Three Policy Options for Crown Financial Policy

Eric Hansen

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AUTHOR

Eric Hansen
New Zealand Treasury
PO Box 3724
Wellington
NEW ZEALAND

Email information@treasury.govt.nz
Telephone 64 4 472 2733
Fax 64 4 473 0982

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NZ TREASURY

New Zealand Treasury
PO Box 3724
Wellington 6008
NEW ZEALAND

Email information@treasury.govt.nz
Telephone 64-4-472 2733
Website www.treasury.govt.nz

Abstract

Crown financial policy is concerned with how the government manages the Crown's assets and liabilities. The recently established New Zealand Superannuation Fund, which is projected to grow to around 45% of GDP over the next few decades, highlights that Crown financial policy is likely to become an important economic policy tool with potentially significant implications for New Zealand economic welfare.

Previous work has identified that four objectives should form the main basis for assessing alternative Crown financial policies. Three of the objectives relate to minimising distortionary taxation, time-inconsistency of policy and agency cost of government. However, the absolute and relative importance of these objectives is subject to considerable uncertainty. The fourth objective, which is to avoid exacerbating any existing inefficiencies or creating any new ones, is considered part of the baseline common to all policies.

In this paper a qualitative analysis is conducted to select three high-level policies for detailed quantitative analysis in future papers. The three policies vary in terms of level of risk:

- A low risk policy that places emphasis on time-consistency and agency cost issues while down-weighting the significance of distortionary taxation;
- A medium risk policy that applies a balanced weighting to the three issues; and
- A high risk policy that places emphasis on distortionary taxation while down-weighting time-consistency and agency cost.

Detailed policy targets are specified for the candidate policies in terms of Crown net worth, overall risk/return properties of the Crown balance sheet, and the level and structure of financial assets and public debt. The policy targets under the status quo are presented for comparative purposes.

JEL CLASSIFICATION E61
H11
H63

KEYWORDS Agency cost of government; Bayesian decision theory; comparative institutional method; Crown balance sheet; public debt management; distortionary taxation; time-inconsistency of policy

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Three Policy Options for Crown Financial Policy

1 Introduction

Crown financial policy specifies how the government manages the Crown's assets and liabilities.[1] Policy analysis in this area is concerned with how the structure and size of the Crown balance sheet could affect the decisions of citizens in managing their own wealth portfolios and government decisions on fiscal and other economic policies.

The practical effect of movements in the Crown balance sheet was evident in the Crown Financial Statements for 2002/03. Due to accrual accounting, a partial revaluation of the Crown balance sheet in 2002/03 reduced the government's operating surplus from $4 billion to $1.4 billion. This adjustment amounted to around 6% of Core Crown revenue.[2]

Crown financial policy is likely to become progressively more important over time as the recently established New Zealand Superannuation Fund accumulates financial assets equivalent to 45% of GDP or around $56 billion in current terms.[3] If these funds accumulate as projected, then a 10 basis point (or 0.1%) improvement (decline) in annual returns at the same risk level would confer a net present value gain (loss) to New Zealand of around $1 billion (at 5% discount rate).

Hansen (2003) organises the theoretical literature within a policy framework to identify specific objectives, targets and instruments associated with the main theories.[4] The paper views the Crown balance sheet as a policy instrument and identifies seven potential objectives to which Crown financial policy could be targeted.

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[1] This paper uses the term Crown financial policy to mean government policies relating to the management of the Crown's aggregate balance sheet. The Crown balance sheet includes the Crown's ownership interest in state-owned enterprises and other central government assets and liabilities meeting Generally Accepted Accounting Practice (GAAP) but excludes Local Authority assets and liabilities. A wider definition of Crown financial policy would include measurement issues, financial reporting and performance and accountability issues but these are excluded for the purposes of this paper.

[2] See Crown Financial Statements at http://www.treasury.govt.nz/.

[3] McCulloch and Frances (2001) describes the New Zealand Superannuation Fund.

[4] The Treasury has conducted research on Crown financial policy in one form or another since at least the mid-1990s. Skilling (1997) and Davis (2001) summarise and develop the literature relevant to Crown financial policy, while Grimes (2001) discusses the operational objectives and practices relevant to managing the Crown's balance sheet. Empirical analyses by Huther (1998), Fabling (2002) and Davis and Fabling (2002) have found tentative evidence that it may be possible to improve the performance of the Crown balance sheet. International contributions include Bohn (1990, 1995), Chari, Christiano and Kehoe (1994), Leong (1999), Lucas and Stokey (1983), and Missale (1997, 1999).

The objectives considered most important related to distortionary taxation, time-inconsistency of policy and agency cost of government. A fourth objective, called "downside efficiency risk", relating to the need to avoid exacerbating existing inefficiencies or creating new ones, was also identified as relevant to the setting of policy targets. Section 2 provides a summary of these objectives and associated policy targets.

Purpose

The purpose of this paper is to fashion the above objectives into several alternative policies suitable for future quantitative analysis. In essence, the paper looks ahead to consider how policy makers would be likely to choose between alternative policy options and the requirements they would have. The aim is to provide direction to ensure Treasury's future research is focussed on producing evidence relevant to policy decisions and avoid spending resources on comparing policies that actually would not be implemented.

The approach adopted in this paper draws from Coase's comparative institutional method and Bayesian decision theory. The comparative institutional method emphasises that policy analysts should avoid comparing real world policy proposals (which necessarily are imperfect) against idealised textbook models. Rather, any policy proposal should be compared against the counterfactual of what would be most likely to happen in the absence of the proposed policy.

A critical fact is that the choice between policy options will be made in a world of uncertainty. Irrespective of how much research is undertaken, policy makers will be faced with considerable uncertainty about the true model of the economy and therefore the relative importance of distortionary taxation, time-inconsistency of policy and agency cost of government. Recognising these uncertainties, a detailed qualitative analysis of alternative policies is conducted based on Bayesian decision theory.

Structure

The structure of the paper is as follows. The next section (Section 2) provides brief descriptions of the main policy objectives identified in Hansen (2003) and the detailed policy targets implied by these objectives. Section 3 discusses the framework adopted in this paper based on comparative institutional and Bayesian decision theory. Section 4 applies the framework to select three high-level policies representing low, medium, and high risk. Section 5 specifies the three candidate policies in terms of the policy targets that would apply in each case. Conclusions are presented in Section 6.

2 Objectives and targets

This section summarises the study of objectives, targets and instruments in Hansen (2003) and discusses potential conflicts between targets. The status quo policy is also discussed for comparative purposes.

2.1 Main objectives

The study in Hansen (2003) concluded that four objectives should inform the design of policy options for Crown financial policy. This section concludes that for the purposes of this paper the focus should be on three objectives – relating to distortionary taxation, time-consistency and agency cost – and that downside efficiency risk (the fourth objective) may be considered part of the baseline common to all candidate policies.

Distortionary taxation

Taxes, due to their involuntary nature, 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 and creates a deadweight loss. A possible policy objective is to minimise the deadweight losses of taxation subject to satisfying the Crown's inter-temporal budget constraint (IBC).[5]

A clear conclusion from all tax smoothing models studied is that all diversifiable risk should be eliminated. Minimising deadweight losses also implies smoothing of the tax rate over the economic cycle and pre-funding of an anticipated permanent increase in government spending (called deterministic smoothing).

Other possible policy targets are conditional on particular assumptions:

- If citizens are fully rational and not constrained by imperfect capital markets, policy should target the minimum-variance portfolio, i.e. in addition to eliminating diversifiable risk, policy should minimise systematic risk up to the maximum extent permitted by available instruments.[6]

[5] The inter-temporal budget constraint requires that at any date the sum of net worth as at that date plus net present value of future tax revenue be greater than or equal to the net present value of future government spending.

[6] If citizens do not alter their portfolios optimally in response to changes in the Crown portfolio, the appropriate policy may involve targeting a level of systematic risk greater than the minimum feasible level. The systematic risk of a portfolio is the risk that cannot be avoided by diversifying the portfolio across the risky assets available in the (global) economy, so that returns on the portfolio will vary with the economy (Copeland and Weston 1988). The systematic risk of a portfolio can be altered by increasing or decreasing the proportion of the portfolio invested in the safe asset (proxied by government bonds).

- If markets are incomplete then policy should consider building a positive Comprehensive Net Worth (CNW)[7] balance to protect against unhedged risks. This policy conclusion applies if innovations in consumption and the tax rate are negatively correlated.

- If high levels of debt would attract an unjustified premium for default risk, an upper bound on gross debt (or on particular debt instruments) should be applied.[8]

Column 2 in Table 1 (page 6) summarises these results.

Time-consistency

Any government with nominal debt outstanding has an incentive to take actions that reduce the real value of debt. Possible mechanisms are unexpected inflation, unexpected increases in capital income taxes, or repudiation. Therefore, a possible objective for Crown financial policy is to structure the Crown balance sheet to minimise the risk of creating unstable fiscal and monetary policies.

The objective implies that an upper bound be set on nominal debt to keep in check the incentives to reduce the real value of debt inappropriately (refer column 3, Table 1). Where the main risk is unexpected inflation (rather than new taxes or repudiation) the upper bound would be set on net local currency debt rather than across debt of all currency denominations. In this case, issuing debt denominated in foreign currencies and/or indexed to inflation and shortening the average maturity of debt also helps mitigate incentives for unexpected inflation.

A further concern is the risk of a refinancing crisis whereby investors collectively refuse to roll over maturing debt at reasonable interest rates. The policy response suggested in the literature is to set an upper bound on the volume of debt maturing in any year.

Agency cost

Public choice theory assumes that Crown decision-makers act in their self-interest. The theory predicts that politicians (and bureaucrats), due to the need to win votes, have an incentive to promote government spending and investment favouring their special interest group constituents, even if such expenditure is inefficient.[9] A possible objective for Crown financial policy could be to minimise the agency cost of government.

Mechanisms that limit the potential for policy makers to act contrary to the interests of citizens include constraining the size of the cyclically-adjusted operating surplus, limiting the build up of fungible assets, and maintaining net debt above a lower bound to create pressure against spending with low benefits (refer column 4, Table 1).

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[7] CNW is an economics concept that means the balance sheet includes the present value of future taxation revenue and the present value of the government's social obligations to citizens (Bradbury *et al* 1999). CNW is broader than the GAAP-based accounting definition of net worth as published in the Crown Financial Statements. It is recognised that available information may be insufficient to allow implementation on CNW basis and that actual policy implementations would likely be based on a narrower definition of the Crown balance sheet. However, CNW is useful for analytical purposes.

[8] A premium for default risk is "unjustified" if the country intends never to default under any circumstances (Bohn, 1995).

[9] This does not imply that all government expenditure is inefficient but rather that incentives may result in some inefficiencies.

Downside efficiency risk

Although a market failure may exist, the limitations of government may mean that policy action would not improve economic welfare. However, it would remain the case that the size and structure of the Crown balance sheet would impact on economic welfare. A relevant economic objective, therefore, is to avoid exacerbating any existing inefficiencies or creating any new ones.

The downside risk objective has three components. The first component relates to the role of tax smoothing as a risk management tool in circumstances where citizens lack the information, incentive, or capability to optimally manage their wealth portfolios. The policy implications are similar to the case of distortionary taxation.

The second component relates to the risk of the Crown being a large player in the local market, thereby distorting asset prices and possibly the governance of private sector companies. One approach would be to place an upper bound on the share or proportion of any asset held by the Crown.

The third component relates to the liquidity and risk-sharing benefits of an active secondary market in safe debt. To facilitate secondary market trading, the Crown should establish benchmark debt maturities and maintain volumes outstanding above a lower bound. This is consistent with the current policy of the New Zealand Debt Management Office.

These results are summarised in column 5 of Table 1.

Status quo

The status quo in Crown financial policy may be identified in legislation, government policy statements and the operating policies of key Crown financial institutions.[10] The main characteristics of the status quo policy are consistent with aspects of the distortionary tax objective. These include smoothing of the tax rate over the economic cycle, partial smoothing of future pension expenses through the NZ Superannuation Fund established in 2002, and the 30% upper bound on gross debt (refer column 1, Table 1). The latter is also consistent with the time-consistency objective.

Also consistent with time-consistency, the NZ Debt Management Office (NZDMO) places an upper bound on maturing debt of around $3.5 billion per annum to protect against confidence crises. Restrictions on Crown financial institutions (such as ACC, GSF and NZSF)[11] against taking a controlling interest in their investments and the NZDMO policy of maintaining benchmark securities are consistent with avoiding “downside risk”.

Focus on three main objectives

In the remainder of this paper the focus is on distortionary taxation, time-consistency and agency cost as the three main objectives. The fourth objective - downside efficiency risk - would be unlikely to prevent the other objectives being achieved.

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[10] Key legislation and policy statements are the Fiscal Responsibility Act 1994, annual Budget Policy Statements, New Zealand Superannuation Act 2001, New Zealand Super Fund’s Statement of Investment Intentions and Performance Objectives, and New Zealand Debt Management Office operating procedures. Carran (2003) discusses the status quo policy in detail.

[11] Accident Compensation Corporation (ACC), Government Superannuation Fund (GSF) and New Zealand Superannuation Fund (NZSF).

The two policy targets are the upper bound on the Crown's ownership share of assets and the lower bound on quantities of benchmark bonds. As discussed further in Section 5.1, these policy targets will form part of the "baseline" common to all candidate policies.

