Smoothing the fiscal costs of population ageing in Australia: effects on intergenerational equity and social welfare.

Ross Guest[1]

Griffith University

Corresponding author:

Ross Guest

Professor of Economics

Griffith Business School

Griffith University

PMB 50

Gold Coast Mail Centre

Queensland 9726

Australia

Smoothing the fiscal costs of population ageing in Australia: effects on intergenerational equity and social welfare.

Abstract

This paper applies an overlapping generations model in order to evaluate the case for smoothing the fiscal costs associated with population ageing. The motivation is the establishment in Australia of the Future Fund which acts to smooth the tax burden over time. A CGE model is applied to determine the effects on intergenerational equity and social welfare. The conclusion is that tax smoothing of the order implied by the Future Fund yields net gains in social welfare in the order of 1.0 percent in equivalent annual increases in GDP. All current generations of workers and retired workers are worse off, with middle-aged workers the worst affected, but future generations are better off and by larger magnitudes.

JEL codes: H31, H32, J18, E21

1 Introduction

The purpose of this paper is to analyse the implications for intergenerational equity and social welfare of smoothing the fiscal costs of population ageing. This is done by simulating an overlapping generations CGE model, calibrated to the Australian economy, and using historical and projected demographic data along with projections of demographically sensitive government spending. The effects of tax smoothing on intergenerational equity are found by comparing the effects on lifetime utility of different generations; and the effects on social welfare are evaluated using a social welfare function.

The motivation for this exercise is the establishment in Australia of the Future Fund (FF). The FF was set up primarily to fully fund the Australian Government's superannuation liabilities, quoted at "around $91 billion" in the 2005-6 Budget papers. The Government plans to issue about $5billion of CGS each year by running budget surpluses. The surpluses will be deposited into the FF during the accumulation phase which is planned to occur up to at least 2020, after which funds can be withdrawn for the specific purpose of meeting the Federal Government's superannuation liabilities.

The FF is seen by the Government as a way of spreading the fiscal costs of population ageing over time, as implied in the Australian Government's 2005-6 Budget Papers, Statement 7: "[the FF] will reduce calls on the budget in the future, at a time when significant intergenerational pressures are expected to emerge." These "pressures" are the spending implications of an ageing population. They consist mainly of health and aged care expenditures, and pensions, which are expected to account for an increase in spending of the Australian Government of 5.7 percent of GDP between 2005 and 2045 (Productivity Commission, 2005).[2] The FF acts as a vehicle for pre-funding these expenses. This amounts to tax smoothing in the sense that current generations will bear a greater tax burden, and future generations a lower burden, than they would under continuously balanced budgets.

Guest (2006) compared the projections of the ageing-related government spending in Productivity Commission (2005) with projections using a general equilibrium model that allowed for various behavioural feedback effects in response to changes in tax rates. One aim was to see whether the behavioural feedback effects would make much difference to the

---

[2] Age-related spending by State Governments is expected to amount to additional 0.8 percent of GDP over the same period.

spending projections. The model gave higher spending projections than those in Productivity Commission (2005) by an amount stabilising at 1 percent of GDP. The present paper extends that study primarily by modelling intergenerational equity effects which requires an overlapping generations model, whereas the model in Guest (2006) was based on the behaviour of an infinitely lived household. The overlapping generations framework allows us to identify winners and losers from tax smoothing. The fact that some generations lose and some win as a result of tax smoothing implies the need for a social evaluation of tax smoothing. This is done using a social welfare function under a range of alternative value judgements regarding the choice of parameters.

There are other relevant studies. Cutler et al. (1990), a seminal study in the macroeconomics of population ageing for the U.S., found trivially small gains from tax smoothing of the costs of ageing. Floden (2003) argued that the findings of Cutler et al (1990) apply to the U.S. only because tax rates there are relatively low. He found the efficiency gains to be non-trivial for a number of other OECD countries that have higher tax burdens. Both of these studies applied infinitely lived dynasty models and were therefore unable to say anything about intergenerational equity. Oksanen (2003), in a study for the European Commission, was concerned with intergenerational fairness of tax smoothing in response to population ageing, but applied a simple partial equilibrium analysis rather than a multi-sector CGE model. Oksanen concluded in favour of partial smoothing on intergenerational equity grounds. Davis and Fabling (2002) estimated the efficiency gains of smoothing the costs of ageing in New Zealand. They found gains a little larger than those in Cutler but smaller than those in Floden. However, theirs was also a partial analysis based on a calibrated deadweight loss function. The innovation in the present study is that it uses an overlapping generations CGE model to explicitly trace out the effects of tax smoothing on each age cohort and determines the effect on social welfare.

The paper proceeds as follows. Section 2 focuses on the intergenerational equity effects of tax smoothing in simple terms using a diagrammatic approach. Section 3 describes the simulation model and Section 4 discusses the social welfare function including the role of social value judgements. The simulations and results are discussed in Section 5. Section 6 concludes the paper along with a brief discussion of limitations of the model for the purpose of a social evaluation of tax smoothing via the Future Fund.

2   Efficiency and equity effects of tax smoothing

The idea that governments should smooth the tax burden over time was first advanced by Barro (1979). He showed that, in a deterministic setting, a constant tax rate over time would minimize the distortions to behaviour arising from taxation. In doing so he assumed that the distortions would increase more than proportionally to increases in the tax rate, which had already been established analytically by Harberger (1964), cited in Browning (1987). An important distortion, or deadweight loss, arises from the substitution of leisure for income in response to taxation on labour. Also, taxes on income from capital distort consumption between time periods, favouring consumption today relative to consumption tomorrow (Lucas, 1990). A policy of tax smoothing would reduce the magnitude of these distortions and therefore lead to a more efficient allocation of resources.

2.1   Intergenerational equity: a simple illustrative model.

The basic intuition for the intergenerational welfare effects of tax smoothing can be illustrated using a simple stylised model. Assume single person households who live for four periods of equal duration. They attend full time education in the first period during which they receive no income, they work in the second and third periods, and are retired in the fourth period. At any time therefore four overlapping generations exist: retired, middle-aged worker, young worker, and future worker (currently in full time education). Assume a single tax rate applying to all income and that this tax rate is projected to rise over time, under a balanced budget policy, due to the fiscal pressure of population ageing. Now suppose that the government introduces an unanticipated policy to smooth the tax rate by switching from a balanced budget to a budget surplus for one period after which balanced budgets are resumed for all subsequent periods. In all of these subsequent periods government assets are higher than they would have been under balanced budgets which allows the tax rate to be lower. Hence under tax smoothing the tax rate is higher for the initial period and lower for all subsequent periods.

