Population Aging and the Efficiency of Fiscal Policy in New Zealand

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[1] The authors are with the New Zealand Treasury. However, the views expressed in this draft paper are those of the authors and do not necessarily reflect the views of the Treasury. The paper is presented not as policy, but with a view to inform and stimulate the wider debate. We are grateful for comments received on an earlier draft. In particular, we would like to thank Phillip Anderson, Steve Cantwell, John Creedy, Arthur Grimes and Peter Wilson for their valuable contributions.

Executive Summary

Over the next half-century, New Zealand's aging population is expected to have a significant impact on the future profile of government expenditure, particularly in the areas of health and superannuation. Recent projections from Treasury's Long-Term Fiscal Model suggest that, under current policy settings, government expenditure (excluding financing costs) will increase by approximately seven percentage points of GDP by 2050.

From the perspective of economic efficiency, we consider a number of different methods for financing that expenditure. Using the balanced budget approach as our benchmark, we model the reduction in deadweight losses associated with tax smoothing. Contrary to previous studies, we find that the welfare gains from tax smoothing, relative to balanced budget, are significant (up to 7.7% of 2000/01 GDP in present value terms depending on how the growing pool of assets is invested).

As a consequence of tax smoothing over a 50-year moving window, and because the expenditure increase is persistent, a substantial pool of assets remains at the end of our assessment period (72% to 118% of 2051/52 GDP). Since those assets would be used to partially fund another fifty years of higher expenditure, our estimates of the benefits of tax smoothing are substantially understated (by a factor of three according to our rough estimate).

The results in favour of tax smoothing are primarily due to our assumption that the assets accumulated under tax smoothing earn an average return over the government's cost of borrowing. This excess return is not without risk since we model asset returns in a stochastic manner. Consistent with Bohn (1990), we find that a diversified portfolio of financial instruments reduces the year-on-year volatility in tax rates relative to a balanced budget strategy.

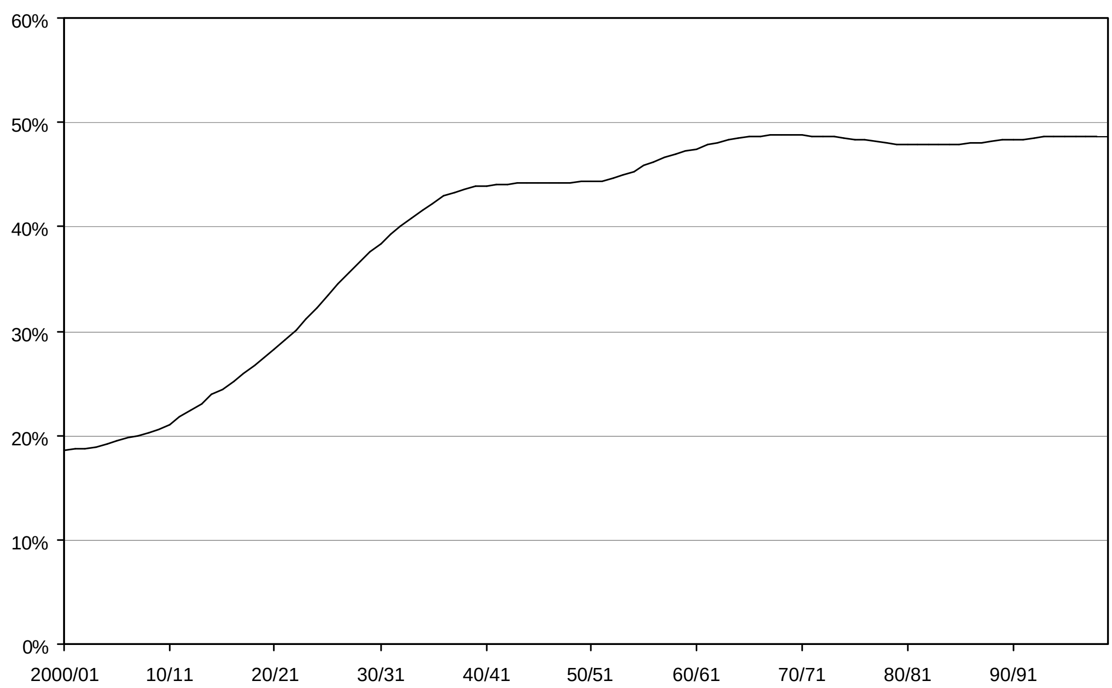
The preference for tax smoothing is robust with respect to variations in discount rates, expenditure growth assumptions, labour supply elasticities and asset allocation. Introducing practical considerations, in particular expenditure creep (where additional government spending is triggered by an improving balance sheet position), tips the scales in favour of a balanced budget approach. If spending increased permanently by $1 for every $10 saved by the government, then the benefits of tax smoothing would be

completely eroded. Hence, strong fiscal institutions are a prerequisite for achieving the welfare gains of tax smoothing.

The Challenge of an Aging Population

New Zealand, like most developed countries, faces the prospect of an aging population. During the next century, the old age dependency ratio[2] is expected to more than double (see Figure 1). This dramatic demographic shift reflects the progression of the large cohort of *baby boomers*[3] into their retirement years. Rising life expectancy and declining fertility is expected to exacerbate this cohort effect.

Figure 1: Old Age Dependency Ratio



Studies of the fiscal implications of population aging consistently show that, in the absence of policy change, a significant deterioration in the fiscal position is inevitable.[4] Two key arguments underpin this fiscal deterioration. First, a slower growing and

[2] The ratio of those aged 65 or more to those aged between 16 and 64.
[3] The baby-boomers are those people born during the high birth rate years following WWII.
[4] For example, see OECD (2001) and Visco (2001) for discussions in the international context, and Polackova (1996) and Bagrie (1999) for New Zealand commentaries.

eventually declining labour force is expected to lead to lower economic growth and tax revenue. Second, increases in the average age of the population are expected to raise *per capita* health and superannuation expenditure.

Recent projections using Treasury's Long-Term Fiscal Model (LTFM) show that, under current policy settings, government expenditure excluding financing costs is expected to increase by approximately 7% of GDP over the next half century. Furthermore, much of the increase is projected to occur up front as the baby boomers begin to retire from 2010 onwards (see figure 2).

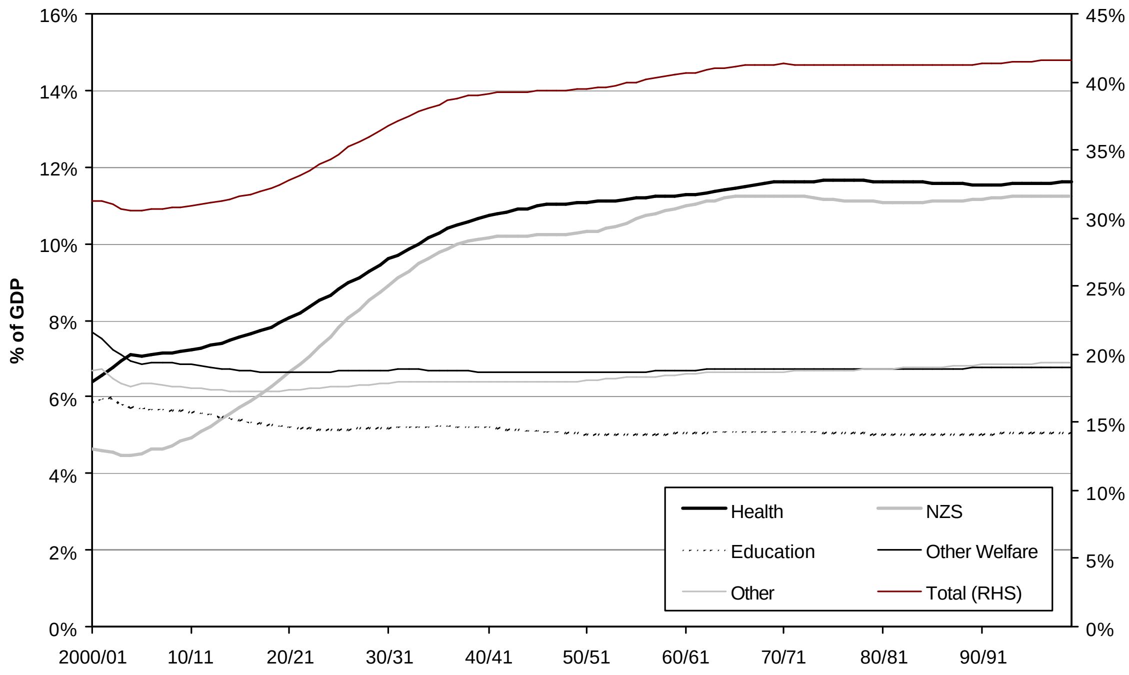


Figure 2: Expenses

Some political and economic commentators point towards the rising share of public expenditure to GDP, and the diminishing share of working age people in the population, and conclude that tax rates should increase now (or at least not decrease). Such arguments are usually based on a view that waiting till later to raise taxes is inefficient, unsustainable and/or unfair. On the other side of the debate, there is a strong lobby for deferring tax increases and maintaining a rough balance between taxation and expenditure. Proponents of this view emphasise the adverse effects of taxes on growth and the potential for less restrained fiscal management associated with a period of sustained primary surpluses. In this paper, we focus on questions of economic efficiency.[5] At the heart of our analysis is the question of how fiscal policy should accommodate the burgeoning expenditures associated with an aging population.

