Modelling Federal Finances under Uncertainty

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Introduction

Recent studies have used stochastic simulation models to analyse issues related to federal fiscal policy. Some studies have estimated the amount of fiscal room available to the federal government over the next few years while others have examined the level of prudence required to maintain balanced budgets under various rules. The stochastic simulation models used in these studies contrast sharply with traditional projection models that are used to analyse many of the same fiscal issues.

The advantage of stochastic models is that they go beyond providing point estimates and capture the uncertainty inherent in the economy and in the budget process. For example, rather than simply providing an estimate of what the surplus will be in a given year, stochastic models also provide a range of possible outcomes, along with probabilities of achieving desired targets. This additional information can be valuable when evaluating different fiscal initiatives.

This paper presents an extended and modified version of the stochastic simulation model presented in Boothe and Reid (1998). The model is relatively simple, tractable and easy to understand. Moreover, it could be used to evaluate a wide range of fiscal policy issues.

The structure of our paper is as follows. Section I surveys recent studies. Section II briefly describes the model and its calibration. Section III presents simulation results of an illustrative application of our model that associates fiscal prudence and fiscal measures -- under alternative fiscal rules -- with probabilities of achieving budget surpluses over the medium term. Section IV provides a summary and conclusions.

I Recent Studies

Before turning to recent stochastic simulation model-based studies, it is helpful to highlight an example of recent work that has addressed similar fiscal policy issues using a deterministic, or non-stochastic, framework.

While a number of these studies exist, perhaps one of the most familiar projection exercises is McCallum (1996). In this study, McCallum uses a projection model and estimates that, over the period 2003-2018, there could be enough federal fiscal room to cut the federal personal income tax in half or increase program spending by a third (relative to GDP). McCallum assumes that the federal government maintains a balanced budget over this period and then projects federal fiscal room given constant growth and interest rate assumptions. While McCallum acknowledges that there is some uncertainty associated with his projections, he does not attempt to quantify the sensitivity of his results.

McCallum (1999) again projects fiscal dividends, however, in this exercise his estimates of fiscal room are reduced by prudence factors "in view of the major uncertainties involved in any future projections". Over the period 1999 to 2007, McCallum estimates that if all of his revised estimate of federal fiscal room were devoted to tax reduction, federal personal income taxes could be cut by 20 per cent after adjusting for prudence factors. While McCallum attempts to account for uncertainty in his estimates, there is no way of determining whether the prudence factors he uses are sufficient to ensure that his fiscal objectives will be achieved.

In contrast to McCallum's approach, Boothe and Reid (1998) use a stochastic model to evaluate the degree of federal fiscal prudence required to ensure against deficits under various balanced-budget rules (i.e., rules where the budget is balanced every year versus two- and four-year rules). Fiscal prudence is incorporated through an annual contingency reserve that is used as a buffer against unfavourable budget shocks. In their model, the federal government bases fiscal forecasts on its "best guess" of macroeconomic conditions. Their main finding is that annual contingency reserves of $6 and $9 billion appear to provide "adequate insurance" under the two- and four-year balanced-budget rules. However, Boothe and Reid's model structure and calibration likely overstate the amount of uncertainty that the government faces, and thus the amount of prudence required.

Robson (1999) uses a stochastic simulation model to estimate the probability that the federal government could undertake various tax reduction initiatives while maintaining minimum surplus levels and ensuring a decline in the debt-to-GDP ratio.[1] Robson argues that federal finances have improved sufficiently that annual tax cuts of $4 billion could be implemented while meeting the benchmarks of consistently running surpluses and reducing the debt-to-GDP ratio with a 90 per cent probability. While Robson's approach is appealing in that it estimates the amount of tax cuts that are feasible given various fiscal benchmarks, the structure of his model limits the range of possible economic outcomes, likely exaggerating the probability of achieving surpluses.

