



EQUALITAS Working Paper No. 22

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2013

Understanding Changes in Progressivity and Redistributive Effects: The Role of Tax-Transfer Policies and Labour Supply Decisions

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Abstract

In this paper we propose a framework to study changes in the redistributive consequences of income taxes and transfers. In contrast with previous approaches the new method allows decomposition of the change in the redistributive impact into four components: the immediate effect of changes in the tax-transfer system in the absence of labour supply responses; the effect of labour supply changes induced by changes in the tax-transfer system; the effect of all other labour supply changes; and a residual capturing the variation not explained by the previous factors. We illustrate the use of our decomposition method by analysing the changes in the redistributive impact of the tax and transfer system in Australia between 1999 and 2007. We find that labour supply changes, and in particular the increase in employment rates over the period, explain to a large extent the observed reduction in the redistributive effect of the tax-transfer system. A sizable part of these labour supply changes were found to be direct responses to tax-transfer reforms. Interestingly, we find that tax reforms were not responsible for the observed reduction in tax progressivity.

Acknowledgments

We acknowledge the support of a Faculty Research Grant from the Faculty of Business and Economics, University of Melbourne. Francisco Azpitarte would also like to acknowledge the financial support from the Spanish Ministerio de Ciencia e Innovación (grant ECO2008-03484-C0201/ECON and ECO2010-21668-C03-03) and the Xunta de Galicia (10SEC300023PR).

JEL Classifications: H23, J22, D31

Keywords: Income; Redistributive effect; labour supply; taxes and transfers

1. Introduction

The tax and transfer system is the main institutional tool through which income is redistributed in developed countries. Understanding trends in progressivity and the extent to which they are driven by changes in policies or other factors is of interest to researchers and policy analysts. Income redistribution measures reflect the capacity of taxes and transfers to generate disposable incomes that exhibit lower inequality than market incomes (i.e., incomes before tax and transfers). It is important to recognise, however, that this 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. Therefore, any attempt to explain trends in income redistribution must take into account not only the impact of tax-policy reforms on the distribution of disposable income but also the changes in the distribution of market income, including those induced by the tax and transfer reforms themselves.

Among the determinants of market income, labour supply decisions are particularly relevant to the analysis of progressivity trends. Labour income constitutes the main source of income for most families. This implies that decisions about whether to participate in the labour market and the number of hours worked influence to a great extent families' market income. Further, in systems where welfare payments are made conditional on meeting low-income criteria, employment decisions are key in determining eligibility for welfare cash payments. Hence, changes in labour supply strongly influence the two factors that define the effective level of redistribution, namely: the average tax and transfer rates, which depend on the total taxes and transfers paid, and the distribution of the tax burden and welfare payments among different income groups.

Interestingly, the existing literature on redistribution has paid little attention to how variations in market income in general, and labour supply decisions in particular, impact the progressivity of the tax-transfer system. To date, two methods aimed at isolating the effects of tax policies on income redistribution have emerged that allow for the analysis of changes in progressivity over time (or across countries). The "fixed-income" procedure proposed by Kasten *et al.* (2004) keeps market incomes fixed and equal to those of a base year, thus permitting the derivation of progressivity rankings of comparable tax-transfer systems after (de)inflating the tax thresholds and the relevant transfer parameters. The "transplant-and-compare" method of Dardanoni and Lambert (2002) compares net income distributions that have been adjusted to a common base regime in which differences in market income inequality, for whatever reason they happened (behavioural changes, for instance), have been eliminated.¹

Although useful to compare the progressivity and redistributive effects of different tax-transfer systems while controlling for changes in market income distribution, these two approaches provide limited insights on the factors driving the observed changes. The aim of this paper is to propose a unifying framework to examine changes in the progressivity and redistributive effects of taxes and transfers that recognizes the endogeneity of labour supply decisions and of the distribution of

¹ Another branch of the literature focuses on the decomposition of the redistributive effects. Jenkins (1988) proposed a decomposition into reranking and vertical effects. Reranking occurs when there are changes in the ranking of incomes in the transition from gross to net income. Duclos (1993) extended this decomposition to allow for the separate contributions of each tax or benefit instrument to be assessed. See Urban (2009) for an overview of the literature and Kim and Lambert (2009) for a recent application of this kind to decomposition to US data for the 1994-2004 period.

market income. The proposed approach allows the decomposition of the observed variation in the progressivity and redistributive effects into four components. These components reflect the contributions of (i) the immediate effect of changes in the tax-transfer system; (ii) the labour supply changes induced by changes in the tax-transfer system; (iii) all other labour supply changes; and (iv) a residual capturing the changes in the demographic characteristics of the population and any other variation not explained by the previous factors.