Efficient Public Finance

Economic efficiency is usually defined in terms of welfare. In the area of public finance, a key source of welfare loss is the excess burden of taxation. Due to their involuntary nature, taxes create incentives for taxpayers to substitute away from taxed activities toward activities that are not taxed, or are taxed at lower marginal rates. If the taxed activities would otherwise be worthwhile, the substitution reduces welfare. It follows that society would benefit if taxes were levied in a way that minimises the welfare costs of taxation.

Barro (1979) first demonstrated that governments should minimise the welfare loss associated with taxation by smoothing tax rates over time. This result arises because welfare costs are thought to increase (decrease) by more than the proportionate rise (fall) in the tax rate. While Barro constructed his argument in a deterministic framework, Lucas and Stokey (1983) and then Bohn (1990) demonstrated that the *tax smoothing* result generalised in a stochastic environment to smoothing tax rates over time and across states of nature. Bohn (1990) highlighted the role for financial instruments in insuring against state-contingent shocks to the primary balance.

The implication for fiscal policy is that, by smoothing taxes, the government can minimise the present value of deadweight losses, as given by $H(\tau) = \sum_{t=1}^{\infty} \frac{h(\tau_t)}{(1+r)^t}$. This measure of welfare loss, $H(\tau)$, can be used to assess the relative efficiency of alternative financing strategies.

[5] While also relevant to the debate, we do not address issues of equity or sustainability.

We follow Browning (1987) in approximating the deadweight loss function by:

$$h(\tau_t) = \left[\frac{\varepsilon.\tau_t^2}{2.(1-\tau_t)}\right].Y_t \qquad (1)$$

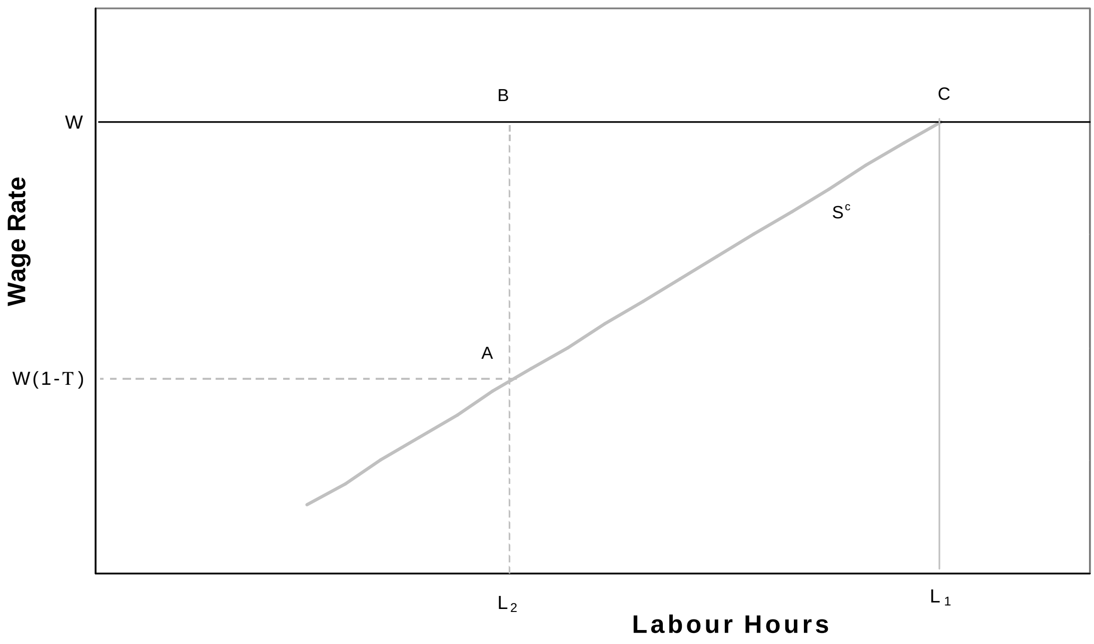
where τ_t is the marginal rate of labour income tax;

Y_t is aggregate labour income at time t; and

ε is the compensated net-of-tax wage elasticity of labour supply.

The intuition behind this formulation can be demonstrated using Figure 3.

Figure 3: Static Illustration of Welfare Costs



Individuals earn a gross wage rate, W, and pay tax at the marginal tax rate, τ. Compensated labour supply, which is the quantity of labour supplied holding utility constant for a given net wage rate, is represented by S^C. The number of hours worked in equilibrium is given by L_2. The total welfare loss due to the imposition of the tax, ABC, is equal to the gross earnings forgone,[6] BCL_1L_2, less the incremental value of additional leisure hours, ACL_1L_2.[7] Equation (1) expresses the area of this Harberger triangle algebraically.

Our theoretical approach is to estimate $H(\tau_t)$ with aggregate data. Browning (1987) notes that, if all households are confronted with the same marginal tax rate and had the same labour supply elasticity, this approach will yield accurate results. However when marginal tax rates and/or elasticities differ, this approach will understate the welfare loss. The degree of understatement increases with the dispersion in marginal tax rates and/or elasticities.

Furthermore we treat all income as labour income. This also biases our welfare loss estimates downwards because marginal deadweight losses for capital income taxes are thought to be higher than for labour income taxes. We use the ratio of total taxes to GDP (ie, an aggregate average tax rate) as our measure of the marginal tax rate. This too biases down our estimates since the aggregate marginal tax rate is higher than the aggregate average tax rate.

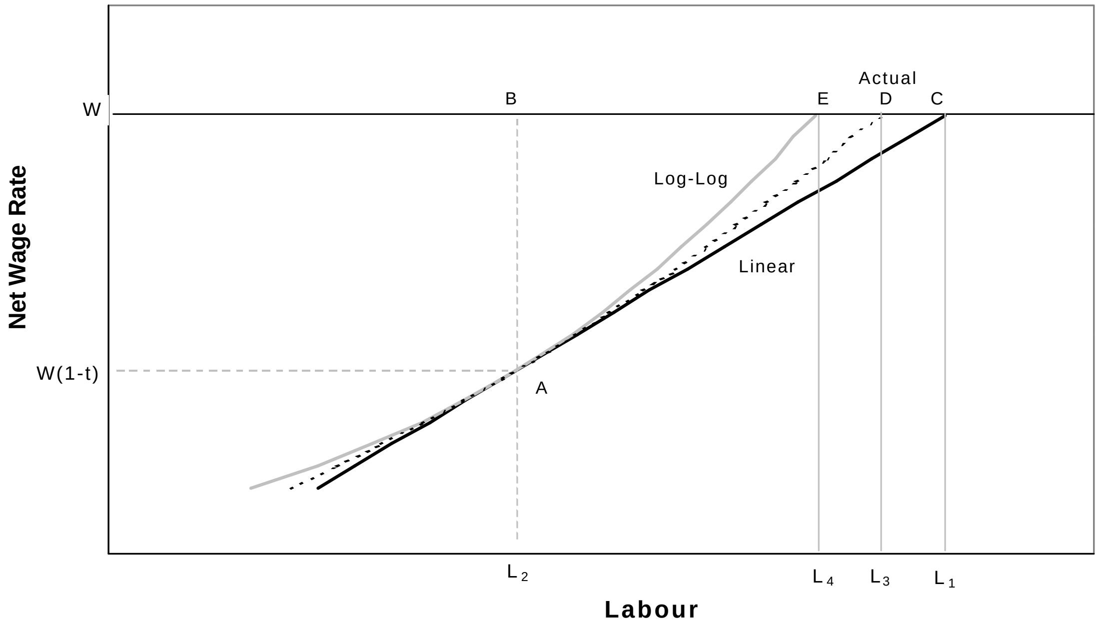
Equation (1) may give estimates that overstate the true welfare cost. First, Browning's partial equilibrium approach assumes that the marginal value product of additional hours worked, and therefore the gross wage rate, is constant. The degree to which this assumption biases the results depends on the elasticity of the marginal product curve relative to the labour supply elasticity. Browning argues that the demand elasticity is high relative to the labour supply elasticity. It follows that the degree of overstatement is small.