Hostland and Matier (1999) provide a detailed examination of the fiscal policy trade-off between debt control, tax smoothing and stabilisation objectives using a stochastic simulation model. Their analysis focuses primarily on strategies/rules that keep the debt-to-GDP ratio on a downward profile. This stands in contrast to the Robson (1999) and Boothe and Reid (1998) studies, which tend to examine strategies that avoid deficit outcomes. Their results demonstrate that a "flexible debt rule" (i.e., a strategy that entails allowing the debt-to-GDP ratio to fluctuate in the short-term but then bringing it back to its desired level over the long-term) provides for a moderate amount of debt control without sacrificing the tax smoothing and stabilisation objectives of fiscal policy.

With the exception of Boothe and Reid (1998), these studies have not directly associated alternative levels of fiscal prudence with probabilities of achieving budgetary surpluses. Moreover, all of the existing studies have failed to incorporate the federal budgetary planning process based on rolling two-year targets. This paper builds on these previous studies by providing a more realistic model-based assessment of fiscal prudence and planning under uncertainty. Given its transparency and tractability, the Boothe and Reid (B-R) model of the federal budget provides the foundation for our stochastic model. We modify and extend the B-R model in order to address these issues.

[1] Robson and Scarth (1999) use the same approach to evaluate various debt reduction strategies.

II Model Description and Calibration

This section describes a compact and transparent stochastic model of the federal budget that consists of two components: the economy and the federal fiscal structure. Nominal GDP and a market interest rate are determined by simple stochastic processes, which in turn affect federal revenues, employment insurance benefits, and public debt charges.

The Economy

Specification and Calibration

As in Boothe and Reid (1998), stochastic processes for nominal GDP Y, and the nominal interest rate i, are described, respectively, by ARI(1,1) and ARI(0,1) processes.

(1) $$? \ln Y_t = a + ß \cdot ? \ln Y_{t-1} + e_t$$

(2) $$? i_t = ? + \mu_t$$

Stochastic processes for nominal GDP growth and interest rates were re-estimated using revised data for the period 1961-98.[2] Consistent with the projection underlying the November 2, 1999 *Economic and Fiscal Update* (henceforth referred to as *The Fall Update*) trend growth in nominal GDP is set at 4.5 per cent.[3] We then re-calibrated the standard error of e to reflect lower volatility in nominal GDP growth consistent with the current low-inflation regime, providing a more realistic range of potential outcomes. Our model generates a variance of nominal GDP growth consistent with the combined variance of real GDP growth over the 1961-98 period and the variance of inflation over the 1991-98 period (and its covariance over 1961-98). The implied standard deviation for nominal GDP growth in our model is 2.26 per cent.

The standard deviation of interest rate changes is set at 1.54 per cent and was not adjusted in the same manner as nominal GDP growth since it is difficult to assess whether this

[2] Regression results are available upon request.

[3] The average of private sector projections (in the Fall of 1999) of nominal GDP growth for 2000-01 was 4.6 per cent and 4.5 per cent for 2002-05.

value would increase or decrease under a low-inflation regime. The correlation between the two shocks is 0.40. This positive correlation implies that in years with lower growth, interest rates will tend to be low and vice-versa.

Equation (3) below defines the effective interest rate on federal net public debt i^D. The market interest rate is represented by i, $?$ is a calibration term (reconciling the market and effective interest rate) and $\bar{i}^D$ is the interest rate at which fixed-rate debt is financed. The effective interest rate is calibrated such that its steady-state level is consistent with *The Fall Update* over the period 1999/00 to 2004/05. The effective rate trends down over the period, as higher cost debt is being refinanced at lower rates.

(3) $$i_t^D = ? + 0.24 \cdot i_t + 0.08 \cdot (i_{t-1} + i_{t-2}) + 0.6 \cdot \bar{i}^D$$

This moving-average specification essentially assumes three kinds of debt. The first is referred to as short term, and is refinanced in every year. The second is referred to as medium term, and is refinanced every three years. Finally, a certain percentage of the debt does not need to be refinanced given that the model only simulates over a five-year horizon and the average term to maturity of the federal debt stock exceeds five years.[4] The specification of the effective interest rate equation, in conjunction with the standard deviation of the interest rate shock, generates a standard deviation (in terms of the first difference of the effective interest rate) of approximately 0.42 per cent.

