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# Fiscal Stimulus: An Overlapping Generations Analysis

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ABSTRACT

*Motivated by the revival of Keynesian-inspired fiscal activism in response to the global financial crisis of 2008-09, this paper analyses stylised simulations of fiscal stimulus using an overlapping generations model that allows for feedback effects of stimulus spending on intertemporal consumption decisions of households, via the tax rate, wages and the interest rate. Simulations vary according to the size and type of stimulus, and the speed and way in which the stimulus is unwound. The main qualitative result is that the short run output gains from fiscal stimulus are transitory — the fiscal multiplier turns negative and remains negative long after the stimulus ends, mainly because it must be reversed in some way. Also, the overlapping generations framework allows an intergenerational welfare analysis. Among the biggest winners from stimulus are those about to retire. The biggest losers are those near the start of their working lives when the stimulus is implemented.*

## 1. INTRODUCTION

DUE TO CONCERN about the likelihood of another Great Depression, governments around the world implemented unprecedented fiscal stimulus in order to counter the impact of the Global Financial Crisis of 2008-09. This large scale fiscal activism, strongly promoted by the International Monetary Fund (Lipsky 2008 and Spilimbergo *et al* 2008) and internationally co-ordinated via a series of G20 heads of government summits, involved a range of budgetary measures that included direct government spending, income transfers and tax cuts in major economies. Nations' budget balances and public debt levels worsened significantly as a result of the crisis, not only because of the discretionary fiscal actions taken worldwide, but also because of the cyclical impact of the crisis itself on government revenue and the direct budgetary contributions to assist crisis-affected financial institutions.

During the worst of the so-called Great Recession, budget deficits averaged about 9 percent of GDP in advanced economies in 2009, and public debt reached an average 100 percent of GDP by the end of 2010 (IMF 2010). Public debt levels of this order have not been seen since after World War II (Cottarelli and Schaechter 2010). Mindful of the risks associated with the sustainability of high public debt levels, many European economies, most notably the United Kingdom, have begun to wind back their budget deficits via extensive fiscal consolidation.

This paper analyses the macroeconomic effects of fiscal stimulus, and its subsequent reversal, over time. It reports stylised simulations of fiscal stimulus using an overlapping generations model that allows for feedback effects of stimulus spending on intertemporal consumption decisions of households, via the tax rate, wages and the interest rate. The overlapping generations approach allows an intergenerational welfare analysis, identifying relative gains and losses to different generations.

The wide-ranging fiscal response to the financial crisis was essentially inspired by traditional Keynesian macroeconomic theory, which had hitherto waned as an influence on fiscal policy in light of arguments put by Monetarist and New Classical economists from the late 1960s onwards. Yet standard Keynesian theory, with its emphasis on short run aggregate demand, largely ignores the future consequences of fiscal activism, particularly the higher future interest rates and income taxes bestowed on future generations. Analysis of the intertemporal consequences of discretionary fiscal actions reveals that any short term gains arising from fiscal stimulus have to be balanced against future economic welfare losses.

Over recent decades, a large literature has developed focusing on the impact of fiscal stimulus on aggregate demand, and hence national output and employment in the short run. In one stream a Ricardian literature (see Barro 1974, Seater 1993, Ricciuti 2003) suggests that, in response to fiscal stimulus, forward looking households reduce current consumption and raise saving to cover future tax liabilities, thus offsetting any short run fiscal impact, completely negating any stimulus in the case of full offset. However, the Ricardian approach unrealistically assumes households have complete information about the future. Though studies published to date have not found a full private-public saving offset, numerous have found evidence of partial offset, with coefficients of between 0.5 and 0.7 (see, for instance, Masson *et al* 1998, and Loayza *et al* 2000).

In another stream of the literature, numerous papers have estimated econometrically the size of fiscal multipliers for a number of economies, using various methods which yield a range of values. For instance, Blanchard and Perotti (2002) and Romer and Romer (2010) found fiscal stimulus for the US generates a positive impact on national output, whereas Mountford and Uhlig (2009) found fiscal stimulus had a negative impact over longer horizons. Meanwhile, Perotti (2005) found relatively lower multiplier values for European countries.

Moreover, the results of econometric studies supportive of the so-called 'expansionary fiscal contraction' hypothesis (Giavazzi and Pagano 1996, Makin 1998, Alesina and Ardagna 1998 and Coleman 2010) are consistent with negative fiscal multipliers. However, there are numerous unsettled questions associated with econometric approaches to gauging the macroeconomic impact of fiscal stimulus. These include how best to identify expansionary fiscal episodes in the data, reverse causation between the budget balance and level of economic activity, and how to disentangle the effects of discretionary fiscal responses from those of automatic stabilisers.

An alternative analytical approach which avoids these difficulties estimates the impact of fiscal stimulus, using structural models and simulation techniques that assume non-Ricardian behaviour as a result of liquidity constraints. Typically, DSGE models in this vein find that the greatest impact of fiscal stimulus occurs at the time of implementation and then gradually diminishes (see for instance Freedman *et al* 2009, Forni *et al* 2009, Cogan *et al* 2010 and Uhlig 2010). Other work examining the fiscal multiplier in optimising models with New Keynesian features includes Woodford (2011), Davig and Leeper (2011), which introduces Markov-switching fiscal rules, and Annicchiarico et al (2012), which employs an overlapping generations approach to analyse the impact of budgetary policy. In these models, the values of fiscal multipliers with respect to national output vary according to model assumptions and behavioural underpinnings.

The remainder of the paper proceeds as follows. Section 2 develops the basic open economy overlapping generations model before the results of numerous simulations are reported in section 4. Section 5 concludes the paper.

## 2. The Simulation Model

The overlapping generations simulation model described in detail below has the standard Overlapping Generations (OLG) model characteristics of a single good, no money,[2] and a fixed price level (as the focus is on the real effects of fiscal stimulus over the longer term).

### *2.1 Firms*

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

$$Y_j = AK_j^{\alpha} L_j^{1-\alpha} \quad (1)$$

where $A$ is an exogenous technology parameter,[3] $K_j$ is the capital stock in period $j$, and $L_j$ is an aggregate labour index consisting of the sum of the labour of all generations. Hence $L_j = \sum_{i=1}^{n} L_{i,j}$ where $L_{i,j}$ is the labour of generation $i$ working in period $j$.

The optimal capital stock, $K_j$, is determined by the first-order condition that the net marginal product of capital (net of depreciation, $\delta$) is equal to the cost of capital, $r_j$, which varies due to imperfect capital mobility (see below). That is, $\frac{dY_j}{dK_j} - \delta = r_j$ , which gives:

$$\frac{K_j}{L_j} = A\left(\frac{\alpha}{r_j + \delta}\right)^{1/(1-\alpha)} \tag{2}$$

Investment, $I_j$, is given by:

$$I_j = K_j - K_{j-1}(1-\delta) \tag{3}$$

The marginal product of labour is given by:

$$w_{L,j} = (1-\alpha)A\left(\frac{K_j}{L_j}\right)^{\alpha} = \frac{Y_j}{L_j} - (r_j + \delta)\frac{K_j}{L_j} \tag{4}$$

This is used to adjust the wage rates of workers of age $i$, which are given by data, such that the total wage bill for the economy, $w_{L,j}L_j$ , is equal to the sum of wages earned by workers of all ages. See calibration section below.

*2.2 Households*

One person households consume both the single good and leisure. A household is formed at age 15 and therefore household consumption includes the consumption of children under age 15. A period of time is one year duration and a new generation of households is born each period. Each household commences working at age 15, retires at age 70 and dies on their 85th birthday with certainty. Hence there are $h = 70$ overlapping generations of working households alive at any time. They commence working life with zero financial assets and have a target financial wealth of zero at death. They pay the same constant tax rate on income from both capital and labour (discussed below). Households know the parameter values with certainty, but the policy shock comes as a surprise at $j = 1$ at which time households must adjust their plans accordingly.

Households are heterogeneous in that they have age-specific labour force participation rates and age-specific wage rates, based on observed data (see section below on data and calibration).

