously assume that: (a) all non-taxpayers have zero incomes; (b) all non-taxpayers earn precisely the taxable threshold amount; and (c) all-non filers have incomes below the taxable threshold, and the observed distribution of taxpayers is a truncated lognormal distribution. Note that if it is indeed true that all but 5 percent of the population abides by the tax laws, then specifications (a) and (b) should be the upper and lower bounds on Australian inequality. However, given that the fraction of adult males paying tax has declined, despite the fact that the taxable threshold as a fraction of average income has moved downwards, it is doubtful that this is a reasonable assumption.

These three alternative specifications are graphed in Figures A1.2 and A1.3. The trends are qualitatively consistent with the preferred specification, in that they show a decline in inequality in the immediate post-war years, and a rise in the 1980s and 1990s. But the alternative specifications do not accord with the primary specification with respect to the 1970s, and show a rise in inequality in the 1980s which is substantially larger than that recorded in any other surveys. For this reason, the census imputation method is preferred, and it is this specification that I will focus on from hereon in.

2.3 Taking account of differing numbers of taxation bands

The last major issue to be considered is that taxation statistics are presented in varying numbers of bands, ranging from 18 to 38. Since inequality is negatively correlated with the number of bands (Dixon et al 1987; Mills and Zandvakili 1997), some correction to the inequality measure is necessary. Most of the measures of inequality shown herein will be presented in terms of the gini coefficient, since it is the most commonly used measure of inequality in the literature. Using incomes from tax data, with earnings imputed as described above, the gini coefficient is calculated using a standard non-parametric formula for grouped data.[11]

$$\mathrm{Gini} = 1 - \sum_{i=1}^{N} P_i (S_i + S_{i-1})$$

Where N is the number of groups, P_i is the fraction of the population in group i, and S_i is the share of total income in group i and all groups below, with S_0=0.

Deltas (2003) presents a means of adjusting for the negative bias in the gini which occurs with small samples. Beginning with the intuition that the maximum value for the gini is N-1/N, he runs Monte Carlo simulations to determine the effect of scaling the gini by N/N-1. He finds that this adjustment substantially reduces the bias for lognormal distributions (which are likely to approximate most of the Australian earnings distribution), and eliminates it for exponential distributions (which may approximate the top end of the income range). In the case of lognormal distributions, the efficacy of the correction depends on the standard deviation of log earnings. Deltas carries out separate sets of simulations for standard deviations of log income equal to 0.5 and 1 (which is the operative range for Australian incomes since WWII). With $\sigma = 0.5$, the bias arising from 20 groups is reduced from 5 percent to 0.3 percent, while the bias arising from 30 groups falls from 4 percent to 0.3 percent. If $\sigma = 1$, the bias with 20 groups is reduced from 7 percent to 3 percent, while the bias with 30 groups is cut from 5 percent to 2 percent. If the distribution of Australian earnings is essentially lognormal, we should expect this second-order bias to be more positive in more unequal years, though in all cases the correction should bring the gini estimate closer to the true figure.

The formula used to calculate the gini is therefore:

$$Gini = \frac{N}{N-1}\left[1 - \sum_{i=1}^{N} P_i (S_i + S_{i-1})\right]$$

[11] A substantial literature exists on the construction of inequality indices from grouped data (see for example Gastwirth and Glauberman 1976; Slottje 1990; Ortega et al 1991; Ryu and Slottje 1996; Wodon and Yitzhaki 2003). Much of the discussion has centered around the question of whether parametric or non-parametric estimation of inequality indices is preferable, with most papers advocating a parametric approach. In the present case, however, a non-parametric approach is favored, since it is then possible to adjust for the bias induced with changes in the number of bands from year to year.

Some minor issues arising from the use of taxation statistics to measure income distribution are addressed in Appendix 3.

3. Inequality Trends

Table 1 shows the pre-tax and post-tax male gini coefficients, based on taxation statistics for filers, and imputing incomes for non-taxpayers on the assumption of log-normality. In addition, Table 1 also presents two other measures of income distribution, which are mostly unaffected by imputation – the 90/50 ratio, and the interquartile range. These ratios are calculated using linear extrapolation, and (unlike the ginis) are not adjusted to account for the number of income bands.

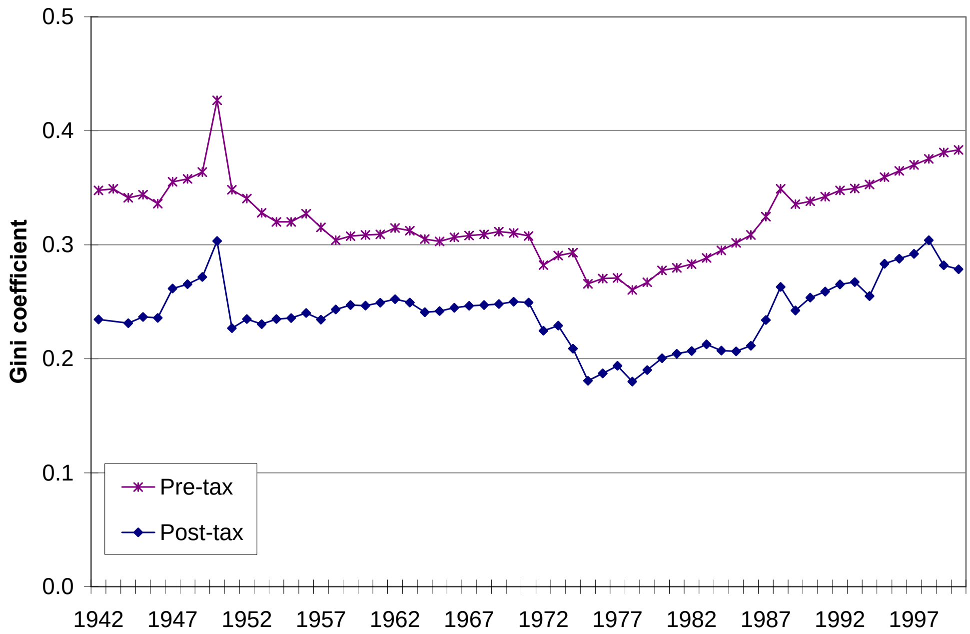
Table 1: Inequality among male adults in Australia

