Understanding Changes in the Distribution and Redistribution of Income: A Unifying Decomposition Framework

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Abstract

Over recent decades income inequality has increased in many developed countries. Although the tax and transfer system is the main institutional tool through which income is redistributed, the role it played in these changes is often poorly understood. By building a bridge between existing approaches, we propose a method allowing for the decomposition of historical changes in various income distribution and redistribution measures into (i) the immediate effect of tax-transfer policy reforms in the absence of labour supply responses, (ii) the effect of labour supply changes induced by these reforms, (iii) the impact of changes in the distribution of other determinants, including the effect of employment changes not induced by policy reforms. We illustrate the use of our decomposition method by analysing the case of Australia between 1999 and 2007. We find that the direct effect of tax-transfer policy reforms accounts for about half of the observed increase in income inequality over the period. About one fifth of this direct effect was offset by labour supply responses to these policy reforms. Although ageing, increased educational attainments and changes in income unit structures played a limited role, we find evidence that the increased dispersion of wages and capital incomes substantially increased income inequality.

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1. Introduction

Over recent decades income inequality has increased in many developed countries. Fiscal policies are the main institutional tools at the disposal of policymakers to address income distribution issues but there is mounting evidence that taxes and transfers have become less effective in redistributing income (Bastagli *et al*. 2012, OECD 2011). Yet, there is currently no available tool allowing analysts to explore the many potential factors driving income distribution changes while explicitly recognising the role played by tax and transfer policies. The aim of this paper is to fill this gap by proposing a new unifying decomposition framework.

Inequality decompositions based on shift-share analyses or on the semi-parametric procedure originally proposed in DiNardo *et al*. (1996) and further developed by Bover (2010) have been widely used in the income distribution literature. These methods allow derivation of counterfactual distributions that are particularly useful to assess how changes in the distributions of particular population characteristics (e.g., age or education) can affect wage and income distributions. However, these approaches are essentially descriptive and are silent on the role played by tax-transfer policy changes.

Importantly, the mere observation that taxes and transfers have become less effective in redistributing income does not necessarily stem from changes in policies. This is because the redistributive capacity depends both on the properties of the tax-transfer system and on the shape of the distribution of market income to which it is applied. To date, a range of decomposition techniques exists to assess the role of fiscal policies in the distribution and redistribution of income while controlling for changes in the distribution of market income. Arguably, the main contributions are those of Kasten *et al.* (2004) and Dardanoni and Lambert (2002), where different tax-transfer systems are applied to a base distribution of market income that is taken as reference. A known limitation of these decomposition methods, however, is that they are only able to capture the primary effect of policy changes and miss the secondary effect that these policies have on market incomes, in particular that on labour supply.

In a recent article, Bargain (2012) addresses this limitation by proposing a decomposition based on tax-benefit microsimulation techniques. First, he identifies changes in income distribution and redistribution measures that are attributable to tax-transfer policy changes directly. Second, he draws on a behavioural microsimulation model to evaluate the indirect contribution of policy changes through labour supply responses.

The aim of this paper is to offer a new decomposition method that combines the flexibility of earlier counterfactual decomposition methods with the strengths of microsimulation techniques. Unlike the decompositions proposed in Bargain (2012) and Kasten *et al*. (2004), the new decomposition allows us to explore the role played by changes in the distributions of a wide range of population characteristics. And unlike earlier inequality decompositions, the new method is capable to isolate the effects of tax-transfer policy changes. In this sense, we propose a unifying framework to understand changes in the distribution and redistribution of income.

The new decomposition method presented in this paper comprises three layers. The first layer relies on a tax-benefit calculator to evaluate the immediate effect of tax-transfer policies. The second (and optional) layer is based on a behavioural microsimulation model and allows the analyst to assess the

role played by labour supply responses, at both the extensive and intensive margins, induced by these reforms. Based on counterfactual methods, the third layer allows the analyst to explore a wide range of other factors potentially contributing to the observed changes in income distribution and redistribution measures.

Hence, while isolating the effects of tax-transfer policies, it is possible to assess the role played by changes in the distributions of various population characteristics such as age, education or household structure. Perhaps more importantly, the method also allows the analyst to assess the contributions of changes in the distribution of employment, at both the extensive and intensive margins, or in the distributions of capital income and wages.

Given that labour income constitutes the main source of income for most families and that in many tax-transfer systems welfare payments are conditional on meeting low-income criteria, we suggest that this third layer is particularly useful to examine how changes in the employment distribution affect income distribution and redistribution measures. One novelty of the decomposition presented in this paper is that it is capable to identify the contribution of changes at the extensive and intensive margins of employment, others than those driven by tax-transfer reforms (and identified in the second layer).

As an illustration, the approach is applied to Australia which, as many other countries, has sustained an increase in disposable income inequality accompanied by a reduction in the redistributive effect of the tax-transfer system.

We focus on the period between 1999 and 2007, which was a period of high economic growth characterised by important changes in labour force participation rates and in income distribution. The results show that the direct effect of tax-transfer policy reforms accounts for about half of the observed increase in disposable inequality over the period. About one fifth of this direct effect was offset by labour supply responses to these policy reforms. Interestingly, tax-transfer reforms only explain about a fifth of the sharp reduction observed in the redistributive effect of the tax-transfer system and they are not responsible for the observed reduction in tax progressivity. The main contributor to both of these reductions resides in the changes at the extensive and intensive margins of employment, and in particular in the increase in employment rates over the period. We also examine the contributions of changes in the wage and capital income distributions as well as in the distribution of age, of education and of family type and size. Although ageing, increased educational attainments and changes in income unit structures played a limited role, we find evidence that the increased dispersion of wages and capital incomes substantially increased income inequality.

The paper is structured as follows. Section 2 presents the decomposition method. Section 3 reports results for Australia. Conclusions are discussed in Section 4.

2. Decomposition approach

Let M denote the index of interest. This can be any inequality or redistributive measure. The latter measures generally involve the comparison of the distributions of market income (g), disposable income (d), income taxes (tax), and benefit payments (ben). Let denote this set of variables by $A=\{g,d,x,tax,ben\}$ and let y represent any variable in this set.

