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Abstract

In this paper we investigate the macroeconomic and welfare effects of the major changes of the mandatory superannuation reform proposed in the 2010-11 Australian federal budget. These changes include gradual increases in the mandatory employer contributions from 9 to 12 percent of gross earnings and a policy that effectively removes the concessional 15 percent tax on mandatory contributions for workers with annual taxable income of up to $37,000. Using a computable overlapping generations model that incorporates main aspects of mandatory superannuation, the means tested age pension and progressive personal income taxation, we find significantly larger superannuation asset accumulations as a result of the reform, which generate increases in domestic total assets and household saving. The reform improves self-funding in retirement, with government expenditures on the age pension falling by almost 4.6 percent in the long run. The reform has also positive impacts on households' long run welfare, with higher income households solely benefiting from the increased superannuation contributions while lower income households from the contribution tax removal. The aggregate efficiency calculations indicate that the superannuation reform improves efficiency, generating a gain of almost 0.8 percent or $11,753 in initial resources for each future generation.

Keywords: Compulsory saving; pension reform; dynamic OLG model

JEL Classification: H55; E21; C68

1 Introduction

In the 2010-11 federal budget, the Australian government announced that mandatory superannuation guarantee [SG] contributions paid by employers will be increased from 9 to 12 percent of gross earnings in order to increase retirement incomes and the national saving rate. The increases in the mandatory contribution rate are proposed to be carried out gradually, with initial increments of 0.25 percentage points in July 2013 and 2014. Further increments of 0.5 percentage points will apply annually up to 2019-20, when the SG rate will reach 12 percent of gross earnings (Treasury, 2010). In addition to higher mandatory contributions, the government announced a contribution of up to $500 for workers with annual taxable income of no greater than $37,000 from July 2012. This policy effectively removes the tax on mandatory contributions for workers on incomes up to that amount. These two policy changes constitute the 2010 reform to mandatory superannuation that we examine in this paper.[1]

Adequacy of the current 9 percent SG rate has been questioned for a long time. Already in 1993, one year after the introduction of the superannuation guarantee, FitzGerald (1993) proposed to increase the mandatory contribution rate to 18 percent of earnings to generate at least a 60 percent replacement rate from superannuation. In the 1995-96 federal budget, the Keating Government committed to lift the mandatory SG contribution rate to 15 percent, but the Liberal Government elected in 1996 ignored this agreement and continued with the already-agreed gradual increases in the SG rate to the existing 9 percent. The Australian Superannuation Fund Association (1998) also proposed mandatory contributions in excess of the current rate. Recently, a number of submissions to Australia's Future Tax System [AFTS] (2009) recommended increasing compulsory savings with targets of 12 or 15 percent of earnings.

The equity of the superannuation taxation arrangements has also been a concern. The existing tax treatment of superannuation savings places a concessional flat tax rate of 15 percent on mandatory (and other employer) contributions and superannuation fund earn-

[1] There were other two superannuation policy changes announced in the 2010-11 federal budget. These were (i) extending mandatory SG contributions to workers aged between 70 and 75 years and (ii) the increase in the annual cap on concessional contributions from $25,000 to $50,000 for people aged 50 years and over with balances below $500,000. We do not examine these changes. The first policy would have a negligible impact as very few households only in the highest income quintile work after age 70 in our model. As for the second policy, not even the highest income groups reach the current contribution limit of $25,000 per year in our framework because we do not consider voluntary contributions.

ings.[2] Because of the progressive personal income tax schedule, higher income earners receive greater tax concessions on their mandatory superannuation contributions compared to lower income earners. Thus, the aim of this announced policy of no tax on SG contributions for lower income workers is to make the superannuation system fairer.[3]

In this paper, we simulate macroeconomic and welfare implications of the 2010 superannuation changes to mandatory superannuation, using a computable general equilibrium model with overlapping generations [OLG] that we calibrate to the Australian economy. Our model is a small open economy version of Auerbach and Kotlikoff's (1987) model that includes both inter- and intra-generational heterogeneity amongst households. The model also accounts for interaction between mandatory superannuation, the means tested age pension and the progressive personal income tax schedule. These features of the model allow us to examine (i) the welfare effects of the superannuation policy changes on different cohorts and on the same cohorts of different income types and, by aggregating across the different households, (ii) the macroeconomic implications of the reform including the effects on per capita domestic assets, labour supply, consumption and age pension expenditures to the government.

The implications of compulsory savings such as mandatory superannuation on household and national savings, labour supply, retirement and replacement rates have been examined by a number of researchers. Empirical literature using time series data and regression modelling has documented a positive impact of compulsory superannuation on total assets and household saving in Australia (Fitzgerald, 1993), Connelly and Kohler, 2004) and Connelly, 2007). For example, Connelly and Kohler (2004) find that an extra dollar in compulsory superannuation would add 62 cents to household wealth and that compulsory superannuation has increased the household saving rate by up to two percent. In addition to the effects on household wealth, the regression results of Connelly (2007) indicate no significant impact of mandatory superannuation on intentions regarding the

[2] Mandatory SG contributions and other employer contributions such as salary sacrificing contributions are made from gross earnings and are taxed in the hands of superannuation funds. These contributions are called concessional contributions as they are taxed at the flat rate. There are also voluntary personal contributions, which are made from after-tax income.

[3] Although this policy would improve vertical equity of the system, it does not go as far as one of the recommendations by AFTS (2010, p.84). According to Recommendation 18, employer contributions should be treated as personal income, taxed at marginal income tax rates and a flat-rate refundable tax offset should be paid to ensure that the majority of taxpayers do not pay more than 15 per cent tax on their concessional contributions.

timing of retirement. However, Buetler *et al.* (2005), using unit record data from some Swiss pension funds, show that fund members with larger accumulated pension capital tend to leave the workforce earlier. The positive effects of compulsory superannuation on national savings, replacement rates and living standards are also derived from micro-simulation projection models (see, for example, Gallagher, 1996), Rothman and Tinnion, 1999) and Kelly and Morrison, 2008).

The methodology and analysis undertaken in this paper fit into the literature that applies life-cycle utility optimisation models. An open economy version of the Ramsey model is developed by Guest and McDonald (2002), who show that higher mandatory contributions would, for example, increase national savings. The results generated by Guest's (2004) life-cycle single household model with housing indicate that compulsory superannuation, while slightly rising net private saving, would have negative impacts on both non-housing and housing consumption. The theoretical basis for the analysis of a superannuation policy change is provided by Creedy and Guest (2008a). They demonstrate that a change in the superannuation contribution rate has both income and price effects; that is, an increase in the contribution rate increases (i) full income, which has a negative effect on labour supply, and (ii) the price of leisure, which has a positive effect on labour supply. A similar open economy OLG model to ours is applied by Creedy and Guest (2008b), who examine macroeconomic and welfare impacts of different tax treatments of superannuation. Compared to their model, our model features a more detailed household sector with household heterogeneity over both ages and income types. Our model also includes a richer structure of the fiscal system with the means tested age pension and progressive personal income taxes.

Our simulation results of the 2010 superannuation changes show significantly larger superannuation asset accumulations due mainly to the higher mandatory SG rate. Although larger superannuation savings partly offset ordinary non-superannuation assets, the domestic total assets increase as a result of the reform and are over 18 percent higher in the long run. The reform improves self-funding in retirement, with government expenditures on the age pension falling by about 4.6 percent in the long run due to greater assets and asset income assessed under the means test of the age pension. However, the larger total asset accumulation produces a dominating income effect on per capita labour supply, which declines by over 1.2 percent in the long run. In contrast, Creedy and Guest

(2008b) show positive effects on aggregate labour supply as a result of the contribution tax removal, which, similarly to the higher SG rate, increases the effective price of leisure. The opposite labour supply effect can be explained by different assumptions in our and their models, namely the choice of the budget-balancing policy instrument and the presence of accidental bequests and borrowing constraints in our paper (see Section 4 for detailed explanation). Similarly to Buetler *et al.* (2005), we find that the increased superannuation assets bring forward full retirement for higher income households. In terms of welfare implications, the reform increases long run welfare for all household types, with higher income households benefiting solely from the increased SG rate, while lower income households benefit from the contribution tax removal. The aggregate efficiency calculations indicate that the reform generates an efficiency gain of almost 0.8 percent or $11,753 in initial resources for each future born generation and, therefore, is potentially Pareto improving.