Households derive utility from consuming private goods, $C$, and leisure, $S$. Government consumption is assumed to provide no direct utility and hence has no effect on the household's optimal lifetime plan.[4] The composite index of consumption and leisure for a household of age $i$ is:

$$M_{i,j} = \left[ \mu_i^{1/\psi} C_{i,j}^{(\psi-1)/\psi} + \left(1-\mu_i\right)^{1/\psi} S_{i,j}^{(\psi-1)/\psi} \right]^{\psi/(\psi-1)} \tag{5}$$

where $\psi$ is the elasticity of substitution between consumption and leisure. The preference for consumption relative to leisure, captured by the parameter $\mu_i$ is assumed to vary over the lifecycle. It is assumed to rise up to middle age and then fall. This pattern is designed to reflect the observed life cycle pattern of consumption which tends to track the well-known observed hump-shaped pattern of income to some degree, rising up to middle age and falling slightly thereafter. Hence $\mu_i$ follows an inverted U-shape, given by the quadratic:

$$\mu_i = \xi_1 + \xi_2 i - \xi_3 i^2 \tag{6}$$

where $\xi_1$, $\xi_2$, and $\xi_3$ are parameters.

Households maximise the following lifetime utility function:

$$U = \sum_{i=1}^{h} \frac{M_{i,j}^{1-\beta}}{1-\beta} \left(1+\theta\right)^{1-i} \tag{7}$$

where $\theta$ is the pure time preference rate and $\beta$ is the elasticity of marginal utility. The price of private consumption goods is normalised to 1 in each period, and the 'price of leisure' at age $i$ in period $j$ is denoted $p_{i,j}$. Utility is maximised subject to a lifetime budget constraint which takes the following form:

$$\sum_{i=1}^{h} C_{i,j} \left( \frac{1}{1+r_j\left(1-t_j\right)} \right)^{i-1} = \sum_{i=1}^{h} \left( w_{i,j} L_{i,j} (1-t_j) + G^T{}_{i,j} \right) \left( \frac{1}{1+r_j\left(1-t_j\right)} \right)^{i-1} \tag{8}$$

where $w_{i,j}$ is the wage earned by household of age $i$ in period $j$. The left hand side represents the present value of private consumption expenditure and the right hand side is the present value of lifetime income. The latter is defined to include transfer payments, $GT^{i,j}$, received by households aged $i$ in period $j$. For simplicity, there are no bequests, and total transfer payments paid by the government in a given period are allocated evenly across all households alive in that period, rather than being allocated to certain generations. Given that there are $h$ generations alive in all periods, total transfers in period $j$ are $G_j^T = hG^T{}_{i,j}$.

The tax rate, $t_j$, is the tax rate in period $j$ applying to income from both labour and financial assets.

The household's intertemporal problem is solved by maximising the utility function in (7) subject to the budget constraint (8). This yields the following relation between consumption of goods and leisure, letting $p_{i,j} = w_{i,j}\left(1-t_j\right)$ :

$$\frac{\mu_i S_{i,j}}{(1-\mu_i)C_{i,j}} = p_{i,j}^{-\psi} \tag{9}$$

Solving (9) for $S_{i,j}$ and substituting into (5), yields

$$C_{i,j} = M_{i,j}\mu_i\left[\mu_i + (1-\mu_i)p_{i,j}^{1-\psi}\right]^{\psi/(1-\psi)} \tag{10}$$

and repeating for $C_{i,j}$ yields

$$S_{i,j} = M_{i,j}(1-\mu_i)p_{i,j}^{\psi}\left[\mu_i + (1-\mu_i)p_{i,j}^{1-\psi}\right]^{\psi/(1-\psi)} \tag{11}$$

Defining $P_{i,j}$ as the minimum price that buys a unit of the consumption index, $M_{i,j}$, we can write $P_{i,j}M_{i,j} = C_{i,j} + p_{i,j}S_{i,j}$ into which is substituted (10) and (11), yielding

$$P_{i,j} = \left[\mu_i + (1-\mu_i)p_{i,j}^{1-\psi}\right]^{1/(1-\psi)} \tag{12}$$

Now (10) and (11) can be simplified using (12) to give:

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

and

$$S_{i,j} = (1-\mu_i)\left(\frac{p}{P}\right)_{i,j}^{-\psi} M_{i,j} \tag{14}$$

To obtain the Euler equation, first use (13) and (14) to substitute for $C_{i,j}$ and $S_{i,j}$ in the budget constraint (8). Then maximise the utility function (7) with respect to $M_{i,j}$ subject to (8). This yields

$$\frac{M_{i,j}}{M_{i-1,j-1}} = \left[\frac{1+r_j(1-t_{y,j})}{1+\theta}\left(\frac{P_{i-1,j-1}}{P_{i,j}}\right)\right]^{1/\beta} \tag{15}$$

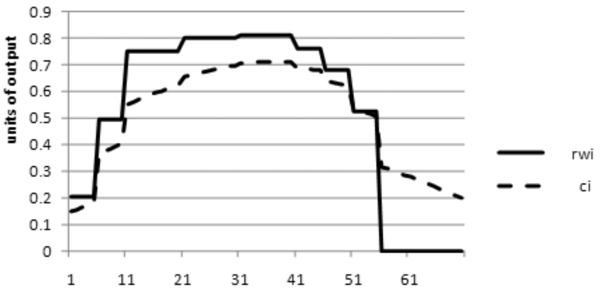
The balance of financial assets at age *i* in year *j* is given by

$$B_{i,j} = B_{i-1,j-1}\left(1 + r_j\left(1 - t_j\right)\right) + w_{i,j}L_{i,j}\left(1 - t_j\right) - C_{i,j} + G^T{}_{i,j} \quad i = 1,..,h \tag{16}$$

The solution to the optimisation problem gives the life cycle consumption path which is illustrated in Figure 1 (showing goods consumption only along with the real wage, pre-shock) and can be obtained numerically as follows. Specify a trial value of $M_{i,j}$ for $i = 1$, then solve forward for $M_{i,j}$ for $i=1,...,h$ according to the Euler equation (15). For $i=1,...,h$ calculate $C_{i,j}$ and $S_{i,j}$ according to (13) and (14). Then calculate $B_{h,,j}$; if it does not equal the target value of zero then adjust $M_{i,j}$ for $i = 1$ and repeat the algorithm iteratively until the value of $B_{h,,j}$ is equal to zero within a degree of tolerance. When the unanticipated fiscal stimulus occurs, households will be at various stages of their lifetime plans — young households will be nearer to the start than older households. At this point they revise their plans for the remainder of their lifetimes given the new relative price of leisure, $p_{i,j}$ and any change in transfer payments, $GT_{i,j}$, due to the need for the government to meet its target budget balance.

The labour market works as follows. Given an open economy with access to foreign capital, firms employ capital up to the point where the interest rate equals the marginal product of capital. This determines the aggregate capital-labour ratio which, in turn, determines the price of a unit of the aggregate labour index, $L_j$, or the real wage, $w_{L,j}$, since firms equate the real wage with the marginal product of the aggregate labour index. The real wage in turn determines the supply of aggregate labour and hence aggregate employment. The age-specific wage rates are adjusted such that the weighted average of wage payments for age-specific labour is equal to the real wage for a unit of the labour index: $\frac{\sum_i w_{L,i,j} L_{i,j}}{L_j} = w_{L,j}$ where $L_{i,j}$ is the labour supply of households aged $i$ in period $j$, and is equal to 1-$S_{i,j}$.

**Figure 1. Real wage and consumption of household, pre-shock**



### 2.2.1 Rule of Thumb Households

The households described above are intertemporal optimisers, as also presumed by the Ricardian approach, which implies that they are pure consumption smoothers, unfettered by habit persistence, liquidity constraints or information problems. Yet, in reality, households have incomplete information about the future. Moreover, in the context of rising public sector liabilities that will need to be extinguished via higher income taxes later on, some households may not expect that the higher future tax burden will apply to them personally and hence will not alter their behaviour.