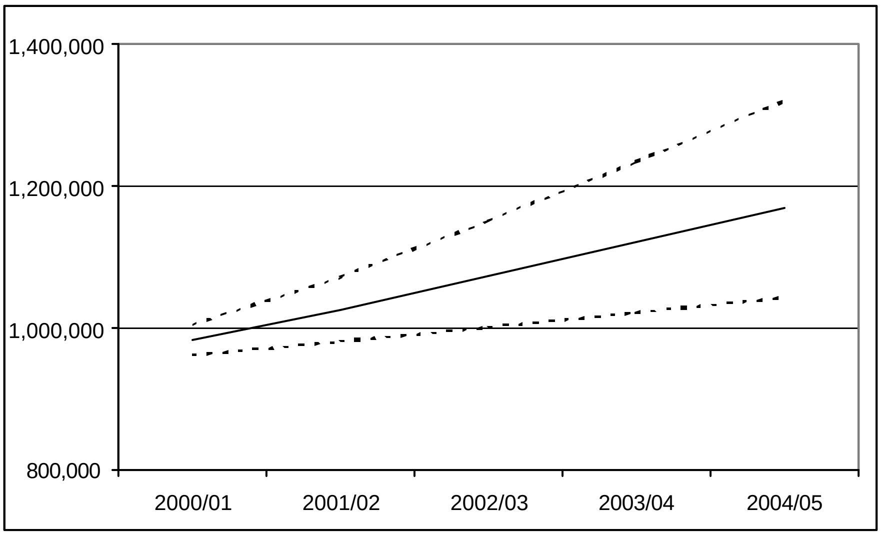
Our estimates of the volatility of nominal GDP growth and public debt charges are considerably lower than Boothe and Reid (1998). The implied standard deviation of GDP growth in our model is about 45 per cent lower than the 4.1 per cent (consistent with the historical period 1950-97) generated by the B-R model. The standard deviation (in terms of the first difference of the effective interest rate) in our model is about two-thirds lower than the B-R model (0.42 per cent versus 1.27 per cent). Boothe and Reid (1998) acknowledge that they likely overstate the volatility of public debt charges given their assumption that the entire debt stock is refinanced each year.

[4] The shares between the three types of debt are assumed to be constant over the period, consistent with the government's current debt management policy.

Range of Economic Outcomes

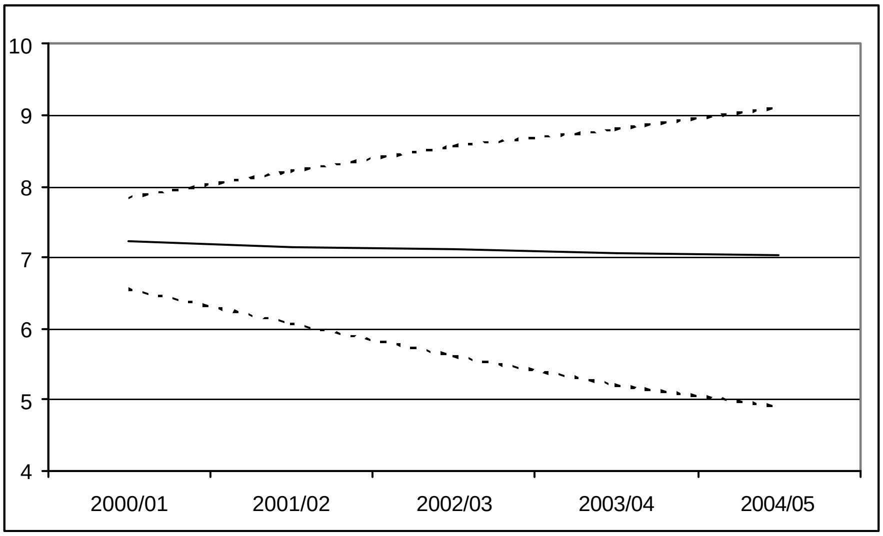
Charts below depict 90 per cent confidence intervals for the level of nominal GDP and the effective interest rate on federal debt. As per *The Fall Update*, in 1999/2000, nominal GDP is assumed to be $941.1 billion and the effective interest rate is 7.2 per cent.

