

A General Equilibrium Analysis of the Australian Means-Tested Age Pension*

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Abstract

This paper develops a computable general equilibrium model with overlapping generations [OLG] to analyse the behavioural, welfare and macroeconomic implications of the following hypothetical age pension policy changes: (i) abolition of the means test, (ii) 50 percent reduction in the income taper rate and (iii) removal of the labour earnings from the income test. The model features intra-generational heterogeneity and essential aspects of Australia's retirement income policy. We show that all three hypothetical pension policy changes have a significant behavioural impact on middle-income households at older ages while low- and high-income households are almost entirely unaffected through general equilibrium impacts on the gross wage rate and the consumption tax rate. As a result of all the three policy changes, middle-income generations work longer hours at older ages and postpone their full retirement. Thus, the model implies that the existing means-tested age pension represents a disincentive for some older Australians to work. The most effective of these age pension policy changes to increase the labour supply of some older Australians is the removal of labour earnings from the income test while the means test abolition delivers larger retirement consumption and welfare gains. The macroeconomic simulation results indicate that the means test abolition would raise the government costs on age pension substantially relative to the costs resulting from the other two pension policy changes.

Keywords: Retirement, pension reform, dynamic OLG model

JEL classification: H55, J26, C68.

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1 Introduction

One hundred years ago, the Australian age pension was introduced to provide an adequate safety net payment to older people unable to support themselves financially in their retirement. Since its inception in 1909, many of its core elements have remained intact. Importantly, the eligibility age for males has remained unchanged (though the eligibility age for females has recently been gradually increased) and the pension payment was, and currently is, subject to income and asset means tests. The increase in the longevity of the population and the significant increase in the proportion of eligible senior citizens that receive the age pension have led to an increasing fiscal burden for taxpayers. There has also been concern that the means tests may discourage private saving and market work at older ages.

With this backdrop, it is important to understand the implications of the age pension structure for incentives of individuals to save and work, for government financial commitments and for the welfare of individuals. The purpose of the present paper is to undertake and discuss an analysis of these issues. To this end, we explore the implications of the following three hypothetical policy changes to the means test of the Australian age pension: (i) the complete means test abolition, (ii) a 50 percent reduction in the taper rate of the age pension income test and (iii) the removal of the labour earnings from the income test. One specific aim is to determine whether the age pension means test provides disincentives for older Australians to engage at some part-time work and bring forward retirement. Other aims are to determine the effects upon saving over the life cycle and upon individual welfare, and to draw out the fiscal implications.

The age pension, which represents the first pillar of Australia's retirement income policy, is unusual among developed countries in that it is means tested against both claimant's income and assets. OECD (2005) shows that although 18 member countries have targeted pension programs, many of these countries also pay some minimum pension or flat-rate basic pension. For instance, in 2000 the earnings test for US social security was eliminated for those over the social security normal age of retirement, which is currently 65 years. In most countries, targeted public pensions are pension-income tested or broader-income tested, and not means-tested against both income and assets like in Australia. A number of retirement income commentators expressed concerns that the existing means test applied to the Australian age pension might discourage pensioners from taking up part-time work because of high effective marginal tax rates (Dunsford and Rise (2004), Dunsford and Wickham (2008), Ingles (2001) and Nielson, 2005). The effective marginal tax rate [EMTR] represents a tax rate applied to additional dollar of income and taking into consideration a reduction in welfare benefits such as the age pension due to the effective income test.

Insert Figure 1 here

That effective marginal tax rates for senior Australians eligible for the age pension are substantially higher than for other workers over a wide range of lower incomes is starkly illustrated in Figure 1. This figure shows the EMTRs in the financial year of 2007-08 for single senior Australians and for other workers who are not eligible for any welfare payment.¹

¹In addition to the income test of the age pension, the calculation of EMTRs for single seniors in Figure 1 accounts for the Medicare levy and tax offsets that the single pensioner may be eligible for. These tax

The horizontal axis records either private income, which excludes the age pension for seniors, (Figure 1a) or taxable income, which includes the age pension (Figure 1b). As depicted, older Australians with some private income face significantly higher EMTRs than ordinary workers over the private income range \$3433 to \$43707. In particular, as soon as the private income of a single senior Australian exceeds the free income area (i.e. income threshold) of the age pension income test, the effective marginal tax is 40 percent on each additional dollar earned (given by the 40 percent taper income rate for the age pension). The EMTR then climbs to a maximum of 73.9 percent over a narrow range of income, plateaus to just under 70 percent for incomes between \$24,413 and \$38,384, and then falls to meet the rate applying to non-seniors at \$43,707.² It is clear from the figure that the confluence of the pension rules and the income tax schedule generates extremely high EMTRs for senior Australians - much higher than for other Australians. The high rates create a potentially important disincentive to work while in receipt of the age pension.

In addition to work disincentives, the age pension means tests have the potential to distort saving decisions over the life-cycle of individuals. Under the assets test, the pension declines as assets (other than the family home and other personal assets) increase beyond an assets threshold and eventually ceases altogether. In addition, income from assets (such as interest, dividends and rent) is included as assessable income under the income test discussed above. Within a life-cycle, utility maximizing framework individuals making savings decisions throughout their pre-retirement, working lives have to take account of future implications, which include how those decisions affect assets and asset incomes once the age pension eligibility age is reached. Thus, the age pension rules will affect the savings profile and changes to these rules will also impact saving decisions.

To investigate the work incentive and saving effects of the means tests for the Australian age pension, we develop an inter-temporal general equilibrium model with overlapping generations of heterogeneous households for Australia. This model allows us to deal with life-cycle saving, consumption and hours of work decisions of households and, moreover, allows us to numerically determine the inter-generational, welfare and macroeconomic implications of the age pension policy and potential changes to this policy. The model is an open economy variant of Auerbach and Kotlikoff's (1987) model and, to our best knowledge, it is the first large scale overlapping generations model capable of studying retirement income policy issues in Australia.³ Our model, in addition to household and production sectors, incorporates essential aspects of Australia's retirement income policy and it includes a government sector. The model also features intra-generational heterogeneity, with every generation comprising low-, middle- and high-income households. The examined age pension policy changes are rev-

offsets include senior Australian tax offset [SATO], low income tax offset [LITO] and mature age worker tax offset [MAWTO]. Similar to the age pension, the Medicare levy and the aforementioned tax offsets are income tested and thus they generate high EMTRs at some incomes.

²The maximum EMTR of 73.9 percent is calculated as follows: the taper rate of 40 percent of the age pension income test + (30 percent personal income tax rate + SATO taper rate of 12.5 percent + LITO taper rate of 4 percent + 10 percent reduction rate of the reduced Medicare levy) \times 60 percent of marginal income.

³Kulish et al. (2006) analysed the macroeconomic consequences of ageing using a computable OLG model calibrated to the Australian economy. Their model is a closed economy model that contains only household and production sectors.

enue neutral as we assume that the consumption tax rate adjusts to balance the government budget as a result of the policy change.

Based on the numerical simulations, it is shown that all the three hypothetical pension policy changes have a significant behavioural impact on middle-income households that are income tested under the benchmark steady state case with the existing age pension means test. These households work longer hours at older ages and postpone their full retirement as the penalty of high EMTRs is completely eliminated or significantly reduced by these age pension policies. Low-income households that already receive the full age pension in the benchmark steady state are affected only through general equilibrium impacts on the gross wage rate and the consumption tax rate. High-income households for which the assets test binds are directly affected only by the means test removal as they receive the universal age pension, which has the pure income effect on their labour supply. Thus, the model indicates that the existing means-tested age pension represents a labour supply disincentive for older Australians who are means tested under the income test. The most effective of these age pension policy changes to increase the labour supply of some older Australians is the removal of labour earnings from the income test while the means test abolition delivers larger retirement consumption and welfare gains. The macroeconomic simulation results show that the means test abolition would raise the government costs on age pension substantially relative to the costs arising from the other two policy changes to the age pension means test.

The rest of this paper is organised as follows. The next section documents related literature. Section 3 describes the OLG model that is used to numerically evaluate the age pension policy changes. Section 4 discusses parameterisation of the model and section 5 provides the benchmark steady state analysis. Section 6 presents the inter-generational, welfare and macroeconomic results of the three hypothetical changes to the age pension means test. Finally, section 7 offers some concluding remarks.

2 Related literature

The policy changes to the age pension that we examine in this paper have been the subject of debate in the broader literature. First, there is a considerable literature on whether publicly provided pension payments should be paid to all citizens from a certain age (i.e. universal age pension) or targeted to those in need (i.e. means tested pension); see, for example, Mitchell et al. (1994). In Australia, the Institute of Actuaries of Australia (1994) recommended the means test abolition and the universal pension paid to all people from age 65.⁴ Arguments for the universal age pension are that it would simplify the public pension pillar, reduce administrative costs and avoid very high EMTRs, thus removing disincentives to work and save for the elderly. On the other hand, government expenditures on targeted pensions are substantially lower than on universal pension payments.⁵

⁴The proposal also featured employer contributions of 6 percent, employee contributions of 6 percent and a tax refund of 10 percent of approved annuity.

⁵Evans and Kelley (2003) assessed the attitude of Australians to alternative age pension systems. Using the survey of 4,830 cases, they concluded that the most preferred was the universal age pension, while the least popular was no government provision, followed by the means-tested pension.

Second, other researchers suggested only partial and gradual adjustments to the Australian age pension means test to encourage pensioners to provide some part-time work and to avoid substantial costs that would result from the shift to the universal pension. Dunsford and Rise (2004) and Dunsford and Wickham (2008) propose the removal of the labour earnings from the income test, while a gradual removal of the means test starting with a reduction in the income taper rate is recommended by Ingles (2001). These proposals motivate the second and third age pension policy changes analyzed in our paper.

Empirical literature based upon overseas policy changes generally supports the view that labour supply responds positively to relaxation of means testing of social security benefits. Baker and Benjamin (1999) estimate the impact of the sequential removal of the earnings test in Canada in the mid-1970s and find an increase in weeks worked conditional on employment and strong evidence of the shift from part-time to full-time work. Disney and Smith (2002) examine the labour supply effects of the abolition of the earnings rule in the United Kingdom in 1989. Using the Family Expenditure Survey for the period of 1984-94, they show a significant effect on the number of hours worked by men, with a lesser impact on women as a result of the means test removal.

The earnings test of the US social security system has also been subject to several empirical studies. Early studies such as the paper by Burtless and Moffitt (1985), who applied a joint model of retirement and post-retirement labour supply, concluded that the earnings test had a small impact on labour supply of the elderly. However, Friedberg (2000) points out that Burtless and Moffitt used data over the period when earnings test parameters were almost unchanged. Friedberg examines the changes in the US social security earnings test between 1978 and 1990 and finds significant impacts of the earnings test on labour supply of the affected population at or near the earnings test threshold. Her labour supply model estimates indicate that the means test removal for those aged 65-69 would have a strongly positive effect on hours and earnings.

Gruber and Wise (2005) document a relationship between social security incentives to retire and the proportion of older people out of the labour force across several developed countries. They show that the departure rates at the early retirement ages are around 60 percent in France and Germany and only about 25 percent in the US, and argue that the differences are due to taxes on continued wage earnings that vary considerably in these countries. The effective tax rates are about 70 percent in France and 40 percent in Germany but approximately zero in the US. French (2005) and Benitez-Silva and Hetland (2007), using structural models of retirement, show positive effects of the earnings test removal on labour supply of those at and near the threshold of the earnings test. Hence, these empirical studies provide evidence that the removal of the earnings test would have a significant effect on labour supply.

Existing approaches to modelling the effects of adopted and proposed retirement income policy changes in Australia are left mainly to micro-simulation models. For instance, the redistributive implications of the IAA (1994) proposal with the universal age pension are examined by Atkinson et al. (1996) using a lifetime simulation model of a single cohort of male individuals. They find that in terms of inequality and progressivity measures, there is not a significant difference between the IAA proposal and the retirement income scheme

at that time, with the assumed choice of superannuation payouts at retirement being a more important factor in determining the lifetime redistributive implications of a retirement income policy. Rothman (1998) applies the cohort projection RIMGROUP model to project the costs of age and veteran pensions up to year 2049-50 assuming various pension scenarios and shows that, under the base case, pension costs will rise to about 4.5 percent of GDP by 2049-50 due to the ageing population. A shift to the universal age pension would lift the costs to 6.45 percent of GDP by 2049-50, which would be 44 percent higher than the existing means-tested pension.

In contrast with such micro-simulation models, the life-cycle based overlapping generations model used in the present paper allows for behavioural responses by households and firms and provides for an inter-temporal, general equilibrium. We can examine both inter-generational and intra-generational effects of policy changes as well as short and long run macroeconomic implications.

3 Dynamic, open economy OLG model

3.1 Model overview

The model is a small open economy version of Auerbach and Kotlikoff's (1987) OLG model. It consists of household, pension, production, government and foreign sectors. The household sector is populated with overlapping generations of heterogeneous households distinguished by their lifetime earning ability. Each generation is assumed to consist of low-income, middle-income and high-income households. Households face lifespan uncertainty and the assets of deceased households are assumed to be inherited by all surviving households as accidental bequests. Labour supply and retirement are endogenous. Hence, households, in addition to their consumption choices, decide on how much work to supply and when to retire to maximise their lifetime utility. Middle-income and high-income households can borrow any time and as much as they wish at the world interest rate provided that their terminal assets are non-negative. Low-income households are assumed to be restricted from borrowing, implying that their ordinary private assets must always be non-negative.

The model incorporates essential aspects of the first two pillars of the Australian pension system – the means tested age pension and the fully funded superannuation guarantee [SG]. The age pension is paid to households from age 65 only if they satisfy the means test. Households also accumulate superannuation assets through the mandatory SG contributions made by the representative producer. The superannuation savings are assumed to be paid out as a lump-sum at age 60.

The production technology is represented by a CES production function, in which a single all-purpose output, that can be consumed, invested in production capital or traded internationally, is produced using capital and labour. Investment decisions follow the Q theory of investment (Tobin, 1969), according to which firms invest whenever the market value of their assets exceeds the cost of replacement.

The government in our model collects tax revenues from household consumption, personal income and superannuation and pays for its consumption and the age pension. We assume that the government maintains fixed debt-output and government consumption-output ratios and that the consumption tax rate is adjusted accordingly to balance the government budget.

The small open economy aspect of the model with perfect capital mobility implies that the domestic interest rate is pegged to the world interest rate. Whenever domestic savings fall short of domestic capital, foreign capital will be employed, which has negative effects on the current account. If output falls more than domestic demand, the trade balance deteriorates.

3.2 Demographics

The model economy contains 70 overlapping generations of heterogeneous households aged from 21 to 90 years ($a = 21, \dots, 90$) at any time period t . Each generation is divided into three income groups i - low-income ($i = 1$), middle-income ($i = 2$) and high-income ($i = 3$). We make the same assumption about the share of each income class, ω_i , as Fehr et al. (2008) that 30 percent of each generation belongs to the low-income group ($\omega_1 = 0.3$), 10 percent to the high-income group ($\omega_3 = 0.1$) and the remaining 60 percent to the middle-income group ($\omega_2 = 0.6$). Every year, the oldest generation of households dies and a new generation is born. Generations are assumed to enter the model structure at age 21 and to face random survival up to a maximum possible lifespan of 70 years. Lifespan uncertainty is described by s_a , the exogenous conditional probability of survival from age a to $a + 1$. The total population is assumed to grow at a constant rate, n , and is given by

$$POP_t = N_t \sum_{a=21}^{90} \frac{\prod_{j=21}^a s_{j-1}}{(1+n)^{a-1}}, \quad (3.1)$$

where N_t denotes the number of people born in period t . The cohort shares, μ_a , in the economy's total population are given by

$$\mu_a = \frac{s_a}{(1+n)} \mu_{a-1}, \quad \text{where } \sum_{a=21}^{90} \mu_a = 1. \quad (3.2)$$

Assumed stationary demographics with the constant population growth rate implies that the generation (or cohort) shares expressed in (3.2) are constant over time.