The rest of this paper is organised as follows. The next section describes the simulation model. Section 3 discusses the baseline calibration of the model and presents the initial (or benchmark) steady state solution. Section 4 provides the macroeconomic and welfare implications of the superannuation policy changes. Section 5 examines the robustness of the main results of the superannuation reform to the alternative simulations of our model and Section 6 offers some concluding remarks.

2 The model economy

2.1 Demographics

We consider an economy populated with overlapping generations of heterogeneous households. There are 70 generations aged between 21 and 90 years in every time period, with each generation divided into five income quintiles - the lowest, second, third, fourth and highest income groups of households. Each year, a new young generation aged 21 years enters the model structure and faces random survival up to a maximum possible age of 90 years, while the oldest generation aged 90 years dies. Lifespan uncertainty is described the exogenous conditional survival probabilities, s_a, which are assumed to constant over time. The total population is also assumed to growth at a constant rate, n, which im-

plies time-invariant cohort shares in the total population, $\mu_a = [s_a \diagup (1+n)]\,\mu_{a-1}$. The fraction of each income group i in every generation is denoted by ω_i.

2.2 Household preferences and budget constraints

Households behaves rationally; they optimally choose paths of consumption, leisure and the timing of full retirement from workforce given their preferences and budget constraints. Preferences over consumption, c, and leisure, l, for each income type i of households in time period t are represented by the expected inter-temporal utility function. The inter-temporal utility function, which is of time separable, nested CES form, for each i-type generation who begins economic life at date t can be expressed as

$$\begin{aligned} E(U_t^i) &= \frac{1}{1-1/\gamma}\sum_{a=21}^{90} S_a\,(1+\beta)^{21-a} \\ &\quad \left[\left(c^i_{t+a-21}\right)^{(1-1/\rho)} + \alpha\left(l^i_{t+a-21}\right)^{(1-1/\rho)}\right]^{\frac{1-1/\gamma}{1-1/\rho}}, \end{aligned} \tag{1}$$

where the parameters (assumed to be the same for all income types) are the inter-temporal elasticity of substitution, γ, the intra-temporal elasticity of substitution, ρ, the leisure distribution parameter, α, and the rate of time preference, β. The term $S_a = \prod_{j=21}^{a} s_{j-1}$ denotes the unconditional survival probability.

The expected lifetime utility function given by Equation (1) is maximised subject to a lifetime budget constraint that can be expressed as period by period asset accumulations:

$$\begin{aligned} A^i_{a,t} - A^i_{a-1,t-1} &= rA^i_{a-1,t-1} + w_t e^i_a (h - l^i_{a,t}) + AP^i_{a,t} + SA^i_{60,t} \\ &\quad + SP^i_{a,t} + SB^i_a + B^i_{a,t} - T(y^i_{a,t}) - (1+\tau^c)\,c^i_{a,t}. \end{aligned} \tag{2}$$

The left-hand side of Equation (2) denotes household saving, which equals the sum of interest income, $rA^i_{a-1,t-1}$, labour earnings, $w_t e^i_a (h - l^i_{a,t})$, age pension, $AP^i_{a,t}$, superannuation payouts, $SA^i_{60,t}$ and $SP^i_{a,t}$, social benefits, SB^i_a, and bequest receipts, $B^i_{a,t}$, minus the sum of progressive income taxes, $T(y^i_{a,t})$, and consumption expenditures, $(1+\tau^c_t)\,c^i_{a,t}$, where τ^c_t is the consumption tax rate.[4] Labour earnings are the product of labour sup-

[4]Social benefits (excluding the age pension), SB^i_a, are assumed to be received by households in the lowest to the fourth income quintile aged younger than 65 years. The reason for including these government benefits is to match the share of welfare payments in gross total income for each household

ply, $h - l^i_{a,t}$, and the hourly wage, $w_t e^i_a$, where w_t is the market wage rate and e^i_a is the age- and income-specific earnings ability variable. The labour supply is required to be non-negative, $h - l^i_{a,t} \geq 0$, which implies that leisure, $l^i_{a,t}$, cannot exceed available time endowment, h. Accidental bequests, $B^i_{a,t}$, are assumed to be aggregated within each income type and equally redistributed to the surviving households of the same type aged between 45 and 65 years. We also assume that households are liquidity constrained by imposing non-negative asset requirements ($A^i_{a,t} \geq 0$) to prevent younger households from borrowing against their superannuation payouts.

2.3 Mandatory superannuation

The superannuation guarantee mandates employers to contribute currently 9 percent of gross labour earnings into the employee's superannuation fund. We assume that mandatory SG contributions by the representative firm are made on behalf of all households aged between 21 and 60 years at the after-tax contribution rate, $(1 - \tau^s)\, cr$, from their gross labour earnings, $w_t e^i_a (h - l^i_{a,t})$. The contributions are accumulated in the superannuation fund that earns investment income at the after-tax interest rate, $(1 - \tau^r)\, r$. Superannuation assets are assumed to be kept in the fund until households reach age 60. At that age, all household types receive their superannuation savings in the form of a lump-sum and the superannuation assets accumulation ceases to exist. The stock of superannuation assets, $SA^i_{a,t}$, accumulates according to

$$SA^i_{a,t} = \begin{cases} \left[1 + (1 - \tau^r)\, r\right] SA^i_{a-1,t-1} + (1 - \tau^s)\, cr \cdot w_t e^i_a (h - l^i_{a,t}), & \text{for } a \leq 60 \\ 0, & \text{for } a > 60, \end{cases} \tag{3}$$

where τ^r is the effective earnings tax rate, τ^s denotes the statutory contribution tax rate and cr is the SG rate. We also assume that working households aged over 60 years are paid the SG contributions directly into their private assets account. The payment of these contributions denoted by $SP^i_{a,t}$ in (2) can be expressed as

$$SP^i_{a,t} = \begin{cases} (1 - \tau^s)\, cr \cdot w_t e^i_a (h - l^i_{a,t}), & \text{for } \ a > 60 \text{ and } l^i_{a,t} < h \\ 0, & \text{otherwise.} \end{cases} \tag{4}$$

income class (see the calibration section for more details).

2.4 Firms and technology

Perfectly competitive firms, which are represented by a single producer, produce a single all purpose output, Y_t, using the capital stock, K_t, and the labour supply, L_t, according to the technology described by the standard CES production function

$$F(K_t, L_t) = \kappa \left[\varepsilon K_t^{(1-1/\sigma)} + (1-\varepsilon) L_t^{(1-1/\sigma)}\right]^{[1/(1-1/\sigma)]}, \tag{5}$$

where κ is the productivity constant, ε denotes the capital intensity parameter and σ is the elasticity of substitution in production.

The firm's optimisation problem is to maximise the present value of all future profits discounted at the world interest rate, r, subject to the capital accumulation equation, as specified by

$$\begin{aligned} \max_{\{K_t,\ L_t,\ I_t\}} \quad & \sum_{t=0}^{\infty} D_t \left[\left(1-\tau^f\right)\left(F(K_t, L_t) - C(I_t, K_t) - I_t - (1+cr) w_t L_t\right)\right] \\ \text{s.t.} \quad & (1+n) K_{t+1} = I_t + (1-\delta) K_t, \end{aligned} \tag{6}$$

where $D_t = (1+n)^t/(1+r)^t$ accounts for discounting and population growth, n is the population growth rate, δ denotes the capital depreciation rate and τ^f stands for the effective corporation tax rate.[5] The function $C(I_t, K_t) = 0.5\psi \left(I_t/K_t - (n+\delta)\right)^2 K_t$ gives the adjustment costs, where I_t is net investment and ψ is the adjustment cost coefficient.