In order to set up a simple two period framework, suppose that following the policy shock the remaining lifetimes of all generations are divided into two periods. The two periods are of equal length for a given generation but will be shorter for older generations because they have less remaining lifetime to divide up. Households must decide how to allocate consumption over these two remaining periods of their lives. This becomes a standard two period consumption allocation problem for each generation. Let W_1 be the level of wealth of

each generation at the start of period 1 at which time the policy shock occurs; let Y_i be income earned at the start of period i (i=1,2); let C_i, be consumption during period i; let r be the constant interest rate, and let t_i be the flat rate of tax on both labour income and capital income in period i. Finally, assume that the household has a target bequest of zero. Then the household's discounted budget constraint over its remaining lifetime, divided into two periods, is:

$$ C_1 + \frac{C_2}{1+r\left(1-t_2\right)} = W_1 + Y_1\left(1-t_1\right) + Y_2\left(\frac{1-t_2}{1+r\left(1-t_2\right)}\right) \tag{1} $$

Consider Figure 1a, which depicts the choices facing the young worker in allocating consumption over the two periods of life remaining after the shock.[3] The young worker will be working in the first of these periods when the tax rate is lower as a result of tax smoothing and working for part of the second period when the tax rate is higher. The horizontal axis in Figure 1a measures consumption and income in period 1 and the vertical axis measures consumption and income in period 2. Two budget lines are drawn representing the lifetime budget constraint (1) for the tax smoothing case and the balanced budget case. The slope of the budget line is $-\left[1+r\left(1-t_2\right)\right]$. It is steeper in the tax smoothing case because t_2 is lower than it is under the alternative policy of continuous balanced budgets. The effect of tax smoothing on the intercepts depend on the values of W_1, Y_1, Y_2, t_1, t_2 and r. In Figure 1a the effect on the intercepts is such that the budget lines intersect which is likely if W_1+Y_1 is close to Y_2 - a plausible scenario for the young worker who has little wealth at the time of the shock.[4]

There are two sets of indifference curves, U, in Figure 1a representing different rates of time preference. U_1 and U_2 are implied by a low rate of time preference, and U_3 and U_4 by a high rate of time preference. The optimal intertemporal consumption choice is the point at which the indifference curve is tangential to the budget line. The young worker is more likely to be better off the lower their rate of time preference. Intuitively, with a low rate of time preference they are prepared to sacrifice current consumption when tax rates are high (in Figure 1a they move from C_1[bal] to C_1[sm]) in order to transfer capital income to the future

---

[3] Assume also that labour supply is exogenous in this simple stylized model. It is, however, endogenous in the formal simulation model.
[4] The intersection point of the budget lines occurs where the intertemporal consumption allocation is unaffected by the policy change.

when tax rates are low (moving from C_2[bal] to C_2[sm]). The result is an increase in utility from U_1 to U_2. On the other hand, when the rate of time preference is high, such an intertemporal trade-off would be too costly in terms of lost utility in the present. In that case their optimal consumption choice implies lower utility (U_4 compared with U_3). Tax smoothing has less effect on lifetime utility for young workers than it does for middle-aged or future workers (discussed below) because young workers experience a higher tax rate for the early part of their working life but a lower tax rate later on.

Figure 1b depicts the case for the middle-aged worker for whom the remaining two periods of life following the shock consist of a period of work (period 1) and a period of retirement (period 2). Under tax smoothing they pay a higher tax rate on their labour income in period 1 and a lower tax rate on their retirement income in period 2. Tax concessions for retirees ensure that they pay very little tax in retirement and therefore the change in their effective tax rate, t_2, as a result of tax smoothing is very small. The result is that both intercepts are lower in Figure 1b and that middle aged households are unambiguously worse-off under tax smoothing irrespective of their rate of time preference.

The case for the retired person is illustrated in Figure 1c. The difference between these people and the middle-aged workers is that they are retired at the time of the tax smoothing shock and, it is assumed, will be dead by the time the lower tax rate arrives. Hence although they face higher tax rates for the rest of their lives, their income is low and therefore their remaining lifetime incomes are little affected. This is reflected by the closeness of the budget lines in Figure 1c.

Finally, Figure 1d represents the case for the future workers who have just commenced full time education at the time of the shock and are therefore paying no tax. They are unambiguously better off under tax smoothing because by the time they enter the workforce in the next period the tax rate is lower than it would have been under balanced budgets. They therefore enjoy lower tax rates for the entire income-earning period of their lives, implying a budget line with steeper slope and shifted to the right.

This illustrative model provides the basic intuition for the intergenerational effects of tax smoothing. The CGE model, discussed and applied below, allows for more complexity and key behavioural feedback effects (such as the effect of the tax rate on labour supply); it also facilitates a social welfare evaluation of tax smoothing.

Before moving on to the simulation model a brief comment on the taxation of capital income is warranted. Tax smoothing implies changes to taxes on capital income that will have

efficiency and equity effects that are somewhat more complicated than those applying to taxes on labour income. In an intertemporal setting, Chamley (1986) shows that the long run optimal tax on capital is the outcome of a trade off between conflicting objectives. Because capital is fixed in the short run, the principal that taxes on fixed factors do not distort behaviour requires a positive optimal tax rate on capital. However, in the long run a positive tax rate on capital income distorts consumption between time periods. In order to avoid these complications it is sometimes assumed, in intertemporal welfare analyses of taxation, that the tax on capital income is zero (for example, Davis and Fabling, 2002). Here however, we are not concerned with optimal taxation and we simply assume that the tax rate on capital income is the same as the tax rate on labour income. Firms pay the pre-tax cost of capital but households receive the after-tax return on capital, which creates a wedge consisting of foregone net gains from employing capital.[5]

3 The simulation model

The simulation model is an open economy, overlapping generations model with four sectors: firms, households, government and an overseas sector.

3.1 Firms

A representative firm produces output of a single good according to a Cobb-Douglas production function. Output, Y, in period j is given by

$$Y_j = AK_j^\alpha L_j^{1-\alpha} \tag{2}$$

where A is a constant exogenous technology parameter,[6] K_j is the capital stock, and L_j is aggregate labour consisting of the sum of the labour of all generations: $L_j = \sum_{i=1}^{n} L_{i,j}$ where $L_{i,j}$ is the labour of generation i working in year j.

---

[5] An open economy framework potentially complicates this analysis because the supply of savings can come from foreign households. But in fact this doesn't change the analysis much because in Australia, as in most countries, non-residents are liable for Australian tax on all assessable income earned in Australia. This includes income from capital in the form of interest, dividend and royalty income. The amount of tax payable depends on whether the recipient is a resident of a country that has a tax treaty with Australia. In the simulation model applied here it is implicitly assumed that foreign and domestic lenders are subject to the same rate of tax.

[6] The technology parameter is constant, implying zero technical progress. The reason, as also given in Kulish et al. (2006), is that the leisure to consumption ratio would eventually decline to zero with continual productivity-induced rises in real wages. See Auerbach and Kotlikoff (1987) for a further discussion. It would be possible to specify a non-standard utility function that could deal with this problem in the presence of technical progress, but this is not pursued here.