Let $\tau_t = (T_t, B_t)$ be the vector with all relevant information on taxes, T_t, and benefits, B_t, at time *t*. This includes all rates, thresholds and eligibility rules embedded in the tax-transfer system. Let P_t denote the set of socioeconomic and demographic characteristics of the population in period *t*. We denote by L_t any variable in P_t whose distributional impact is of interest to the analyst. Given its important role for the distribution of income, we assume in the following discussion that this variable of interest is employment. Thus, vector L_t provides information on employment status at both the extensive and intensive margins. The information provided in L_t allows us to divide the population into a set of *J* mutually exclusive categories based on employment status and hours worked. The distribution of this variable at time *t* can be expressed as follows:

$$F_t(r) = \sum_{j=1}^{J} E_t[1(y \leq r|j)] \Pr_t(j), \qquad (1)$$

where $E[\cdot]$ is the expectation operator, $1(\cdot)$ is the indicator function, and *j* indicates the population subgroup as defined by the employment variables in L_t. To evaluate the impact of changes in employment between periods *t* and *t+1* on the distribution of *y*, we estimate the counterfactual distribution that would have prevailed in one period had the distribution of employment been that of the other period. This technique is used here to obtain descriptive evidence on the link between employment choices and income distribution and redistribution measures. For example, the counterfactual distribution of *y* that would be observed at time *t* assuming employment choices of period *t+1* is:

$$F_t^{t+1}(r) = \sum_{j=1}^{J} E_t[1(y \leq r|j)] \Pr_{t+1}(j). \qquad (2)$$

The comparison of (4) and (5) provides a simple way to quantify the contribution of employment to variations in the distribution of the index of interest. Similarly, the effect of labour supply can be assessed using the distribution for period *t+*1 that would be observed had the labour supply been that of period *t*. The way in which we combine the information from the two decompositions to evaluate the labour supply effect is discussed below.

To single out the effect of employment changes from those of other determinants we further condition the counterfactual estimations on other observable variables. The latter may include any other variable in P_t capturing household and individual characteristics such as family type, household size, or educational attainment. For a given conditioning variable, *X*, the conditional distribution is given by:

$$F_t^{t+1}(r|X) = \sum_{j=1}^{J} E_t[1(y \leq r|X, j)] \Pr_{t+1}(j|X). \qquad (3)$$

The marginal counterfactual distribution in this case can be expressed as:

$$F_t^{t+1}(r) = \sum_{k=1}^{K} F_t^{t+1}(r|X) \Pr_t(k), \qquad (4)$$

where *K* represents the number of mutually exclusive categories as defined by the variable *X*. As shown in Bover (2010), by applying the law of iterated expectations one can derive the following equivalent expression

$$F_t^{t+1}(r) = E_t[1(y \leq r)\frac{\Pr_{t+1}(L=j|X=k)\Pr_{t+1}(X=k)}{\Pr_t(L=j|X=k)\Pr_t(X=k)}], \qquad (5)$$

which simplifies to a great extent the estimation of the counterfactual distribution function.

Assuming that all variables in *A= {g,d,x,tax,ben}* depend on *τ*, *P*, and *L*, the value of any index, *M*, at time *t* can be written as

$$M_t = M(P_t, L_t, \tau_t).$$

We are interested in understanding changes in this index between two periods, 0 and 1. Let $M_1 = M(P_1, L_0, \tau_1)$ denote the value of the redistributive measure in period 1 assuming the distribution of employment at both the extensive and intensive margins of period 0. To derive this value, we estimate the counterfactual distributions of the variables in *A= {g,d,x,tax,ben}* required to compute the index *M* using the methods outlined above. The observed changes in *M* between periods 0 and 1 can be then decomposed as follows:

$$\Delta = M_1 - M_0$$

$$= M(P_1, L_1, \tau_1) - M(P_0, L_0, \tau_0)$$

$$= M(P_1, L_1, \tau_1) - M(P_1, L_0, \tau_1) \qquad (6)$$

$$+ \; M(P_1, L_0, \tau_1) - M(P_0, L_0, \tau_0) \qquad (7)$$

where the term (6) is the part of the variation in *M* due to all changes in employment distribution whereas (7) represents the part of the change explained by other factors. The contribution of employment changes can be further decomposed to identify the specific contribution of the variations in labour supply induced by changes in the tax-policy between the two periods. The term (6) is broken down into:

$$M(P_1, L_1, \tau_1) - M(P_1, L_0, \tau_1)$$

$$= M(P_1, L_1, \tau_1) - M\left(P_1, L_1^{\tau_0}, \tau_1\right) \qquad (8)$$

$$+ \; M\left(P_1, L_1^{\tau_0}, \tau_1\right) - M(P_1, L_0, \tau_1) \qquad (9)$$

where $L_1^{\tau_0}$ refers to the distribution of labour supply choices that one would observe in period 1 had the population of that period believed that the tax-transfer regime was going to be τ_0 instead of τ_1. $M\left(P_1, L_1^{\tau_0}, \tau_1\right)$ represents the corresponding value of the index of interest.[1] Following Bargain (2012), these two elements are derived making use of a behavioural microsimulation model, preferably one based on a structural labour supply model. This model is used to estimate labour supply responses at

[1] In the following analysis the vector of tax thresholds, transfer parameters, and incomes, for period 0 is always assumed to be adjusted in nominal terms to period 1 values, using an 'uprating' factor. The choice of an appropriate uprating factor is important, a point to which we come back in the application.

both the extensive and intensive margins to changes in tax-transfer policies. The term (8) accounts for the contribution of labour supply responses due to changes in τ, whereas (9) represents the effect of the changes in employment not explained by modifications in the tax-transfer regime.

Some caution is needed in interpreting behavioural effects obtained by using such a model. Tax microsimulation models are partial equilibrium supply side models. Thus they are able to simulate the effect on each individual's labour supply of a change in the tax-transfer system, but they do not allow for demand-side factors or for potential general equilibrium effects on wage rates. In addition, tax-transfer policy changes may affect fertility, household formation, migration, educational choice and other variables which, in the present approach, become subsumed under the residual component of the decomposition.