For over two decades empirical research has cast doubt over the validity of the pure consumption smoothing model (Campbell and Mankiw 1989, 1990, 1991; Deaton, 1991, 1999). According to the evidence, the desire to smooth consumption is constrained by a range of factors — external (such as liquidity constraints) and preferential (such as a precautionary saving motive and habits), resulting in a very limited degree of consumption smoothing. Campbell and Mankiw, for example, argue in their papers that the observed evidence implies that a proportion of households are 'rule-of-thumb' consumers who simply consume a given proportion of their income each year with no attempt to smooth out temporary income fluctuations.

In order to reflect this evidence, household consumption here is assumed to be determined partly by consumption smoothing and partly by a rule-of-thumb, the latter referring to a desire to consume a fixed proportion of disposable income in every period. Hence consumers are hybrid consumers. Their consumption in period $t$ is a weighted average of consumption determined by intertemporal optimisation and consumption determined by a rule-of-thumb:

$$C_{i,j} = (1-\phi)C_{i,j}^{opt} + \phi C_{i,j}^{rot} \tag{17}$$

where $C_{i,j}^{opt}$ is consumption according to the intertemporal optimising model and $C_{i,j}^{rot}$ is consumption determined by the rule of thumb. The latter is a constant proportion, $\upsilon$, of disposable income. Hence $C_{i,j}^{rot} = \nu\left(w_{i,j}L_{i,j}(1-t_j)+G^{T}{}_{i,j}\right)$ where $\left(w_{i,j}L_{i,j}(1-t_j)+G^{T}{}_{i,j}\right)$ is disposable income at age $i$. If $\phi = 0$ consumers are pure intertemporal optimisers and if $\phi = 1$ households are pure rule-of-thumb consumers. Simulations are conducted for alternative values of this parameter, with the baseline value being $\phi = 0.5$; and the baseline value of $\upsilon$ is 0.9. In all simulations, household consumption remains bound by the target bequest of zero — that is, $B_{h,j} = 0$. This is achieved by adjusting as described above in the solution to the intertemporal optimising problem.

*2.3 Government and the Fiscal Stimulus Shock*

Government spending is denoted, $G$, and is assumed to consist of government consumption spending, $G^C$, and transfer payments, $G^T$. Hence:

$$G_j = G_j^C + G^T{}_j \tag{18}$$

Total tax revenue, $T$, is collected from income from wages and financial assets at the common rate, $t$. Hence:

$$T_j = \sum_{i=1}^{h} \left( w_{i,j} L_{i,j} + B_{i-1,j} r_j \right) t_j \tag{19}$$

The government starts with a balanced budget before the unexpected fiscal stimulus shock arrives, after which agents adjust their plans in response to the shock. The fiscal shock is an increase in $G^C$ for $j=1,..,N$, where the length of the shock, $N$, is set at 2 years in the baseline case. The assumption of 2 years of fiscal stimulus is perhaps conservative given empirical studies of fiscal expansion in advanced economies, suggesting that fiscal stimulus is implemented over several years and indeed often arrives after the worst of a downturn has passed. See for instance, Auerbach (2003), Gali and Perotti (2003), Lane (2003) and Leigh and Stehn (2009).

At $j=N+1$, $G^C$ returns to its pre-shock level and the government begins to repay its debt by increasing the tax rate, $t_j$, until the debt to GDP ratio returns to its pre-shock level. In one simulation (simulation I) some of the adjustment of debt is shared between increases in the tax rate and decreases in $G^C$ to levels below the pre-shock level, which in fact is what happened in the UK starting in 2010. In order to avoid an initial jump in the tax rate, the tax rate is assumed to increase gradually for an initial period $j=N+1,..,2N$ following the shock. Beyond this period, the tax rate increases according to:

$$t_j = t_0 \left( 1 + \varepsilon \left[ \left( \frac{D}{Y} \right)_j - \left( \frac{D}{Y} \right)_0 \right] \right) \tag{20}$$

where $\varepsilon$ is a speed of adjustment parameter. In the simulation (simulation I) where the adjustment also falls on cuts in $G^C$, the equation for $G^C$ for an initial period $j=N+1,..h$ is

$$G_j^C = G_0^C \left( 1 - \varepsilon_G \left[ \left( \frac{D}{Y} \right)_j - \left( \frac{D}{Y} \right)_0 \right] \right) \tag{21}$$

Given the neoclassical set up, unemployment is implicitly ruled out. It is assumed that fiscal stimulus provides a short run boost to employment (and therefore GDP) by increasing both labour supply and labour demand at the going wage rate. This is an expedient in order to focus on the longer run effects of fiscal stimulus through its effect on the interest rate, taxes and the real wage. The short run employment multiplier from fiscal stimulus is assumed to be 0.5, which implies that if stimulus spending is 2 per cent, for example, the contemporaneous boost to employment is 1 per cent. This is consistent with a GDP multiplier for government consumption of 0.6 (OECD 2009) and an employment multiplier for GDP growth of 0.75 (Australian Treasury 2009).

The foregoing abstracts from price level adjustment, which becomes less realistic the closer the economy is to full employment when fiscal stimulus is applied. In this framework a rising price level would impose numerous further costs on the economy, including the so-called 'menu cost' to firms of inflation, as prices are marked up more frequently. A rising price level also introduces uncertainty to wage setting and investment, and lowers household disposable income, with implications for consumption if nominal wages are not fully indexed. Although it is beyond the scope of this paper, allowing for the macroeconomic consequences of a rising price level would conceivably lower the size of the GDP multiplier for government spending.

The response of employment to fiscal stimulus is given by

$$L_j^{expost} = L_j^{exante}\left(1 + x\frac{\Delta G_j^C}{G_j^C}\right) \tag{22}$$

where $L_j^{exante}$ and $L_j^{expost}$ are employment before and after the stimulus, and $x$ is the employment multiplier of 0.5. The one exception is the case where the stimulus is in the form of transfer payments (Simulation D — see Table 2). In this case the initial boost to employment is less because households save a proportion of the transfer payments. The marginal propensity to save (MPS) is assumed to be the same as the MPS prior to the shock, which is 0.15.

The government is assumed to pay the same interest rate on its debt as all agents in the economy. Hence its debt, $D$, evolves according to:

$$D_j = D_{j-1}\left(1 + r_j\right) + G_j - T_j \tag{23}$$

Capital is imperfectly mobile in the sense that the interest rate is subject to a sovereign risk premium, whereby the interest rate as a function of the level of public debt, lagged one period:

$$r_j = \overline{r} + \lambda\left(\frac{D}{Y}\right)_{j-1} \tag{24}$$

Hence the marginal cost of borrowing increases as public debt increases. The strength of this effect depends on the value of $\lambda$. The risk premium reflects expectations of higher future public debt and heightened investor concern about debt sustainability and contingent fiscal risks. Higher expected inflation due to the possible future debt monetisation would also tend to raise the interest rate as higher budget deficits will fuel growth in the stock of public debt. This has empirical support, as discussed in Section 3 along with a discussion of the base case value of $\lambda$.

The level of foreign liabilities, F, is given by the standard national accounting identity:

$$F_j = F_{j-1}\left(1+r_j\right)+\sum_{i=1}^{T} C_{i,j} + G_j^C + I_j - Y_j \tag{25}$$

*2.4 Fiscal Multiplier*

Following Uhlig (2010),[6] the fiscal multiplier at time *t* is calculated as the discounted sum of the changes in output from *j*=1 (when the stimulus commences) to *t*, divided by the discounted sum of the stimulus spending from *j*=1 to *t*:

$$\varphi_t = \frac{\sum_{j=1}^{t} \Delta Y_j \left(1+r_j\right)^{1-j}}{\sum_{j=1}^{t} \Delta G_j \left(1+r_j\right)^{1-j}} \tag{26}$$

The fiscal multiplier tends to fall over time as the stimulus is unwound, through either higher tax rates or cuts in government spending.