2.5 The government

The government pays the age pension, $AP^i_{a,t}$, to eligible households aged 65 years and over provided that they satisfy the income test, $APi^i_{a,t}$, and asset test, $APa^i_{a,t}$, with the test that results in lower age pension payments applied. The means tests of the age pension can be expressed as

$$\begin{aligned} AP^i_{a,t} &= \min\left\{APi^i_{a,t}, APa^i_{a,t}\right\} \\ APi^i_{a,t} &= \max\left\{\min\left\{p, p - \theta\left(\widehat{y}^i_{a,t} - IT\right)\right\}, 0\right\} \\ APa^i_{a,t} &= \max\left\{\min\left\{p, p - \phi\left(A^i_{a,t} - AT\right)\right\}, 0\right\}, \end{aligned} \tag{7}$$

[5] Note that the total wage rate faced by the representative firm ($(1+cr)w_t$) also includes the mandatory SG rate and so the total wage bill is given by $(1+cr)w_t L_t$.

where p is the legislated single rate of the maximum age pension, θ is the income taper rate, ϕ represents the annual asset taper rate, IT denotes the income threshold, AT is the asset taper rate and assessable income is given by $\widehat{y}^i_{a,t} = rA^i_{a-1,t-1} + 0.5 \times w_t e^i_a (h - l^i_{a,t})$.[6]

In addition to the age pension expenditures, AP_t, the government pays for the social benefits, SB, and spends on public consumption, G. The total government expenditures are funded through the collection of tax revenues from household income, TR^Y_t, consumption, TR^C_t, and superannuation, TR^S_t, and firm's profits, TR^F_t. The government budget can be expressed, in per capita terms, as

$$TR^Y_t + TR^C_t + TR^S_t + TR^F_t = G + SB + AP_t, \tag{8}$$

where G and SB are assumed to be constant and the per capita pension expenditures and tax receipts from households and firms in period t are given by

$$\begin{aligned}
AP_t &= \textstyle\sum_{i=1}^{5} \omega_i \sum_{a=65}^{90} \mu_a \; AP^i_{a,t} \\
TR^Y_t &= \textstyle\sum_{i=1}^{5} \omega_i \sum_{a=21}^{90} \mu_a \; T(y^i_{a,t}) \\
TR^C_t &= \textstyle\sum_{i=1}^{5} \omega_i \sum_{a=21}^{90} \mu_a \; \tau^c_t \; c^i_{a,t} \\
TR^S_t &= \textstyle\sum_{i=1}^{5} \omega_i \sum_{a=21}^{60} \mu_a \left[\tau^s \cdot cr \cdot w_t e^i_a (1 - l^i_{a,t}) + \tau^r \cdot rSA^i_{a-1,t-1}\right] \\
TR^F_t &= \tau^f \cdot (Y_t - \delta q_t K_t - (1 + cr) w_t L_t),
\end{aligned}$$

which are the weighted averages of each component across households, with weights given by the intra-generational shares, ω_i, and cohort shares, μ_a, of the population.[7] In the per capita corporation tax revenue, Y_t is output net of adjustment costs, $\delta q_t K_t$ represents depreciation of the value of the capital stock and $(1+cr)w_t L_t$ gives the total labour costs. The government budget is assumed to be balanced through adjusting the consumption tax rate, τ^c_t.[8]

[6] According to the current policy, half of labour earnings up to \$13,000 per year is exempt from assessable income for the pension income test.

[7] The per capita social benefits are given by $SB = \sum_{i=1}^{4} \omega_i \sum_{a=21}^{64} \mu_a \; SB^i_a$.

[8] In Section 5, we assume a proportional change to the progressive income taxation as an alternative policy instrument to balance the budget defined in (8).

2.6 International budget constraint

In this small open economy model, the domestic interest rate, r, is exogenous and equal to the world interest rate.[9] The international budget constraint, in per capita terms, is

$$(1+n)FD_{t+1} - FD_t = TB_t - rFD_t, \tag{9}$$

where FD_t denotes net foreign debt, TB_t is the trade balance and rFD_t represents the interest payments on net foreign debt. This constraint equates capital flows on the left-hand side with the current account on the right-hand side.

2.7 Market clearing conditions

The following market clearing conditions for labour, capital and output markets must be satisfied in every time period t:

$$\begin{aligned} L_t &= \textstyle\sum_{i=1}^{5} \omega_i \sum_{a=21}^{90} e^i_{a,t}(h - l^i_{a,t})\mu_a \\ q_t K_t &= \textstyle\sum_{i=1}^{5} \omega_i \sum_{a=21}^{90} \left(A^i_{a,t} + SA^i_{a,t}\right)\mu_a - FD_t \\ Y_t &= \textstyle\sum_{i=1}^{5} \omega_i \sum_{a=21}^{90} c^i_{a,t}\mu_a + I_t + G_t + TB_t, \end{aligned} \tag{10}$$

where q_t is the price of capital (i.e., Tobin's q) that is obtained by solving the firm's profit maximisation problem defined in (6).

3 The model calibration

We start with computing the benchmark (initial) steady state equilibrium, which targets the key macroeconomic data of the Australian economy averaged over the five-year period ending in June 2010. To solve for this benchmark equilibrium we have to assign the values to the model parameters. In this section we present our parameter choices and then compare the initial steady state solution generated by the model with Australian data for some variables.

[9] The exogenous interest rate assumption is relaxed in Section 5.

3.1 Intra-generational heterogeneity

To implement the intra-generational heterogeneity in the model, we consider five income types of households in each generation that differ by their exogenously given earnings ability and social benefits (excluding the age pension).

3.1.1 Earnings ability

The earnings ability, e_a^i, which is full wage earned with all time endowment allocated to work, is constructed using the estimated lifetime wage function for males with completed high school education taken from Reilly *et al.* (2005) and the income distribution shift parameter ζ^i and is specified as

$$e_a^i = \zeta^i \times e^{2.235+0.04(a-17)-0.00067(a-17)^2}. \tag{11}$$

The parameter ζ^i is set to 0.26 for the lowest quintile, 0.55 for the second quintile, one for the third quintile, 1.52 for the fourth quintile and 2.63 for the highest quintile. These values are derived from ABS (2007), namely from Table 6, which divides households into quintiles based on their final income and reports private income, welfare transfers and gross total income for each quintile. We use the data on private income and calculate the ratios of the private incomes of lower and higher quintiles to the private income of the third quintile. These ratios give the values of ζ^i. Thus, the earnings ability profile for the middle income households, e_a^3, (those in the third quintile) is taken from Reilly *et al.* (2005) and the profiles for lower and higher income quintiles are shifted down and up to approximately replicate the private income distribution in Australia (ABS, 2007). We also assume that the earnings ability after age 65 declines at a constant rate, reaching zero at age 90 for each income class as Reilly *et al.* considered only workers aged 15-65.

3.1.2 Social welfare benefits

To account for the fact that working households not only earn private income but also receive social welfare, which is greater for lower income groups, we assume that households are paid government social benefits, SB^i. These benefits are assumed to be constant at each age and received by households in the lowest to fourth quintile aged younger 65

years. We calculate these benefits as follows. First, we use the ABS (2007) data to derive the share of social welfare transfers in gross total income for each eligible income quintile. These shares are 0.44 for the lowest quintile, 0.3 for the second quintile, 0.15 for the third quintile and 0.06 for the fourth quintile. Then, we calculate the value of social benefits for the eligible households in the benchmark steady state such that these payments together with the endogenous age pension yield the aforementioned shares in their lifetime gross income.[10]

The inclusion of social welfare benefits enhances the realism of the model in a number of ways. First, we are able to approximately match the private earnings as well as welfare payments and gross total incomes for each income quintile. Second, the social benefits have also an income effect on labour supply of their recipients. Without these payments, lower income groups would be unrealistically working the longest hours for most of their working life. Thus, incorporating these benefits generates more realistic labour supply profiles for lower income households due to the income effect on their working hours.

3.2 Demographic, utility and technology parameters

The values of the demographic, utility and technology parameters of the model are reported in Tables 1. The demographic structure of the model is stationary, where the constant annual population growth rate, n, is calibrated together with the male survival probabilities taken from the 2007-09 life tables (ABS, 2010a) to generate the current old aged dependency ratio of 0.2. The intra-generational shares, ω_i, are based on ABS (2007) that divides households into income quintiles; that is, each income type of households has an equal share of 20 percent in every generation.

Insert Table 1 here

The values of utility and technology parameters are standard in the literature. The utility function parameters are the same across all income types of households. The subjective rate of time preference, β, is chosen to generate the capital output ratio of 3 (ABS, 2010b). The technology constant, κ, is calibrated to reproduce the market wage rate that is normalised to one in the benchmark steady state equilibrium. The capital

[10]These benefits are constant in every t and they do not change as a result of the superannuation reform simulations presented in the next section.

depreciation rate, δ, is set to target the investment capital ratio of 0.09 (ABS, 2010b). The elasticity of substitution in production, σ, and the capital intensity parameter, ε, are calibrated via the producer's first order profit-maximisation conditions to match the interest rate and national account data for factor shares. The time endowment, h, is normalised to unity. The exogenous interest rate is assumed to be 5 percent and the adjustment cost parameter is taken from Auerbach and Kotlikoff (1987). We also target the ratio of net foreign debt to the capital stock of 0.195, reflecting the net foreign ownership of about 19.5 percent of Australia's capital stock (ABS, 2010b).