The term (7) is the part of the change in *M* not explained by differences in labour supply between periods 0 and 1. This can be decomposed to identify the direct effect of changes in τ:

$$
\begin{aligned}
& M(P_1, L_0, \tau_1) - M(P_0, L_0, \tau_0) \\
&= M(P_1, L_0, \tau_1) - M(P_0, L_0, \tau_1) && (10) \\
&+ M(P_0, L_0, \tau_1) - M(P_0, L_0, \tau_0) && (11)
\end{aligned}
$$

where $M(P_0, L_0, \tau_1)$ is the value of *M* assuming that population from period 0 was to face the tax-transfer regime τ_1 from period 1 without being able to adjust their labour supply decisions in consequence. The term (11) thus captures the direct effect of a change from the tax-transfer regime of period 0, τ_0, to that of period 1, τ_1, in the absence of behavioural responses.

The term (10) can be seen as a residual capturing the part of the variation in *M* due to changes in other population characteristics. They cover a wide range including changes in the age, occupational, educational and demographic structure as well as the effect of non-uniform income growth, for instance, by occupation, sector, region or by income source. However, as we illustrate in the application, an adaptation of the counterfactual methods used to derive $M(P_1, L_0, \tau_1)$ in (6) allows us to explore the contributions of some of these factors. In essence, instead of considering the contribution of changes in the conditional distribution of employment in the term (9), we can examine the role played by changes in the distributions of the age structure of the population, of educational attainments, of the size and composition of the tax units, of capital income or of wages.

In summary, using (8) to (11) we can express the variation in the index of interest *M* between two periods as:

$$
\begin{aligned}
& M(P_1, L_1, \tau_1) - M(P_0, L_0, \tau_0) \\
&= M(P_1, L_1, \tau_1) - M\left(P_1, L_1^{\tau_0}, \tau_1\right) && (\text{TLS}) \\
&+ M\left(P_1, L_1^{\tau_0}, \tau_1\right) - M(P_1, L_0, \tau_1) && (\text{E}) \\
&+ M(P_0, L_0, \tau_1) - M(P_0, L_0, \tau_0) && (\text{T}) \\
&+ M(P_1, L_0, \tau_1) - M(P_0, L_0, \tau_1) && (\text{O})
\end{aligned}
$$

where (TLS) is the part of the variation due to changes in labour supply induced by changes in the tax-transfer system, (E) is the variation attributed to other changes in employment, (T) is the effect of a switch in the tax-transfer regime in the absence of labour supply responses, and (O) is a residual that picks up the effect of changes in all other population characteristics.

Importantly, each of these four components can be computed in alternative ways. For example, the effect (T) of a switch in the tax-transfer regime in the absence of labour supply responses can be computed using population from period 1 instead of that from period 0. Similarly, the residual term that picks up the changes in other population characteristics can be computed using the tax-transfer regime of period 1 rather than that of period 0.

In principle, there are 24 possible decomposition paths. In practice, however, only eight decompositions are relevant. Indeed, the O, E, and TLS components must be positioned consecutively as they correspond to a split of the initial "other effects" after the effect of a switch in the tax-transfer regime (T) is evaluated (see Bargain 2012, p. 713). As there is no particular reason to prefer one ceteris paribus condition, it can be argued on the grounds of symmetry that an appropriate measure of the effect is obtained by averaging over all possible effects. Following Shapley (1953) and Shorrocks (2013), the effect of each component is measured by their arithmetic mean values over all possible decompositions (that is, attributing the same probability to each) given by:

$$\overline{TLS} = \frac{2}{8}\sum_{i=0,1}\sum_{j=0,1}\left(M(P_i, L_i^{\tau_1}, \tau_k) - M(P_i, L_i^{\tau_0}, \tau_k)\right.$$

$$\overline{E} = \frac{1}{8}\sum_{i=0,1}\sum_{j=0,1}\sum_{k=0,1} M(P_i, L_1^{\tau_j}, \tau_k) - M(P_i, L_0^{\tau_j}, \tau_k)$$

$$\overline{T} = \frac{4}{8}\sum_{i=0,1} M(P_i, L_i^{\tau_i}, \tau_1) - M(P_i, L_i^{\tau_i}, \tau_0)$$

$$\overline{O} = \frac{1}{8}\sum_{i=0,1}\sum_{j=0,1}\sum_{k=0,1} M(P_1, L_j^{\tau_k}, \tau_i) - M(P_0, L_j^{\tau_k}, \tau_i)$$

where $L_k^{\tau_k} = L_k$.

3. Empirical application: Australia 1999/00 to 2007/08

As an illustration of the decomposition method, we analyse the changes in the distribution and redistribution of income in Australia between the financial years 1999/00 and 2007/08. The following subsection gives more detail about the variables and definitions used in the empirical application. We then present the main changes in labour force participation and in income distribution that occurred over the period under analysis. The main results from the decomposition analysis are presented in the third subsection. In the fourth and final subsection we illustrate the flexibility of the approach by exploring other potential contributing factors to the observed trends.

3.1 Data sources and definitions

We use various editions of the Australian Survey of Income and Housing (SIHC).[2] This is a nationally representative survey designed to collect detailed information on the income sources and the socioeconomic characteristics of the households and their members. In particular, the SHICs provide rich information on the various components of labour and capital income that we use to generate our measure of market income. The values of taxes and benefits are based on calculation of entitlements by the Melbourne Institute Tax and Transfer Simulator (MITTS) described briefly in Appendix A, not the actual receipt. MITTS allows the derivation of all major social security transfers, family payments, rebates and income taxes, ensuring a reasonable approximation to disposable income.

The unit of analysis throughout is the individual, where each individual in an income unit is assigned the total income of the unit per adult equivalent. Following Banks and Johnson (1994) and Jenkins and Cowell (1994), the adult equivalent size, *s*, is obtained using the following parametric scales:

$$s = \left(n_a + \theta n_c\right)^{\delta} \qquad (15)$$

where n_a and n_c are respectively the number of adults and children in the unit, θ is the weight attached to children and δ represents the extent of economies of scale. The weight attached to children, θ, was set at 0.6 and the economies of scale parameter was set at δ=0.8. These values produce scales that are similar to the OECD scales. All the results are aggregated to the population level using the household weights provided with SIHC.

