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Comparing Budget Repair Measures for a Small Open Economy with Growing Debt*

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Abstract

We quantify the macroeconomic and welfare effects of alternative fiscal consolidation plans in the context of a small open economy. Using an overlapping generations model tailored to the Australian economy, we examine immediate and gradual eliminations of the existing fiscal deficit with (*i*) temporary income tax hikes, (*ii*) temporary consumption tax hikes and (*iii*) temporary transfer payment cuts. The simulation results indicate that all three fiscal measures result in favourable long-run macroeconomic and welfare outcomes, but have adverse consequences in the short run that are particularly severe under the immediate fiscal consolidation plan. Moreover, our results show that cutting transfer payments leads to the worst welfare outcome for all generations currently alive. Increasing the consumption tax rate results in smaller welfare losses, but compared to raising income taxes, the current poor households pay much larger welfare costs. The adverse effects on wellbeing of current generations highlight political constraints when implementing a fiscal consolidation plan. However, after compensating current generations for all welfare losses, there is still an overall efficiency gain. This implies possibilities to devise a fiscal consolidation plan supported by a compensation scheme to improve wellbeing of future generations.

Keywords: Fiscal deficit; Public debt; Fiscal consolidation; Welfare; Dynamic general equilibrium; Small open economy

JEL Classification: C68, E21, E63, H31, H60, J26

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1 Introduction

Recent unfavourable macroeconomic conditions have put many advanced economies in a tough fiscal situation with large budget deficits and rapidly growing government debt. According to IMF (2010), Japan tops the list with a gross government debt-GDP ratio well over 200%. Greece is the second with gross debt over 150% of GDP. Countries with gross government debt-GDP ratios over 100% include Italy, Portugal, Ireland, and the United States. Major European countries face a similar debt problem. France and the United Kingdom are in the 80%-100% range, as is fiscally responsible Germany. Persistently sluggish economic growth has prevented the normal cyclical improvement in fiscal balances. Accordingly, fiscal consolidation has become a topical policy issue in Europe and America.

Among advanced economies, Australia stands out as a special case as it has not experienced any economic recession over the last 25 years. However, since the global financial crisis, it has suffered from significant fiscal deficits that have resulted in fast-growing government debt. Specifically, the underlying cash deficit reached 4.2% of GDP in 2010 and 3.1% of GDP in 2014, with net (gross) Commonwealth government debt amounting to 12.8% (over 20%) in June 2014 (Australian Government, 2015). Similarly to many other developed countries, the Australian government is committed to returning its budget to surplus as soon as possible. According to the recent government projections in the 2015-16 Federal Budget (Australian Government, 2015), the government plans to gradually eliminate budget deficits by 2020, with a modest surplus of 0.4% of GDP forecasted for the final projection year of 2026.

A number of fiscal consolidation measures have been proposed to achieve this goal, including temporary tax increases and/or spending cuts. There is a significant degree of uncertainty regarding achieving this projected path to budget surpluses. Undoubtedly, the proposed budget repair measures will have some unpleasant macroeconomic and welfare impacts. However, ambiguity over potential outcomes of the proposed budget repair measures and disagreement on the timing of these interventions have exacerbated uncertainty and therefore stimulated heated debates among the Australian public and policymakers. More specifically, there are no clear answers to several fundamental questions: What exactly are the macroeconomic effects during the austerity period and in the long run? What are the effects on the wellbeing of households? Which households and generations will be the winners or losers and how much will they gain or lose comparatively? Which combination of policy actions is the most preferable - weighing up the macroeconomic effects and the implications for intergenerational and distributional equity?

In this paper, we aim to address these questions in the context of a dynamic general equilibrium, overlapping generations (OLG) framework. In particular, we aim to quantify and compare the economy-wide implications of several budget repair measures to achieve either the immediate elimination of the 2014 budget deficit (in 2015) or the gradual elimination of the existing budget deficit (starting in 2015), as projected by Australian Government (2015).

These fiscal policy measures include: (*i*) temporary increases in the progressive income taxes; (*ii*) temporary increases in the consumption tax rate; and (*iii*) temporary cuts in the transfer payments. We are especially interested in the welfare implications for different age cohorts and household income types. Understanding these implications (and the macroeconomic effects) of the examined budget repair measures in the Australian context will benefit not only Australian fiscal policy but also other small open economies facing similar problems with large budget deficits and rapidly-growing public debt.

To undertake this quantitative analysis, we employ a small open economy OLG model that is calibrated to the Australian economy. The model comprises overlapping generations of heterogeneous households, perfectly competitive firms, a government sector incorporating essential fiscal policy settings, and a foreign sector with an exogenous interest rate. The heterogeneous households are different with respect to ages and skill types. The government sector consists of various public transfer programs and a variety of tax financing instruments such as progressive income, consumption, superannuation and corporate taxes. The government can also issue debt to finance its fiscal deficits. Importantly, the economic decisions made by households and firms (i.e., labour supply, saving and investment decisions) are subject to the distortions introduced by the fiscal policy. The rich structure of household heterogeneity and the detailed composition of government fiscal activities are essential to study the effects of various budget repair measures on macro aggregates and wellbeing of different households.

We first discipline households in our model to mimic the lifecycle behaviour of Australian households, including labour supply and earnings and pension payments observed from the household survey data. We also calibrate our benchmark economy to target key Australian macroeconomic aggregates, the government budget deficits and net debt between 2000 and 2014. Next, we compute the baseline transition that assumes an unchanged budget deficit-GDP ratio (as observed in 2014) and allows for net government debt to gradually increase to a new steady state debt implied by the current budget deficit. Finally, we apply our model to simulate the two fiscal consolidation plans achieved by either increasing tax rates or cutting social benefits, and compare their macroeconomic and welfare effects with those derived under the baseline transition.

Our simulation results indicate that while all three budget measures achieve the same fiscal goal (of reducing and eventually eliminating government debt), the macroeconomic and welfare effects of each budget measure differ significantly across households, generations and over time. More specifically, each examined fiscal measure results in favourable long-run macroeconomic and welfare outcomes, but have adverse short run consequences that are particularly severe under the immediate fiscal consolidation plan. The current generations born before the fiscal consolidation are likely not be supportive of any of the fiscal measures as they would suffer significant welfare losses of (on average) up to 12% in their remaining resources due to cuts in transfer payments (including age pensions) or facing higher tax rates. In contrast, future

generations are shown to experience welfare gains of up to 0.8% in their lifetime resources, as a result of no public debt in the long run allowing for smaller taxes or higher transfer payments.

We show that taxing consumption or income leads to opposing macroeconomics and welfare implications. In particular, temporary increases in the consumption tax rate generate only small economic distortions with the impact on per capita labour supply, assets and output being modest, but they reduce the welfare of poor households most. Conversely, temporary increases in progressive income tax rates have largely negative effects on the economy, but reduce the welfare of poor households least. Moreover, there are interesting welfare trade-offs when choosing between transfer payment cuts and tax hikes. Cutting the transfer payments results in the largest welfare losses for current low-income generations, but the highest welfare gains for future generations, compared to the two tax measures.

In general, our results highlight challenges for the government when implementing any of the proposed budget repair measures. We show that each of the fiscal consolidation plans improves the wellbeing of future generations, but at the expense of large welfare losses borne by current generations. However, when we introduce a system of income transfers administered by a hypothetical Lump Sum Redistribution Authority (LSRA), we find positive overall efficiency/welfare outcomes. This implies that it is possible to devise a fiscal consolidation plan to improve wellbeing of future generations, if the government introduces a redistribution program to offset the adverse effects of budget repair measures on current generations.

Related studies. Our paper contributes to several branches of the literature. There is a fairly large body of literature that has been devoted to analysing the macroeconomic and distributional effects of fiscal policy. Jager and Keuschnigg (1991) examine the burden of increased public debt in open economies, using a numerical overlapping generations model with inelastic labour supply. Baxter and King (1993) use an infinitely-lived, representative agent model to explore the general equilibrium effects of changes in government spending and tax financing instruments. Heathcote (2005) investigates the effects of tax cuts in a heterogeneous agent model with infinitely-lived agents and incomplete markets. Fehr and Ruocco (1999) investigate the distributional and efficiency consequences of the Italian debt reduction, whereas Kitao (2010), using a similar large-scale OLG model, examines the effects of temporary tax cuts and rebate transfers in the US. Recently, Imrohoroglu *et al.* (2016) develop a large-scale OLG model to measure the effects of pension and tax reforms on pension and non-pension deficits in Japan. Glomm *et al.* (forthcoming) quantify the macroeconomic and welfare effects of fiscal austerity measures in Greece. In this paper, we also use an OLG model, but focus on the fiscal consolidation in Australia that has a fast-growing but relatively low government debt, which is far below the steady state level implied by the existing budget deficit.

There is also a growing body of macroeconomic literature that analyses the effects of public debt financing. Erceg and Linde (2012) study the effects of fiscal consolidation in relation to whether monetary policy is constrained by a currency union membership or by the zero lower

bound on policy rates. Forni *et al.* (2010) quantify the macroeconomic implications of permanently reducing the public debt to GDP ratio in euro area countries. Chen and Imrohoroglu (2016), using a neoclassical growth model, investigate the consequences of different tax policies to reduce government debt for the US economy. Hansen and Imrohoroglu (2016) build a similar model to quantify the impact of different tax policies needed to restore fiscal balance in Japan. Notice that since these papers use a representative agent framework, they abstract from intergenerational and distributional effects of fiscal consolidations. Our paper is complementary to these papers as we incorporate agent heterogeneity and a variety of government activities into our model. We can analyse not only the aggregate welfare effect but also the distributional welfare effects within and across cohorts.

Finally, we contribute directly to the literature evaluating the economic effects of fiscal policy in Australia. The core models for fiscal projections and policy analyses by the Federal Treasury (Australian Government, 2015) and the Productivity Commission (Productivity Commission, 2013) are micro-simulation models, which abstract from modelling microfoundations of household behaviour. Contrary to the micro-simulation approach, there is a growing body of literature, using general equilibrium OLG models that incorporate the behaviour of households and firms to analyse the impacts of fiscal policy reforms in Australia (e.g., Kudrna and Woodland (2011a, b) and Kudrna *et al.*, 2015). We extend these studies by incorporating a more detailed disaggregation of households into income quintiles, technical progress and the government's ability to issue public debt. Notably, this paper is the first attempt to evaluate the welfare effects of the proposed budget repair measures, using an OLG model calibrated to the Australian economy.

The paper is structured as follows. The next section sets up a dynamic, general equilibrium OLG model used for the fiscal policy analysis and Section 3 provides details on the calibration of the model. In Section 4, we examine a range of policy experiments to eliminate the existing fiscal deficit, with the results presented in terms of macroeconomic and welfare implications. Section 5 performs a sensitivity analysis of alternative assumptions of the model. Section 6 offers some concluding remarks.[1]

2 Model

The model is essentially a small open economy variant of Auerbach and Kotlikoff's (1987) model augmented to capture key features of the Australian economy and that consists of household, production, government and foreign sectors. The detailed description of the model and a

[1]The paper also contains an appendix with the results for alternative budget repair measures, and there is also an online technical appendix, which provides further details on the specification, calibration and computation of the model, and some additional results. The online technical appendix is available on the authors' website.

definition of its competitive equilibrium are provided below.[2]

2.1 Demographics, endowments and preferences

Demographics. The model economy is populated by 70 overlapping generations aged 21 to 90 years ($j = 21, ..., 90$) in every year t. Every year, a new generation aged 21 years enters the model structure and faces random survival with the maximum possible lifespan of 70 years, while the oldest generation aged 90 years dies. Lifespan uncertainty is described by the conditional survival probabilities, π_j. The model assumes stationary demographics with a constant population growth rate, n, which implies time-invariant cohort shares, $\mu_j = [\pi_j \diagup (1+n)]\, \mu_{j-1}$.

Endowments. Each cohort consists of five skill (or income) types i - the lowest, second, third, fourth and highest quintiles that are distinguished by their exogenously given labour productivity and social welfare payments. The skill type is pre-determined and unchanged over the life span and time periods. We denote the intra-generational shares by ω_i.

In each period of life, households of age j in time t are endowed with $h_{j,t}$ unit of labour time that has earning ability (efficiency unit) given by e^i_j. Following Kotlikoff *et al.* (2007), we incorporate a time-augmenting technical progress to ensure that the model is consistent with a well-defined balanced growth path. This approach assumes that the time endowment, $h_{j,t}$, increases for every successive generation at the rate of technological progress, g, according to $h_{j,t} = (1+g)\, h_{j,t-1}$.[3] The efficiency unit, e^i_j, is skill and age dependent. Similarly to Altig *et al.* (2001), e^i_j is assumed to increase due to the accumulation of human capital and also due to technical progress that makes the labour productivity profile steeper for each skill type.