3.3 Retirement income and taxation parameters

The values of the age pension and superannuation parameters displayed in Table 2 are those applicable in 2009-10. The age pension eligibility age is 65 years.[11]

Insert Table 2 here

The consumption and corporation tax rates are set to their statutory rates of 10 percent and 30 percent, respectively. We then compute the "tax base" parameters to replicate the average ratios of these tax revenues to GDP ($TR^C/Y = 0.0389$ and $TR^F/Y = 0.0527$) over the five-year period ending in June 2010 (Commonwealth of Australia, 2011). The products of the statutory tax rates and the computed tax base parameters give the effective rates on consumption, $\tau^c = 7.04\%$, and on corporation profits, $\tau^f = 25.9\%$. We assume a balanced government budget with no government debt.

The model incorporates a differentiable approximation function of the Australian progressive personal income tax schedule in 2009-10. The approximation income tax, $T(y)$, is a function of taxable income, and it takes the form

$$\begin{aligned} T(y) &= t_5(y) - t_5(yt_1)\exp\left(\sum_{z=1}^{M-1} -(0.1)^z \nu_z \times \frac{y^z}{z}\right),\ z = 1, ..., M-1, \qquad (12) \\ t_5(y) &= m_5(y - yt_5) + tax_5, \end{aligned}$$

where $\nu_z = (\nu_1, \nu_2, \nu_3, \nu_4)$ are is a parameter vector, M denotes the number of tax brackets ($M = 5$), yt_1 and yt_5 are the lowest and highest tax thresholds ($yt_1 = 0$ and $yt_5 = 180$,

[11] Considering a recent government policy that the age pension age will gradually increase to age 67 in 2023, we examine the sensitivity of the superannuation reform results to gradual increases in the age pension age (see Section 5).

expressed in \$1,000) and m_5 is the top marginal tax rate ($m_5 = 0.45$) and tax_5 is the tax payable at that top threshold ($t = 54.55$, expressed in \$1,000).

The parameter vector $\nu_z = (\nu_1, \nu_2, \nu_3, \nu_4)$ is estimated by nonlinear least squares using the Stata software. We construct a grid of equally spaced incomes in the range [0, 200.5] and the corresponding income taxes based on the 2009-10 Australian tax schedule, with both variables expressed in unitis of \$1,000. The obtained parameter estimates are $\nu_z =$ (0.1446, 0.0160, -0.0049, 0.0003).

3.4 Computation and benchmark steady state solution

We use the GAMS software to solve for the steady state equilibrium as well as for the transition paths. Our algorithm applies the iterative Gauss-Seidel computational method suggested by Auerbach and Kotlikoff (1987). In particular, these are the steps carried out to solve for the initial steady state of our model. First, choose initial values for the accidental bequest, B, the consumption tax rate, τ^c, and the labour input, L. Second, calculate the implied market clearing wage rate, w, capital stock, K, and output, Y, using the first order necessary conditions for profit maximization by the producer. Third, given w, B and τ^c solve the household optimization problem (using the DNLP solver, CONOPT) for each income group to obtain household consumption, labour supply and assets profiles. Fourth, given these household optimisation solutions, update values of B, τ^c and L using the bequest allocation rule, the government budget constraint and setting L equal to aggregate household labour supply. The second through fourth steps are iterated until the solutions for B, τ^c and L converge.

The solution of the household optimisation problems is complicated by the fact that the means test for the age pension causes the budget set to be non-convex. We use a similar technique to deal with the kinked households' budget constraints as Altig *et al.* (2001).[12] First, we identify households that choose to locate at the kinks in particular periods by evaluating their income assessable under the pension income test. We then

[12] In the model by Altig *et al.* (2001), the household's budget constraint is kinked due to the tax deduction applied against wages, which causes the discontinuity of the marginal income tax rates. To computationally deal with such problem, they first evaluate each period's leisure choice and corresponding wage income above and below the kink. Then they calculate a set of shadow marginal tax rates from the first-order conditions that put such households exactly at kinks in each period in which being at a kink is optimal.

impose a condition that if the assessable incomes are close (rounded to 5 decimal places) to the income threshold of the pension income test, these incomes are set to exactly equal that threshold.

Insert Table 3 here

Table 3 provides a comparison of the simulation results for some macroeconomic variables generated by the benchmark steady state solution of the model with the actual data, which are reported as averages over the five-year period ending in June 2010. The table indicates that the model replicates the Australian economy fairly well. The components of domestic aggregate demand are close to their actual values expressed in percent of GDP, except for the trade balance, which is implied by the calibration target for the net foreign debt to capital ratio. The same holds for most of the displayed government indicators. The model income tax revenues are higher than the actual receipts because we do not consider any income tax offsets. The difference between the model and actual revenues from superannuation taxation is due to the full maturity of the superannuation system assumed in the model.

4 Implications of superannuation policy changes

In this section we present the simulation results of the mandatory superannuation reform that was announced in the 2010-11 federal budget. The reform includes (i) gradual increases in the mandatory SG rate and (ii) removal of the concessional tax rate on the SG contributions for the households with taxable income of no greater than $37,000 per year. Recall that the increases in the mandatory SG rate are scheduled to begin in 2013, with an initial increase of 0.25 percentage points. The rate is again to be lifted by 0.25 percentage points in 2014 and in the subsequent years, it increases by 0.5 percentage points annually until 2019 when the SG rate reaches 12 percent. Thus, the values of the

SG rate, cr, that appears in Equations (3) and (4) are

$$\begin{aligned}
cr &= 0.09, && \text{for } t < 2013,\\
cr &= 0.0925, && \text{for } t = 2013,\\
cr &= 0.095, && \text{for } t = 2014,\\
cr &= 0.1, && \text{for } t = 2015,\\
cr &= 0.105, && \text{for } t = 2016,\\
cr &= 0.11, && \text{for } t = 2017,\\
cr &= 0.115, && \text{for } t = 2018,\\
cr &= 0.12, && \text{for } t \geq 2019.
\end{aligned}$$

The second policy change is implemented in 2012 and the values of the contribution tax rate, τ^s, in Equations (3) and (4) become

$$\begin{aligned}
&\tau^s = 0.15, \quad \text{for } t < 2012\ ,\\
&\tau^s = 0.15, \quad \text{for } t \geq 2012 \ \text{ iff } \ y^i_{a,t} > \$37,000,\\
&\tau^s = 0, \qquad \text{for } t \geq 2012 \ \text{ iff } \ y^i_{a,t} \leq \$37,000.
\end{aligned}$$

The macroeconomic effects of the examined superannuation policy changes are reported in Table 4, while the distributional welfare and aggregate efficiency effects are presented in Table 5. The discussion on the policy implications that follows focuses on the effects for the 2010 superannuation reform as a whole, pointing out interesting effects due to the two components of the reform where appropriate.

Insert Tables 4 and 5 here

4.1 Macroeconomic effects

The macroeconomic effects of the superannuation changes that are displayed in Table 4 are presented as percentage changes in the selected per capita variables in the selected years of the transition from the initial steady state solution. The reform is announced in 2010 (i.e., year of the reform announcement), with the superannuation tax changes adopted in 2012 and the higher SG rate policy phased in from 2013. The results for year 2150 represent the long run steady state effects of the policy changes. Below we discuss

the macroeconomic effects in terms of the implications for the labour market, assets and capital accumulations, the goods market and for selected government indicators.

Labour market The superannuation policy implications for household labour supply consist of the substitution and income effects. The higher SG rate and contribution tax changes increases the effective price of leisure, which reduces demand for leisure, implying higher labour supply (the substitution effect). Both policy changes also generate larger superannuation balances and greater lifetime incomes for directly affected households, allowing these households to demand more leisure and thus reducing their labour supply (the income effect).[13] The interaction of these two effects across households of different ages and income types determines the implications for the per capita labour supply.