3.3 Household behaviour

Household behaviour is modelled on the basis of the life-cycle theory pioneered by Modigliani and Brumberg (1954). According to this theory, people make rational choices about their consumption and saving over their finite lifespan. In our model, households optimally choose consumption and leisure at each age and when to retire given their preferences, lifetime budget and time constraints. The households' preferences are represented by the expected lifetime utility function, which is assumed to be time-separable and of the nested constant-

elasticity-of-substitution [CES] form. The expected lifetime utility of a household of type i who begins her economic life at time t , $E(U_t^i)$, can be expressed as

$$E(U_t^i) = 1/(1 - 1/\gamma) \sum_{a=21}^{90} S_a (1 + \beta^i)^{21-a} u(c_{a,t+a-21}^i, l_{a,t+a-21}^i)^{(1-1/\gamma)} \quad (3.3)$$

where $u(c_{a,t+a-21}^i, l_{a,t+a-21}^i)$ is the instantaneous utility (i.e. felicity) that the household of the type i in year t obtains from consumption, c , and leisure, l .

The expected lifetime utility (3.3) is the sum of current and future utilities, where any future utility is discounted by the rate of time preference, β^i , and the unconditional survival probability, $S_a = \prod_{j=21}^a s_{j-1}$.⁶ The greater is β^i the smaller the weight attached to future utility. Households also discount the future due to lifespan uncertainty. Thus, the effective discount rate at age a is equal to $S_a / (1 + \beta^i)^{a-21}$, meaning that households only care of their future utility as long as they stay alive. The parameter γ is the inter-temporal elasticity of substitution of utility at any two ages. It represents the percentage change in the ratio of utility at any two ages with respect to the change of relative prices of utility between the two ages. A large value of γ indicates a great degree of substitutability of current utility for any future utility in response to a change of the after tax interest rate.

The felicity function takes the CES form

$$u(c_{a,t+a-21}^i, l_{a,t+a-21}^i) = \left[(c_{a,t+a-21}^i)^{(1-1/\rho)} + \alpha (l_{a,t+a-21}^i)^{(1-1/\rho)} \right]^{1/(1-1/\rho)}, \quad (3.4)$$

where ρ is the intra-temporal elasticity of substitution and α is the leisure distribution parameter. The leisure distribution parameter, α , gives household's strength of preferences for leisure relative to consumption. The greater α is the less labour households supply.

Denoting $A_{a,t}^i$ to be the stock of ordinary private assets for type i household at the end of age a and at time t , the within period budget constraint (or assets accumulation equation) is given by

$$\begin{aligned} A_{a,t}^i &= (1 + r)A_{a-1,t-1}^i + w_t e_a^i (h - l_{a,t}^i) + AP_{a,t}^i + SA_{60,t}^i + SP_{a,t}^i + B_t \\ &\quad - T(y_{a,t}^i) - (1 + \tau_t^c) c_{a,t}^i, \end{aligned} \quad (3.5)$$

with $A_{90,t}^i = 0$ and $A_{a,t}^i \geq 0$ only for low-income households and where r is the exogenous world interest rate and h denotes the annual time endowment. The constraint (3.5) indicates that households earn investment income, $rA_{a-1,t-1}^i$, and labour earnings, $w_t e_a^i (h - l_{a,t}^i)$, where $w_t e_a^i$ represents the hourly wage and $h - l_{a,t}^i$ is labour supply. The term w_t is the aggregate wage rate and e_a^i is the exogenous earnings ability variable that allows for different wages per hour over working lives. In addition to investment and labour incomes, households of qualifying age and satisfying the means test receives the age pension payments, $AP_{a,t}^i$, and at age 60, the households collect their superannuation savings denoted by $SA_{60,t}^i$. The term $SP_{a,t}^i$ stands for the superannuation pension that amounts to post-superannuation-payout

⁶While the rate of time preference is assumed to differ across the three types of households, survival probabilities are the same.

mandatory contributions made by employer. This pension is received only by households aged 61 years and over provided that they are still working.⁷

Households pay the consumption tax at the rate of τ_t^c and the progressive income tax, $T(y_{a,t}^i)$, from their taxable income, $y_{a,t}^i$. Taxable income, $y_{a,t}^i = w_t e_a^i (h - l_{a,t}^i) + rA_{a-1,t-1}^i + AP_{a,t}^i$, comprises labour earnings, investment income and the age pension. Although the model features no bequest motive (i.e. intended bequests), due to uncertain lifespan there are accidental bequests, B_t .

The time constraint is

$$l_{a,t}^i \leq h, \quad (3.6)$$

which implies that households, in addition to their consumption and leisure choices, decide upon the allocation of time between work and leisure. When $l_{a,t}^i = h$, households no longer provide any work and are fully retired from the workforce.

3.4 The pension sector

In the description of the age pension and superannuation that follows the subscript t for time periods is omitted.

3.4.1 Age pension

The age pension is received by the households aged 65 years and over who satisfy the means test. The means test consists of income and asset tests. The income test works as follows. The legislated maximum age pension, p , is paid to the eligible households of i type provided that their assessable income, \widehat{y}_a^i , is not greater than the given income threshold, IT . If the assessable income exceeds the income threshold, the maximum age pension gets reduced at the income taper rate, θ , for every additional dollar of assessable income earned, $\widehat{y}_a^i - IT$. The age pension paid under the income test, $AP_{a,i}^i$, can be expressed as

$$AP_{a,i}^i = \begin{cases} \max \{ \min \{ p, p - \theta (\widehat{y}_a^i - IT) \}, 0 \}, & \text{for } a \geq 65 \\ 0 & \text{for } a < 65 \end{cases}, \quad (3.7)$$

where the private assessable income comprises labour earnings and investment income, that is, $\widehat{y}_a^i = w e_a^i (h - l_a^i) + rA_{a-1}^i$.

Similar to the income test, households aged 65 years and over are paid the maximum age pension, p , under the asset test only if the stock of their private assets, A_a^i , does not exceed the given asset threshold, AT . If the private assets exceed the asset threshold, then the age pension is reduced at the asset taper rate, ϕ , for every dollar of private assets over the asset threshold, $A_a^i - AT$. The age pension paid under the asset test, APa_a^i , is computed as

$$APa_a^i = \begin{cases} \max \{ \min \{ p, p - \phi (A_a^i - AT) \}, 0 \}, & \text{for } a \geq 65 \\ 0 & \text{for } a < 65 \end{cases}, \quad (3.8)$$

⁷More on the age pension and superannuation is provided in the next subsection.

Finally, only the binding test applies. The age pension actually paid to the eligible households of type i is equal to the age pension payment under the test that results in the lower rate. The final payout of the age pension, AP_a , is calculated as

$$AP_a^i = \begin{cases} \min \{AP_a^i, AP_a^i\}, & \text{for } a \geq 65 \\ 0 & \text{for } a < 65 \end{cases} . \quad (3.9)$$

As the age pension depends upon private income and assets, households have less incentive to work and/or save. Prior to age 65, households consider that supplying an additional hour of work and earning an additional dollar may reduce future age pension entitlements because of greater private assets (i.e. effective assets test) or higher investment income (i.e. effective income test). Similarly, for households aged 65 years and over higher labour supply and/or savings may reduce current age pension entitlements due to increased labour and investment incomes or larger private assets. Lower lifetime labour supply and private saving may also arise from the publicly provided age pension acting as a substitute of private income.

3.4.2 Superannuation guarantee

Mandatory SG contributions are paid by the representative producer on behalf of households of type i between ages 21 and 60 at the after-tax contribution rate, $(1 - \tau^{sc}) cr$, from their gross labour earnings, $we_a^i(h - l_a^i)$.⁸ The contributions are made into the superannuation fund and added to the stock of superannuation assets, SA_a^i , which is invested and earns fund's investment income at the given after-tax interest rate, $(1 - \tau^r) r$. The stock of superannuation assets is assumed to be vested in the fund until households reach age 60. The households of that age, regardless of whether they work, receive their superannuation savings in the form of a lump-sum and the superannuation accumulation ceases to exist.⁹ The superannuation assets accumulation, as describe above, can be expressed as a sequence of period-by-period accumulations

$$SA_a^i = \begin{cases} [1 + (1 - \tau^r) r] SA_{a-1}^i + [(1 - \tau^{sc}) cr] we_a^i(h - l_a^i), & \text{for } a \leq 60 \\ 0 & \text{for } a > 60 \end{cases} , \quad (3.10)$$

where r is the world interest rate, τ^r is the earnings tax rate, τ^{sc} denotes the contribution tax rate and cr is the mandatory SG contribution rate.¹⁰

⁸In addition, the model assumes post-payout mandatory contributions paid by firms as a superannuation pension directly into the ordinary private accounts of working household aged 61 years and over. However, we do not model any voluntary contributions.

⁹Currently, superannuation benefits can be withdrawn as lump-sum payments or income streams upon reaching the superannuation preservation age of 55 years and being retired from workforce. The model assumption of lump-sum payout of superannuation benefits seems reasonable as over a five year period ending in June 2005 about 75 percent of all superannuation benefits, on average, were paid as lump-sum payments (APRA, 2007). The assumed superannuation payout age of 60 years is based on the following: (i) average retirement age of recent retirees of 60.3 years and (ii) high proportion of people around that age taking superannuation lump-sum payments (ABS, 2008).

¹⁰Superannuation benefits are assumed to tax free as the benefit taxation was abolished for people aged 60 years and over in July 2007.

To ensure that the effective wage rate, $w(1 + cr)$, that includes the mandatory SG contribution rate, paid by the producer is the same across all working households at time t , the model assumes that if households after receiving superannuation lump-sum payments (i.e. those aged 60 years and over) work, they are paid the mandatory SG contributions directly into their ordinary private asset accounts. These mandatory contributions take the form of the superannuation pension labelled as SP_a^i in the private budget constraint (3.5). The superannuation pension is defined as follows:

$$SP_a^i = \begin{cases} cr \times we_a^i(h - l_a^i), & \text{for } a \geq 61 \text{ and } l_a \neq h \\ 0 & \text{for } a \leq 60. \end{cases} \quad (3.11)$$

The justification of the model assumption dealing with post-payout SG contributions is that since July 2005, people who have reached the superannuation preservation age of 55 years could draw on their superannuation savings while still working. Thus, these post-payout contributions could be regarded as the so-called ‘transition to retirement’ pensions. Note that this superannuation pension represents labour supply incentives for older households and it allows for a direct interaction of superannuation with the age pension as long as households provide some labour supply.

3.5 The production sector

The production sector is represented by the aggregate producer, which produces a single output, Y_t , using the capital stock, K_t , and the labour input, L_t . The production technology is assumed to be described by a standard CES production function which takes the form

$$F(K_t, L_t) = \kappa \left[\varepsilon K_t^{(1-1/\sigma)} + (1 - \varepsilon) L_t^{(1-1/\sigma)} \right]^{1/(1-1/\sigma)}, \quad (3.12)$$

where κ is a productivity constant, ε represents the capital share and σ is the elasticity of substitution in production.

Following Hayashi (1982), capital formation is subject to adjustment costs. This implies that the net output is the difference between the gross output given by (3.12) and adjustment costs that are assumed to be quadratic in investment, i.e.,

$$Y_t = F(K_t, L_t) - 0.5\psi \left(\frac{I_t}{K_t} - (n + \delta) \right)^2 K_t, \quad (3.13)$$

where I_t represents investment, ψ is the adjustment cost coefficient, n is the population growth rate and δ denotes the capital depreciation rate. The adjustment cost function taken from Fehr (2000) indicates that adjustment costs occur only during the transition path to the other as the steady state investment rate equals to the sum of depreciation and population growth rates in the steady state equilibrium.

The aggregate producer maximises the present value of all future profit payments discounted at the world interest rate subject to the adjustment costs and the capital accumulation

equation, $I_t = K_{t+1} - (1 - \delta) K_t$. The first order conditions from the producer's profit maximisation problem are:

$$(1 + cr) w_t = F_{L_t} \quad (3.14a)$$

$$q_{t+1} = 1 + \psi \left(\frac{I_t}{K_t} - (n + \delta) \right) \quad (3.14b)$$

$$r q_t = F_{K_t} + 0.5\psi \left[\left(\frac{I_t}{K_t} \right)^2 - (n + \delta)^2 \right] + (1 - \delta)q_{t+1} - q_t. \quad (3.14c)$$

According to (3.14a), the producer demands labour until the wage rate inclusive of the SG contribution rate, $(1 + cr) w_t$, equals the marginal product of labour, F_{L_t} . Condition (3.14b) implies that the producer will invest until the marginal benefits, q_{t+1} , from an additional unit of capital in the next period amount to the marginal cost of acquisition and installation. The term q_t is also Tobin's q – capital price (Tobin, 1969). Equation (3.14c) represents the arbitrage condition that requires identical returns to financial and real investments. The left side of (3.14c) gives the return to financial investment of amount, q_t . The right side comprises the net return to capital and capital gains, $(1 - \delta)q_{t+1} - q_t$. The net return to capital includes the marginal product of capital, F_{K_t} , and reduction in marginal adjustment costs. There is no taxation at the corporate level.

3.6 The government sector

The government sector is represented by an inter-temporal public budget constraint. The expenditure side of the public budget constraint consists of government consumption, G_t , age pension expenditures and interest payments on net government debt, $r D_t$. The government collects revenues from income, consumption and superannuation taxation denoted as TR_t and it can also issue debt, D_{t+1} , in order to pay for its outlays. The public budget constraint can be written as

$$D_{t+1} = (1 + r) D_t + G_t + \sum_{i=1}^3 \omega_i \sum_{a=65}^{90} AP_{a,t}^i \mu_a - TR_t, \quad (3.15)$$

where $\sum_{i=1}^3 \omega_i \sum_{a=65}^{90} AP_{a,t}^i \mu_a$ is the cohort weighted average of age pension expenditures. The issuance of new debt, $D_{t+1} - D_t$, represents the path of government deficits.

The model assumes that the government maintains fixed ratios of government consumption to output and debt to output. To balance the public budget (3.15) with these fixed ratios, the consumption tax rate, τ_t^c , is adjusted accordingly. This implies that, even though government consumption is unproductive and generates no utility to households in this model, any reduction in the public outlays (e.g. lower age pension expenditures) and any increase in government revenues (e.g. higher income tax revenue) are passed onto households in the form of a lower consumption tax rate. Total tax revenue collected from households consists of the revenues from personal income taxation, consumption taxation and superannuation taxation, i.e., $TR_t = TR_t^Y + TR_t^C + TR_t^S$.