The third policy target relates to smoothing of tax rates to ensure the Crown portfolio does not contribute volatility when citizens lack the information, incentive or capability to manage their wealth portfolios. Rather than deal with this as a separate issue, it is put aside and dealt with implicitly along with the distortionary taxation objective.

Table 1 - Policy targets under status quo and four objectives

Targets	**Status quo**[12] (1)	**Distortionary taxation** (2)	**Time-consistency** (3)	**Agency costs** (4)	**Downside risk** (5)
Risk/return properties:					
Tax-smoothing over cycle	Full	Full	-	-	Full
Deterministic smoothing	Partial	Full	-	-	Full
Diversifiable risk	-	Minimise	-	-	Minimise
Systematic risk	-	Minimise[13]	-	-	Minimise
Net worth:					
Bound on cyclically-adjusted OB	-	-	-	Upper	-
Net worth buffer	-	Positive[14]	-	-	Positive
Financial asset structure:					
Bound on fungible assets	-	-	-	Upper	-
Bound on share of asset held	Upper	-	-	-	Upper
Debt structure:					
Bound on total debt (%of GDP)	≤ 30%	Upper[15]	Upper	Lower	-
Bound on debt maturing	< $3.5bpa	-	Upper	-	-
Bound on benchmark quantities	≥ $3b	-	-	-	Lower
Bound on average maturity	-	-	Lower[16]	-	-
Bound on inflation-indexed debt	-	-	Lower	-	-
Bound on net foreign-currency debt	Zero	-	Lower	-	-
Bound on floating rate instruments	20-30%	-	-	-	-

Note: The table is read from right-to-left. For example, "Full" in the first row of status quo column is read as "full tax-smoothing over the economic cycle. "Upper" means "upper bound on ….", implying that the target is expressed as an upper bound on the relevant variable. Similarly for "Lower".

[12] Under the status quo the policy targets relating to the $3.5 billion upper bound on debt maturing, $3 billion lower bound on benchmark debt and 20-30% target for floating rate instruments are specified for NZ dollar denominated debt. The upper bound on debt maturing excludes Treasury Bills. The target of zero net foreign-currency debt applies where the definition of net foreign-currency debt is gross foreign-currency debt net of foreign exchange reserves and NZDMO-managed foreign-currency assets.

[13] The target would be for greater than minimum variance in case where citizens are non-responsive and the government objective is to minimise expected deadweight losses.

[14] Positive balance applies if and only if negative correlation between tax and consumption, otherwise zero balance.

[15] Upper bound applies if economy subject to unjustified risk premia.

[16] Lower bound is contingent on breach of threshold on upper bound for total debt. Same for lower bounds on inflation-indexed and foreign-currency debt.

2.2 Conflicting targets

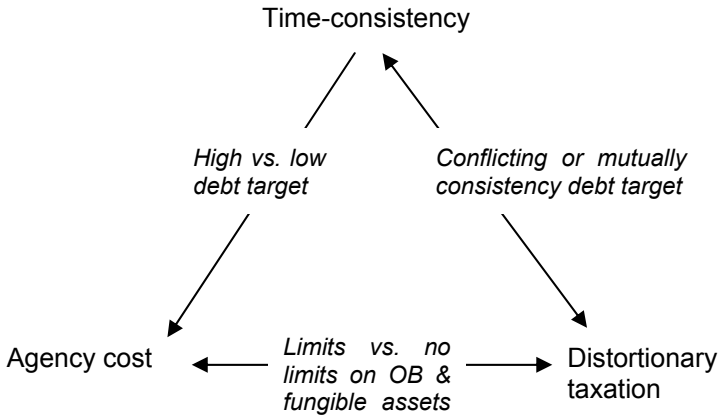
The three main objectives imply a range of targets could be adopted for the Crown balance sheet, some of which would be conflicting. The main conflicts are as follows (see Figure 1 below):

- the distortionary taxation and agency cost objectives tend to conflict over the setting of tax rates and hence the Operating Balance (OB) and accumulation of fungible assets. The distortionary tax objective subjugates the level of the Operating Balance and fungible assets to the needs of hedging risk (to smooth tax rates), whereas the agency cost objective implies the tax rate should adjust to limit operating surpluses and prevent any significant build up of fungible assets;

- the time-consistency and agency cost objectives tend to conflict over debt levels. The time-consistency objective implies low debt levels so that the risk premium is low or zero.[17] The agency cost objective implies high debt as a discipline on government spending; and

- the distortionary tax objective may or may not conflict with the time-consistency objective in terms of debt levels. The distortionary tax objective may reinforce the low debt target to the extent that high debt would lead to "unjustified" risk premia on sovereign debt. However, if unjustified risk premia do not occur at any level of debt then a policy aimed at smoothing tax rates may imply aggressive leveraging of the balance sheet to fund the acquisition of financial assets.

Figure 1: Conflicting targets



[17] The potential for conflict is reduced if the main risk is unexpected inflation (rather than new taxes or repudiation). In this case, time-consistency arguments imply an upper bound on net local currency debt, allowing scope to issue foreign-currency debt to limit agency cost. However, the risk properties of foreign-currency debt may conflict with the tax smoothing objective.

3 Framework for analysis

This section sets out a framework for identifying a small number of policy options for detailed quantitative analysis in future papers. The framework emphasises the need to conduct comparative institutional analysis and explicitly take into account uncertainty about the benefits and costs of different policy options.

3.1 Comparative institutional method

Standard economics texts teach that policy analysis should be conducted by deriving an optimal policy from an appropriately specified model. The rigours of formally deriving an optimal policy function requires that the model be highly stylised and omit important features and real world imperfections faced by policy makers. Most models omit transition issues and assume the policy maker knows the true structure and characteristics of the economy. Further, the optimising approach is not suitable in situations where the policy maker wishes to draw implications from two or more non-nested theoretical models.

These concerns are consistent with Coase (1964), who said that economists should always judge alternative arrangements as opposed to judging reality against some theory that is always bound to win. As Coase put it:

> *Contemplation of an optimal system may provide techniques of analysis that would otherwise have been missed and, in certain special cases, it may go far to providing a solution. But in general its influence has been pernicious. It has directed economists' attention away from the main question, which is how alternative arrangements will actually work in practice. It has led economists to derive conclusions for economic policy from a study of an abstract market situation. … Until we realize that we are choosing between social arrangements which are all more or less failures, we are not likely to make much headway.* (Coase, 1964, p.194-5)

In commenting on Coase's approach to economic policy making, Gorringe (1992) considered that Coase's concerns were aimed at those who do not think about or model the alternatives in an even-handed way. Gorringe gave the example of basing policy advice on an analysis of market failure without considering government failure (and *vice versa).*

The aim of comparing "real with real" does not imply that the traditional approach has nothing useful to offer. Rather, as indicated at the beginning of the quote above, the optimising approach retains an important role. Critical insights from the various models serve as important inputs to identifying and formulating candidate policies.

The comparative institutional method has direct application to Crown financial policy. Hansen (2003) shows that the economic models relevant to Crown financial policy derive from a wide range of theory literatures, including theories of optimal public debt management, time-consistency of fiscal and monetary policy, and the principal-agent approach to public sector management. The models are non-nested and their stylised nature ignores key uncertainties faced by policy makers.

Consistent with the comparative institutional method, the approach adopted in this paper is to identify three policy options that could potentially be put to the government for

consideration. A key priority is that these policy options should be "implementable", rather than strictly optimal in terms of any one theoretical model of Crown financial policy.

3.2 Uncertainty and policy making

Policy makers are inevitably faced with making decisions under considerable uncertainty. Gorringe (1991) considered that uncertainty about how the world really works is great because:

- economies are large and complex systems;
- the structure of relationships within economies has limited stability through time;
- often unpredictable human action is involved;
- the use of controlled experiments is generally not possible;
- the quantity and quality of the available data is limited; and
- the tools of economic theory and econometrics are limited.

These uncertainties are especially relevant to areas of theoretical policy that have limited history of application. In contrast to monetary and fiscal policy, where many aspects have evolved into reasonably stable operating principles and practices, Crown financial policy is largely untried in practice.[18] Consequently, policy makers face considerable uncertainty about how alternative Crown financial policies would impact on economic welfare. These uncertainties are likely to remain large for the foreseeable future irrespective of how much empirical research is untaken prior to initial implementation.

Limitations of standard statistical inference

Most published research adheres to a standard statistical methodology for dealing with uncertainty that involves a 'null' hypothesis and an 'alternative' hypothesis. The null hypothesis is that the variable of interest has no impact. Typically, the alternative hypothesis is rejected in favour of the null hypothesis unless the relevant parameters are different from zero at the 5% level of significance. It has been recognised since at least the 1960s that this method, known as the Neyman-Pearson theory of statistical inference, is inappropriate for policy decisions (Blaug 1992 pp. 21-3).

[18] Two exceptions are policies relating to tax smoothing over the economic cycle and debt management (the latter becoming established in New Zealand during the 1990s). However, in broader terms, the risk/return properties of the Crown balance sheet have evolved as a residual of other policies rather than as an explicit policy.

The key problem with the Neyman-Pearson method is that it assumes the cost of falsely rejecting the status quo (the null hypothesis) is an order of magnitude larger than the cost of falsely rejecting the competing proposal (the alternative hypothesis).[19] While this assumption may be appropriate for guiding the progress of science, for policy (and other decisions) the relative magnitude of costs often are more balanced. To provide a sound basis for policy to maximise economic welfare, it is necessary to estimate of the costs and benefits arising under various scenarios and the probabilities of those scenarios, occurring. Blaug (1992 pp.21-3) and Gorringe (1991, 1998) discuss these issues in more detail.

An example where the inappropriateness of statistical inference for policy making has been taken seriously is the literature on monetary policy under model uncertainty. The monetary policy literature assesses the performance of alternative policy reaction functions in circumstances where the "true" model of the economy is different from that specified in the reaction function.[20]

Bayesian decision theory

In addition to comparative institutional analysis, we adopt a version of Bayesian decision theory. In essence, the Bayesian approach is an application of standard micro-theoretic decision making under uncertainty where the decision maker's objective is to maximise expected utility.[21] A key assumption in the Bayesian approach is that the decision maker can assign a subjective probability to every potential outcome.[22]

To develop notation for later use, consider a policy option (PO) that is an alternative to the status quo (or another policy option). The policy maker must decide whether to implement the policy option or retain the status quo in the face of uncertainty about the true nature of the economy. A decision to implement is indicated by placing a high weight (denoted "H") on the policy option, whereas a decision to retain the status quo is indicated by placing a low weight ("L") on the policy option.[23]

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[19] A second problem is that in applications the null hypothesis usually specifies the variable of interest as having "zero coefficient". The statistical test conducted is whether the coefficient is zero (null hypothesis) or non-zero (alternative hypothesis). However, in most policy decisions the relevant test is whether the coefficient is less than or equal to zero versus positive.

[20] See, for example, Christodoulakis, Kemball-Cook and Levine (1993) and Onatski and Williams (2003) for general discussions and Conway *et. al.* (1998) and Drew and Hunt (1999) for analyses relevant to monetary policy in New Zealand.

[21] Descriptions of Bayesian decision theory and applications are available in Cyert and DeGroot (1987), Gorringe (1991, 1998), Hirshleifer and Riley (1992), Rhodes (1994), and Silvey (1975).

[22] Knight (1920) distinguished between risk and uncertainty on the basis of the existence of numerical probabilities. He defined a state of uncertainty as existing for an event when no numerical probability or frequency of the event occurring can be assigned. In contrast, a state of risk exists when a numerical probability can be assigned. Bayesian decision theory is based on the view that every event can be assigned a subjective probability by the decision maker, so that no distinction is made between risk and uncertainty.

[23] In Section 5 the high and low weights correspond to the assignment of different values to policy targets. A high weight corresponds to assigning values to the relevant policy targets at the conservative end of plausible values, implying strong constraints on the Crown balance sheet, while a low weight corresponds to assigning values that imply weaker constraints. The approach is flexible in that the values assigned could represent the long-term direction of policy (as assumed in Section 5) or could be small changes from the status quo for the purpose of conducting marginal analysis of the next step along a transition to the long-term policy target. Also, the assumption of two states and two policy choices is a simplification. The references in Footnote 21 provide more general analyses where the state space and decision choices are continuous.

Suppose that the "correct" decision depends on whether the true impact of the policy action exceeds a threshold value. If the impact exceeds the threshold it is called economically significant ("s") and the policy option should be implemented. If the impact is less than the threshold it is called economically insignificant ("i") and the status quo should be retained. The policy maker does not know whether the impact would be significant or insignificant but has formed a probability distribution over the true states, s and i.

There are four possible outcomes:

- *True Positive (TP)* The impact is significant (s) and the policy maker correctly assigns high weight (H); or
- *False Negative (FN)* The impact is significant (s) but the policy maker incorrectly assigns low weight (L); or
- *True Negative (TN)* The impact is insignificant (i) and the policy maker correctly assigns low weight (L); or
- *False Positive (FP)* The impact is insignificant (i) but the policy maker incorrectly assigns high weight (H).[24]

Let the payoffs for the scenarios be random variables $\tilde{V}_{TP}$, $\tilde{V}_{FN}$, $\tilde{V}_{TN}$ and $\tilde{V}_{FP}$.