*2.5 Intergenerational Welfare Analysis*

The unanticipated fiscal stimulus introduced at *j*=1 will have different effects on the utilities of individuals born in periods *k*=2-*h* to *h*. The effects occur through changes to their wage income, the tax rate and the interest rate. When the stimulus shock arrives, individuals re-optimise, determining their optimal consumption of goods and leisure over the remainder of their lifetimes. For a generation born in period *k* (*k*=2-*h*…*h*), the total utility from the time of the stimulus shock to the end of life, discounted to the time of the shock, is given by

$$U_k = \sum_{i=2-k}^{h} \frac{M_{i,j}^{1-\beta}}{1-\beta}\left(1+\theta\right)^{i-h} \tag{27}$$

This is compared with the total discounted utility that would have been derived over the same period in the absence of the shock. For example an individual aged 60 at the time of the shock re-optimises for the remaining 25 years of life. Hence we want to compare the discounted utility from aged 60 to 85 (discounted to age 60) with and without the shock. The difference in utility is the effect on the individual's economic welfare. We want to compare the effects on the welfare of all generations.

This gives rise to an ethical dilemma. How should the effect of the shock on an individual aged 60 at the time of the shock be compared with the effect on an individual aged 30? Suppose that the 60 year old has a large change in utility over each of the remaining 25 years of life which amounts to less than the sum of smaller changes in utility over each of the remaining 45 years of the 30 year old's life. Who is worse off — the 60 year old who suffers a lot for a short period of time or the 30 year old who suffers less in any year but more in aggregate over their remaining lifetime? This is analogous to the choice, when comparing discounted social welfare changes over current and future populations of different sizes, between the effect on average per capita utility and the effect on the total utility of the population (see Dasgupta 1982, for example).

There are two main possibilities in the present context. One is to calculate the total effect on discounted utility from the time of the shock to the end of the individual's life. The other is to average this change in utility over the remaining years of life, giving the average change in utility per period of remaining life. The approach taken here is to compare the results of both methods.

## 3. Data and Parameters

The simulations are generic — they are not meant to apply to a particular country. So, where possible, parameter values are chosen that are representative of OECD economies. In some cases, data were drawn from Australia, partly for convenience and partly because Australia is a medium sized OECD economy which adopted quite significant fiscal stimulus. For example, specific labour force participation rates of households are based on Australian data (Australian Bureau of Statistics, Catalogue 6291.0); age-specific wage rates are drawn from Australian Bureau of Statistics Catalogue 6310.0 which gives adult wage rates by age; and the initial tax rate of 0.27 is a typical recent historical tax to GDP ratio for Australia and a rate projected to apply, approximately, in the medium term.

The base case parameter values are given in Table 1. There is only one interest rate in the economy applying to both government and private sector. The underlying real interest rate, $\bar{r}$, for an economy with zero government debt is set at 4 per cent. This value is close to average real interest rates experienced by many economies over recent decades. For instance, in Australia's case, the long run average real interest rate on inflation-indexed bonds between 1986-2010 was 3.9 per cent.

The base case value of $\lambda$ is set equal to 0.03, implying that a 10 percentage point increase in the ratio of public debt to GDP increases the interest rate by 0.3 of one percent (30 basis points) which is at the lower end of the range of empirical estimates. As surveyed by Gale and Oszag (2003, 2004), earlier econometric studies have found that an increase in budget deficits of one percent of GDP can raise long term interest rates by 30-60 basis points,

**Table 1 Base Case Parameters and Initial Values**

| *Parameter* | *Value* |
|---|---|
| $\bar{r}$, interest rate with zero public debt | 0.04 |
| $\theta$, rate of time preference of households | 0.029 |
| $\alpha = \left(\frac{\bar{K}}{\bar{Y}}\right)_0 (r+\delta)$ capital elasticity of output | 0.27 |
| $\delta$, depreciation | 0.05 |
| Initial capital to output ratio $\left(\frac{\bar{K}}{\bar{Y}}\right)$ | 3.0 |
| Foreign liabilities to GDP ratio, $F/Y$, in 2010 | 0.0 |
| Change in $r$ for a 10 percentage point increase in $D/Y$, $\lambda$ | 0.003 (0.3 percent) |
| Public debt to GDP ratio, $D/Y$, in 2010 | 0.0 |
| Elasticity of marginal utility, $\beta$ | 2.0 |
| Elasticity of substitution between consumption and leisure, $\psi$ | 0.8 |
| Bequest as a proportion of household's lifetime income | 0.0 |
| Initial tax rate, $t_y$ | 0.27 |
| Employment multiplier, $x$ | 0.5 |
| Duration of stimulus spending, $N$ | 2 years |
| Magnitude of stimulus spending (% increase in $G^C$) | 2% |
| Speed of adjustment of tax rate post-shock based on government debt levels, $\varepsilon$ | 0.5 |
| Rate of cuts in $G^C$ post-shock to levels below pre-shock levels, $\varepsilon_G$ | 0.0 |
| Proportion of consumption determined by rule of thumb, $\phi$ | 0.5 |
| Proportion of disposable income consumed as a rule of thumb for those households who adopt the 'rule of thumb', $\upsilon$ | 0.9 |

and a higher public debt of one percent of GDP increases interest rates by between 2-7 basis points. The relatively low base case value of 0.03, and the even lower value of 0.01 chosen for sensitivity analysis, is justified partly in order to be conservative, since the results turn out to be quite sensitive to this parameter. Also, a low value of $\lambda$ might be justified on the grounds that central banks could adopt expansionary monetary policy in order to offset any upward pressure on the interest rate arising from fiscal stimulus. On the other hand, this is more likely to be successful at the short end of the yield curve.

Monetary stimulus is unable to offset fully the impact of fiscal stimulus on long term interest rates, which are the most relevant rates that affect business decisions about real capital accumulation. This is because in open economies, long term rates are also influenced by world interest rates via interest parity, investor concern about debt sustainability and other risks, including higher expected inflation as a result of possible future debt monetisation.

Although the 'expectations theory' of the term structure proposes that long term rates reflect a weighted average of expected future short term rates, this perspective lacks strong empirical support and is less relevant for explaining long term interest rate determination in economies whose bond markets are highly internationally integrated. Hence, if monetary stimulus is combined with fiscal stimulus, a smaller but still positive value of $\lambda$ is likely to eventuate. Note however that the interest rate is always real in the simulations to follow, given our starting assumption of an invariant price level.

Households' rate of time preference, $\theta$, is set equal to $\bar{r}(1-t_0)$ where $t_0$=0.27 which is the initial tax rate and also the ratio of government spending to GDP. The capital share parameter in the Cobb Douglas production function is consistent with a capital to output ratio of 3.0, its approximate value for Australia in 2010. Both the ratio of foreign liabilities to GDP, F/Y, and the ratio of public debt to GDP, D/Y, are set equal to zero. Sensitivity to the initial public debt ratio, D/Y, is simulated by taking an alternative initial value of 0.6 (see Simulation K). The impact is small due to the linear effect of D/Y on the interest rate. The values of the elasticities, $\beta$ and $\psi$, are set equal to values commonly used in related studies in the literature — see for example Foertsch (2004).

## 4. SIMULATIONS

### *4.1 List of Simulations*

The simulations vary according to the following parameters (summarised in Table 2): the proportion of consumption determined by the rule of thumb, ($\phi$); the proportion of disposable income consumed as a rule of thumb, ($\upsilon$); the type of stimulus — whether it is government consumption spending, ($G^C$) or transfer payments, ($G^T$); the duration of the stimulus after which the spending drops back to its original level; the employment multiplier, ($x$); the speed of adjustment of the tax rate following the period of stimulus, ($\varepsilon$); the speed of adjustment of government spending when the burden of reducing debt falls partly on government spending, ($\varepsilon_G$); and the initial debt ratio, $D_0/Y_0$.

### *4.2 Results of simulations*

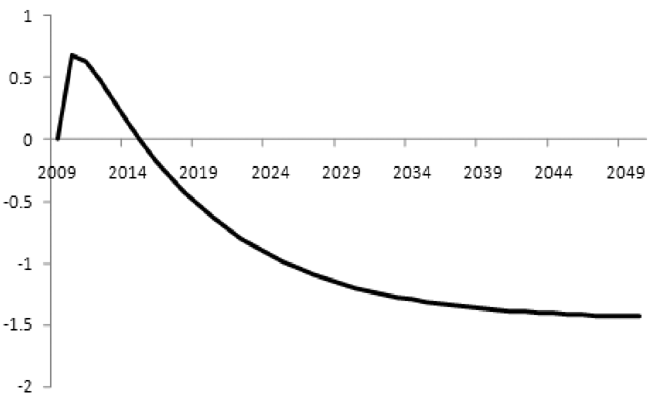
The results of the 10 simulations labelled A to J (listed in Table 2) are reported in Tables 3 to 9. Also Figures 2, 3 and 4 plot the base case results for GDP (impulse response), the fiscal multiplier and consumption (impulse response). An impulse response is defined here as the percentage change from the pre-stimulus level.