Second, if the actual compensated labour supply curve is convex (eg, 'Actual' in Figure 4) instead of linear, then the welfare loss measured using equation (1), ABC, overstates the true welfare loss, ABD. An alternative approach is to use a compensated labour supply function that exhibits constant wage elasticity (eg, 'Log-Log' in Figure 4). Whether a constant elasticity specification over or understates the true welfare cost is unclear. The available evidence provides little basis for determining

[6] Gross earnings decline because the worker, having been compensated for any loss in utility from reduced income, will supply less labour after the imposition of the tax than before.
[7] Note that the analysis is based on the common assumption that the market wage rate remains unchanged with labour supply and that the compensated labour supply curve is linear.

an appropriate form for compensated labour supply. For this reason, it is important to test the sensitivity of welfare loss estimates to changes in the functional form.

Figure 4: Welfare Loss For Alternative Compensated Labour Supply Curves



Alternative Approaches to Financing Government Expenditure

While in theory it is efficient to smooth the burden of taxes over time, in practice, and with few exceptions, governments do not tend to follow strategies that resemble tax smoothing (Alesina and Perotti 1994). One hypothesis that might be formed from this observation is that the quantitative benefits of smoothing taxes are insignificant. Alternatively, one might suppose that there is something in tax smoothing that renders it impractical or economically costly in practice. We consider both of these issues in turn.

Does Tax Smoothing Pay?

Previous estimates of the welfare costs of alternative financing strategies, in the face of demographic-related expenditure growth, have found the gains of tax smoothing over balanced budget to be insignificant. In a study for the United States, Cutler *et al* (1990) report that “the change in the present value deadweight loss between 1990 and 2060 is 1% of 1990 GNP” (see p. 49). In a similar study for Denmark, Jensen and Nielsen (1995) find that the difference in the present value of deadweight losses between the two strategies “accounts for only about 0.03% of GDP in 1993” (see p. 17). For New Zealand, Dahanayake (1998) estimates that “the maximum gain of tax-smoothing [using a 40-year fixed horizon] over balanced-budget is only about 0.87% of projected [2007/08] GDP”.[8]

Following the standard approach, we consider the present value of deadweight loss associated with taxation, $H(\tau)$, as the criterion for assessing the relative efficiency of different financing strategies.[9] We compare two financing strategies: balanced budget and tax smoothing over a 50-year time frame.

Modelling Approach

While our approach is similar to previous studies there are some important differences:

- ***Endogenous Labour Supply*** - we make total hours worked endogenous to account for the substitution effect of taxes on labour supply. This adjustment is implicit in Browning’s formulation of the welfare loss but is overlooked by other studies.

- ***Moving Horizon*** - we employ a moving-horizon (fixed smoothing period length) in our tax-smoothing simulations.[10] This has the effect of generating a rising tax rate over the next 50 years, irrespective of the financing strategy.

- ***Stochastic Productivity Growth*** - we model labour productivity growth as a stochastic process. This has the effect of making nominal GDP growth and tax revenue stochastic, while maintaining the LTFM’s hypothesised negative relationship between population aging and economic growth.

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[8] In Dahanayake’s analysis, net debt was reduced to zero before commencing the tax-smoothing strategy. Hence, comparisons between balanced budget and tax smoothing take place in 2007/08, the year net debt was projected to reach zero.

[9] Note that we assume that government expenditure generates benefits equivalent to the value of that expenditure.

[10] We also report the fixed-horizon (diminishing smoothing period) results for comparative purposes.

- ***Government Investment in Risky Assets*** - we assume that the government invests primary surpluses in assets that are expected to earn returns in excess of the government's cost of borrowing.[11] Importantly, this excess return is not without risk since returns are modelled stochastically. The risk/return properties of the financial portfolio are allowed to vary with the government's choice of asset allocation.

Other aspects of our approach are more conventional. For example, we start by assuming that the government's expenditure profile is exogenous. This assumption is partially relaxed later in the paper. The expenditure profile is obtained from Treasury's LTFM (see Woods (2001) for an overview of that model). Tax rates are determined using deterministic GDP forecasts rather than stochastic ones. This avoids making the unrealistic assumption that the government has perfect foresight. Finally, for the tax smoothing scenarios, the tax rate is determined as the rate that is expected to return net debt to its initial level (relative to GDP) at the end of the smoothing period.[12]

Base Case

The modelling of alternative financing strategies and the calculation of welfare costs require a number of parameter assumptions. We define a set of base assumptions below.

Compensated Labour Supply Elasticity

We follow the approach of Browning (1995) in deriving a calibrated economy-wide estimate based on a recent survey of the empirical literature by Blundell and MaCurdy (1998). Based on this survey, we obtain midpoint estimates of compensated wage elasticities of 0.13 and 0.70 for men and women respectively.[13] A weighted-average of these estimates (with a 35% weight for women, approximately equal to their share of total labour income) yields a figure of 0.33. This is the same figure obtained by Browning (1995) based on earlier surveys by Pencavel (1986) and Killingsworth and Heckman (1986). Based on these estimates, we use 0.3 as our base estimate.

[11] A transfer mechanism is employed to maintain gross debt (domestic and foreign) as a constant percentage of nominal GDP. The interest rate on the debt is deterministic.
[12] Our definition of net debt – Gross debt less total financial assets – is not to be confused with that used in the Crown Financial Statements.
[13] In obtaining the mid-point estimates, we drop the single largest and smallest values.

Labour Supply Functional Form

As discussed earlier, the available evidence provides little basis for determining an appropriate form for compensated labour supply. We use a linear specification since that is consistent with Browning's formulation of the welfare loss. Later in the paper we test the sensitivity of the results to this assumption.

Demographics

Statistics New Zealand provides The Treasury with a number of different demographic projections. The LTFM uses the medium fertility, medium mortality series with three alternative migration assumptions. We choose the medium migration series for our base case. This series assumes a net inflow of 5,000 people per annum.

Expenditure Growth

We use the LTFM's base assumptions for expenditure growth, namely, 1.5% real growth in welfare, health, education and defence expenditure.

Asset Allocation

The majority of the Crown's marketable securities are currently invested in New Zealand bonds, and some foreign bonds, with little investment in equity markets. The New Zealand Superannuation Fund (NZSF) is anticipated to shift the composition of Crown investment towards offshore equities. These practical considerations aside, it would be prudent for any government accumulating financial assets over the long-term to adopt a diversified financial portfolio. Recent studies have shown that the government can reduce investment volatility by investing in a relatively broad range of asset classes (Huther, 1998 & Fabling, 2002). For these reasons we have chosen a "balanced" asset allocation[14] as our base assumption. Information on asset class returns, including the underlying correlation structure, is included in Appendix One.