The structure of the decision and possible outcomes are illustrated in Figure 2 below, where the dashed oblong indicates the policy maker (P) does not know whether the true state is 's' or 'i'. The true state is thought of as being determined by nature (N).

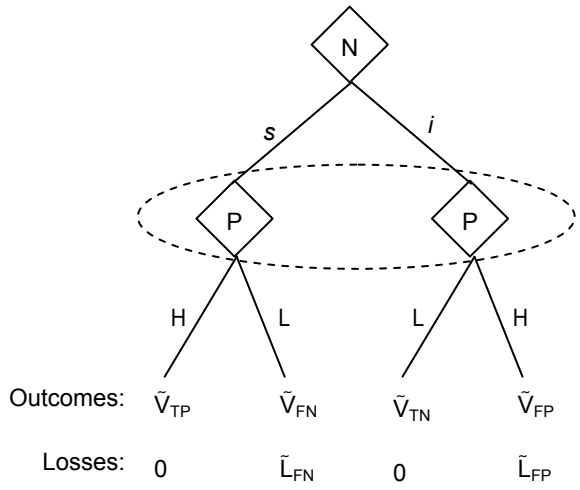
A property of a decision structure of this nature is that attention can be restricted to the false positive and false negative decision errors. This is achieved by defining the loss from a decision error as the value forgone relative to the correct decision.[25]

Bayesian decision theory assumes there exists a utility function that represents the decision makers' risk preferences over losses incurred under false positive and false negative errors. Consistent with standard micro-economic theory, the optimal decision is to implement the policy option if and only if the expected utility of losses under implementation is less than the expected utility of losses under the status quo.

[24] In statistical theory the false positive is called a Type I error and the false negative is called a Type II error. The former error is the decision to reject a null hypothesis that is in fact true while the later error is the decision to accept a null hypothesis that is in fact false.

[25] The losses are defined as $L_{FN} = V_{TP} - V_{FN}$ and $L_{FP} = V_{TN} - V_{FP}$.

Figure 2: Decision structure facing policy maker



Application to public policy

The practice of applying Bayesian decision theory to public policy needs to take into account that the policy analyst conducting the analysis is not the same person as the policy maker. In particular, the policy analyst is unlikely to know the policy maker's prior probability beliefs and utility function (i.e. degree of risk aversion). One approach for overcoming the information gaps could involve surveying the policy maker's prior beliefs and risk preferences and then proceeding to derive the optimal decision.

Another approach, adopted in this paper, would involve the policy analyst presenting to the policy maker a menu of policy options that differ in their risk levels. The policy maker would compare expected loss and measures of risk across policy options, and would choose the policy with risk/return properties that best meets his or her preferences.

The policy options may be ordered from low to high risk, drawing out an efficient frontier of policy options, as illustrated in Figure 3 below. Policy options lying inside the frontier would be dominated and could be discarded.

If the policy maker's preferences are transitive, the most desired policy option may be identified through a sequence of pair-wise tests where the policy maker assesses whether the incremental benefit offered by policy option 'n' relative to policy option n-1 is outweighed by the increased risk:

Policy Option 2 tested against Policy Option 1, i.e. Test: $PO_2 \leq PO_1$

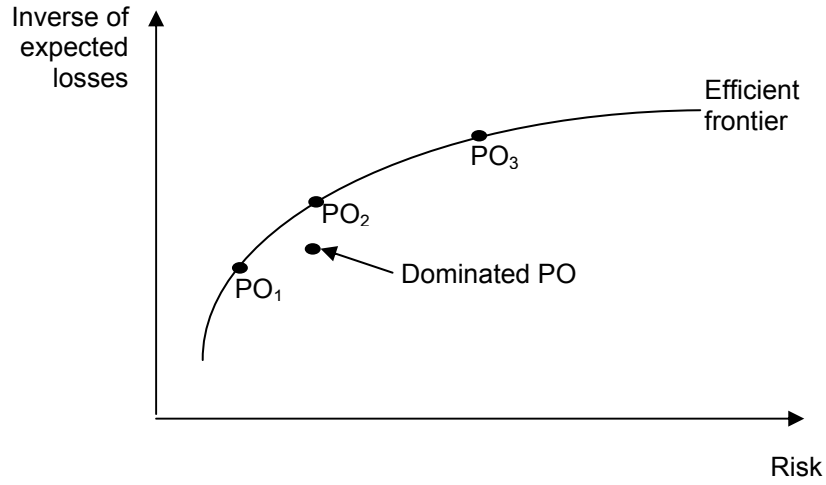
Policy Option 3 tested against Policy Option 2, i.e. Test: $PO_3 \leq PO_2$

…

Policy Option N tested against Policy Option N-1, i.e. Test: $PO_N \leq PO_{N-1}$,

where "≤ " is read as meaning "less preferred than".

Figure 3: Efficient policy frontier



3.3 Qualitative risk assessment

A full evaluation of the risk properties associated with each policy would require the conduct of comprehensive empirical research. The purpose of this section is to identify qualitative indicators to distinguish risk levels in broad terms in advance of more detailed empirical analysis.

Average, variance and worst-case losses

A risk averse policy maker would be concerned about the probability of a decision error, the average loss and range of losses possible if such an error did occur. Relevant considerations would include the degree of uncertainty about the level of losses and the magnitude of 'worst-case' losses.

Persistence vs. reversibility

The policy decision may or may not be subject to future review. A policy where a decision error would be revealed early in the post-implementation period and which could be reversed quickly and at low cost normally would be less risky than a policy that would be irreversible or reversible only slowly and at high cost.

An example of the difference is provided by the different roles of the Commerce Commission in Mergers & Acquisition applications versus some other regulatory functions. M&A decisions are clearly irreversible while decisions whether or not to impose price regulation are reversible. In addition, a decision to impose price regulation may stifle the release of further information about the competitiveness of the market whereas a decision to not impose price regulation has the advantage of allowing further observations about competitive conditions and thus whether regulation is warranted.

Monetary policy, where decisions on the Official Cash Rate are made six-weekly, is another example where policy decisions are made under considerable uncertainty but have the benefit of being reversible.

Combinations of objectives

In the case of multiple objectives, the impact of placing high or low weight on each objective depends on which other objectives are included in the policy. For example, in the case of Crown financial policy, a policy that places high weight on both tax-smoothing and agency cost would have quite different implications than if either objective received high weight alone. The former policy is balanced in the sense of creating countervailing incentives for and against the build up of financial assets, while the other policies that place high weight on one objective would result in a more extreme balance sheet structure. Thus, in most cases, the risks associated with an objective can be evaluated only by taking into consideration the other components of policy.

Implementation risk

Proposed policy options must be capable of being implemented without undue risk. One source of implementation risk arises when the policy is based on a model that assumes decision makers have more information and better capability to interpret that information than would actually be the case. This concern with implementation risk is consistent with Coase's dictum noted above that economists should always judge alternative arrangements as they would actually operate.

Voter misperception risk

Voter misperception risk is defined as the risk that an economically desirable decision leads to outcomes that the public perceives as a mistake. For example, in the case of Crown financial policy, a desirable hedging strategy could lead to outcomes where the market value of Crown financial assets were revised downward by (say) $5 billion as an offset to upward revaluation in the tax asset. Because the Operating Balance would include the downward revision in the financial asset but exclude the increase in the tax asset, the public may view the outcome as reflecting poor economic management by the government of the day. Misperception risks drive a wedge between the interests of policy makers (as agents) and the public (as principals), potentially causing desirable policy to be over-turned in favour of a false positive or false negative position.

4 Assessment of policy options

This section applies the framework developed above to conduct a qualitative assessment of stylised policy options available for Crown financial policy. Eight policies are identified and assigned either to the low, medium or high risk category (Appendix II provides the detailed qualitative analysis in support of these assignments). From each risk category, one policy option is chosen as warranting detailed empirical analysis.

The section begins with an outline showing how the framework is applied to Crown financial policy issues. This is followed by a discussion of key judgements made and then an analysis of each risk category.

4.1 Multiple objectives

The framework developed in Section 3.2 considered the case where the policy choice is defined by a single variable. The analysis assumed that the policy maker chooses whether to place high ("H") or low ("L") weight on the proposed policy in face of uncertainty about whether the impact on economic welfare would be significant ("s") or insignificant ("i"). The application to Crown financial policy involves extending the framework to a multi-variate analysis. This reflects that the Crown balance sheet may impact on economic welfare through three main channels:

- Deadweight losses caused by the average level and variability of the tax rate;
- Higher debt servicing costs and reduced investment due to greater uncertainty (and losses caused by confidence crises) that could result if monetary or fiscal policy became time-inconsistent; and
- Inefficient forms of government expenditure arising as a result of the principal-agent relationship between government and citizens.

Both the absolute and relative magnitudes of these effects are subject to considerable uncertainty. In the following the true state or "true model" of the economy is described by the vector (x, x, x), where each "x" may be significant (s) or insignificant (i). For example, the state vector (s, i, i) would indicate that tax smoothing is economically significant but losses due to time-inconsistency and agency cost are insignificant.

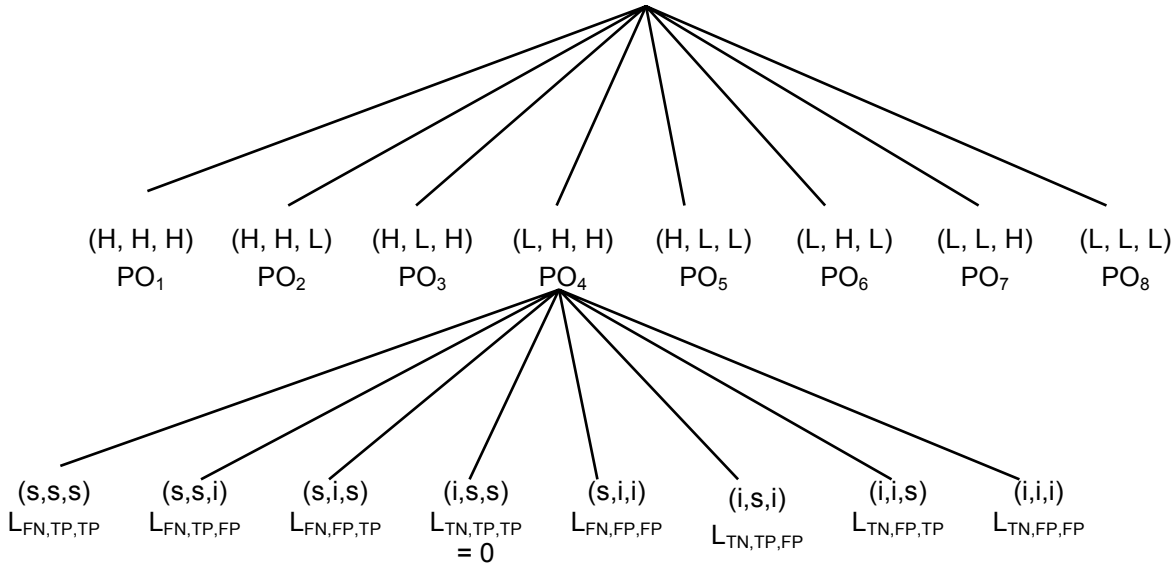
Similarly, policy is described by the vector (X, X, X) where each "X" may be high (H) or low (L) weight. For example, the policy option (H, L, L) would indicate high weight on policy targets aimed at tax smoothing and low weights on policy targets to mitigate time-inconsistency and agency cost. This structure gives rise to eight (= 2^3) possible policy options, as listed in Table 2.

Table 2 - Available policy options

Policy Options	Distortionary taxation	Time-consistency	Agency cost
1	H	H	H
2	H	H	L
3	H	L	H
4	L	H	H
5	H	L	L
6	L	H	L
7	L	L	H
8	L	L	L

Figure 4 illustrates that for each policy there are eight possible outcomes that depend on the true model of the economy. In the case where the policy vector matches the state vector the loss is zero. In all other cases the losses are positive.

Figure 4: Policy options and losses



4.2 Key judgements

A key judgement made in this paper is that existing institutional arrangements do not fully mitigate the risks of time-inconsistency and agency cost in all relevant circumstances. Although the risk of time-inconsistency appears low in the context of the Reserve Bank Act 1989 and Fiscal Responsibility Act 1994 and currently moderate debt levels, the level of risk could increase significantly if the Crown followed a highly leveraged strategy in pursuit of tax smoothing. Empirical evidence on tax smoothing for both NZ and the US imply debt levels in excess of 2500% of GDP (Bohn 1990 and Davis and Fabling 2002). It may be unwise to assume the current legislative arrangements would be robust to a highly leveraged strategy.[26]

In terms of agency cost, current institutional arrangements such as the New Zealand Superannuation Act 2001 are likely to help protect against "direct raiding" of funds by a future government. However, these arrangements do not preclude "indirect raiding" or "expenditure creep", whereby the pressure for inefficient government expenditure would increase as Crown net worth increases.

Related to these issues, it is assumed that a high debt target would be an effective instrument in reducing agency cost. The proposition has been adopted as an application of Jensen's (1986) free cash flow theory of corporate finance.

[26] Future analysis could assess the possibility of strengthening existing arrangements or adding new arrangements. For example, adopting a foreign currency in place of the New Zealand dollar would remove governments ability to engage in surprise inflation.