Year	Interquartile range (75/25)	90/50 ratio	Gini (pre-tax)	Gini (post-tax)
1942	1.97	1.77	0.348	0.235
1943	1.96	1.77	0.349	*
1944	1.96	1.76	0.341	0.231
1945	1.93	1.79	0.344	0.237
1946	1.81	1.77	0.336	0.236
1947	1.77	1.78	0.355	0.262
1948	1.73	1.77	0.358	0.265
1949	1.73	1.80	0.364	0.272
1950	1.69	1.85	0.427	0.303
1951	1.69	1.72	0.348	0.227
1952	1.65	1.72	0.341	0.235
1953	1.65	1.70	0.328	0.230
1954	1.68	1.69	0.320	0.235
1955	1.69	1.75	0.320	0.236
1956	1.69	1.81	0.327	0.240
1957	1.70	1.78	0.315	0.234
1958	1.69	1.80	0.304	0.243
1959	1.71	1.78	0.308	0.247
1960	1.74	1.77	0.309	0.247
1961	1.74	1.76	0.309	0.249
1962	1.79	1.86	0.315	0.252
1963	1.75	1.85	0.312	0.249
1964	1.77	1.80	0.305	0.241
1965	1.77	1.78	0.303	0.242
1966	1.80	1.82	0.307	0.245
1967	1.82	1.81	0.308	0.247
1968	1.87	1.79	0.309	0.247
1969	1.89	1.80	0.312	0.248
1970	1.88	1.80	0.310	0.250
1971	1.89	1.80	0.308	0.249
1972	1.79	1.76	0.282	0.225
1973	1.82	1.80	0.291	0.229
1974	1.86	1.73	0.293	0.209
1975	1.73	1.73	0.266	0.181
1976	1.79	1.72	0.270	0.187
1977	1.82	1.71	0.271	0.194
1978	1.74	1.70	0.261	0.180
1979	1.83	1.72	0.267	0.190
1980	1.92	1.72	0.278	0.201
1981	1.92	1.75	0.280	0.204
1982	1.94	1.78	0.283	0.207
1983	1.99	1.78	0.289	0.213
1984	2.01	1.79	0.295	0.207
1985	2.06	1.81	0.302	0.207
1986	2.07	1.82	0.309	0.211
1987	2.09	1.84	0.325	0.234

Year	Interquartile range (75/25)	90/50 ratio	Gini (pre-tax)	Gini (post-tax)
1988	2.20	1.90	0.349	0.263
1989	2.20	1.93	0.336	0.242
1990	2.31	1.97	0.338	0.254
1991	2.27	2.00	0.342	0.259
1992	2.32	2.00	0.348	0.265
1993	2.34	2.03	0.350	0.267
1994	2.24	2.00	0.353	0.255
1995	2.35	2.05	0.359	0.283
1996	2.41	2.08	0.365	0.288
1997	2.46	2.06	0.370	0.292
1998	2.50	2.08	0.376	0.304
1999	2.41	2.07	0.381	0.282
2000	2.36	2.08	0.383	0.279

* 1943-44 post-tax estimate omitted due to the shift to pay-as-you-earn (see Appendix 1).
Note: Year is the financial year starting on July 1 (eg. 1942 is the financial year July 1, 1942 to June 30, 1943).

Figure 4: Distribution of Male Incomes in Australia 1942-2000



Note to Figure 4: The 1943-44 post-tax gini is omitted due to the shift to pay-as-you-earn (see Appendix 1).

Figure 4 provides a graphical depiction of these trends, suggesting that male pre-tax inequality during World War II stayed relatively stable, and then fell steadily during the 1950s, except for brief spike upwards during the wool boom of 1950-51.[12] During the

[12] Some readers have questioned whether the 1950-51 spike might be an error in the data. It is worth noting that this shock is also reflected in other Australian economic statistics. For example, nominal GDP in financial year 1950-51 was 33 percent higher than in the previous year.

1960s, inequality remained flat, and fell again during the early-1970s. In 1978, inequality in Australia was at its nadir. At this point, it might have been possible to argue that Australian inequality traced out a Kuznets curve path (Kuznets 1955), but the pattern since has rendered this untenable. From the late-1970s onwards, inequality has been on a steady upwards trajectory. Australia today is more unequal than at any time in the post-war era, with the exception of the brief 1950-51 spike. The post-tax gini has followed a relatively similar path to the pre-tax gini.