Preferences. Each i-type household who begins her economic life at time t chooses consumption, c, and leisure, l, at each age j to maximize the expected lifetime utility function given by

$$U^i_t = E_t \left[\sum_{j=21}^{90} \beta^{j-21} \left(\prod_{z=21}^{j} \pi_{z-1} \right) \frac{u(c^i_{t+j-21}, l^i_{t+j-21})^{1-\frac{1}{\gamma}}}{1-\frac{1}{\gamma}} \right], \tag{1}$$

where the annual CES utility, $u(c,l) = \left[c^{(1-1/\rho)} + \alpha l^{(1-1/\rho)}\right]^{1/(1-1/\rho)}$, being discounted by the subjective discount factor, β, and the unconditional survival probability, $\prod_{z=21}^{j} \pi_{z-1}$. The remaining parameters in (1) are the inter- and intra-temporal elasticities of substitution denoted

[2] The model is an extended version of the general equilibrium OLG model developed for the Australian economy by Kudrna and Woodland (2011a, b). The extensions include (*i*) a detailed intra-generational heterogeneity based on income distribution data from Australian Bureau of Statistics (ABS) (2007), (*ii*) technical progress and (*iii*) a detailed calibration of the fiscal structure.

[3] Notice that the typical approach of accounting for technical progress by multiplying the labour input in the production function by a growing productivity factor would not be compatible with a long run equilibrium path in our setup with CES preferences (see Auerbach and Kotlikoff, 1987, p.35). We therefore assume the time augmenting technical change, which implies that in a steady state, all household variables as well as aggregate variables (defined in per capita terms later in the text) grow at the rate of technical progress.

by γ and ρ and the leisure preference parameter, α.

2.2 Technology and adjustment cost

The production sector contains a large number of perfectly competitive firms that produce a single all-purpose output good that can be consumed, invested in production capital or traded internationally.

Production function. The production technology is described by a CES production function

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

where K_t is the capital stock, L_t is the labour input, κ is the productivity constant, ε is the capital intensity parameter and σ is the elasticity of substitution in production.

Adjustment cost. The firms face adjustment costs when accumulating new capital. As in Fehr (2000), we assume that adjustment costs can occur only during the transition according to the following function

$$C(I_t, K_t) = 0.5\psi \left(\frac{I_t}{K_t} - [n + g + n \cdot g + \delta]\right)^2 K_t,$$

where ψ is the adjustment cost coefficient and δ is the capital depreciation rate. Notice that there are no adjustment costs when the economy is in a steady state as $I = (n + g + n \cdot g + \delta) K$. However, along the transition paths when the capital stock is below or above the steady state level, firms optimally smooth out their investment expenditures.[4]

2.3 Fiscal policy

Public pension. The model incorporates main features of the two publicly stipulated pillars of Australia's retirement income policy. The first is a publicly-managed "safety net" pillar that is represented by a means tested age pension financed through general taxation revenues.

The age pension, $p^i_{j,t}$, is paid to households of skill type i and age pension age ($j \geq 65$) if they satisfy the following income test.[5] Let $p^{\max}$ denote the maximum age pension paid by the government to pensioners provided that their assessable income does not exceed the income

[4]The CES production technology assumption is based on the findings of empirical literature that estimates σ to be lower than one. Karanassou and Sala (2010) estimate this parameter to be 0.56 for Australia. In addition, the capital adjustment cost assumption is based on the previous literature (for instance, see Altig *et al.* (2001) and Kotlikoff *et al.*, 2007). More importantly, accounting for the firm's convex costs of installing new capital goods is consistent with the observed lags in the investment process. We will relax these assumptions in the sensitivity analysis section.

[5]The actual means test of the age pension also includes the asset test and it is the binding test (the income test or the asset test resulting in a lower pension benefit) that is used to determine the pension payment. The model considers only the income test as it affects most of part age pensioners.

threshold, $\underline{y}$. The maximum pension, $p^{\max}$, is then reduced at the pension taper (withdrawal) rate, θ, for every dollar of assessable income above $\underline{y}$. Algebraically, the age pension benefit for the age-eligible households can be written as

$$p^i_{j,t} = \max\left\{\min\left\{p^{\max}, p^{\max} - \theta\left(\widehat{y}^i_{j,t} - \underline{y}\right)\right\}, 0\right\}, \qquad j \geq 65, \tag{2}$$

where the assessable income, $\widehat{y}^i_{j,t}$, consists of interest income, $rA^i_{j-1,t-1}$, and half of labour earnings, $0.5 \times w_t e^i_j ls^i_{j,t}$. The means-tested pension benefit function is plotted in Figure A1 in the online technical appendix, which provides more detail on the modelling (and calibration) of the age pension. The total expenditure of the public pension program is given by

$$P_t = \textstyle\sum_{i=1}^{5} \omega_i \sum_{j=65}^{90} p^i_{j,t}\ \mu_j,$$

where ω_i and μ_j denote intra- and inter-generational shares.

Private pension. The second pillar is represented by mandatory, privately-managed retirement saving accounts, which are based on defined contributions made by employers and are regulated by the government. This private pension program, known as the Superannuation Guarantee, requires employers to contribute a given percentage of gross wages into the employee's superannuation fund.

Accordingly, the model assumes that mandatory contributions are made by firms on behalf of working households at the contribution rate, ν, from their gross labour earnings, $w_t e^i_j ls^i_{j,t}$. The contributions net of the contribution tax, $\tau^s \cdot \nu$, are added to the stock of superannuation assets, $\widehat{s}^i_{j,t}$, which earns investment income at the after-tax interest rate, $(1-\tau^r)\, r$. The superannuation asset accumulation can be expressed as

$$\widehat{s}^i_{j,t} = \left[1 + (1-\tau^r)\, r\right] \widehat{s}^i_{j-1,t-1} + (1-\tau^s)\, \nu \cdot w_t e^i_j ls^i_{j,t}, \qquad j \leq 60,\ \widehat{s}^i_{20,t} = 0, \tag{3}$$

where r the market interest rate, τ^r and τ^s denote the earnings and contribution tax rates paid by the superannuation fund. The superannuation assets must be kept in the fund until households reach age 60 when the accumulation ceases and households are assumed to receive their accumulated balances as lump sum payouts. It is further assumed that working households aged 60 years are paid mandatory contributions directly into their private asset accounts. Therefore, superannuation payouts denoted by $s^i_{j,t}$ in (8) may be expressed as

$$s^i_{j,t} = \begin{cases} 0 & j < 60 \\ \widehat{s}^i_{60,t} & j = 60 \\ (1-\tau^s)\, \nu \cdot w_t e^i_j ls^i_{j,t} & j > 60. \end{cases} \tag{4}$$

Social welfare. The government also runs a social welfare program that pays the social welfare benefits, $st^i_{j,t}$, to households aged $j < 65$. These benefits are skill-dependent (targeted

to lower income households) and determined exogenously (with further details provided in the calibration section). The total social welfare payment, ST_t, is given by

$$ST_t = \sum_{i=1}^{5} \omega_i \sum_{j=21}^{64} st_{j,t}^{i} \ \mu_j.$$

Taxes. The government collects taxes to finance its spending programs. The total tax revenue, T_t, consists of revenues from five different taxes: household progressive income tax, T_t^Y, consumption tax, T_t^C, superannuation tax paid by the superannuation fund, T_t^S, and other household tax, T_t^{LS}, as well as corporate tax paid by firms, T_t^F. The per capita tax receipts in period t are given by

$$\begin{aligned} T_t^Y &= \sum_{i=1}^{5} \omega_i \sum_{j=21}^{90} \tau(y_{j,t}^{i}) \ \mu_j \\ T_t^C &= \sum_{i=1}^{5} \omega_i \sum_{j=21}^{90} \tau_t^c \ c_{j,t}^{i} \ \mu_j \\ T_t^S &= \sum_{i=1}^{5} \omega_i \sum_{j=21}^{60} \left[\tau^s \nu \cdot w_t e_j^i l s_{j,t}^i + \tau^r r \cdot \widehat{s}_{j-1,t-1}^{i}\right] \mu_j \\ T_t^{LS} &= \sum_{i=1}^{5} \omega_i \sum_{j=21}^{90} \overline{\tau}^i \ \mu_j \\ T_t^F &= \tau^f \varrho_t, \end{aligned} \tag{5}$$

where $\tau(y_{j,t}^{i})$ is the income tax payment paid by individual households; τ_t^c represents the consumption tax rate; $\overline{\tau}^i$ denotes other household taxes assumed to be collected as lump sum taxes within each skill type i; τ^f is the corporate tax rate imposed on the firm's profit, ϱ_t; ω_i and μ_j denote intra- and inter-generational shares. The total tax revenue is then given by $T_t = T_t^Y + T_t^C + T_t^S + T_t^{LS} + T_t^F$.

Budget balance. The government activities include an issue of new debt, $\Delta D_{t+1} = D_{t+1} - D_t$, and tax revenues, T_t, that finance general government consumption expenditure, G_t, interest payments on current public debt, rD_t, and transfer payments to households, $TR_t = P_t + ST_t$. In each period, the government budget constraint is balanced, so that

$$\Delta D_{t+1} + T_t = G_t + rD_t + TR_t. \tag{6}$$

Note that in our setting, the issue of new government debt (or the change in net government debt) in period t is equal to the budget deficit in that period.

2.4 Markets

We employ a small open economy framework since that description best fits the Australian economy.

In our small open economy model, the domestic capital market is fully integrated with the world capital market. Capital freely moves across borders, so that the domestic interest rate, r,

is exogenously set by the world interest rate, r^w.[6] There is no interaction between the domestic and international labour markets. The domestic labour market is isolated from rest of the world. The wage rate adjusts to clear the domestic labour market in equilibrium. Finally, it is assumed that there is no difference between domestically and internationally produced consumption goods.

Letting A_t^F stand for the (per capita) net foreign assets at the beginning of t, the international budget constraint can be specified as

$$(1+n)(1+g)A_{t+1}^F - A_t^F = rA_t^F + X_t, \tag{7}$$

where the left side of (7) represents per capita capital flows and the right side is the current account comprising the per capita net trade balance denoted by X_t, and the per capita interest receipts (payments) from foreign assets (debt), rA_t^F.

2.5 Household problem

Households are assumed to make optimal consumption/saving and leisure/labour supply choices by solving a utility maximization problem with the objective function (1) subject to the per-period budget constraints written as

$$\begin{aligned} a_{j,t}^i &= (1+r)a_{j-1,t-1}^i + w_t e_j^i ls_{j,t}^i + p_{a,t}^i + s_{j,t}^i \\ &\quad + st_{j,t}^i + b_{j,t}^i - c_{j,t}^i - tax_{j,t}^i. \end{aligned} \tag{8}$$

In (8), $a_{j,t}^i$ denotes the stock of ordinary private assets held at the end of age j and time t, which equals the assets at the beginning of the period, plus the sum of interest income, $ra_{j-1,t-1}^i$, gross labour earnings, $w_t e_j^i ls_{j,t}^i$, public age pension payments, $p_{j,t}^i$, private superannuation payouts, $s_{j,t}^i$, social welfare payments, $st_{j,t}^i$, and bequest receipts, $b_{j,t}^i$, minus the sum of consumption, $c_{j,t}^i$, and total household taxes denoted by $tax_{j,t}^i$.

The gross labour earnings are equal to the product of labour supply, $ls_{j,t}^i = h_{j,t} - l_{j,t}^i$, and the hourly wage, $w_t e_j^i$, where w_t is the market wage rate and e_j^i is the age- and skill-specific earnings ability variable. Notice that the labour supply is required to be non-negative and constrained by the time endowment, $0 \leq ls_{j,t}^i \leq h_{j,t}$. Thus, when the agent chooses to allocate all time endowment to leisure, $l_{j,t}^i = h_{j,t}$, that agent must be fully retired from workforce, $ls_{j,t}^i = 0$.

The household taxes in (8) include the progressive income, consumption and other taxes, $tax_{j,t}^i = \tau(y_{j,t}^i) + \tau_t^c c_{j,t}^i + \overline{\tau}^i$. The progressive income tax, $\tau(y_{j,t}^i)$, is a function of the taxable income, $y_{j,t}^i$, which comprises labour earnings and assets income.

Following Gokhale *et al.* (2001), we abstract from intended bequests, with all inter-

[6] The exogenous interest rate assumption is relaxed in Section 5, which examines how sensitive the results are to the imperfect capital mobility assumption with an endogenous interest rate.

generational transfers being accidental. The accidental bequests, $b^i_{j,t}$, are calculated by aggregating the assets of deceased agents within each skill type i and equally redistributing them to all surviving i-type agents aged between 45 and 65 years. The model is a pure life cycle model in the sense that households are assumed to be born with no wealth and exhaust all wealth if survive to the maximum age of 90 (i.e., $a^i_{20,t} = a^i_{90,t+70} = 0$). We also impose borrowing constraints (i.e., $a^i_{j,t} \geq 0$) to prevent younger households from borrowing against their superannuation (private pension) payouts, as such borrowing is prohibited by the current legislation.