However, the inter-temporal budget constraint facing the Crown is usually thought of as less stringent than for a corporation. Except for the recent period in New Zealand, it is not clear that high levels of debt has been an effective constraint on government spending in many countries.[27]

A further key judgement is that the potential loss from a false positive error on distortionary taxation is significantly larger than for a false positive error on time-inconsistency and agency cost. The difference is that placing high weights on the time-consistency and agency cost issues serves to constrain government policy action while a high weight on distortionary taxation would motivate an "activist" policy. Actively seeking to smooth taxes carries the significant risk of implementation failure due to highly uncertain correlations between asset returns. A further risk, due to the taxation of capital, is that tax smoothing could lead citizens to take on excessive risk in their portfolios (Coleman, 1997). Thus, incorrectly placing high weight on tax smoothing (a false positive error) would carry the risk of large losses in the absence of other constraints.

The judgement is made that a high level of debt would attract a risk premium for default risk. It is assumed that the risk premium would be "unjustified" in the sense that the country never intends to default or deflate the real value of the debt. The result of this judgement is that both distortionary taxation and time-consistency objectives motivate an upper bound on debt levels. Therefore, the two objectives tend to be substitutes for each other when evaluating the losses associated with debt targets.

A further working assumption made throughout this section (and Appendix II) is that the debt target implied by the agency cost objective conflicts with the debt target implied by the time-consistency and distortionary taxation objectives. This need not be the case as the "high" debt target motivated by agency cost considerations could be lower than the "low" debt target motivated by the other two objectives.

4.3 Low risk policies

The analysis presented in Appendix II suggests that low risk policies are those that place low weight on tax smoothing and avoid conflict between agency cost and time-consistency. Table 3 shows two such policies and a third where agency cost and time-consistency are conflicting.[28]

Table 3 - Low risk policies

Policy Options	Distortionary taxation	Time-consistency	Agency cost
4	L	H	H
6	L	H	L
8	L	L	L

[27] This issue deserves further analysis. If high debt was judged to be an ineffective instrument for reducing agency cost the results of this paper could change significantly.

[28] This selection has been made by comparing the results report in Appendix Table 3. It is based on a 'diffuse prior', where each scenario has equal probability of occurring.

The main advantages of the three policies are:

- A low weight on distortionary taxation avoids the risk of potentially large losses from a false positive error that could occur if tax smoothing were given high weight;
- A low weight on distortionary taxation would confer relatively small losses in two types of situation:
    - o where either or both agency costs and time-consistency are correctly assigned high weights, since in these cases there may be few opportunities for tax smoothing; and
    - o where either or both agency costs and time-consistency are incorrectly assigned low weights, since in these cases a high weight on distortionary taxation would cause significant agency cost and risk of time-inconsistency.

The main disadvantages are two-fold. First, in situations where agency cost is insignificant and receives low weight, the opportunity exists to engage fully in tax smoothing without constraint on the level of fungible assets and operating surpluses. False negative errors on distortionary taxation (where distortionary taxation is significant but receives low weight) represent lost opportunities. Second, in addition, a false positive error on agency cost (where agency cost is insignificant but receives high weight) carries the risk of unnecessarily constraining tax smoothing in those cases where distortionary taxation is significant and receives high weight.[29]

Selection of (L,H,H) as low risk candidate

The judgement in this paper is that the policy placing low weight on distortionary taxation and high weights on time-consistency and agency cost should be selected as the low risk candidate. The policy has an advantage over the (L,H,L) policy by ensuring balance between time-consistency and agency cost in their demands for low and high debt targets respectively. The policy is also more definitive in protecting against time-consistency and agency cost than a policy that places low weight on all three issues, (L,L,L). The later policy would carry some risk that the Crown balance sheet would evolve in a random manner.

4.3.1 Medium risk policies

A policy that places high weight on all three issues, (H,H,H), is assessed as medium risk. Although this policy is similar in many ways to a policy that places low weight on all objectives, the worst-case scenarios involving poor implementation of tax smoothing and significant distortions to personal portfolios suggest a higher risk assessment.

Table 4 - Medium risk policies

Policy Options	Distortionary taxation	Time-consistency	Agency cost
1	H	H	H
7	L	L	H

[29] These cases can be difficult to distinguish. The first is the case of true negative on agency cost and false negative on distortionary taxation. The second is the case of true positive on distortionary taxation and false positive on agency cost.

Also assessed as medium risk is the policy that places low weight on distortionary taxation and time-consistency but high weight on agency cost, (L,L,H). Similar to policy (L,H,L), which was assessed as low risk, the (L,L,H) policy is unbalanced across time-consistency and agency cost. The main difference between the two policies is the worst-case scenario. By placing high weight exclusively on agency cost, the (L,L,H) policy would result in a relatively high debt target, thereby increasing the risk of time-inconsistency. The worst-case scenario is that adverse shocks could result in a financial crisis, leading to large reductions in GDP as has been experienced by other countries such as Argentina, Mexico, and the South East Asian countries.[30] In contrast, the worst scenario for the (L,H,L) policy is relatively benign, with the high weight on time-consistency potentially leading to excessively low debt target and thereby insufficient discipline on government expenditure. The losses are likely to be much lower than the case of financial crisis associated with the worst scenario for (L,L,H).

Selection of (H,H,H) as medium risk candidate

The judgement in this paper is that the policy placing high weight on all three issues should be selected as the medium risk candidate. It is a balanced policy that motivates a search for mechanisms to achieve tax-smoothing benefits without jeopardising time-consistency and agency cost. For example, for distortionary taxation it may be possible to achieve significant benefits through insurance products and possibly derivative instruments (the latter being subject to mitigation of implementation risks). For time-consistency it may be possible to use the composition of debt to relax constraints.

A further advantage is that the (H,H,H) policy would be directly comparable to the low risk candidate (L,H,H), with the only difference being the switch from low to high weight on distortionary taxation.

4.4 High risk policies

Three of the eight policy options are assessed as high risk. The three policies have in common that they place high weight on distortionary taxation and low weight on one or both of time-consistency and agency cost. In two of the cases, the policies are assessed as high risk because the high weight on distortionary taxation is not balanced by high weight on agency cost. The absence of a countervailing force implies full engagement in tax smoothing, creating the potential for large losses across a range of situations. Where agency cost is significant but receives a low weight, the strong emphasis on tax smoothing would further exacerbate losses.

These situations are assessed as outweighing the advantage that a low weight on agency cost would avoid unnecessarily constraining tax smoothing. This advantage applies only in cases where distortionary taxation is significant and agency cost is insignificant.

[30] On the basis of this discussion, a reasonable person could classify the (L,L,H) policy as high risk. For the purposes of this paper the policy has been retained tentatively as medium risk because the number of worst-case scenarios is lower than for the other policies classified as high risk. However, as with all assessments in this paper, future empirical analysis could lead to a change in classification.

Table 5 - High risk policies

Policy Options	Distortionary taxation	Time-consistency	Agency cost
2	H	H	L
3	H	L	H
5	H	L	L

Selection of (H,L,L) as high risk candidate

The judgement in this paper is that the policy placing high weight on distortionary taxation and low weight on time-consistency and agency cost should be selected as the high risk candidate.

Comparison of (H,L,L) against the medium risk policy (H,H,H) would provide an estimate of the incremental benefit available from tax smoothing if the constraints from time-consistency and agency cost were relaxed. If the incremental benefits were found to be economically significant then policy makers would need to consider the benefit/risk trade-off. The perceived increase in risk would depend on the extent to which policy makers are confident that institutional arrangements mitigate the risks of time-consistency and agency cost.

Consideration of the (H,L,L) policy would place an emphasis on evaluating relevant Acts such as the Reserve Bank Act 1989, Fiscal Responsibility Act 1994, and NZ Superannuation Act 2001. It would also provide a motivation to consider whether any weak links could be strengthened.

4.5 Summary of proposed policy options

The conclusion of this section is that the best candidate policies warranting empirical analysis are:

- Low risk: Policy (L,H,H), which places emphasis on time-consistency and agency cost issues while down-weighting the significance of distortionary taxation;
- Medium risk: Policy (H,H,H), which applies a balanced weighting to all three issues; and
- High risk: Policy (H,L,L), which places emphasis on distortionary taxation while down-weighting time-consistency and agency cost.

5 Detailed policy targets

The analysis above was conducted on the basis that policy is defined over three dimensions, each dimension representing the aggregate economic welfare impact either of distortion taxation, time-consistency or agency cost. This was a simplification to make the analysis tractable. In contrast, the background discussion on objectives and targets (Section 2) identified 15 dimensions or targets over which policies may be defined (refer also to Table 6 below). The purpose of this section is to refine the three candidate policies in terms of how they would apply to the 15 dimensions. The status quo policy is recorded for comparison purposes.

Non-controversial targets

It is sometimes the case that the various targets associated with an objective have quite different risk properties. It is of interest to identify whether any particular targets would be particularly low risk and non-controversial. One test of whether a target would be non-controversial is whether it is supported by some objectives and contradicted by none. A policy target meeting this test could be adopted as part of the "baseline" applicable to all policy options.

Three of the 15 dimensions are considered non-controversial:

- *Tax smoothing over the cycle (refer row 1 in Table 6 below).* Full smoothing of tax rates over the economic cycle is supported by tax distortion considerations. It has also explicitly or implicitly been part of the status quo policy for many years. Full tax smoothing over the cycle is potentially contradicted by the agency-costs objective, but in practice is unlikely to be a significant issue provided the amplitude and duration of cycles are not too large or long.

- *Upper bound on share of assets held (row 8).* Both large player and agency cost considerations imply an upper bound on the proportion of any asset held by the Crown.[31] Potentially this could be contrary to the objective of minimising distortionary tax if empirical correlations indicated a large weight on NZ assets, but this appears unlikely.

- *Lower bound on quantities of benchmark bonds (row 11).* Placing a lower bound on the quantities of benchmark bonds on issue is aimed at avoiding high liquidity premia. For reasons similar to those above, the proposal is unlikely to be contrary to other objectives.

These three targets have been included in all policy options (refer Table 6, rows 1, 8 and 11). This means, for example, that the low risk policy (L,H,H), despite placing low weight on distortionary taxation, incorporates full tax-smoothing over the economic cycle.

[31] The upper bound might also be expressed as a nominal dollar limit rather than only in proportional terms.

Basis for specifying remaining targets

For the purposes of this paper, it is assumed that future work will establish a plausible range of values for each policy target. It is assumed that, for each target, one end of the range of values would represent a strong or conservative stance while the other end of the range would represent a weaker or more ambivalent stance. The proposal is to specify the policy targets as follows:[32]

1. A policy that assigns high weight to an objective (that is not countered by high weights on other dimensions) would be represented by choosing values for the relevant targets at the strong or conservative end of the range, e.g. "strong" upper bound on total debt;

2. A policy that assigns low weight to an objective would be represented by choosing values for the relevant targets at the weak end of the range or specifying no target at all; and

3. Where the weights assigned by a policy imply conflicting assignments, the values for the relevant targets would be chosen at the middle or weak end of the range as appropriate.

The remainder of this section discusses the application of this approach to the three candidate policies. Results are summarised in Table 6 below.

Low risk policy (L,H,H)

In the low risk policy, the high weight on agency cost would translate into strong upper bounds on the Operating Balance and fungible assets. There are no countervailing forces as distortionary taxation receives low weight.

The debt target is more complicated: The high weight on agency cost implies high debt levels (i.e. a strong lower bound set at the high end of range), while the high weight on time-consistency implies low debt levels (i.e. a strong upper bound set at the low end of range). Whether these assignments are conflicting is an empirical matter, and may change over time. If they do not conflict then the policy implication is that the level of debt would be maintained within a collar defined by the upper and lower debt targets. If they conflict then it is proposed that the value of the debt target would be the midpoint of the upper and lower bounds.

[32] The proposal assumes that the main interest is to consider the long-term direction of Crown financial policy. If instead the main interest is to conduct marginal analysis of the next step along a transition to the long-term policy target then the values assigned to the policy targets would be small changes from the status quo policy. The remainder of analysis would remain largely unchanged.

Table 6 – Status quo and candidate policy options

Targets	Status quo[33]	Low risk policy (L,H,H)	Medium risk policy (H,H,H)	High risk policy (H,L,L)
Risk/return properties				
Tax-smoothing over cycle	Full	Full	Full	Full
Deterministic smoothing	Partial	-	Partial	Full
Diversifiable risk	-	-	Minimise	Minimise
Systematic risk	-	-	Partial hedge	Minimise[34]
Net worth				
Bound on cyclically-adjusted OB	-	Strong upper	Weak upper	-
Positive CNW buffer	-	-	Small[35]	Large
Financial asset structure				
Bound on fungible assets	-	Strong upper	Weak upper	-
Bound on share of asset held	Upper	Upper	Upper	Upper
Debt structure				
Bound on total gross/net debt	≤ 30%	Collar[36]	Collar	Strong upper[38]
Bound on debt maturing	< $3.5bpa	Upper	Upper	-
Bound on benchmark quantities	≥ $3b	Lower	Lower	Lower
Bound on average maturity	-	Strong lower[37]	Strong lower	-
Bound on inflation-indexed debt	-	Strong lower	Strong lower	-
Bound on net foreign-currency debt	Zero	Strong lower	Strong lower	-
Bound on floating rate instruments	20-30%	-	-	-

Note: The table is read from right-to-left in the sense that, for example, "Full" in the first row of status quo column is read as "full tax-smoothing over the economic cycle. "Strong upper" means "strong upper bound on ….", implying that the target is expressed as an upper bound on the relevant variable and "strong" means the value assigned would be near the conservative end of plausible values to provide a strong constraint against jeopardising the relevant objective. "Weak" means the value assigned would be near the opposite end of plausible values to provide a weaker constraint against jeopardising the relevant objective. "Collar" means there is both an upper and lower bound on the relevant variable.