An important difference with the methods proposed by Kasten *et al.* (2004) and Dardanoni and Lambert (2002) is that our approach identifies the effect of labour supply decisions while acknowledging the influence of tax policy on these decisions. The available empirical evidence suggests that both the intensive and extensive margins of labour supply are affected by the tax-transfer regime, especially in the case of married women and lone mothers (Saez *et al.* 2012, Meghir and Phillips 2010). Hence, any attempt to quantify accurately the overall contribution of tax policy reforms to changes in redistribution must take into account the labour supply effects of those reforms.

The new approach combines non-parametric and microsimulation decomposition techniques. In particular, we use the method recently proposed in Bover (2010) to derive non-parametric counterfactual cumulative distribution functions. These statistical methods provide a means to derive descriptive decompositions that are used to quantify the relative contribution of changes in labour supply to the variation in the redistributive impact of taxes and transfers. Our approach also draws on recent research on the decomposition of inequality changes by Bargain (2012) based on microsimulation techniques. Importantly, the approach proposed by Bargain identifies only the impact of labour supply responses induced by policy reforms leaving all other changes in labour supply as part of the residual component. This may explain to a large extent why the residual component is generally the largest factor when the method is applied to the UK (Bargain 2012) and to Australia (Creedy and Hermalin 2011).

In this paper, the approach is applied to analyse the changes in income redistribution in Australia between 1999 and 2007, a period of high economic growth characterised by a rise in participation rates accompanied by important changes in the income distribution (Greenville *et al.* 2013, Whiteford 2013), including a significant drop in the redistributive impact of the tax-transfer system. This application represents the first attempt to describe and understand the recent trends in progressivity and redistributive effects of income taxes and cash transfers observed in Australia. The results show that tax-transfer reforms and labour supply changes, some of the latter being induced by the tax-policy reforms, account for a large share of the decline in the net redistributive impact of the tax-transfer system observed over the period. Interestingly, however, we find that tax reforms were not responsible for the reduction in tax progressivity.

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

This section presents a framework to understand changes in the redistributive impact of tax-transfer systems. The methodology we propose to analyse observed changes in these measures combines the decomposition approaches proposed by Bover (2010) and Bargain (2012). The counterfactual

decomposition methods presented in the former article is employed here to identify the contribution of changes in labour supply that are not directly induced by tax-transfer policy reforms. The microsimulation techniques proposed in Bargain (2012) is used to quantify the direct effect of tax-policy reforms as well as the labour supply effects due to these reforms.

Let M denote the redistributive index of interest. This can be any redistributive measure, including measures commonly used in the literature to characterize the redistributive consequences of taxes and transfers, such as the redistributive effect index (Musgrave and Thin, 1948):

$$RE = G(g) - G(d), \quad (1)$$

where G is the Gini index, g is market income, and d is disposable income (i.e. income after taxes and transfers);² the progressivity of the tax system as measured by the disproportionality index introduced by Kakwani (1977):

$$PG = C^x(\text{tax}) - G(x), \quad (2)$$

where x is pre-tax income, that is market income plus transfers, and $C^x(\text{tax})$ is the concentration coefficient of income taxes, tax , where the superscript x indicates that computation units are ranked according to their value of x ;³ and the measure of transfer regressivity proposed in Lambert (2001, p. 270):

$$RG = G(g) - C^g(\text{ben}), \quad (3)$$

where $C^g(\text{ben})$ is the concentration coefficient of benefit payments, ben .