Discount Rate

The debate on what discount rate to use for welfare analysis has a long history. Previous studies of this type use the government's long-term borrowing rate. For this reason, we use the yield on the 2016 inflation-indexed bond (4.7%) adjusted for expected inflation (1.5%) to give our base discount rate of 6.2%. However, we are

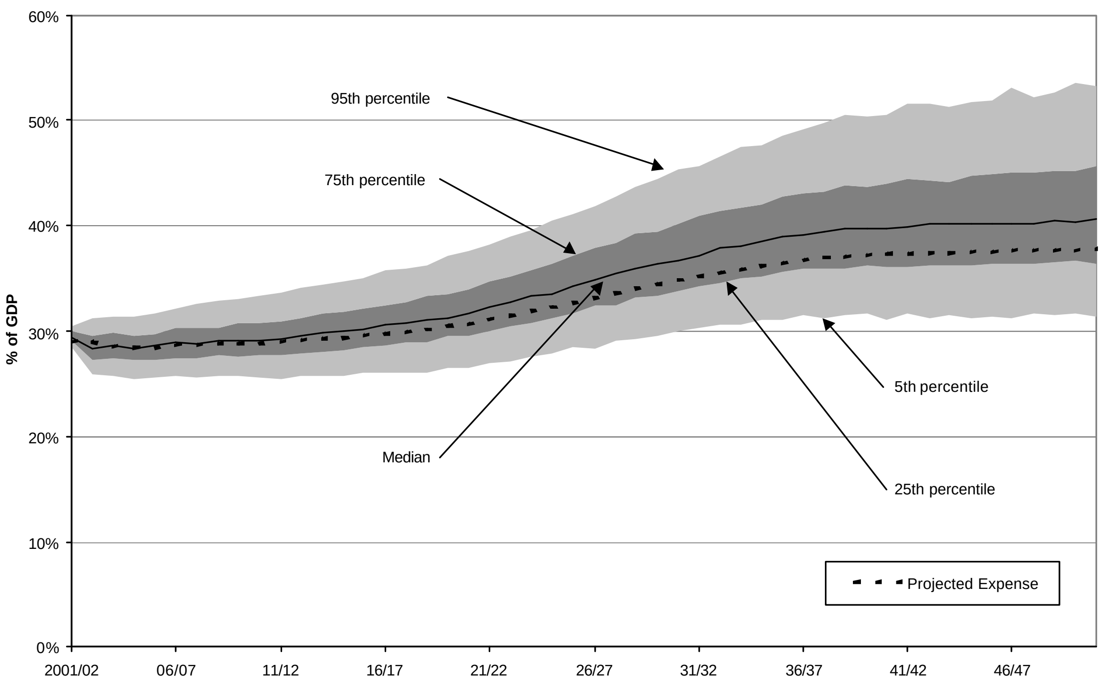
[14] The balanced portfolio combines New Zealand Bonds, New Zealand Equities, Foreign Bonds and Foreign Equities in equal proportions.

sympathetic to the arguments of Caplin and Leahy (2000) and others who maintain that individuals discount the future too much and that governments should employ a lower discount rate for the purposes of welfare analysis than individuals would choose in determining their utility from future consumption. This result is derived from changes in individuals' preferences as they age (changes that individuals do not anticipate). A similar argument can be justified on grounds of intergenerational equity. We consider the sensitivity of welfare costs to different discount rates later in the paper.

Results

We begin by analysing the balanced budget scenario. The first thing to note about the stochastic modelling is that even in the absence of risky portfolio returns, volatility in the tax base (GDP growth) has a very strong impact on the volatility of tax rates (see Figure 5). This volatility largely results from the decision not to use the balance sheet to absorb short-run volatility in the tax rate. If the gross debt target were relaxed somewhat this volatility would decline substantially (see Davis (2001) for a demonstration of banded debt targets in a stochastic environment).

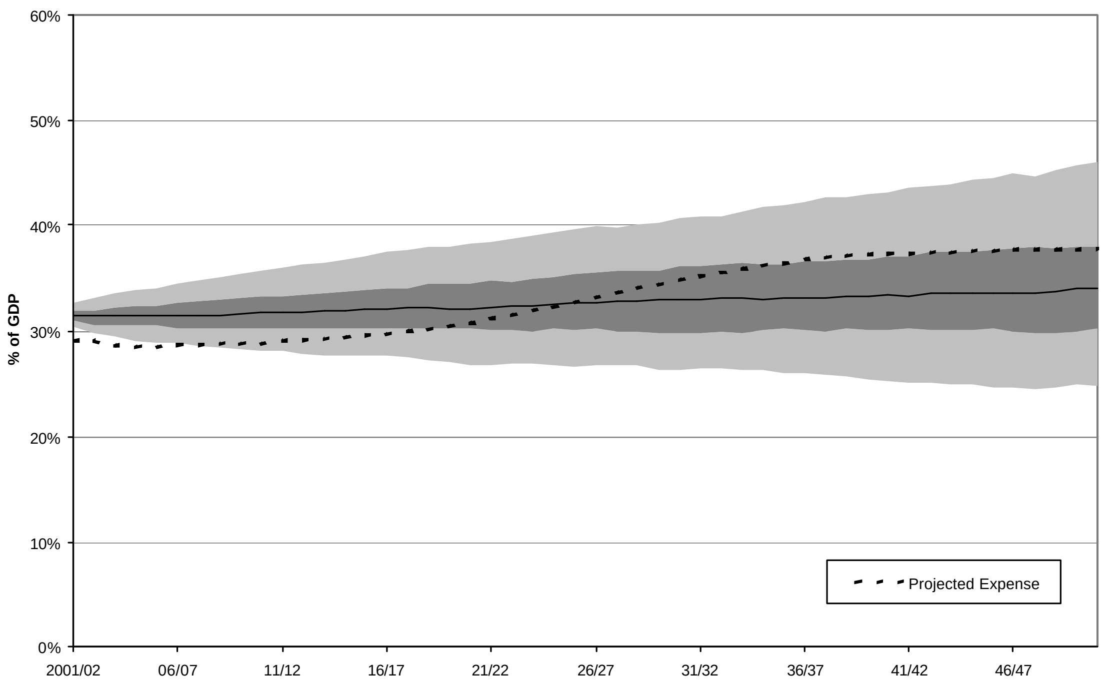
Figure 5: Balanced Budget Tax Rate



Due to the initial stock of debt, the government needs to run operating surpluses in order to maintain net debt as a constant share of output. The rising expenditure profile requires the median tax rate to increase from the current tax rate of 32% to 41% of GDP by 2050/51. The stochastic nature of GDP growth does not rule out tax rates in excess of 53% by the end of the projection period.

Figure 5 can be compared with the distribution of tax rates under a 50-year tax smoothing strategy (see Figure 6). The profile of tax rates is much smoother and the median tax rate rises through time.[15] This latter result reflects the fact that government expenditure is expected to reach and then maintain a higher level for the foreseeable future.

Figure 6: Tax Smoothing (50yr Moving Window) Tax Rate



[15] In a fixed horizon model, the profile of the median tax rate would be flat but this is unrealistic since it implies a significant upward adjustment to the tax rate in 2051/52.

Figure 7: Tax Smoothing (50yr Moving Window) Net Debt

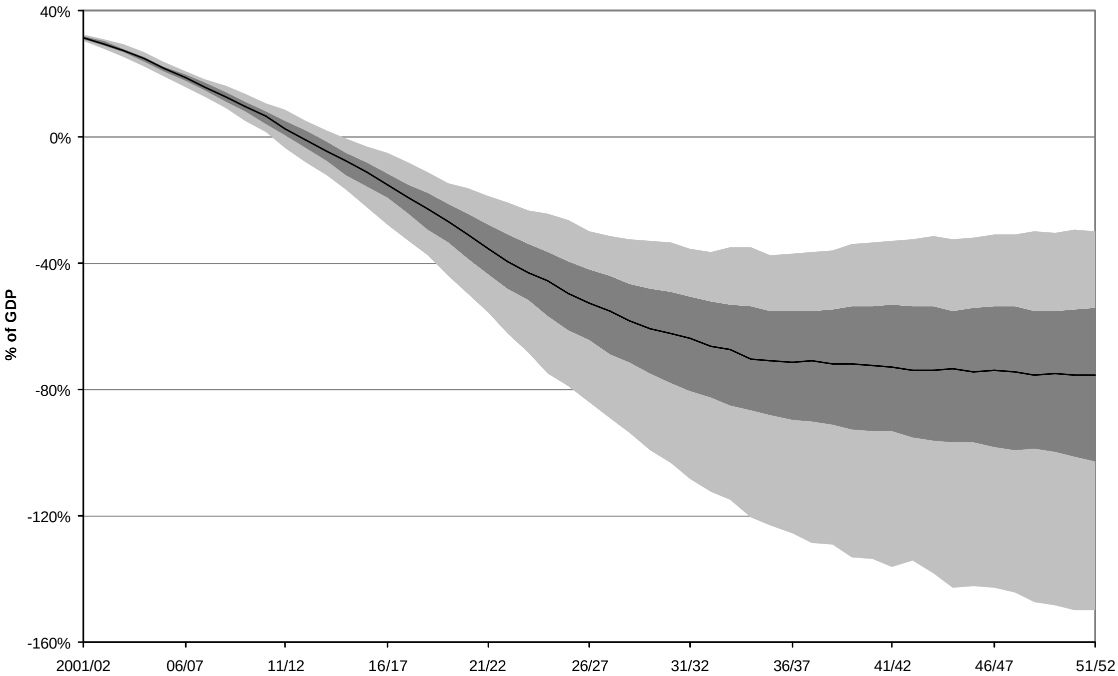


Figure 7 demonstrates the extent of the asset accumulation that occurs under tax smoothing. By assumption, gross liabilities remain at a constant share of GDP implying that the median financial asset portfolio reaches around 107% of GDP in 2051/52. Note also the large variation in net debt levels under different simulations. This volatility is a function of both the size of the asset portfolio and the underlying volatility in returns. Despite this volatility, the two financing strategies generate distributions of tax rates that are quite similar in breadth.