[33] Under the status quo the policy targets relating to the $3.5 billion upper bound on debt maturing, $3 billion lower bound on benchmark debt and 20-30% target for floating rate instruments are specified for NZ dollar denominated debt. The upper bound on debt maturing excludes Treasury Bills. The target of zero net foreign-currency debt applies where the definition of net foreign-currency debt is gross foreign-currency debt net of foreign exchange reserves and NZDMO-managed foreign-currency assets.

[34] Systematic risk should not be minimised in the case where citizens are non-responsive and the government objective is to minimise expected deadweight losses.

35 Positive balance applies if and only if negative correlation between tax rates and consumption, otherwise zero balance. Same condition applies to other policy options where relevant.

36 Time-consistency implies an upper bound while agency cost implies a lower bound. If not conflicting, the two bounds would form a collar. If the bounds are conflicting (in the sense that the lower bound exceeds the upper bound) then the target would be set at the midpoint between the two bounds. This applies also to the 'medium risk' column.

[37] Lower bound is contingent on breach of the threshold upper bound for total debt. The same condition applies to the lower bounds on inflation-indexed and foreign-currency debt under all policy options where relevant.

[38] Strong upper bound is implied by the distortionary tax objective to the extent that "unjustified risk premia" occur at high debt levels.

Medium risk policy (H,H,H)

The medium risk policy differs from the low risk policy principally by the switch from low to high weight on distortionary taxation (while maintaining high weight on time-consistency and agency cost). The practical impact is that the strong upper bounds on the Operating Balance and fungible assets are likely to conflict with requirements for tax smoothing. To reflect the increased emphasis on distortionary taxation it is proposed that the two upper bounds would be assigned values more toward the middle or weaker part of the range of plausible values. The assigned values would be sufficient to maintain a high level of assurance that the time-consistency and agency cost objectives are not jeopardised.

The high weight on distortionary taxation motivates tax smoothing over deterministic profiles of government expenditure and hedging of all risk. Consistent with views earlier in this paper, there may be potential for diversifiable risk to be reduced substantially (possibly eliminated) without conflicting with the agency cost objective. In contrast, deterministic smoothing, hedging of systematic risk, and the building of a positive CNW balance are likely to conflict with the upper bounds on the Operating Balance and fungible assets. Therefore, to be consistent with the upper bounds, the medium risk policy would target only partial smoothing of deterministic spending profiles, partial hedging of systematic risk, and a small positive CNW balance at most.

High risk policy (H,L,L)

With low weights on time-consistency and agency cost issues, the high risk policy would enable full engagement in tax smoothing. This would translate into full smoothing of deterministic spending profiles, full hedging of both diversifiable and systematic risk, and a larger positive CNW balance to provide greater self-insurance against adverse shocks. Also, given the assumption that high levels of debt result in “unjustifiable” risk premia, total debt would be subject to a strong upper bound. Setting of the upper bound would need to take into account any offset achieved by holding financial assets.

6 Conclusions

This paper has applied a framework for policy making under uncertainty to select a small number of policy options as the focus for future quantitative analysis. The paper is based on the view that detailed qualitative analysis assessing the relative losses and risks of alternative policy options is worthwhile prior to empirical estimation and numerical simulation, which typically are more resource intensive.

Three policies were selected:

- a low risk policy that places emphasis on time-consistency and agency cost issues while down-weighting the significance of distortionary taxation;
- a medium risk policy that applies a balanced weighting to the three issues; and
- a high risk policy that places emphasis on distortionary taxation while down-weighting time-consistency and agency cost.

The detailed policy targets that would apply for each candidate policy have been specified in terms of Crown net worth, overall risk/return properties of the Crown balance sheet, and the level and structure of financial assets and public debt.

The three policies are potential candidates for eventually putting to the government for consideration. The intention is that the government would select a preferred policy by comparing the incremental benefit versus risk of each policy relative to the status quo and other policy options.

A significant program of empirical estimation and numerical simulation analysis will need to be completed before any such recommendations can be made. Work will be required to formulate the loss functions, assign numerical values to the policy targets, and identify the variables that drive the sensitivity of the results. While initial rounds are likely to be rudimentary, as modelling progresses it will be important to place emphasis on comparative institutional analysis. This will require that, within reason, the policy targets and policy reaction functions incorporated in modelling work reflect how policy would actually be implemented based on the incentives, information and other constraints that would apply under the proposed institutional arrangement.

Inevitably, further analysis will identify significant knowledge gaps regarding the choice between alternative policies. Decisions will be required on which gaps can be reduced significantly through further empirical work and where judgemental assessments will be required. In respect of the latter, a small-scale survey of informed people could be desirable (e.g. for assessing 'prior beliefs'). Again, attention will be required to ensure any judgements made are consistent with the incentives, information and other constraints under the proposed institutional arrangement.

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Appendix I: Policy making under uncertainty

Formal treatments of Bayesian decision theory are available in Cyert and DeGroot (1987), Hirshleifer and Riley (1992), Rhodes (1994), and Silvey (1975). Gorringe (1991, 1998) discusses the implications for policy making under uncertainty. The purpose of this Appendix is to outline the decision framework in a manner directly applicable to the qualitative analysis in this paper. The first part models the simplest case where policy is described by one variable. The second part generalises the model to the case where policy is described by two variables.

One dimensional policy

Consider the structure described in Section 3.2 where the true model of the economy is either s or i and the policy choice is either H or L. The policy maker does not know which is the true model but assigns probabilities p_s and p_i such that $p_s + p_i = 1$. The payoffs under each policy option are random variables $\tilde{V}_{TP}$, $\tilde{V}_{FP}$, $\tilde{V}_{TN}$, and $\tilde{V}_{FN}$. Equivalently, in Bayesian terminology, the policy option should be implemented if the "risk" of the policy option is less than the "risk" of the status quo.

The ex ante values of policies H and L are denoted $\tilde{v}_H$ and $\tilde{v}_L$, respectively, and are given by:

$$\tilde{v}_H = p_s\tilde{V}_{TP} + p_i\tilde{V}_{FP} \qquad (1a)$$

$$\tilde{v}_L = p_i\tilde{V}_{TN} + p_s\tilde{V}_{FN} \qquad (2a)$$

Equations (1a) and (2a) may be rewritten as:

$$\tilde{v}_H = \tilde{V} - p_i\tilde{L}_{FP} \qquad (1b)$$

$$\tilde{v}_L = \tilde{V} - p_s\tilde{L}_{FN} \qquad (2b)$$

where

$$\tilde{V} = p_s\tilde{V}_{TP} + p_i\tilde{V}_{TN}$$

$$\tilde{L}_{FP} = \tilde{V}_{TN} - \tilde{V}_{FP} > 0$$

$$\tilde{L}_{FN} = \tilde{V}_{TP} - \tilde{V}_{FN} > 0$$

$\tilde{V}$ is the weighted-average value of the true positive and true negative outcomes. It is the *ex ante* value obtainable if the policy maker could learn the true model prior to making the policy decision, thereby being sure of avoiding false positive and false negative errors. $\tilde{L}_{FP}$ and $\tilde{L}_{FN}$ are the losses associated with false positive and false negative errors that occur when policies H and L are inconsistent with the true model.

Equation (1b) says that the value of policy H, $\tilde{v}_H$, is the *ex ante* value with learning ($\tilde{V}$) less the probability-weighted loss of policy H being "incorrect" ($p_i\tilde{L}_{FP}$). Similarly, equation (2b) says that the value of policy L, $\tilde{v}_L$, is the *ex ante* value with learning ($\tilde{V}$) less the probability-weighted loss of policy L being "incorrect" ($p_s\tilde{L}_{FN}$).

Risk neutral policy maker

A risk neutral policy maker would prefer policy L to policy H if and only if the expected value of policy L exceeds the expected value of policy H:

$$E[\tilde{v}_L] > E[\tilde{v}_H]$$

$$\Leftrightarrow \quad p_s E[\tilde{L}_{FN}] < p_i E[\tilde{L}_{FP}], \tag{3}$$

where E[.] is the expectations operator.

Equation (3) indicates that a risk neutral policy maker would prefer policy L if and only if the expected loss is lower than for policy H. Hence, minimising expected losses is equivalent to maximising expected value.

Risk averse policy maker

A risk averse policy maker would consider both expected losses and risk levels. Bayesian decision theory assumes the policy maker has a preference ordering satisfying standard axioms so that there exists a cardinal utility function, U(.). A risk averse policy maker is assumed to maximise expected utility. Policy L would be preferred if and only if $E[U(\tilde{v}_L)] > E[U(\tilde{v}_H)]$.

As noted in Section 3.2, a practical consideration in public policy is that the analyst is not the decision maker and under public service conventions would not presume to know the decision makers risk preferences. The proposal in this paper is that the policy analyst should present to the policy maker estimates of expected loss and various measures of risk such as variance, skew and kurtosis. The worst-case loss may be presented also. From the information presented the policy maker would choose the policy option that maximises his or her expected utility.

Multi-dimensional policy

Section 4.1 noted that for Crown financial policy the policy options are multi-dimensional. The following extends the previous analysis to the case where policy is two-dimensional.

With policy defined on two dimensions the set of feasible policies available is {(H, H), (H, L), (L, H) (L, L)}. The set of possible state vectors is {(s, s), (s, i), (i, s), (i, i)}. Analogous to the procedure above, the value of policy (H, H) is:

$$\tilde{v}_{H,H} = p_{s,s}\tilde{V}_{TP,TP} + p_{s,i}\tilde{V}_{TP,FP} + p_{i,s}\tilde{V}_{FP,TP} + p_{i,i}\tilde{V}_{FP,FP}$$

$$= \tilde{V} - \{p_{s,i}\tilde{L}_{TP,FP} + p_{i,s}\tilde{L}_{FP,TP} + p_{i,i}\tilde{L}_{FP,FP}\} \tag{5}$$

where

$p_{x,x}$ is the probability of state (x,x)

$\tilde{V} = p_{s,s}\tilde{V}_{TP,TP} + p_{s,i}\tilde{V}_{TP,TN} + p_{i,s}\tilde{V}_{TN,TP} + p_{i,i}\tilde{V}_{TN,TN}$

$\tilde{L}_{TP,FP} = \tilde{V}_{TP,TN} - \tilde{V}_{TP,FP}$

$\tilde{L}_{FP,TP} = \tilde{V}_{TN,TP} - \tilde{V}_{FP,TP}$

$\tilde{L}_{FP,FP} = \tilde{V}_{TN,TN} - \tilde{V}_{FP,FP}$

Equation (5) says that the value of policy (H, H) is the *ex ante* value with learning ($\tilde{V}$) less the probability-weighted losses of policy (H, H) being incorrect on one dimension and correct on the other (cases $\tilde{L}_{TP,FP}$ and $\tilde{L}_{FP,TP}$) or being incorrect on both dimensions ($\tilde{L}_{FP,FP}$).

The full set of solutions for all policy options may be written in matrix notation as:

$$\tilde{v} = \tilde{V}\mathbf{1} + p'\mathbf{L}$$

where $\tilde{V}$ is a scalar and

$\tilde{v}' = (\tilde{v}_{H,H}, \tilde{v}_{H,L}, \tilde{v}_{L,H}, \tilde{v}_{L,L})$

$\mathbf{1}' = (1,1,1,1)$

$p' = (p_{s,s}, p_{s,i}, p_{i,s}, p_{i,i})$

$$\mathbf{L} = \begin{pmatrix} 0 & \tilde{L}_{TP,FN} & \tilde{L}_{FN,TP} & \tilde{L}_{FN,FN} \\ \tilde{L}_{TP,FP} & 0 & \tilde{L}_{FN,FP} & \tilde{L}_{FN,TN} \\ \tilde{L}_{FP,TP} & \tilde{L}_{FP,FN} & 0 & \tilde{L}_{TN,FN} \\ \tilde{L}_{FP,FP} & \tilde{L}_{FP,TN} & \tilde{L}_{TN,FP} & 0 \end{pmatrix}$$

Appendix II: Qualitative Assessment of Risks

This Appendix applies the indicators developed in Section 3.3 to assess qualitatively the risk properties of alternative policy options. The Appendix is in two parts: Part A discusses the key characteristics of the distortionary tax, time-consistency and agency cost objectives in general terms without reference to specific loss functions. Part B applies these general comments to the loss functions relating to the eight policy options available .

Part A: General Discussion

1. Distortionary taxation

The two possible decision errors in relation to distortionary taxation are:

- *False positive error:* False conclusion that tax smoothing would confer a significant benefit. A decision to target the minimum-variance portfolio (and possibly build a positive CNW buffer and place an upper bound on total gross debt) that in fact confer no significant benefit relative to the absence of such targets; and

- *False negative error:* False conclusion that tax smoothing is an insignificant issue. A decision to adopt no specific risk/return target (or other bounds) that in fact would confer a significant benefit had they been adopted.

Implementation risk

Implementation risk could be substantive under the case where tax smoothing is significant. In particular, uncertainty surrounds the risk/return properties of any particular asset or liability, including those on the Crown balance sheet.