**Table 2. List of simulations**

| *Simulation* | $\phi$ | $\upsilon$ | *Stimulus type* | *Stimulus size* | *Stimulus duration* | $x$ | $\varepsilon$ | $\varepsilon_G$ | $\lambda$ | *Initial D/Y* |
|---|---|---|---|---|---|---|---|---|---|---|
| A (base) | 0.5 | 0.9 | GC | 0.02 | 2 (years) | 0.5 | 0.5 | zero | 0.03 | 0 |
| B | zero | n/a | GC | 0.02 | 2 (years) | 0.5 | 0.5 | zero | 0.03 | 0 |
| C | 0.5 | 1.0 | GC | 0.02 | 2 (years) | 0.5 | 0.5 | zero | 0.03 | 0 |
| D | 0.5 | 0.9 | GT | 0.02 | 2 (years) | 0.5 | 0.5 | zero | 0.03 | 0 |
| E | 0.5 | 0.9 | GC | 0.04 | 2 (years) | 0.5 | 0.5 | zero | 0.03 | 0 |
| F | 0.5 | 0.9 | GC | 0.02 | 4 (years) | 0.5 | 0.5 | zero | 0.03 | 0 |
| G | 0.5 | 0.9 | GC | 0.02 | 2 (years) | 0.8 | 0.5 | zero | 0.03 | 0 |
| H | 0.5 | 0.9 | GC | 0.02 | 2 (years) | 0.5 | 0.9 | zero | 0.03 | 0 |
| I | 0.5 | 0.9 | GC | 0.02 | 2 (years) | 0.5 | 0.2 | 1.0 | 0.03 | 0 |
| J | 0.5 | 0.9 | GC | 0.02 | 2 (years) | 0.5 | 0.5 | zero | 0.01 | 0 |
| K | 0.5 | 0.9 | GC | 0.02 | 2 (years) | 0.5 | 0.5 | zero | 0.03 | 0.6 |

The 2 percent stimulus spending in each of two years in the form of government consumption results in an initial (first year) boost to GDP of 1.5 percent in the base case and in the other simulations it ranges from 1 percent to 3 percent (Table 3 and Figure 1). This implies a first year multiplier of 0.68 in the base case and ranging from 0.49 to 1.01 in the other cases (Figure 3 and Table 5). The smallest response occurs in Simulation D where the stimulus spending is in the form of transfer payments rather than government consumption spending. In this case the initial GDP boost and fiscal multiplier is smaller because households save part of the increase in transfer payments and spread out higher consumption over their lifetimes. Simulation E also stands out because the size of the stimulus is double — that is, 4 percent of GDP in each of the 2 years.

**Figure 3. Fiscal multiplier (base case)**




By the third year, when the stimulus has ceased and taxes start to rise, the GDP response becomes negative (relative to the pre-stimulus level) in all simulations. The fiscal multiplier remains positive for the first 5 years in the base case and most other simulations (Table 5). The multiplier remains positive for several years even though the GDP response has turned negative, because the multiplier is calculated as the cumulative discounted GDP response divided by the cumulative discounted stimulus spending (equation 25). The initial boost to GDP diminishes almost immediately for a combination of several factors. First the interest rate starts to rise given the increase in government debt, which lowers investment and to a less extent consumption. This, it turns out, is the most important driver (see Simulation J where the sensitivity of the interest rate is reduced).

Second, after the stimulus period the tax rate rises in order to start paying off the debt. This reduces the price of leisure, which lowers labour supply. Third, the lower price of leisure is compounded via a lower pre-tax real wage, as a result of the lower capital-labour ratio, further reducing the supply of labour. As the debt is eventually paid off, the tax rate and the interest rate return to their original levels and hence so does GDP. This process takes several decades to complete (Figure 2 for example). The fiscal multiplier turns negative after 5 years in the base case and reaches -1.43 by 2050 (Table 5, Figure 3). After 10 years (by 2020) the fiscal multiplier is negative in all simulations. From then on the fiscal multiplier remains negative in all simulations and by 2050 the multiplier ranges from -0.71 to -2.8. These values are consistent with the simulation results in Uhlig (2010), who finds multipliers generally less than 1.0 in the short run and negative in the long run. Uhlig concludes that although fiscal stimulus may dampen the severity of a recession in the short run it may extend the duration of the recession by a considerable period.

**Figure 3. Fiscal multiplier (base case)**

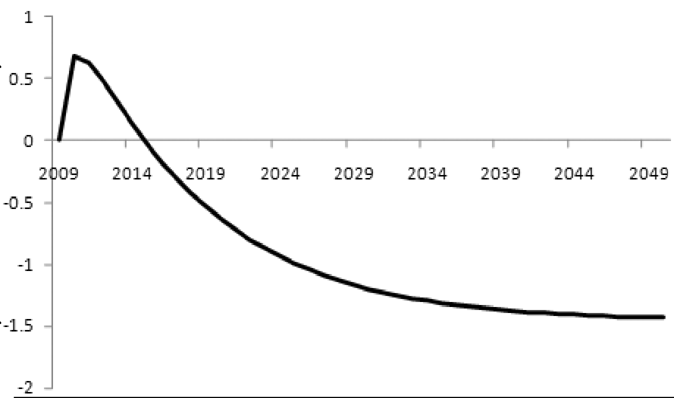
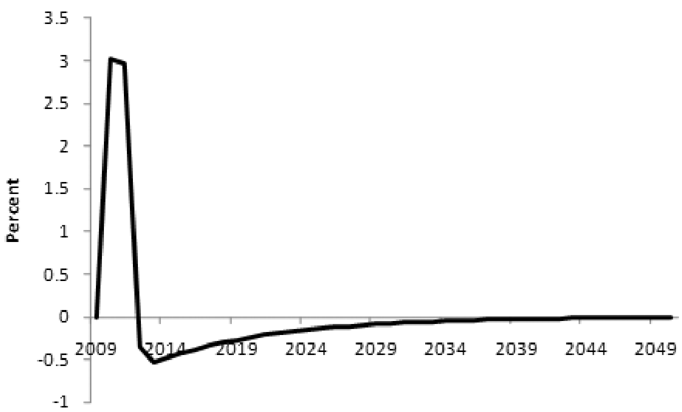



**Figure 4. Consumption Impulse response (base case)**




Several simulations are worth noting in terms of fiscal multipliers. In Simulation J the multiplier remains positive for longer; and although the long run multiplier eventually turns negative, it is less negative than in the other simulations. The reason is the much lower response of the interest rate to government debt ($\lambda$=0.01 compared with base case value of 0.03). A value of 0.01 implies that a 10 percent rise in debt to GDP results in a 10 basis point increase in the interest rate, compared with a 30 basis point increase in the base case. Although 10 basis points is below the low end of empirical estimates (20 to 70 basis points), it is worth simulating such a low value for the reasons discussed in Section 3. Note that even in the simulation with a small value of $\lambda$ (=0.01), the multiplier eventually turns negative (albeit only slightly).

Simulation H is another noteworthy case. Here the tax rate adjusts more rapidly after the 2 year stimulus has ended. For the first 4 years after the stimulus has ended the tax rate increases on average by 0.7 percent of GDP, compared with 0.4 percent in the base case. This has a positive impact on the long run fiscal multiplier — the long run value is still negative but only half the negative value in the base case (-0.7 compared with -1.4). This shows the long run benefits of a short period of tighter fiscal policy in unwinding the stimulus.

In Simulations D and I, the long run multiplier is more negative than in the other cases. This is explained in Simulation D by the low initial GDP boost as described above. In Simulation I, the stimulus is partly unwound by cutting back government consumption expenditure, unlike the other simulations where the stimulus is unwound entirely through higher taxes. Cutting back government expenditure over time reduces the cumulative stimulus, which reduces the long run multiplier.