Table 1 **Financing strategy**	**Median Deadweight loss**[16]	
	(% 2000/01 GDP)	**Savings over Balanced Budget (%GDP)**
Balanced budget	67	N/A
Tax smoothing (50yr fixed horizon)	61	5.5
Tax smoothing (50yr moving window)	64	2.9

[16] All deadweight loss calculations in this paper are presented in present value terms.

Table 1 compares the present value of deadweight loss associated with the two financing strategies. In each case, the deadweight loss is a large percentage of current GDP. These estimates are broadly in line with previous calculations by Browning (1987) but they emphasise that the welfare costs of taxation are significant.

However, our estimates of the welfare *savings* of tax smoothing are higher than previous studies. Using the fixed horizon approach consistent with previous studies, we estimate that tax smoothing generates present value savings of 5.5% of GDP over a balanced budget strategy. This compares with previous estimates of between 0.03% of GDP and 1.0% of GNP. The main reason for this difference lies in the excess return that we assume over the government's cost of borrowing.

It would not make sense to implement a fixed horizon tax smoothing strategy in practice. Hence the remaining tax smoothing simulations are conducted on a moving horizon basis. Under our base assumptions, we estimate the welfare savings from tax smoothing to be 2.9% of 2000/01 GDP or approximately $3.3 billion. Furthermore since we are applying a 50-year moving window and the expenditure increase is persistent, a substantial pool of assets remains at the end of our assessment period. Thus the benefits of tax smoothing are underestimated substantially since, by construction, those assets would be used to partially fund another fifty years of higher expenditure.

To see how significant this underestimate might be, consider the following rough calculation of the deadweight losses outside the projection period (essentially assuming that expenditure has converged to a long-run rate). The median balanced budget tax rate in 2050/51 is 40.6% compared with 33.9% for tax smoothing with assumed future nominal growth in GDP of 2.8% p.a., thus we have:

DWL Savings $\approx$ DWL difference * discounted annuity increasing at GDP growth rate

$$= \frac{e}{2Y_0}\left(\frac{{t_{50}^{BB}}^2 Y_{50}^{BB}}{1-t_0+e\left(t_0-t_{50}^{BB}\right)} - \frac{{t_{50}^{TS}}^2 Y_{50}^{TS}}{1-t_0+e\left(t_0-t_{50}^{TS}\right)}\right)\frac{1}{(1+r)^{51}}\frac{1}{r-g}$$

$$= \frac{0.3}{228}\left(\frac{0.406^2 \times 531}{1-0.321+0.3(0.321-0.406)} - \frac{0.339^2 \times 547}{1-0.321+0.3(0.321-0.339)}\right)\frac{1}{1.062^{51}}\frac{1}{0.062-0.028}$$

$$= 7\%$$

While this underestimate is significant, the rest of the paper is restricted to 50-year simulations. This is due to the availability of forecast demographic and expenditure paths, and to allow easier comparison with earlier studies of deadweight losses.

Conclusion

The purpose of this section was to quantify our base estimates of the welfare benefits of tax smoothing over balanced budget. Our main finding is that the potential benefits are larger than have previously been estimated, around 3% of 2000/01 GDP in present value terms. Furthermore, our results understate the potential benefits considerably since we have ignored the effect of a much stronger balance sheet position relative to balanced budget moving forward from 2050.

Alternative Cases

This section considers the impact on the results of varying our underlying assumptions.

Compensated Labour Supply Elasticity

We re-estimate the results (reported in table 2) with a range of elasticities between 0.2 and 0.5.

Table 2 Financing strategy	**Median Deadweight loss (for various elasticities)**							
	(% GDP)				**Savings over Balanced Budget (%GDP)**			
	0.2	**0.3**	**0.4**	**0.5**	**0.2**	**0.3**	**0.4**	**0.5**
Balanced budget	44	67	90*	110*	N/A			
Tax smoothing	43	64	85	103	1.7	2.9	4.6	6.5

For higher elasticities, a number of the balanced budget simulations do not have solutions.[17] This is because projected government expenditure exceeds the revenue-maximising tax rate for some simulations.[18] In comparing the relative efficiency of the financing strategies, it is necessary to exclude the simulations for which there are no

[17] For ε=0.4, seven simulations do not have balanced budget solutions. The number of "failed" simulations rises to 208 when ε=0.5. That is, there is a 21% chance that continuously balancing the budget becomes impossible.

[18] The "failed" simulations do not imply that the balanced budget strategy is unsustainable since we do not account for the countervailing *income effect* of tax changes on the labour supply. In other words, we are capturing welfare effects rather than the total fiscal impact of tax changes.

balanced budget solutions. This biases the median statistics downwards.[19] Importantly, the extent of the bias will be worse for balanced budget, underestimating the savings from tax smoothing reported in table 2.

Labour Supply Functional Form

If the compensated labour supply is not linear, the welfare cost equation takes a different form. As an alternative, we model a constant elasticity labour supply where the relationship between labour supply and the wage rate is given by $L = L_1(w/w_1)^e$. The corresponding deadweight loss function is:

$$h(t_t) = Y_t \left\{ \frac{1}{e+1} \left[\frac{1}{(1-t_t)^e} - (1-t_t) \right] - t_t \right\}$$

Table 3 Financing strategy	Median Deadweight loss (alternative labour supply functional form)	
	(% GDP)	Savings over Balanced Budget (%GDP)
Balanced budget	62	N/A
Tax smoothing	58	3.5

We can see from these results that the potential overestimate from assuming a linear labour supply curve is minimal (at least at an elasticity of 0.3).

Expenditure profile

In the absence of rapidly increasing per capita health and superannuation costs, the question of how best to finance public expenditure would be much less important. The tax profiles associated with the balanced budget and tax smoothing strategies would be less distinct. For this reason, we consider alternative expenditure paths (low and high growth in health and education) and compare the results with those under the base case.[20] Figure 9 illustrates the sensitivity of the expenditure profile, and the tax smoothing tax rates, to variations in the real per capita expense growth.

[19] For example, the present value deadweight loss for tax smoothing, when ε=0.5, is 114% of 2000/01 GDP rather than 103%, as reported in table 2.

[20] The low (high) growth case assumes real per capita expenditure growth in health and education of 1% (2%) per annum.

The difference in median tax rates is marked. Under the high growth scenario, expenditure grows throughout the entire projection period to reach 42% of GDP in 2050/51. With low expenditure growth, public spending peaks at just under 35% of GDP before beginning a slow decline around 2040.