Information revelation

Apart from implementation risks, the probability and timing that a false positive or false negative error would be revealed as a mistake is similar across the two cases.

Consider a false positive that tax smoothing would confer significant benefit. Although a stable tax rate would be observed over time, the supposed welfare gains are unobservable. In particular, the difficulties of distinguishing econometrically the tax effects from other influences on economic performance suggests that *ex post* analysis would be unlikely to yield substantively new and more powerful information than available in the literature currently. (The main information that would come available following adoption of a tax smoothing policy would be the difficulties or otherwise of successful implementation).

Similar comments apply in the case of a false negative that the benefits of tax smoothing would be insignificant.

Reversibility

Assuming a policy mistake did become known, both cases should be low cost to reverse:

- in the case where a false positive (in favour of tax smoothing) was revealed, the Crown would be faced with unwinding asset positions that had been built up specifically for smoothing purposes. Provided the unwinding is conducted in an orderly manner, the cost of reversal should be fairly low; and

- In the case where a false negative (against tax smoothing) was revealed, the government would have the option of establishing the tax-smoothing regime. The legislative and other institutional arrangements would take some time to work through but would be relatively low cost. Losses would be incurred to the extent that the delay resulted in some or all of the window of opportunity passing by (e.g. with population ageing profile over next few decades).

Worst scenario

Losses under the worst scenario in the case of a false positive (in favour of tax smoothing) may or may not be larger than in the case of a false negative (against tax smoothing).

Under a false positive the worst scenario would be a substantial permanent reduction in asset values accompanied by failure to hedge the Crown balance sheet due to instability in correlations between assets. Under a false negative the worst scenario would be the loss in economic performance of the country due to instability in the tax rate. The loss would be greater to the extent that, for example, population ageing is a one-off change and the delay in implementing tax-smoothing mean the window of opportunity passed by.

Dependence on state variables

The loss arising from a false positive (in favour of tax smoothing) would be less sensitive to state variables than the loss arising from a false negative (against tax smoothing):

- A false positive means, by assumption, either that variation in tax rates has insignificant impact on economic welfare or that implementation is too difficult and costly.

- A false negative means, by assumption, that variation in tax rates does have significant impact on economic welfare (over and above the cost of implementation). Therefore the cost of being wrong would depend on the state of the economy and the profile of government expenditure.

Vote misperception risk

A correct conclusion in favour of tax smoothing faces the problem that the public would tend to look at specific measurable outcomes that may not be closely related to the policy objective. For example, a desirable hedging strategy could lead to an outcome where the market value of Crown financial assets was revised downward by (say) $5 billion as an offset to upward revaluation in the tax asset. Because accounting rules mean that the highly visible headline Operating Balance would include the downward revision in financial asset value but exclude the increase in the tax asset, the public would likely view the outcome as reflecting poor economic management by the government of the day. The hedging benefits are difficult to communicate. In contrast, a correct conclusion against tax smoothing would not face the same issues.

A tax smoothing policy shifts the burden of taxation over time. The current situation for New Zealand is that tax smoothing implies accumulating assets in preparation for government expenses associated with population ageing and may also imply a need to build a positive CNW balance (if tax rates and consumption are negatively correlated). These imply bearing the cost of a higher tax rate now in return for lower tax rate (relative to counterfactual) in several decades in the future.

2. Time-consistency of policy

The two possible decision errors in relation to the time-consistency of policy are:

- *False positive error:* False conclusion that time-inconsistency is a significant issue. A decision to impose strong upper bound on total net debt (and possibly bounds on other debt variables) that in fact confer no significant benefit relative to the absence of such bounds; and

- *False negative error:* False conclusion that time-consistency is an insignificant issue. A decision to impose no upper bound on total net debt that in fact would confer a significant benefit had they been imposed.

Implementation risk

Differences in implementation risk are negligible. The main risk facing the decision to impose upper bounds on total net debt relate to judgements about the appropriate level of the bound. The risk is considered fairly small as the incentives on a government to pursue a time-inconsistent policy relate to the broad magnitude of the debt rather than its precise level.

Information revelation

A false positive that time-inconsistency issues are significant (and hence bounds imposed) has high probability of never being revealed. This is because if time-inconsistency truly is an insignificant issue then inconsistent policies are unlikely to be observed but it may not be clear whether this is due to success of the constraints or lack of underlying issue.

In contrast, a false negative that time-consistency is an insignificant issue (and hence no bounds imposed) would mean that future policy inconsistencies would occur with positive probability. At some point as the risk of time-inconsistency increases, the financial markets would be likely to price the risk as an observable interest rate premium on government bonds. Therefore, a false negative is more likely to be revealed than a false positive.

Reversibility

The reverse conclusion holds in terms of reversibility, since removing debt targets found to be unwarranted may be easier than imposing debt targets in difficult circumstances. Particularly, in the circumstance where the country is caught in a financial crisis it may be very difficult to introduce debt targets. Thus, a false negative would be less easily reversed than a false positive.[39]

Worst scenario

The worst case scenario under the false positive (that time-consistency is significant) relate to the costs of being constrained from structuring the Crown balance sheet to meet other objectives, such as tax smoothing and limiting agency costs. These costs are likely to be moderate.

The worst case scenario under the false negative (that time-consistency is insignificant) relate to the costs arising if the country is caught in a financial crisis. The experiences of other countries such as Argentina, Mexico, South East Asia suggests the potential for substantial reductions in GDP.

Uncertainty about information revelation

Considerable uncertainty exists around the timing of information revelation under the false negative (that time-consistency is insignificant). Ideally, well functioning financial markets would steadily increase risk premia as the risks of time-inconsistency increased. But, equally, given the experiences of other countries, shocks can plunge a country into crisis very quickly and without substantive warning by credit rating agencies and observed risk premia. The false positive (that time-consistency is significant) faces much lower uncertainty.

Uncertainty about reversibility

Similar conclusions apply to the reversibility of policy. Considerable uncertainty exists whether debt targets would be imposed when the false negative is revealed.

Dependence on state variables

The losses arising from a false negative (that time-consistency is insignificant) depends on the state of the Crown balance sheet, in particular the government's future borrowing requirements. Under the false positive (that time-inconsistency is significant) it is less clear how the losses would be affected by the state of the Crown balance sheet or the economy more generally.

[39] John Carran has suggested that the opposite conclusion can be justified. The argument is that debt targets may get locked in due to perception and credibility concerns. Thus, the false positive may be quite difficult to reverse. Equally, in the case where a country is caught in financial crisis the government is likely to find it relatively easy to motivate and justify tough debt targets (e.g. NZ reforms of mid-1980s). Thus, the false negative may be relatively easy to reverse. This line of argument, and the implications for policy conclusions, deserves further attention.

Voter misperception risk

A correct conclusion that time-consistency is an insignificant issue may nevertheless lead to significant risk. The public may perceive high Crown debt levels as risky and an indicator of poor government financial management. A correct conclusion that time-consistency is significant does not create similar issues.

3. Agency costs of government

The two possible decision errors in relation to agency costs of government are:

- *False positive error:* A false conclusion that agency cost is a significant issue. The conclusion leads to the imposition of upper bounds on the cyclically-adjusted Operating Balance and total fungible assets and a lower bound on total net debt that in fact confer no significant benefit relative to the absence of such bounds; and

- *False negative error:* A false conclusion that agency cost is insignificant. The conclusion leads to no bounds on the Operating Balance, fungible assets, and net debt whereas in fact such bounds would confer a significant net benefit.

Implementation risk

Implementation risk could arise under the case where agency cost is significant. In particular, setting an upper bound on the Operating Balance may prove ineffective in the face of strong political pressures. An upper bound also could cause an increase in inefficient government expenditure in the case of governments that would prefer to increase expenditure rather than reduce tax rates so as to keep the Operating Balance within the upper bound.

Information revelation

A false positive that agency cost is significant is less likely to be revealed as a mistake than a false negative that agency cost is insignificant:

- A false positive would be associated with bounds being imposed on the Operating Balance and the levels of fungible assets and gross debt. Assuming these bounds are effective (i.e. ignoring implementation risk), the observed outcome would be government expenditure and other operating decisions at relatively efficient levels. However, it may not be clear whether these outcomes were the result of the bounds acting as effective constraints to prevent inefficient decisions or due to other mechanisms and incentives operating in the political system;

- A false negative would be associated with bounds not being imposed on the Operating Balance, fungible assets and gross debt. Over time, the observed outcomes for government expenditure and other operating decisions would display significant levels of inefficiency. Thus, the mistaken conclusion that agency cost is insignificant would become apparent.

Reversibility

Assuming a false positive (that agency cost is significant) was revealed, the policy is more likely to be reversible than a false negative. It would be relatively easy to remove the bounds on the Operating Balance, fungible assets and gross debt. In contrast, given the nature of agency costs, it would likely be difficult to persuade the government of the day to introduce constraints on their actions perceived to be in their own political interest.[40] The risk arises that successive governments could win office on the promise to fix the problem but later renege or put in place only a partial solution. Reversal of policy is likely to be slow relative to the case where agency cost is mistakenly assumed to be insignificant.

Worst scenario

The worst-case scenarios for the two cases are assessed as broadly equal. Under the false positive (that agency cost is significant), the worst scenario is the inefficiency arising by preventing tax smoothing over an anticipated significant expenditure cycle or step increase. The consequences for economic growth could be significant. Under the false negative (that agency cost is insignificant) the worst scenario would be if agency costs did not become apparent until a sizable balance of fungible assets had been built up and the policy could not be reversed until those assets had largely dissipated.

Uncertainty about information revelation

Uncertainty about the timing of a false conclusion being revealed as a mistake appears greater for the false conclusion that agency cost is insignificant. It will depend both on the ability to distinguish between efficient and inefficient government decisions. Also, the propensity to make inefficient decisions may depend on the state of the economy.

Uncertainty about reversibility

For similar reasons, uncertainty about the speed and cost of reversing an incorrect policy would be greatest for the false conclusion that agency cost is insignificant.

Dependence on state variables

In both cases, the costs arising from a false conclusion would depend on the state of economy. Dependence on state variables is assessed as being broadly equal for the two cases.

Voter misperception risk

Public information and understanding of the costs and benefits of a correct conclusion that agency cost is significant appears broadly symmetrical. It would seem that the public would perceive a lower bound on total debt as imposing some cost in terms of loss of flexibility for the government to respond to events. Equally, it would seem that the public perceive the need for some limits on government discretion.

The reverse arguments apply to the case where agency cost is assumed correctly to be insignificant. Therefore, the two cases are assessed as neutral.

[40] Passage of the Fiscal Responsibility Act 1994 could be viewed as contrary evidence. However, the Act came about only after a long period of lack of fiscal restraint.

Part B: Application to Loss Functions

Appendix Table 1 below reproduces Table 1 in the main text for ease of reference.

Appendix Table 1 – Available policy options with three objectives

Policy Options	Distortionary taxation	Time-consistency	Agency cost
1	H	H	H
2	H	H	L
3	H	L	H
4	L	H	H
5	H	L	L
6	L	H	L
7	L	L	H
8	L	L	L

The value of each policy option is the value of the correct assignment less the probability-weighted value of losses where the assignments are incorrect (refer equation 5 in Appendix I). Given that each of the three issues may be economically significant or insignificant, each policy option gives rise to one combination where the assignment of high and low weights is correct and seven combinations where the assignments are incorrect, i.e. seven loss functions may be defined for each policy option. The loss matrix, **L**, is presented in AppendixTable 2 below.

Appendix Table 2 – Matrix of loss functions with three objectives

Loss Functions	Policy Options							
	1	2	3	4	5	6	7	8
1	-	TP,TP,FN	TP,FN,TP	FN,TP,TP	TP,FN,FN	FN,TP,FN	FN,FN,TP	FN,FN,FN
2	TP,TP,FP	-	TP,FN,FP	FN,TP,FP	TP,FN,TN	FN,TP,TN	FN,FN,FP	FN,FN,TN
3	TP,FP,TP	TP,FP,FN	-	FN,FP,TP	TP,TN,FN	FN,FP,FN	FN,TN,TP	FN,TN,FN
4	FP,TP,TP	FP,TP,FN	FP,FN,TP	-	FP,FN,FN	TN,TP,FN	TN,FN,TP	TN,FN,FN
5	TP,FP,FP	TP,FP,TN	TP,TN,FP	FN,FP,FP	-	FN,FP,TN	FN,TN,FP	FN,TN,TN
6	FP,TP,FP	FP,TP,TN	FP,FN,FP	TN,TP,FP	FP,FN,TN	-	TN,FN,FP	TN,FN,TN
7	FP,FP,TP	FP,FP,FN	FP,TN,TP	TN,FP,TP	FP,TN,FN	TN,FP,FN	-	TN,TN,FN
8	FP,FP,FP	FP,FP,TN	FP,TN,FP	TN,FP,FP	FP,TN,TN	TN,FP,TN	TN,TN,FP	-

The following makes a qualitative assessment of the average size of losses, the variability or uncertainty of losses and the worst-case scenario for the 56 loss functions (= 8 policy options x 7 loss functions per policy).