The response of national consumption (including the government consumption stimulus) is illustrated in Table 6. Again, once the stimulus is turned off, consumption drops sharply and becomes negative for several decades in most simulations. The drop in consumption reflects the drop in employment (Table 4), output and therefore household income.

**Table 3. GDP. Impulse response (%). Simulations A to K**

| | A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2010 | 1.54 | 1.54 | 1.54 | 1.05 | 3.08 | 1.56 | 2.45 | 1.53 | 1.53 | 1.53 | 1.55 |
| 2011 | 1.29 | 1.26 | 1.29 | 0.81 | 2.57 | 1.37 | 2.19 | 1.26 | 1.26 | 1.44 | 1.43 |
| 2012 | -0.75 | -0.78 | -0.75 | -0.99 | -1.50 | 1.02 | -0.78 | -0.94 | -0.66 | -0.41 | -0.59 |
| 2013 | -0.94 | -0.96 | -0.94 | -1.16 | -1.92 | 0.72 | -0.98 | -1.21 | -0.65 | -0.60 | -1.05 |
| 2014 | -0.86 | -0.88 | -0.86 | -1.07 | -1.77 | -1.35 | -0.90 | -0.97 | -0.56 | -0.53 | -1.04 |
| 2015 | -0.78 | -0.80 | -0.78 | -0.97 | -1.60 | -1.62 | -0.81 | -0.77 | -0.48 | -0.48 | -0.96 |
| 2020 | -0.49 | -0.50 | -0.49 | -0.65 | -1.01 | -1.48 | -0.51 | -0.24 | -0.24 | -0.27 | -0.61 |
| 2025 | -0.31 | -0.32 | -0.31 | -0.44 | -0.64 | -0.95 | -0.33 | -0.07 | -0.14 | -0.15 | -0.39 |
| 2030 | -0.20 | -0.20 | -0.20 | -0.32 | -0.42 | -0.63 | -0.22 | -0.01 | -0.09 | -0.07 | -0.26 |
| 2040 | -0.09 | -0.09 | -0.09 | -0.18 | -0.18 | -0.29 | -0.10 | 0.01 | -0.05 | -0.01 | -0.11 |
| 2050 | -0.04 | -0.04 | -0.04 | -0.11 | -0.07 | -0.13 | -0.04 | 0.02 | -0.02 | 0.01 | -0.04 |

**Table 4. Employment. Impulse response (%). Simulations A to J**

| | A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2010 | 1.64 | 1.62 | 1.65 | 1.15 | 3.29 | 1.79 | 2.55 | 1.60 | 1.60 | 1.57 | 1.65 |
| 2011 | 1.62 | 1.59 | 1.62 | 1.14 | 3.24 | 1.77 | 2.52 | 1.57 | 1.57 | 1.55 | 1.63 |
| 2012 | -0.15 | -0.17 | -0.15 | -0.39 | -0.31 | 1.74 | -0.18 | -0.36 | -0.08 | -0.21 | -0.09 |
| 2013 | -0.37 | -0.38 | -0.37 | -0.59 | -0.76 | 1.69 | -0.40 | -0.70 | -0.16 | -0.40 | -0.40 |
| 2014 | -0.34 | -0.35 | -0.34 | -0.55 | -0.70 | -0.12 | -0.37 | -0.55 | -0.15 | -0.36 | -0.40 |
| 2015 | -0.31 | -0.32 | -0.31 | -0.51 | -0.65 | -0.38 | -0.34 | -0.44 | -0.14 | -0.32 | -0.38 |
| 2020 | -0.21 | -0.22 | -0.21 | -0.37 | -0.43 | -0.65 | -0.23 | -0.13 | -0.10 | -0.17 | -0.25 |
| 2025 | -0.14 | -0.15 | -0.14 | -0.27 | -0.29 | -0.45 | -0.16 | -0.04 | -0.08 | -0.09 | -0.17 |
| 2030 | -0.10 | -0.10 | -0.10 | -0.22 | -0.21 | -0.32 | -0.12 | 0.00 | -0.06 | -0.04 | -0.12 |
| 2040 | -0.05 | -0.05 | -0.05 | -0.14 | -0.11 | -0.18 | -0.06 | 0.01 | -0.04 | 0.00 | -0.06 |
| 2050 | -0.02 | -0.02 | -0.02 | -0.09 | -0.04 | -0.09 | -0.03 | 0.01 | -0.02 | 0.02 | -0.03 |

**Table 5. Fiscal multiplier. Simulations A to J**

| | A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2010 | 0.68 | 0.68 | 0.68 | 0.49 | 0.67 | 0.69 | 1.01 | 0.68 | 0.68 | 0.68 | 0.69 |
| 2011 | 0.63 | 0.63 | 0.63 | 0.44 | 0.62 | 0.65 | 0.97 | 0.62 | 0.62 | 0.66 | 0.66 |
| 2012 | 0.49 | 0.48 | 0.49 | 0.23 | 0.48 | 0.60 | 0.83 | 0.44 | 0.57 | 0.58 | 0.55 |
| 2013 | 0.30 | 0.28 | 0.30 | -0.03 | 0.29 | 0.54 | 0.67 | 0.20 | 0.48 | 0.47 | 0.35 |
| 2014 | 0.13 | 0.11 | 0.13 | -0.26 | 0.12 | 0.41 | 0.51 | -0.01 | 0.40 | 0.37 | 0.14 |
| 2015 | -0.03 | -0.06 | -0.03 | -0.48 | -0.04 | 0.25 | 0.36 | -0.17 | 0.29 | 0.28 | -0.05 |
| 2020 | -0.63 | -0.68 | -0.63 | -1.35 | -0.65 | -0.60 | -0.19 | -0.59 | -0.40 | -0.03 | -0.82 |
| 2025 | -0.99 | -1.05 | -0.98 | -1.92 | -1.01 | -1.18 | -0.52 | -0.70 | -1.15 | -0.17 | -1.30 |
| 2030 | -1.20 | -1.26 | -1.19 | -2.27 | -1.22 | -1.52 | -0.72 | -0.72 | -1.61 | -0.24 | -1.58 |
| 2040 | -1.38 | -1.44 | -1.37 | -2.65 | -1.40 | -1.85 | -0.89 | -0.72 | -1.99 | -0.28 | -1.83 |
| 2050 | -1.43 | -1.50 | -1.42 | -2.80 | -1.46 | -1.95 | -0.95 | -0.71 | -2.14 | -0.27 | -1.91 |

**Table 6. Consumption. Impulse response (%). Simulations A to J**

| | A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2010 | 3.01 | 2.79 | 3.04 | 0.82 | 6.10 | 2.93 | 3.48 | 3.03 | 3.06 | 3.07 | 3.02 |
| 2011 | 2.97 | 2.74 | 3.00 | 0.74 | 5.99 | 2.89 | 3.43 | 2.99 | 3.01 | 3.05 | 2.99 |
| 2012 | -0.35 | -0.29 | -0.36 | -0.12 | -0.70 | 2.83 | -0.33 | -0.49 | -0.90 | -0.25 | -0.31 |
| 2013 | -0.53 | -0.39 | -0.55 | -0.32 | -1.10 | 2.80 | -0.52 | -0.79 | -0.85 | -0.45 | -0.61 |
| 2014 | -0.48 | -0.35 | -0.50 | -0.28 | -0.99 | -0.50 | -0.47 | -0.64 | -0.70 | -0.41 | -0.60 |
| 2015 | -0.43 | -0.30 | -0.44 | -0.25 | -0.88 | -0.70 | -0.42 | -0.50 | -0.58 | -0.37 | -0.54 |
| 2020 | -0.24 | -0.15 | -0.25 | -0.10 | -0.50 | -0.71 | -0.23 | -0.16 | -0.20 | -0.24 | -0.32 |
| 2025 | -0.14 | -0.07 | -0.14 | -0.02 | -0.28 | -0.39 | -0.12 | -0.06 | -0.05 | -0.16 | -0.18 |
| 2030 | -0.08 | -0.03 | -0.08 | 0.02 | -0.16 | -0.21 | -0.07 | -0.03 | 0.00 | -0.11 | -0.11 |
| 2040 | -0.02 | 0.00 | -0.03 | 0.04 | -0.05 | -0.06 | -0.02 | -0.01 | 0.02 | -0.06 | -0.04 |
| 2050 | -0.01 | 0.00 | -0.01 | 0.03 | -0.02 | -0.02 | 0.00 | -0.01 | 0.01 | -0.03 | -0.01 |