Figure 9: Median Tax Smoothing Tax Rate for various expenditure paths

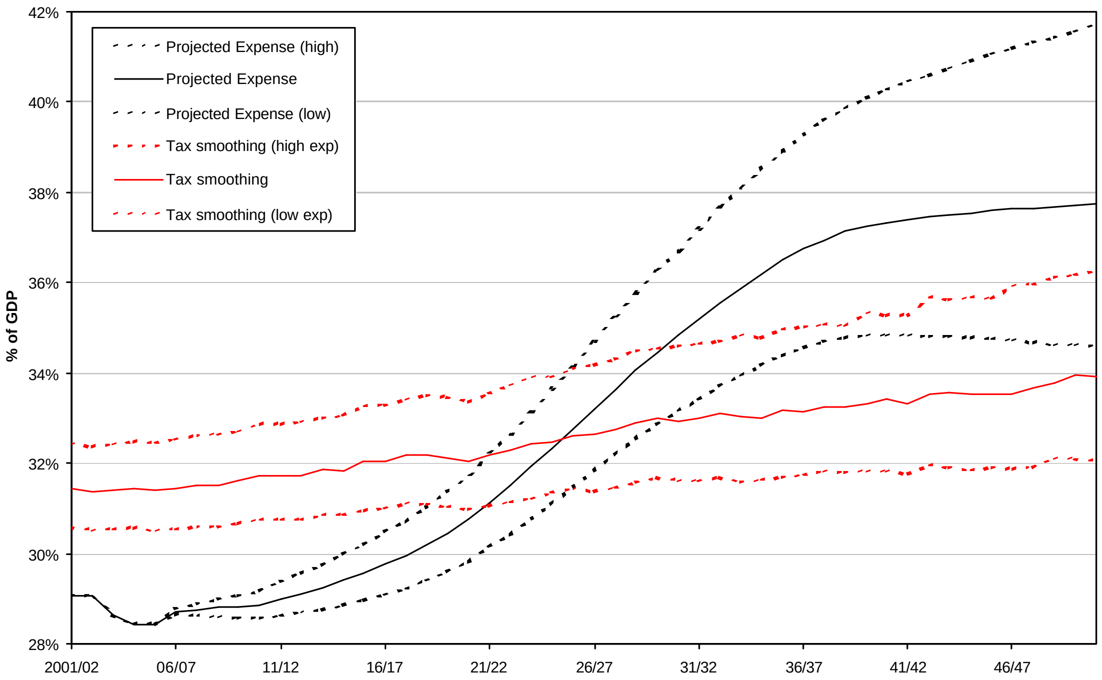


Table 4 demonstrates the effect that these alternative expenditure profiles have on deadweight losses. Under the high growth assumption, the adjustment to taxes under a balanced budget strategy is more severe which tends to favour the tax smoothing strategy. On the other hand, low expenditure growth requires a smaller adjustment to taxes. However, even under the low growth scenario the benefits of tax smoothing remain significant.

Table 4 Financing strategy	Median Deadweight loss (for alternative expenditure paths)	
	(% GDP)	Savings over Respective Balanced Budget (%GDP)
Balanced budget (low exp)	61	N/A
Tax smoothing (low exp)	59	2.1
Balanced budget	67	N/A
Tax smoothing	64	2.9
Balanced budget (high exp)	74	N/A
Tax smoothing (high exp)	70	4.0

Discount Rate

We re-estimate the results (reported in table 5) with a range of discount rates between 1.5% (ie, 0% real) and 7.2%.

Table 5 Financing strategy	Median Deadweight loss (for various discount rates)									
	(% GDP)					Savings over Balanced Budget (%GDP)				
	1.5%	3%	5%	6.2%	7.2%	1.5%	3%	5%	6.2%	7.2%
Balanced budget	233	148	88	67	54	N/A				
Tax smoothing	195	130	81	64	53	37.6	18.9	6.6	2.9	1.0

Unsurprisingly, the deadweight loss savings associated with tax smoothing are highly sensitive to the discount rate, ranging from 1.0% to 37.6% of GDP. For the purposes of policy analysis, we would tend towards applying a lower discount rate based on the reasoning of Caplin and Leahy (2001). For this reason, we believe that our base discount rate should be interpreted as an upper bound.

Asset Allocation

The government's choice of asset allocation is interesting for two reasons. First, it determines the return to be expected from assets set aside to fund future primary deficits. Other things being equal, a higher portfolio return will lower the tax rate required to finance future government expenditure (and decrease the size of the asset pool required).

Second, the asset allocation will affect the stochastic properties of the tax rate since different portfolio compositions imply different volatilities. Importantly, a more volatile portfolio (for example, one heavily weighted in equities) need not necessarily result in a more volatile tax rate because tax rate volatility is dependent on the correlation between portfolio returns and the primary balance. In the spirit of Bohn (1990), there may be efficiency benefits from diversification of the government's portfolio.

We model two alternative portfolios (All New Zealand Bonds[21] and All Foreign Equities) and compare the results with those of the base case.

Table 6 Financing strategy	Median Deadweight loss (for various portfolio allocations)					
	(% GDP)			Savings over Balanced Budget (%GDP)		
	NZ bond	Balanced	Foreign equity	NZ bond	Balanced	Foreign equity
Balanced budget	67	67	67	N/A		
Tax smoothing	68	64	59	-1.1	2.9	7.7

According to these results, a strategy of tax smoothing that involved debt repayment (and then bond accumulation) would be dominated by a balanced budget strategy. However, this ignores the fact that this strategy generates an asset portfolio of 118% of GDP by 2051/52 that is expected to finance another fifty years of tax smoothing.[22] As discussed earlier, the extent of the understatement of benefits is likely to considerably raise all of the savings figures in table 6.

Focussing on the comparative results, note that the deadweight loss savings are quite sensitive to portfolio composition. On the basis of expected savings alone, the modelling suggests that the Crown should follow a particularly aggressive investment strategy. However, the volatility of the investment returns should also be considered.

Figure 10 compares the distribution of deadweight loss savings for different portfolio allocations. As expected, the width of the distribution for the foreign equities portfolio is considerably wider than the other portfolios. This reflects the volatile nature of equity returns. However, most of the risk appears to be on the upside since the whole distribution sits much higher up the scale than the other portfolios. Table 7 contains the probabilities that the deadweight loss is lower than balanced budget for each of the portfolios.

[21] The portfolio required in this case exceeds the stock of government debt but we ignore this inconsistency for illustrative purposes.
[22] By contrast, the All Foreign Equities portfolio has only reached 74% of GDP.

Figure 10: Distribution of Deadweight Loss Savings over Balanced Budget

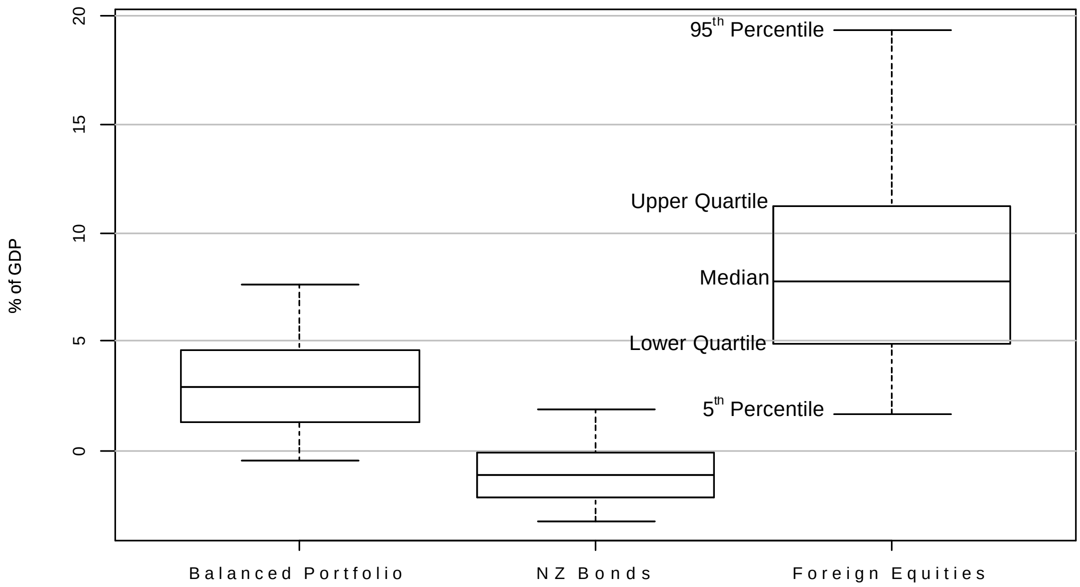


Table 7 Portfolio Allocation	Probability Deadweight loss is lower than Balanced Budget
All NZ Bonds	22.5%
Balanced Portfolio	91.1%
All Foreign Equities	99.3%