The optimal capital stock, K_j, is determined by the first order condition that the marginal product of capital (net of depreciation, δ) is equal to the cost of capital, r_j, which is constant by assumption.

That is, $\left(\dfrac{dY_j}{dK_j} - \delta \right) = r_j$, which gives

$$\left(\frac{K}{L} \right)_j = A \left(\frac{\alpha}{r_j + \delta} \right)^{1/1-\alpha} \tag{3}$$

And investment, I_j, is given by

$$I_j = K_j - K_{j-1}(1-\delta) \tag{4}$$

Competitive firms equate the price of labour, w_j, to the marginal product of labour:

$$w_j = (1-\alpha)A \left(\frac{K}{L} \right)_j^{\alpha} = \left(\frac{Y}{L} \right)_j - (r_j + \delta) \left(\frac{K}{L} \right)_j \tag{5}$$

The wage of each worker is given by

$$w_{i,j} = \alpha_i w_j \tag{6}$$

where $w_{i,j}$ is the wage of a worker of age i in year j, α_i is a weight equal to the wage for age i divided by the average of wages for all age groups which are given by data (see Section 5).

The interest rate is a function of the level of foreign liabilities as a share of GDP, (7), in order to reflect extensive evidence that capital is not perfectly mobile internationally even for small open economies. For a discussion of the various explanations see Gordon and Bovenberg (1996).

$$r_j = \bar{r} + \gamma \left(\frac{D}{Y} \right)_j \tag{7}$$

3.2 Households

Each household consists of one person who dies at age 90 with certainty. A period of time is five years duration and a new generation of households is born each period, implying that households live for $h=18$ periods and that there are there are h overlapping generations of households alive at any time. The households supply labour between the age of 15 and 70; hence there are eleven generations of workers. Households pay the same single tax rate on income from both capital and labour. Future values of the demographic variables and the parameters are known with certainty, except for the tax smoothing shock which comes as a surprise at which time households must adjust their plans accordingly.

Households derive utility from consuming a composite index of private goods, C, and leisure, S. Households also derive utility from consuming public goods, G^C, which is exogenous and separable from both private consumption and leisure in generating utility, following the approach in Foertsch (2004). Therefore G^C does not affect the household's choice of private consumption or leisure and can therefore be ignored in solving the household's optimisation problem. The assumption of separability between public and private consumption is quite common, as noted in Foertsch (2004), because of lack of evidence about the substitutability between private and government consumption.

The composite index of consumption and leisure is

$$\Pi_{i,j} = \left[\mu_i^{1/\psi} C_{i,j}^{\frac{\psi-1}{\psi}} + \left(1 - \mu_i\right)^{1/\psi} S_{i,j}^{\frac{\psi-1}{\psi}} \right]^{\frac{\psi}{\psi-1}} \tag{8}$$

where $C_{i,j}$ and $S_{i,j}$ are the goods consumption and leisure, respectively, of generation i in period j. The preference for consumption relative to leisure, captured by the parameter μ_i, is assumed to vary over the lifecycle. In particular it is assumed to rise up to middle age and then fall. Hence μ_i follows a hump-shape which is given by the quadratic:

$$\mu_i = \xi_1 + \xi_2 i - \xi_3 i^2 \tag{9}$$

The hump-shape pattern on μ_i generates a hump-shape path of consumption relative to leisure over the life cycle. This pattern is designed to reflect the observed life cycle pattern of consumption which tends to track the hump-shaped pattern of income to some degree, rising during the household's working life and falling after retirement (see, for example, Deaton, 1999).

Households maximise the following intertemporal utility function:

$$U = \sum_{i=1}^{h} \frac{\Pi_{i,j}^{1-\beta}}{1-\beta} \left(1+\theta\right)^{1-i} + v\left(G^C_{\ j}\right) \tag{10}$$

with respect to $C_{i,j}$ and $S_{i,j}$ after substituting for $\Pi_{i,j}$, and subject to a lifetime budget constraint:

$$\sum_{i=1}^{h} C_{i,j} \left(1 + r_j \left(1 - t_j\right)\right)^{1-i}$$
$$= \sum_{i=1}^{h} \left(p_{i,j} L_{i,j} + G^T_{\ i,j}\right)\left(1 + r_j \left(1 - t_j\right)\right)^{1-i} + Q\left(1 + r_j\left(1 - t_j\right)\right)^{1-(h-6)} - \bar{A}_{1-h} \tag{11}$$

where the right hand side is the present value of lifetime income. The latter includes transfer payments[7], $G^T_{i,j}$, and inheritance, Q, which is received when the household is aged h-6=60 less a target bequest, $\bar{A}$;[8] t_j is the tax rate in year j applying to income from both labour and financial assets; and $p_{i,j} = w_{i,j}\left(1 - t_j\right)$ is the after-tax wage, and therefore relative price of leisure, facing a household of age i in year j.

The first order condition for the solution of the household's intertemporal optimisation problem yields the Euler equation for the evolution of the consumption index over the lifecycle:

$$\frac{\Pi_{i,j} - \Pi_{i-1,j-1}}{\Pi_{i-1,j-1}} = \frac{1}{\beta}\left(r_j(1-t_j) - \left(\frac{P_{i,j} - P_{i-1,j-1}}{P_{i-1,j-1}}\right) - \theta \right) \tag{12}$$

The solution to the household's intratemporal optimisation problem yields the following relation between consumption of goods and leisure as a function of the relative price of leisure:

$$\frac{\mu_i S_{i,j}}{\left(1 - \mu_i\right) C_{i,j}} = p_{i,j}^{-\psi} \tag{13}$$

Define total expenditure at each age as

$$Z_{i,j} = C_{i,j} + p_{i,j} S_{i,j} \tag{14}$$

Rearranging this and substituting into (13) yields

$$C_{i,j} = \frac{\mu_i Z_{i,j}}{\mu_i + \left(1 - \mu_i\right) p_{i,j}^{1-\psi}} \tag{15}$$

and

$$S_{i,j} = \frac{p_{i,j}^{-\psi}\left(1 - \mu_i\right) Z_{i,j}}{\mu_i + \left(1 - \mu_i\right) p_{i,j}^{1-\psi}} \tag{16}$$

---

[7] For simplicity, total transfer payments paid by the government in a given year are allocated evenly across all households alive in that year, rather than being allocated to certain generations. Hence $f_{i,j} = \dfrac{f_j}{N_j}$

[8] Households leave a bequest equal to 10 percent of their total lifetime pre-tax income. The bequest is received by the generation 30 years younger, which is a simplification for the purpose of generating lifetime budgets because the demographic data used for the simulations reflects the actual patterns of age-specific fertility.