2.6 Firm problem

The perfectly competitive firms demand capital, K_t, labour, L_t, and gross investment, I_t, to maximize the present value of all future profits subject to the (per capita) capital accumulation equation:

$$\begin{aligned} \max_{\{K_t,\ L_t,\ I_t\}} \quad & \sum_{t=0}^{\infty} D_t \left[\left(1-\tau^f\right) \varrho_t\right] \\ \text{s.t.} \quad & (1+n)(1+g)K_{t+1} = I_t + (1-\delta)\, K_t, \end{aligned} \tag{9}$$

where $\varrho_t = (F(K_t, L_t) - C(I_t, K_t) - I_t - (1+\nu)w_t L_t)$ is the firm's profit comprising the sale of output, minus the costs of capital formation and of the labour input, $D_t = (1+n)^t(1+g)^t/(1+r)^t$ is the discount rate adjusted by population and economic growth, and τ^f stands for the corporation tax rate. Notice that labour costs also include the superannuation contributions made by firms at the mandatory rate ν on gross labour earnings.

Solving the profit maximization problem (9) yields the first-order necessary conditions and gives expressions for the equilibrium wage rate, w_t, interest rate, r, and capital price, q_t.

2.7 Competitive equilibrium

Given government policy settings for the taxation and pension systems, the demographic structure and the world interest rate, a competitive equilibrium is such that

(a) households make optimal consumption and leisure decisions by maximizing their lifetime utility (1) subject to their budget constraint (8);

(b) competitive firms choose labour and capital inputs to solve their profit maximization problem in (9);

(c) the government budget constraint (6) is satisfied;

(d) the labour, capital and goods markets clear

$$\begin{aligned} L_t &= \sum_{i=1}^{5} \omega_i \sum_{j=21}^{90} e_j^i \; ls_{j,t}^i \; \mu_j, \\ q_t K_t &= \sum_{i=1}^{5} \omega_i \sum_{j=21}^{90} (a_{j-1,t-1}^i + \widehat{s}_{j-1,t-1}^i)\mu_j + A_t^F - D_t, \\ Y_t &= \sum_{i=1}^{5} \omega_i \sum_{j=21}^{90} c_{j,t}^i \; \mu_j + I_t + G_t + X_t. \end{aligned} \tag{10}$$

(e) the bequest transfers are equal to the sum of the assets left by the deceased agents within each skill type, $b_t^i = \sum_j (1 - \pi_j)\,(a_{j,t}^i + \widehat{s}_{j,t}^i)\mu_j$.[7]

3 Calibration

We now provide specific details on the calibration procedure that is to replicate or closely approximate the key Australian macro data and fiscal indicators in 2014, including the budget deficit and net government debt to GDP ratios in that year. As already mentioned, Australia has only recently started accumulating public debt. Hence, the standard assumption of a steady state equilibrium would not do the job in matching these two government indicators, as the current budget deficit to GDP ratio would imply much larger government debt to GDP ratio in a steady state than that observed from the data.[8] We use the following alternative approach that allows for 2014 - the base year for our fiscal policy analysis - to be a non-steady state year.

First, we compute the initial steady state that targets key Australian macroeconomic data and fiscal indicators for the period of 2000-08.[9] Given that the Australian government ran small budget surpluses and had literally no debt during that period, we make an assumption of a balanced government budget with zero public debt in this initial steady state. We calibrate fiscal policy variables to match the observed ratios of government indicators to GDP averaged over the period of 2000-08 (discussed further below). The values of the main parameters used in this initial steady state and the sources are reported in Table 1.

Insert **Table 1** around here

Second, we run the baseline transition from this initial steady state where we calibrate the fiscal policy parameters to match the observed ratios of government revenues and expenditures

[7] We assume that accidental bequests are equally redistributed to surviving households of the same income type aged between 45 and 65 years. This means that the bequests received by higher income households are significantly larger than those received by lower income types.

[8] In a steady state, the net government debt to GDP ratio can be derived from the budget constraint in (6) as Deficit_GDP$/\,(n + g + ng)$. Given the rates of population growth and technical progress and the budget deficit of 3.07% of GDP in 2014, the implied steady state net debt would equal to 98.27% of GDP, compared to the actual net debt of only 12.8% of GDP in 2014.

[9] We use the GAMS software to compute this steady state equilibrium (as well as the baseline and fiscal policy transition paths that are discussed later in the text). Details on our algorithm are provided in the online technical appendix.

to GDP for the period of 2009-2014. As shown later in this section, this approach generates net government debt that closely approximates the actual net public debt in 2014.

3.1 Demographics, endowments and preferences

Demographics. The demographic parameters include the age-specific survival rates, π_j, and the annual population growth rate, n, which are assumed to be time-invariant, implying constant cohort shares, μ_j. We take π_j as the average survival probability for males and females from the 2011-13 life tables (ABS, 2014b) and set n to 1.6%, which is the annual population growth rate from 2013 to 2014. Given the chosen values for the two demographic factors, the model generates an old-age dependency ratio of 0.22, which is similar to the actual dependency ratio in 2014. The intra-generational shares, ω_i, are equal to 0.2 for each skill or income type of households in the model, based on the quintiles used by ABS (2007).

Endowments. There are five skill types (i.e., income quintiles) in each cohort, which differ by their exogenously given earnings ability (and social welfare benefits and other household taxes that are discussed in the subsection on the calibration of fiscal policy). The earnings ability profiles are constructed using the estimated lifetime wage function taken from Reilly *et al.* (2005) and the income distribution shift parameters derived from ABS (2007). In particular, the earnings ability profile for the third quintile in the model is taken from Reilly *et al.* and is adjusted for technical progress in the same way as in Altig *et al.* (2001).[10] The earnings ability profiles for lower and higher income quintiles are shifted down and up, using the shift parameters, to approximately replicate the private income distribution in Australia.[11] Based on ABS (2007) data, the shift parameter is set to 0.26 for the lowest quintile, 0.55 for the second quintile, 1.0 for the third quintile, 1.52 for the fourth quintile and 2.63 for the highest quintile. Given that Reilly *et al.* (2005) considered only workers aged 15-65, the earnings ability after age 65 is assumed to decline at a constant rate, reaching zero at age 90 for each income class.

Preferences. The functional form of household utility is standard in related literature. Importantly, the values assigned to the utility parameters are similar to those used by others (see, for example, Auerbach and Kolikoff (1987) and Fehr, 2000). We calibrate the subjective discount factor, β, in the lifetime utility (1) to match the capital to output ratio (= 3.085).

[10] The growth-adjusted earnings ability profile for the third quintile takes the form: $e_a = \exp(\alpha_0 + (g+\alpha_1)X + \alpha_2 X^2)$, where parameters α_0, α_1 and α_2 are taken from Reilly *et al.* as average estimates for males and females with 12 education years, X represents years of potential experience ($a - 5 -$education years) and g denotes the rate of technical progress.

[11] It is also assumed that the two lower income types have 10 years of schooling and the two higher income types 15 years of schooling, resulting in labour productivity profiles that differ not only by the level but also by the shape (i.e., being relatively flat for lower income types compared to higher income types).

3.2 Technology and adjustment cost

We use the CES production function and calibrate the elasticity of substitution parameter to be $\sigma = 0.78$ in our benchmark model. As mentioned, this assumption is based on the empirical literature that estimates σ to be lower than one for Australia (e.g., see Karanassou and Sala, 2010). Most of other production parameters are also calibrated to replicate calibration targets such as the investment rate of 0.085. The wage rate, w, is normalized to one by calibrating the value of the productivity constant, κ.

Following Auerbach and Kolikoff (1987), we set the adjustment cost parameter, ψ, in the capital adjustment cost function to 10. The rate of technological progress, g, is set to 1.5% per year, which is taken from Productivity Commission (2013). We will consider alternative assumptions about the technology, capital adjustment costs and the rate of technological progress in the sensitivity analysis section.

3.3 Fiscal policy

We base on the policy settings for the age pension, mandatory superannuation and taxation, and their parameter values for the period between 2000 and 2014 to calibrate the fiscal policy in the benchmark model. As discussed, we divide the calibration period into two sub-periods: a steady state sub-period of 2000-08 when there was no fiscal deficit, and a transition sub-period of 2009-14 when there were large budget deficits and growing government debt due to the global financial crisis.

Table 2 reports on the calibration of fiscal policy in the initial steady state (2000-08) and in the base year (2014). The statutory tax and transfer rates reported in column 1 are actual rates set by the Australian government for 2013-14. The compositions of the government budget in columns 2 and 3 are computed from data in Australian Government (2015). The effective tax and transfer rates in columns 4 and 5 are calibrated to match the corresponding shares in GDP in the initial steady state and in the base year. Technically, the effective rates are the product of the statutory rates and adjustment factors. The details of our calibration strategy are discussed below.

Insert **Table 2** around here

Public pension. The age pension parameters (maximum benefit of $21,504 per year, income test threshold of $4,056 per year and taper rate of 50 percent) relate to those applicable for single pensioners from September 2013 to June 2014. The pension expenditure as the share of GDP averaged over the period of 2000-08 and in 2014 is 2.5% and 2.93%, respectively. Hence, the effective age pension payments are adjusted for each skill type to match these shares. Specifically, the maximum pension benefit is adjusted down by 10% in the initial steady state and up by 3% in 2014.

Private pension. The mandatory superannuation contribution rate is 9.5% of gross earnings, which is the effective rate in the model. However, the effective tax rates on superannuation contributions and earnings in the model are lower than the statutory ones in data. We actually have to scale down that the statutory rate in order to match its GDP shares in the initial steady state and over the calibration period 2009-14. This is because of the private pension system is fully mature in the model (with mandatory contributions at 9.5% of gross earnings made over the entire working lives), whereas it has yet to achieve full maturity in Australia.

Social welfare. Using the ABS (2007) data, we calculate the share of social welfare in gross total income for each income quintile, which is 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. These government benefits include all social welfare payments such as family benefits, disability support pension and unemployment benefit. In the calibration of our initial steady state, we compute the skill-specific social welfare payments denoted by $st^i_{j<65,t}$ in (8) such that the model replicates the aforementioned shares. Note that the social welfare benefits are assumed to be paid at a constant (skill-specific) rate to eligible households (in the lowest to fourth income quintiles at each age $j < 65$). During the calibration period 2009-14, the social welfare benefits are scaled up (by 14% in 2014) to match increasing government expenditures on social welfare.

Taxes. The income tax rates are nonlinear and progressive. We use a differentiable income tax function that is estimated to approximate the 2013-14 progressive income tax schedule. The estimated income tax function is depicted by Figure A2 in the online technical appendix. The figure shows that our function is a close approximation of the actual 2013-14 income tax schedule. Nevertheless, our model does not account for tax deductions and also tax offsets available for lower income earners. Therefore, in order to match the income tax revenue as the exact share of GDP during the calibration period, the income tax function is scaled down with the adjustment parameter of 0.82 and 0.77 in the initial steady state and in 2014, respectively.

The consumption and corporation income tax rates are linear with the statutory rates given by 10% and 30%, respectively. In our calibration, we adjust these statutory rates to match the actual ratios of the given tax revenue to GDP. The corporate effective tax rate is indeed smaller in our calibration, reflecting the fact that many firms in reality use various other deductions to lower their tax rate (and some operating in the informal sector paying no tax at all). As indicated in Table 2, the effective consumption tax rate equals 12.8% in the initial steady state and 11.3% in 2014. These effective rates are higher than the statutory Goods and Services Tax (GST) rate of 10%. This is because we target the total consumption tax revenue, which includes not only the GST revenue but also receipts from other indirect taxes.

The other tax, $\overline{\tau}^i$, in (8) is assumed to be collected as a lump sum tax within each income type and is to target the government non-taxation revenue, in order for the model to exactly replicate the total revenue of the government budget. We use again the ABS (2007) data and derive the share for each income type in the total taxes paid. These shares are 0.08 for the

lowest quintile, 0.1 for the second quintile, 0.15 for the third quintile, 0.22 for the fourth quintile and 0.45 for the highest quintile. In our calibration, we first calculate the other tax to match the observed ratio of the non-taxation revenue to GDP. We then apply the above-mentioned shares to derive skill-specific other taxes, which represent the third exogenous source of heterogeneity among the five skill types of households in our model.

Deficit path. In addition to matching government tax revenues and expenditures over the transition period of 2009-2014, we set the budget deficit to GDP ratios in the model to those observed from the data during that period. This approach then generates net government debt that is close to the actual net public debt in 2014 - the base year for the fiscal policy analysis that is not a steady state year.[12] We further assume that public consumption, G_t, adjusts endogenously to balance the government budget in (6) with a growing public debt over the period of 2009-14.

3.4 Markets

In our small open economy model, the domestic interest rate is exogenous and given by the world interest rate, which is set to 4%. We also use the equilibrium condition for the capital market in order to target the net foreign assets to capital ratio of -0.173 in the initial steady state. This reflects the net foreign ownership of 17.3% of Australia's capital stock averaged over the period of 2000-08 (ABS, 2014a).

3.5 Model performance

The benchmark steady-state solution (2000-08) and the solutions in the selected years of the calibration period (2009-14) for the key macroeconomic and fiscal variables are reported in Table 3, which also provides a comparison with Australian data. The comparison of model generated and actual macroeconomic indicators indicates that the model replicates the Australian economy fairly well. Importantly, the model exactly matches the observed budget deficit to GDP ratios over the calibration period of 2009-2014 and closely approximates the net government debt in % of GDP in 2014.[13]

Insert **Table 3** around here

[12] As mentioned, this approach involves solving for the baseline transition path, where we use the parameter values presented in Table 1 and apply the Gauss-Seidel algorithm that is specified in the online technical appendix.