Personal income taxation The model incorporates progressive personal income taxation. Broadly, this means that high incomes are taxed at higher average income tax rates than low incomes. This is accomplished by applying different marginal tax rates to ranges of different income (tax) brackets. The Australian income tax system has five tax brackets and five marginal tax rates. The model implements the approximation function of the Australian personal income tax taken from Woodland (2005), to avoid the discontinuity of the actual tax function and thus to simplify the model computation. The approximation income tax, $T(y)$, that appears in the private budget constraint (3.5) as a function of the taxable income takes the form¹¹

$$T(y) = t_5(y) - t_5(yt_1) \exp \left(\sum_{i=1}^{M-1} -(0.1)^s v_s y^{s-1} \right), \quad s = 1, \dots, M-1, \quad (3.16)$$

where

$$t_5(y) = m_5(y - yt_5) + tax_5,$$

and where $v_s = (v_1, v_2, v_3, v_4)$ is a parameter vector, M denotes the number of tax brackets, yt_1 and yt_5 represent lowest and highest tax thresholds, m_5 is the top marginal tax rate and tax_5 is the tax payable at the top tax threshold. The revenue from personal income taxation, TR_t^Y , is the average of income tax payments across households weighed by their intra-generational shares, ω_i and cohort shares, μ_a , and it is calculated as

$$TR_t^Y = \sum_{i=1}^3 \omega_i \sum_{a=21}^{90} T(y_{a,t}^i) \mu_a. \quad (3.17)$$

Superannuation taxation Superannuation taxes in the benchmark steady state are imposed on contributions and fund investment earnings. Total revenue from superannuation taxation, TR_t^S , is then

$$TR_t^S = \tau^{sc} \sum_{i=1}^3 \omega_i \sum_{a=21}^{60} cr \times w_t e_a^i (h - l_{a,t}^i) \mu_a + \tau^r \sum_{i=1}^3 \omega_i \sum_{a=21}^{60} r \times SA_{a-1,t-1}^i \mu_a. \quad (3.18)$$

Consumption taxation The consumption tax is linear and aims to represent the Australian Goods and Services Tax [GST]. The consumption tax rate that adjusts endogenously to balance the public budget constraint (3.15) is computed as

$$\tau_t^c = \frac{G_t + \sum_{i=1}^3 \omega_i \sum_{a=65}^{90} AP_{a,t}^i \mu_a + (r - n)D_t - (TR_t^Y + TR_t^S)}{\sum_{i=1}^3 \omega_i \sum_{a=21}^{90} c_{a,t}^i \mu_a}. \quad (3.19)$$

3.7 The foreign sector

The model is a small open economy model with perfect capital mobility where the domestic interest rate, r , is pegged to the exogenously given world interest rate. Letting FA_t stand

¹¹The subscripts for household type, i , age, a , and time period, t , are omitted in the income tax function (3.16).

for the foreign asset holding at the beginning of time period t , the international budget constraint can be specified as follows:

$$FA_{t+1} - FA_t = TB_t + rFA_t, \quad (3.20)$$

where the left side of (3.20) represents capital flows and the right side is the current account comprising the trade balance, TB_t , and the interest receipts (payments) on foreign assets holdings (debt), rFA_t .

3.8 Competitive equilibrium

A competitive equilibrium in this stationary demographic environment consists of consumption tax rate, τ_t^c , balancing the government budget constraint, accidental bequests, B_t , optimal household allocations $\left\{ \left\{ c_{a,t}^i, l_{a,t}^i, A_{a,t}^i, y_{a,t}^i, \hat{y}_{a,t}^i, AP_{a,t}^i, SA_{a,t}^i \right\}_{a=21}^{90} \right\}_{i=1}^3$, factor demands K_t and L_t , wage rate w_t and capital price q_t and clearing conditions for capital, labour and goods markets such that:

- Given the wage rate and interest rate, households solve their optimisation problem; i.e. maximisation of expected lifetime utility expressed in (3.3) subject to the budget constraint (3.5) and time constraint (3.6).
- The producer maximises the present value of the future profit streams discounted at the exogenously given world interest rate, r , subject to the capital accumulation equation. This yields the first order necessary conditions given by (3.14a), (3.14b) and (3.14c).
- The government budget constraint (3.15) is satisfied with the consumption tax rate, τ_t^c , computed as in (3.19) and with the fixed ratios of G_t/Y_t and D_t/Y_t .
- Accidental bequests assumed to be equally redistributed to all surviving households are calculated as

$$B_t = \sum_{i=1}^3 \omega_i \sum_{a=21}^{90} (1 - s_a) [A_{a,t}^i + SA_{a,t}^i] \mu_a. \quad (3.21)$$

- The labour market clears in every t ; that is, demand for labour by the representative producer (i.e. labour input in production) equals the cohort weighted average of effective labour supply across households:

$$L_t = \sum_{i=1}^3 \omega_i \sum_{a=21}^{90} e_a^i (h - l_{a,t}^i) \mu_a. \quad (3.22)$$

- The capital market clears in every t , which implies that the market value of the capital stock plus public debt equals the sum of domestic total assets and foreign assets, that is

$$q_t K_t + D_t = \sum_{i=1}^3 \omega_i \sum_{a=21}^{90} (A_{a,t}^i + SA_{a,t}^i) \mu_a + FA_t. \quad (3.23)$$

- The goods market clears; the following resource constraint for the model small open economy is satisfied in every t (i.e. output equal to the sum of consumption, investment, government spending and trade balance):

$$Y_t = \sum_{i=1}^3 \omega_i \sum_{a=21}^{90} c_{a,t}^i \mu_a + I_t + G_t + TB_t. \quad (3.24)$$

As the model features no growth rate of technological progress, the subscript t above can be omitted because in the competitive steady state equilibrium, all macroeconomic variables, that are expressed as cohort weighted averages (i.e. per model capita) in our model, are constant in every time period.

4 Parameterisation of the model

To solve the model, numerical values have to be assigned to the parameters of the model. The values of these parameters are chosen to generate the benchmark steady state equilibrium that roughly corresponds with the actual macroeconomic data for the Australian economy in the financial year of 2004-05. Some parameters are taken from related literature (utility function parameters), some exactly match actual values in 2004-05 (pension sector parameters) and some are calibrated to reproduce calibrations targets (most of the production function parameters). The chosen values of the main parameters of the model are presented in Table 1.

Insert Table 1 here

Demographics The population growth rate of $n = 0.012$ is approximately the annual growth rate of the Australian population in the five year period ending in June 2005. The same population growth rate was chosen by Kulish et al. (2006). The conditional survival probabilities, s_a , are taken from the ABS (2005) life tables for males and the number of people born in the first time period, N_t , is set to one. As mentioned, the intra-generational shares for i household types, ω_i , are based on Fehr et al. (2008) who assume that 30 percent of each generation are low-income households, 10 percent are high-income households and 60 percent are middle-income households.

Utility function parameters The values of the utility function parameters are within the estimated ranges obtained from relevant empirical studies. Most studies estimate that the inter-temporal elasticity of substitution, γ , lies between 0.1 and 0.5. For instance, Ghez and Becker (1975) find to be 0.28 and MaCurdy (1981) between 0.1 and 0.45. We set γ to 0.3. There is far less empirical evidence on the intra-temporal elasticity of substitution, ρ . Ghez and Becker (1975) estimate ρ to be 0.83. The value of this parameter chosen in this paper is 0.9. The subjective rate of time preference, β^i , differs across the household types. It is set to 0.012 for middle-income households, to 0.017 for low-income households and to 0.007 for the high income type. This accounts for the fact that richer households tend to be more time patient and discount the future less than poorer households (Hurd, 1990). The

leisure distribution parameter, α , is set to be 1.6, which leads to a realistic life-cycle profile of average labour supply.

Production parameters The technology parameter, κ , is a scaling parameter and is calibrated to reproduce the gross wage rate of $w = 1$ in the initial steady state. The elasticity of substitution in production, σ , is calibrated to the exogenous interest rate of $r = 0.05$. The value for the target interest rate is based on empirical observations of the historical real rate of return on bonds and the historical real rate of return on equities in Australia. The depreciation rate of the capital stock, δ , is set to target the investment-output ratio of $I/Y = 0.258$. The capital share of $\varepsilon = 0.36$ is derived as follows. Using data from ANA in June 2005, the labour share of output was 0.57, capital share 0.32 and indirect taxes less subsidies 0.11. Assuming the last component of the income method of calculating GDP is zero, the capital share equals 0.36. The adjustment cost parameter of $\psi = 10$ is taken from Auerbach and Kotlikoff (1987).

Labour efficiency The labour efficiency (or earnings ability) profiles for the three income types of households vary by both their heights and shapes. The model incorporates the age-specific efficiency profiles that are based on the estimates from Reilly et al. (2005). Their estimated wage function is normalised such that the wage for a 20 year old middle-income household with no experience in the model is equal to one, that is,

$$\bar{e}_a^i = \exp \left(2.235 + 0.04 [a - S^i - 5] - 0.00067 [a - S^i - 5]^2 \right) / \exp(\bar{e}_{20}^i), \quad (4.1)$$

where S denotes years of schooling and a represents age. Normalisation of the wage function is performed to account for the fact that the estimates by Reilly et al. were obtained for year 1999. The three income types of households are assumed to attend different years of schooling. Low-income household have 10 years of schooling ($S^1 = 10$), middle-income 12 years ($S^2 = 12$) and high-income households 15 years of schooling ($S^3 = 15$). As Reilly et al. consider only workers aged 15 to 65, we assume that the wages after age 65 decline at a constant rate and reaches zero at age 90 the low- and middle-income households and at age 80 for high-income households. This assumption is made in order to avoid positive labour supply at very old ages.

The age-specific earnings ability, which is the full wage earned with all the time endowment allocated to work for each income class, $e_{a,i}$, is then given by

$$e_a^i = \xi^i \times \bar{e}_a^i \times \bar{w}, \quad (4.2)$$

where \bar{w} is the wage earned by a 20 year old average earner with full time endowment spent at work and ξ^i is the shift parameter. The term \bar{w} is based on Gruen and Garbutt's (2003) age pattern of average hourly wages for Australian males (i.e. \$16 for middle income male aged 20 years) and the full time endowment assumed to be 5460 hours per year, which corresponds to about 15 non-sleeping hours per day. As we normalise the time endowment to one and re-scale the model such that all monetary variables are expressed in units of \$100,000, \bar{w} is set to 0.8736 ($= \$16 \times 5460 \text{hours} / \$100,000$). Similar to Fehr et al. (2008),

the shift parameter is set to 0.3 for the low-income households, one for the middle-income households and three for the high-income households.

Government outlays and tax revenues In the benchmark steady state, we calculate the government consumption to output ratio that produces the consumption tax rate of $\tau^c = 0.1$, which corresponds to the Australian goods and services tax [GST] rate. The government debt to output ratio is set to zero that implies the balance government budget. The actual net government debt-output ratio was 0.014 with the government surplus of 1.5 percent of GDP in 2004-05 (Commonwealth of Australia, 2006). The ratio of $D/Y = 0$ assumed in the model can be justified by future fiscal projections in 2005 that suggested the complete elimination of the net government debt. The income tax function (3.16) taken from Woodland (2005) is approximated to the 2004-05 Australian personal income tax schedule. The values of the parameter vector are $v_i = (0.3174, 0.0877, -0.0784, 0.0167)$, the top marginal tax rate, $m_5 = 0.47$, the lowest income threshold, $yt_1 = 0$, the highest income tax threshold, $yt_5 = 70$, and the tax payable at the highest income threshold was $tax_5 = 18.612$.¹²

Age pension and superannuation The values of the age pension parameters are taken from Dale (2004) and were applicable in November 2004. The asset threshold is for non-homeowners as our model does not include housing. The superannuation taxes are imposed on contributions and fund earnings. The model abstracts from benefit taxation as the government abolished exit taxes for people aged 60 years and over in July 2007.

5 Benchmark steady state analysis

The simulation technique to solve for the steady state and the transition path is described in detail in Appendix A. The benchmark steady state [SS] solutions for the main variables are presented at the disaggregate household as well as macroeconomic levels.

5.1 Disaggregate household results

In a SS equilibrium, households of different ages behave exactly same as the single household of type i over the entire life-cycle. Households at every age choose how much to consume and how much time to devote to leisure and work. Resulting labour supply and the wage determine labour earnings, which together with investment income and the age pension represent total taxable income. The excess of after-tax income over consumption expenditures is saved and added to the stock of ordinary private assets. Households also accumulate superannuation assets that must be kept in the superannuation fund until age 60. At this age,

¹²The parameter vector, v_i , is estimated by nonlinear least squares. Following the description in Woodland (2005), a grid of equally spaced incomes in the range $[0, 100.5]$ and the corresponding income taxes in 2004-05 were generated. There are 202 observations for both variables - income and income tax, both expressed in units of \$1,000. The income tax, $T(y)$, is rescaled in the model to be expressed in units of \$100,000.

the superannuation savings are paid out and the superannuation assets accumulation ceases to exist.

Insert Figure 2 here

Figure 2 shows the model-generated and HILDA average life-cycle profiles of consumption expenditures, labour supply, labour earnings and total (financial) assets. The life-cycle consumption profile generated by the SS model simulation is hump-shaped (Figure 2a). The increasing part of the consumption profile is due to (i) the interest rate greater than the effective rate of discount and (ii) substitutability between consumption and leisure. At younger ages, high survival probabilities result in a low effective discount rate, which is below the exogenously given world interest rate. This implies an increasing instantaneous utility derived from consumption and leisure. Either consumption or leisure or both must increase for the utility to grow. However, because of declining survival probabilities, households discount future utility more heavily at older ages. Eventually, the effective discount rate exceeds the interest rate, leading to a falling instantaneous utility. In addition, the substitutability between consumption and leisure means that households work and consume more (less) when leisure is relatively expensive (cheap). Given the hump-shaped earnings ability profiles, labour supply and consumption profiles are hump-shaped while the age profile of leisure is U-shaped.

The actual age-specific consumption expenditures calculated from the HILDA survey are also hump-shaped, peaking earlier at age 51 but then they decline more rapidly compared to model consumption. It should be emphasised that the HILDA expenditure profiles are related to a household that changes its size over a life-cycle, which makes comparison with the model-generated consumption difficult. Adjusting for demographic factors would make the HILDA profiles flatter. Nevertheless, many empirical studies find that even after controlling for demographic factors there is a significant hump in life-cycle consumption; see, for example, Gourinchas and Parker (2002).

As depicted in Figure 2b, the average model household at age 21 allocates about 32 percent of the time endowment to work (i.e. about 1,750 hours worked per year or 33.5 hours worked per week), with the remaining time devoted to leisure.¹³ Labour supply increases until age 37, after which it starts decreasing mainly due to the falling earnings ability at older ages. Full retirement in the model occurs at age 73 when none of the three types of households is in the labour force. In fact, low- and middle-income households fully retire at age 65. The model-generated labour supply profile seems to slightly underestimate the average HILDA labour-supply data for males but it overestimates the HILDA “combined” data that also include lower labour supply of females.

There are two kinks in the consumption, leisure and labour supply profiles generated by the model, one at age 60 and the other at age 65. The first kink is due to the superannuation payout to low-income households that, as opposed to the other two households, are assumed to be liquidity constrained and cannot borrow to fund consumption early on. Consequently, these households increase their consumption and rapidly reduce working hours at age 60. The second kink arises from the commencement of means-tested age pension entitlements

¹³The actual hours worked per year are obtained by multiplying the displayed fraction of time spent working should with 5,460 non-sleeping hours of the actual annual time endowment.

at age 65. The age pension income test combined with progressive income taxation may lead to high effective taxation of additional private income earned. The prospect of high EMTRs makes consumption and labour supply relatively expensive compared to leisure – the reason of why consumption and labour supply fall at age 65 while leisure goes up to raise instantaneous utility.

The life-cycle model profile of average total assets in Figure 2d consists of ordinary private and superannuation assets. The stock of ordinary private assets is initially negative as middle- and high-income households at early ages borrow against future superannuation payout to fund their consumption excess (not plotted). In contrast, the stock of superannuation assets grows exponentially over the entire accumulation period. At age 60, the superannuation fund pays out the superannuation benefits as a lump-sum into households' private assets accounts and after that age, households draw down their ordinary private assets holdings to finance retirement consumption. The HILDA data points of average financial assets are below the model generated assets for most of the life-cycle. This is because the model assumes full maturity of the superannuation system – 40 years of the superannuation assets accumulation with nine percent SG contributions while the superannuation guarantee was introduced in 1992 with only three percent contributions initially.