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 socioeconomic and demographic characteristics of the population in period t . We denote by L_t the vector with information on labour supply decisions comprising those related to 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.⁴ The redistributive measures (1)-(3) involve the comparison of the distributions of income, tax, and transfer variables in the set $A=\{g,d,x,\text{tax},\text{ben}\}$. Let y represent any variable in A . The distribution of this variable at time t can be expressed as follows:

$$F_t(r) = \sum_{j=1}^J E_t[1(y \leq r|j)] \Pr_t(j), \quad (4)$$

where $E[\cdot]$ is the expectation operator, $1(\cdot)$ is the indicator function, and j indicates the population subgroup as defined by the labour supply variables in L_t . To evaluate the impact of changes in labour

² 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). The redistributive effect can also be computed as a relative rather than an absolute change (see Pechman and Okner, 1974) and it can be based on Atkinson indices rather than Gini coefficients (see Blackorby and Donaldson, 1984 and Kiefer, 1985).

³ 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.

⁴This could be, for instance, information to classify individuals according to their employment status or the number of hours that they work.

supply between periods t and $t+1$ on the distribution of y , we follow Bover's (2010) application of DiNardo et al.'s (1996) approach to decompose changes in cumulative distribution functions. Following the method proposed in Bover (2010) we estimate non-parametrically the counterfactual distribution that would have prevailed in one period had the characteristics of the labour supply been those of the other period. This technique is used here to derive descriptive evidence on the link between employment choices and the redistributive effect of taxes and transfers. For example, the counterfactual distribution of y that would be observed at time t assuming labour supply choices of period $t+1$ is:

$$F_t^{t+1}(r) = \sum_{j=1}^J E_t[1(y \leq r|j)] \Pr_{t+1}(j). \quad (5)$$

The comparison of (4) and (5) provides a simple way to quantify the contribution of labour supply to variations in the distribution of the variable of interest.⁵ To single out the effect of labour supply from those of other determinants decisions we further condition the counterfactual estimations on observable variables. The latter may include 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:

$$F_t^{t+1}(r|X) = \sum_{j=1}^J E_t[1(y \leq r|X, j)] \Pr_{t+1}(j|X). \quad (6)$$

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

$$F_t^{t+1}(r) = \sum_{k=1}^K F_t^{t+1}(r|X) \Pr_t(k), \quad (7)$$

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

$$F_t^{t+1}(r) = E_t[1(y \leq r) \frac{\Pr_{t+1}(L = j|X = k) \Pr_{t+1}(X = k)}{\Pr_t(L = j|X = k) \Pr_t(X = k)}], \quad (8)$$

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 redistribute measure, 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 labour supply choices of period 0. To derive this value, we estimate the

⁵ 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.

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:

$$\begin{aligned} \Delta &= M_1 - M_0 \\ &= M(P_1, L_1, \tau_1) - M(P_0, L_0, \tau_0) \\ &= M(P_1, L_1, \tau_1) - M(P_1, L_0, \tau_1) \quad (9) \\ &+ M(P_1, L_0, \tau_1) - M(P_0, L_0, \tau_0) \quad (10) \end{aligned}$$

where the term (9) is the part of the variation in M due to all changes in labour supply whereas (10) represents the part of the change explained by other factors. The contribution of labour supply 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 (9) is broken down into:

$$\begin{aligned} &M(P_1, L_1, \tau_1) - M(P_1, L_0, \tau_1) \\ &= M(P_1, L_1, \tau_1) - M(P_1, L_1^{\tau_0}, \tau_1) \quad (11) \end{aligned}$$

$$+ M(P_1, L_1^{\tau_0}, \tau_1) - M(P_1, L_0, \tau_1) \quad (12)$$

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 . $M(P_1, L_1^{\tau_0}, \tau_1)$ represents the corresponding value of the redistributive measure.⁶ Following Bargain (2012), these two elements are derived making use of a behavioural microsimulation model that allows the estimation of labour supply responses to changes in tax-transfer policies. The term (11) accounts for the contribution of labour supply responses due to changes in τ , whereas (12) represents the effect of the changes in labour supply not explained by modifications in the tax-transfer regime.