Nominal GDP ($millions)



From the above chart, it is apparent that the model allows for a wide range of GDP outcomes, with uncertainty increasing throughout the period. Nominal GDP grows, on average, at the 4.5 per cent trend growth rate and the bounds of a 90 per cent confidence interval (CI) vary from $962 billion to $1,005 billion in 2000/01. By 2004/05, this range increases to between $1,043 billion and $1,321 billion, with a median of $1,170 billion. This range appears reasonable, with the lower bound representing average annual growth in nominal GDP of 2.1 per cent over the period, and the upper bound representing about 7.0 per cent. It is important to note that while the implied standard deviation of GDP growth in our model is 2.26 per cent, the historical standard deviation of about 4 per cent (for the period 1961-98) would generate a much larger range of outcomes.

Effective Interest Rate (per cent)



Market interest rates follow a random walk and are translated into the effective interest rate on public debt. In 2000/01, the median effective interest rate is 7.2 per cent and this falls steadily to 7.0 per cent by 2004/05. A 90 per cent CI varies from 6.5 per cent to 7.8 per cent in 2000/01 and in 2004/05, this range is between 4.9 per cent and 9.1 per cent.

The stochastic trends embodied in nominal GDP and the interest rate treat all shocks as if they were permanent, resulting in growing confidence intervals over the five-year period. In commenting on the Boothe and Reid study, Egelton (1998) concludes that this type of specification generates "extreme" outcomes. Egelton argues that a process that treated output shocks as "temporary and gradually brought output back to potential" would better approximate economic reality. While this alternative would be appropriate for a "best guess" forecast, it could truncate the range of "possible outcomes" by more than would be appropriate for a true "contingency" analysis. Moreover, a process that treated output shocks as temporary could also give rise to highly persistent movements that would resemble a stochastic trend process over the five-year time horizon considered in this paper. Consequently, the distinction between adjustment processes over the time period in question is not crucial.

Another issue is whether adding more structure would reduce the amount of uncertainty. However, the implications of this are not clear. A model with more structure could reduce, or expand, the range of economic outcomes beyond that implied by our economic structure over such a relatively short time horizon. In addition, it is important to note that there are other sources of uncertainty that are not taken into account in our framework. This includes, for example, parameter and model uncertainty, as well as fiscal uncertainty unrelated to economic uncertainty.

<u>Fiscal Structure</u>

Revenue

A one-to-one relationship between revenue and nominal GDP growth is assumed, consistent with the estimates presented in *The Fall Update.* As well, revenue is assumed to grow by 0.36 per cent following a 100-basis point increase in the nominal interest rate, reflecting the increased rate of return on the federal government's assets (which are accounted for in non-tax revenue). Equation (4) defines revenue growth.[5]

(4) $$?\ \ln R_t = ?\ \ln Y_t + 0.36 \cdot ?\ i_t$$

The median revenue path generated by the model (assuming no fiscal measures), shown in the table below, is very close to the projection presented in *The Fall Update.* Total revenues grow from $158.0 billion in 1999/00 to $196.7 by 2004/05. In 2000/01, the bounds of a 90 per cent CI vary between $160.6 billion and $169.5 billion. By 2004/05, this band increases such that a 90 per cent CI yields a range of about $50 billion.

Budgetary Revenue Outcomes (assuming no fiscal measures)

($ billions)	**1999/00**	**2000/01**	**2001/02**	**2002/03**	**2003/04**	**2004/05**
Budgetary Revenue	158.0	165.0	172.4	180.3	188.4	196.7
95th percentile	-	*169.5*	*181.3*	*194.7*	*207.9*	*223.4*
5th percentile	-	*160.6*	*163.5*	*166.4*	*169.5*	*173.2*
The Fall Update	158.0	164.5	172.5	180.0	188.0	197.0

[5] Boothe and Reid incorporate a lag in their revenue equation because of lags associated with transmitting calendar year GDP outcomes into fiscal-year results. In order to avoid this, we use fiscal year GDP and retain the original one-to-one relationship between revenue and nominal GDP growth.