Insert Figure 3 here

The model profile of gross labour earnings that is plotted in Figure 2c has a similar shape as the labour supply profile. The figure indicates that likewise the labour supply profile, the model average labour earnings are below the HILDA data for males and above the HILDA combined data due to lower salaries of females. Labour earnings represent the major component of total income for most of the average household's working life. The other two components of the model total income are investment income and the means tested age pension. As shown in Figure 3, the average household aged 65 years and over receives some age pension, which is lower initially due to the effective means test but it increases with age as private income and assets assessed under the means test for the top two income groups decline. The age pension becomes the major source of total income towards the end of life-cycle. Comparison of the age pension payments across the three income types reveals that low-income households get full age pension from age 65 onwards while middle-income households receive part age pension initially due to effective income test and high-income households that hold large assets are paid some age pension only advanced age pension ages.

5.2 Macroeconomic results

The main macroeconomic solutions to the benchmark SS and the comparison with the actual values in the financial year of 2004-05 are presented in Table 2. It is shown that the model with the chosen parameter replicates the Australian economy fairly well. The components of domestic aggregate demand are very close to their actual values presented in percent of GDP apart from the trade balance. The positive trade balance or external demand in the model is implied by the negative foreign assets in the calibration of the benchmark SS. The foreign assets (i.e. net international investment position) were largely negative; foreigners owned about 19 percent of Australia's capital stock in June 2005 (ABS, 2006). Negative

net foreign assets generate a positive trade balance in the benchmark SS equilibrium for the economy on a dynamic efficient growth path ($r > n$), i.e., $TB = (n - r)FA$, while the Australian trade balance is negative.¹⁴ This indicates that the Australian economy is not in a long run steady state equilibrium.

Insert Table 2 here

The government indicators presented in percent of GDP are slightly greater than the actual data except for the assumed zero government surplus in the model. The significant difference between the model and actual revenues from superannuation taxes can be explained by the full maturity of the superannuation system in our OLG model. The government consumption to output ratio (G/Y) generated by the model to reproduce the consumption tax rate of $\tau^c = 0.1$ is very close to the actual G/Y in 2004-05. The capital-output ratio (K/Y) and investment rate (I/K) are almost identical to their actual values in Australia.

5.3 Sensitivity analysis

None of the taste and production parameters presented in Table 2 was econometrically estimated using Australian data. As mentioned, some of the parameters are taken from relevant literature and some are calibrated to the calibration targets. For this reason, this subsection explores implications of alternative parameterisations of the model for the steady state equilibrium. The values of the main parameters are changed individually and the simulation results for some variables and ratios in the long run are displayed in Table 3.

Insert Table 3 here

In sum, the sensitivity analysis indicates that the solution to this open economy OLG model is driven mainly by changes in effective labour supply across households. The resulting labour input determines long-run changes in the capital stock and output. Provided that a policy shift or a shock does not alter the wage rate, the capital stock in the long-run steady state equilibrium must exactly follow the long-run change in the labour input to hold the capital-labour ratio constant.

A higher value of the inter-temporal elasticity of substitution, γ , means a greater substitutability of the current utility for any future utility, leading to a larger accumulation of domestic total assets. The overall impact on labour supply is negative as a decline in older households' labour supply more than offsets longer working hours supplied by young cohorts. Some of the capital stock is exported abroad, the foreign assets holding increases ($FA/K > 0$) and the trade balance deteriorates ($TB/Y < 0$). The consumption tax rate, τ^c , falls because of higher revenues from personal income and superannuation taxation. On the other hand, a higher value of the subjective time preference parameter, β , lowers the domestic total assets as households become more time impatient, wanting to have more consumption and leisure at early ages rather than later on.¹⁵ A higher labour input implies larger capital stock. The increase in the capital stock is funded by foreigners, which is shown

¹⁴In the steady state, the international budget constraint (3.21) becomes $nFA = TB + rFA$ because of the steady state requirement for foreign assets, $\Delta FA = 0$.

¹⁵Only the value of the subjective rate of time preference for the middle-income household, β^2 , is changed.

by lower FA/K . The consumption tax rate increases to offset lower income tax revenues.¹⁶

Higher elasticity of substitution in production, σ , leads to capital deepening (greater K/L) and a higher wage rate. Domestic total assets are also up but by less than the increase in the capital stock (see high K/Y), which results in capital imports, larger foreign debt and improving trade balance. The consumption tax rate increases due to higher government consumption even though the revenues from personal income and superannuation taxation have gone up. Similar implications are caused by a higher value for the capital share, ε . The capital depreciation rate, δ , that is calibrated to reproduce the ratio of $I/Y = 0.258$ in the benchmark steady state, is quite high. Using $\delta = 0.052$ that corresponds to the depreciation rate of the Australia's aggregate capital stock has a similar effect on the displayed variables as the changes in σ and ε . However, the consumption tax rate falls because of the increase in income and superannuation tax revenues and as the decline in age pension expenditures outweigh the increase in government consumption.

A higher value of the world interest rate, r , increases domestic total assets and leads to foreign exports and worsening trade balance. K/Y falls as the capital stock declines more than output. Any increase in the population growth rate, n , implies a higher steady state investment rate, which is $I/K = n + \delta$. Labour, capital stock, output and foreign debt are also higher while the consumption tax rate falls slightly as a result of higher n .

6 Dynamic simulations of pension policy changes

In this section we present the simulation findings of the following policy changes to the existing means test of the Australian age pension: (i) the complete abolition of the means test, (ii) 50 percent reduction in the income taper rate and (iii) the removal of the age pension from the income test. The simulated age pension policy changes are hypothetical but all have been debated amongst policy makers, academics and industry experts. In fact, the income taper rate was reduced from 50 percent to the current 40 percent rate in year 2000. The intergenerational, welfare and macroeconomic implications of these parametric pension policy changes are discussed below.

6.1 The means test abolition

This policy simulation aims to demonstrate the implications of eliminating both the income and assets tests of the age pension. In this policy scenario, the three income types of households aged 65 years and over receive the universal age pension (i.e. the maximum age pension, p) regardless of their private incomes and assets. Thus, the only requirement to get the age pension is reaching the age pension eligibility age of 65 years.

¹⁶Note that the utility function parameters have no impact on the wage rate as its value is implied by the exogenous interest rate and production function parameters in the steady state.

6.1.1 Intergenerational implications

Intergenerational implications refer to policy effects on households of different ages (i.e. different cohorts of households) over their remaining life-cycle. For ease of exposition, the intergenerational implications of the means test abolition are plotted only for the middle-income households and for three different cohorts – aged 21 years (representing young people), 65 and 70 years (representing older people) at the time of the reform. The effects of this policy on low- and high-income households are not plotted due to the space constraint but they are briefly discussed.

Insert Figure 4 here

Figure 4a clearly shows that the labour supply incentives of the means test removal outweigh the income effect of higher age pension payments as the cohorts of middle-income households aged 21 and 65 at the time of the reform provide some work at age pension ages and significantly postpone their retirement. For example, the young cohort still works about 820 hours per year at age 65 (i.e. 15 percent of time endowment) and postpones full retirement by about seven years relative to the benchmark SS simulation with the means tested age pension. Thus, the simulation results support the argument that the existing means-tested age pension provides a disincentive for some older people to supply labour. The positive labour supply effect of the means test removal on the already retired cohort aged 70 years indicates that some age pensioners (e.g. those affected by the existing means test) may return to workforce as they would no longer face high EMTRs.

The universal age pension policy has positive implications for retirement consumption with the middle-income cohorts aged 65 and 70 years increasing their consumption (Figure 4b). This is because the means test removal makes leisure more expensive, which generates higher consumption and labour supply. The young cohort also consumes significantly more after the commencement of the universal age pension but before age 65, its net consumption falls relative to the benchmark SS simulation due to an increase in the consumption tax rate that funds higher government expenditures on the universal age pension.

The intergenerational policy impacts on consumption and labour supply for low- and high-income households vary considerably from those for the middle-income households. Low-income households that were already receiving full age pension consume less as a result of the means test removal because of a higher consumption tax rate they face (discussed with respect to macroeconomic implications). Older cohorts of the high-income households spend more on consumption due to universal age pension payments while younger high-income cohorts' consumption is lower over the most of the life-cycle because the increased consumption tax rate more than offsets the gains from the universal age pension. Labour supply of low-income households is hardly affected, but high-income households supply less working hours due to the pure income effect of the universal age pension.

6.1.2 Welfare implications

The welfare implications are assessed on the basis of equivalent variations for generations of type i households born at date g . The equivalent variation for a particular generation is

defined as the percentage increase in this generation’s wealth in each year of remaining life needed in the benchmark scenario to produce the realised remaining lifetime utility in the reform scenario. Given the homogenous property of the utility function (see Auerbach and Kotlikoff, 1987, p.87), these increases in generations’ wealth are identical to the proportional increases in consumption and leisure, which would make them in the benchmark scenario as well off as in the reformed scenario. The needed increase or decrease in percent of initial resources for generation g of type i is computed as

$$W_g^i = \left[\left(\widehat{U}_g^i / \widetilde{U}_g^i \right)^{1/(1-1/\gamma)} - 1 \right] \times 100, \quad (6.1)$$

where \widehat{U}_g^i is the value of the remaining lifetime utility after the policy change and \widetilde{U}_g^i is the value of the remaining lifetime utility in the benchmark scenario. For example, a positive value of $W_g^i = 1$ represents a welfare gain; namely, that this generation would need one percent more resources in the benchmark scenario to be as well off as under the policy change.

Insert Figure 5 here

Figure 5 shows the welfare effects of the means test removal for generations of low-, middle- and high-income households. Low-income households that were already receiving the full age pension over the entire retirement period experience welfare losses during the transition and in the long-run because of (i) the higher consumption tax rate that increases to fund the universal age pension payments and (ii) the lower wage rate that falls due to higher employment. Similarly, very old cohorts of middle-income households on the full age pension are negatively affected by the resulting higher consumption tax rate that reduces their net consumption. On the other hand, most of middle-income cohorts alive during the transition gain in utility, measured in wealth equivalent, because of significantly higher consumption at age pension ages, even though these generations work longer hours at older ages. For example, the middle-income cohort aged 65 years at the time of the means test abolition achieves an almost two percent rise in welfare. High-income households of early age pension ages at the time of the reform gain the most as the universal pension payments allow them to consume considerably more and work less. The long-run welfare implications (i.e. welfare of future born generations) are small, slightly positive for high-income households and negative for middle-income households, mainly reflecting high discounting of higher retirement consumption by future born generations.¹⁷

6.1.3 Macroeconomic implications

The macroeconomic implications of the means test removal are presented in Table 4 as the percentage changes in the main model variables from the benchmark steady state labelled as

¹⁷It takes about 100 years for the economy to reach a new steady state. However, because of relatively stable consumption tax rate over the transition path, the welfare implications for generations born 40 years after the policy change (presented here as long-run welfare effects) are approximately same as the implications for future generations born 100 years after the policy is implemented.

‘Initial SS’. The following discussion involves the impacts of this policy change on the labour market, capital accumulations, output market and government indicators.

Insert Table 4 here

Labour market The means test abolition has a positive impact on employment, which on impact increases by 0.209 percent compared to the benchmark SS. This indicates that the increase in labour supply of some older generations of the middle-income households outweighs the decrease in labour supply of the middle-income generations younger than 65 at the time of the policy change and high-income households that experience the income effects of universal age pension payments. In the subsequent years, aggregate labour supply keeps on rising and converges to a new SS value, which is 1.116 percent higher than in the benchmark SS. The changes in aggregate labour supply determine the effect on the gross wage rate, w , which is negative during the transition. However, in the long-run, the wage rate is determined by the world interest rate and the parameters of the CES production function in this open economy model. Because of no change in the exogenous world interest rate and production parameters, the wage rate returns to its initial SS value in the long run.

Assets and capital accumulations As a result of the means test abolition, aggregate domestic assets (i.e. sum of aggregate private and superannuation assets) decline over the entire transition path. This is because the decrease in total assets of generations of all three income classes younger than 65 years outweighs the increase in total assets of older middle- and high-income households. The older middle-income households accumulate larger assets as they earn some labour income and because they are paid the universal age pension. The older high-income households earn less from working but their retirement income increases due to the universal pension payments. In the long run, domestic assets decline by 3.282 percent. In contrast with aggregate domestic assets, the capital stock increases over the entire transition as the capital price, p_k , (i.e. marginal benefits of a purchase of addition capital) is positively affected by the means test removal. The increased capital stock is financed partly from abroad by capital imports, which leads to larger foreign debt. The foreign assets fall by 19.635 percent in the new steady state. In other words, this policy leads to an increase in foreign debt from 19 percent of the capital stock in the initial steady state to almost 23 percent of the capital stock in the new steady state.

Goods market The impact of the means test abolition on output (i.e. GDP) is positive; output increases because of higher labour and capital. The largest component of domestic demand, consumption goes up as older generations of middle- and high-income households consume more. Long-term consumption is about 0.45 percent higher than benchmark SS consumption, reflecting higher consumption of older middle- and high-income households that is enough to offset reduced consumption of low-income households and of younger middle- and high-income households. Investment demand expands as investors expect a positive net return on capital and government consumption increases, exactly following the

percentage changes in output. In the long run, the trade account improves because output exceeds domestic demand.¹⁸

Government indicators The government budget expands, with age pension expenditures up by 22.548 percent when the means test is abolished. In other words, age pension expenditures increase from the benchmark 3.62 percent to 4.39 percent of GDP. Because of the model assumption of stationary demographics, this age pension increase is constant over the entire transition path. In the long-run, total government expenditures are higher by 4.628 percent due to increased government consumption and larger age pension expenditures. On the income side of the government budget, the revenue from income taxation increases gradually because of the higher universal age pension that is a component of taxable income. The impact on superannuation taxation is negligible while consumption tax receipts are up by 14.317 percent in the long-run. The two sources of higher consumption tax revenues are greater consumption and the consumption tax rate that has to rise to finance the increased age pension costs. In particular, the consumption tax rate increases by 12.141 percent on impact and by 13.81 percent in the long-run - from 10 percent in the benchmark SS to 11.38 percent in the new SS.

6.2 50 percent reduction in the income taper rate

In this simulation we reduce the existing income taper rate of $\theta = 40$ percent by 50 percent to a new rate of 20 percent. All the other age pension parameters stay unchanged. The motivation for this policy change is that a lower income taper rate reduces EMTRs. Thus, this policy provides a greater incentive for the elderly to work. It can be shown that the income taper rate of 20 percent instead of the existing 40 percent rate would generate maximum EMTR in 2007-08 of 65.2 percent, which is lower than the 73.9 percent maximum EMTR recorded in Figure 1.¹⁹ In addition to lower EMTRs, the reduced income taper rate would increase the maximum private income that the elderly could earn and still receive some age pension.

6.2.1 Intergenerational implications

Low-income households are not directly affected by this policy change because the means test does not bind for them, implying that they were already paid the full age pension prior to this policy change. Therefore, life-cycle consumption and labour supply of this income group are hardly changed. For the most of the age pension eligibility period, high-income households are assets tested. Only at some older ages when their assets fall significantly, the income test becomes to bind for high-income households. Over that short period, these high-income households gain directly in terms of a higher age pension due to the reduction

¹⁸Give the steady state condition, $TB = (n - r)FA$, the long-run percentage change in the trade balance has to be of the same value with the opposite sign as the percentage change in foreign assets in the long run.