The term (10) 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 :

$$\begin{aligned} &M(P_1, L_0, \tau_1) - M(P_0, L_0, \tau_0) \\ &= M(P_1, L_0, \tau_1) - M(P_0, L_0, \tau_1) \quad (13) \end{aligned}$$

$$+ M(P_0, L_0, \tau_1) - M(P_0, L_0, \tau_0) \quad (14)$$

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 (14) thus captures the 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 (13) can be

⁶ In the following analysis the vector of thresholds and transfer parameters for period 0 is always assumed to be adjusted in nominal terms to period 1 values, using an 'uprating' factor.

seen as a residual capturing the part of the variation in M due to changes in other population characteristics.

In summary, using (11) to (14) we can express the variation in the index of interest M between two periods as:

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

where (TLS) is the part of the variation due to changes in labour supply induced by changes in the tax-transfer system, (OLS) is the variation attributed to other changes in labour supply, (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 of a switch in the tax-transfer regime in the absence of labour supply responses (T) 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 total, there are eight possible decompositions. 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:

$$\begin{aligned}
\overline{TLS} &= \frac{2}{8} \sum_{i=0,1} \sum_{j=0,1} (M(P_i, L_i^{\tau_j}, \tau_k) - M(P_i, L_i^{\tau_0}, \tau_k)) \\
\overline{OLS} &= \frac{1}{8} \sum_{i=0,1} \sum_{j=0,1} \sum_{k=0,1} M(P_i, L_1^{\tau_j}, \tau_k) - M(P_i, L_0^{\tau_j}, \tau_k) \\
\overline{T} &= \frac{4}{8} \sum_{i=0,1} M(P_i, L_i^{\tau_1}, \tau_1) - M(P_i, L_i^{\tau_1}, \tau_0) \\
\overline{O} &= \frac{1}{8} \sum_{i=0,1} \sum_{j=0,1} \sum_{k=0,1} M(P_1, L_j^{\tau_k}, \tau_i) - M(P_0, L_j^{\tau_k}, \tau_i)
\end{aligned}$$

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

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

We illustrate the use of our decomposition method by analysing the changes in the redistributive impact of the tax and transfer system in Australia between the financial years 1999/00 and 2007/08.

This was a period of high economic growth with important changes in the distribution of income and 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.

We use the various editions of the Australian Survey of Income and Housing (SIHC) conducted over the period of analysis.⁷ This is 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 net 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:

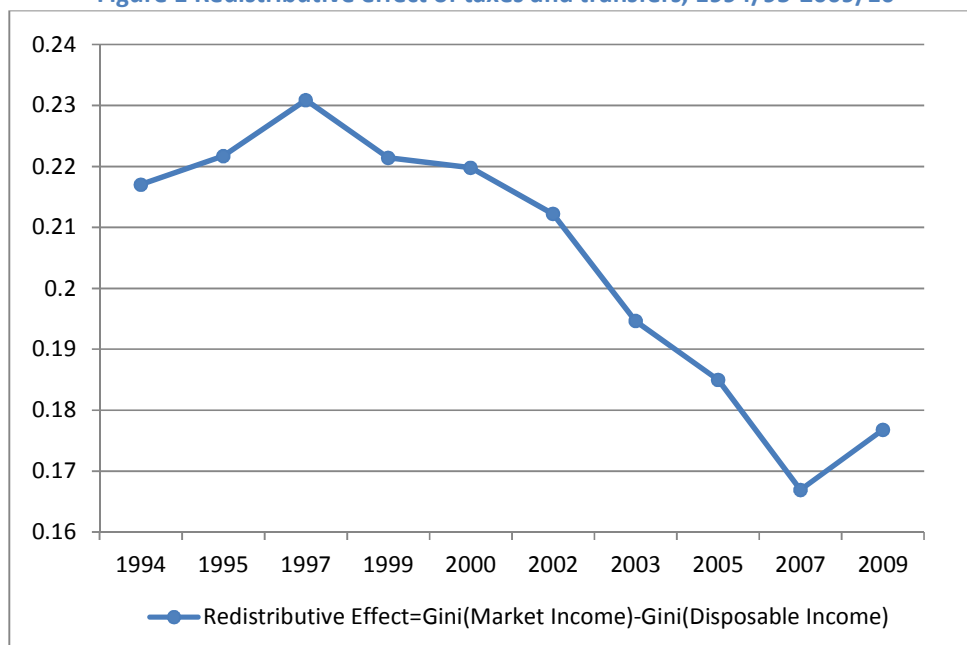
$$s = (n_a + \theta n_c)^\delta \quad (15)$$

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 $\delta=0.8$. These values produce scales that are similar to the OECD scales. Lastly, all the results are aggregated to the population level using the household weights provided with SIHC.