**Table 7. Government debt (%GDP). Simulations A to J**

| | A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2010 | 2.0 | 2.0 | 2.0 | 2.0 | 4.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 61.0 |
| 2011 | 4.1 | 4.1 | 4.1 | 4.1 | 8.2 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 63.2 |
| 2012 | 4.1 | 4.1 | 4.1 | 4.1 | 8.3 | 6.3 | 4.1 | 3.9 | 3.6 | 4.1 | 64.5 |
| 2013 | 3.7 | 3.7 | 3.7 | 3.7 | 7.6 | 8.6 | 3.7 | 3.1 | 3.0 | 3.7 | 64.5 |
| 2014 | 3.3 | 3.3 | 3.3 | 3.3 | 6.9 | 8.8 | 3.4 | 2.5 | 2.5 | 3.3 | 64.1 |
| 2015 | 3.0 | 3.0 | 3.0 | 3.0 | 6.2 | 8.6 | 3.1 | 2.0 | 2.1 | 3.0 | 63.8 |
| 2020 | 1.8 | 1.8 | 1.8 | 1.8 | 3.8 | 5.5 | 1.9 | 0.6 | 0.9 | 1.8 | 62.3 |
| 2025 | 1.1 | 1.1 | 1.1 | 1.1 | 2.3 | 3.3 | 1.1 | 0.2 | 0.4 | 1.1 | 61.4 |
| 2030 | 0.7 | 0.7 | 0.7 | 0.7 | 1.4 | 2.0 | 0.7 | 0.1 | 0.1 | 0.7 | 60.9 |
| 2040 | 0.2 | 0.2 | 0.2 | 0.2 | 0.5 | 0.7 | 0.3 | 0.0 | 0.0 | 0.2 | 60.3 |
| 2050 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.3 | 0.1 | 0.0 | 0.0 | 0.1 | 60.1 |

**Table 8. Tax rate. Simulations A to J**

| | A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2010 | 27.0 | 27.0 | 27.0 | 27.0 | 27.0 | 27.0 | 27.0 | 27.0 | 27.0 | 27.0 | 27.0 |
| 2011 | 27.0 | 27.0 | 27.0 | 27.0 | 27.0 | 27.0 | 27.0 | 27.0 | 27.0 | 27.0 | 27.0 |
| 2012 | 27.3 | 27.3 | 27.3 | 27.3 | 27.6 | 27.0 | 27.3 | 27.5 | 27.1 | 27.3 | 27.2 |
| 2013 | 27.5 | 27.5 | 27.5 | 27.5 | 28.1 | 27.0 | 27.6 | 27.9 | 27.2 | 27.5 | 27.6 |
| 2014 | 27.5 | 27.5 | 27.5 | 27.5 | 28.0 | 27.3 | 27.5 | 27.8 | 27.2 | 27.5 | 27.6 |
| 2015 | 27.5 | 27.5 | 27.5 | 27.5 | 27.9 | 27.6 | 27.5 | 27.6 | 27.1 | 27.4 | 27.6 |
| 2020 | 27.3 | 27.3 | 27.3 | 27.3 | 27.6 | 27.8 | 27.3 | 27.2 | 27.1 | 27.3 | 27.3 |
| 2025 | 27.2 | 27.2 | 27.2 | 27.2 | 27.3 | 27.5 | 27.2 | 27.1 | 27.0 | 27.2 | 27.2 |
| 2030 | 27.1 | 27.1 | 27.1 | 27.1 | 27.2 | 27.3 | 27.1 | 27.0 | 27.0 | 27.1 | 27.1 |
| 2040 | 27.0 | 27.0 | 27.0 | 27.0 | 27.1 | 27.1 | 27.0 | 27.0 | 27.0 | 27.0 | 27.1 |
| 2050 | 27.0 | 27.0 | 27.0 | 27.0 | 27.0 | 27.0 | 27.0 | 27.0 | 27.0 | 27.0 | 27.0 |

### *4.2.1 Intergenerational Welfare*

The intergenerational welfare analysis is illustrated in Tables 9a and 9b. As flagged in Section 2.5, Table 9a reports the total effect on discounted utility from the time of the shock to the end of the individual's life, for generations born in the years indicated. Table 9b reports the average of this change in utility over the remaining years of life of the respective generations. Taking the annual average (Table 9b) shifts the relative gains/losses toward older generations since their total utility change is averaged over fewer years.

Generations who are currently retired at the time of the stimulus are better off as a result of the stimulus and, of these, the older the generation the greater the benefit. They benefit from higher interest rates on their saving. The younger retirees benefit less; although they receive higher interest income, they face higher tax rates on their retirement income for a greater proportion of the retired years. Of the working generations the older ones benefit more because they receive the benefits of higher wage income caused by the stimulus spending.[7]

Younger generations benefit less because they face longer period of higher taxes and a longer period after the benefits of the stimulus spending in terms of wage income have worn off. The younger generations, especially those near the start of their working lives, as well as the unborn generations, are actually worse off because the benefits of the stimulus have completely worn off by the time they enter the workforce, yet the higher tax rates have not unwound completely. However they are not worse off by as much as the older generations are better off.

Whether there is a net social gain depends on several factors, including the social discount rate applied to the lifetime utility of future generations, the size of each generation, and the direct utility effect of stimulus for different generations. If there is no discounting of future utilities and the generations are of equal size, the effects on utilities of generations can be simply added up. This sum is positive (see Tables 9a and 9b), which would suggest a net social welfare gain from stimulus.

However, in a growing population, younger generations are larger than older generations, which would increase the negative contribution to social welfare from the effect on younger generations. On the other hand, if the utility of unborn generations is discounted, for example because of the possibility that they will not exist,[8] the social welfare contribution from their utility is diminished. Also, it was assumed that there is no direct utility from government consumption expenditure. Such expenditure may have quite different direct utility effects among generations, which would be difficult to tease out.

Some differences across the simulations, reported in Tables 9a and 9b, are worth noting. Simulation D stands out in that the gains to older generations are much larger. In this simulation the stimulus, although the same share of GDP as in the base case, is in the form of transfer payments rather than government consumption. Unlike consumption stimulus, transfer payments add directly to the household's disposable income. Hence the utility effect is larger and is evident especially for older households since they have a fewer number of years over which to spread these gains. Simulation E also shows effects of greater magnitude for the simple reason that the size of the stimulus is double that of the base case. Similarly, the larger effects in Simulation G are simply caused by the higher value of the employment multiplier (0.8 compared with 0.5 in the base case).

**Table 9a. Utility. Simulations A to J**

**Percentage difference in total utility from date of stimulus to end of life, discounted to date of stimulus**

| Age of gen in 2010* | A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 85 | 0.655 | 0.444 | 0.695 | 7.113 | 1.302 | 0.665 | 1.037 | 0.650 | 0.649 | 0.651 | 0.54 |
| 75 | 0.066 | 0.122 | 0.056 | 1.153 | 0.129 | 0.154 | 0.123 | 0.027 | 0.132 | 0.019 | 0.08 |
| 65 | 0.387 | 0.447 | 0.376 | 0.914 | 0.789 | 0.697 | 0.435 | 0.382 | 0.265 | 0.251 | 0.48 |
| 55 | 0.140 | 0.167 | 0.135 | 0.476 | 0.284 | 0.430 | 0.181 | 0.025 | 0.149 | 0.023 | 0.17 |
| 45 | 0.053 | 0.063 | 0.051 | 0.313 | 0.106 | 0.187 | 0.084 | -0.019 | 0.099 | -0.036 | 0.05 |
| 35 | 0.014 | 0.015 | 0.014 | 0.244 | 0.026 | 0.074 | 0.038 | -0.027 | 0.066 | -0.048 | 0.00 |
| 25 | -0.029 | -0.034 | -0.028 | 0.200 | -0.062 | -0.036 | -0.012 | -0.043 | 0.025 | -0.054 | -0.05 |
| 15 | -0.088 | -0.087 | -0.088 | 0.031 | -0.181 | -0.219 | -0.085 | -0.050 | -0.037 | -0.056 | -0.11 |
| 5 | -0.045 | -0.041 | -0.045 | -0.068 | -0.092 | -0.138 | -0.048 | -0.006 | -0.018 | -0.023 | -0.05 |
| -5 | -0.018 | -0.016 | -0.019 | -0.035 | -0.037 | -0.058 | -0.020 | 0.002 | -0.008 | -0.005 | -0.02 |
| -15 | -0.007 | -0.006 | -0.007 | -0.017 | -0.014 | -0.023 | -0.008 | 0.002 | -0.003 | 0.001 | -0.01 |
| -25 | -0.001 | -0.001 | -0.001 | -0.006 | -0.003 | -0.006 | -0.002 | 0.002 | -0.001 | 0.002 | 0.00 |