Define $P_{i,j}$ as the price of the consumption index, $\Pi_{i,j}$, which implies that it is the minimum $Z_{i,j}$ such that $\Pi_{i,j}=1$. Hence $Z_{i,j}=P_{i,j}\Pi_{i,j}$. Using this definition of $P_{i,j}$ and substituting equations (15) and (16) into the expression for $\Pi_{i,j}$ yields

$$P_{i,j} = \left[\mu_i + \left(1-\mu_i\right) p_{i,j}^{1-\psi} \right]^{1/1-\psi} \tag{17}$$

Substituting (17) into $Z_{i,j}=P_{i,j}\Pi_{i,j}$ and then substituting the resulting expression for $Z_{i,j}$ into (15) and (16) yields

$$C_{i,j} = \mu_i \left(\frac{1}{P_{i,j}} \right)^{-\psi} \Pi_{i,j} \tag{18}$$

$$S_{i,j} = \left(1-\mu_i\right)\left(\frac{p}{P} \right)_{i,j}^{-\psi} \Pi_{i,j} \tag{19}$$

Figure 2 shows household labour income (after tax) and consumption over the lifecycle. The slight hump in the consumption path is due to the assumed path of μ_t discussed above.

The balance of financial assets at age i in year j is given by

$$A_{i,j} = \begin{pmatrix} A_{i-1,j-1}\left(1+r_j\left(1-t_j\right)\right)+\left(w\frac{L}{N}\right)_{i,j}\left(1-t_j\right)-C_{i,j}+G^T_{i,j} & i=1,..,11,13,..,18 \\ A_{i-1,j-1}\left(1+r_j\left(1-t_j\right)\right)+\left(w\frac{L}{N}\right)_{i,j}\left(1-t_j\right)-C_{i,j}+G^T_{i,j}+Q & i=12 \end{pmatrix} \tag{20}$$

Note that the wage of a worker, $w_{i,j}$, is multiplied by $(L/N)_{i,j}$ to reflect the fact that there are $L_{i,j}$ workers but $N_{i,j}$ households of age i in year j.

The solution to the household's optimisation problem is obtained numerically as follows. Specify a trial value of $\Pi_{i,j}$ for $i=1$, then solve forward for $\Pi_{i,j}$ for $i=1,...,h$ according to the Euler equation (12). For $i=1,...,h$ calculate $C_{i,j}$ and $S_{i,j}$ according to (18) and (19). Then calculate $A_{h,j}$; if it does not equal the target bequest[9], then adjust $\Pi_{i,j}$ for $i=1$ and repeat the algorithm iteratively until the target bequest is met within a degree of tolerance.

The labour supply of households aged i in year j, $L_{i,j}$, is given by $L_{i,j} = e_{i,j}\bar{L}_{i,j}$ where $\bar{L}_{i,j}$ is the exogenously given size of the labour force of age i in year j and $e_{i,j}$ is work intensity

---

[9] The target bequest is set exogenously as a proportion of the household's lifetime income. In the base case this proportion is 10 percent.

defined as $e_{i,j} = \dfrac{1}{S_{i,j}}$. The notion of work intensity here follows that in Barro and Sala-i-Martin (1995, p.322) where no distinction is drawn between an increase in $e_{i,j}$ that reflects a rise in effort from one that reflects a rise in hours worked. Both amount to an increase in labour supply. Our model implies, for example, that a 1 percent increase in demand for leisure gives rise to a 1 percent decline in labour supply in terms of either effort or hours worked. The total resources available to the household from which to provide work effort are therefore normalised to $e_{i,j}S_{i,j} = 1$.

The labour market clearing condition is

$$L_j = \sum_{i=1}^{h} L_{i,j} \tag{21}$$

where L_j is labour demand and the right hand side is the labour supply of households. The labour and capital market clear simultaneously in each period, given the optimal capital-labour ratio determined by (3), by a process that can be outlined as follows. The optimal capital-labour ratio determines the marginal product of labour and therefore the real wage according to (5). Given the real wage, employment is determined by the labour supply of households. The demand for capital is determined by the interest rate (negatively) and the employment level (positively). The supply of capital from both households and overseas is a positive function of the interest rate as implied by (12) and (7) respectively. Any disequilibrium in the labour or capital market is instantaneously eliminated by shifts in demand for labour and capital for any given real wage and interest rate.

The standard national accounting identity gives the evolution of foreign liabilities:

$$D_j = D_{j-1}\left(1+r_j\right) + \sum_{i=1}^{h} C_{i,j} + G_j^C + I_j - Y_j \tag{22}$$

3.3 Government

Government spending, G_j, is an exogenously given share of GDP. It is set equal to 0.3 for the period up to 2005 after which it is assumed to increase according to the increase in age-related spending of the Australian Government as projected in Productivity Commission (2005). The projected age-related spending of State governments from 2004-2045 is only 0.8 percent of GDP (compared with 5.7 percent for the Australian Government) and is ignored here to enable comparisons with the Future Fund which is drawn only from the Australian

Government budget. All government spending other than transfer payments is assumed for simplicity to be government consumption spending. Hence

$$G_j = G_j^C + G_j^T \tag{23}$$

The categories of age-related G_j^C spending are given in Productivity Commission (2005) and consist of health, aged care, carers and education; and the categories of G_j^C are age and service pensions, family tax benefits, disability support benefit, unemployment allowances and parenting payments. The resulting series for aggregate $(G/Y)_j$ is plotted in Figure 3 as the series labelled "bal budg" because under balanced budgets $(G/Y)_j$ is also the tax to GDP ratio, $(T/Y)_j$. As Figure 3 indicates, age-related spending of the Australian Government is projected to increase by 5.7 percent between 2003 and 2045 according to the Productivity Commission (2005).

The government faces the following dynamic budget constraint:

$$D_j^{gov} = D_{j-1}^{gov}\left(1+r_j\right) + G_j - T_j \tag{24}$$

where D_j^{gov} is government debt (net) and T_j is total taxes.

4   Social value judgements

A social evaluation of tax smoothing requires value judgements which can be made explicit by defining a social welfare function. It is assumed that the social judge evaluates only the aggregate consumption of society in the present and the future. This implies that there is no regard for past consumption of generations still alive.[10] Also, by considering only aggregate consumption the social evaluation does not explicitly account for the lifetime utility of particular generations.

The social welfare function applied here is

$$V = \sum_{j=1}^{H} N_j \left[\frac{\Pi_j}{1-\beta_s}\right]^{1-\beta_s} \left(1+\theta_s\right)^{1-j} \tag{25}$$

---

[10] This assumption can imply time inconsistent aggregate consumption paths as shown by Calvo and Obstfeld (1988) in the context of optimal fiscal policy implemented by a central planner. Here we are not concerned with planning optimal consumption paths using fiscal policy as the instrument, but simply with evaluating consumption paths taking fiscal policies as given.

where $\Pi_j = \sum_{i=1}^{h} \Pi_{i,j}$ is the aggregate value of the consumption index of all households alive in period j; j=1 in 2005; H is an arbitrarily long time in the future; and V is discounted social welfare which we will simply call social welfare.