The impact (or announcement) effect of the reform as a whole on per capital labour supply is negative, with effective labour supply declining by 0.25 percent in 2010. This decrease is due to lower labour supply of mainly younger households that reduce their working hours prior to gradual increases in the mandatory SG rate.[14] When the SG rate increases begin to be phased in and in the medium term (see the labour supply effects in 2015 and 2030), the substitution effect dominates, households work longer hours and the per capita labour supply improves. In the long run, however, average labour supply declines by almost 1.25 percent, which is due to the stronger income effect arising from larger superannuation assets. The income effect of larger superannuation assets also brings forward full retirement for higher income households by about one year in the long run. These results are supported by empirical evidence provided by Buetler *et al.* (2005).

Although Creedy and Guest (2008b) do not directly evaluate the effects of higher mandatory superannuation contributions, they examine the abolition of the flat tax on superannuation contributions, which should have similar effects on the behaviour of households as well as on aggregate variables as both superannuation policy changes increase the effective price of leisure. However, they find the positive effect of this policy on aggregate labour supply over the entire transition on in the long run. The opposite labour supply effect can be explained by the following differences in the assumptions of their and

[13] The effects of changes in the superannuation contribution rate and tax rates applied to superannuation on the effective price of leisure and full income are derived by Guest and Creedy (2008a).

[14] The focus here is placed on the higher SG rate policy as the superannuation tax policy change (i.e., removal of the contribution tax for low income households) has a minimal and insignificant impact on per capita labour supply.

our models. First, they reduce exogenous transfer payments to balance the government budget, which effectively eliminates the income effect of the contribution tax removal on labour supply. Second, their model abstracts from life uncertainty and accidental bequests. In our model, these bequests, which are assumed to be received by households aged 45 to 65 years, increase due to larger assets held by older generations, thus strengthening the income effect on labour supply of bequest recipients. Third, in their model households face no borrowing constraints. Removing the non-negativity private asset restriction and thus allowing households to borrow against their larger future superannuation payouts in our framework would lead to significantly larger superannuation offset, generating smaller increases in domestic assets and thus weakening the income effect on labour supply.[15]

The SG rate creates a wedge between the market wage rate received by households (w_t) and the total wage rate faced by the representative firm ($w_t \times (1 + cr)$). The total wage rate is set by the profit maximising firm to the marginal product of labour (MPL_t), which, under the constant return to scale assumption for the production function, depends on the capital-labour ratio. This, combined with small open economy property of our model, implies that the capital labour ratio in the long run steady state is determined by the exogenous interest rate and the production function parameters. Since the exogenous interest rate is assumed to be constant, the capital labour ratio, the marginal product of labour (as well as capital) and the total wage rate faced by the firm (not displayed) are unchanged in the long run steady state.

The wage rate reported in Table 4 is the market wage rate received by households (i.e., $w_t = MPL_t/(1 + cr)$). The negative effects of the reform on w_t are caused by a lower marginal product of labour during the transition (as labour supply improves) and the increases in the SG rate. The 2.79 percent long run decrease in w_t is entirely driven by the increased SG rate from 9 to 12 percent as the long run marginal product of labour is unchanged.

[15] For comparison, we have examined long run steady state effects of the abolition of the contribution tax rate for all household types and find a reduction in the long run per capita labour supply by about 0.3 percent. However, assuming proportional changes to the age pension payments as a budget-balancing instrument and constant accidental bequests, we find an increase of about 0.28 percent in the long run average labour supply. The abolition of the contribution tax in the model without borrowing constraints (assuming accidental bequests and budget balancing adjustments in the consumption tax rate) generates a labour supply increase of about 0.29 percent in the long run.

Asset and capital accumulations Households accumulate (supply) two types of assets - ordinary private (non-superannuation) and superannuation. The sum of the two asset types gives the domestic total assets.[16] As expected, the superannuation reform leads to large increases in superannuation assets, with the increases arising primarily from the higher SG rate. The share of superannuation assets in the total assets increases from 52 percent in the initial steady state equilibrium to almost 60 percent in the new steady state equilibrium. Although some of the increases in superannuation assets are offset through decreases in ordinary non-superannuation assets, domestic total assets are over 18 percent larger in the long run as a result of the superannuation reform, indicating positive and significant reform effects on household saving. These large increases in total assets and household saving correspond with the finding of papers that examine the effects of voluntary tax-favored retirement accounts (see, for example, Imrohoroglu *et al.*, 1998) and Fehr *et al.*, 2008).[17]

The short and medium run implications of the reform for the per capita capital stock are also positive. These increases are caused by a higher price of capital (not displayed), which indicates that investors expect a higher net return on real capital. In the long run, the change in the capital stock is implied by the long run change in per capita labour supply (as the capital labour ratio is unchanged in the long run), with the capital stock falling by about 1.25 percent. The capital market clearance condition, which equates the value of the capital stock with domestic assets and net foreign debt (i.e., savings of foreigners in Australia less savings of the Australians overseas), implies that the increases in total domestic assets are exported abroad, which leads to a significant reduction in net foreign debt in the long run.

Goods market The domestic output is produced using labour and capital inputs. Thus, the effects of the superannuation reform on output and the economy are determined by the changes in two production inputs. The phasing-in period of the higher SG contributions has a positive effect on the output per capita but the long run per

[16] Note that private and total assets after age 60 are identical as the superannuation assets (vested in the superannuation fund) are paid out into ordinary private assets when households reach age 60.

[17] The increases in the domestic assets and household saving would be significantly smaller if we allow households to borrow against their superannuation assets. Creedy and Guest (2008b) using the OLG model with liquidity unconstrained households even find a small reduction in the saving rate as a result of the removal of the flat tax on superannuation contributions.

capita output falls as both inputs to production decline.[18] The output supply (or GDP) is equal to the sum of private and public consumption demand, investment demand and external demand (i.e., net export or trade balance), all measured in per capita terms in our framework. Per capita consumption, which accounts for nearly 56 percent GDP per capita, is negatively affected by the superannuation reform in the short and medium run, but it increases by about 1.22 percent in the long run. The long run increase in average consumption (a measure of living standards) results from greater household retirement consumption, which outweighs lower consumption of younger households facing higher consumption taxes and lower market wages.[19]

Government indicators One particular interest of the paper is the effect of the superannuation reform on the age pension expenditures to the government. In contrast to Creedy and Guest (2008b), our model incorporates the main features of the age pension means test, which enable us to examine the effects of superannuation changes on the means tested public pension payments.

The results for the pension expenditures indicate that overall reliance of eligible households on pension payments declines as a result of increased superannuation savings, which lead to greater household private incomes and assets in retirement. In the long run, the per capita age pension expenditures decrease by 4.65 percent due to the means testing of larger incomes and assets. The reduced pension expenditures imply smaller total government expenditures and revenues as we assume a balanced government budget and constant public consumption expenditures.

The total government revenues include tax receipts from household personal income, consumption and superannuation and from the firm's profit (i.e., corporate taxation). Personal income tax receipts represent the largest tax revenue that amounts to over 12 percent of GDP. These tax receipts decline significantly, caused by decreases in all the sources of personal income taxation - labour earnings, investment income (lower due to smaller private assets of households aged younger than 60) and the age pension.

[18] Note that the gross national product (GNP) would increase because of a significant reduction in interest payments on net foreign debt.

[19] The effects on the other components of aggregate demand are not displayed. In brief, net export increases in the medium term (as output increases and consumption demand declines) and decreases substantially in the long run to balance lower output and higher consumption. Government consumption is kept constant over the entire transition and the policy effects on investment demand are similar to those in the capital stock discussed above.

The effects on superannuation tax revenues differ between the two examined policy changes. Under the higher SG rate policy, superannuation tax receipts are significantly greater because of larger superannuation asset balances, while the removal of the superannuation contribution tax for lower income households lowers the tax receipts from superannuation. The implications of the superannuation reform as a whole are negative for the superannuation tax revenues initially when the contribution tax change is implemented but the revenues are 18.43 percent greater in the long run due to the higher SG rate policy.

The simulations of the superannuation policy changes assume that it is the consumption tax rate that ensures the balance between government expenditures and tax revenues. Although the pension costs to the government and thus the total government expenditures decline, the consumption tax rate increases over the entire transition and is almost 7.9 percent higher in the long run. The increases in the consumption tax rate are required to mainly offset the reductions in the revenues from personal income taxation.

4.2 Welfare and efficiency effects

We use the concept of standard equivalent variation to calculate the distributional welfare effects of the superannuation reforms. Equivalent variation for a particular generation measures 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. The increase in this generation's wealth brings about the proportional increase in consumption and leisure, which would make them as well off in the benchmark scenario as in the reform scenario (for more detailed information, see Auerbach and Kotlikoff, 1987, p. 87).