1. High weight on all issues (H,H,H)

$L_{TP,TP,FP}$ = $V_{TP,TP,TN}$ - $V_{TP,TP,FP}$: The loss when agency cost is insignificant but receive high weight, while distortionary taxation and time-consistency are significant and correctly receive high weight. Policy erroneously seeks to restrict operating surpluses, limit the build up of fungible assets, and seeks to discipline government expenditure by maintaining fairly high debt levels.

Ave: H — High expected loss because the high weight on agency costs substantially inhibits tax smoothing and jeopardises time-consistency by maintaining fairly high debt levels

Var: H — Variance of losses high because the adverse impact of limited tax smoothing depends on whether economy suffers adverse shocks. Similarly, risk of time-inconsistency depends on adverse shocks occurring.

Worst: H — Same reasoning as above.

$L_{TP,FP,TP}$ = $V_{TP,TN,TP}$ - $V_{TP,FP,TP}$: The loss when time-consistency is insignificant but receives high weight, while distortionary taxation and agency cost is significant and correctly receive high weight. Policy erroneously targets low net debt to avoid incentives for unexpected inflation and other forms of debt repudiation.

Ave: L — Low expected loss because agency cost and tax smoothing issues counteract each other in any case. Agency costs may be somewhat higher due to debt target being too low, but impact limited because distortionary taxation also implies debt restrictions in cases of unjustified risk premia.

Var: L

Worst: L

$L_{FP,TP,TP}$ = $V_{TN,TP,TP}$ – $V_{FP,TP,TP}$: The loss when distortionary taxation is insignificant but receives high weight, while time-consistency and agency cost is significant and correctly receive high weight. Policy erroneously seeks to hedge risks through build up of assets (via operating surpluses) and leverage (up to level that attracts unjustified risk premia) and may seek to build up positive CNW buffer (if negative correlation between taxes and consumption).

Ave: M — The pressure to build up financial assets results in higher agency costs than under the correct policy. Implementation risk and potential distortions of citizens' investment portfolios due to capital income taxation (Coleman, 1997) add to losses. A false positive error favouring tax smoothing is also likely to be persistent as difficult to observe the error *ex post*. But, fundamentally, the high weight on agency costs limits the size of losses incurred on tax smoothing.

Var: L — Magnitude of losses not highly dependent on state of the economy or other factors.

Worst: H — High agency cost, poor implementation of tax smoothing, and significant distortion to private investment.

$L_{TP,FP,FP}$ = $V_{TP,TN,TN}$ - $V_{TP,FP,FP}$: The loss when both time-consistency and agency cost is insignificant but receive high weight, while distortionary taxation is significant and correctly receives high weight.

Ave: H
Var: H
Worst: H
— Same reasons as for first case, $L_{TP,TP,FP}$

$L_{FP,TP,FP}$ = $V_{TN,TP,TN}$ – $V_{FP,TP,FP}$: The loss when both distortionary taxation and agency cost is insignificant but receive high weight, while time-consistency is significant and correctly receives high weight.

Ave: L — The high weights on tax smoothing and agency cost counteract each other. Implementation risk and private sector distortion would be limited. No agency costs incurred. Some additional risk of time-inconsistency as the high weight on agency costs may limit run down of debt.

Var: L

Worst: L

$L_{FP,FP,TP}$ = $V_{TN,TN,TP} - V_{FP,FP,TP}$: The loss when both distortionary taxation and time-consistency are insignificant but receive high weight, while agency cost is significant and correctly receives high weight.

Ave: M
Var: L
Worst: H
} Same as for $L_{FP,TP,TP}$

$L_{FP,FP,FP}$ = $V_{TN,TN,TN} - V_{FP,FP,FP}$: The loss when all three issues are insignificant but receive high weight.

Ave: L — The high weight on all issues means they counteract each other. Potential exists for implementation risk on tax smoothing and distortions to citizen's but losses would be limited.

Var: L

Worst: L

2. Agency costs considered unimportant (H,H,L)

$L_{TP,TP,FN}$ = $V_{TP,TP,TP} - V_{TP,TP,FN}$: The loss when agency cost is significant but receive low weight, while distortionary taxation and time-consistency are significant and correctly receive high weight.

Ave: H — High agency cost is incurred and could be persistent. The false negative error would likely be observed fairly quickly but may be difficult to reverse due to political self-interest of both politicians and bureaucrats.

Var: L — Level of agency cost would relate to extent of tax smoothing, and would not be highly dependent on state of economy or other sources of volatility.

Worst: H — Situation where agency cost becomes problem once substantial fund of assets has been built up. Problems not resolved until assets dissipated through inefficient government expenditure.

$L_{TP,FP,FN}$ = $V_{TP,TN,TP} - V_{TP,FP,FN}$: The loss when time-consistency is insignificant but receives high weight, agency cost is significant but receive low weight, while distortionary taxation is significant and correctly receives high weight.

Ave: H
Var: L
} Same as previous case with addition of unnecessary constraint on debt that inhibits tax smoothing

Worst: H

$L_{FP,TP,FN}$ = $V_{TN,TP,TP} - V_{FP,TP,FN}$: The loss when distortionary taxation is insignificant but receives high weight, agency cost is significant but receives low weight, while time-consistency is significant and correctly receives high weight.

Ave: H — Agency cost incurred, plus implementation risk and private sector distortions.

Var: L

Worst: H

$L_{TP,FP,TN}$ = $V_{TP,TN,TN}$ - $V_{TP,FP,TN}$: The loss when time-consistency is insignificant but receives high weight, while distortionary tax and agency cost receive their correct high and low weights respectively.

Ave: L — The high weight on time-consistency unduly constrains leveraging of balance sheet for tax smoothing purposes. But impact limited to the extent that unjustified risk premia also would limit leveraging. Also, over time, tax smoothing achieved by building financial assets through operating surplus.

Var: L

Worst: M — Adverse shocks occur in transition period before full hedging in place.

$L_{FP,TP,TN}$ = $V_{TN,TP,TN}$ – $V_{FP,TP,TN}$: The loss when distortionary taxation is insignificant but receives high weight, while time-consistency and agency cost receive their correct high and low weights respectively.

Ave: H — In absence of constraints from agency cost concerns, government places strong emphasis on tax smoothing. High losses could be expected from poor implementation and distortions to citizens' wealth portfolios.

Var: M — Implementation risk depends on whether variance-covariance matrix is stable or unstable over relevant period.

Worst: H — Poor implementation and significant distortions to wealth portfolios.

$L_{FP,FP,FN}$ = $V_{TN,TN,TP}$ – $V_{FP,FP,FN}$: The loss when distortionary taxation and time-consistency are insignificant but receive high weight and agency cost is significant but receive low weight.

Ave: H — High agency costs, poor implementation and distorted portfolios.

Var: M

Worst: H

$L_{FP,FP,TN}$ = $V_{TN,TN,TN}$ – $V_{FP,FP,TN}$: The loss when distortionary taxation and time-consistency are insignificant but receive high weight, while agency cost is insignificant and correctly receive low weight.

Ave: H

Var: M — Similar to previous case but with no agency cost. Still high losses.

Worst: H

3. Time-consistency considered unimportant (H,L,H)

$L_{TP,FN,TP}$ = $V_{TP,TP,TP}$ - $V_{TP,FN,TP}$: The loss when time-consistency is significant but receives low weight, while distortionary taxation and agency cost are both significant and correctly receive high weight.

Ave: L — Tax smoothing points to leveraging of balance sheet to hedge risks while agency costs imply high debt levels to discipline government expenditure. However, risk is limited because unjustified risk premia issues would constrain leveraging. To the extent that policy inconsistencies may occur in future with positive probability, the financial markets would be likely to price the risk as an observable interest rate premium on government bonds. Government would have an incentive to reverse the policy as soon as possible.

Var: H The realisation and magnitude of losses depend on occurrence of adverse shocks.

Worst: H High losses if the country is caught in a financial crisis, at which time would be difficult to reverse the policy. The experiences of other countries such as Argentina, Mexico, South East Asia suggests the potential for substantial reductions in GDP.

$L_{TP,FN,FP}$ = $V_{TP,TP,TN}$ - $V_{TP,FN,FP}$: The loss when time-consistency is significant but receives low weight and when agency cost is insignificant but receives high weight, while distortionary taxation is significant and correctly receives high weight.

Ave: H Losses much higher than previous case as the high weight on agency costs constrains unnecessarily the ability to engage in tax smoothing.

Var: H Same as above

Worst: H Same as above

$L_{FP,FN,TP}$ = $V_{TN,TP,TP}$ – $V_{FP,FN,TP}$: The loss when distortionary taxation is insignificant but receives high weight and time-consistency is significant but receives low weight, while agency cost is significant and correctly receives high weight.

Ave: H The high weight on tax smoothing unnecessarily causes agency costs and also poses implementation risk and distortions to wealth portfolios. With failure to accord high weight to time-consistency, the emphasis on tax smoothing and agency cost also puts time-consistency at risk. To the extent that policy inconsistencies may occur in future with positive probability, the financial markets would be likely to price the risk as an observable interest rate premium on government bonds. Government would have an incentive to reverse the policy as soon as possible to place high weight on time-consistency.

Var: H Same as above

Worst: H Same as above

$L_{TP,TN,FP}$ = $V_{TP,TN,TN}$ - $V_{TP,TN,FP}$: The loss when agency cost is insignificant but receives high weight, while distortionary taxation and time-consistency correctly receive high and low weights respectively.

Ave: H The high weight on agency cost constrains unnecessarily the ability to engage in tax smoothing. No impact on time-consistency as insignificant in any case.

Var: H Same as above

Worst: H Same as above

$L_{FP,FN,FP}$ = $V_{TN,TP,TN}$ – $V_{FP,FN,FP}$: The loss when distortionary taxation and agency cost is insignificant but receive high weight and time-consistency is significant but receives low weight.

Ave: L The high weights on tax smoothing and agency cost mostly counteract each other, with the exception that both tend to motivate high debt levels. This is limited to the extent that unjustified risk premia occur. To the extent that policy inconsistencies may occur in future with positive probability, the financial markets would be likely to price the risk as an observable interest rate premium on government bonds. Government would have an incentive to reverse the policy as soon as possible.

Var: L

Worst: H High losses if the country is caught in a financial crisis, at which time would be difficult to reverse the policy.

$L_{FP,TN,TP}$ = $V_{TN,TN,TP} - V_{FP,TN,TP}$: The loss when distortionary taxation is insignificant but receives high weight, while time-consistency and agency costs correctly receive low and high weights respectively.

Ave: H The high weight on distortionary taxation unnecessarily causes agency costs and also poses implementation risk and distortion to private portfolios.

Var: H

Worst: H Poor implementation and significant distortions to private portfolios

$L_{FP,TN,FP}$ = $V_{TN,TN,TN} - V_{FP,TN,FP}$: The loss when distortionary taxation and agency cost is insignificant but receive high weight, while time-consistency is insignificant and correctly receives low weight.

Ave: L
Var: L } Same as for $L_{FP,FN,FP}$

Worst: L

4. Tax smoothing considered unimportant (L,H,H)

$L_{FN,TP,TP}$ = $V_{TP,TP,TP} - V_{FN,TP,TP}$: The loss when distortionary taxation is significant but receives low weight, while time-consistency and agency cost is significant and correctly receive high weight.

Ave: L Failure to assign high weight to distortionary taxation causes some losses but extent is limited because time-consistency and agency costs would constrain opportunity for tax smoothing under the correct policy.

Var: L

Worst: L

$L_{FN,TP,FP}$ = $V_{TP,TP,TN} - V_{FN,TP,FP}$: The loss when distortionary taxation is significant but receives low weight and agency cost is insignificant but receives high weight, while time-consistency is significant and correctly receives high weight.

Ave: H The high weight on agency costs constrains unnecessarily the ability to engage in valuable tax smoothing.

Var: H Extent of loss depends on occurrence of adverse shocks to economy.

Worst: H

$L_{FN,FP,TP}$ = $V_{TP,TN,TP} - V_{FN,FP,TP}$: The loss when distortionary taxation is significant but receives low weight and time-consistency is insignificant but receives high weight, while agency cost is significant and correctly receives high weight.

Ave: L Insufficient emphasis on tax smoothing, but losses are limited due to constraints from agency costs. The erroneously high weight on time-consistency could cause agency costs to be higher than warranted but impact limited because the high weight on distortionary taxation under the correct policy would also tend to limit debt levels (up to level where unjustified risk premia occur).

Var: L

Worst: L

$L_{FN,FP,FP}$ = $V_{TP,TN,TN} - V_{FN,FP,FP}$: The loss when distortionary taxation is significant but receives low weight and time-consistency and agency cost is insignificant but receive high weight.

Ave: H

Var: H Same as for $L_{FN,TP,FP}$

Worst: H

$L_{TN,TP,FP}$ = $V_{TN,TP,TN} - V_{TN,TP,FP}$: The loss when agency cost is insignificant but receives high weight, while distortionary taxation and time-consistency correctly receive low and high weights respectively.

Ave: L Too much weight on agency costs implies high debt target, thereby increasing the risk of time-inconsistency. However, risk is minimal provided time-consistency also receives high weight.

Var: L Low variance due to cautionary stance on debt level.

Worst: L

$L_{TN,FP,TP}$ = $V_{TN,TN,TP} - V_{TN,FP,TP}$: The loss when time-consistency is insignificant but receives high weight, while distortionary taxation and agency cost correctly receive low and high weights respectively.