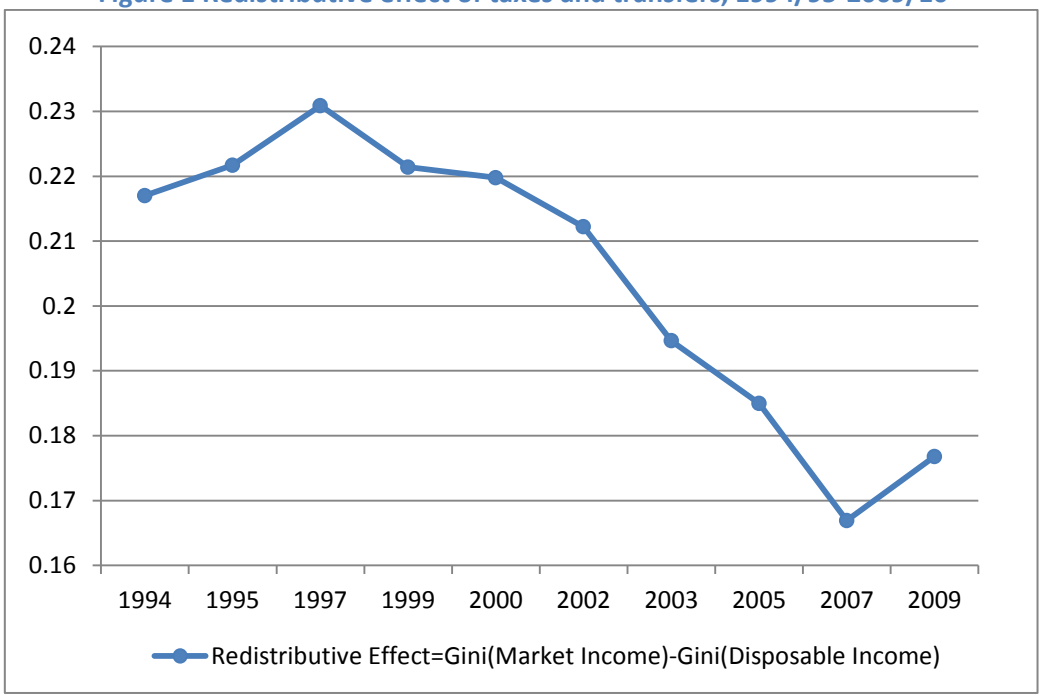
Tax thresholds, transfer parameters, and incomes are all adjusted in nominal terms to 2007/08 values, using a common 'uprating' factor. We use a wage index based on average earnings for full-time workers provided by the Australian Bureau of Statistics.[3] The index increased by 44 per cent during this period. This means that any failure of the tax thresholds or transfer parameters to keep up with wage growth is assimilated to a policy choice. For the case of Australia, this means that the typically slower growth in benefit payment rates than in wages is attributed to a policy decision.

3,2 Background

The 1994-2009 period was a period of high economic growth marked by important changes in the distribution of income and in labour force participation (Greenville *et al.* 2013, Whiteford 2013), as well as, policy reforms with a potential impact on the redistributive capacity of taxes and transfers. Figure 1 shows the values of the net redistributive effect of taxes and transfers, as measured by the Musgrave and Thin (1948) index. This index is equal to the difference in the Gini indices for market and disposable incomes (i.e. income after taxes and transfers) for the 1994/95-2009/10 period.[4] The early 2000s witnessed a sharp decline in the redistributive impact of the tax-transfer system. There was a steady decline in the index from 1999 to 2007, year in which the index reached its lowest level since 1994.

[2] Commenced in 1994, the SIHC was conducted annually up to 2003/04, except in the years 1998/99 and 2001/02 in which the survey was not run. From 2003/04 it has been conducted biennially.
[3] See Australian Bureau of Statistics (cat. no. 6302.0, Table 3, series ID A2734023X).
[4] Originally conceived to measure the redistributive effect of taxes, this index can be equally used to measure the net redistributive effect of taxes and transfers (Lambert, 2001).

Figure 1 Redistributive effect of taxes and transfers, 1994/95-2009/10



Source: Authors' calculations based on MITTS and SIHC data.

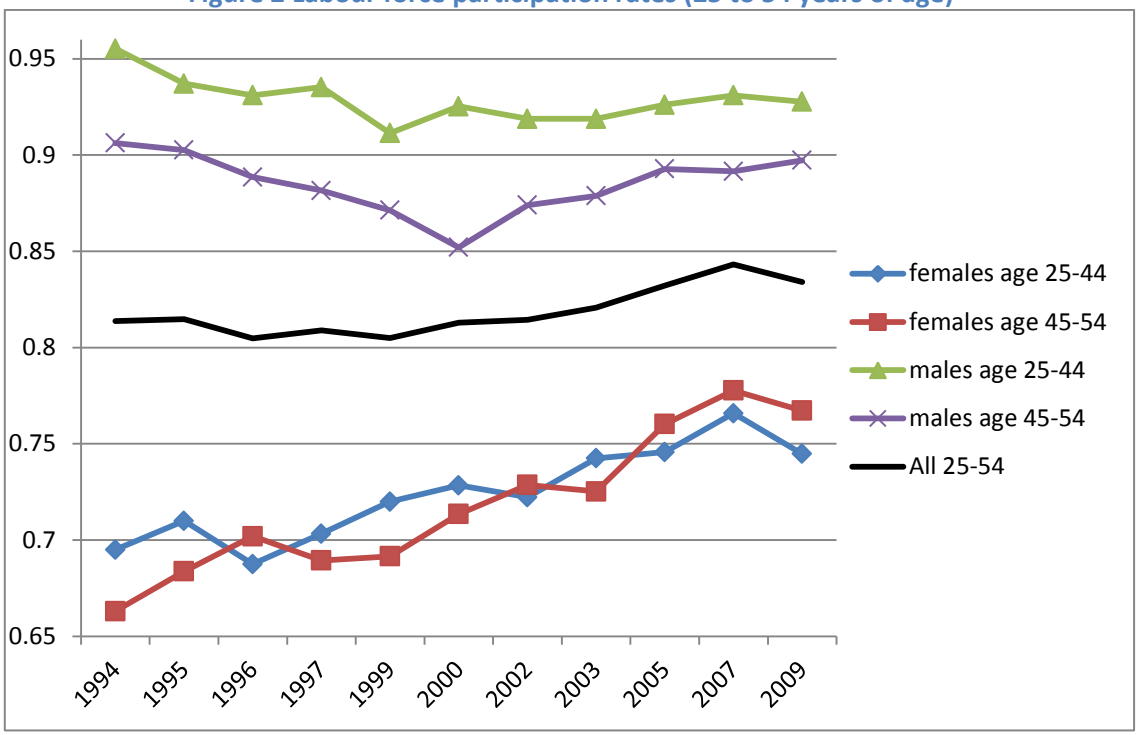
As shown in Figure 2, the overall rate of labour force participation among the working-age population steadily increased from 80.5 per cent in 1994 to almost 85 per cent in 2007. This rise in participation rates was largely driven by females. In particular, the participation rate among females in the 45-54 age group increased by more than 10 percentage points between 1994 and 2007 (from 66 to 77 per cent).