The distributional welfare effects of the two superannuation changes and the reform as a whole are reported in Table 5 (labelled as "Without LSRA"). These effects are presented as percentage changes in remaining utility for generations of different ages at the time of the policy announcement (inter-generational welfare effects) and for the five income types of households (intra-generational welfare effects).[20] Several observations

[20] Note that the youngest generation at the time of the policy announcement is aged 21 years, which is the assumed entry age in the model. All the generations aged 20 years and younger are those born in the succeeding years of the transition. The results for the generation aged -80 in year 2010 (i.e., generation

can be drawn from these results. First, the reform package has negative impact on welfare of older cohorts that no longer participate in workforce and, therefore, do not receive any SG contributions. These cohorts face higher consumption taxes that reduce their net consumption. Second, younger cohorts of the two low income types that accumulate superannuation assets experience welfare improvements, which arise entirely from the removal of the tax on their SG contributions. The future born generations of the second income quintile gain the most in welfare from the reform, with a long run welfare increase of 0.49 percent. Third, younger and future born generations of the two highest income quintiles also attain higher welfare, but their welfare gains are driven solely by the increased SG rate.[21] Fourth, younger cohorts of the middle income households (those in the third quintile) experience welfare gain due mainly to the higher SG contributions but also, to some extent, due to the removal of the contributions tax.[22]

Table 5 also shows that the two superannuation policy have opposite effects on the vertical equity of the superannuation system. The contribution tax policy improves the vertical equity as younger cohorts of lower income households benefit from this policy, while the higher income groups affected only indirectly through higher consumption taxes lose in welfare. On the other hand, the policy of the gradual increases in the mandatory SG rate would worsen the vertical equity as welfare increases only for higher income groups because of superannuation tax concessions. Under this policy alone, lower income groups suffer welfare losses as superannuation for them does not provide any tax advantages (their often face marginal income tax rates lower than 15 percent) but they (as other income types) would be paid lower wages.

The discussion of the welfare implications above has revealed that while some generations and income classes would gain others would lose in welfare. To provide overall assessment of the superannuation reform changes, we calculate an aggregate efficiency effects by applying a hypothetical Lump Sum Redistribution Authority [LSRA], an approach described, for example, by Auerbach and Kotlikoff (1987) and Nishiyama and Smetters (2007). The LSRA restores utility of households alive at the time of the policy

born in 2110) represent the long run welfare effects.

[21] Note that these households face marginal income tax rates of well above 15 percent that is applied to their superannuation contributions.

[22] Only few cohorts of middle income households do not have to pay the contribution tax as their taxable income does not exceed the $37,000 threshold. These are of very young ages and just before age 60 when superannuation savings are paid out.

announcement through lump-sum transfers or taxes and raises or reduces lifetime utility of all future born generations by a uniform amount. In the case of an increase in lifetime utility of future born generations, the given policy change generates efficiency gains and is potentially Pareto improving. Table 5 shows that the 2010 superannuation reform is potentially Pareto improving, generating an aggregate efficiency gain of almost 0.8 percent or $11,753 in initial resources for each future born generation, arising primarily from the increased mandatory SG rate.

5 Robustness check to alternative assumptions

In this section, we examine the robustness or the sensitivity of the macroeconomic and welfare impacts of the 2010 mandatory superannuation reform to three alternative assumptions of the model.

The first modification of the model considers the effects of the superannuation reform, assuming the government budget to be balanced through adjustments in the taxation of household income.

In the second variant of the model, we endogenise the domestic interest rate such that it adjusts to the changes in the net foreign debt to output ratio. Following Guest (2006) and Valkonen (1999), we set the domestic interest rate, r_t, as

$$r_t = \overline{r} + \gamma \left(\frac{FD_t}{Y_t} - \frac{FD_{2010}}{Y_{2010}} \right), \tag{13}$$

where $\overline{r}$ is the exogenous world interest rate, FD_t/Y_t is the ratio of net foreign debt to output and the parameter γ gives responsiveness to the changes in FD_t/Y_t. We set γ to 0.02 - the same value used by Guest (2006).[23]

The third modification of the model implements gradual increases in the age pension age. We closely follow the new legislation by assuming that the eligibility age for the age pension is increased to 66 years in 2018 (for households currently aged 57 to 53 years) and to 67 years in 2023 (for those currently aged 52 years and younger).

Insert Tables 6 and 7

[23]The expression in (13) implies that any reduction in Australia's net foreign debt will reduce the domestic interest rate, while higher net foreign debt will increase it.

The robustness check to the three alternative assumptions is carried out only for the simulations of the superannuation reform as a whole. Table 6 reports the percentage point changes in the selected macroeconomic variables from the "baseline" results of the superannuation reform. The deviations of the welfare effects (effects without LSRA) and aggregate efficiency implications (effects with LSRA) under the three variants of the model from the welfare results in Section 4 are presented in Table 7.

5.1 Income tax adjustments balancing the budget

The budget-balancing consumption tax rate used in Section 4 is assumed to be fixed here and the changes to the household income taxation are made to balance the government expenditures and revenues. At present, it is quite unlikely that the statutory GST rate of 10 percent in Australia would change, while changes to the personal income tax schedule were often implemented in the past. Rather than adjusting particular tax parameters such as tax brackets and/or marginal tax rates, we simply assume that the government budget is balanced by proportionally raising or lowering the household income taxation schedule, thus proportionally raising or lowering average and marginal income tax rates.

The effects of the superannuation reform on the average income tax rates are reported in the last column of Table 6. The rates increase significantly during the transition, with the average income tax rate being 4.13 percent higher in the long run. These tax rate increases are needed to offset decreases in all income tax sources (labour and investment incomes and the age pension). The decreases in the age pension costs are smaller compared to those presented in Section 4 (the long run decline is 0.389 percentage points smaller), but they are still significant, confirming improved self-funding of many households in retirement through larger asset accumulations. The larger superannuation assets generate greater domestic total assets, but note that the increases in domestic total assets are not as high as under the budget-balancing consumption tax rate. The reason is a relatively greater decline in the per capita labour supply, which, under this alternative model assumption, falls due to the income effect of larger superannuation assets and also because of higher average income tax rates. Using the proportional income tax changes as a budget-balancing policy instrument is also less favorable for household consumption. The long run increase is 0.69 percentage points smaller relative to the

long run increase in per capita consumption generated by the reform simulation with the endogenous consumption tax rate.

Several observations can be drawn from the relative changes in the welfare and efficiency results under this alternative assumption that are presented in Tables 7. First, older already retired generations (e.g., those aged 80 years in 2010) are better off under the income tax adjustments policy as they face low or no income taxes. Second, the long run welfare gains for lower (higher) income classes are greater (smaller) when the budget-balancing income tax changes are used. The increases in the average income tax rates negatively affect especially the households in the two highest quintiles, whose welfare gains declines by 0.12 and 0.267 percentage points, respectively. Third, the result for the overall assessment of the superannuation reform shows a decrease in efficiency gains by 0.25 percentage points or by $3,766 in initial resources compared to the efficiency gain reported in Section 4.

5.2 Endogenous domestic interest rate

The assumption of imperfect capital mobility with the endogenous domestic interest rate (adjusting to changes in the net foreign debt to output ratio) implies that the capital labour ratio and the total wage rate faced by the representative producer will change not only during the transition but also in the long run. Hence, under this alternative simulation of the superannuation reform, the long run percentage changes in the capital stock and output will differ from the long run changes in labour supply.[24]

The results indicate that the superannuation reform initially increases the domestic interest rate because of higher net foreign debt. In the medium term, the rate of interest declines as the international asset position improves and in the long run, the rate declines by over 6.6 percent. The lower interest rate drives larger investment expenditures, which lead to a greater accumulation of capital. The long run capital stock is almost 6.43 percentage points higher in the long run. The market wage rate declines far less relative to the reform simulation with the exogenous interest rate in Section 4. This is because here capital deepening (higher capital labour ratio) occurs during the transition as well

[24]This would also occur in the closed economy simulation. Similar results to those discussed below are obtained by Fehr *at al.* (2008) who using a closed economy OLG model, show that the introduction of voluntary tax-favored retirement accounts would increase significantly total assets, capital stock and output and lower interest rate in the long run.

as in the long run. The higher capital stock is also behind increased per capita output in the long run and the long run average consumption is about 1.14 percentage points greater compared to the long run consumption increase presented in Section 4. While the lower interest rate positively affects the capital stock, the long run increase in domestic assets is smaller, which leads to a relatively smaller long run reduction in the age pension expenditures to the government.