Figure 1 shows the values of the net redistributive effect of taxes and transfers, as measured by the Musgrave and Thin (1948) index equal to the difference in the Gini indices for market and disposable incomes, for the 1994/95-2009/10 period. 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.

⁷ 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.

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



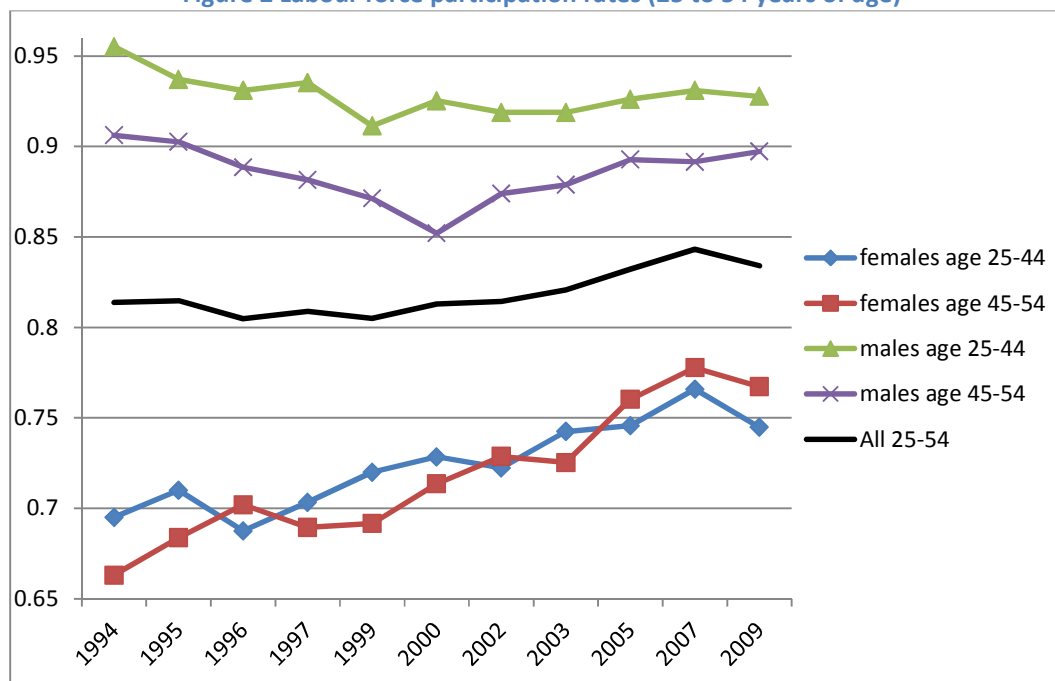
Source: Authors' calculations based on MITTS and SIHC data.

The 1994-2009 period was a period of strong economic growth characterized by an important rise in labour force participation. 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. Interestingly, the 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).

During this period, there have been important policy reforms relevant to the redistributive capacity of the Australian tax-transfer system. As regards the income tax, various changes were introduced, affecting the total amount of taxes paid and its distribution by income groups.⁸ 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 have also been subject to important reforms since 1994. Indeed, 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.

⁸ For a more detailed discussion on the changes in the Australian tax and transfer system over the period 1994-2009, see Herault and Azpitarte (forthcoming).

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 impact of taxes and transfers remains unclear. We make use of the new decomposition technique presented above to address this question. In particular, we apply the decomposition to the years 1999/00 and 2007/08.