[13] Our model does also a good job in approximating the lifecycle behaviour of Australian households observed from the HILDA surveys (Wooden *at al.*, 2002). The comparison of lifecycle labour supply, labour earnings and pension payments generated by the model for the initial steady state and for selected years of the calibration period with the cross-sectional profiles derived from HILDA is available from authors upon request.

4 Quantitative analysis

In this section, we report on the implications of several budget repair measures to either immediately or gradually eliminate the 2014 budget deficit. As shown in Figure 1, under the immediate elimination, the budget deficit is set to zero in 2015, whereas the gradual elimination of the 2014 budget deficit follows the projected path to budget surpluses by Australian Government (2015). Further note that under the gradual consolidation plan, the budget surplus of 0.4% of GDP projected by the government for 2026 is assumed to decline at a constant rate to reach zero in 2030. After 2030, similarly to the immediate fiscal consolidation plan, there is no longer budget surplus or deficit.

The results for key macroeconomic variables and for welfare across and within generations are presented with respect to the baseline transition with the deficit path that is also plotted in Figure 1. We first outline some of the key macroeconomic effects of the baseline transition and then we proceed to the discussion of the macroeconomic and welfare implications of the three budget repair measures under the immediate and gradual eliminations of the 2014 budget deficit.

Insert **Figure 1** around here

4.1 Baseline transition

The baseline transition includes the calibration period of 2009-14 (that matches the composition of the government budget as discussed in the previous section) and the remaining period from 2015 to a new steady state in 2150. In that remaining period of the baseline transition, we keep the budget deficit as % of GDP observed in 2014 unchanged and only adjust public consumption to balance the government budget with an increasing net debt and interest payments. From now on, we will concentrate on the implications over the period from 2015 to 2150.

Table 4 reports the macroeconomics effects in the selected years of the baseline transition and in the long run that relates to year 2150. The results are presented as percentage changes in de-trended, per capita variables relative to year 2014, with net government debt expressed in % of GDP. The table also shows the values for the selected variables in 2014, which are reported in units of $\$100,000$ and as per capita for all the monetary variables, as per capita and in efficiency units for labour supply and in % of GDP for net government debt.

Insert **Table 4** around here

The results for the baseline transition in Table 4 can be summarized as follows. First, net government debt increases significantly during the transition despite the reductions in public consumption that is required to keep the budget deficit constant at 3.07% of GDP. In the long

run, net government debt reaches 98.27% of GDP and is more than 8 times larger than in the base year of 2014.[14] Second, the large increases in net government debt are shown be funded from abroad through capital imports, which lead to significant decreases in net foreign assets during the baseline transition. As shown in Table 4, net foreign assets decrease by 136.5% in the long run relative to 2014.[15] Third, in our small open economy, these substantial changes in government debt and foreign assets have no impact on the domestic interest rate and so the effects of the baseline transition on the other key macroeconomic and fiscal variables reported in Table 4 are relatively small.[16]

4.2 Two fiscal consolidation plans

We now consider two fiscal consolidation plans: immediate one in which the government eliminates the 2014 budget deficit immediately in 2015 and gradual one in which the government eliminates the 2014 budget deficit gradually over the period of 15 years (see Figure 1).

4.2.1 Implementation

The government is assumed to have three fiscal measures to finance each of the two consolidation plans: (*i*) the income tax rates, (*ii*) the consumption tax rate and (*iii*) transfer payments.[17] The adjustments in income or consumption taxes or transfer payments are made to balance the government budget constraint in (6) from year 2015 onwards. While it is straightforward to implement the consumption tax adjustments via temporary increases in the effective consumption tax rate, τ_t^c, additional assumptions need to be made for the other two measures. In the case of the income tax adjustments, we assume a proportional increase or decrease in the

[14] As pointed out before, the steady state debt to GDP ratio is implied by the assumed deficit to GDP ratio and the rates of population growth and technological progress. Note that the higher these growth rates are the smaller government debt to GDP ratio would be for the given budget deficit to GDP ratio.

[15] The negative value for net foreign assets in 2014 implies net foreign debt, which increases significantly during the transition due to capital inflows that finance increased public borrowing depicted by a growing net government debt.

[16] In a small open economy model with the exogenous domestic interest rate, the marginal products of capital and labour as well as the capital labour ratio are unchanged in the long run. Hence, the change in labour supply must be matched by the change in the capital stock in the long run. The observed difference between the long run effects on labour and capital in Table 4 is due to the changes in the effective tax rate on firm's profits (that are to match observed company tax revenues in % of GDP) during the calibration period of 2009-14, which alter the capital labour ratio in the long run.

[17] We also consider two alternative tax measures to repair the government budget: (*i*) temporary levy on labour income and (*ii*) temporary levy on total assets income. The macroeconomic and welfare effects of these two alternative budget repair measures are discussed in the appendix (at the end of this paper), with further details relegated to the online technical appendix.

progressive income tax function through a scalar, λ_t, that is calculated as[18]

$$\lambda_t = \frac{G_t + TR_t + rD_t - \left(\Delta D_t + T_t^C + T_t^S + T_t^{LS} + T_t^F\right)}{\sum_{i=1}^{5} \omega_i \sum_{j=21}^{90} t(y_{j,t}^i)\mu_j}.$$

In the case of the transfer payment measure, a similar scalar is computed to adjust (temporarily cut) the transfer payments ($TR_t = P_t + ST_t$) to finance the deficit reductions.

We assume that the government announces each fiscal consolidation plan (as depicted by Figure 1) at the beginning of 2015 and that both plans are unanticipated by existing households. This means that the existing households of different ages and income types (alive in 2015) unexpectedly learn about the government's fiscal consolidation plans and re-optimize their labour supply, consumption and saving decisions over their remaining lifetimes. Note that these households are endowed with their assets that they accumulated in 2014 prior to the fiscal consolidation. We take these assets from the simulation of the baseline transition. Further note that all the existing and future born households are assumed to have perfect foresight about the future tax or transfer changes required to repair the government budget.

4.2.2 The effects of an immediate plan

Macroeconomic effects. The simulation results of the three budget repair measures for the key macroeconomic variables under the immediate fiscal consolidation plan are provided in Table 5. The table shows these effects as percentage changes in the selected per capita variables in the selected years of the transition and in the long run with respect to the baseline results. Recall that the baseline transition assumed the actual budget deficit of 3.07% of GDP in 2014 to stay unchanged during the period of 2015-2150. The long run effects in Table 5 then compare the implications in the new policy and baseline steady states and essentially can be approximated by the results for year 2150.

Insert **Table 5** around here

As expected, the immediate fiscal consolidation leads to either significant tax hikes or transfer payment cuts initially. For instance, in 2015 (when the budget deficit is completely eliminated), the required tax hike is 42.42% in progressive income tax rates or 55.9% in the consumption tax rate. Alternatively, the required cut in transfer payments to households in 2015 amounts to almost 40%. In the subsequent transitional years, the required tax hikes or transfer payment cuts start to moderate. Eventually, all three fiscal adjustments result in the reduced tax rates or increased transfer payments. As shown in Table 5, the immediate (as well as the gradual) fiscal consolidation leads to a reduction of 14.3% in the consumption tax rate or an

[18]Note that under the immediate consolidation plan, the budget deficit is set to zero, $\Delta D_t = 0$ for $t = 2015, ..., \infty$.

increase of 8.6% in the transfer payments in the long run. This long run result of lower tax rates or higher transfer payments is due to reduced net government debt, which initially further increases from 12.8% of GDP in 2014 to around 15% of GDP in 2015. However, as the government eliminates the budget deficit and then pays off interest payments and the principle, net government debt starts to decline, converging to zero in the new steady state of each fiscal policy measure.[19] The results also indicate that reduced government debt leads to large increases in net foreign assets (i.e., reductions in net foreign debt).

Table 5 reveals quite distinct impacts on key macroeconomic variables such as per capita labour supply among the three fiscal policy adjustments. Let's first consider the two tax measures to finance this immediate fiscal consolidation plan. Both tax measures have negative effects on per capita labour supply initially, but the negative impact effect of the distortive, income tax hikes is much greater (6.55% decline) than that due to the less distortive, consumption tax hikes (0.26% decline). Similarly, in the medium run the progressive income tax hikes generate significant declines in per capita labour supply, output and domestic assets, whereas the impact of the consumption tax hikes on the economy is relatively modest. In the long run, however, zero government debt allows for a reduction in income tax rates (by 12.67% relative to the baseline transition), providing labour supply and saving incentives and leading to higher per capita labour supply and domestic assets.

The implications of the temporary cuts to transfer payments are positive for per capita labour supply on impact (in 2015) as well as in the medium run. This is due to the reduced income effect on household labour supply that these payments (i.e., social transfers to households aged $j < 65$ and age pension payments to households aged $j \geq 65$) generate. In the long run, the implications for most macro variables are opposite as is the adjustment in transfer payments (8.6% increase). For example, the long run decreases in per capita labour supply and domestic assets from higher transfer payments are 0.74% and 3.08%, respectively.

Table 5 also shows that while the aforementioned effects on net government debt are very similar across the three budget repair policies, the effects on other selected fiscal variables (e.g., income and consumption tax revenues and pension expenditure) differ greatly, depending on the underlying fiscal policy instrument that finances the fiscal consolidation. For example, the consumption tax hike in 2015 raises the consumption tax revenue by 48.6% in the same year. In the long run when the tax rate is lower, the consumption tax revenue declines by 13.1% relative to the baseline result with the unchanged consumption tax rate.

Welfare effects. We calculate standard equivalent variations to measure the effects of the three examined budget repair measures on welfare across generations and skill types. These calculations measure the proportional percentage increase/decrease in consumption and leisure for each generation (over the remaining life span) that is needed during the baseline transition

[19]Recall that the net government debt to GDP ratio reaches almost 100% of GDP in the new steady state of the baseline transition with the budget deficit of 3.07% of GDP.

with the constant deficit to GDP ratio (as in 2014) to produce the realized remaining lifetime utility in each reform scenario (for more detailed information, see Auerbach and Kotlikoff (1987), p.87).

Figure 2 depicts the distributional and average welfare effects of the immediate fiscal consolidation plan. Panels 2a-2c present percentage changes in the remaining utility for each income quintile of every generation relative to the remaining utility level under the baseline transition. In order to compare the three fiscal adjustments, Panel 2d plots the intergenerational welfare effects averaged over the five skill classes.[20]

Insert **Figure 2** around here

Several observations can be drawn from these welfare results. First, all existing generations alive in 2015 (i.e., cohorts aged 21-90 years) when the deficit is eliminated attain welfare losses. Figure 2d shows that the welfare losses are particularly large in the case of temporary transfer payment cuts, with some older cohorts loosing, on average, up to 12% of remaining resources due to reductions in their pension payments. The temporary increases in the consumption tax rate have also negative effects on the welfare of older generations. Although the magnitude of these effects is much smaller than those observed for the transfer payment cuts, the consumption tax hikes are more negative for the welfare of older households than the income tax hikes. This is simply because all cohorts pay the consumption tax, whereas the income taxes are predominantly paid by the working-age cohorts.

Second, while all the existing generations bear the welfare costs of this immediate fiscal consolidation due to required tax hikes or transfer payment cuts, future generations experience welfare gains. As shown in Figure 2d (and Table B2 for the average welfare), in the long run, generations gain, on average, 0.76% or 0.51% in their lifetime resources because of the transfer payment adjustments or the tax adjustments, respectively. Note that the tax hikes or transfer payment cuts to fund the fiscal consolidation are only temporary, with the long run elimination of public debt resulting in reverse changes in these policy instruments. Consequently, the long run tax cuts or transfer payment increases have positive effects on the welfare of future generations.

Third, Figures 2a-2c display interesting differences in the intra-generational welfare effects across the three fiscal policy measures. The consumption tax hikes and in particular the transfer payment cuts are more negative for the welfare of lower income types of the existing cohorts. This is due to the regressive nature of the flat consumption tax rate and because reduced transfer payments represent an important income source for low income households. For instance, in the case of the transfer payment cuts, some older cohorts in the lowest quintile

[20]The numerical values for the welfare effects of these budget repair measures on selected generations are displayed in Table B2 in the appendix. That table also provides a comparison with the welfare effects under the gradual consolidation plan and of two alternative budget repair measures.

experience welfare losses of 13.3% in their remaining resources, while the welfare losses for the same age cohorts in the highest quintile do not exceed 2.7% (see the results for the cohort aged 80 in 2015 in Table B2).

Conversely, the temporary increases in the income tax rates, which are progressive, reduce the welfare of higher income types more than the welfare of lower income types. Panel 3a shows welfare losses more than 2% in remaining utility for some young and middle age cohorts in the highest quintile but only less than 0.2% welfare losses for the same age generations in the lowest quintile. In the long run, the reverse effects on each of the fiscal policy instruments (i.e., either tax cuts or transfer payment increases balancing the government budget with no public debt) produce opposing distributional welfare effects to those during the fiscal consolidation. Specifically, the highest income households of future generations born after the fiscal consolidation benefit the most from the income tax cuts (with long run welfare up by almost 1.1% in lifetime resources), whereas future generations in the lowest quintile attain the highest welfare gain (almost 1.4% in the long run) under the transfer payment policy.