Figure 5: Distribution of Male Incomes in Australia 1942-2000

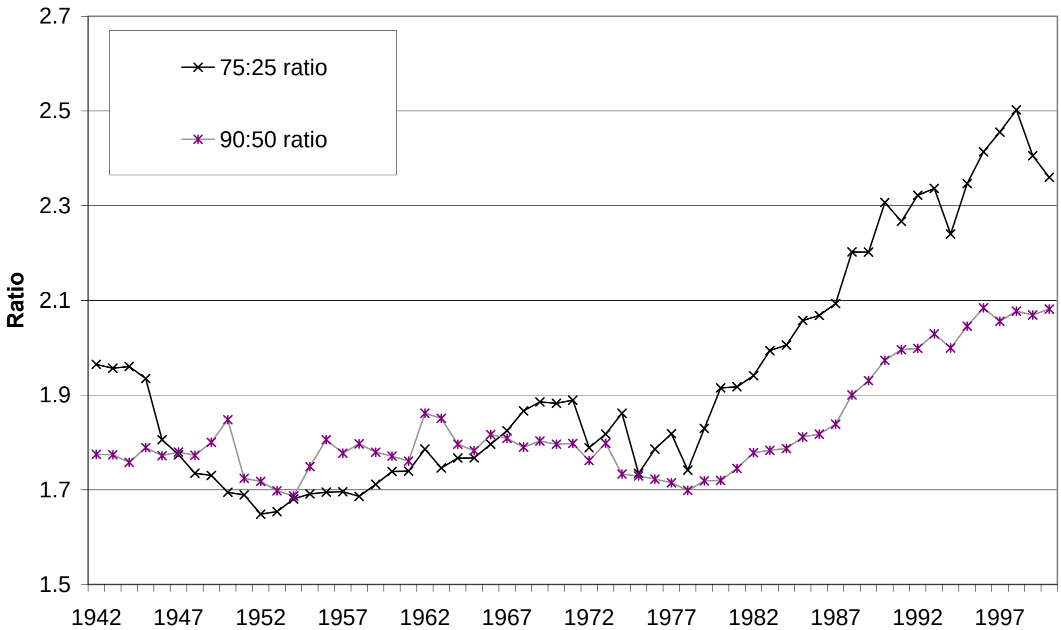
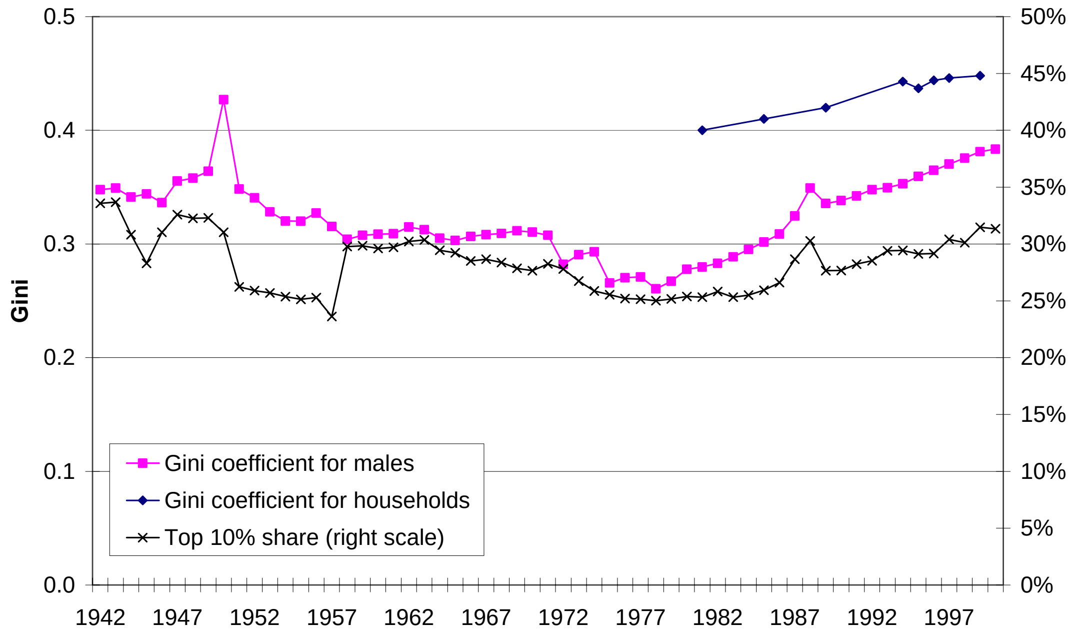


Figure 5 charts the interquartile range and 90/50 ratio. Both appear to have followed a somewhat similar path to the gini. Of note is the fact that, over the past two decades, the interquartile range has risen more rapidly than the 90/50 ratio.

4. Comparison with other Inequality Data

Having constructed a series of male inequality data, it is instructive to compare these figures with recent data on income distribution in Australia, and long-run inequality trends in other developed countries. Figure 6 compares the estimates for pre-tax male inequality with estimates for non-equivalized household pre-tax inequality produced by the Australian Bureau of Statistics during the 1980s and 1990s (ABS Cat 6523.0 and its predecessor surveys). Figure 6 also plots the top 10 percent share, from Atkinson and Leigh (2003). Male inequality appears to follow the same broad sweeps as the two other measures of inequality, and to have risen at about the same pace as household inequality in the past two decades. This provides further evidence that male inequality is a reasonable proxy for household inequality in earlier years.