Important policy reforms were implemented during this period. As regards the income tax, various changes were introduced, affecting the total amount of taxes paid and its distribution by income groups.[5] The income tax rates were substantially cut and the top tax thresholds increased. Furthermore various tax offsets, such as the Low Income Tax Offset, were extended to isolate low-income families from potential bracket-creeping due to the reduction (in real terms) of the tax-free threshold.

Welfare benefits were also subject to important reforms. This period saw the implementation of policy reforms clearly aimed at reducing welfare dependency and promoting self-reliance through paid work (Goodger and Larose 1999, Australian Senate 2012). The Australians Working Together package of 2003 and the 2006 Welfare to Work reform introduced policy initiatives to increase the conditionality of welfare payments and to strengthen the incentives to work, which likely contributed to the rise in participation rates observed during the period.

[5] For a more detailed discussion of the changes in the Australian tax and transfer system over the period 1994-2009, see Herault and Azpitarte (2014).

Figure 2 Labour force participation rates (25 to 54 years of age)



Source: Authors' calculations from SIHC data.

However, the extent to which these policy reforms contributed to the decline in the net redistributive effect of taxes and transfers remains unclear. We make use of the new decomposition technique presented above to address this question and to explain changes in income distribution. In particular, we apply the decomposition to the years 1999/00 and 2007/08.

As is clear from Figure 1, these two years mark the start and end of the period of decline in the net redistributive effect. Moreover this period has the advantage to avoid distortions from business cycle variations as it represents a peak-year to peak-year comparison.[6] Table 1 presents summary statistics on the distribution of income and estimates of standard redistributive measures. The period from 1999/00 to 2007/08 was marked by a reduction in market income inequality as measured by the Gini coefficient and an increase in disposable income inequality. The income percentile ratios suggest that disposable income inequality increased in part because those at the bottom of the distribution failed to keep up with those around the middle. While income differences in the upper part of the distribution were slightly reduced, differences in the lower end significantly widened as the poorest percentiles fell further behind the median. The decline in the redistributive effect of income taxes and transfers was particularly pronounced, dropping by almost 25 per cent from 0.22 to 0.16.

Table 1 also presents estimates of the size and progressivity of taxes and transfers. Tax progressivity is measured by the disproportionality index introduced by Kakwani (1977) which is equal to the concentration coefficient of income taxes minus the Gini of pre-tax income (i.e., market income plus

[6] Quarterly GDP growth was negative in the fourth quarters of 2000 and 2008 (OECD Quarterly National Accounts).

transfers).[7] The regressivity of transfers is measured using the index proposed in Lambert (2001, p. 270) defined as the difference between the Gini of market income and the concentration coefficient of benefit payments.

Between 1999/00 and 2007/08, Australia saw a reduction in the average tax rate, defined as income tax as a proportion of pre-tax income. Taxes also became less progressive. Similarly, average benefit payments declined sharply (even faster than the average tax rate) and they became slightly less regressive. [8] The next section examine to what extent these changes were driven by tax-transfer policy reforms, by behavioural responses to these reforms and by other factors.

Table 1 Income distribution and redistribution measures 1999/00 and 2007/08

	1999/00	2007/08	Percentage change
Gini (market income)	0.507	0.471	-7.1
Gini (disposable income)	0.285	0.304	6.5
Redistributive effect (RE)	0.221	0.167	-24.5
Tax progressivity (PG)	0.256	0.237	-7.2
Transfer regressivity (RG)	1.124	1.086	-3.4
Average tax rate	0.232	0.209	-10.0
Average transfer rate	0.151	0.110	-27.1
Disposable income percentile ratios			
P90/P10	3.40	3.86	13.5
P90/P50	2.02	1.94	-4.2
P50/P10	1.68	1.99	18.5

Source: Authors' calculations based on MITTS and SIHC data.

3.3 Decomposition analysis

The decomposition of the variation in any measure of income distribution or redistribution, $\Delta = M_{1999/00} - M_{2007/08}$, requires various counterfactual estimates of the index of interest. Concretely, for the computation of the contributions of the employment changes, whether induced by policy reforms (TLS) or not (E), we first estimate the value of the index that would be observed in one year assuming the employment distribution of the other year using the method outlined in the previous section.

For the present illustration we characterize the employment distribution at any point in time using three possible categories that distinguish those not working, those working part-time and those working full-time (i.e. more than 30 hours per week). This information is then aggregated at the income unit level so that each unit is classified according to the number of equivalent part-time jobs in the unit (i.e., one for each part-time worker and two for each full-time worker). Given that the approach has to be applied at the income unit level, where benefit rates are determined, using

[7] Lambert (1985) shows that, differently to the measures of the redistributive effect, the Kakwani progressivity index does not satisfactorily extend to net taxes (defined as transfers received minus taxes paid) as it does not satisfactorily account for a mix of positive, negative and zero values.