4.2.3 The effects of a gradual plan

Macroeconomic effects. Table 6 reports the macroeconomic effects of the three budget repair measures under the gradual elimination of the 2014 budget deficit, as projected by Australian Government (2015). Similarly to the results for the immediate consolidation plan, the effects are presented as percentage changes in the selected per capita variables in the selected years of the transition and in the long run with respect to the baseline results.

Insert **Table 6** around here

Table 6 indicates that while the long run macroeconomic effects are the same irrespective of the budget deficit being eliminated immediately or gradually, the short run and transitional effects differ greatly between the two fiscal consolidation plans. For instance, under the gradual consolidation plan, the required 2015 tax hike is only 0.21% in progressive income tax rates and 6.93% in the consumption tax rate (compared to the same year tax hikes of 42.4% and 55.9% under the immediate fiscal consolidation plan reported in Table 5). However, in 2020 when the government budget returns to a surplus under the gradual plan, the required tax hikes are 42.61% in average income tax rates or 52.15% in the consumption tax rate, which are significantly higher tax hikes than those under the immediate plan in 2020. Similarly, the required cut in transfer payments under the gradual plan is only 5.42% in 2015, whereas the cut in 2020 amounts to almost 36%.

The results for this gradual plan indicate that there are important announcement effects as households foresee significant future tax hikes and adjust their lifecycle behaviour accordingly. This is particularly apparent in the case of the income tax adjustments, which result in a

2.07% increase in per capita labour supply in 2015 (compared to a 6.55% decline in per capita labour supply under the immediate plan). As mentioned, the households alive in 2015 foresee significant income tax hikes to be implemented in the near future (e.g., in 2020) and so they increase their labour supply (and savings) initially when the tax rates are still relatively low. However, when the large increases in the progressive income tax rates are actually adopted, households work less, resulting in a decline in per capita labour supply of 6.64% in 2020 under the gradual consolidation plan.

Welfare effects. The distributional and average welfare effects of the three budget repair measures financing this gradual fiscal consolidation plan are displayed in Figure 3. The results measure equivalent variations (comparing each reform scenario with the baseline transition) for households of different ages in 2015 and of different skill types.

Insert **Figure 3** around here

The comparison of Figures 2 and 3 indicates that, while the welfare effects on future generations are similar (the same in the long run) for the two fiscal consolidation plans, there are some important differences in relation to the welfare effects on the existing households. These differences are particularly significant for some older households under the consumption tax and transfer payment policy measures. As shown in Figure 3d, the transfer payment cut generates an average welfare loss of 1.5% for the oldest generation (aged 90 in 2015). This welfare loss is significantly smaller compared to the average loss of 12% reported in Figure 2d for the same age cohort with the transfer payment cut funding the immediate fiscal consolidation plan. Similarly, the consumption tax hikes reduce the average welfare of the oldest generation by 0.2% under the gradual plan and by 2% under the immediate plan. Therefore, the gradual elimination of the 2014 budget deficit helps to mitigate the negative welfare effects that especially cuts in transfer payments and consumption tax hikes have on some very old cohorts and lower income classes.

4.2.4 Lump sum redistributive authority (LSRA)

The analysis of the two consolidation plans indicates opposing welfare effects across generations and income groups. Indeed, there are welfare trade-offs between current and future generations and between the rich and poor. This implies political constraints when implementing a fiscal consolidation plan.

To assess the efficiency implications of the two consolidation plans, we follow Auerbach and Kotlikoff (1987) and Nishiyama and Smetters (2005) to introduce a system of income transfers administered by a hypothetical Lump Sum Redistribution Authority (LSRA). In a nutshell, the LSRA undertakes lump sum redistributions across all generations and household types (via lump sum transfers or taxes) to ensure that (i) the utility levels of households alive at the time

of the policy announcement remain at their pre-reform levels and (*ii*) the lifetime utility levels of the future-born generations are raised or reduced by a uniform amount. The additional lump sum transfers (or taxes) to the future-born generations are determined so that the present value of all lump sum transfers (taxes) at the time of the policy announcement is zero. In the case of an increase in the lifetime utility of the future-born generations, the given policy change is said to generate an efficiency gain and is weakly Pareto improving in the sense that the welfare of some (future) households increases while no households are worse off.

Table 7 displays the aggregate efficiency implications. It appears that the immediate plan dominates the gradual plan in terms of efficiency gains and the income tax is the most efficient financing instrument. Overall the two consolidation plans result in Pareto improving, under the assumed redistributive mechanism, generating an aggregate efficiency gain of at least 0.209% or $3,800 in initial resources for all income types.

Insert **Table 7** around here

The increase in aggregate efficiency arises because of the reduction in the deadweight losses associated with the higher taxes to finance the burden of increasing government debt during the baseline transition. The fiscal consolidation plans result in smaller (and eventually no) government debt in the future, which allows government to cut taxes, thus reducing tax distortions and benefiting to more populous future-born generations. This reduction creates an efficiency gain that can be redistributed via lump-sum transfers by the LSRA to generate a potential Pareto improvement in welfare.

The overall efficiency gain implies that the government can devise a redistribution program to overcome the political challenge caused by the opposing welfare effects. That is, the government could compensate welfare losses attained by the current generations, while achieving better wellbeing of future generations.[21]

5 Sensitivity analysis

This section provides a sensitivity analysis of the long run steady state results for key macroeconomic aggregates reported in Section 4 to alternative assumptions of the model. The modifications of our benchmark model include: (*i*) imperfect capital mobility with an endogenous domestic interest rate; (*ii*) an economic slowdown via a reduced rate of technical progress; (*iii*)

[21] One should also notice large initial LSRA debt also reported in Table 7. For example, the initial LSRA debt due to compensating the current generations amounts to over 50% of GDP when income tax adjustments are used to repair the government budget. In our small open economy model, the LSRA debt is funded via capital imports from abroad and has no impact on the domestic interest rate. Relaxing this small open economy assumption would mean that such large LSRA debt would increase the domestic interest rate, leading to capital shallowing with negative implications for wages of future-born generations. Thus, the positive efficiency implications that we find are to some extent conditional on our small open economy setup.

an ageing demographic environment with improved survival probabilities and reduced population growth; and (*iv*) a Cobb-Douglas production function and no capital adjustment costs. Given the focus of this section on the long run effects, we do not distinguish between the immediate and gradual eliminations of the 2014 budget deficit, as the long run results of the two plans are the same.

5.1 Endogenous interest rate

Our benchmark model described in Section 2 made the assumption that the domestic interest rate was equal to the exogenously given world interest rate. We now relax this small open economy assumption and examine the effects of the three budget repair measures by assuming imperfect capital mobility with an endogenous domestic interest rate. In this setting, the domestic interest rate, r_t, is determined as

$$r_t = \overline{r} - \gamma \left(A_t^F / Y_t - A_{2014}^F / Y_{2014} \right),$$

where $\overline{r}$ is the exogenous world interest rate (= 4%), A_t^F/Y_t is the ratio of net foreign assets to GDP and the parameter $\gamma > 0$ gives responsiveness to the changes in A_t^F/Y_t. Following Guest (2006), we set γ to 0.02. Under this specification, the domestic interest rate will fall (increase) if the ratio of net foreign assets to GDP increases (decreases). In contrast to the small open economy assumption, this imperfect capital mobility framework implies that the capital labour ratio and the total wage rate faced by firms will also change in the long run, and so the long run changes in the capital stock, labour supply and output will differ. The effects that we discuss below may be thought of as being similar to those derived from a closed economy model.

Table 8 shows the sensitivity of the long run macroeconomic effects by comparing the effects derived from this endogenous interest rate framework with the long run effects from our benchmark model discussed in Section 4. The table also compares the two interest rate frameworks under the baseline transition assumption with the 2014 budget deficit to GDP ratio. The results for this baseline transition assumption indicate a long run increase of 13.77% in the domestic interest rate, which is due to reduced net foreign assets (or higher net foreign debt that funds an increasing government debt). However, relative to the small open economy results, Table 8 indicates that net foreign assets increase significantly as the higher interest rate leads to larger domestic assets and lower capital stock. Per capita labour supply is shown to further decline in the endogenous interest rate framework, which is due to work disincentives from the reduced wage rate. Consequently, as both inputs to production fall, the effect on GDP per capita is more negative than in the small open economy. The long run government debt amounts to 98.27% of GDP in both economies, and thus the displayed difference in Table 8 is zero.[22]

[22]Recall that the net government debt to GDP ratio in the long run is implied by the given deficit to GDP

Insert **Table 8** around here

The effects of the examined budget repair measures are positive for most macroeconomic variables relative to those derived from the small open economy model. For example, the long run capital stock, labour supply, GDP and consumption per capita all increase in this imperfect capital mobility framework. These positive effects are due to improved net foreign assets that cause the domestic interest rate to decline. The reduced interest rate increases investment demand and leads to a larger capital stock. The resulting capital deepening then generates a positive effect on the wage rate, which provides further incentives for households to increase their labour supply. Consequently, both labour supply and GDP per capita increase. The reduced interest rate, however, implies a lower rate of return on assets, leading to smaller domestic assets than in our benchmark model. The relative net foreign assets are then shown to decline as more capital inflows are needed to support the increased capital stock.[23] The long run results in Table 8 also indicate a larger tax cut or a larger transfer payment increase resulting from the government debt elimination when the domestic interest rate is endogenous.

5.2 Economic slowdown

Recent economic projections for Australia indicate that the economy could stay in unfavourable macroeconomic conditions for quite a while (International Monetary Fund [IMF], 2015). How would economic slowdown affect key macroeconomic and fiscal variables, including the level of net government debt in the long run? And how would the macroeconomic effects of the examined budget repair measures presented in Section 4 alter in a situation when the economy experiences a slowdown? This subsection aims to provide answers to these questions. Specifically, we consider a scenario in which the economy has a lower annual rate of technical progress set to 1% compared to the technical change of 1.5% assumed in our benchmark model.

Table 9 compares the long run macroeconomic results for the baseline transition (with the 2014 budget deficit of 3.07% of GDP) and the three budget repair measures (with zero budget deficit) generated by the modified model with lower technical progress with those derived from the benchmark model. In our model, altering technical progress rate, g, affects household behaviour through changes in (i) earning ability profile, e^i_j, and (ii) time endowment, $h^i_{j,t}$. Any reduction in g flattens the earning ability profile, thus reducing the effective wage rate for each quintile over the lifecycle, as well as making younger households relatively less productive than older households.

Insert **Table 9** around here

ratio (3.07% of GDP) and by exogenous rates of population growth and technical progress.

[23]Note that in both economies all three budget repair measures lead to increased net foreign assets in the long run. However, the long run improvements are larger in the small open economy. This is because the reduced government debt has no impact on the domestic interest rate and so it has much smaller impacts on domestic assets and the capital stock than in this modified model with an endogenous interest rate.

The "baseline transition" results in Table 9 show significant declines in long run per capita labour supply, capital stock, GDP and consumption due to lower g. Notice that we report the impact on effective labour supply, which decreases directly due to the reduced labour productivity and indirectly because of the dominating substitution effect on households' hours of work from the reduced labour productivity. Interestingly, the stock of domestic assets is shown to increase compared to our benchmark model. The intuition behind this result is that younger households save more due to lower expected future earnings, generating higher average domestic assets. In retirement, however, total assets are smaller compared to the economy with higher g, resulting in the increased expenditure on the means tested pension.

Economic slowdown modelled through reduced g directly affects net government debt that increases by additional 19 percentage points of GDP relative to the benchmark model simulation of the baseline transition.[24] The reduced tax revenues and increased expenditures on pensions and interest payments require further cuts in government consumption that is assumed to clear the government budget constraint during the baseline transition.

The comparison of the long run effects of eliminating the budget deficit and net debt reveals that these effects vary greatly across the three fiscal measures. Nevertheless, there are two results that are common for each fiscal policy measure. First, the elimination of larger government debt in the economy with reduced growth allows for a more significant tax cut or transfer payment increase in the long run. As a result, positive long run effects on consumption per capita are larger than those obtained from our benchmark model. For instance, Table 9 shows that the additional 5.95 percentage point increase in transfer payments generates a further 0.47 percentage point increase in per capita consumption. Second, the elimination of larger government debt (relative to net debt in the economy with higher g) leads greater improvement in foreign investment position, as indicated by the further increase in net foreign assets. As for the differences in macro effects between the two tax measures, the long run reduction in distortive, income tax rates have positive and significant effects on labour supply and especially domestic assets, while the additional long run consumption tax cut leads to insignificant macro effects and the additional long run transfer payment increase reduces per capita labour supply and domestic assets in comparison with the results reported in Section 4.