Figure 6: Comparison with Other Inequality Measures

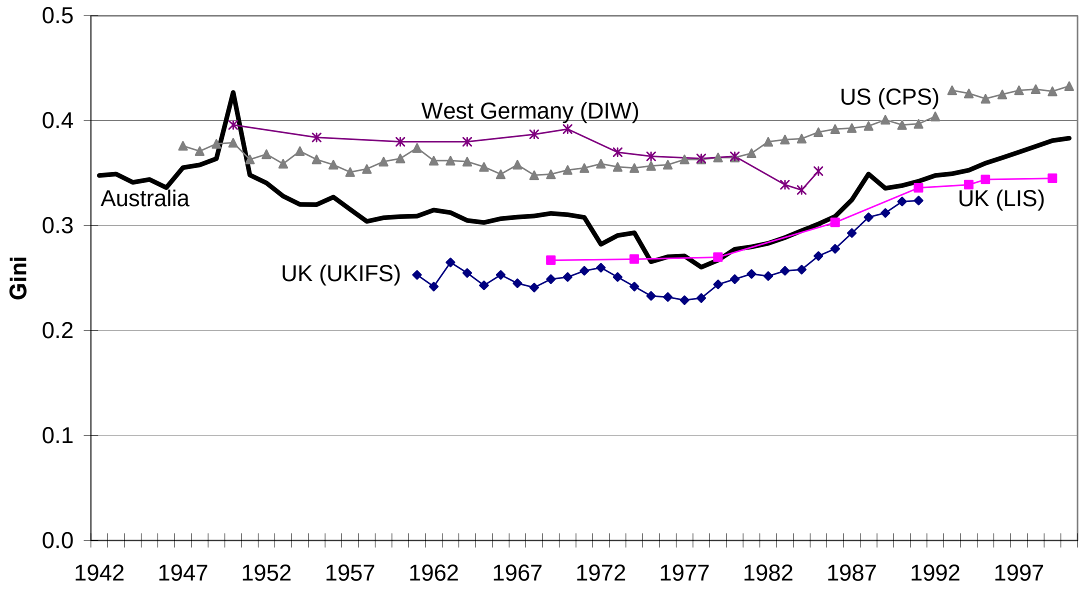


If we assume that male inequality is a reasonable proxy for household inequality, then we can ask the question: how do these estimates compare to trends in other developed nations? Figure 7 shows Australian income inequality trends with those from three other countries for which long-run data is available – the UK, US, and West Germany.[13] Although the levels are not comparable, it is possible to compare Australia's

[13] US (CPS) series is on a family basis, using pre-tax income, from "Table F-4: Gini Ratios for Families", available at www.census.gov/hhes/income/histinc/f04.html. UK (IFS) series is on a household basis, using net income, from Goodman and Webb (1994). UK (LIS) series is on a household basis, calculated using disposable income, from the Luxembourg Income Survey, available at

trends with these three nations. The Australian pattern appears to be closest to that of the UK, which saw stability during the 1960s, a small decline in the early-1970s, and a steady rise since.[14]

Figure 7: Comparing Trends in Australian Inequality with West Germany, the UK and the US
Note: Levels are not comparable across series; only trends.



5. <u>Taxation and Inequality</u>

Using taxation data, it is also possible to calculate the progressivity of the personal income tax. I apply three of the most commonly employed measures, the Reynolds-Smolensky index (Reynolds and Smolensky 1977), the Musgrave-Thin index (Musgrave and Thin 1948), and the Suits index (Suits 1977). These capture three distinct aspects of progressivity. The Reynolds-Smolensky index is the difference between the post-tax and pre-tax ginis; the Musgrave-Thin index is a measure of the ratio of the post-tax and pre-tax ginis; and the Suits index measures the concentration of taxes with respect to income (the Suits index is calculated like a gini coefficient, but with income on the horizontal axis and tax payments on the vertical axis). Of the three, the Suits index is said to be the most commonly used (Congressional Budget Office 1988). Where G_A and G_B are the gini coefficients for after-tax and before-tax income respectively,

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www.lisproject.org/keyfigures/ineqtable.htm. West Germany (DIW) series is on a household basis, using net income, from Guger (1989).

[14] This remains true even when other countries are considered. Atkinson (2002b) presents data on trends in household inequality for six other countries – Finland, Canada, Sweden, Norway, the Netherlands, and Italy – in addition to the UK, US, and West Germany. The UK remains the closest match to Australia.