The relative changes in the welfare effects on older generations are insignificant (see Table 7). The younger cohorts and the generations born shortly after the reform announcement are relatively worse off as they face higher consumption taxes. However, the long run welfare improves substantially for all income classes of households in this endogenous interest rate framework, which is due to relatively lower consumption taxes and higher wages. For example, the households in the lowest income quintile experience a 0.334 percentage point increase in their lifetime resources. This alteration of the model also generates an increase in the aggregate efficiency gain by 0.129 percentage points, indicating that the larger discounted welfare gains in the long run outweigh the higher welfare losses in the short run.

5.3 Higher age pension eligibility age

This variant of the model accounts for the gradual increases in the age pension eligibility age that were announced in the 2009-10 federal budget. We first compute the transition path with the higher age pension age alone and then we simulate the superannuation reform in the higher age pension age setting.[25] In Table 6, we report the relative changes in the selected macroeconomic variables between the two simulations and the reform simulation in Section 4. Similarly, Table 7 reports the relative changes in the welfare and efficiency results between the two simulations and the reform simulation with the constant age pension age.

Both macroeconomic and welfare results reveal that the alternative assumption of gradual age pension age increases does not significantly change the main effects of the superannuation reform. There is a relatively smaller long run reduction in the average

[25]It should be noted that the gradual increases in the age pension age alone significantly reduce the age pension costs to the government as especially lower income households receive the pension from the new higher eligibility age (see Kudrna and Woodland, 2011). Lower income households also postpone their full retirement from workforce, which leads to greater per capita labour supply.

age pension expenditures, which is because of the shorter period of age pension payments to lower and middle income households (shorter period of means testing of their larger assets).[26] Relatively higher age pension expenditures per capita partly explain higher consumption tax rates, which are behind somewhat smaller welfare gains for future born generations and a lower aggregate efficiency gain compared to compared to those in Section 4.

6 Summary

We have presented the macroeconomic and welfare effects of the 2010 reform to mandatory superannuation. Using a general equilibrium OLG model, we have simulated the major policy changes of the reform, including the gradual increases in the mandatory SG rate from 9 percent to 12 percent and the policy that effectively removes the 15 percent tax on mandatory contributions for lower income households.

Our simulations show that the superannuation reform as a whole would significantly increase superannuation assets, leading to larger domestic total assets and saving. The household self-funding in retirement would improve and the reliance on pension payments would fall due to the means testing of larger retirement assets and private incomes. Larger total asset accumulations would also generate a dominating income effect on per capita labour supply and bring forward full retirement for higher income households by one year. The increased mandatory SG rate policy has been shown to be the dominant policy of the reform, while the main goal for the supporting policy of the contribution tax change was to improve fairness of superannuation. The equity improvements arising from that policy change have been demonstrated by the distributional welfare analysis. Although the reform improves long run welfare for all income types, higher income quintiles benefit entirely from the increased SG rate, while lower income quintiles benefit solely from the contribution tax policy. Using the LSRA, which restores remaining utility of all existing generations to their pre-reform level, we have also found the superannuation reform to be potentially Pareto improving, producing an aggregate efficiency gain of \$11,753 in initial resources for each future born household.

[26] Note that from year 2023 onwards the means testing no longer applies for assets and asset incomes at ages 65 and 66 years as the new age pension eligibility age is 67.

We have also examined sensitivity of our policy results to alternative model assumptions. While incorporating the gradual increases in the age pension age is insignificant for the results of the superannuation reform, the other alternative assumptions have more robust effects on the results. The superannuation reform with the budget-balancing changes in the income taxation would provide disincentives for working households to supply labour due to the increases in average income tax rates, generating less favorable outcomes for per capita labour supply and consumption and for welfare of younger and future born generations of higher income quintiles. The superannuation reform with the endogenous interest rate has been shown to reduce the domestic interest rate in the medium and long term, raising the demand for capital, generating capital deepening with positive effects on wages and significantly improving long run welfare for every income group.

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Table 1: Values of Key Parameters of Benchmark Steady State Model

Symbol	Description	Value	Source
	Demographics		
n	Population growth rate	0.017	Calibrated[a]
ω_i	Fraction of households of income group i	All 0.2	Data[b]
s_a	Conditional survival probabilities	ABS (2010a)	Data
	Utility function		
γ	Inter-temporal elasticity of substitution	0.35	Literature[c]
ρ	Intra-temporal elasticity of substitution	0.9	Literature[c]
β	Subjective rate of time preference	0.014	Calibrated
α	Leisure intensity parameter	1.4	Literature[c]
	Production function		
κ	Production constant	0.885	Calibrated
σ	Elasticity of substitution in production	0.939	Calibrated
ε	Capital share	0.450	Calibrated
δ	Depreciation rate	0.073	Calibrated
ψ	Adjustment cost parameter	10	Literature[d]

Notes: [a] The population growth rate is calibrated such that it together with survival probabilities generates the old age dependency ratio of 0,2;[b] Each generation is divided into income quintiles based on ABS (2007); [c] The values of these parameters are similar to those in Auerbach and Kotlikoff (1987) and are close to the estimated values by Ghez and Backer (1975); [d] This value is taken from Auerbach and Kotlikoff (1987);

Table 2: Values of Policy Parameters in Benchmark Steady State Model

Symbol	Description	Value	Source
$\bar{\tau}^c$	Statutory consumption tax rate [GST]	0.1	Data
$\bar{\tau}^f$	Statutory corporation tax rate	0.3	Data
υ^c	Consumption tax base parameter	0.704	Calibrated[a]
υ^f	Corporation tax base parameter	0.866	Calibrated[b]
p	Maximum pension per year (in $100,000)	0.174694	Data
IT	Income test threshold (in $100,000)	0.03976	Data
θ	Assets test threshold (in $100,000)	3.07	Data
AT	Income reduction (taper) rate	0.5	Data
ϕ	Assets reduction (taper) rate	0.039	Data
cr	Mandatory superannuation contribution rate	0.09	Data
τ^s	Superannuation contribution tax rate	0.15	Data
τ^r	Superannuation earnings tax rate	0.071	Data[d]

Notes: [a] The product of this tax base parameter and the statutory GST rate of 10 percent gives the effective consumption tax rate of 7.04 percent that appears in the households' budget constraint; [b] The product of this tax base parameter and the statutory corporation tax rate generates the effective corporation tax rate of about 25.9 percent; [c] This is roughly a value for the effective tax rate on superannuation earnings.

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Table 3: Benchmark Steady State Solution and Macroeconomic Data

Variable	Benchmark model	Australia [a]
Expenditures on GDP (percent of GDP)		
- Private consumption	55.27	56.22
- Investment	27.03	27.38
- Government consumption	15.78	17.88
- Trade balance	1.93	-1.30
Government indicators (percent of GDP)		
- Age pension expenditure	2.78	2.70
- Personal income taxes	12.41	11.49
- Corporation taxes	5.27	5.27
- Consumption taxes (GST revenue)	3.89	3.89
- Superannuation taxes	1.14	0.80
Targeted calibration ratios		
- Capital-output (*K/Y*)	3.00	3.00
- Investment-capital (*I/K*)	0.09	0.09
- Foreign debt-capital (*FD/K*)	0.195	0.195

Source: Our simulations and ABS (2010b) and Commonwealth of Australia (2011)
Notes: [a] The data for Australia are five year averages over the period ending in June 2010.