¹⁹This maximum EMTR is calculated as follows: the new taper rate of 20 percent + (30 percent personal income tax rate + SATO taper rate of 12.5 percent + LITO taper rate of 4 percent + 10 percent reduction rate of the reduced Medicare levy) \times 80 percent of marginal income.

in the income taper rate. However, life-cycle behaviour of high-income households is also hardly changed. Because of the minimal impact on low- and high-income households, the intergenerational implications for labour supply and consumption are plotted only for middle-income households and as in the case of the means test removal, only the effects on middle-income cohorts aged 21, 65 and 70 years at the time of the reform are graphically illustrated in Figure 6.

Insert Figure 6 here

The middle-income cohorts aged 21 and 65 years when the policy is adopted work longer hours at age pension ages, postpone their retirement and consume more from age 65 onwards. The oldest cohort that already retired re-enters the labour force and increases its consumption over the remaining lifetime. This is because these generations whose age pension was reduced under the income test face lower EMTRs as a result of the reduction in the income taper rate. Recall that the income taper rate functions as an implicit tax rate. The EMTRs are still considerably greater than under the complete means test abolition, which leads to lower labour supply and consumption increases compared to the policy change of the means test removal.

6.2.2 Welfare implications

Figure 7 depicts the intergenerational welfare implications of the 50 percent reduction in the income taper rate for the three income groups of households.

Insert Figure 7 here

The welfare effects on low-income cohorts are small as none of these generations is directly affected by the income taper rate reduction. These generations are influenced only by general equilibrium effects on the consumption tax rate and the gross wage rate and also through redistribution of accidental bequests. High-income households receive some age pension at very old ages because of a rapid drawdown of their ordinary private assets. Falling private assets eventually lead to the age pension being means tested under the income test and that is when these households benefit directly from this policy change. The first high-income cohorts for which the income test binds is the cohort aged 81 years at the time of the reform (i.e. born 60 years prior to the policy change). As shown, utility of this high income cohort, measured in wealth equivalent, increases by about 0.5 percent. Similarly to the means test removal, the winner of this policy change in terms of welfare amongst middle-income generations is the generation that just becomes eligible for the age pension (i.e. aged 65 years) when this policy is implemented, gaining about 0.9 percent of initial wealth. In the long-run, the welfare of middle-income households increases slightly by about 0.1 percent, indicating that the gains from larger age pension payments more than offset negative effects of the higher consumption tax rate. Interestingly, the implications for the long-run welfare of low-income households that are not directly affected by this policy change are positive. Even though these future-born low-income households face a higher consumption tax rate, they benefit in terms of welfare due to higher accidental bequests.

6.2.3 Macroeconomic implications

Table 5 reports the macroeconomic implications on impact, during the transition as well as in the long run for the labour, capital and goods markets and government indicators from the 50 percent reduction in the taper rate of the age pension income test.

Insert Table 5 here

Labour market The labour input is positively affected by this policy change, rising almost in every year of the transition path to the new steady state. Higher aggregate labour supply comes solely from middle-income households that work longer hour at early age pension ages as the income taper rate reduction lower disincentives for these households to work. In the long-run, the labour input is about 0.54 percent greater than the initial SS labour supply. The positive impact on the overall labour supply causes the gross wage rate to fall below that in the initial SS, which in the long-run, returns back to its initial value as none of the production function parameters and the exogenous interest rate were changed.

Assets and capital accumulations The impacts on aggregate domestic assets are very small, suggesting that greater assets holdings of older, middle-income generations roughly offset lower assets accumulations of younger cohorts. The stock of aggregate domestic assets falls by less than 0.1 percent in the long-term, implying a negligible impact on long-run aggregate saving. The capital stock increases over the entire transition path because of the positive effects of this policy on the capital price. Investors anticipate higher net rate of return on capital and thus, investment demand expands. As a consequence, the capital stock goes up. The capital increases, however, are funded by foreigners, implying worsening in the foreign assets position. The long-run foreign assets decline by 3.15 percent, which is significantly less than the decline in the case of the means test removal policy.

Goods market The higher capital and labour inputs generate positive implications for output, which increases by 0.21 percent on impact and 0.54 percent in the long-run. Aggregate consumption is also positively affected by this policy change mainly because of higher consumption spending by older, middle-income households. The long-run consumption is about 0.432 percent greater than in the initial SS. Investment increases as the capital price is higher, which indicates expectations of greater net returns on capital. The trade account balances domestic demand and output. In the long-run, output increases more than domestic demand and the trade balance improves.

Government indicators The reduction in the income taper rate increases the age pension expenditures, but only by 4.05 percent, which is a considerably smaller increase compared to the age pension costs under the complete abolition of the means test removal. Greater age pension costs and government consumption that follows the percentage changes in output generate higher total government expenditures, which are up by 1.07 percent in the long run. On the revenue side of the government budget, the income tax receipt increases over the entire transition because of higher taxable incomes of older middle-income and high-income

households. The superannuation tax revenue falls slightly due to lower superannuation assets accumulation of all the three income-type households. The last source of the government receipts - consumption tax revenue - is higher than in the initial SS, which is caused by the positive effects of this policy change on aggregate consumption and the consumption tax rate. The consumption tax rate, however, increases only by 2.07 percent in the long-term compared to the long-run increase of 13.81 percent when the means test is abolished.

6.3 Labour earnings removal from the income test

The simulation of the third hypothetical policy change to the age pension means test examines the intergenerational, welfare and macroeconomic impacts of the removal of labour earnings from the income test. In this age pension policy change, labour earnings of households of each income type i aged 65 years and over are no longer assessed under the means test but eligible households (i.e. households aged 65 years and over) are still means tested with respect to their investment income or accumulated assets.

6.3.1 Intergenerational implications

The intergenerational implications for labour supply and consumption of middle-income households (i.e. labour supply and consumption impacts on cohorts aged 21, 65 and 70 years at the time of the reform over their remaining lives) are plotted in Figure 8.

Insert Figure 8 here

Similarly to the means test removal, this policy change is expected to increase labour supply of the age pensioners affected by the existing income test, as they would no longer be penalised by high EMTRs for working beyond the age pension age. This expectation is supported by the simulation results that indicate that all three cohorts of middle-income households, that are means tested under the income test prior to the policy change, supply some labour at the age pension ages (Figure 8a). Moreover, the cohorts work longer hours and retire later than in the policy simulation of the means test abolition. The young middle-income cohort postpones full retirement by 10 years and the cohort 65 years at the time of the reform by about 8 years relative to the benchmark SS scenario. The results not only confirm that the means test of the age pension discourages some age pensioners from part-time work but also suggest that this policy change provides a greater incentive for some older people to supply part-time work than if the means test was removed completely. A possible explanation is that under the labour earnings removal policy, middle-income households are still means-tested with respect to their investment income. The resulting lower age pension payments compared to the universal pension policy generate a relatively weaker income effect of the labour earnings removal policy on labour supply of middle-income households.

Figure 8b shows positive impacts on life-cycle consumption for all three middle-income cohorts at older ages, but the consumption increases are of lower magnitude relative to the means test removal policy with higher age pension payments. In contrast to the means test removal, consumption of the young middle-income cohort prior to age 65 is hardly changed as the impact on the consumption tax rate is initially minimal.

As a result of this age pension policy, low- and high-income households hardly change their behaviour. This is because of the small impact on the consumption tax rate initially and no direct effects of this policy on the two income groups in terms of changes in their lifetime assets as low-income households fully satisfy the means test while high-income households are means tested against their assets at early age pension ages.

6.3.2 Welfare implications

The welfare implications graphically illustrated in Figure 8 reveal that older cohorts of all three income groups are positively affected by this hypothetical policy change because of a lower consumption tax rate in the initial years of the transition (see the macroeconomic implications for explanation). The middle-income households directly affected by this policy change work longer hours at older ages or re-enter the labour force as their labour earnings are no longer income tested and their retirement consumption increases. Some cohorts of this income group gain in welfare as higher consumption at older ages outweighs the increases in old age labour supply and the rising consumption tax rate. The winner of this policy change is the middle-income generation that just reach the age pension eligibility age of 65 years when this policy is adopted, gaining about 0.5 percent in initial resources. However, the long-run welfare of middle-income households declines relative to the benchmark SS as the fall in discounted leisure exceeds in absolute terms the increase in discounted consumption contributing to lifetime utility. Future born generations also face the increasing consumption tax rate, which is the reason behind the falling welfare of low- and high-income households. In the long-run, the welfare declines by about 0.18 percent for high-income households and by 0.3 percent for low-income households.

Insert Figure 8 here

6.3.3 Macroeconomic implications

The macroeconomics implications resulting from the labour earnings removal from the income test of the age pension are reported in Table 6.

Insert Table 6 here

Labour market The implications of this policy change for aggregate labour supply are positive, with the labour input increasing over the entire transition path. On impact, employment is up by 0.317 percent. Labour supply of middle-income generations at early age pension ages increases significantly as their labour income no longer reduces their age pension payments. As mentioned, the other two income groups are not directly affected and their labour supplies hardly change. The labour-supply incentives of this policy for the middle-income households of the age pension ages are even stronger than in the means test removal scenario as these households are still income tested against their investment income and, therefore, receive a lower age pension which acts as a supplement of private income. Higher working hours of older middle-income households lead to greater overall employment. In the subsequent years, employment continues to grow and in the long run, it reaches a new

SS value which is about 1.76 percent above the initial SS labour supply. Given the positive impact on the overall labour supply, the gross wage rate falls below that in the initial SS. As in the simulation of the means test abolition and the reduction in the income taper rate, the gross wage rate returns to its initial SS value in the long-run.

Assets and capital accumulations The impacts of this policy change on aggregate domestic assets are largely negative as both superannuation and ordinary private assets decline. The long-run stock of aggregate domestic assets falls by 6.495 percent, indicating lower household saving in the long-term. The decline in superannuation assets is caused by the lower wage rate and labour supply of the middle-income households aged 60 and younger (i.e. those households accumulating superannuation assets). Ordinary private assets fall as households younger than 65 years earn lower income and have higher gross consumption expenditures that include consumption taxes. On the other hand, the impacts on the capital stock are positive, with the long-term capital up by 1.76 percent. The negative difference between domestic assets and the value of capital implies falling foreign assets, which indicates capital imports from abroad. The value of foreign assets declines by 36.01 percent in the long run.

Goods market As a result of the labour earnings removal from the income test, output increases by 0.201 percent on impact. As both labour and capital inputs keeps on rising, output grows over the entire transition and converges to the new SS value of 1.76 percent higher than the initial SS output. Private consumption initially jumps by 1.387 percent, caused entirely by higher consumption of the middle-income generations of the age pension ages. In the subsequent years of the transition, overall consumption declines relatively to the immediate impact because of a rising consumption tax rate and its negative impact on disaggregate household consumption of all three income groups. The long-run consumption is still about 0.418 percent greater than in the initial SS. The second largest component of domestic demand, investment goes up due to the positive impact of this policy change on the capital price. As domestic demand initially increases more than output, the trade balance deteriorates. This reverses after 20 years when output exceeds domestic demand due to declining private consumption, implying improvements in the trade balance.

Government indicators Probably the most significant difference between the three age pension policy changes simulated in this paper is the impact on overall costs of the age pension to the government. While the means test abolition policy increased the age pension costs by 22.548 percent, this labour earnings removal policy initially reduces the age pension expenditures because of higher assessable income (i.e. investment income of middle-income households aged 65 years and over assessed under the income test). Because assessable investment income falls over the transition period, government spending on the age pension goes up and in the long run it is 1.245 percent higher than in the initial SS. The total government expenditures increase by 1.67 percent in the long-term, reflecting also higher government consumption. The impacts on tax receipts from income and superannuation taxation are minimal. The revenue from consumption taxation goes up initially due to higher

private consumption and later on also because of the higher and increasing consumption tax rate. The consumption tax rate declines by 0.75 percent on impact but the long-run consumption tax rate is up by 5.04 percent. Put it differently, as a result of the labour earnings removal from the income test the consumption tax rate increases from 10 percent in the initial SS to 10.5 percent in the new SS.

7 Concluding remarks

This paper applies a computable OLG model to simulate policies that reflex the Australian pension rules. The model demonstrates that the existing means-tested age pension provides a strong disincentive for older middle-income households to work. The numerical simulations of all three pension policy changes show that generations of middle-income households work longer hours at older ages and delayed their retirement as the penalty of higher EMTRs for working beyond the age pension age is completely eliminated (in case of the policies of the means test abolition and the labour earnings removal from the income test) or significantly reduced (in case of the policy change of the 50 percent reduction in the income taper rate). Low-income households for which neither income test nor assets test binds and whose productivity at older ages is very low are not affected by the pension policy changes directly, but only through the general equilibrium impact on the consumption tax rate, the gross wage rate and the size of accidental bequests. The same holds for high-income households under the policy of the labour earnings removal from the income test. This is because these households are assets tested at the early age pension ages and thus, any changes to the income test are irrelevant. The means test removal, however, generates the pure income effect on high-income households, reducing their labour supply. Similar effects on the labour supply of the elderly were found by Friedberg (2000) who finds a significantly positive impact of the earnings test removal in the US on hours worked and earnings of those individuals at or near the earnings test threshold but a negative effect on labour supply of more affluent elderly.

The most effective of the simulated age pension policy changes to increase labour supply of some older Australians is the removal of labour earnings from the income test while the means test abolition delivers larger retirement consumption and welfare gains for the affected households. This is because the means test abolition results in higher age pension payments relative to the age pension payments received under the labour earnings removal from the income test with the eligible households still means tested against their investment income or assets. The costs of the complete means test removal to the government are significantly greater than the age pension expenditures arising from the other two pension policies. In reality, government expenditures on age pensioners would be higher than simulated by the model because many supplementary payments, services and concessions (e.g. pensioner concession cards) are paid only to recipients of the age pension or similar age-related payments.

A desirable extension of the model would be to implement non-stationary demographics with the increasing share of older households in the total population in future years. The present model assumes stationary demographics with the model population growing at a constant annual growth rate and with constant population age distribution. However, be-

cause of population ageing, the growth rate of population is expected to decline and the proportion of those aged 65 years and over is projected to increase significantly in the next 50 years (Productivity Commission, 2005). The macroeconomic implications of population ageing, if implemented in the model, for the simulated age pension policies are likely to be positive in terms of higher labour supply, consumption and output. On the other hand, population ageing would significantly increase government expenditures on the age pension as a result of the means test abolition.

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A Appendix - Solving the model

We use the GAMS software to solve for the steady state [SS] equilibrium and the transition path. Our algorithm applies the iterative computational technique - the Gauss-Seidel method - suggested by Auerbach and Kotlikoff (1987) that initially treats some endogenous variables as exogenous. In particular, the following steps are carried out to solve for the benchmark SS of our open economy OLG model:

1. Guess the accidental bequest, B , the consumption tax rate, τ^c , and the labour input, L .
2. Given the exogenous world interest rate, r , and the guessed value for L , solve for the market clearing wage rate, w , capital stock, K , and output, Y , using equations (3.14a), (3.14c) and (3.12) (recall that there are no adjustment costs in a steady state and the price of capita equals one).²⁰
3. Given the exogenous world interest rate, r , the wage rate, w , and the guesses of B and τ^c , solve the household optimisation problem - maximisation of the lifetime utility function (3.3) subject to budget constraint (3.5) and leisure constraint (3.6) - to obtain solutions for disaggregate consumption, labour supply and assets of each income group (recall that in a SS equilibrium, every household behaves in the same way as the single household optimising over its entire life-cycle). The household optimisation problem is solved directly in GAMS software using a DNLP solver called CONOPT. An advantage of using GAMS is that it can handle the inequality time (or retirement) constraint, $l_a^i \leq h$, which implies that we do not have to guess the shadow wage that becomes positive only when households retire.
4. Given the solution for the household optimisation problem, update guesses of B , τ^c , and L using expressions (3.21), (3.19) and (3.22).
5. Repeat steps 2 through 4 until the guessed variables equal their solution from the previous iteration.
6. Calculate foreign assets as the difference between the values of the capital stock and domestic assets using (3.23) and derive the trade balance from (3.24).