As it is clear from Figure 1, these two years mark the start and end of the period of decline in the net redistributive index. Moreover this period has the advantage to avoid distortions from business cycle variations as it represents a peak-year to peak-year comparison.⁹ Figure 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. As the lower panel of Figure 1 shows, disposable incomes became more unequal 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 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 capacity of income taxes and transfers clearly contributed to the rise in the inequality of disposable incomes. Indeed, the net redistributive effect of taxes and benefits declined by almost 25 per cent, from 0.22 to 0.16. Income taxes accounted for a smaller proportion of income, as reflected by the reduction in the average tax rate, and also became less progressive. Similarly, average benefit payments declined sharply (even faster than the average tax rate) and they became slightly less regressive.¹⁰ However,

⁹ Quarterly GDP growth was negative in the fourth quarters of 2000 and 2008 (OECD Quarterly National Accounts).

¹⁰ The net redistributive effect can be decomposed into the (re)progressivity and the average rates of taxes and benefits (Lambert, 1985). Larger values of the (re)progressivity measures and of the average rates contribute positively to the net redistributive impact.

these figures do not tell us to what extent these changes were driven by tax-transfer policy reforms, by behavioural responses to these reforms or by other factors. It is the aim of the decomposition to address this issue.

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			
P95/P50	2.39	2.37	-1.1
P90/P50	2.02	1.94	-4.2
P75/P50	1.48	1.41	-4.4
P50/P25	1.41	1.47	4.5
P50/P10	1.68	1.99	18.5
P50/P5	1.78	2.13	19.8

Source: Authors' calculations based on MITTS and SIHC data

The decomposition of the variation in the redistributive measures, $\Delta = M_{1999/00} - M_{2007/08}$, into the TLS, OLS, T, and O components requires various counterfactual estimates of the index of interest. Concretely, for the computation of the contributions of the labour supply changes, whether induced by policy reforms (TLS) or not (OLS), we first estimate the value of the index that would be observed in one year assuming the labour supply of the other year. This is done using the counterfactual decomposition methods in Bover (2010) outlined in the previous section. For the present illustration we characterize the distribution of labour supply choices at any point in time using three possible categories depending on whether he/she is not working, working part-time or working full-time (i.e. more than 30 hours per week). Labour supply 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). This 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. Moreover, given that the approach has to be applied at the income unit level, where benefit values are determined, using actual hours worked is not possible in practice as it gives rise to too many combinations for multi-individual income units.

To isolate the effect of labour supply 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. The robustness of the results was assessed 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 both cases, we only found to a small

impact on the decomposition results.¹¹ 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.¹²

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 described in the Appendix. Finally, in order to quantify the impact of policy reforms in the absence of labour supply response (T), it is necessary to estimate the value of the redistributive index in a given year assuming that the population 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 modelling component of MITTS. This component of the simulator uses information on the parameters of the tax-transfer scheme to compute the benefits and taxes paid by income units in Australia without allowing for labour supply responses.

Table 2 presents the decomposition of the changes 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. The observed decline 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 labour supply changes that occurred over the period, only a small part of which was directly driven by tax and transfer policy changes. In fact, labour supply 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 labour supply 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 and 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. The decomposition shows that tax-transfer policy reforms alone contributed to a reduction in the average tax rate in the order of 20 per cent (or twice the size the observed reduction). Appendix Table 4, 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.

¹¹ Results from these robustness checks are not presented here but are available upon request.

¹² This is reassuring with respect to the robustness of the approach, especially in view of the fact that labour supply changes were not trivial during the period of analysis. However, it is a result that is specific to this particular application.

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. 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 incomes. In particular, labour supply 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. Table 2 shows 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 labour supply 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 labour supply, about a third of which being attributed to direct responses to tax-transfer policy reforms. In other words, the increase in labour supply 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. Overall, the observed decline in the redistributive effect of the tax-transfer system is attributable for one sixth to tax and transfer policy changes, for 11.5 per cent to the labour supply responses to these changes, for 29 per cent to other changes in labour supply and for 45.5 per cent to other changes in the structure of the population. The residual term encompasses all effects other than those due to labour supply and tax-transfer policy changes. Complementary results presented in Appendix B suggest that changes in the distributions of age and educational attainment contributed to the decline in the redistributive impact but their contribution was relatively limited compared to the other components presented in Table 2.