MT index = $(1-G_A)/(1-G_B)$

RS index = G_A-G_B

And where K denotes the area below the line of proportionality, and L denotes the area below the Lorenz curve of tax payments against income:

Suits index = 1- L/K

Figure 8: Progressivity of the Personal Income Tax 1942-2000

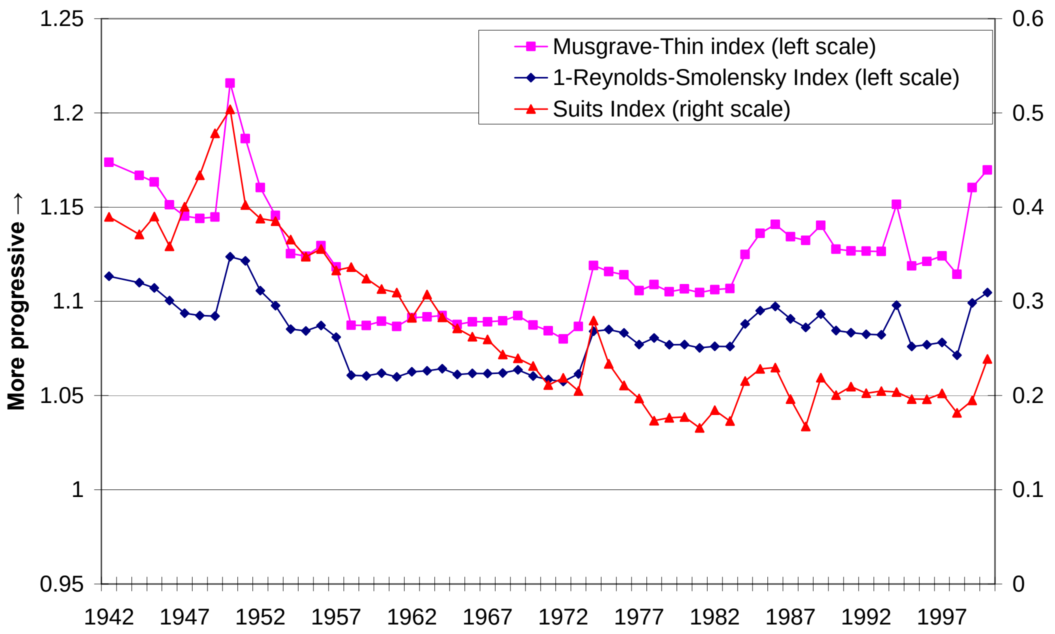

Figure 8 graphs the three indices over the period 1942-2000. For ease of interpretability, I present 1–RT, so a movement upwards always represents a more progressive tax system. During the 1940s and 1950s, the three indices agree that personal income taxation in Australia became less progressive, but while the MT and RS indices suggest stability in the 1960s and rising progressivity in the 1970s, the Suits index suggests declining progressivity during both decades. Over the past two decades, the Suits and RS indices suggest that progressivity has basically been stable, while the MT indicates a slight rise in progressivity.[15] This reflects the fact that when the level of pre-tax inequality is higher, the MT index gives a higher weight to any absolute change in the gini, while the other two indices do not. Applying a social welfare function in which progressivity is not weighted more highly in a more unequal society, one would conclude that the

[15] Smith (1997) calculates the Musgrave-Thin index using data only for taxpayers, and finds that the taxation system in the 1990s was less progressive than in the 1970s. But when changes in the number of taxpayers are taken into account, the opposite appears to be true.

progressivity of Australian personal income taxation remained basically constant during the 1980s and 1990s.

6. Conclusion

Measuring inequality using taxation statistics is never a first-best option. But in the absence of adequate survey data, taxation statistics can help to fill in gaps in our knowledge about long-run trends in inequality. By using only the incomes from male taxpayers; imputing the incomes of non-taxpayers based on the observed distribution of taxpayers; and adjusting the gini coefficient for the number of income bands, it is possible to considerably narrow the confidence interval around inequality measures that are derived from taxation statistics.

In the case of Australia, taxation statistics can be used to derive an annual measure of male inequality for the past sixty years, including a quarter-century in which no income distribution figures were previously available. The resulting series indicates that pre-tax inequality in Australia fell in the 1950s and the 1970s, and rose during the 1980s and 1990s, with post-tax inequality following much the same pattern. For other countries in which mass taxation preceded high-quality income surveys, such analysis may prove similarly fruitful.

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Appendix 1: Sources of Income Tax Data for Australia				
Year	**Source**	**Number of bands**	**Income measure**	**Bands organized by**
1942-43	Schedule No 7	19	Taxable income	Actual income
1943-44	Schedule No 6	19	Taxable income	Actual income
1944-45	Schedule No 11	19	Taxable income	Actual income
1945-46	Schedule No 11	19	Taxable income	Actual income
1946-47	Schedule No 11	19	Taxable income	Actual income
1947-48	Schedule No 11	21	Taxable income	Actual income
1948-49	Schedule No 10	21	Taxable income	Actual income
1949-50	Schedule No 10	21	Taxable income	Actual income
1950-51	Schedule No 97	24	Taxable income	Actual income
1951-52	Schedule No 98	18	Taxable income	Actual income
1952-53	Schedule No 99	21	Taxable income	Actual income
1953-54	Schedule No 1	21	Taxable income	Actual income
1954-55	Schedule No 1	24	Taxable income	Actual income
1955-56	Schedule No 1(1)	24	Taxable income	Actual income
1956-57	Schedule 1(1)	24	Taxable income	Actual income
1957-58	Schedule 1(1)	24	Taxable income	Actual income
1958-59	Schedule 1(1)	32	Actual income	Actual income
1959-60	Schedule 1(1)	32	Actual income	Actual income
1960-61	Schedule 1(1)	32	Actual income	Actual income
1961-62	Schedule 1(1)	32	Actual income	Actual income
1962-63	Schedule 1.1	32	Actual income	Actual income
1963-64	Schedule 1.1	32	Actual income	Actual income
1964-65	Schedule 1.1	32	Actual income	Actual income
1965-66	Schedule 1.1	36	Actual income	Actual income
1966-67	Schedule 1.1	36	Actual income	Actual income
1967-68	Schedule 1.1	36	Actual income	Actual income
1968-69	Schedule 1.1	36	Actual income	Actual income
1969-70	Schedule 1.1	36	Actual income	Actual income
1970-71	Schedule 1.1	38	Actual income	Actual income
1971-72	Schedule 1.1	38	Actual income	Actual income
1972-73	Schedule 1.1	35	Actual income	Actual income
1973-74	Schedule 1.1	35	Actual income	Actual income
1974-75	Schedule 1.1	28	Actual income	Actual income
1975-76	Schedule 1.1	26	Actual income	Actual income
1976-77	Schedule 1.1	29	Actual income	Actual income
1977-78	Schedule 1.1	29	Actual income	Taxable income
1978-79	Schedule 1.1	24	Actual income	Taxable income
1979-80	Schedule 1.1	27	Actual income	Taxable income
1980-81	Schedule 1.1(e)	27	Actual income	Taxable income
1981-82	Schedule 1.1(a)	27	Actual income	Taxable income
1982-83	Table 1.3(e)	27	Actual income	Taxable income
1983-84	Table 1.3(e)	27	Actual income	Taxable income
1984-85	Table 1.3(e)	27	Actual income	Taxable income
1985-86	Tables 1.3(e) & 1.25	27	Actual income	Taxable income