Although the social evaluation in (25) is concerned only with aggregate consumption, it accounts for intergenerational equity indirectly through the parameters that weight future consumption. These parameters are β_s and θ_s which are analogous in their role to the parameters β and θ in the household's utility function. The parameter θ_s is a social rate of pure time preference which is the rate at which intra-period j social welfare is discounted in deriving our measure of social welfare. The parameter β_s measures the social degree of aversion to variability in consumption at any given point in time. Both parameters β_s and θ_s discount consumption occurring at different time periods, but θ_s discounts a given level of future consumption according to the distance of that consumption in the future, whereas β_s discounts consumption at a given point in the future according to the size of that consumption.

Although they are analogous, the values of the social and private discount parameters need not be equal. For example, while it may be privately optimal for individuals to adopt a zero rate of pure time preference it may not be socially optimal, as an implication of the axioms in Koopmans (1960). In particular, if θ_s=0, the consumption of generations near to the present would have negligible weightings in social welfare when H is large. The result would be that the future swamps the present in social importance. It could justify crushing the present generation to yield an infinitely small increase in the utility of each generation in the future.

5   Empirical application

5.1   Data and parameters

The demographic data consist of actual historical population levels, and projected future population levels, for each age group. These data are given in the following Australian Bureau of Statistics (ABS) Catalogues: historic population, Catalogue 320109.1; projected population, Catalogue 3222.0; labour force participation rates by age, Catalogue 6291.0; and wage rates by age, Catalogue 6310.0. The data source for government expenditure is Productivity Commission (2005).

Table 1 gives the parameter values. The base case value of the interest rate parameter, γ, is 0.02, implying that an increase in the foreign liabilities to GDP ratio of 10 percent would imply an increase in the interest rate of 0.2 percent. The value of $\bar{r}$ is determined such that the interest rate in 2005 is equal to 4 percent given the value of D/Y in 2005. The latter value is set equal to its actual value of 0.6 by calibration – in particular, by finding the required ratio of D/Y in the period 1915-1919 which is the period when the household aged 86-90 in 2005 was born. The household's rate of time preference, θ, is equal to r-$\beta\gamma$ which is the rate that would, if both the tax rate and the parameter μ_t were constant, ensure that consumption grows at the long run rate of growth of output.[11] The capital elasticity of output, α, is calibrated such that the initial capital to output ratio is equal to 3.0, the approximate actual value for Australia in 2005. The initial tax to GDP ratio is set equal to 0.3 the actual value for Australia in 2005. The values of the elasticities, β and ψ, are set equal to 2 and 0.8, respectively, which are common values used in related studies in the literature, see for example Foertsch (2004).

There is no assumption that the economy is in a steady state prior to the tax smoothing policy shock, nor that the economy converges to a steady state. Nevertheless, the properties of the OLG model lead to fairly well-behaved state variables. In particular, debt and the capital stock do not take extreme values at any point in the optimal path.

5.2 Simulations and results

The three paths of the tax rate illustrated in Figure 3 consist of the continually balanced budget case referred to above and two tax smoothing scenarios: a pure smoothing scenario in which the tax rate is constant, and a partial smoothing case in which the tax rate rises more steeply than in the balanced budget case but does not jump instantly to a constant rate as in the pure smoothing case. The partial smoothing scenario is an attempt to mimic the outcome of the Future Fund in which the income stream from the Fund allows the tax rate to be lower after 2020 then it would otherwise be. The partial smoothing scenario implies budget surpluses of around 1 percent of GDP for the next 20 years after which the surpluses decline to zero by about 2040. The pure smoothing scenario is a somewhat hypothetical case in which the tax rate immediately jumps by 3 percent of GDP generating budget surpluses that decline from 3 percent to zero by about 2040. Such a sudden jump in the tax rate would be politically

---

[11] This equation for θ is not, however, a condition for a stable equilibrium in OLG models.

infeasible and is not implied by the Future Fund. Nevertheless, it shown here as the limiting case.

The implications of these smoothing scenarios for government assets are shown in Figure 4. In the pure smoothing case the stock of government assets stabilises at a little over 70 percent of GDP by 2045; in the partial smoothing case the figure is around 30 percent by 2040 which is consistent with projections of the likely Future Fund balance.

A key aim of the analysis is to determine whether households of different generations are better off or worse off under tax smoothing, and by how much. The most appropriate indicator for this purpose is household lifetime utility (10) because it takes account of optimal adjustments between leisure and goods consumption, and between consumption in one period relative to another. The effect on lifetime utility is calculated and expressed in units of equivalent annual income. This facilitates the sensitivity analysis reported below since comparisons in units of utility are not valid when parameters in the utility function are changed. The change in equivalent annual income is found by an iterative procedure that adjusts annual income for a household by a constant percent in each period, in the balance budget scenario, until the lifetime utility is the same value as that in the smoothing scenario. Figure 5 shows the equivalent percentage change in annual income, as a result of tax smoothing, for each generation currently alive and future generations born up to the year 2050.

All current and retired workers will be worse off under tax smoothing. The magnitudes range from 0.5 percent to 1.9 percent in the pure smoothing case, and from 0.2 to 1.0 percent in the partial smoothing case. The greatest losses apply to the generations born around 1965-70 because they will pay higher tax rates throughout the high income earning years of their lives than they would have under balanced budgets. Figure 5 shows that the youngest workers, aged around 15-20, are least affected by tax smoothing because the higher taxes paid initially are offset by lower taxes later on. Future workers – those generations born after 1990 - are better off under tax smoothing, with the greatest gains accruing to generations born after 2025 (3.8 percent and 2.2 percent in the pure and partial smoothing cases, respectively).

These results are consistent with the diagrammatic analysis presented in Section 2, where it was suggested that middle aged workers would be worse off, young workers and retired workers would be less affected (retired workers would be a little worse off and young workers could be either a little worse or a little better off), and future workers would be

unambiguously better off. Sensitivity to key parameters is discussed further below, but the essential outcome is that the results are qualitatively unaffected by a plausible range of parameter values.