Table 4: Macroeconomic Implications of Superannuation Policy Changes
(Percentage Changes in the Selected Macroeconomic Variables from the Initial Steady State [SS] Solution)

Variable	Initial SS Solution		(i) Gradual Increases in the Mandatory SG rate				(ii) Contribution Tax Removal for Low Income Groups				(iii) Superannuation Reform (Policies (i) and (ii))			
			2010	2015	2030	2150	2010	2015	2030	2150	2010	2015	2030	2150
Labour supply	0.4084	%	-0.21	0.16	0.66	-1.16	-0.04	0.12	0.11	0.05	-0.25	0.28	0.77	-1.25
Wage rate	1.0000	%	0.10	-0.91	-2.80	-2.68	0.02	-0.04	-0.01	0.00	0.11	-0.95	-2.82	-2.68
Capital stock	2.3133	%	0.00	0.16	0.38	-1.16	0.00	0.04	0.08	0.05	0.00	0.20	0.45	-1.25
Domestic assets	1.8629	%	0.00	0.00	3.53	15.37	0.00	0.04	0.42	1.02	0.00	0.04	4.26	18.29
- Ordinary private	0.9450	%	0.00	-0.22	-6.34	0.79	0.00	-0.17	-0.79	-1.08	0.00	-0.40	-6.88	2.56
- Superannuation	0.9705	%	0.00	0.21	13.21	30.37	0.00	0.25	1.62	3.16	0.00	0.47	15.19	34.45
Foreign debt	-0.4504	%	0.95	2.21	-13.0	-69.6	0.30	0.30	-1.31	-3.96	1.25	2.52	-15.6	-82.1
Output (GDP)	0.7702	%	-0.12	0.16	0.54	-1.16	-0.02	0.09	0.10	0.05	-0.15	0.25	0.64	-1.25
- Consumption	0.4257	%	-0.10	-0.13	-0.37	0.89	0.03	0.00	0.06	0.20	-0.06	-0.16	-0.41	1.22
Pension expenditures	0.0215	%	-0.02	-0.05	-0.18	-3.51	-0.01	-0.08	-0.15	-0.29	-0.03	-0.14	-0.37	-4.65
Total tax revenues	0.1749	%	0.00	-0.01	-0.02	-0.43	0.00	-0.01	-0.02	-0.04	0.00	-0.02	-0.05	-0.57
- Personal income	0.0955	%	-0.22	-1.07	-3.75	-5.13	0.05	0.00	-0.02	-0.09	-0.17	-1.07	-3.76	-5.10
- Superannuation	0.0088	%	-0.07	6.54	24.22	29.05	-0.01	-9.26	-8.71	-8.16	-0.09	-3.69	12.82	18.43
Consumption tax rate	0.1000	%	1.46	1.80	4.05	5.96	-0.04	2.52	2.31	2.19	1.41	4.60	7.14	7.90

Notes: The monetary values of the initial steady state solution (rounded to 4 decimal places) are expressed in units of $100,000 and per capita.

Table 5: Welfare Implications of Superannuation Policy Changes

Policy Change	Age in 2010	Without LSRA [a] Household Income Type					With LSRA for all Types [b]	
		Lowest	Second	Third	Fourth	Highest	(%)	($)
(i) Gradual Increases in the SG Rate	80	-0.045	-0.045	-0.044	-0.043	-0.042	0.000	0
	60	-0.067	-0.065	-0.062	-0.055	-0.046	0.000	0
	40	-0.103	-0.080	-0.031	0.026	0.071	0.000	0
	20	-0.140	-0.059	0.080	0.216	0.294	0.733	10,599
	-20	-0.081	-0.035	0.185	0.410	0.536	0.733	10,599
	-80	-0.103	-0.057	0.161	0.387	0.513	0.733	10,599
(ii) Removal of Contribution Tax for Low Income Groups	80	-0.047	-0.047	-0.046	-0.046	-0.044	0.000	0
	60	-0.043	-0.033	-0.047	-0.051	-0.050	0.000	0
	40	0.125	0.166	-0.038	-0.054	-0.053	0.000	0
	20	0.252	0.316	0.030	-0.057	-0.055	0.006	88
	-20	0.317	0.348	0.062	-0.050	-0.048	0.006	88
	-80	0.317	0.348	0.062	-0.050	-0.048	0.006	88
(iii) Reform as a Whole	80	-0.099	-0.098	-0.097	-0.095	-0.092	0.000	0
	60	-0.123	-0.111	-0.120	-0.118	-0.108	0.000	0
	40	0.038	0.117	-0.077	-0.041	0.006	0.000	0
	20	0.139	0.337	0.104	0.146	0.226	0.795	11,753
	-20	0.312	0.507	0.301	0.363	0.491	0.795	11,753
	-80	0.293	0.488	0.280	0.342	0.470	0.795	11,753

Notes: [a] Standard equivalent variations measures; [b] Measured as both percentage and dollar gains in initial resources.

Table 6: Robustness Check of Macroeconomic Effects of Superannuation Reform to Alternative Assumptions
(Percentage Point Changes in the Selected Macroeconomic Variables from "Baseline" Results of Superannuation Reform)

Alternative assumptions	Year	Capital stock	Domestic assets	Foreign debt	Output (GDP)	Consum-ption	Labour supply	Wage rate	Interest rate (a)	Pension costs	Tax rate (b)
(i) Income Tax Changes Balancing Government Budget	2010	0.000	0.000	-0.967	0.049	0.002	0.085	-0.038	0.000	0.013	0.214
	2015	-0.128	-0.060	-1.333	-0.222	-0.095	-0.291	0.072	0.000	0.056	1.889
	2030	-0.367	-0.643	0.393	-0.418	-0.435	-0.456	0.038	0.000	0.244	3.479
	2150	-0.472	-1.057	1.949	-0.472	-0.690	-0.472	0.000	0.000	0.389	4.132
(ii) Endogenous Domestic Rate of Interest	2010	0.000	0.000	-0.352	-0.052	0.022	-0.090	0.041	0.254	-0.101	0.067
	2015	0.006	-0.023	0.551	-0.106	0.052	-0.187	0.086	0.698	-0.292	0.335
	2030	0.985	-0.700	12.158	0.288	0.241	-0.217	0.522	-0.962	0.230	1.461
	2150	6.427	-5.110	54.147	3.273	1.136	1.032	2.330	-6.643	3.617	-5.798
(iii) Higher Age Pension Eligibility Age	2010	0.000	0.000	-0.011	-0.004	0.014	-0.006	0.003	0.000	-0.001	-0.049
	2015	0.000	-0.030	0.115	0.001	0.029	0.002	-0.001	0.000	0.000	-0.029
	2030	-0.003	-0.245	0.737	0.001	0.062	0.004	-0.003	0.000	0.074	0.763
	2150	0.010	-1.456	2.308	0.010	-0.179	0.010	0.000	0.000	0.536	2.575

Notes: [a] The interest rate adjusts only under the second alternative policy simulation and in the remaining alternative policy simulations, the interest rate is exogenous and assumed to be constant; [b] The tax rate is the consumption tax rate, except for the first alternative simulation where this column shows the proportional changes to the household income taxation.

Table 7: Sensitivity of Welfare Effects of Superannuation Reform to Alternative Assumptions (Deviations from "Baseline" Welfare Results of Superannuation Reform)

Alternative Assumptions	Age in 2010	Without LSRA (a) Household Income type					With LSRA for all types (b)	
		Lowest	Second	Third	Fourth	Highest	(%)	($)
(i) Income Tax Changes Balancing Government Budget	80	0.041	0.051	0.058	0.062	0.069	0.000	0
	60	0.056	0.063	0.063	0.055	0.022	0.000	0
	40	0.089	0.071	0.031	-0.012	-0.089	0.000	0
	20	0.098	0.068	0.005	-0.065	-0.173	-0.254	-3,766
	-20	0.099	0.063	-0.021	-0.117	-0.265	-0.254	-3,766
	-80	0.097	0.061	-0.023	-0.120	-0.267	-0.254	-3,766
(ii) Endogenous Domestic Interest Rate	80	-0.007	0.002	0.005	0.005	0.006	0.000	0
	60	-0.007	-0.007	-0.003	-0.002	0.013	0.000	0
	40	-0.003	-0.018	-0.020	-0.018	-0.029	0.000	0
	20	-0.036	-0.044	-0.045	-0.042	-0.067	0.129	1,774
	-20	0.196	0.212	0.228	0.215	0.160	0.129	1,774
	-80	0.334	0.348	0.370	0.356	0.302	0.129	1,774
(iii) Higher Age Pension Eligibility Age	80	-0.001	-0.001	-0.001	-0.001	-0.001	0.000	0
	60	-0.003	-0.002	-0.002	-0.002	-0.002	0.000	0
	40	0.030	0.005	0.001	-0.006	-0.005	0.000	0
	20	0.057	0.001	-0.006	-0.016	-0.010	-0.096	-1,461
	-20	0.022	-0.062	-0.043	-0.053	-0.035	-0.096	-1,461
	-80	0.018	-0.063	-0.046	-0.055	-0.038	-0.096	-1,461

Notes: [a] Standard equivalent variations measures; [b] Measured as both percentage and dollar gains in remaining resources.