5.3 Population ageing

Similarly to other developed countries, population ageing in Australia is expected to accelerate in the next several decades, reducing population growth and generating a significantly higher proportion of the elderly in the total population. In this subsection, we examine the long run macroeconomic effects of keeping the existing budget deficit to GDP ratio unchanged (as under

[24] In the long run steady state, the net government debt to GDP ratio equals to $\text{Deficit\_GDP}/(n+g+ng)$, which with $g = 1\%$, $n = 1.6\%$ and $\text{Deficit\_GDP} = 3.07\%$ implies net government debt of 117.35% of GDP, compared to 98.27% of GDP reported in Section 4.

the baseline transition) and of the three fiscal policy measures (with zero budget deficit) in an ageing environment. Specifically, we set the age-specific survival probabilities, π_j, to those from the medium population projections by Productivity Commission (2013) for year 2050. We then calculate the annual rate of population growth, n, to generate an old-age dependency ratio of 0.40 taken from their projections for 2050. The implied annual population growth rate is about 0.67% - less than half of the growth rate in our benchmark model.

We report the results in Table 10 as the percentage point deviations in selected macro variables in the long run steady states with ageing from those derived from our benchmark model with the current demographic structure. The "baseline transition" results indicate that in an ageing environment, domestic assets increase significantly (due to increased longevity and proportion of older households with large asset holdings) but labour supply and output (due to a reduced proportion of the working age population).[25] The decline in the population growth rate implies a higher net government debt to GDP ratio, which increases to over 140% of GDP in the long run (43.11 percentage point increase relative to the long run net debt reported in Table 4). The increased interest payment on government debt and especially the increased government expenditure on the age pension require further cuts in public consumption, which declines by additional 12.46 percentage points to balance the government budget in this ageing economy. The large fiscal costs of population aging are consistent with the results from other studies for the U.S., Australia and Japan by Kitao (2014), Kudrna *et al.* (forthcoming), Hsu and Yamada (forthcoming), respectively.

Insert **Table 10** around here

Table 10 also indicates that in the ageing economy, the elimination of the budget deficit and of the greater government debt leads to (*i*) a further increase in net foreign assets and (*ii*) an additional long run tax (transfer payment) cut (increase), which has positive impact per capita consumption, labour supply and domestic assets. These long run effects are qualitatively similar to those reported in Table 9 for the reduced economic growth scenario.

5.4 Alternative technologies

We also conduct a sensitivity analysis of two alternative assumptions related to the production sector: (*i*) Cobb-Douglas production function and (*ii*) abstracting from capital adjustment costs. In this subsection, we briefly summarize the main findings for these two sensitivity checks, with the results being presented and discussed in detail in the online technical appendix.

Production function. In our benchmark model, we assume a CES production technology with $\sigma = 0.78$. The Cobb-Douglas function commonly used in the literature is nested as a

[25]For a detailed analysis of the economic effects of demographic transition in Australia see Kudrna *et al.* (2015).

special case of the general CES specification. We check our results, using a Cobb-Douglas production function (where $\sigma = 1$). Note that we keep all other model assumptions (including the capital adjustment cost assumption) unchanged.

We first compute the baseline transition, which assumes the budget deficit to GDP ratio from 2015 onwards to stay constant, as observed in 2014. We find that the macroeconomic effects during the baseline transition are very similar when comparing our benchmark model and this alternative model with a Cobb-Douglas production technology. We then simulate the gradual fiscal consolidation with income tax adjustments, using this alternative model with a Cobb-Douglas technology. We find that the effects on most macroeconomic variables are relatively smaller compared to those derived from our benchmark model with the CES technology, but the differences are very small.

Adjustment cost. In this sensitivity check, we compute the baseline and fiscal consolidation transition paths, using the CES production function (as in the benchmark model) but abstracting from capital adjustment costs. The differences in the macroeconomic effects during the baseline transition are very small, when comparing our benchmark model and this alternative (see the online technical appendix for the numerical results). Given that increasing net government debt has no impact on the domestic interest rate, the implications on the economy are rather small under all simulated baseline transition paths.

However, comparing the results for the gradual fiscal consolidation with income tax adjustments reveals that there are more pronounced differences in the magnitude of some of the reported variables derived from the models with and without adjustment costs in the short run and over the transition. As discussed, in the small open economy model (with perfect capital mobility) without any capital adjustment costs, the changes in labour supply have to be exactly matched by the changes in the capital stock (because of the constant capital-labour ratio that is determined by the exogenous and constant world interest rate). As a direct result, the macroeconomic implications in the model without adjustment costs are more pronounced, driven entirely by the changes in labour supply.

5.5 Summary of sensitivity results

This section has examined the sensitivity of the long run macroeconomic effects derived from our benchmark model to (*i*) alternative market structure, (*ii*) alternative economic growth, (*iii*) alternative demographic structure, and (*iv*) alternative production sector. Although we show that these alternative specifications and assumptions of the model generate some differences in the magnitude of the long run macroeconomic effects, the general thrust of the examined budget repair measures remain intact (at least in the long run). In other words, the robustness tests undertaken in this section have revealed that the direction of long run macroeconomic impacts of the examined fiscal policy options was largely unaffected.

6 Conclusion

In this paper, we have quantified and compared the macroeconomic and welfare effects of the immediate and gradual fiscal consolidation plans funded by either temporary tax hikes or transfer payment cuts in the context of a small open economy. Using a computable, general equilibrium OLG model calibrated to match both the macroeconomic and household lifecycle data in Australia, we find that, while all the examined budget repair options achieve the same fiscal goal, the macroeconomic and welfare outcomes differ significantly. Specifically, the current generations would not support any fiscal austerity measures because they are worse off by having their transfer payment cut or having to pay higher taxes. Our results suggest interesting outcomes when choosing between temporary transfer payment cuts or tax increases to fund the fiscal consolidation. Cutting transfer payments results in the worst welfare losses for the current generations (especially older and low skill households), but generates the highest welfare gain for the future generations.

Our results carry implications for designing a feasible fiscal consolidation strategy for Australia. Even though the long-run benefits of the budget repair strategies examined in this paper are undeniable, the transitional costs to the economy and welfare are significant and unavoidable. The budget repair measures are indeed challenging policy choices for a better future in Australia. Our results consistently suggest that none of the examined fiscal austerity measures are politically feasible as they will likely fail to gain the political support of current generations. The conflict of interest between the current and future generations suggests political infeasibility for any fiscal consolidation plan alone. However, we have shown that in a small open economy framework, it is possible to devise a fiscal consolidation plan coupled with a compensation scheme for the current generations to achieve better living standard for future generations.

Our dynamic general equilibrium framework with overlapping generations can be applied to study the effects of structural tax reforms proposed by the recent Henry Taxation Review (AFTS, 2010). Notice that, in our paper we abstract from altruistic motives, so that there are no intended bequests and other forms of intergenerational transfers through family line. Introducing this type of intergenerational transfers creates a new channel that links the welfare of current generations to that of future generations, which might affect welfare outcomes and increase political support by current generations for the fiscal consolidation plan. It also needs to be pointed out that our analysis only considers the examined budget repair strategies separately, while the government may implement a combination (mix) of such fiscal policy options designed to ensure that no generation is worse off from the fiscal consolidation. We leave these extensions for future research.

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Appendix: Alternative budget repair measures

The government has a wide range of policy measures to repair its budget. In this appendix, we consider two alternative tax measures: a special levy on labour income (i.e., introduction of a flat payroll tax rate) and a special levy on total assets income (i.e., introduction of a flat capital income tax rate).[26] The effects of these two alternative budget repair measures and the comparison with the three policy measures examined in Section 4 are discussed below.

Table B1 reports the macroeconomic implications of the two alternative policy measures as percentages changes in selected transitional years and in the long run relative the baseline results. The results show significant differences between the two tax hikes as well as between the two consolidation plans within each tax hike. While the special levy on labour income is relatively small (9% levy in 2020 under the gradual plan), the capital income levy is significantly higher (37% levy in 2020 under the gradual plan). This difference is due to (*i*) total assets income being smaller than labour income and (*ii*) more distortive nature of the capital income tax. Comparing the two consolidation plans, the immediate plan requires a high levy in 2015 (10% levy on labour income or 34% levy on capital income), whereas under the gradual plan, each levy is initially modest but increases significantly by 2020.

Insert **Table B1** around here

Table B1 also shows significant differences in the effects of the two alternative tax measures on effective labour supply, domestic assets and consumption. For example, the gradual consolidation plan with the labour income levy initially increases per capita labour supply (due to the announcement effects), but the capital income levy generates a significantly decline of 4.34% in labour supply in 2015 relative the baseline result. Notice that under the second policy measure, households demand not only more leisure but also more consumption, with per capita consumption increasing by 3.2% in 2015. These two behavioural responses have a very negative impact on assets accumulation, resulting in large reductions in domestic assets in the medium run (9.18% decline in 2020 under the gradual plan).

The welfare effects of the two alternative measures and three main policy measures are displayed in Table B2. The effects are presented for the selected skill type (income quintile) and for average welfare of four selected cohorts (two current cohorts aged 80 and 40 years in 2015 and two future generations aged 0 and -150). The results for the two alternative measures indicate that while the labour income levy has no effect on older cohorts (as these households already retired from work), the capital income levy results in significant losses for older cohorts. Moreover, the welfare losses are greater for higher income quintiles as they hold larger assets relative to lower income types. In the long run, the government debt elimination generates a

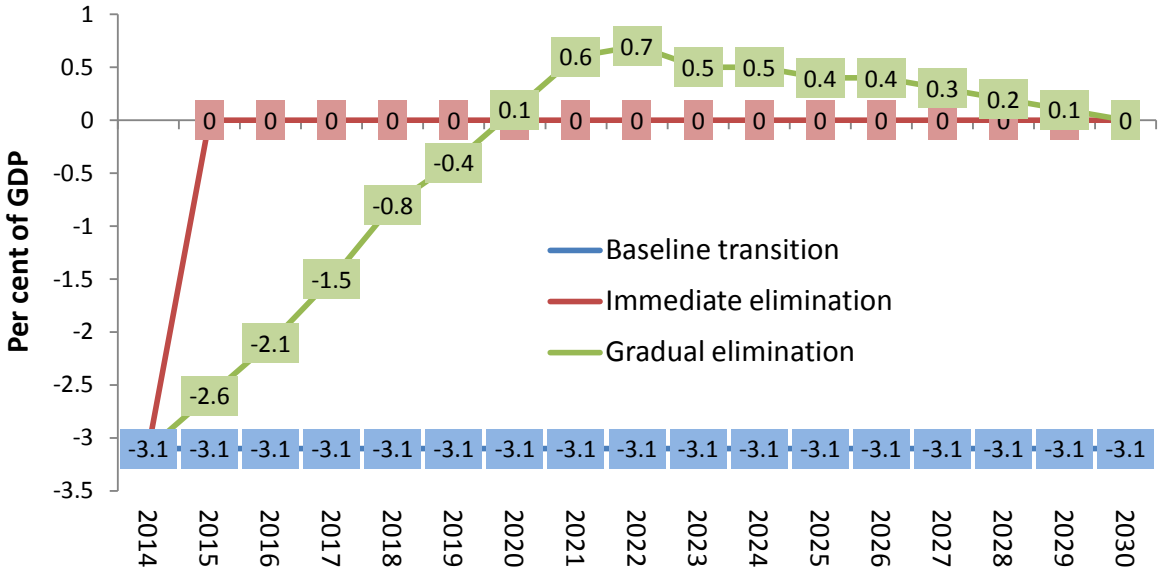
[26] Although Australia does not have any payroll tax (paid by workers) and a flat capital income or interest tax, many countries (e.g., Germany) have such taxes, which motivate the present analysis.

subsidy on labour or capital income, which produces gains in average welfare and in welfare of more affluent households (see the result for cohorts aged -150).