Program Spending

In our model, trend program spending PE^T is predetermined, the same approach used by Robson (1999). The trend growth rate is assumed to be 2.8 per cent, slightly below the forecasted combined growth in the population (1.2 per cent) and inflation (1.8 per cent) over the five-year period.[6]

Fluctuations in program spending, due to the sensitivity of EI benefits to economic conditions, are modelled in equation (5) below as a function of nominal GDP. The sensitivity of EI benefits is calibrated such that a 1 per cent increase (decrease) in nominal GDP (relative to its trend steady-state level Y^T) results in a $500 million decrease (increase) in EI benefits each year.[7] Incorporating this sensitivity into the model *ceteris paribus* increases the dispersion of budget outcomes given its counter-cyclical nature.

(5) $$PE_t = PE_t^T - 500 \cdot \left[100 \cdot \left(\frac{Y_t - Y_t^T}{Y_t^T} \right) \right]$$

Assuming no fiscal measures, median program spending (shown in the table below) rises from $111.5 billion in 1999/00 to $128.1 billion in 2004/05. In 2000/01, the bounds of a 90 per cent CI are $113.5 billion and $115.7 billion. By 2004/05, 90 per cent of the outcomes fall between $121.7 billion and $133.5 billion, a range of about $12 billion. Thus, relative to revenues, program spending is fairly stable from year to year.

Program Spending (assuming no fiscal measures)

($ billions)	**1999/00**	**2000/01**	**2001/02**	**2002/03**	**2003/04**	**2004/05**
Program Spending	111.5	114.6	117.9	121.1	124.5	128.1
95th percentile	-	*115.7*	*120.1*	*124.5*	*129.0*	*133.5*
5th percentile	-	*113.5*	*115.7*	*117.5*	*119.5*	*121.7*
The Fall Update	111.5	113.5	118.0	121.0	124.0	127.5

[6] Estimates of the growth in population and inflation are taken from *The Fall Update*.

[7] This amount is taken from the Department of Finance's sensitivity analysis of EI benefits.

Public Debt Charges and the Budgetary Surplus

In equation (6), the effective interest rate (defined in equation (3) above) is applied to the previous period's level of debt *D*. All *ex post* budgetary surpluses *S* are applied to the debt.

$$(6) \qquad DS_t = i_t^D \cdot D_{t-1}$$

$$(7) \qquad D_t = D_{t-1} - S_t$$

Public debt charges generated by the model (assuming no fiscal measures) cannot be directly compared to *The Fall Update.* For budget planning purposes, those projections assumed that the debt stock falls by $3 billion per year, implying that the Contingency Reserve would not be required and would be applied to the net public debt (as per the Debt Repayment Plan). Under the same assumption about the debt stock, the model would project median public debt charges similar to the forecast in *The Fall Update.*

Fiscal Rules

Previous studies have failed to incorporate the current federal budgetary planning process which is based on rolling two-year fiscal plans. For example, the fiscal rule in the B-R model adjusts program spending such that the federal budget is balanced in an expected-value sense (allowing for a contingency reserve). This rule, as Egelton (1998) notes, assumes that there are no rigidities and/or constraints to changes in program spending on year-to-year basis. Thus, this rule can generate large, unrealistic, year-over-year changes in program spending.

This paper provides a more realistic model-based assessment of fiscal prudence and planning under uncertainty. As well, it allows us to evaluate the relative merits of different approaches to budget planning.