A negative value denotes generations unborn at 2010. E.g. "-5" denotes the generation to be born in 2015

**Table 9b. Utility. Simulations A to J**

**Percentage difference in average annual utility from date of stimulus to end of life, discounted to date of stimulus**

| Age of gen in 2010* | A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 85 | 0.655 | 0.655 | 0.444 | 0.695 | 7.113 | 1.302 | 0.665 | 1.037 | 0.650 | 0.649 | 0.537 |
| 75 | 0.006 | 0.006 | 0.011 | 0.006 | 0.089 | 0.013 | 0.014 | 0.011 | 0.003 | 0.012 | 0.001 |
| 65 | 0.018 | 0.016 | 0.019 | 0.016 | 0.039 | 0.033 | 0.037 | 0.019 | 0.014 | 0.012 | 0.005 |
| 55 | 0.005 | 0.004 | 0.005 | 0.004 | 0.014 | 0.008 | 0.012 | 0.005 | 0.001 | 0.005 | 0.002 |
| 45 | 0.001 | 0.001 | 0.001 | 0.001 | 0.007 | 0.002 | 0.004 | 0.002 | 0.000 | 0.002 | 0.001 |
| 35 | 0.000 | 0.000 | 0.000 | 0.000 | 0.005 | 0.000 | 0.001 | 0.001 | -0.001 | 0.001 | 0.000 |
| 25 | 0.000 | -0.001 | -0.001 | -0.001 | 0.003 | -0.001 | -0.001 | 0.000 | -0.001 | 0.000 | -0.00 |
| 15 | -0.001 | -0.001 | -0.001 | -0.001 | -0.002 | -0.003 | -0.003 | -0.001 | -0.001 | -0.001 | -0.00 |
| 5 | -0.001 | -0.001 | -0.001 | -0.001 | -0.001 | -0.002 | -0.003 | -0.001 | 0.000 | 0.000 | -0.00 |
| -5 | 0.000 | 0.000 | 0.000 | -0.001 | -0.001 | -0.001 | -0.002 | -0.001 | 0.000 | 0.000 | 0.000 |
| -15 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | -0.001 | 0.000 | 0.000 | 0.000 | 0.000 |
| -25 | 0.006 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

A negative value denotes generations unborn at 2010. E.g. "-5" denotes the generation to be born in 2015

## 5 Conclusion

Traditional Keynesian theory focuses on the short run and, by stressing aggregate demand as the source of economic expansion, essentially neglects the future implications of public spending and transfer payments, and the fiscal deficits and higher public debt that result. Yet, from an intertemporal perspective, it is important to recognise that because of the higher budget deficits and public debt that fiscal activism bequeaths, the vast majority of the extant population can, within their lifetimes, expect to experience higher taxes and interest rates. Using an overlapping generations model, the key objective of this paper has been to illustrate the magnitude of these longer run macroeconomic costs and the differential effects on the welfare of generations.

This paper has focused on fiscal stimulus in the forms of government consumption spending and transfer payments to households, although fiscal stimulus can alternatively be implemented via increased government investment spending and/or reduced direct and indirect taxes. An examination of the short and long run effects of deploying these other fiscal instruments lies beyond the scope of this paper, though remains a useful topic for future research. In the case of increased government investment spending, key questions to be addressed would include the implications of higher public investment on output generation, and the extent to which there are any productivity spillovers from public infrastructure to private firms, an issue that has generated mixed empirical results (see, for instance, Aschauer 1989, Lynde and Richmond 1992, Munnell 1992 and Holz-Eakin 1994). Assuming output and productivity spillover effects are significantly positive, this would likely mitigate the negative effects of the forms of fiscal stimulus modelled in this paper.

The simulations here support the findings in Uhlig (2010), that the positive benefits of fiscal stimulus are short-lived; the fiscal multiplier becomes negative in all simulations after 10 years from the time the stimulus was introduced. This qualitative conclusion is robust to a range of assumptions, although the magnitude of the multiplier depends on the size and duration of the stimulus, the degree to which it pushes up interest rates, the rate at which it is unwound and whether it is unwound by tax rises or spending cuts. The intergenerational analysis identifies the winners and losers from fiscal stimulus. The biggest winners are the generations about to retire at the time of the stimulus, and the oldest of the retirees. The biggest losers are those about to start their working lives at the time the stimulus is introduced.

The approach here could be used to examine the reverse case of fiscal consolidation. This would be relevant to the ongoing debate about whether contractionary fiscal policy can be expansionary over the longer term. Of particular interest would be the impact that various options for lowering budget deficits and public debt — cuts to transfer payments or government spending, or tax increases — would have on different generations.

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## ENDNOTES

1. Economics, Griffith Business School, Griffith University, Gold Coast campus 4222, Australia, r.guest@griffith.edu.au; t.makin@griffith.edu.au. We gratefully acknowledge the reviewers' constructive comments.

2. Hence there is no exchange rate, although there is an imperfect external capital market.

3. The technology parameter is constant, implying zero technical progress. This is done in order to prevent the leisure to consumption ratio declining to zero with continual productivity-induced rises in real wages (Auerbach and Kotlikoff 1987 Kulish et al 2006). An alternative would be to introduce the parameter, A, into the utility function so that leisure grows at the same rate as consumption in the long run.

4. This is equivalent to assuming that government consumption is exogenous and separable from both private consumption and leisure in generating utility, which is the approach of Foertsch (2004), for example. Here government consumption is excluded from utility for the purpose of calculating the intergenerational welfare effects of fiscal stimulus. Otherwise arbitrary assumptions would have been required about the direct utility effects of stimulus on different generations. Instead, stimulus affects utility indirectly through its effects on employment, wages, the interest rate and the tax rate.

5. Simulation B is the case where $\phi$=0 (pure intertemporal optimisers). See Tables 4 to 9, which show that this assumption has a very small effect on the results. For example comparing $\phi$=0 and $\phi$=0.5 (Simulation A, the base case) the difference in the long run fiscal multiplier is 0.07.

6. Uhlig (2010) analyses the macroeconomic effects of fiscal stimulus, but there are a number of differences in model set up and simulations. For example: (i) Uhlig uses a Ramsey model, rather than an OLG model which allows for an intergenerational welfare analysis; (ii) Uhlig assumes that the debt is necessarily unwound via tax increases whereas the simulations here include the case where the debt is unwound via spending cuts; (iii) Uhlig considers stimulus via government consumption spending and tax cuts, where as the model here considers stimulus in the form of transfer payments, as well as consumption spending, but does not consider tax cuts. Australia was an exception among OECD countries in not cutting taxes. Although the simulations are generic the authors had the Australian case in mind and have adopted certain Australian parameter values; (iv) Uhlig assumes that government spending and output follow stochastic processes whereas they are deterministic here.

7. Stimulus spending soaks up under-employed labour which, by assumption, is spread throughout generations. When this labour becomes employed the wage income earned belongs to that generation and shows up as higher wage income earned by that generation.

8. Nicholas Stern in his climate change analysis assumed this probability was 0.1 percent per annum and therefore adopted that rate as the social discount rate (Stern 2007).

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