Appendix 1: Sources of Income Tax Data for Australia

Year	Source	Number of bands	Income measure	Bands organized by
1986-87	Tables 1.3(e) & 1.24	27	Actual income	Taxable income
1987-88	Tables 1.3(e) & 1.24	26	Actual income	Taxable income
1988-89	Tables 1.3(e) & 1.24	26	Actual income	Taxable income
1989-90	Tables 1.3(c) & 1.24	26	Actual income	Taxable income
1990-91	Tables 1.3(f) & 1.24	26	Actual income	Taxable income
1991-92	Tables 1.3(f) & 1.24	26	Actual income	Taxable income
1992-93	Tables 1.3(f) & 1.22	26	Actual income	Taxable income
1993-94	Tables 1.6(i) & 1.13	26	Actual income	Taxable income
1994-95	Tables P16 & C5	20	Actual income	Taxable income
1995-96	Tables I4 & I14	31	Actual income	Taxable income
1996-97	Tables I4 & I15	31	Actual income	Taxable income
1997-98	Tables I2 & I14	31	Actual income	Taxable income
1998-99	Tables I4 & I14	31	Actual income	Taxable income
1999-2000	Personal Tax Tables 6A, 6B & 9	20	Actual income	Taxable income
2000-01	Personal Tax Tables 5B & 9	20	Actual income	Taxable income

Notes:
1. All sources are tables in the annual *Report of the Commissioner of Taxation*.
2. Number of bands is the number of bands in which income statistics are reported.
3. Taxable income is actual (total) income, less deductions, and includes interest payments, dividends, business income, transfer payments, and (from 1986 onwards) realized capital gains.

Appendix 2: Three Alternative Methods of Imputing Incomes of Non-Taxpayers

In the main text, I calculate the gini coefficient on the assumption that the income distribution of non-taxpayers can be represented by the difference between the density functions for taxation statistics and census statistics. This appendix presents three alternative methods of calculating the distribution of non-taxpayers. In each case, I assume that 5 percent of the population are *avoiders*, a representative sample of the population who do not pay tax. The remaining 95 percent are then assumed to be law-abiding, and to fall into two categories: *filers*, whose incomes were over the taxable threshold; and *non-filers*, whose incomes fell below the taxable threshold. Once *avoiders* are excluded, the observed distribution may be regarded a truncated version of the real distribution of incomes.

The first and second specifications are straightforward. In both cases, I maintain the assumption that 5 percent of the adult male population avoids tax, so the imputation procedure applies to the group defined by MP*0.95–MT, where MP is the number of adult males aged 20 or over, and MT is the number of male taxpayers. The first alternative specification assumes that all non-filers have an income of zero, while the second assumes that all non-filers have an income equal to the taxable threshold. If all but 5 percent of the population abides by the tax law, these two specifications should represent the upper and lower bounds on the primary specification.