We consider two alternative types of fiscal rules. The first fiscal rule commits the fiscal authority to a pre-determined path of fiscal measures. In this case, the fiscal authority determines a path of fiscal measures prior to the five-year period using various levels of fiscal prudence and then implements these measures accordingly, regardless of future economic/fiscal conditions. There is no flexibility to change, or backtrack, on these measures; nor are these measures increased if circumstances turn out to be better-than-expected. Favourable outcomes result in additional debt reduction. This is the type of fiscal rule in Robson (1999).

The second fiscal rule allocates an expected surplus (net of fiscal prudence)[8] to fiscal measures based on a rolling two-year planning horizon. In period *t-1*, the fiscal authority forecasts revenues and expenditures for periods *t* and *t+1*. Fiscal measures for those years are then set exactly equal to the expected surplus less fiscal prudence.[9] Under this rule, once measures are announced in period *t-1*, they are implemented regardless of the economic/fiscal conditions realised in periods *t* and *t+1*. There is no flexibility to change, or backtrack, on these measures; these measures are permanent and irreversible.

However, it is important to note that these fiscal measures are only announced if there is in fact fiscal room available (i.e., expected surpluses net of fiscal prudence). If no fiscal room is available, no measures are announced. Next, in period *t*, the previous period's announced measures are implemented and forecasts for the next two years are again calculated. Moreover in period *t*, fiscal measures for *t+1* can be increased above their previously announced levels if and only if additional fiscal room is available. Minimum fiscal measures for period *t+2* are also announced at this time if fiscal room warrants.

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[8] Fiscal prudence, as defined in federal budget documents, includes a contingency reserve and an extra degree of economic prudence. For modelling purposes, we do not distinguish between the two components.

[9] Fiscal measures can be allocated in any proportion between program spending and taxes.

III Illustrative Application: Fiscal Prudence and Fiscal Rules

Given starting values from *The Fall Update*, our model (under the two fiscal rules described above) was simulated repeatedly over a five-year horizon generating 1000 realisations of the period 2000/01 to 2004/05.[10]

Five-year Commitment Rule

Under the five-year commitment rule, the table below shows how much prudence would be required for various probabilities of achieving a surplus in a given year. The corresponding fiscal measures[11] and joint probability of consistently running surpluses are also included in each case.

With no fiscal prudence, the entire fiscal room ($28.8 billion) would be devoted to fiscal measures -- tax reductions and new spending. By construction, there would be a 50 per cent chance of achieving a surplus in a given year. The probability of running five consecutive surpluses is 33 per cent.

If a 70 per cent probability of being in surplus in a given year were desired, the model suggests prudence in the first two years of $1.5 billion and $2.9 billion, and then rising to $8.9 billion in the fifth year (2004/05). However, total measures would fall by an equivalent amount in each year, leaving $19.9 billion by 2004/05. The probability of consistently running surpluses over the five-year period rises to 55 per cent.

In order to increase the probability of being in surplus in a given year to 90 per cent, the model suggests prudence of $3.3 billion and $7.2 billion in the first two years, rising to $20.3 billion in 2004/05. While such an approach would go a long way to ensuring a surplus (e.g., the probability of consistently running surpluses rises to just over 80 per cent) it leaves considerably less room for the government to introduce fiscal

[10] For each simulation this entails generating 5000 realisations of the error terms that are normally distributed with mean zero and standard deviations/correlation described Section II.

[11] In all cases, fiscal measures are defined as the difference between the new revenue or expenditure stream and the path of revenues and/or expenditures *that would have been realised in the absence of the new fiscal measure*.

measures. In fact, measures of $5.7 billion and $6.3 billion could be enacted in years one and two, with room for only $8.5 billion in measures in the fifth year (2004/05).