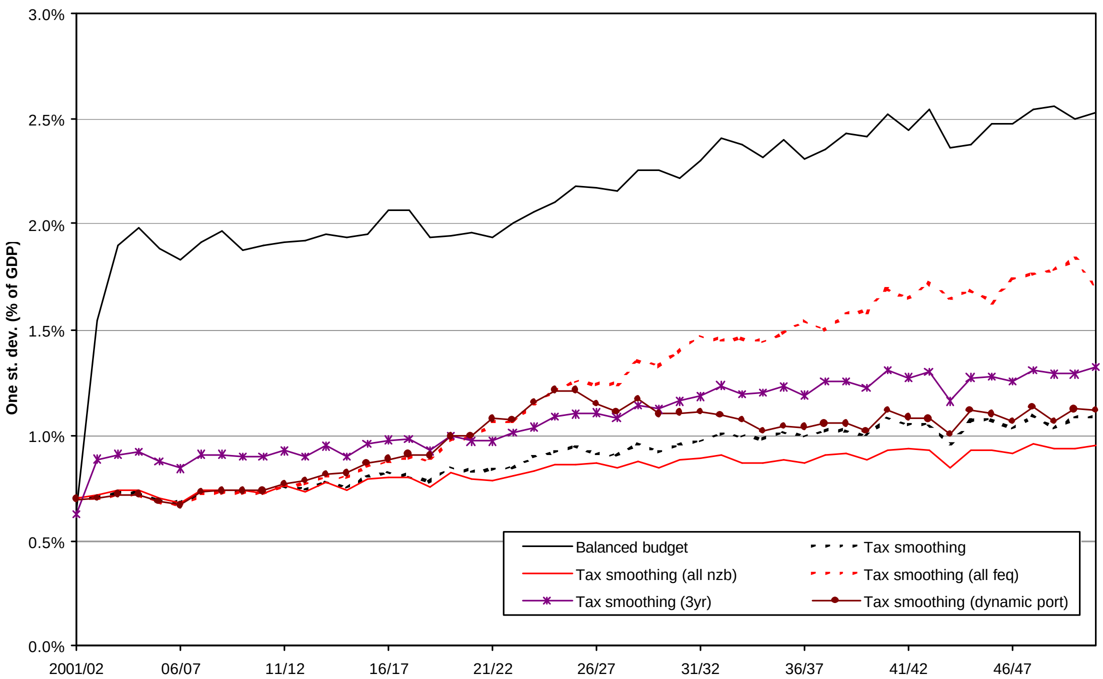
These probabilities suggest that, given our modelling assumptions, only a government with a very low risk tolerance could justify moving away from a strategy of investing all primary surpluses in foreign equities.[23] However, this result would be sensitive to our assumption about the size of the equity risk premium and the correlation coefficients.

Another way of thinking about risk is to consider the volatility of tax rates under various portfolio allocations. Figure 11 shows the year-to-year volatility in tax rates for different portfolio allocations. Throughout the period, the three tax smoothing investment strategies generate significantly lower year-to-year volatility in tax rates compared with

[23] The probability that the present value deadweight loss for the foreign equity scenario is greater than the Balanced portfolio (All NZ Bonds) scenario is 1.3% (0.6%).

the balanced budget strategy.[24] As the stock of assets accumulates under the tax smoothing strategies, return volatility contributes more to volatility in the operating balance, leading to an increase in tax rate volatility over time. This is particularly the case for the foreign equity scenario, where tax rate volatility trends upwards.[25] This upward trend could be stemmed by dynamically adjusting the composition of the portfolio as it increases in size. For example, investing primary surpluses entirely in foreign equities until 2025/26, and then shifting to a balanced portfolio over a 10-year transition period, stifles the growth in year-to-year tax rate volatility in relation to the foreign equity strategy (see "Dynamic Port" scenario in Figure 11).[26]

Figure 11: Volatility of Individual Tax Rate Changes for Various Portfolios



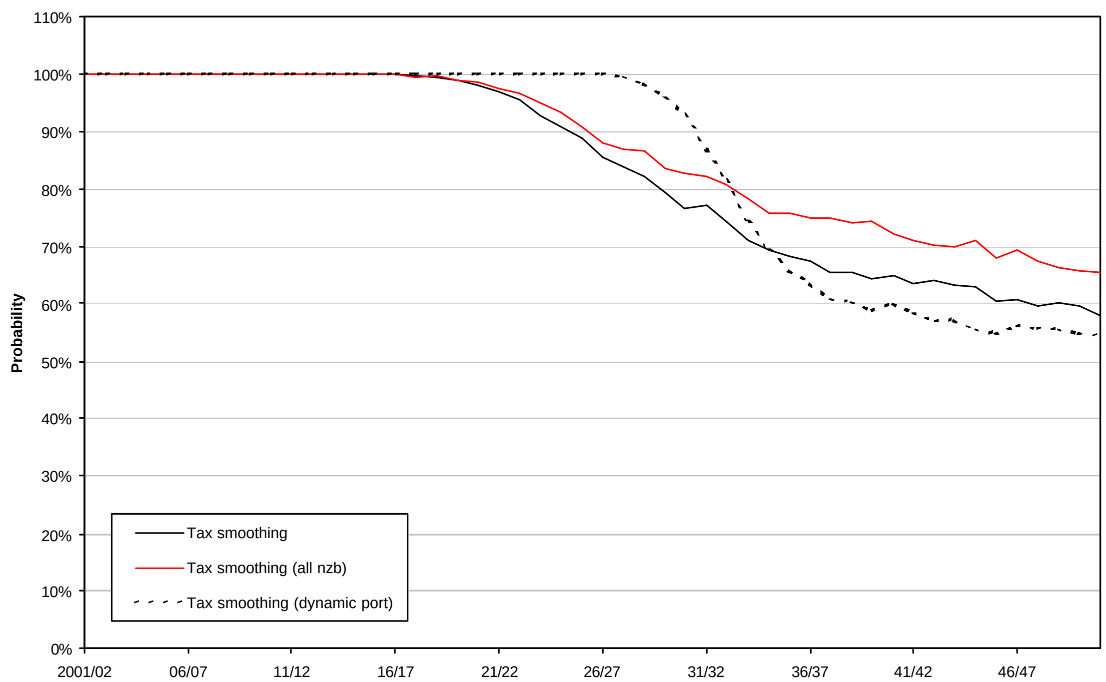
Another consideration is that, by the end of the projection period, the median tax smoothing tax rates are considerably below the balanced budget tax rate, particularly for the foreign equity strategy. This raises the question of whether it is better to have a

[24] Much of the volatility in tax rates under the balanced budget strategy can be eliminated by smoothing over a very short time-frame (see "Tax Smoothing (3 yr)" in Figure 12).
[25] Note that by 2050 the size of the foreign equity portfolio has almost peaked so that this upward trend in volatility would be expected to flatten off after this point.
[26] This strategy generates present value deadweight loss savings of 6% of GDP over balanced budget.

less volatile but higher tax rate or a more volatile but lower median tax rate. To illuminate this trade-off, we consider the probability that the Foreign Equity tax rate is lower than the NZ Bond and Balanced portfolio tax rates.

Figure 12 shows that this outcome is almost certain for the next sixteen years. After that, the volatility of the large and growing foreign equity portfolio leads to some adverse outcomes. Consequently, the probability that the Foreign Equity tax rate will be lower falls to 65.3% for the NZ Bond portfolio and 58.0% for the Balanced portfolio. Adopting the dynamic allocation strategy lowers that probability even further by the end of the period. These results highlight the potential for significant one-off adverse outcomes associated with the Foreign Equity strategy, and convey the sensitivity of the tax smoothing calculation to initial conditions.

Figure 12: Probability the All Foreign Equities Smoothed Tax Rate is Higher than Alternative Smoothed Tax Rates



Conclusion

The purpose of this section was to consider the effect of alternative modelling assumptions on the estimated deadweight loss savings from tax smoothing. We have seen that the savings are particularly sensitive to the discount rate. To a lesser extent they are also sensitive to the investment strategy, the elasticity of labour and the expense growth assumptions. The conclusion that tax smoothing offers significant benefits over balanced budget is robust to sensitivity testing.

Practical Limitations to Tax Smoothing

Having established that the efficiency gains from tax smoothing are potentially significant, we must consider practical obstacles that might prevent its implementation or substantially erode the expected efficiency gains.