Figure A1: Alternative Specifications for Imputing Incomes of Non-Taxpayers

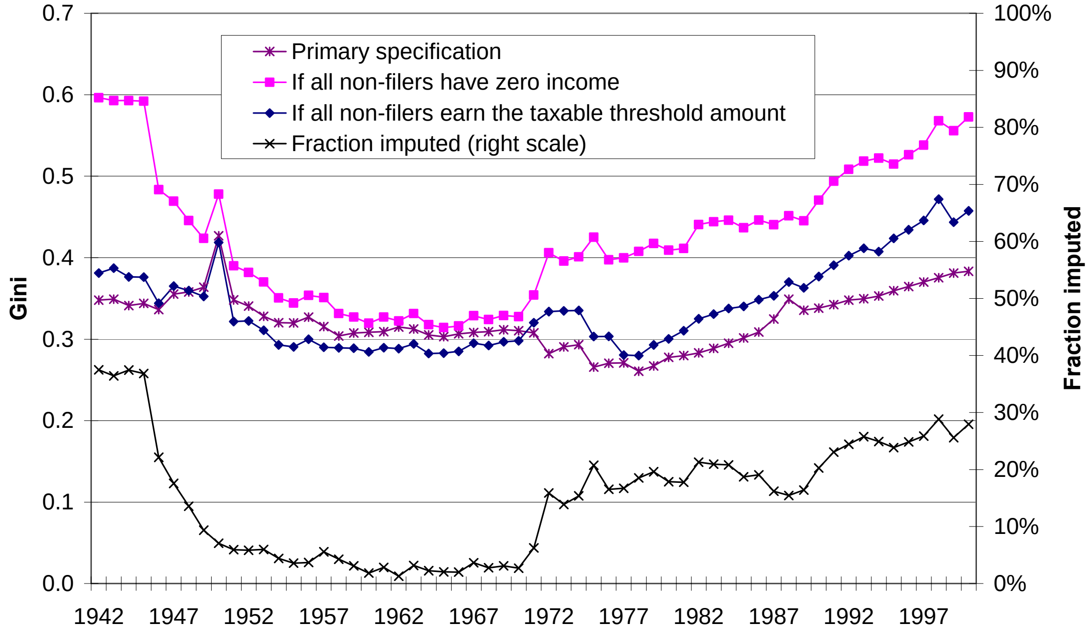

Figure A1 shows the first two alternative specifications, plotted against the primary specification. The three lines are closest together during the 1960s, when the fraction of males paying tax was highest. During recent decades, the fraction of males not paying tax has risen, and the lines have diverged somewhat. Both track the primary specification quite closely in the 1960s, but diverge in the 1940s, and from the 1970s onwards. Both of the first two alternative specifications show a sharper rise in inequality during the 1980s and 1990s than does the primary specification.

The third specification is somewhat more sophisticated. If we assume a functional form for the overall distribution, then it is possible to impute incomes in the truncated region. Since the goal is to impute incomes at the bottom of the income distribution, the natural functional form to select is a log-normal distribution. Using the taxable threshold as the truncation point, calculating the fraction of the adult male population below the truncation point from annual population statistics, and taking the mean of the truncated distribution, one can derive the mean and standard deviation of the non-truncated distribution.

To derive the moments of a non-truncated distribution, we begin with the basic formula for the moments of the truncated normal distribution (Greene 2003, 759).

If $x \sim N[\mu, \sigma^2]$ and observations below point t (the natural log of the truncation point) are truncated:

(1) $\quad E[x|\text{truncation}] = \mu + \sigma\left(\frac{\phi(\alpha)}{1-\Phi(\alpha)}\right)$

(2) $\quad V[x|\text{truncation}] = \sigma^2\left[1-\left(\frac{\phi(\alpha)}{1-\Phi(\alpha)}\right)\left(\frac{\phi(\alpha)}{1-\Phi(\alpha)}-\alpha\right)\right]$

where $\alpha = \frac{t-\mu}{\sigma}$ and $\phi(\alpha)$ is the standard normal density.

In the usual case, we know the mean and variance of the non-truncated distribution, and equations (1) and (2) show how to derive the mean and variance of the truncated distribution. Here, however, the reverse is true. We know the parameters of the non-truncated distribution, but need to obtain μ and σ (the mean and variance of the non-truncated distribution).

If the fraction of the population to the left of the truncation point is p (such that $0<p<1$), then:

(3) $\quad \Phi(\alpha) = p$

(4) $\quad \alpha = \Phi^{-1}(p)$

(5) $\quad \phi(\alpha) = \phi(\Phi^{-1}(p))$

Substituting into (1), and rearranging:

(6) $\quad E = \mu + \sigma\left(\frac{\phi(\Phi^{-1}(p))}{1-p}\right)$

Rearranging again:

(7) $\quad \sigma = \frac{(1-p)(E-\mu)}{\phi(\Phi^{-1}(p))}$

Further, we know that

(8) $\quad \sigma = \frac{t-\mu}{\Phi^{-1}(p)}$

Finally, we can combine equations (7) and (8) to derive the mean and standard deviation (in logs) for the non-truncated distribution in terms of p, t and E:

(9) $$\mu = \frac{E\Phi^{-1}(p) - t\frac{\phi(\Phi^{-1}(p))}{(1-p)}}{\Phi^{-1}(p) - \frac{\phi(\Phi^{-1}(p))}{(1-p)}}$$

(10) $$\sigma = \frac{1}{\Phi^{-1}(p)}\left(t - \frac{E\Phi^{-1}(p) - t\frac{\phi(\Phi^{-1}(p))}{(1-p)}}{\Phi^{-1}(p) - \frac{\phi(\Phi^{-1}(p))}{(1-p)}} \right)$$

Using these parameters, it is then possible to impute incomes between zero and the taxable threshold to the non-taxpaying population. Note that this third alternative specification assumes that all but 5 percent of the population pays tax, and that the distribution is log-normal in the relevant range.

Figure A2 graphs the third alternative specification against the primary specification. The two series show the same trends for the 1950s (declining inequality), 1960s (stable), and 1980s-1990s (rising). But, as with the first two alternative specifications, the third alternative specification shows a rise in inequality during the 1980s and 1990s that is substantially larger than that recorded in any other income distribution survey during this period.