Insert **Table B2** around here

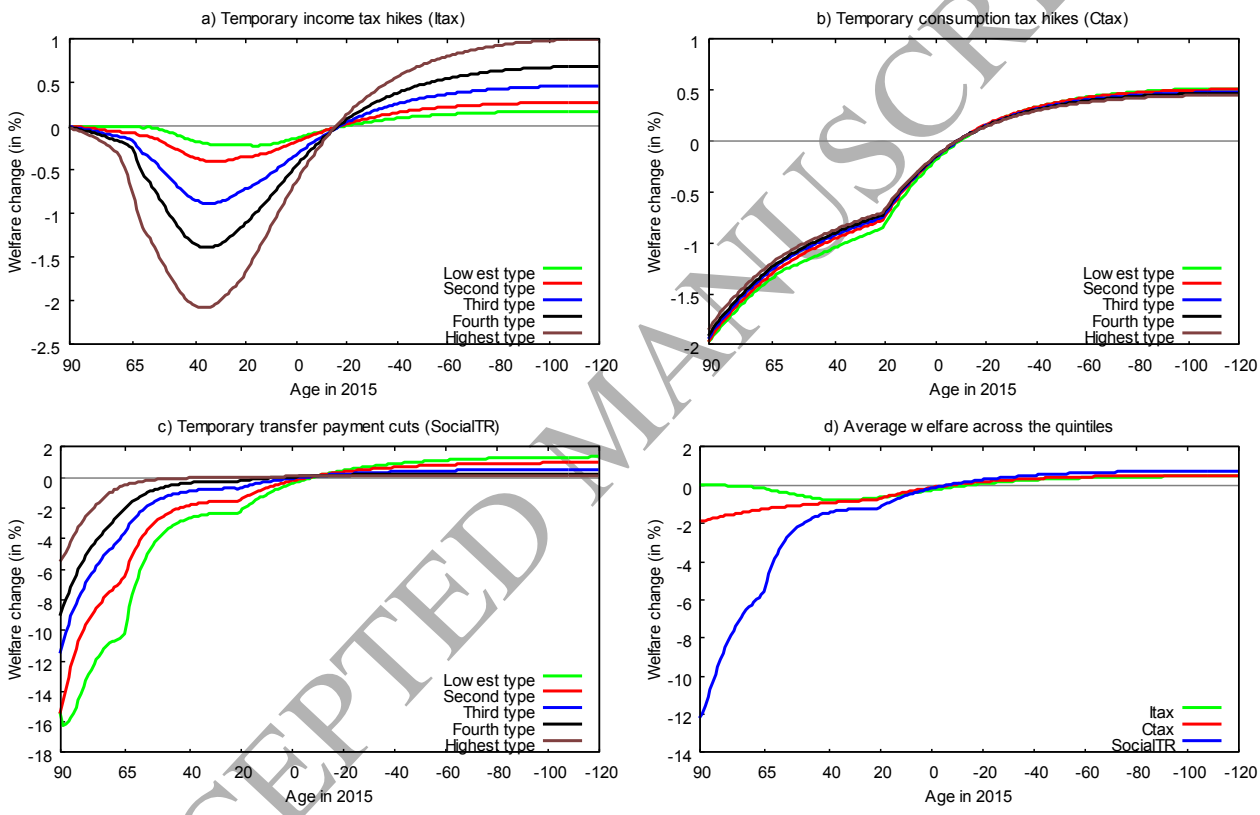
Table B2 also compares the welfare effects of all five budget repair measures. In terms of the inter-generational welfare effects, the budget repair measure with transfer payment adjustments results in the highest (average) welfare gain in the long run, followed by the capital levy/subsidy adjustments. The two fiscal measures, however, produce the worst welfare losses for current generations. The comparison of the intra-generational welfare effects reveals that while temporary consumption tax hikes and transfer payment cuts hurt especially the poor, the income tax hikes generate larger losses for the rich. In the long run, the intra-generational effects reverse as zero public debt allows for tax cuts or higher transfer payments. In sum, these welfare trade-offs between different generations, as well as between the rich and poor, highlight political constraints when implementing a fiscal consolidation plan.

Figure 1: Budget deficits/surpluses under different fiscal consolidation scenarios



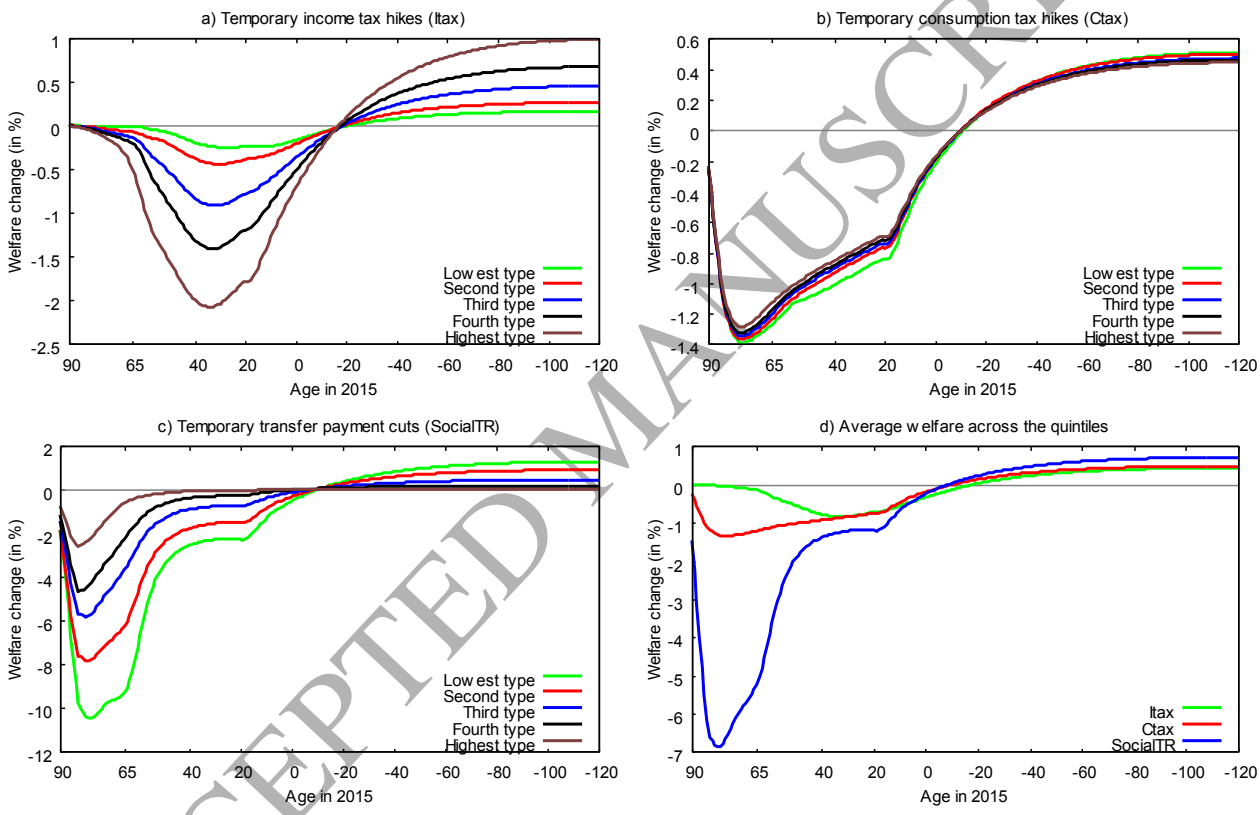
Notes: The underlying cash balance (budget deficit/surplus) for 2014 and gradual eliminations of budget deficits are taken from Australian Government (2015).

Figure 2: Welfare implications of immediate elimination of budget deficits with different policy instruments (Percentage changes in welfare relative to baseline transition with unchanged 2014 budget deficit to GDP ratio)



Notes: Equivalent variation measures in percent; Oldest (youngest) household in 2015 when the immediate elimination of budget deficits is adopted is 90 years (21 years) old. All generations younger than 21 years are born in the subsequent periods of the transition.

Figure 3: Welfare implications of gradual elimination of budget deficits with different policy instruments (Percentage changes in welfare relative to baseline transition with unchanged 2014 budget deficit to GDP ratio)



Notes: Equivalent variation measures in percent; Oldest (youngest) household in 2015 when gradual reductions of budget deficits are phased in is 90 years (21 years) old. All generations younger than 21 years are born in the subsequent periods of the transition.

Table 1: Values of main model parameters

Description	Value	Source
Demographics		
Population growth rate	0.016	Data
Intra-generational shares	All 0.2	Data [a]
Conditional survival probabilities	ABS (2014b)	Data
Utility function		
Inter-temporal elasticity of substitution	0.4	Literature [b]
Intra-temporal elasticity of substitution	0.9	Literature [b]
Subjective discount factor	0.99	Calibrated
Leisure parameter	1.5	Literature [b]
Technology		
Productivity constant	0.872	Calibrated
Elasticity of substitution in production	0.778	Calibrated
Capital intensity parameter	0.45	Data
Capital depreciation rate	0.055	Calibrated
Adjustment cost parameter	10	Literature [c]
Technical progress rate	0.015	Data

Notes: [a] Households are disaggregated into income quintiles based on ABS (2007); [b] The values of these parameters are similar to Auerbach and Kotlikoff (1987) and Fehr (2000); [c] This value is taken from Auerbach and Kotlikoff (1987).

Table 2: Calibration of fiscal policy in initial steady state and base year of 2014

Variable	Statutory rate	Share in % of GDP		Effective rate	
	(Data) (2013-14)	(Data) (2000-08)	(Data) (2014)	(Calibrated) (2000-08)	(Calibrated) (2014)
Public pension		2.5	2.93		
- Maximum pension p.a. ($)	21,504	-	-	Down by 10%	Up by 3%
- Income test threshold p.a. ($)	4,056	-	-		
- Taper/withdrawal rate (%)	50	-	-		
Private pension					
- Contribution rate (%)	9.5	-	-	9.5	9.5
- Contribution tax rate (%)	15	0.7	0.5	8.7	6.2
Social welfare transfers	-	4	4.59	Calibrated	Calibrated
Personal income tax	[a]	11.49	10.9	Calibrated	Calibrated
Consumption tax (%)	10	6.95	6.4	12.8	11.3
Corporate tax (%)	30	4.7	4.6	27.6	27
Other lump-sum tax	-	1.53	1.4	Calibrated	Calibrated

Notes: Data from Australian Government (2015); Effective rates derived by adjusting statutory rates to match the corresponding shares in % of GDP; [a] The income tax function estimated using 2013-14 progressive income tax schedule.

Table 3: Comparison of model generated values for key variables with Australian data

Variable	Model generated [a]				Australian data [b]			
	2000-08	2010	2012	2014	2000-08	2010	2012	2014
Private consumption [c]	54.12	56.42	57.08	56.84	57.71	55.38	53.72	55.47
Public consumption [c]	18.87	19.77	17.50	18.86	17.41	18.01	17.88	17.68
Investment [c]	26.54	26.23	26.33	26.53	26.44	27.76	28.18	27.40
Trade balance [c]	0.47	-2.43	-0.91	-2.23	-1.71	-0.97	-0.13	-0.43
Total tax revenue [c]	25.37	22.70	22.80	23.80	25.37	22.70	22.80	23.80
Budget surplus [c]	0.00	-4.21	-2.92	-3.07	0.74	-4.21	-2.92	-3.07
Net government debt [c]	0.00	2.06	9.25	12.13	3.16	3.30	9.90	12.80
Capital to GDP [d]	3.09	3.06	3.08	3.10	3.09	3.16	3.05	3.22
Investment to capital [d]	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Foreign assets to capital [d]	-0.17	-0.18	-0.20	-0.21	-0.17	-0.18	-0.18	-0.17

Notes: [a] The model-generated values relate to the initial steady state equilibrium in 2000-08 and to selected years of the calibration period in 2009-14; [b] The values are derived from ABS (2014a) and Australian Government (2015), with the values for 2000-08 being averages over that period; [c] In % of GDP; [d] Ratio.

Table 4: Macroeconomic implications during baseline transition
(Percentage changes in selected detrended per capita variables from year 2014)

Variable	2014 [a]		2015	2020	2030	2050	Long run
Labour supply	0.356	%	0.00	-0.03	-0.06	-0.08	-0.06
Capital stock	2.351	%	-0.04	-0.22	-0.40	-0.50	-0.51
Domestic assets	1.950	%	-0.05	-0.23	-0.38	-0.44	-0.68
Net foreign assets	-0.485	%	-4.22	-23.34	-53.28	-91.16	-136.51
Net government debt [b]	12.130	-	14.74	26.67	45.65	69.85	98.27
Output (GDP)	0.758	%	-0.02	-0.09	-0.17	-0.22	-0.22
- Private consumption	0.431	%	-0.03	-0.15	-0.30	-0.33	-0.36
- Public consumption	0.143	%	-0.61	-3.38	-7.65	-12.88	-18.94
Age pension costs	0.022	%	0.10	0.49	0.83	0.87	0.94
Total tax revenue	0.180	%	-0.03	-0.16	-0.32	-0.40	-0.43
- Personal income tax	0.083	%	-0.05	-0.26	-0.50	-0.64	-0.69
- Consumption tax	0.049	%	-0.03	-0.15	-0.30	-0.33	-0.36

Notes: [a] The values for monetary variables in 2014 are presented in units of $100,000 and per capita; Labour supply is presented in per capita and efficiency units; Net government debt in 2014 and other selected years of the transition is presented in % of GDP.

Table 5: Macroeconomic effects of immediate elimination of budget deficit with different policy instruments (Percentage changes in selected variables from baseline results with unchanged 2014 budget deficit to GDP ratio)

Variable	(i) Temporary income tax hikes				(ii) Temporary consumption tax hikes				(iii) Temporary transfer payment cuts			
	2015	2020	2030	Long run	2015	2020	2030	Long run	2015	2020	2030	Long run
Labour supply	-6.55	-5.06	-2.48	0.66	-0.26	-0.13	0.05	-0.11	2.54	1.96	1.28	-0.74
Capital stock	0.00	-1.26	-1.53	0.66	0.00	-0.01	0.04	-0.11	0.00	0.55	0.82	-0.74
Domestic assets	0.00	-6.00	-12.79	7.88	0.00	-0.85	-1.71	-0.06	0.00	-0.16	-0.76	-3.08
Net foreign assets	14.27	8.00	7.39	76.82	0.26	14.98	32.25	64.98	-5.92	12.76	32.43	61.19
Government debt [a]	15.42	13.15	9.51	0.00	14.77	12.66	9.30	0.00	14.50	12.47	9.21	0.00
Output (GDP)	-4.42	-3.80	-2.16	0.66	-0.17	-0.09	0.05	-0.11	1.67	1.48	1.12	-0.74
- Consumption	-4.11	-4.61	-4.50	2.65	-4.69	-3.94	-2.68	1.38	-3.41	-2.45	-1.18	0.47
Age pension costs	0.40	0.84	2.02	-2.14	0.00	0.06	0.17	0.04	-42.60	-34.34	-21.99	11.08
Total tax revenue	12.95	10.65	7.05	-3.89	12.90	10.56	6.82	-3.62	-0.04	0.18	0.30	-0.58
- Income tax	34.32	28.88	19.63	-10.40	-0.20	-0.29	-0.31	-0.14	0.60	0.78	0.64	-1.19
- Consumption tax	-4.11	-4.61	-4.50	2.65	48.59	39.91	25.87	-13.13	-3.41	-2.45	-1.18	0.47
Policy instrument [b]	42.42	37.64	26.93	-12.67	55.90	45.65	29.34	-14.31	-39.84	-31.67	-19.42	8.60

Notes: [a] Net government debt presented in % of GDP; [b] The fiscal policy measure to eliminate the 2014 budget deficit immediately in 2015 is either (i) income taxation or (ii) consumption tax rate or (iii) transfer payments.