Ave: L Too much weight on time-consistency inhibits the ability to use high debt level as a discipline on government expenditure, thereby increasing agency costs. The loss occurs only to the extent that the upper bound on debt implied by time-consistency would be less than the lower bound on debt implied by agency costs.

Var: L

Worst: L

$L_{TN,FP,FP}$ = $V_{TN,TN,TN} - V_{TN,FP,FP}$: The loss when time-consistency and agency cost are insignificant but receive high weights, while distortionary taxation is insignificant and correctly receives low weight.

Ave: L The high weights on time-consistency and agency cost is unnecessary but cause little damage. They act to constrain the actions of government but in a relatively harmless way because there is no tax smoothing imperative in any case.

Var: L

Worst: L

5. Exclusive focus on tax smoothing (H,L,L)

$L_{TP,FN,FN}$ = $V_{TP,TP,TP}$ - $V_{TP,FN,FN}$: The loss when time-inconsistency and agency cost are significant but receive low weights, while distortionary taxation is significant and correctly receives high weight.

Ave: H — An over-emphasis on tax smoothing relative to other issues increases agency cost and time-inconsistency risk through leveraging of the balance sheet.

Var: M — Losses due to time-consistency depend on occurrence of adverse shocks.

Worst: H — High losses could occur if agency costs do not become apparent until substantial fund of assets accumulated. Policy reversal could be difficult given political self-interest. High losses if the country is caught in a financial crisis, at which time would be difficult to reverse the policy on time-consistency.

$L_{TP,FN,TN}$ = $V_{TP,TP,TN}$ - $V_{TP,FN,TN}$: The loss when time-consistency is significant but receives low weight, while distortionary taxation and agency cost correctly receive high and low weights respectively.

Ave: L — Tax smoothing tend to imply leveraging of the balance sheet. However, extent of leveraging would be limited to the level where unjustified risk premia occur. To the extent that policy inconsistencies may occur in future with positive probability, the financial markets would be likely to price the risk as an observable interest rate premium on government bonds.

Var: M — Depends on occurrence of adverse shocks

Worst: H — High losses if the country is caught in a financial crisis, at which time would be difficult to reverse the policy on time-consistency.

$L_{TP,TN,FN}$ = $V_{TP,TN,TP}$ – $V_{TP,TN,FN}$: The loss when agency cost is significant but receives low weight, while distortionary taxation and time-consistency correctly receive high and low weights respectively.

Ave: H
Var: M — Same assessment as for $L_{TP,FN,FN}$

Worst: H

$L_{FP,FN,FN}$ = $V_{TN,TP,TP}$ – $V_{FP,FN,FN}$: The loss when distortionary taxation is insignificant but receives high weight and time-consistency and agency cost are significant but receive low weights.

Ave: H
Var: M — Same assessment as previous case

Worst: H

$L_{FP,FN,TN}$ = $V_{TN,TP,TN} - V_{FP,FN,TN}$: The loss when distortionary taxation is insignificant but receives high weight and time-inconsistency is significant but receives low weight, while agency cost is insignificant and correctly receives low weight.

Ave: M — Losses from tax smoothing arise from implementation risk and distortions to private portfolios. Tax smoothing also increases the risk of time-inconsistency up to the extent that unjustified risk premia put limit on leveraging of the Crown balance sheet.

Var: L — Magnitude of losses not highly dependent on state of economy.

Worst: H — Poor implementation and significant distortions to portfolios.

$L_{FP,TN,FN}$ = $V_{TN,TN,TP} - V_{FP,TN,FN}$: The loss when distortionary taxation is insignificant but receives high weight and agency cost is significant but receive low weight, while time-inconsistency is insignificant and correctly receives low weight.

Ave: H — High losses due to agency cost and implementation risk and portfolio distortions

Var: H

Worst: H

$L_{FP,TN,TN}$ = $V_{TN,TN,TN} - V_{FP,TN,TN}$: The loss when distortionary taxation is insignificant but receives high weight, while time-consistency and agency cost are insignificant and correctly receive low weight.

Ave: M
Var: L — Same as $L_{FP,FN,TN}$

Worst: H

6. Exclusive focus on time-consistency (L,H,L)

$L_{FN,TP,FN}$ = $V_{TP,TP,TP} - V_{FN,TP,FN}$: The loss when distortionary taxation and agency cost are significant but receive low weight, while time-consistency is significant and correctly receives high weight.

Ave: L — Low loss to the extent the structure of the Crown balance sheet would be similar to the case where high countervailing weights would be placed on both distortionary tax and agency cost. Losses occur to the extent that risks could be hedged without having an adverse impact on agency cost. Losses also occur to the extent that high weight on time-consistency results in lower debt target, causing higher agency cost.

Var: L — Relative to the correct policy where hedging would be constrained by agency cost issues, the size of losses would not be sensitive to state of the economy.

Worst: M — The worst case would be where derivative instruments and insurance products would allow substantive hedging without constraint from agency cost.

$L_{FN,TP,TN}$ = $V_{TP,TP,TN} - V_{FN,TP,TN}$: The loss when distortionary taxation is significant but receives low weight, while time-consistency and agency cost correctly receive high and low weights respectively.

Ave: H — With agency cost insignificant, the failure to place high weight on distortionary taxation is a lost opportunity.

Var: H — Size of loss depends on occurrence of adverse shocks

Worst: H

$L_{FN,FP,FN}$ = $V_{TP,TN,TP} - V_{FN,FP,FN}$: The loss when distortionary taxation and agency cost are significant but receive low weight and time-consistency is insignificant but receives high weight.

Ave: L

Var: L — Same assessment as for $L_{FN,TP,FN}$

Worst: M

$L_{TN,TP,FN}$ = $V_{TN,TP,TP} - V_{TN,TP,FN}$: The loss when agency cost is significant but receive low weight, while distortionary taxation and time-consistency correctly receive low and high weights respectively.

Ave: L — The low weight on tax smoothing limits the loss from incorrectly placing low weight on agency cost. Losses arise to the extent that time-consistency results in low debt target that causes higher agency cost.

Var: L

Worst: L

$L_{FN,FP,TN}$ = $V_{TP,TN,TN} - V_{FN,FP,TN}$: The loss when distortionary taxation is significant but receives low weight and time-consistency is insignificant but receives high weight, while agency cost correctly receive low weight.

Ave: H

Var: H — Same as for $L_{FN,TP,TN}$

Worst: H

$L_{TN,FP,FN}$ = $V_{TN,TN,TP} - V_{TN,FP,FN}$: The loss when time-consistency is insignificant but receives high weight and agency cost is significant but receives low weight, while distortionary taxation correctly receives low weight.

Ave: L

Var: L — Same as for $L_{TN,TP,FN}$

Worst: L

$L_{TN,FP,TN}$ = $V_{TN,TN,TN} - V_{TN,FP,TN}$: The loss when time-consistency is insignificant but receives high weight, while distortionary taxation and agency cost correctly receive low weights.

Ave: L The excess weighting on time-consistency motivates a low debt target, but at low cost since tax smoothing offers few gains and high debt targets are not needed to disciple government spending.

Var: L

Worst: L

7. Exclusive focus on agency cost (L,L,H)

$L_{FN,FN,TP}$ = $V_{TP,TP,TP} - V_{FN,FN,TP}$: The loss when distortionary taxation and time-consistency are significant but receive low weights, while agency cost correctly receives high weight.

Ave: L Losses to the extent that some tax smoothing could occur without causing significant agency cost. High debt target to discipline government spending increases the risk of time-inconsistency.

Var: L Strong fiscal disciplines allow scope to respond to most adverse shocks, e.g. by increasing the tax rate

Worst: H High losses if the country is caught in a financial crisis

$L_{FN,FN,FP}$ = $V_{TP,TP,TN} - V_{FN,FN,FP}$: The loss when distortionary taxation and time-consistency are significant but receive low weights and agency cost is insignificant but receives high weight.

Ave: H Losses much larger than the previous case because tax smoothing would not be constrained under the correct policy (where agency cost receives low weight).

Var: H Magnitude of losses depend on adverse shocks

Worst: H

$L_{FN,TN,TP}$ = $V_{TP,TN,TP} - V_{FN,TN,TP}$: The loss when distortionary taxation is significant but receives low weight, while time-consistency and agency cost correctly receive low and high weights respectively.

Ave: L Losses to the extent that some tax smoothing could occur without causing significant agency cost. But assume that high weight on agency cost would limit the extent of tax smoothing in the correct policy.

Var: L

Worst: L

$L_{TN,FN,TP}$ = $V_{TN,TP,TP} - V_{TN,FN,TP}$: The loss when time-consistency is significant but receives low weight, while distortionary taxation and agency cost correctly receive low and high weights respectively.

Ave: L High debt target to discipline government spending increases the risk of time-inconsistency.

Var: L Strong fiscal disciplines allow scope to respond to most adverse shocks, e.g. by increasing the tax rate

Worst: H High losses if the country is caught in a financial crisis

$L_{FN,TN,FP}$ = $V_{TP,TN,TN} - V_{FN,TN,FP}$: The loss when distortionary taxation is significant but receives low weight and agency cost is insignificant but receives high weight, while time-consistency correctly receives low weight.

Ave: H

Var: H Same as for $L_{FN,FN,FP}$

Worst: H

$L_{TN,FN,FP}$ = $V_{TN,TP,TN} - V_{TN,FN,FP}$: The loss when time-consistency is significant but receives low weight and agency cost is insignificant but receives high weight, while distortionary taxation correctly receives low weight.

Ave: L

Var: L Same as $L_{TN,FN,TP}$

Worst: H

$L_{TN,TN,FP}$ = $V_{TN,TN,TN} - V_{TN,TN,FP}$: The loss when agency cost is insignificant but receives high weight, while distortionary tax and time-consistency correctly receive low weights.

Ave: L The over-weight on agency cost constrains evolution of the balance sheet but at small cost since both tax smoothing and time-consistency are unimportant.

Var: L

Worst: L

8. All issues considered unimportant (L,L,L)

$L_{FN,FN,FN}$ = $V_{TP,TP,TP} - V_{FN,FN,FN}$: The loss when distortionary tax, time-consistency and agency cost are all significant but all receive low weight.

Ave: L Losses to the extent that some tax smoothing could occur without causing significant agency cost. But assume that high weight on agency cost would limit the extent of tax smoothing in the correct policy. There is no reason to expect the debt target would be higher than under the correct policy, therefore time-inconsistency risks would be no higher.

Var: L

Worst: L

$L_{FN,FN,TN}$ = $V_{TP,TP,TN} - V_{FN,FN,TN}$: The loss when distortionary tax and time-consistency are significant but receive low weight, while agency cost correctly receives low weight.

Ave: H With agency cost insignificant, the failure to place high weight on distortionary taxation is a lost opportunity. With no pressure from either tax smoothing or agency cost, a low debt target would be consistent with low risk of time-inconsistency.

Var: H Magnitude of loss depends on occurrence of adverse shocks.

Worst: H Loss of tax smoothing benefits in face of adverse shocks

$L_{FN,TN,FN}$ = $V_{TP,TN,TP} – V_{FN,TN,FN}$: The loss when distortionary tax and agency cost are significant but receive low weight, while time-consistency correctly receives low weight.

Ave: L
Var: L } Similar to $L_{FN,FN,FN}$
Worst: L

$L_{TN,FN,FN}$ = $V_{TN,TP,TP} - V_{TN,FN,FN}$: The loss when time-consistency and agency cost are significant but receive low weights, while distortionary taxation correctly receives low weight.

Ave: L With low weight on tax smoothing there is no pressure to build up fungible assets, implying low agency cost. With low weight on agency cost there is no pressure to maintain high debt target, so risk of time-inconsistency is low.

Var: L

Worst: L

$L_{FN,TN,TN}$ = $V_{TP,TN,TN} – V_{FN,TN,TN}$: The loss when distortionary taxation is significant but receives low weight, while time-consistency and agency cost correctly receive low weights.

Ave: H
Var: H } Similar to $L_{FN,FN,TN}$
Worst: H

$L_{TN,FN,TN}$ = $V_{TN,TP,TN} – V_{TN,FN,TN}$: The loss when time-consistency is significant but receives low weight, while distortionary taxation and agency cost both correctly receive low weights.

Ave: L
Var: L } Similar to $L_{TN,FN,FN}$
Worst: L

$L_{TN,TN,FN}$ = $V_{TN,TN,TP} - V_{TN,TN,FN}$: The loss when agency cost is significant but receives low weight, while distortionary taxation and time-consistency both correctly receive low weight.

Ave: L With low weight on tax smoothing there is no pressure to build up fungible assets, implying low agency cost. With low weight on time-consistency there is no pressure for very low debt targets, implying relatively low agency cost.

Var: L

Worst: L

Summary of results

Appendix Table 3 summarises the results above. The table records for each policy option the number of "high" (H) assessments for the average loss, variance of losses, and worst case. This is based on a 'diffuse prior', where the probability of each scenario has equal weight. The allocation of policy options to low, medium and high risk categories reported in Section 2 is based on this table.

Appendix Table 3 – Number of "High (H)" assessments

	Policy options							
	1 H,H,H	2 H,H,L	3 H,L,H	4 L,H,H	5 H,L,L	6 L,H,L	7 L,L,H	8 L,L,L
Average loss	2	6	4	2	4	2	2	2
Variance	2	0	5	2	1	2	2	2
Worst case	4	6	6	2	7	2	5	2