The effect of tax smoothing on labour supply is shown in Figure 6. The higher tax rate that applies for an initial period under tax smoothing causes a relatively sharp decrease in labour supply in the 2005 period, relative to the balanced budget case, which lessens over time and eventually becomes an increase in labour supply relative to the balanced budget case. This pattern can be explained as follows. The unanticipated shock causes an adjustment to lifecycle plans of all generations of workers. The adjustment occurs through both the income and substitution effect of higher taxes on their leisure/work choice. For middle age households the income effect is unambiguously negative (as illustrated in Figure 1b for the simple stylised model), which tends to lower demand for leisure and raise labour supply. But the substitution effect on leisure is positive, raising demand for leisure and lowering labour supply, and this effect slightly outweighs the negative income effect, resulting in a net decrease in labour supply for middle-age households. For young households, the negative income effect on leisure is not as strong (because they benefit from lower taxes later on) but the substitution effect is positive as for middle aged households. Therefore younger households also reduce their labour supply. The result is a relatively large drop in labour supply following the shock. As time goes on however, the gap between the smooth tax rate and the balanced budget rate narrows and eventually the smoothed rate becomes the lower of the two. This implies that the substitution effect on leisure switches to negative, raising labour supply. Offsetting this is the income effect on leisure which for newer generations becomes increasingly positive as they experience the benefits of the lower smoothed tax rate for a larger proportion of their lifetimes. Hence the ultimate increase in labour supply is not as great as the initial decrease in labour supply (see Figure 6).

Having identified the generations of winners and losers from tax smoothing we turn now to the social welfare function (25) in order to make a net social evaluation of tax smoothing which jointly takes account of efficiency and equity effects of tax smoothing. Efficiency gains from tax smoothing arise from the reduction in distortions to both the labour-leisure choice arising from taxation of labour income and to the intertemporal consumption allocation arising from the taxation of capital income. Intergenerational equity is accounted for indirectly, as noted in the previous section, through the parameters in (25) that weight future consumption. No attempt was made to isolate the relative contribution to the gains in

social welfare from the reduction in the two distortions and from the intergenerational equity effects.

The results are reported in Table 2 by expressing gains in social welfare in terms of equivalent annual gains in GDP per annum from tax smoothing. These were calculated by finding the annual increase in GDP under continual balanced budgets that would generate the same value of social welfare as in the tax smoothing scenario. Results are given for a range of values of the two key parameters in the social welfare function: the social discount rate, θ_s, and the parameter measuring the social aversion to inequality in consumption, β_s. The values chosen for θ_s range from zero to 8 percent; and the values chosen for β_s range from 0.2 to 10. The first point to note is that the gains are positive for all of the parameter combinations. This indicates net social gains from tax smoothing. For the hypothetical limiting case of pure tax smoothing the annual gains range from 0.8 to 2 percent of GDP. For practical purposes, however, we can safely ignore the pure smoothing case, as argued above. The magnitudes for the partial smoothing case range from 0.7 to 1 percent of GDP in annual gains from tax smoothing. These amount to $315 and $450, respectively, per annum per person, based on a 2004/5 GDP of $900 billion and a population of 20 million.

5.2.1 Sensitivity

A sensitivity analysis was conducted for some key parameters. The results are reported in Table 3.

The rate of time preference was shown to be potentially important in the illustrative model of Section 2, at least for young workers. Table 3 reports results for a zero rate of time preference, compared with the base case value of 3 percent. The results partly support the intuition given in Section 2, in that young workers are better off the lower rate of time preference, but the effect is still slightly negative even for a zero rate of time preference. A similar effect occurs with a higher rate of interest, because workers are induced by the higher return on saving to postpone consumption - see the row in Table 3 for value of $\bar{r}$ of 4 percent which is one percent higher than the base case value of 3 percent.

None of the alternative parameter values alter the direction of the effect of tax smoothing on lifetime utility that was found for the base case parameter values. The effect for all current generations of workers, and retired workers, remains negative and the effect for future workers remains positive, for all alternative parameter values. The range of values in Table 3 is small. For existing workers the range is well within 1 percentage point and for future workers the range is 1.6 percentage points.

The final column in Table 3 reports the effect of alternative parameter values on social welfare as defined by (25). In each case the values of the parameters in (25) have been held at their base case values – the sensitivity with respect to those parameters was reported in Table 2. Again, the direction of the effect is unaltered by the alternative parameters chosen for the sensitivity analysis. That is, the effect on social welfare remains positive, ranging from 0.45 percent to 1.5 percent in terms of equivalent annual gains in GDP. Converted to dollars per capita as reported above for the base case, this range is equivalent to a range of $225 to $675, respectively, per annum per person.

6   Conclusion
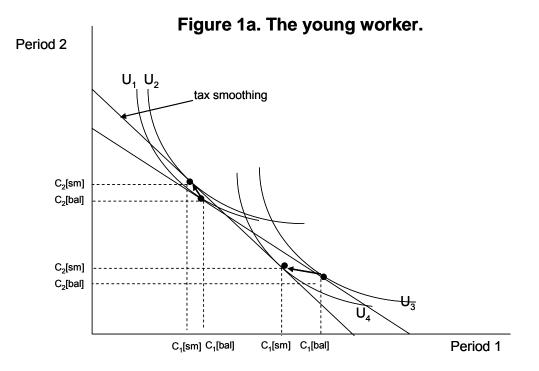
This paper has analysed the welfare effects of tax smoothing, both in terms of the welfare of successive generations of representative households and in terms of social welfare. It was motivated by the decision of the Australian Government to establish the Future Fund into which budget surpluses will be deposited during an accumulation phase which is anticipated to continue until around 2020. The paper was also motivated by a lack of evidence in the literature about the implications of tax smoothing for intergenerational equity taking account of general equilibrium effects.

The simulation analysis reveals differential generational effects of tax smoothing compared with continual balanced budgets. For all of the parameter values that were simulated, current generations of workers are worse off in terms of lifetime utility, but by magnitudes that may be considered small. The magnitudes in the partial smoothing simulation (which mimics the effect of the Future Fund) are in the order of -0.2 percent for retired workers, -1 percent for middle aged workers, and -0.6 percent for young workers, where these numbers measure the effect on lifetime utility in terms of equivalent annual income. Future workers are better off and by larger magnitudes, in the range of 2 to 3 percent in terms of equivalent annual income.
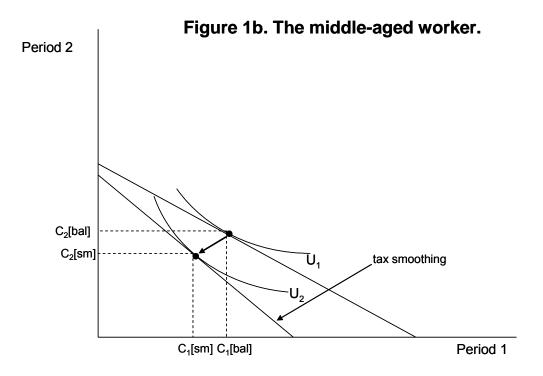
A social evaluation of these gains and losses requires value judgements about appropriate discount weights and about the degree of aversion to inequality over time. These value judgements are embodied in the social welfare function. It turns out that tax smoothing increases social welfare under a range of values for the social welfare parameters and other parameters in the model. The implication is that the lifetime utility gains to future generations outweigh the losses to current generations in terms of social welfare. The magnitudes of the increases in social welfare for partial smoothing case are in the order of 1 percent, plus or