Prudence and Probabilities of Surplus under Five-Year Commitment Rule

($ billions)	2000/01	2001/02	2002/03	2003/04	2004/05
Fiscal Room	9.1	13.5	18.3	23.7	28.8
Probability of Surplus: 50%					
Fiscal Measures	9.1	13.5	18.3	23.7	28.8
Fiscal Prudence	0.0	0.0	0.0	0.0	0.0
Surplus in every year					*33%*
Probability of Surplus: 60%					
Fiscal Measures	8.3	12.1	16.4	20.6	25.0
Fiscal Prudence	0.8	1.4	1.9	3.0	3.8
Surplus in every year					*45%*
Probability of Surplus: 70%					
Fiscal Measures	7.6	10.6	13.5	16.6	19.9
Fiscal Prudence	1.5	2.9	4.8	7.1	8.9
Surplus in every year					*55%*
Probability of Surplus: 80%					
Fiscal Measures	6.7	8.8	10.6	12.7	14.6
Fiscal Prudence	2.3	4.7	7.7	11.0	14.1
Surplus in every year					*67%*
Probability of Surplus: 90%					
Fiscal Measures	5.7	6.3	6.6	7.5	8.5
Fiscal Prudence	3.3	7.2	11.7	16.1	20.3
Surplus in every year					*81%*

The Fall Update incorporated total prudence of $4.0 billion, $5.0 billion, $6.0 billion, $6.5 billion and $7.0 billion (for planning purposes) over the period 2000/01 to 2004/05. Roughly speaking, this would suggest that the probability of being in surplus is in the 80 per cent to 90 per cent range in the first two years, consistent with the government's commitment to budget balance over a two-year horizon. The probability of achieving a surplus falls below 80 per cent in the third year and is between 60 per cent and 70 per cent in the last two years if measures were fully pre-committed over the entire five-year period.

Rolling Two-year Rule

Now we consider a fiscal rule where the government allocates an expected surplus (net of fiscal prudence) to fiscal measures based on a rolling two-year planning horizon. The table below shows results using the rolling two-year rule under varying amounts of fiscal prudence.

Under the rolling two-year rule, the amount of fiscal measures varies within each year over the five-year period. Given the opportunities to revise upward and the conditional nature of our two-year fiscal rule, a range of fiscal measures is generated for given levels of fiscal prudence. As a result, there is no unique path of fiscal measures as in the case of the five-year commitment rule. Thus under the rolling two-year rule, it is not possible to determine *ex ante* the total amount of fiscal measures that will be implemented over the five-year period. Minimum measures can be announced and will be implemented under the rolling two-year rule since there is in fact an expected surplus (net of fiscal prudence) for fiscal years 2000/01 and 2001/02.

With fiscal prudence of $2 billion in the first year and $2.5 billion in the second year of the planning horizon, the probability of being in surplus in 2000/01 is 77 per cent and quickly falls, reaching 45 per cent by 2004/05. This probability falls significantly in part because relatively substantial fiscal measures are committed in advance for the first two years. As well, lower levels of prudence imply that, on average, larger fiscal measures would be committed to during the five-year period.[12] The probability of consistently running surpluses over the five-year period in this case is only 20 per cent and a given sequence of two-year plans runs into deficit by the fourth and fifth year more often than not.

The rolling two-year rule with fiscal prudence of $2 billion and $2.5 billion allows for median fiscal measures of $7.0 billion in 2000/01 rising to $29.7 billion in 2004/05. By 2004/05, 90 per cent of the simulations have fiscal measures that fall between

[12] While there are opportunities to re-plan under this fiscal rule, we have assumed for simplicity that announced fiscal measures can only be revised upward. Moreover, in cases where no fiscal room is forecasted (i.e., deficits net of fiscal prudence are forecasted) future measures are not announced and no fiscal actions are undertaken to prevent or alleviate a forecast deficit.

$12.5 billion and $56.7 billion, a range of $44 billion. Minimum measures are $7.0 billion in 2000/01 and $11.0 billion in 2001/02.

With fiscal prudence of $4 billion and $5 billion in the two-year planning horizon -- the current amounts used by the federal government for budget planning -- the probability of achieving a surplus is 94 per cent in 2000/01, 78 per cent in 2001/02, and falls to 66 per cent in 2004/05. This allows for median fiscal measures of $28.0 billion in 2004/05, with a range of about $46 billion. Minimum measures are $5.0 billion in 2000/01 and $8.5 billion in 2001/02. Compared to the previous case, the probability of consistently running surpluses more than doubles to 46 per cent and an *ex post* surplus is realised on average.