[8] The net redistributive effect can be decomposed into the progressivity (or regressivity) index and the average rates of taxes and benefits (Lambert, 1985). Larger values of the progressivity (or regressivity) measures and of the average rates contribute positively to the net redistributive effect.

actual hours worked is not possible in practice as it gives rise to too many combinations for multi-individual income units. The choice of these three categories to characterize the employment distribution is motivated by the fact that little variation was found in the distribution of hours worked among full-time and part-time workers over the period of analysis.

To isolate the effect of employment changes from that of other determinants we condition the counterfactual estimations on a set of observables that includes income unit type (couple, couple with children, single, lone parent) and unit's size. We assessed the robustness of the results by conditioning on other variables such as the age and education of the head of the unit and by applying the approach without conditioning on any attribute. In all cases, we only found a small impact on the decomposition results.[9] This indicates that the decomposition method is capable of accommodating the observed changes in labour supply choices without introducing any significant distortions to the population structure.[10]

The evaluation of the impact of changes in the tax-transfer regime requires two additional counterfactual exercises (see Section 2). To assess the contribution of the changes in labour supply induced by policy reforms (TLS), we must simulate the labour supply responses to a change in the tax-transfer regime from that of 1999/2000 to that of 2007/08, and vice-versa. These simulations are performed using the behavioural component of MITTS, which is based on a structural model of labour supply (see Appendix A for more detail).

Finally, in order to quantify the impact of policy reforms in the absence of labour supply response (T), it is necessary to estimate counterfactual distributions assuming that the population of given year was to face the tax-transfer regime of the other year without being able to modify their labour supply decisions. This counterfactual is derived using the arithmetic tax and benefit calculator embedded in MITTS. This component of the simulator uses information on the parameters of the tax-transfer system to compute the benefits received and taxes paid by all income units at their observed hours of work.

Table 2 presents the decomposition of the changes in Gini coefficients of market and disposable incomes, in the progressivity and redistributive measures as well as in the average tax and transfer rates. Interestingly, the results indicate that the observed decline in tax progressivity was not due to the changes made to the tax-transfer system between 1999/00 and 2007/08. On the contrary, these changes were progressive and contributed to limit the decline in tax progressivity, which would have been substantially larger had the tax-transfer system remained unchanged. Indeed, we find that keeping the distribution of market income constant following the approach of Kasten *et al.* (2004), the tax-transfer system of 2007/08 exhibits a higher level of tax progressivity than that of 1999/00.

[9] Results from these robustness checks are not presented here but are available upon request.

[10] This is reassuring with respect to the robustness of the approach, especially in view of the fact that employment changes were not trivial during the period of analysis. However, it is a result that is specific to this particular application.

Table 2 Decomposition of changes in income distribution and redistribution between 1999/00 and 2007/08

	Tax progressivity (PG)	Transfer regressivity (RG)	Average tax rate	Average transfer rate	Redistributive effect (RE)	Gini		Disposable income percentile ratios		
						market income	disposable income	P90/P10	P90/P50	P50/P10
1999/00 base value	0.256	1.124	0.232	0.151	0.221	0.507	0.285	3.40	2.02	1.68
1999/00 to 2007/08 change										
Relative (in per cent of base value)	-7.2	-3.4	-10.0	-27.1	-24.5	-7.1	6.5	13.5	-4.2	18.5
Absolute	-0.018	-0.038	-0.023	-0.041	-0.055	-0.036	0.019	0.460	-0.085	0.310
Contributions to historical changes (in per cent)										
T	-86.9	136.6	208.1	-33.7	16.9	0.0	49.6	46.2	22.4	40.1
TLS	20.0	-0.5	-6.5	17.0	11.5	23.1	-11.0	-3.0	12.9	0.9
E	64.1	-5.6	-16.5	41.2	29.0	53.6	-18.8	-1.6	57.3	13.3
O	102.8	-30.6	-85.1	75.5	42.6	23.3	80.1	58.4	7.5	45.7
Total	100	100	100	100	100	100	100	100	100	100

Source: Authors' calculations based on MITTS and SIHC data

Note: T: Tax and transfer policy changes; TLS: labour supply responses to changes in the tax and transfer system; E: other employment changes; O: All other population changes.

The observed declined in tax progressivity was caused by variations in market incomes. In particular, we find that the decrease in tax progressivity is explained to a large extent by the employment changes that occurred over the period, only a small part of which was driven by labour supply responses to tax and transfer policy changes. In fact, employment changes, which mainly consisted in an increase in employment rates, account for more than 84 per cent (20 plus 64.1) of the observed reduction in tax progressivity. These changes contributed to an increase in the proportion of tax payers in the population, which in turn reduced the concentration of income taxes.

Although tax-transfer policy changes are not responsible for the observed decline in tax progressivity, they are by far the main contributor to the large decline in the average tax rate. Policy reforms alone contributed to a reduction in the average tax rate in the order of 4 percentage points (or twice the size the observed reduction). Appendix Table B.1, which presents the income tax schedules for both years, clearly shows that income tax rates were substantially cut over the period while the top three tax thresholds were increased, leading to a lower average tax rate. This trend was reinforced by the extension of various tax offsets, such as the Low Income Tax Offset, which ensured that low-income households were essentially isolated from potential bracket-creeping due to the reduction (in real terms) of the tax-free threshold.

The small reduction in transfer regressivity is largely attributable to changes in transfer policies over the period. However, the main change with respect to transfers concerns their overall level, which dropped by more than 27 per cent (or 4 percentage point as a share of market income). The decomposition shows that tax and transfer policy changes alone would have led to an increase in the average transfer rate, equivalent in size to a third of the observed reduction. However these policy effects were more than offset by other changes affecting the distribution of market income. In particular, employment changes are largely responsible for the observed reduction in the average transfer rates.