minus 0.5 percent. A figure of 1 percent converts to around $500 of additional GDP per person per annum.
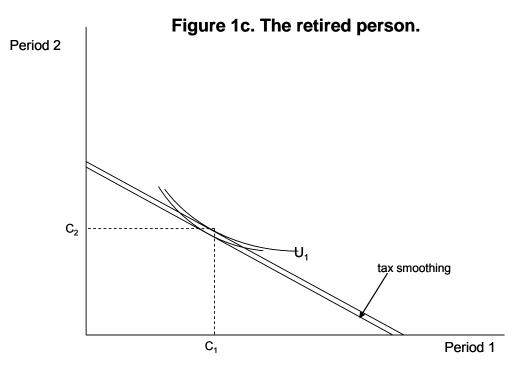
A more complete social evaluation of the Future Fund would encompass political economy issues. One such issue is the risk that the Fund may be raided for political purposes; and/or that there may be political interference in the investments undertaken by the Fund. The extent to which this can be prevented through legislation is not clear *a priori*. A related political issue is the effect that a significant income stream generated by the Fund might have on discipline to control government spending. There are also the governance and management costs of the Fund to be considered. Future work could attempt to incorporate these political economy effects along with the conventional economic mechanisms captured in the CGE model applied here. Another avenue for future work would be to try to separate out the social welfare gains arising from reductions in distortions to labour supply from those arising from reductions in distortions to intertemporal consumption – a separation of these effects was not considered in this paper.

Figure 1a. The young worker.

Period 2

U_1 U_2

tax smoothing

$C_2[sm]$
$C_2[bal]$

$C_2[sm]$
$C_2[bal]$

U_4 U_3

$C_1[sm]$ $C_1[bal]$ $C_1[sm]$ $C_1[bal]$

Period 1
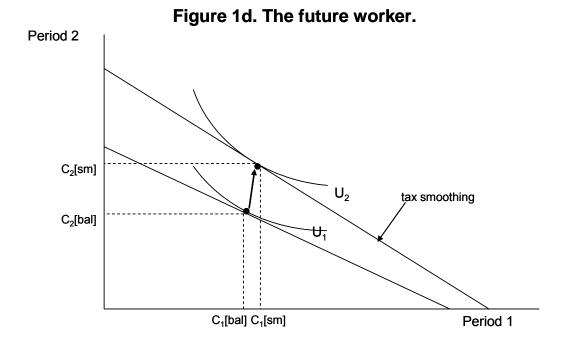
Young workers are relatively unaffected by tax smoothing. They are slightly better off with a lower rate of time preference (U_1, U_2), and slightly worse off with a higher rate of time pref (U_3, U_4).

Figure 1b. The middle-aged worker.

Period 2

$C_2[bal]$
$C_2[sm]$

U_1 tax smoothing

U_2

$C_1[sm]$ $C_1[bal]$

Period 1
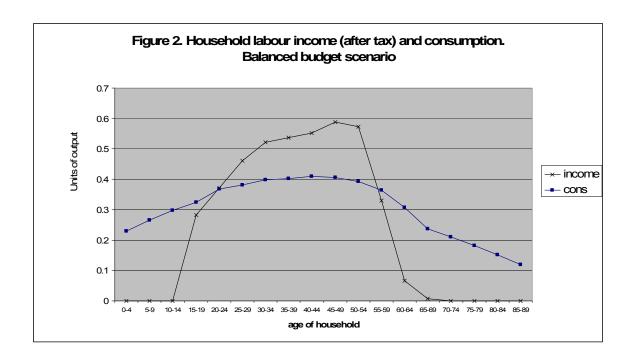
Middle aged workers are worse off, because they will retired by the time that tax rates become lower than they would have been under a balanced budget.

Figure 1c. The retired person.

Period 2

C_2

U_1

tax smoothing

C_1

Period 1
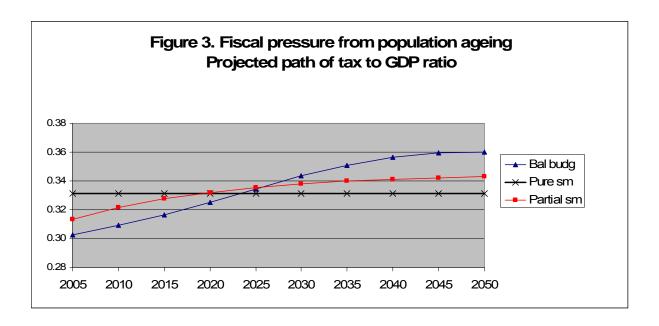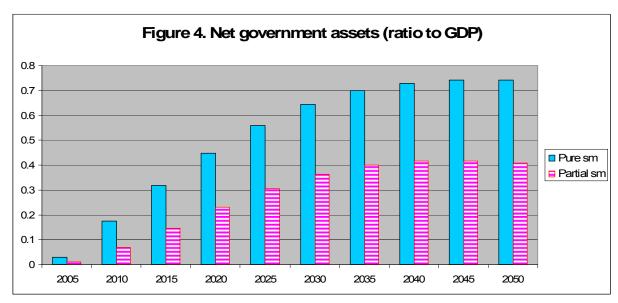
Retired people are only very slightly worse off because they no longer earn labour income and pay a low effective tax rate on their income from capital.

Figure 1d. The future worker.

Period 2

$C_2[sm]$

$C_2[bal]$

U_2

tax smoothing

U_1

$C_1[bal]$ $C_1[sm]$

Period 1
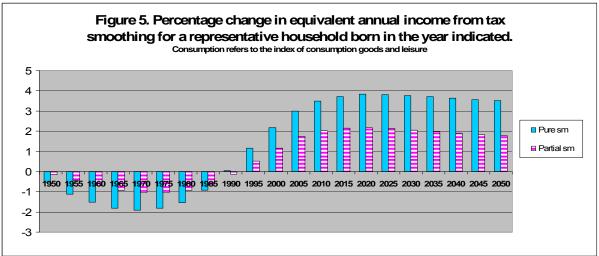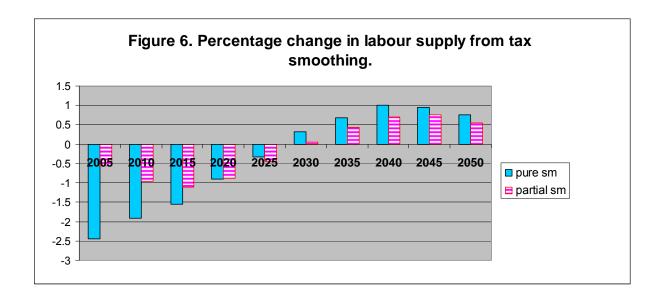
The future worker is unambiguously better off, because they pay tax rates throughout their working lives that are lower than they would have been had tax smoothing not been implemented.