One argument employed by critics of tax smoothing is that, given the high frequency of small tax changes, it would be impossible to implement in practice. For example, the lead-time required to change income tax rates extends to some months. There are also administrative costs associated with implementing a change to the tax regime and the additional economic uncertainty to consider. While these are valid criticisms, we have shown that the need to change tax rates frequently is not unique to tax smoothing. Almost by definition, a balanced budget strategy will require frequent changes to tax rates. These considerations suggest placing a limit on the frequency of tax changes.

We implement this approach using a frequency of three years.[27] This has the effect of converting tax rates into a step-wise function. The results are as follows:

Table 8	**Median Deadweight loss (with three year tax change frequency)**	
Financing strategy	**(% GDP)**	**Saving over 3yr Tax Smoothing (%GDP)**
Tax smoothing (3yr fixed horizon)[28]	67	N/A
Tax smoothing	64	2.9

The savings are basically the same. As expected, the volatility of tax rate changes has increased (due to the lower frequency of changes). However the increased volatility of three year tax smoothing (over balanced budget) is proportionately lower, since this financing strategy benefits from smoothing short-run shocks to GDP.

[27] Three years is chosen to be consistent with the length of the electoral cycle.
[28] It makes sense to use a three year tax-smoothing horizon as the base case (ie, balance the budget across the interval that taxes are fixed). In practice, using a year-on-year balanced budget approach this way is unstable since the underlying expenditure path is not constant.

Another consideration is that the informational requirements for tax smoothing are huge. There may be an option value in waiting due to the cost of getting it wrong (ie, maintaining taxes now to finance an expected expenditure profile that doesn't grow as expected comes at a high cost). Furthermore, as Jensen and Nielsen (1995) point out, "even if the government's time horizon is long, it might be tempted to enjoy the short-term benefits from the reduced pressure on public expenditures during the 'breathing space' period" (p, 10). We model this latter scenario, assuming that the government operates a balanced budget until the baby boomers start to retire in 2010. Table 9 suggests that, while waiting till 2010 before implementing tax smoothing requires a much greater upwards adjustment in tax rates, the deferred tax smoothing strategy still generates a welfare gain relative to balanced budget.

Table 9 **Financing strategy**	**Median Deadweight loss**	
	(% GDP)	**Savings over Balanced Budget (%GDP)**
Balanced budget	67	N/A
Tax smoothing (delay)	66	1.0

Another reason that has been put forward against tax smoothing is the negative relationship between tax rates and GDP growth rates. While we have modelled an effect of this sort, through the substitution effect on the labour supply, the possibility remains that we have underestimated the adverse effect of tax rates on growth. A recent OECD study on the relationship between taxation and economic performance concluded that the increase in the weighted-average tax rate of about 10 percentage points over the past 35 years has been accompanied by a 0.5 percentage point reduction in the average annual rate of economic growth (OECD, 1997).

Another point to note on the feasibility of tax smoothing is the issue of time-inconsistency. Realising the efficiency gains from tax smoothing relies on future governments' commitment to the strategy. However, in a political environment where support for a tax smoothing strategy is divided, a change in government can lead to a costly change in strategy. This problem is likely to be particularly acute in the first few years, especially if the financial asset portfolio performs poorly.

Even after a few years, the policy will remain vulnerable if political decision-makers abandon the pre-funding strategy to pursue some other objective (eg, tax cuts).

However, the welfare costs of abandonment are likely to increase through time and an electorate cognisant of that fact may constrain the options of political decision-makers. In this sense, tax smoothing might become more entrenched as time goes on, assuming it gets over the hurdle of the first few years.

There is a final practical consideration that deserves more serious consideration: the critical assumption of exogenous government expenditure. Pinfield (1998) argues that tax smoothing would be undermined "if the period of operating surpluses were to trigger higher expenditure than would otherwise be the case – 'expenditure creep' in other words" (p. 1). Historical evidence suggests that the level of inefficient public spending and investment rises when public finances are healthy (see Bohn (1991) and Alesina and Perotti (1995)).

Since tax smoothing involves the accumulation of financial assets, it is possible that future governments might increase expenditure simply because they feel wealthier. Similarly, a future government may alter its investment strategy to pursue welfare objectives (Davis, 1998). The extent to which this sort of behaviour will occur depends on the time-consistency of the government's financing strategy and the strength of its governing institutions. Even with strong institutions, however, some form of expenditure creep is likely.

To demonstrate the effect of expenditure creep we introduce a simple linear rule that ties government expenditure to the level of financial assets held by the government. Endogenous government expenditure is modelled by:

$$G_t^{adj} = e_t G_{t-1}^{adj} + \delta \max(P_{t-1}, 0)$$

where G_t^{adj} is adjusted government expenditure;

P_t is the operating balance excluding portfolio returns;

e_t is the (deterministic) forecast growth rate in government expenditure; and

δ is the responsiveness of government spending to changes in net wealth.

Under this formulation, expenditure creep represents a permanent shift in the level of government expenditure. Furthermore, expenditure creep ceases to be an issue beyond the point at which the portfolio peaks. This is because it is increasing in wealth but always non-negative. Somewhat arbitrarily, we set δ equal to 10%.[29] The results of modelling are presented in Table 10. The main result is that expenditure creep is sufficient to completely erode the efficiency gains of the tax smoothing strategy.

Table 10 **Financing strategy**	**Median Deadweight loss (with expenditure creep)**	
	(% GDP)	**Savings over Balanced Budget (% GDP)**
Balanced budget	67	N/A
Tax-smoothing	81	-13.7

Conclusions

We have addressed the question, from the perspective of economic efficiency, of whether to smooth tax rates or run a balanced budget in face of a large demographic-driven increase in public expenditure. While all modelling exercises of this type must be interpreted with caution, we believe that our results have meaningful implications for the debate on long-term fiscal policy. First, we find significantly higher welfare benefits from tax smoothing compared with previous studies. Second, realising the welfare gains from tax smoothing relies heavily on achieving a credible long-term commitment to the tax smoothing strategy, particularly to maintaining tight budgetary control in the presence of a very strong balance sheet. Expenditure creep, in particular, has the potential to completely erode the efficiency gains from tax smoothing.

[29] Whether or not δ=10% is a reasonable assumption is, in our view, a completely open question. Intuitively, it would depend on the quality of both the fiscal and political institutions. To our knowledge, little empirical or quantitative work has been done in this area.

Appendix One

Assumptions for Stochastic Simulations

The stochastic simulations were based on 1000 50-year scenarios for each of: labour productivity growth; New Zealand bond returns; New Zealand equity returns; foreign bond returns; and foreign equity returns. All series were modelled in nominal terms but, since CPI is deterministic in our fiscal model, the implicit assumption is that the real series are stochastic. The series were modelled as jointly-dependent normally distributed variables with the following population parameters:

Variables	**Mean**	**Standard Deviation**
Labour Productivity Growth (LPG)	3.0%	1.9%
New Zealand Bond Returns (NZB)	7.0%	4.6%
New Zealand Equity Returns (NZE)	8.6%	17.1%
Foreign Bond Returns (FBD)	6.7%	10.4%
Foreign Equity Returns (FEQ)	12.5%	14.9%

Correlation Coefficients[30]	LPG	NZB	NZE	FBD	FEQ
LPG (GDP)[31]	1.00	0.22	0.32	-0.16	0.03
NZB	0.22	1.00	0.11	0.34	0.06
NZE	0.32	0.11	1.00	-0.24	0.41
FBD	-0.16	0.34	-0.24	1.00	0.18
FEQ	0.03	0.06	0.41	0.18	1.00

The parameters represent the sample means, standard deviations and correlation coefficients for representative series[32] over the period 1991:Q1 to 2001:Q3. There is one exception: the return on foreign bonds was adjusted downwards by two percentage points to be lower than the return on New Zealand bonds.

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[30] The balanced portfolio has a correlation of 0.17 with LPG and has a mean return of 8.7% and standard deviation of 7.5%.

[31] Since LPG is the only stochastic input that affects GDP growth, the volatility of LPG (and the correlations with other series) represents the volatility of GDP growth. For this reason, we used a nominal GDP series to derive the volatility and correlations of the LPG series. Hence, the volatility and correlation parameters should be interpreted as relating to GDP rather than LPG.

[32] All series means were measured in real terms and increased by 1.5% to obtain nominal values. The representative series are Statistics NZ nominal GDP and the MSCI gross return indices for NZ (3-5 yr) bonds, NZ equities, World Sovereign bonds (3-5 yr), and World equities.

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