The increase in labour force participation over the period reduced the reliance on the income support system as a source of income. Part of this higher self-reliance through paid-work is directly attributable to the changes in the financial incentives built into the new tax-transfer system. Results in Table 2 show that this factor accounts for 17 per cent of the observed decline in the average transfer rate. However, most of the reduction in the average transfer rate attributable to employment changes is due to other factors, which accounted for 41.2 per cent of the observed change. Figuring high in the list of these potential factors is likely to be the increased reliance of the transfer system on activity-tested payments, the precise impact of which is difficult to measure and is not included in the TLS component of the decomposition as this type of reforms does not directly alter financial incentives.

The decomposition of changes in the redistributive effect of the tax-transfer system is a reflection of the results discussed above as well as of the changes in the distribution of market income over the period. The results show that more than three quarters of the observed reduction in market income inequality was due to changes in employment, about a third of which being attributed to labour supply responses to tax-transfer policy reforms. In other words, the increase in employment rates over the period, part of which was driven by changes in the tax-transfer system, largely explains the observed reduction in market income inequality.

However, the decline in the average rates and in the progressivity of the taxes and transfers prevented this reduction in market income inequality from translating into a reduction in disposable income inequality, which instead increased. Indeed, the decomposition of changes in income percentile ratios shows that tax-transfer reforms explain to large extent why the incomes of those at the bottom of the distribution failed to keep up with the incomes of the rest of the population.

Overall, the observed decline in the redistributive effect of the tax-transfer system is attributable for one sixth to tax-transfer policy changes, for 11.5 per cent to the labour supply responses to these changes, for 29 per cent to other changes in employment and for 45.5 per cent to other population changes. The residual term encompasses all effects other than those due to employment and tax-transfer policy changes. The next section examines the effects of some of these factors.

3.4 Additional decompositions: an exploration of other factors

Results from the decomposition suggest that employment changes and policy reforms contributed to changes in the distribution of income and in the redistributive effect of taxes and transfers. However, the size of the residual component of the decomposition indicates that a non-negligible part of these changes is explained by other factors not explicitly considered in the decomposition. By simple adaptations of our decomposition, we assess the role of some of these factors. In particular, we adapt the third component of the decomposition methods discussed in Section 2 to evaluate the contribution of changes in the distribution of age and education (of the income unit head) and in the distribution of the population by income unit type (couple, couple with children, single, single with children) and income unit size. We also examine the role played by the changes in the wage and capital income distributions. For wages, we distinguish twenty groups according to the level of the income unit head's real wage rate for those in work. For capital income, we classify income units according to the level of capital income per adult equivalent into 21 groups: units with negative capital income, units with no capital income and 19 groups according to the level of capital income (in 2007 dollars) for units with positive capital income. For this exercise, counterfactual measures derived conditioning on employment status are used to quantify the contribution of each of these factors (one at a time) to the (O) term of the decomposition. This is to avoid double-counting of the effect of employment changes presented in Table 2. The two other components of the decomposition, namely the contributions of policy reforms and of labour supply responses, remain unchanged.

Table 3 presents the results from these decompositions. Although changes in demographics contributed to the observed changes in income distribution and redistribution measures (amplifying or mitigating the observed trends), their contributions were limited in comparison to the effects of tax-transfer policies and employment changes presented in Table 2.

We note that changes in the age distribution, more specifically the ageing of the Australian population under the period of analysis, contributed to mitigate the observed decline in both tax progressivity and transfer regressivity. Retirees tend to pay less taxes and to receive larger transfers, particularly in the form of pensions, than other age groups.

Another interesting finding is that the changes in the distribution of the population by income unit type and size contributed to an increase in the level of transfer regressivity. The share of couples and singles with children decreased and the average income unit size shrank between 1999/00 and 2007/08. Given that large income units, and especially those with children, tend to be the main transfer recipients a reduction in these population subgroups' size means than transfers became more concentrated.

Table 3 Additional decomposition results

	Tax progressivity (PG)	Transfer regressivity (RG)	Average tax rate	Average transfer rate	Redistributive effect (RE)	Gini		Disposable income percentile ratios		
						market income	disposable income	P90/P10	P90/P50	P50/P10
1999/00 base value	0.256	1.124	0.232	0.151	0.221	0.507	0.285	3.40	2.02	1.68
1999/00 to 2007/08 change										
Relative (in per cent of base value)	-7.2	-3.4	-10.0	-27.1	-24.5	-7.1	6.5	13.5	-4.2	18.5
Absolute	-0.018	-0.038	-0.023	-0.041	-0.055	-0.036	0.019	0.460	-0.085	0.310
Contributions to historical changes (in per cent)										
Changes in the age distribution	-9.8	-8.2	1.0	-3.4	-3.7	-11.2	10.9	46.2	22.4	40.1
Changes in education attainments	3.5	-1.3	-4.8	-2.3	-2.0	-8.9	11.3	5.7	-3.7	3.4
Changes in the distribution of the population by income unit type and size	4.1	-11.7	0.6	5.1	2.8	-0.2	8.4	7.8	3.5	6.8
Changes in the wage distribution	12.1	-14.8	-16.4	5.6	0.6	-9.1	19.5	10.8	13.1	11.3
Change in the capital income distribution	-17.8	-20.5	-32.0	19.7	3.8	-17.3	44.9	6.2	-26.6	-2.1

Source: Authors' calculations based on MITTS and SIHC data

Note: * Contrary to the results presented in Table 2, contributions do not add up to 100 per cent as each is derived from a different decomposition.

Table 3 also shows that changes in wage dispersion led to an increase in both market and disposable income inequality. This relates to an observed shift away from the bottom wage brackets to the middle wage brackets combined with a growth in the proportion of income units in the top wage bracket. This is consistent with the increase in wage inequality documented in Coelli and Borland (2014). This trend also contributed to an increase in the average tax rate and a reduction in tax progressivity.

Changes in the distribution of capital income appear to have led to substantial changes in income distribution. They contributed to increase both market and disposable income inequality. The main change in the distribution of capital income between 1999 and 2007 is an increase the share of tax units reporting positive capital income. However, part of this trend may be driven by a better ability to capture capital incomes in the 2007 than in the 1999 survey (Wilkins 2014).