Figure 2. Household labour income (after tax) and consumption. Balanced budget scenario

Figure 3. Fiscal pressure from population ageing Projected path of tax to GDP ratio

Figure 4. Net government assets (ratio to GDP)

Figure 5. Percentage change in equivalent annual income from tax smoothing for a representative household born in the year indicated.
Consumption refers to the index of consumption goods and leisure

Figure 6. Percentage change in labour supply from tax smoothing.

25

Table 1. Base case parameter values and initial values.

Interest rate, $\bar{r}$, for a zero level of foreign liabilities	0.03
Interest rate risk premium parameter, γ	0.02
Household's rate of time preference, θ	0.03
Depreciation	0.05
Capital elasticity of output: $\alpha = \left(\dfrac{\bar{K}}{\bar{Y}}\right)_0 (r_0 + \delta)$	0.27
Initial capital to output ratio $\left(\dfrac{\bar{K}}{\bar{Y}}\right)$	3.0
Initial tax rate on all income, t	0.3
Foreign liabilities to GDP ratio, D/Y, in 2003	0.6
Elasticity of marginal utility w.r.t. consumption index, β	2.0
Elasticity of substitution between consumption and leisure, ψ	0.8
Bequest as a proportion of household's lifetime income	0.1

Table 2. Social welfare gains from tax smoothing in units of equivalent GDP per annum

Social time pref rate (θ_s) %	Aversion to inequality parameter (β_s)	Pure smoothing %	$ * per capita	Partial smoothing %	$ per capita
0.0	2.0	2.0%	900	1.0%	450
3.0	2.0	1.8%	810	0.9%	405
6.0	2.0	1.7%	765	0.8%	360
4.0	0.2	1.6%	720	0.7%	315
4.0	1.0	1.7%	765	0.8%	360
4.0	10.0	1.8%	788	0.9%	405

* The annual $ per capita calculation is based on a 2004/5 GDP of $900 billion and a population of 20 million.

Table 3. Sensitivity to parameter values					
Effect (%) of partial tax smoothing on lifetime utility of generation measured in equivalent annual income					
		Retired worker Born in 1935	Middle-aged worker Born in 1960	Young worker Born in 1985	Future worker Born in 2010	**Effect on gains in social welfare (V)**
Parameter						$\theta_s=0.03,\ \beta_s=2.0$
base case parameters		-0.12%	-0.92%	-0.63%	2.04%	0.80%
θ	zero (base=0.03)	-0.11%	-0.65%	-0.42%	1.74%	0.70%
$\overline{r}$	0.04 (base=0.03)	-0.20%	-1.17%	-0.46%	3.64%	1.00%
γ	zero (base = 0.02)	-0.18%	-1.23%	-0.71%	3.12%	0.90%
β	1.0 (base=2.0)	-0.26%	-1.47%	-0.88%	3.22%	0.95%
ψ	1.2 (base=0.8)	-0.29%	-1.52%	-0.74%	3.06%	0.45%
bequest	zero (base = 0.1)	-0.14%	-1.40%	-0.22%	3.28%	1.50%

References

Auerbach, A.J. and Kotlikoff, L.J. (1987) "The Effects of a Baby Boom on Stock Prices and Capital Accumulation in the Presence of Social Security", <u>Econometrica</u> 71, 2, 551-578.

Barro, R. (1979), 'On the Determination of Public Debt', <u>Journal of Political Economy</u>, 87, 5, 940-971

Browning, E. K. (1987), 'On the Marginal Welfare Cost of Taxation', <u>The American Economic Review</u> 77, 1, 11-23

Calvo, G. and Obstfeld, M. (1988), 'Optimal Time-Consistent Fiscal Policy with Finite Lifetimes", <u>Econometrica</u>, 56, 2, 411-432

Cass, D. (1965), 'Optimum Growth in an Aggregative Model of Capital Accumulation', <u>Review of Economic Studies</u>, 32, 233-240.

Chamley, C. (1986), 'Optimal Taxation of Capital Income in General Equilibrium with Infinite Lives', <u>Econometrica</u>, 54, 1, 607-622

Cutler, D.M., Poterba, J.M., Sheiner, L.M. and L.H. Summers (1990), 'An Aging Society: Opportunity or Challenge?', <u>Brookings Papers on Economic Activity</u>, (1), pp.1-74.

Davis, N. and R. Fabling (2002), 'Population Ageing and the Efficiency of Fiscal Policy in New Zealand', <u>New Zealand Treasury Working Paper</u> 02/11

Deaton, A. (1999) Saving and Growth, in Schmidt-Hebbel, K. and Serven, L. (eds.) The Economics of Saving and Growth, Cambridge University Press, Cambridge.

European Commission (2003), '<u>Public Finances in EMU 2003</u>', Commission of the European Communities, Brussels.

Floden, M (2003), 'Public Saving and Public Policy Coordination in Aging Economies', <u>Scandinavian Journal of Economics</u>, 105, 3, 379-400

Foertsch, T. (2004), 'Macroeconomic Impacts of Stylized Tax Cuts in an Intertemporal Computable General Equilibrium Model', <u>Technical Paper Series, Congressional Budget Office</u>, Washington, DC.

Gordon, R.H. and Bovenberg, A.L. (1996), "Why is Capital So Immobile Internationally? Possible Explanations and Implications for Capital Income Taxation", American Economic Review, 86, 5, 1057-1075.

Guest, R. (2006), 'Population Ageing, Fiscal Pressure and Tax Smoothing: A CGE Application to Australia', <u>Fiscal Studies</u> 27, 2, 183-204

Harberger, A.C. (1964), 'Taxation, Resource Allocation, and Welfare', in <u>The Role of Direct and Indirect Taxes in the Federal Revenue System</u> NBER Other Conference Series No.3, University Microfilms.

HM Treasury (2003), 'Long-Term Public Finance Report: Fiscal Sustainability with and Ageing Population', <u>HM Treasury, Crown,</u> London

Koopmans, T.C. (1960), 'Stationary Ordinal Utility and Impatience', <u>Econometrica</u>, Vol. 28, p.287-309.

Kulish, M., Smith K. and Kent, C. (2006) "Ageing, Retirement and Savings: A General Equilibrium Analysis" Research Discussion Paper 2006-06, <u>Reserve Bank of Australia.</u>

Lucas, R.E. (1990), 'Supply-Side Economics: An Analytical Review', <u>Oxford Economic Papers</u> 42, 293-316

Obstfeld, M. and K. Rogoff (1996), 'Foundations of International Macroeconomics', MIT Press**.**

Oksanen, H. (2003), 'Population Ageing and Public Finance Targets', <u>European Commission Economic Papers,</u> No. 193, December, European Commission, Brussels.

Productivity Commission (2005), '<u>Economic Implications of an Ageing Australia</u>', Commonwealth of Australia, Canberra.