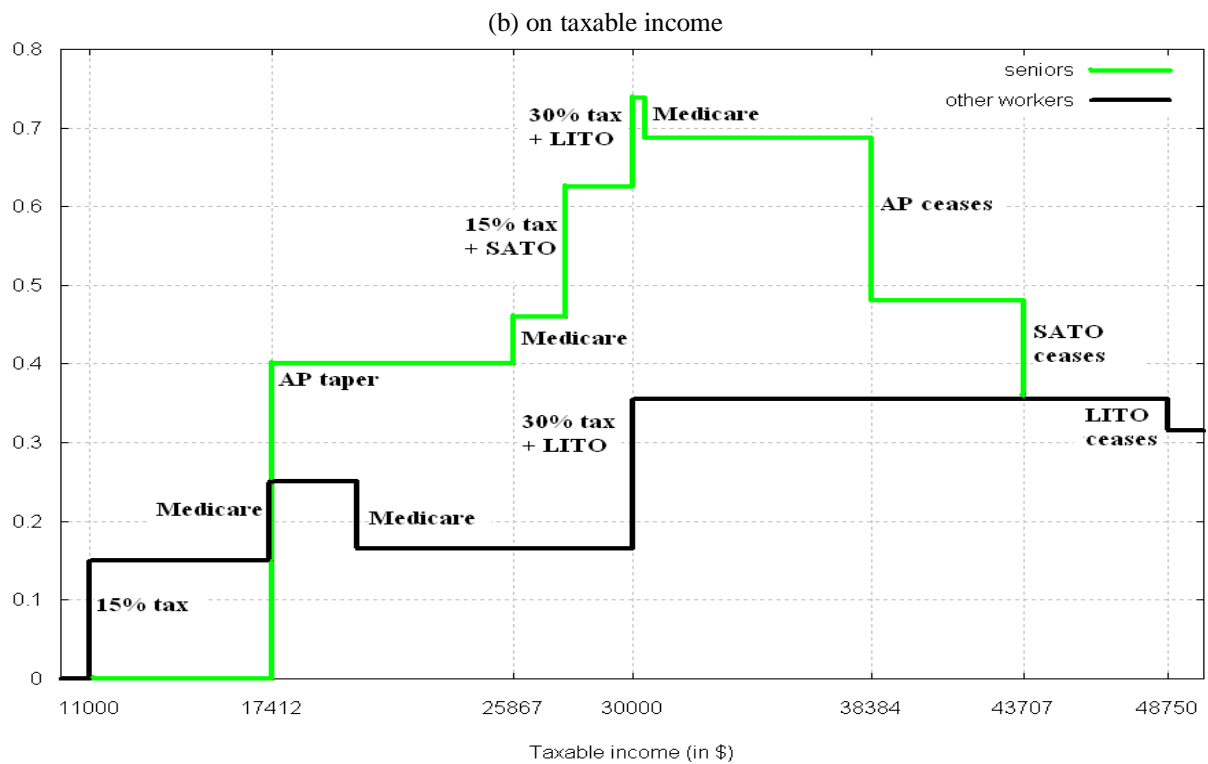
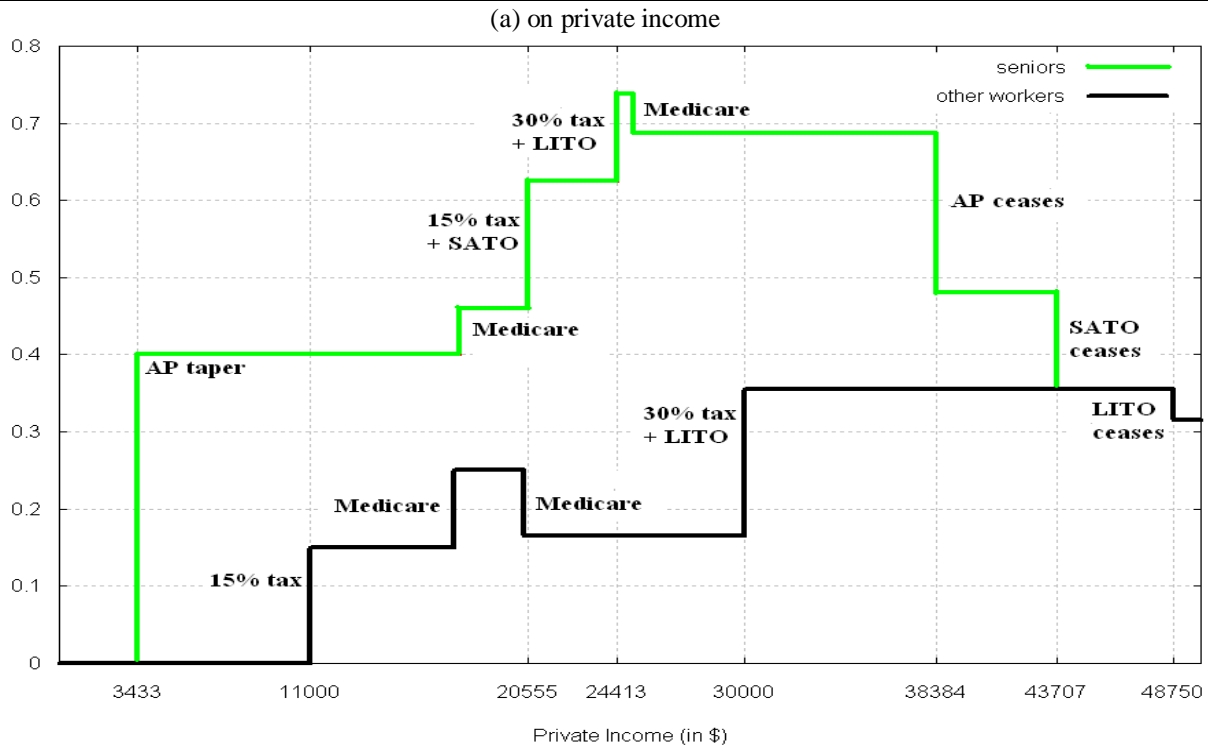
Computing the transition path from one SS equilibrium to another involves the same steps. However, there are the following two differences that make the computation of the transition path a bit more complicated compared to solving the steady state:

- Capital adjustment costs can occur during the transition path. This implies that the capital price (Tobin's q), the wage rate as well as the capital-labour ratio can differ from their benchmark SS values.

²⁰In fact, in a steady state of this small open economy model, the wage rate, w , can be expressed as a function of the exogenous interest rate, r , and the production function parameters. So one can only guess B and τ^c and solve the optimisation problems for the three income types of households.

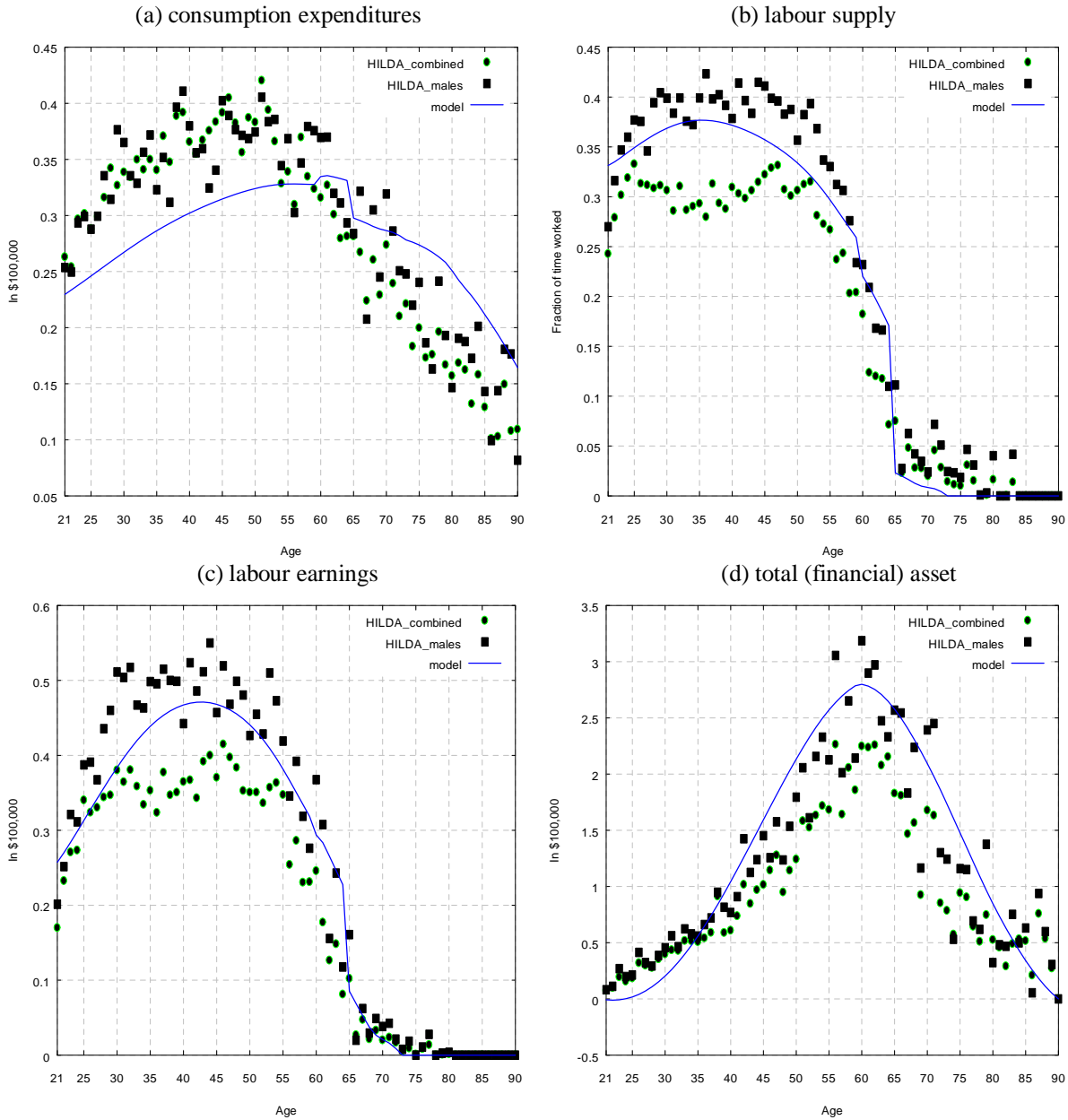
- On the household side, the generations of the three income classes alive at the time the policy change is adopted must be treated differently from the SS simulation. At the time of the policy change, existing generations solve their optimisation problems again but over shorter lifetimes given their ordinary private and superannuation assets accumulated prior to the policy change. The initial assets for these generations are obtained from the benchmark SS simulation. In contrast to the SS computation, which solves the optimisation problems of three income types of households, in the transition path program with the economy assumed to span over 150 years, three income groups and 70 years of the maximum life horizon, there are 660 households whose optimisation problems have to be solved. This includes 207 households (i.e. 69 generations of three household income types) born prior to year when the policy was adopted.

Figure 1: Effective marginal tax rates for seniors and other workers in 2007-08



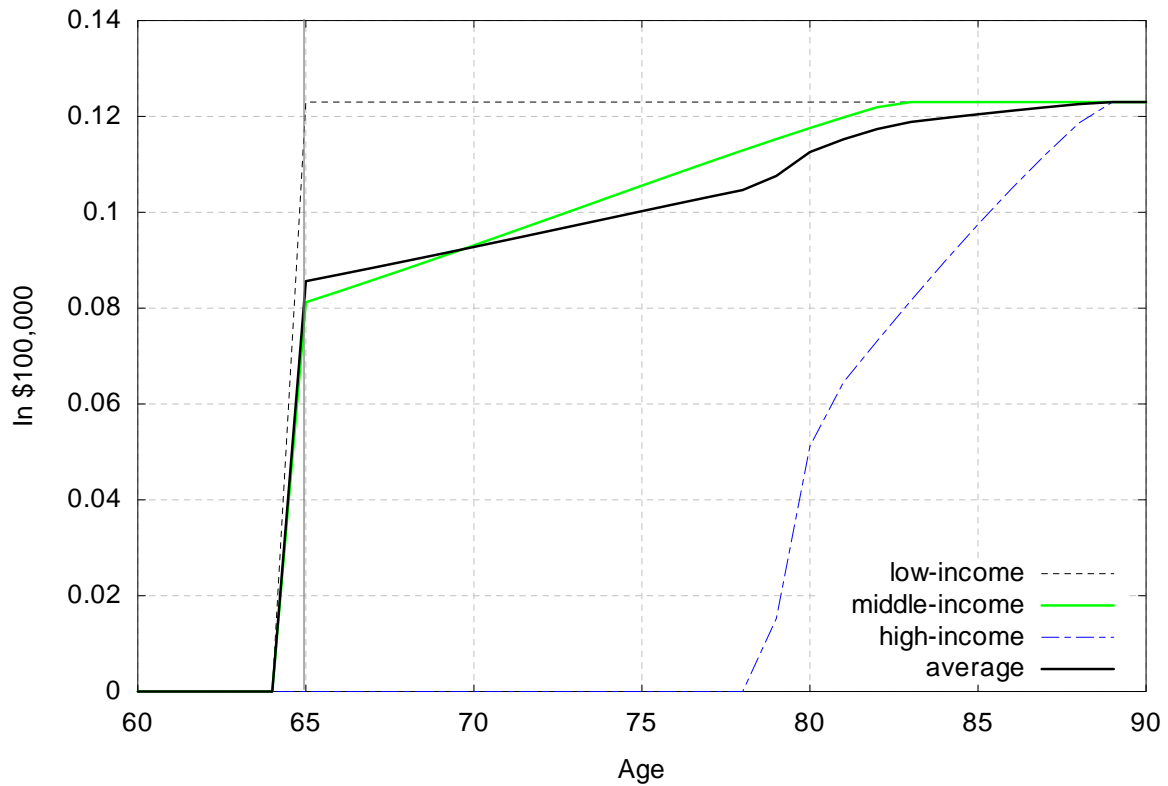
Notes: The calculation of the EMTR for seniors includes the age pension and its income test, senior Australian tax offset [SATO], low income tax offset [LITO], mature age worker tax offset [MAWTO] and the Medicare levy.