Prudence and Probabilities of Surplus under Rolling Two-Year Rule

($ billions)	2000/01	2001/02	2002/03	2003/04	2004/05
Fiscal Prudence (year 1/year 2):					
2.0/2.5 $billion					
Median Surplus	2.1	0.8	0.2	-0.2	-0.5
Probability of Surplus	77%	57%	52%	48%	45%
Median Fiscal Measures	7.0	11.8	18.2	24.1	29.7
95th percentile	*7.0*	*20.4*	*31.2*	*43.7*	*56.7*
5th percentile	*7.0*	*11.0*	*11.5*	*12.0*	*12.5*
Surplus in every year					*20%*
4.0/5.0 $billion					
Median Surplus	4.1	3.1	2.5	2.2	2.0
Probability of Surplus	94%	78%	70%	68%	66%
Median Fiscal Measures	5.0	9.9	16.3	22.1	28.0
95th percentile	*5.0*	*18.6*	*29.2*	*41.9*	*55.5*
5th percentile	*5.0*	*8.5*	*8.9*	*9.3*	*9.7*
Surplus in every year					*46%*
6.0/7.5 $billion					
Median Surplus	6.1	5.2	4.7	4.4	4.3
Probability of Surplus	99%	91%	84%	81%	80%
Median Fiscal Measures	3.0	8.1	14.5	20.2	26.2
95th percentile	*3.0*	*16.8*	*27.5*	*40.2*	*54.3*
5th percentile	*3.0*	*6.0*	*6.3*	*6.5*	*6.8*
Surplus in every year					*68%*

With fiscal prudence of $6 billion and $7.5 billion, a surplus is virtually guaranteed in 2000/01 and the probability of achieving a surplus in 2001/02 is 91 per cent. Over the last three years, the probability of achieving a surplus in a given year is over 80 per cent. These levels of fiscal prudence still allow for $26.2 billion in median fiscal measures (with minimum measures of $3.0 billion in 2000/01 and $6.0 billion in 2001/02). On the other hand, there is still close to a one-in-three chance of falling into deficit at least once over the five-year period.

Comparing the two fiscal rules illustrates a fundamental trade-off in fiscal planning and implementation. For a given amount of fiscal measures, the probability of avoiding a deficit in a given year is higher under the rolling two-year rule. For example, using the rolling two-year rule, $28.0 billion in fiscal measures could be implemented (on average) with a probability of achieving a surplus in 2004/05 of 66 per cent. In contrast, under the five-year commitment, $28.8 billion in fiscal measures could be implemented with only a 50 per cent of achieving a surplus in 2004/05. This trade-off is similar in terms of the probability of *consistently* running surpluses with similar fiscal measures under the two different fiscal rules (approximately 46 per cent versus 33 per cent respectively under the rolling two-year and five-year commitment rules).

As noted above however, under the rolling two-year rule, there is a *range* of actual fiscal measures. While there may be less uncertainty about the budgetary balance under the rolling two-year rule, this does come at a cost -- increased uncertainty surrounding the amount of fiscal measures that will be implemented relative to a longer-term commitment. However, the implied commitment to a long-term sequence of fiscal measures may prove illusory in the face of negative economic shocks, suggesting that this "cost" should not be overstated.

Summary and Conclusions

The model presented in this paper is a relatively simple stochastic simulation model, which is tractable and easy to understand. It generates a wide range of economic and fiscal outcomes, with the uncertainty surrounding these variables increasing over time. It does not generate forecasts in and of itself, but it provides important supplementary information that allows policy inferences to be drawn from a given forecast.

We use the model to associate levels of fiscal prudence and fiscal measures with probabilities of achieving budget surpluses over the medium term, under alternative fiscal rules. The example shows that a rolling two-year fiscal rule can offset some of the uncertainty associated with future budget outcomes. By proceeding in annual steps, the risk of deficit outcomes can be significantly decreased.

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