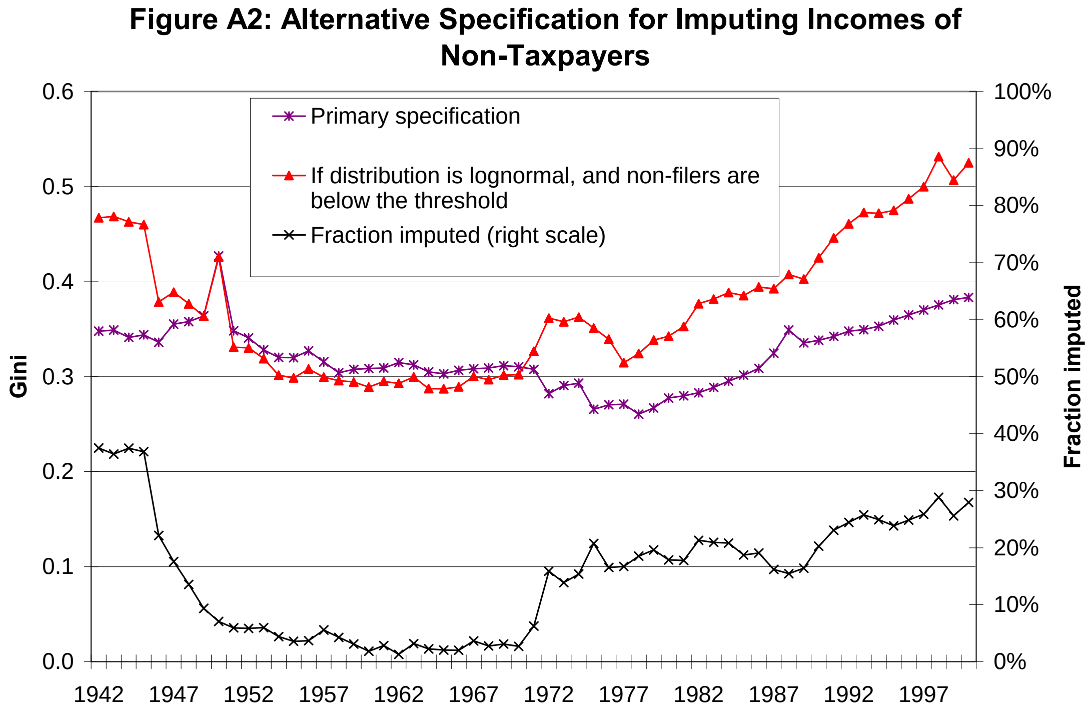
Figure A2: Alternative Specification for Imputing Incomes of Non-Taxpayers
Primary specification
If distribution is lognormal, and non-filers are below the threshold
Fraction imputed (right scale)
Gini
Fraction imputed
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
1942
1947
1952
1957
1962
1967
1972
1977
1982
1987
1992
1997

Appendix 3: Other Potential Problems Arising from the Use of Taxation Statistics to Determine Inequality

Section 1 discusses three of the drawbacks in calculating inequality using taxation data. In addition to these problems, six more minor issues arise. Some of have been mentioned in the literature (Brown 1957; Hancock 1971), while others are new.

1. Late returns are omitted from the tabulations.

Tabulations of taxation data for income years 1942-43 to 1997-98 were published with a one-year lag. Figures for 1998-99 onwards have been published with a two-year lag. While it is not possible to know precisely how many tax returns are omitted, it is unlikely that this would have a significant impact on the tabulations.

2. From 1942-43 to 1957-58, only taxable income, rather than total income, is provided. This could potentially affect inequality measures if the distribution of taxable and total incomes followed a different pattern. In practice, however, it seems to make little difference. For example, using taxable income rather than total income in 1958-59 makes a difference of just 1/10th of a gini point

3. Income bands are for total income from 1942-43 to 1976-77, and for taxable income thereafter. This could potentially be a problem if it significantly changed the rankings of taxpayers – for example, if those with high actual incomes had particularly low taxable incomes. There are two reasons this seems unlikely. First, measures of income inequality using taxable and actual incomes produce similar gini coefficients (see paragraph 2). And second, while there is no year in which income is reported separately in bands of taxable income and total income, there is certainly no sharp change in inequality from 1976-77 to 1977-78 – as one might expect if the change in classification was a problem.

4. The most detailed taxation statistics include non-resident taxpayers. In theory, this could affect measures of income inequality if there were a large number of non-resident taxpayers, who had a markedly different distribution of income than non-residents. However, non-resident taxpayers constitute only about 0.1 percent of total taxpayers – a figure that remains constant over the period in question.

5. In certain years, income is not disaggregated by gender. From 1942-47, and in 1994, 1999, and 2000, taxation statistics presented figures on the number of males and females in each band, and the total income within each band for both males and females. For these years, therefore, I assume that within each band, males have a proportionate share of the income. Although this may induce some bias, it remains preferable to the alternative of assuming that males earned at the midpoint of their band in these years.

6. The transition to pay-as-you-earn taxation in 1943-44 caused some anomalies. With the shift to pay-as-you-earn system, income tax was substantially remitted in 1943-44 (see Smith 2001, 269). The post-tax estimate for 1943-44 has therefore been omitted.