Table 6: Macroeconomic effects of gradual elimination of budget deficit with different policy instruments
(Percentage changes in selected variables from baseline results with unchanged 2014 budget deficit to GDP ratio)

Variable	(i) Temporary income tax hikes				(ii) Temporary consumption tax hikes				(iii) Temporary transfer payment cuts			
	2015	2020	2030	Long run	2015	2020	2030	Long run	2015	2020	2030	Long run
Labour supply	2.07	-6.64	-2.96	0.66	0.63	-0.28	0.02	-0.11	1.91	2.02	1.29	-0.74
Capital stock	0.00	-1.61	-2.04	0.66	0.00	-0.04	0.00	-0.11	0.00	0.56	0.85	-0.74
Domestic assets	0.00	-1.61	-12.82	7.88	0.00	0.14	-1.61	-0.06	0.00	1.80	-0.42	-3.08
Net foreign assets	11.25	18.63	5.95	76.82	-0.08	10.24	30.48	64.98	-5.62	10.46	31.18	61.19
Government debt [a]	14.55	20.24	11.78	0.00	14.68	19.30	11.35	0.00	14.56	19.05	11.23	0.00
Output (GDP)	1.34	-4.98	-2.65	0.66	0.42	-0.20	0.01	-0.11	1.26	1.52	1.14	-0.74
- Consumption	-1.05	-4.68	-4.77	2.65	-1.25	-4.35	-2.79	1.38	-2.87	-2.41	-1.18	0.47
Age pension costs	0.08	0.63	1.85	-2.14	-0.08	-0.11	0.12	0.04	-7.15	-39.15	-23.06	11.08
Total tax revenue	1.84	12.14	7.39	-3.89	1.92	12.07	7.16	-3.62	-0.09	0.32	0.34	-0.58
- Income tax	2.16	32.88	20.86	-10.40	0.44	-0.21	-0.34	-0.14	0.59	1.05	0.71	-1.19
- Consumption tax	-1.05	-4.68	-4.77	2.65	5.60	45.53	27.21	-13.13	-2.87	-2.41	-1.18	0.47
Policy instrument [b]	0.21	42.61	29.22	-12.67	6.93	52.15	30.86	-14.31	-5.42	-35.89	-20.33	8.60

Notes: [a] Net government debt presented in % of GDP; [b] The fiscal policy measure to eliminate the 2014 budget deficit gradually is either (i) income taxation or (ii) consumption tax rate or (iii) transfer payments.

Table 7: Aggregate efficiency implications with LSRA

Variable	Immediate plan			Gradual plan		
	Itax	Ctax	SocialTR	Itax	Ctax	SocialTR
Efficiency gain [a]	0.444	0.340	0.210	0.434	0.338	0.209
Efficiency gain [b]	0.083	0.062	0.039	0.081	0.061	0.038
Initial LSRA debt [c]	51.32	37.34	36.81	51.19	36.02	35.09

Notes: [a] Measured as % change of initial resources for all income types; [b] Measured as $ change (in units of $100,000); [c] Initial annual LSRA debt measured as % of GDP (in 2015).

Table 8: Sensitivity of long run macroeconomic effects to imperfect capital mobility
(% point differences between long run results with endogenous and exogenous interest rates)

Variable	Baseline transition [a]	Policy instrument to eliminate budget deficit [b]		
		(i) Income tax rates	(ii) Consumption tax rate	(iii) Social transfers
Labour supply	-0.88	1.54	0.99	0.53
Wage rate	-3.39	5.14	4.01	3.61
Capital stock	-8.35	13.93	10.46	8.92
Domestic assets	13.14	-14.26	-12.94	-12.81
Net foreign assets	98.75	-37.20	-33.46	-32.15
Net government debt [c]	0.00	0.00	0.00	0.00
Interest rate	13.77	-17.36	-13.73	-12.39
Output (GDP)	-3.51	5.60	4.12	3.32
- Private consumption	-1.26	3.43	2.42	1.69
Age pension costs	-2.58	2.40	2.70	9.74
Total tax revenue	-0.34	-1.79	-1.76	0.12
- Personal income tax	-1.91	-3.33	2.34	1.45
- Consumption tax	-1.26	3.43	-6.85	1.69
Policy instrument	-2.63	-6.56	-8.60	5.42

Notes: [a] Deficit of 3.07% of GDP kept unchanged with adjustments in public consumption reported under "Policy instrument"; [b] Long run deficit of 0% of GDP with adjustments in (i) income taxation, (ii) consumption tax rate or (iii) social transfers; [c] Deviation in net debt to GDP ratio.

Table 9: Sensitivity of long run macroeconomic effects to economic slowdown
(% point differences between long run results with technical change of 1% and 1.5%)

Variable	Baseline transition [a]	Policy instrument to eliminate budget deficit [b]		
		(i) Income tax rates	(ii) Consumption tax rate	(iii) Social transfers
Labour supply	-7.01	0.31	-0.09	-0.47
Capital stock	-6.98	0.31	-0.09	-0.47
Domestic assets	8.41	7.65	-0.04	-2.01
Net foreign assets	50.78	48.79	26.96	21.59
Net government debt [c]	19.08	0.00	0.00	0.00
Output (GDP)	-7.00	0.31	-0.09	-0.47
- Private consumption	-2.82	2.33	1.12	0.47
Age pension costs	20.38	-1.76	0.02	7.10
Total tax revenue	-5.31	-3.44	-3.09	-0.35
- Personal income tax	-6.76	-9.44	-0.11	-0.89
- Consumption tax	-2.82	2.33	-10.59	0.47
Policy instrument	-12.72	-11.07	-11.27	5.95

Notes: [a] Deficit of 3.07% of GDP kept unchanged with adjustments in public consumption reported under "Policy instrument"; [b] Long run deficit of 0% of GDP with adjustments in (i) income taxation, (ii) consumption tax rate or (iii) social transfers; [c] Deviation in net debt to GDP ratio.

Table 10: Sensitivity of long run macroeconomic effects to ageing demographic
(% point differences between long run results in ageing and non-ageing economies)

Variable	Baseline transition [a]	Policy instrument to eliminate budget deficit [b]		
		(i) Income tax rates	(ii) Consumption tax rate	(iii) Social transfers
Labour supply	-4.57	0.56	-0.19	-1.16
Capital stock	-4.55	0.56	-0.19	-1.16
Domestic assets	34.94	14.66	-0.09	-4.69
Net foreign assets	105.46	172.51	96.14	74.22
Net government debt [c]	43.11	0.00	0.00	0.00
Output (GDP)	-4.56	0.56	-0.19	-1.16
- Private consumption	2.77	5.43	2.49	0.73
Age pension costs	47.05	-4.18	0.06	16.40
Total tax revenue	1.20	-7.51	-6.63	-1.02
- Personal income tax	3.01	-19.43	-0.23	-2.13
- Consumption tax	2.77	5.43	-23.51	0.73
Policy instrument	-12.46	-22.34	-24.69	12.29

Notes: [a] Deficit of 3.07% of GDP kept unchanged with adjustments in public consumption reported under "Policy instrument"; [b] Long run deficit of 0% of GDP with adjustments in (i) income taxation, (ii) consumption tax rate or (iii) social transfers; [c] Deviation in net debt to GDP ratio.

Table B1: Macroeconomic effects of eliminating budget deficit with alternative policy instruments
(Percentage changes in selected detrended variables from baseline results with 2014 budget deficit to GDP ratio)

Variable	(i) Temporary labour income levy						(ii) Temporary capital income levy					
	Immediate elimination			Gradual elimination			Immediate elimination			Gradual elimination		
	2015	2020	LR	2015	2020	LR	2015	2020	LR	2015	2020	LR
Labour supply	-3.59	-2.28	0.03	2.81	-3.41	0.03	-4.14	-1.97	-0.74	-4.34	-2.77	-0.74
Capital stock	0.00	-0.44	0.03	0.00	-0.70	0.03	0.00	-0.08	-0.74	0.00	-0.18	-0.74
Domestic assets	0.00	-4.80	2.34	0.00	0.39	2.34	0.00	-10.51	16.91	0.00	-9.18	16.91
Net foreign assets	5.98	5.19	68.85	3.66	17.21	68.85	3.75	-16.98	94.94	4.94	-20.16	94.94
Government debt [a]	15.10	12.86	0.00	14.48	19.80	0.00	15.16	12.82	0.00	15.18	19.44	0.00
Output (GDP)	-2.40	-1.66	0.03	1.84	-2.50	0.03	-2.77	-1.33	-0.74	-2.90	-1.90	-0.74
- Consumption	-4.96	-4.59	1.76	-2.32	-4.93	1.76	3.03	0.94	1.27	3.20	1.59	1.27
Age pension costs	0.50	0.75	-0.83	0.10	0.64	-0.83	-0.14	1.45	-3.87	-0.10	0.93	-3.87
Total tax revenue	12.96	10.64	-3.73	1.78	12.16	-3.73	12.88	10.73	-1.90	2.28	12.16	-1.90
- Income tax	-15.48	-13.21	3.13	1.85	-14.86	3.13	-2.91	-2.97	1.69	-3.06	-3.55	1.69
- Consumption tax	-4.96	-4.59	1.76	-2.32	-4.93	1.76	3.03	0.94	1.27	3.20	1.59	1.27
Policy instrument [b]	0.10	0.08	-0.02	0.00	0.09	-0.02	0.34	0.33	-0.10	0.09	0.37	-0.10

Notes: [a] Net government debt presented in % of GDP; [b] The fiscal policy instrument to eliminate the 2014 budget deficit is temporary levy on either (i) labour income or (ii) capital (total assets) income.

Table B2: Welfare implications of eliminating budget deficit with different policy instruments

Policy instrument	Age in 2015	Immediate elimination				Gradual elimination			
		Lowest quintile	Third quintile	Highest quintile	Average welfare	Lowest quintile	Third quintile	Highest quintile	Average welfare
Temporary income tax hikes	80	-0.01	-0.06	-0.14	-0.06	0.00	-0.04	-0.07	-0.03
	40	-0.18	-0.85	-2.06	-0.80	-0.19	-0.83	-2.00	-0.78
	0	-0.14	-0.33	-0.64	-0.30	-0.16	-0.36	-0.70	-0.33
	-150	0.18	0.50	1.09	0.47	0.18	0.50	1.09	0.47
Temporary consumption tax hikes	80	-1.69	-1.62	-1.54	-1.63	-1.35	-1.31	-1.26	-1.31
	40	-1.05	-0.93	-0.88	-0.96	-1.01	-0.90	-0.85	-0.93
	0	-0.20	-0.17	-0.15	-0.17	-0.22	-0.19	-0.17	-0.20
	-150	0.54	0.50	0.47	0.51	0.54	0.50	0.47	0.51
Temporary transfer payment cuts	80	-13.33	-6.96	-2.61	-8.49	-10.41	-5.81	-2.41	-6.87
	40	-2.72	-0.95	-0.07	-1.48	-2.56	-0.89	-0.06	-1.39
	0	-0.45	-0.10	0.02	-0.21	-0.51	-0.12	0.02	-0.24
	-150	1.38	0.50	0.02	0.76	1.38	0.50	0.02	0.76
Temporary labour income levy	80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	40	-1.04	-1.23	-1.47	-1.19	-0.96	-1.16	-1.40	-1.12
	0	-0.35	-0.41	-0.44	-0.38	-0.39	-0.46	-0.49	-0.43
	-150	0.46	0.55	0.63	0.53	0.46	0.55	0.63	0.53
Temporary capital income levy	80	-0.09	-0.93	-1.60	-0.77	-0.06	-0.67	-1.18	-0.56
	40	-0.93	-1.63	-2.03	-1.44	-0.94	-1.69	-2.12	-1.48
	0	-0.08	-0.02	0.02	-0.03	-0.10	-0.05	-0.01	-0.06
	-150	0.39	0.70	0.87	0.61	0.39	0.70	0.87	0.61

Notes: Standard equivalent variation measures (in %) for selected quintiles and average welfare relative to baseline transition with the government deficit to GDP ratio kept constant as in 2014; Age -150 in 2015 shows long run welfare effects.