4. Conclusions

Tax-transfer policies are crucial in determining the distribution and redistribution of income. The main difficulty in assessing the role of these policies lies in the endogeneity of the market income distribution to the tax-transfer system. This is problematic because measures of progressivity and redistributive effects of the tax-transfer system themselves depend on the distribution of market income. The two existing approaches of Kasten *et al.* (2004) and of Dardanoni and Lambert (2002) are useful to assess the evolution of progressivity and redistributive measures over time, or even to make cross-country comparisons. However, they do not explicitly recognise the role of employment decisions or the influence of tax policies on these decisions.

The aim of this paper is to present a new approach allowing for an additive decomposition of the observed changes in income distribution and redistribution measures, while fully accounting for and measuring the impact of concomitant changes in employment and their consequences in terms of market income distribution. Furthermore, we introduce a distinction between employment changes directly driven by labour supply responses to tax-transfer reforms and other employment changes. This is achieved by combining the method developed by Bargain (2012) with the use of counterfactual decomposition techniques proposed in DiNardo *et al.* (1996) and Bover (2010) to generate counterfactual distributions. Furthermore, the flexibility of the approach means that it can be used to explore the role played not only by employment changes but also by changes in the distributions of a wide range of population characteristics.

The application of this decomposition to Australia over the 1999-2008 period represents the first attempt to describe and understand the recent changes in progressivity and redistributive effects of income taxes and cash transfers in this country. The decomposition indicates that employment changes played an important role the reduction in market income inequality. This period was also marked by a reduction in tax progressivity and in the redistributive effect of the tax-transfer system, which are reflected in the increase in disposable income inequality. The decomposition shows that tax-transfer reforms accounted for half of the observed increase in disposable income inequality. This is despite the fact that tax reforms actually helped limit the reduction in tax progressivity. The reductions in tax progressivity and in the redistributive effect of the tax-transfer system were found to be driven to a large extent by employment changes, a substantial part of which being attributable to labour supply responses to tax-transfer reforms. These results demonstrate the importance of

considering employment changes in the analysis of the redistributive effects of tax and transfer systems.

We exploit the flexibility of the decomposition approach to investigate other potential sources of the observed changes in income redistribution. We find that although ageing, increased educational attainments and changes in income unit structures all played a role, their contributions were limited in comparison to the effects of tax-transfer reforms and labour supply changes. The results suggest that the increased dispersion of wages and capital incomes played a more substantial role by increasing both market and disposable income inequality.

Finally, it is important to recognise that even though the application presented in this paper draws on a behavioural microsimulation model, the approach can also be applied with a simple tax-benefit calculator. In this case no distinction can be made between the contributions of labour supply changes driven by tax-transfer policy reforms and other employment changes. However, the primary effect (i.e., in the absence of behavioural responses) of tax-policy reforms can still be identified. Moreover, the role of a variety of determinants such as ageing or changes in household structures can be assessed in the same way as illustrated in this paper.

Appendix

Appendix A: MITTS: The Melbourne Institute Tax and Transfer Simulator

This appendix provides a brief description of the Melbourne Institute Tax and Transfer Simulator (MITTS), a behavioural microsimulation model of direct tax and transfers in Australia. Since the first version was completed in 2000, and described in Creedy et al. (2002), it has undergone a range of substantial developments. For an overview of refereed publications and books relating to the MITTS model, see:

http://www.melbourneinstitute.com/labour/microsimulation/MITTS-publications.html

MITTS consists of two components. MITTS-A is the arithmetic tax and benefit modelling component and provides, using the wage rate of each individual, the budget constraints that are crucial for the analysis of behavioural responses to tax changes. For those individuals in the data set who are not working, an imputed wage is obtained. MITTS-B examines the effects of any specified tax reform, allowing individuals to adjust their labour supply. Behaviour is based on quadratic preference functions where the parameters are allowed to vary with individuals' characteristics. Individuals are considered as being constrained to select from a discrete set of hours levels. For singles, 11 discrete points are distinguished. For couples, a joint set of discrete labour supply points are used. The female hours distribution covers a wider range of part-time and full-time hours than the male distribution, which is mostly divided between non-participation and full-time work. Therefore, women's labour supply is divided into 11 discrete points, whereas men's labour supply is represented by just 6 points. The joint labour supply of couples is estimated simultaneously, unlike a popular approach in which female labour supply is estimated with the spouse's labour supply taken as exogenous. Thus, for couples there are 66 possible joint labour supply combinations.

Simulations are probabilistic, as utility at each hours level is the sum of a deterministic component (depending on hours worked and net income) and a random component. Hence MITTS generates a

probability distribution over the discrete hours levels. The self-employed, disabled, students and those over 65 have their labour supply fixed at observed hours. Simulations begin by recording the discrete hours level for each individual that is closest to the observed hours level. The deterministic component of utility is obtained using the parameter estimates of the quadratic preference function. To generate the random component, a draw is taken from the distribution of the error term for each hours level (an Extreme Value Type I distribution). The utility-maximising hours level is found by adding the two components of utility for each hours level and choosing the hours with the highest utility. Draws from the error terms are taken conditionally on the observed labour supply; that is, they are taken in such a way that the optimal pre-reform labour supply is equal to the actually observed labour supply. As a result, post-reform labour supply is simulated conditional on the observed pre-reform labour supply. A user-specified number of draws is produced.

For the post-reform analysis, the new net incomes cause the deterministic component of utility at each hours level to change, so using the same set of draws from the calibration stage, a new set of optimal hours of work is produced. This gives rise to a probability distribution over the set of discrete hours for each individual under the new tax and transfer structure. Rather than using the arithmetic mean hours for each individual over the discrete hours available for work, as in Bargain (2012), we use the `pseudo distribution' method proposed by Creedy *et al.* (2006) for dealing with the complete distribution.

Appendix B: Income tax schedules

Table B.1 Income tax schedules 1999/00 and 2007/08

1999/00 (uprated)		2007/08	
Threshold	Tax rate	Threshold	Tax rate
7,785	0	6,000	0
29,842	0.20	34,000	0.15
54,783	0.34	80,000	0.30
72,083	0.43	180,000	0.40
>72,083	0.47	>180,000	0.45

Source: Australian Taxation Office

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