Figure 2: Average life-cycle household profiles generated by the benchmark steady state model simulation and using HILDA data surveys



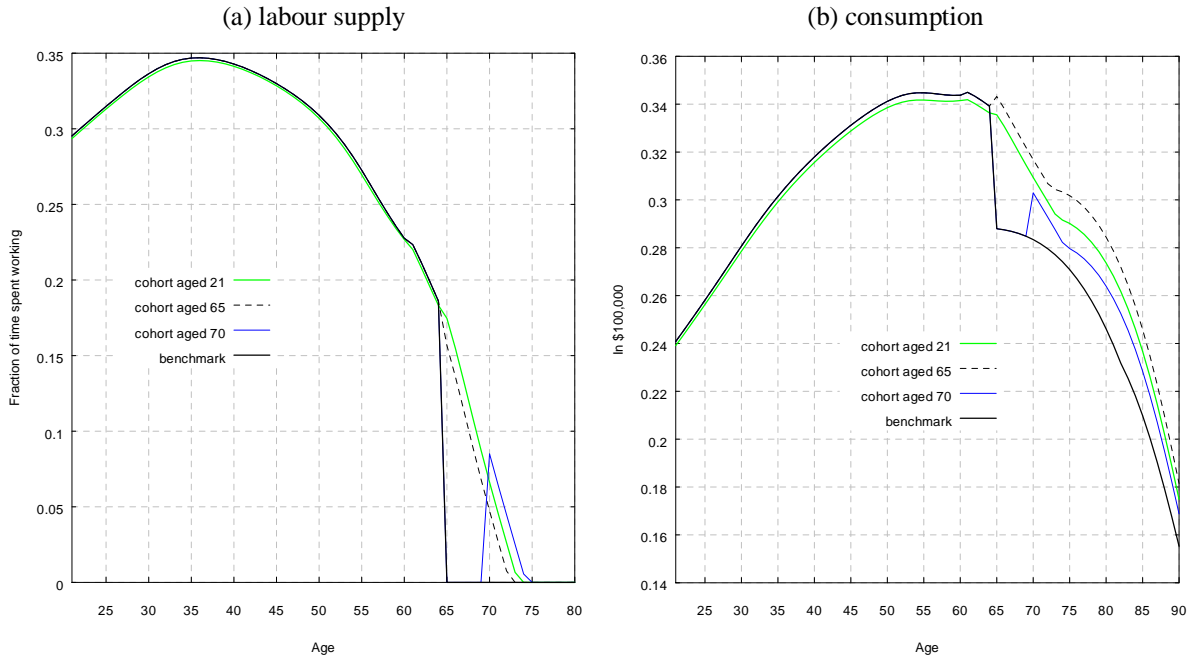
Notes: HILDA combined profiles are averages over both males and females. Model profiles are life-cycle profiles averaged across the three income household types. (a) HILDA profiles of consumption expenditures are related to average household rather than individual. The individual's data set of survey wave 6 conducted in 2006 rather than wave 5 was used because it contains more detailed expenditures. (b) HILDA profiles of labour supply are derived from individual's data set of wave 5 conducted in 2005. The provided average weekly hours worked are converted to average annual labour supply and then divided by the assumed annual endowment of 5460 hours. (c) To obtain HILDA profiles of average labour earnings, the derived variable of annual gross wages and salaries in the data set of survey wave 5 is used. (d) HILDA profiles of average financial assets are derived from survey wave 6 with special topic on wealth. The individual's data set contain only information on superannuation and bank accounts. The plotted HILDA data points are obtained as follows: (i) using the individual's data set, average age-specific sum of superannuation and bank account holdings is calculated, (ii) using household data set, the average age-specific share of superannuation and bank account assets in total financial assets is calculated, (iii) to obtain total individual's financial assets, division of (i) by (ii) is performed and (iv) the obtained average age-specific financial assets are deflated at the three percent rate to 2005.

Figure 3: Age pension payments generated by the benchmark steady state model simulation



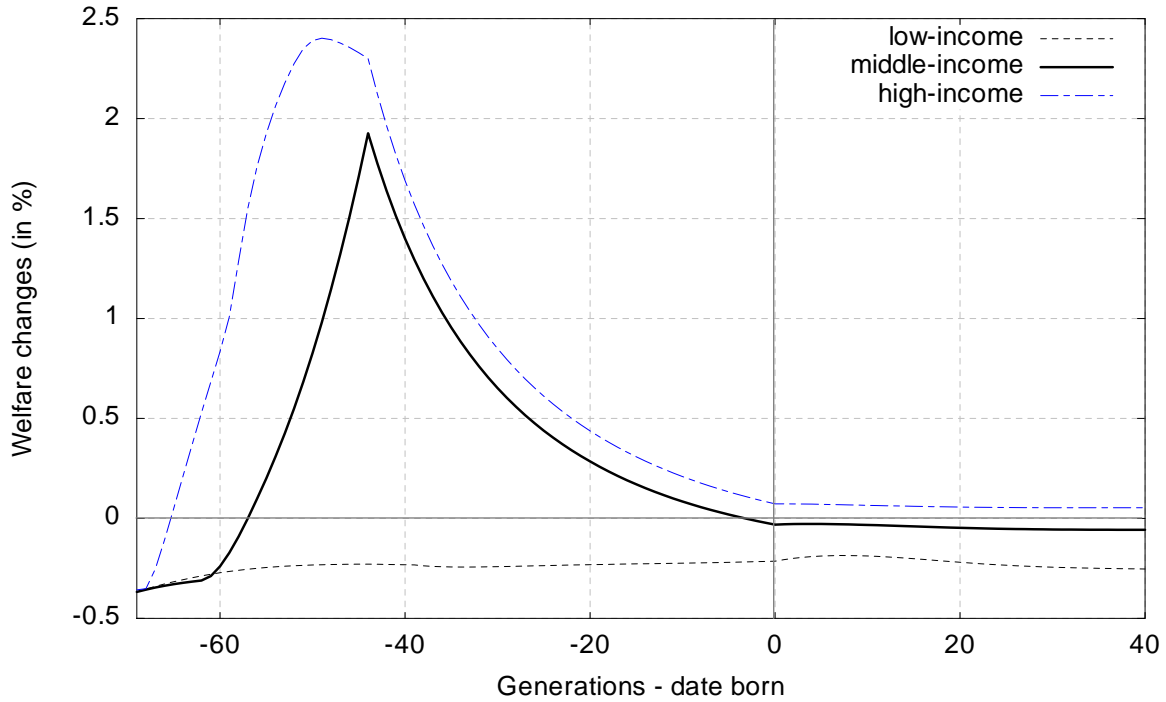
Notes: The profile labelled “average” relates to the age profile of the average age pension across the three income groups taking into consideration the fraction of each income type in every cohort.

Figure 4: Intergenerational implications of the age pension means test removal for middle-income households



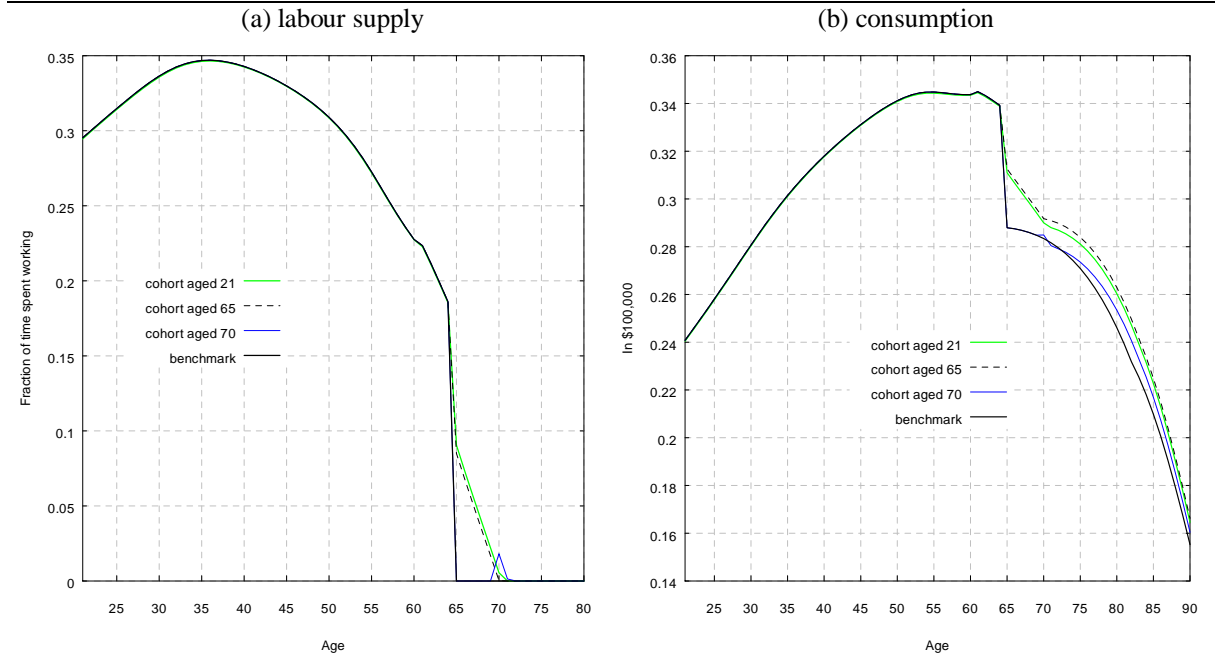
Notes: This figure shows life-cycle behaviour of middle-income households in the benchmark SS (i.e. prior to the means test removal) labelled as benchmark and the life-cycle impacts on the selected cohorts of middle-income households.

Figure 5: Welfare implications of the age pension means test removal



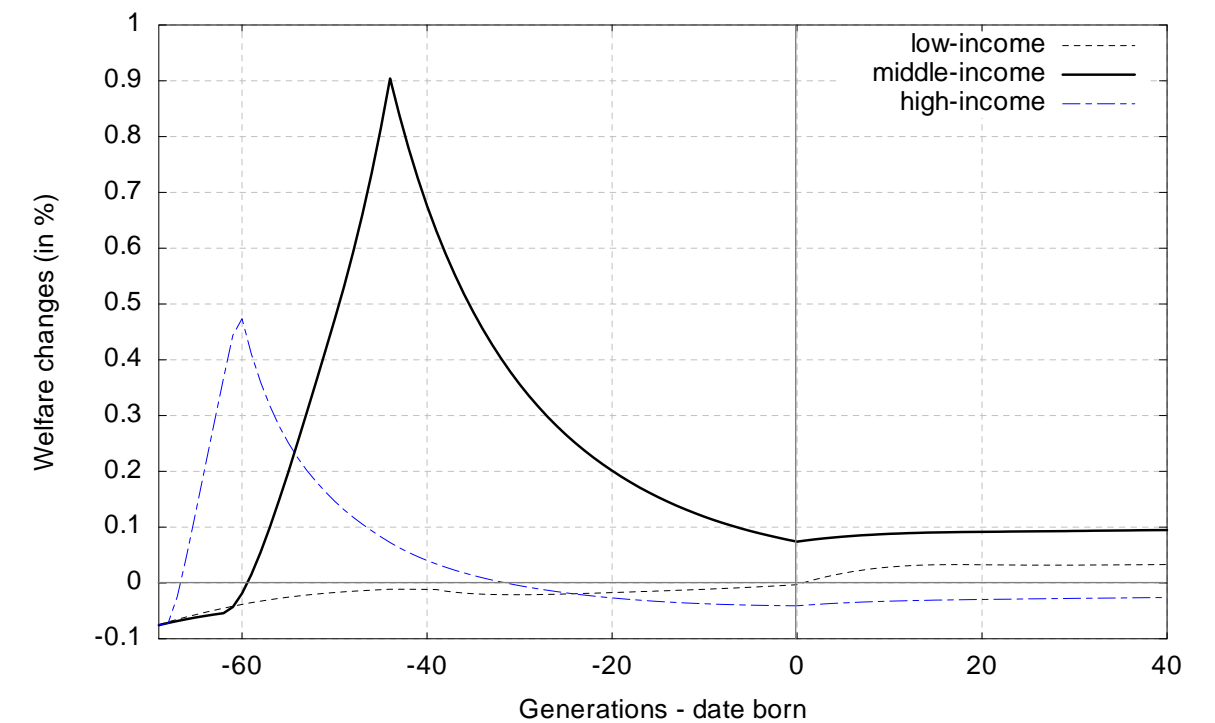
Notes: The horizontal axis records the periods when generations enter the model relative to the period of the policy change which is assumed to be period 0. A generation's age at the time of the policy shift can be obtained by subtracting the number on the horizontal axis from the assumed entry age of 21. For example, the generation born 40 years (-40) prior to the policy change is 61 years old at the time of reform.

Figure 6: Intergenerational implications of the 50 percent reduction in the taper rate of the income test for middle-income households



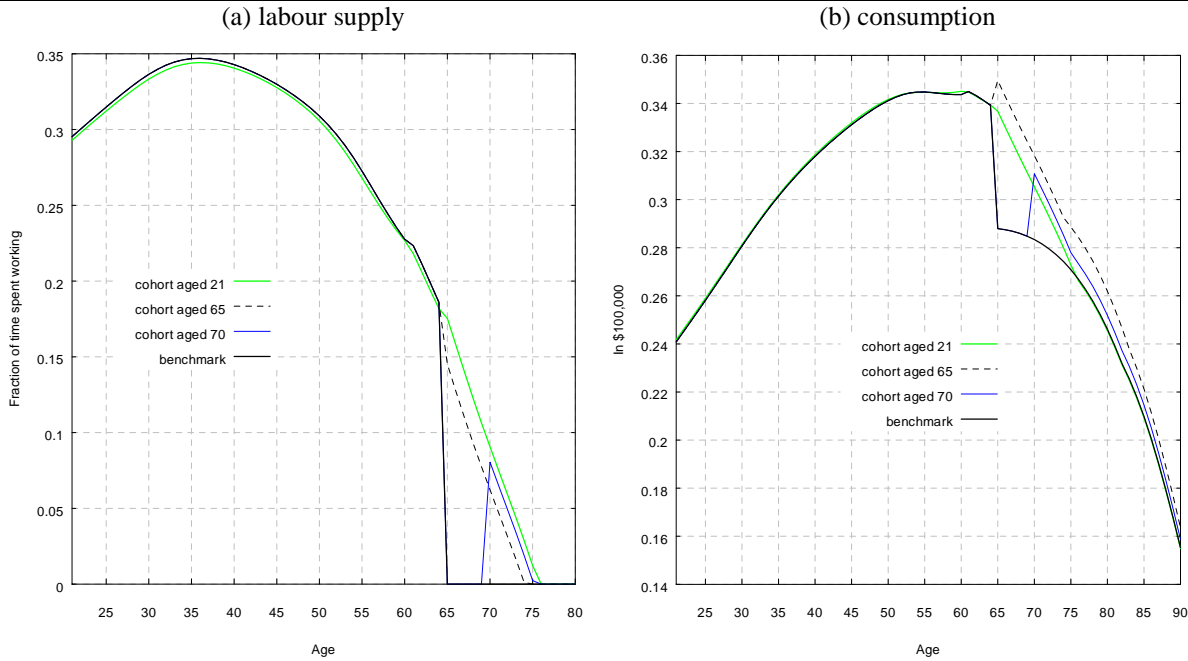
Notes: This figure shows life-cycle behaviour of middle-income households in the benchmark SS (i.e. prior to the reduction in the income taper rate) labelled as benchmark and the life-cycle impacts on the selected cohorts of middle-income households.