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

	Tax progressi- vity (PG)	Transfer regressivity (RG)	Average tax rate	Average transfer rate	Redistri- butive effect (RE)	Gini	
						market income	disposable income
1999/00 base value	0.256	1.124	0.232	0.151	0.221	0.507	0.285
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
Absolute	-0.018	-0.038	-0.023	-0.041	-0.055	-0.036	0.019
Contributions to historical changes (in per cent)							
T	-86.9	136.6	208.1	-33.7	16.9	0.0	49.6
TLS	20.0	-0.5	-6.5	17.0	11.5	23.1	-11.0
OLS	64.1	-5.6	-16.5	41.2	29.0	53.6	-18.8
O	102.8	-30.6	-85.1	75.5	42.6	23.3	80.1
Total	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; OLS: other labour supply changes; O: All other population changes.

4. Conclusions

In this paper we propose a unifying framework to study changes in the redistributive consequences of income taxes and transfers. In isolating tax-transfer reforms and of labour supply changes, the main difficulty lies in the endogeneity of the market income distribution to the tax and transfer system. 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 labour supply decisions or the influence of tax policy on these decisions.

The aim of this paper is to present a new approach allowing for an additive decomposition of the observed changes in progressivity and redistributive measures over time, while fully accounting for and measuring the impact of concomitant changes in labour supply and their consequences in terms of market income distribution. Furthermore, we introduce a distinction between labour supply changes directly driven by changes in the tax-transfer system and other labour supply changes. This is achieved by combining the method developed by Bargain (2012) to decompose income inequality changes with the approach proposed in Bover (2010) to produce counterfactual distribution functions.

The application of this decomposition approach to Australia over the 1999/00-2007/08 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. This period was characterised by policy initiatives that put strong emphasis on promoting labour market participation and reducing welfare dependency. Indeed, employment rates increased sharply over the period. The decomposition indicates that this trend contributed to a reduction in market income inequality. But this period was also marked by a reduction in tax progressivity and in the redistributive effect of the tax-transfer system. The decomposition shows that tax-transfer reforms

accounted for a non-negligible, albeit small, share of the observed decline in redistributive effect. Interestingly, these 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 labour supply changes, a substantial part of which being attributable to responses to tax-transfer reforms. These results demonstrate the importance of considering labour supply responses in the analysis of the redistributive effects of tax and transfer systems.

In addition, 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.

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 labour supply changes. However, the immediate effect of tax-policy reforms in the absence of behavioural responses 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: Complementary decomposition results

The counterfactual decomposition technique proposed in Bover (2010) is used in this paper to assess the contribution of the changes in the distribution of labour supply choices. However, it is a flexible approach that can also be used to assess the contribution of changes in other population characteristics to the observed variation in income redistribution. For example, it can be used to evaluate the contribution of changes in the age structure of the population or changes in educational attainments. By conditioning on hours worked, such additional decompositions shed light on population changes that may have affected income distribution but that are not explicitly distinguished in Table 3 and are instead all included together in the "All other population changes" decomposition component. The two other components of the decomposition, namely the contributions of policy reforms and of labour supply responses to these reforms, remain unchanged (and are thus not repeated here).

Table 3 presents the contributions 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. The results show that although these population changes contributed to the observed changes in income distribution and redistribution measures (amplifying or mitigating the observed trends), their contributions were limited compared to the other components presented in Table 2. We note that changes in the age distribution, or more specifically ageing in the case of Australia under the period of analysis, contributed to mitigate the observed decline in both tax progressivity and transfer regressivity. Indeed, retirees tend to pay less taxes and to receive larger transfers than the general population. Another interesting result 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 that transfers became more concentrated.

Table 3 Additional decomposition results

	Tax progress- sivity (PG)	Transfer regres- sivity (RG)	Average tax rate	Average transfer rate	Redis- tributive effect (RE)	Gini	
						market income	disposable income
1999/00 base value	0.256	1.124	0.232	0.151	0.221	0.507	0.285
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
Absolute	-0.018	-0.038	-0.023	-0.041	-0.055	-0.036	0.019
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
Changes in educational attainments	3.5	-1.3	-4.8	-2.3	-2.0	-8.9	11.3
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

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.

Appendix C: Income tax schedules

Table 4 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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