Figure 7: Welfare implications of the 50 percent reduction in the taper rate of the income test



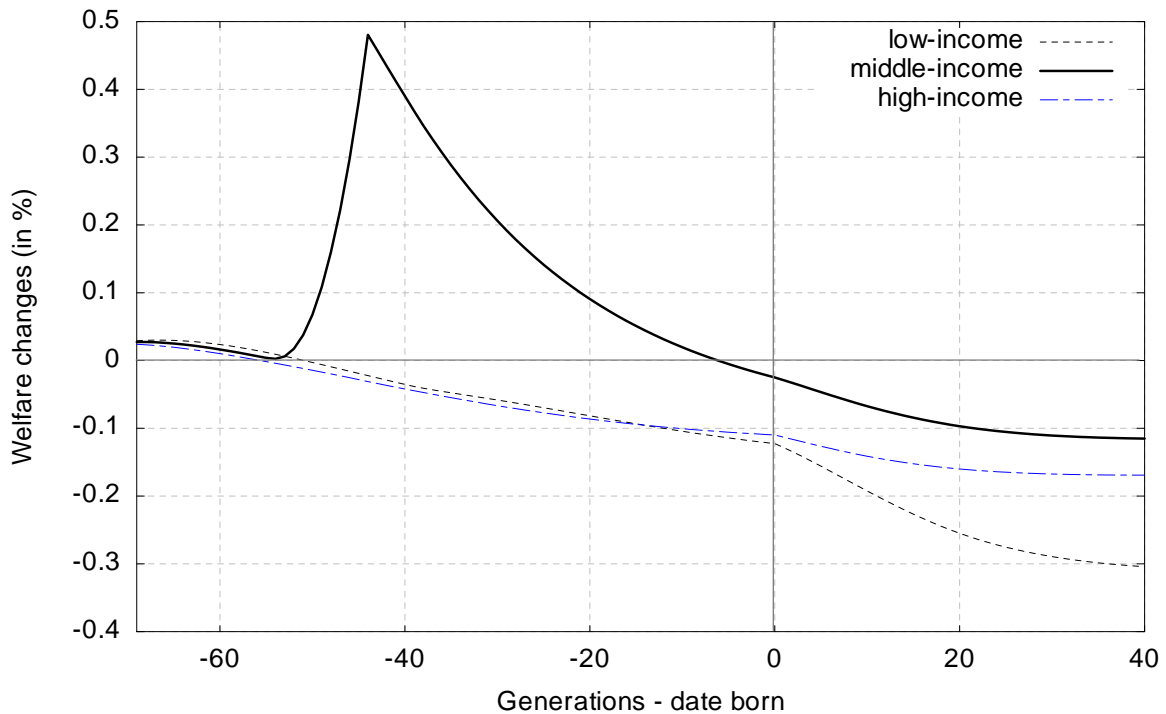
Notes: The horizontal axis records the periods when generations enter the model relative to the period of the policy change which is assumed to be period 0. A generation's age at the time of the policy shift can be obtained by subtracting the number on the horizontal axis from the assumed entry age of 21. For example, the generation born 40 years (-40) prior to the policy change is 61 years old at the time of reform.

Figure 8: Intergenerational implications of the removal of labour earnings from the age pension income test



Notes: This figure shows life-cycle behaviour of middle-income households in the benchmark SS (i.e. prior to the labour earnings removal from the income test) labelled as benchmark and the life-cycle impacts on the selected cohorts of middle-income households.

Figure 9: Welfare implications of the removal of labour earnings from the income test



Notes: The horizontal axis records the periods when generations enter the model relative to the period of the policy change which is assumed to be period 0. A generation's age at the time of the policy shift can be obtained by subtracting the number on the horizontal axis from the assumed entry age of 21. For example, the generation born 40 years (-40) prior to the policy change is 61 years old at the time of reform.

Table 1: Parameter values of the model in the benchmark SS

Symbol	Description	Value
	<i>Demographics</i>	
n	Population growth rate	0.012
ω_i	Fraction of households of income group i	[a]
s_a	Conditional survival probabilities	[b]
	<i>Utility function</i>	
γ	Inter-temporal elasticity of substitution	0.3
ρ	Intra-temporal elasticity of substitution	0.9
β^i	Subjective rate of time preference	[c]
α	Leisure parameter	1.6
	<i>Production function</i>	
κ	Production constant	0.969
σ	Elasticity of substitution in production	1.015
ε	Capital share	0.36
δ	Depreciation rate	0.079
ψ	Adjustment cost parameter	10
	<i>Age pension [d]</i>	
p	Maximum legislated single rate age pension per year	0.12238
IT	Income threshold to which p is payable under the income test	0.03172
θ	Income reduction (taper) rate	0.4
AT	Assets threshold to which p is payable under the asset test	2.635
ϕ	Assets reduction (taper) rate	0.078
$eage$	Age pension eligibility age	65
	<i>Superannuation guarantee</i>	
cr	Mandatory superannuation contribution rate	0.09
τ^{cs}	Tax rate imposed on superannuation contributions	0.15
τ^r	Tax rate applied to fund investment income	0.15
$sage$	Assumed superannuation eligibility age	60

Notes: [a] $\omega_1 = 0.3, \omega_2 = 0.6, \omega_3 = 0.1$. [b] Taken from ABS (2005); [c] $\beta^1 = 0.017, \beta^2 = 0.012, \beta^3 = 0.007$.

[d] The age pension parameters are those applicable in November 2004 (Dale, 2004) and the monetary values are expressed in units of \$100,000.

Table 2: Benchmark steady state and macroeconomic data

Variable	Benchmark steady state	Australia 2004-05 [a]
<i>Expenditures on GDP (Per cent of GDP)</i>		
- Private consumption	53.35	58.04
- Investment	25.82	25.82
- Government consumption	18.75	18.10
- Trade balance	2.08	-2.52
<i>Government indicators (Per cent of GDP)</i>		
- Age pension expenditures	3.62	2.89
- Government surplus	0.00	1.50
Current revenues		
- Personal income tax	15.36	12.10
- Corporation tax	-	4.97
- Consumption tax (GST)	5.33	4.12
- Superannuation taxes	1.68	0.71
Capital-output ratio	2.82	2.92
Foreign assets-capital ratio [a]	-0.19	-0.19
Investment-capital ratio	0.09	0.09
Consumption tax rate	0.10	0.10

Notes: [a] Foreign assets are represented by net international investment position.

Source: ABS (2006a) and Commonwealth of Australia (2006).

Table 3: Sensitivity analysis – alternative parameterisation

	Benchmark SS [a]	γ (=0.4)	β^2 (=0.015)	σ (=1.1)	ε (=0.45)	δ (=0.52)	r (=0.06)	n (=0.02)
$Y[b]$	0.540	0.536	0.543	0.592	0.846	0.618	0.498	0.565
$K[b]$	1.522	1.512	1.533	1.817	2.993	2.223	1.304	1.595
$L[c]$	0.314	0.312	0.316	0.314	0.313	0.313	0.303	0.329
C/Y	0.533	0.557	0.519	0.498	0.427	0.533	0.591	0.507
I/Y	0.258	0.258	0.258	0.281	0.324	0.230	0.239	0.281
TB/Y	0.021	-0.002	0.035	0.034	0.061	0.049	-0.018	0.025
K/Y	2.821	2.821	2.821	3.069	3.539	3.595	2.616	2.821
I/K	0.092	0.092	0.092	0.092	0.092	0.064	0.092	0.100
FA/K	-0.194	0.023	-0.329	-0.291	-0.455	-0.360	0.143	-0.291
w	1.000	1.000	1.000	1.041	1.343	1.148	0.958	1.000
τ^c	0.100	0.077	0.113	0.112	0.114	0.075	0.072	0.096

Notes: [a] In the benchmark SS, $\gamma = 0.3$, $\beta^2 = 0.012$, $\sigma = 1.015$, $\varepsilon = 0.36$, $\delta = 0.079$, $r = 0.05$, $n = 0.012$.

[b] Output (i.e. GDP), the value of capital stock and other monetary aggregate variables are expressed per average household and in units of \$100,000; [c] Labour input is represented by a fraction of time spent working per average household.

Table 4: Macroeconomic implications of the age pension means test removal

Variable	Initial SS [a]	Time period [b]								New SS [a]
		0	5	10	20	30	40	50	200	
Labour supply	0.3141	0.209	0.251	0.508	0.850	1.023	1.111	1.149	1.166	0.3178
Wage rate	1.0000	-0.075	-0.034	-0.068	-0.083	-0.066	-0.046	-0.028	0.000	1.0000
Capital stock	1.5222	0.000	0.156	0.319	0.618	0.838	0.983	1.070	1.166	1.5399
Domestic assets	1.2267	0.000	-0.295	-0.835	-2.001	-2.765	-3.125	-3.273	-3.282	1.1865
Foreign assets	-0.2955	-1.643	-3.682	-6.821	-12.883	-16.760	-18.638	-19.449	-19.635	-0.3535
Capital price (Tobin's q)	1.0000	0.319	0.320	0.331	0.268	0.185	0.115	0.067	0.000	1.0000
Output [c]	0.5395	0.132	0.216	0.438	0.765	0.956	1.064	1.120	1.166	0.5458
- Consumption	0.2878	0.241	0.548	0.753	0.751	0.572	0.471	0.444	0.446	0.2891
- Investment	0.1393	0.343	0.511	0.679	0.903	1.033	1.104	1.139	1.167	0.1409
- Trade balance	0.0112	-5.280	-11.958	-10.601	-0.576	9.843	15.493	18.207	19.635	0.0134
Government expenditures [d]	0.1207	3.762	3.832	4.018	4.292	4.452	4.542	4.589	4.628	0.1263
- Age pension expenditures	0.0195	22.548	22.548	22.548	22.548	22.548	22.548	22.548	22.548	0.0239
Total government revenues	0.1207	3.762	3.832	4.018	4.292	4.452	4.542	4.589	4.628	0.1263
- Income tax revenues	0.0829	1.237	1.341	1.479	1.611	1.691	1.751	1.785	1.830	0.0844
- Consumption tax revenues	0.0288	12.412	12.388	12.779	13.561	14.007	14.215	14.305	14.317	0.0329
- Superannuation taxation	0.0090	-0.631	-0.572	-0.597	-0.639	-0.660	-0.657	-0.633	-0.567	0.0090
Consumption tax rate (=GST)	0.1000	12.141	11.776	11.936	12.715	13.360	13.667	13.800	13.809	0.1138

Notes: [a] SS values for the monetary variables are expressed per average household and in units of \$100,000. Labour supply is presented as a fraction of time spent working per average household. [b] Values for all the displayed variables over the transition path are presented as percentage changes from the initial SS. [c] Output consists of consumption, investment, government consumption and trade balance with government consumption, G, not displayed as it is fixed in the benchmark SS ratio to output and thus percentage changes in G are identical to those in output. [d] Government expenditures include government consumption and age pension expenditures.

Table 5: Macroeconomic implications of the 50 percent reduction in the taper rate of the income test

Variable	Initial SS [a]	Time period [b]							New SS [a]	
		0	5	10	20	30	40	50		200
Labour supply	0.3141	0.328	0.345	0.424	0.505	0.537	0.546	0.545	0.535	0.3158
Wage rate	1.0000	-0.118	-0.079	-0.070	-0.047	-0.028	-0.016	-0.008	0.000	1.0000
Capital stock	1.5222	0.000	0.126	0.228	0.374	0.457	0.502	0.523	0.535	1.5303
Domestic assets	1.2267	0.000	0.083	0.070	-0.068	-0.164	-0.180	-0.166	-0.096	1.2255
Foreign assets	-0.2955	-1.507	-1.509	-1.865	-2.799	-3.365	-3.501	-3.458	-3.152	-0.3057
Capital price (Tobin's q)	1.0000	0.292	0.234	0.190	0.115	0.063	0.032	0.014	0.000	1.0000
Output [c]	0.5395	0.208	0.265	0.353	0.457	0.508	0.530	0.537	0.535	0.5424
- Consumption	0.2878	0.061	0.224	0.351	0.432	0.418	0.413	0.415	0.432	0.2891
- Investment	0.1393	0.303	0.372	0.427	0.492	0.523	0.535	0.538	0.535	0.1400
- Trade balance	0.0112	2.797	-0.019	-0.528	0.649	2.621	3.476	3.660	3.152	0.0116
Government expenditures [d]	0.1207	0.831	0.881	0.921	0.997	1.041	1.060	1.067	1.065	0.1220
- Age pension expenditures	0.0195	4.054	4.069	3.863	3.792	3.804	3.807	3.811	3.808	0.0203
Total government revenues	0.1207	0.831	0.881	0.921	0.997	1.041	1.060	1.067	1.065	0.1220
- Income tax revenues	0.0829	0.327	0.433	0.514	0.603	0.650	0.676	0.687	0.697	0.0834
- Consumption tax revenues	0.0288	2.607	2.503	2.440	2.503	2.555	2.560	2.550	2.507	0.0295
- Superannuation taxation	0.0090	-0.209	-0.182	-0.184	-0.188	-0.191	-0.185	-0.173	-0.154	0.0090
Consumption tax rate (=GST)	0.1000	2.544	2.274	2.082	2.062	2.128	2.138	2.127	2.066	0.1021

Notes: [a] SS values for the monetary variables are expressed per average household and in units of \$100,000. Labour supply is presented as a fraction of time spent working per average household. [b] Values for all the displayed variables over the transition path are presented as percentage changes from the initial SS. [c] Output consists of consumption, investment, government consumption and trade balance with government consumption, G , not displayed as it is fixed in the benchmark SS ratio to output and thus percentage changes in G are identical to those in output. [d] Government expenditures include government consumption and age pension expenditures.

Table 6: Macroeconomic implications of the labour earnings removal of the age pension income test

Variable	Initial SS [a]	Time period [b]										New SS [a]
		0	5	10	20	30	40	50	200			
Labour supply	0.3141	0.317	0.561	0.859	1.288	1.524	1.652	1.716	1.755	0.3196		
Wage rate	1.0000	-0.114	-0.107	-0.123	-0.120	-0.092	-0.064	-0.041	0.000	1.0000		
Capital stock	1.5222	0.000	0.263	0.516	0.950	1.264	1.472	1.601	1.755	1.5489		
Domestic assets	1.2267	0.000	-1.380	-2.631	-4.540	-5.634	-6.185	-6.432	-6.495	1.1470		
Foreign assets	-0.2955	-2.810	-9.795	-16.151	-25.725	-31.273	-34.139	-35.476	-36.010	-0.4019		
Capital price (Tobin's q)	1.0000	0.545	0.524	0.496	0.381	0.262	0.168	0.100	0.000	1.0000		
Output [c]	0.5395	0.201	0.452	0.733	1.164	1.429	1.586	1.674	1.755	0.5490		
- Consumption	0.2878	1.387	1.292	1.176	0.864	0.609	0.481	0.424	0.418	0.2890		
- Investment	0.1393	0.591	0.833	1.051	1.357	1.542	1.649	1.706	1.755	0.1417		
- Trade balance	0.0112	-35.060	-25.817	-14.585	6.478	21.037	29.141	33.325	36.010	0.0153		
Government expenditures [d]	0.1207	0.168	0.284	0.538	1.024	1.324	1.500	1.595	1.672	0.1227		
- Age pension expenditures	0.0195	0.000	-0.581	-0.474	0.298	0.785	1.050	1.187	1.245	0.0198		
Total government revenues	0.1207	0.168	0.284	0.538	1.024	1.324	1.500	1.595	1.672	0.1227		
- Income tax revenues	0.0829	0.094	0.067	0.120	0.240	0.343	0.423	0.476	0.548	0.0833		
- Consumption tax revenues	0.0288	0.631	1.188	2.101	3.799	4.757	5.251	5.485	5.567	0.0304		
- Superannuation taxation	0.0090	-0.628	-0.601	-0.610	-0.622	-0.606	-0.568	-0.523	-0.429	0.0090		
Consumption tax rate (=GST)	0.1000	-0.746	-0.103	0.914	2.909	4.123	4.747	5.040	5.128	0.1051		

Notes: [a] SS values for the monetary variables are expressed per average household and in units of \$100,000. Labour supply is presented as a fraction of time spent working per average household. [b] Values for all the displayed variables over the transition path are presented as percentage changes from the initial SS. [c] Output consists of consumption, investment, government consumption and trade balance with government consumption, G , not displayed as it is fixed in the benchmark SS ratio to output and thus percentage changes in G are identical to those in output. [d] Government expenditures include government consumption and age pension expenditures.