

**Evaluation of the Government's Decision to Target a
Higher Fixed Rate Debt Structure**

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EXECUTIVE SUMMARY

This report evaluates the Government's decision to target a higher fixed-rate debt structure. The goal is to provide stable, low-cost funding for the Government and to maintain a well-functioning market for Government of Canada securities. Canada's policy objectives are compared to the policy objectives of other countries, and are generally found to be similar.

A number of possible secondary policy objectives from the theoretical literature are evaluated as well. These include averting a confidence crisis; adjusting debt maturity structure to promote economic growth; minimizing the tax impact of economic shocks; and influencing future government policy. In general, we conclude that the secondary objectives are consistent with current practice. They amplify the primary objectives, and should be considered when formulating government debt management policy.

The report also evaluates current quantitative methodologies and indicators. Government hedging policy addresses the tradeoff between costs and risk employing Cost at Risk (CaR). An alternative measure, the asset-liability-management (ALM) framework, is evaluated in the context of Government policy objectives. Advantages associated with an ALM approach are that it is an endogenously derived benchmark that accounts for shifts in the market value of debt. Disadvantages include the lack of evidence regarding applicability of ALM to governments, the need to rebalance, and the need to perform difficult asset value assessments. Because there are no plans for significant asset sales by the Government, this report does not recommend that the ALM model be pursued further.

The report notes that the Government measures its exposure to interest rate risk using a fixed-floating ratio, with supplementary use of average time to maturity and duration. Exposure is quantified through calculating Cost at Risk and comparing it to the contingency reserve. The evaluation suggests that these measures are consistent with best practices in other countries as well as relatively simple to employ and to understand. Alternative measures of risk include rollover risk and investor confidence.

Consistently with best practices, interest rates are modelled using a Cox-Ingersoll-Ross (CIR) two-factor model over a five-year horizon. The report argues that there is room for improvement in model estimation techniques, and notes that a current Government study is moving in this direction. Beyond the term structure, there are important opportunities to enhance the economic model behind the simulation by creating analytical links among the surplus or deficit position of the government, the evolution of the term structure and general economic conditions. Further advantages that could derive from model improvements include incorporating a disaster scenario to endogenize stress testing as well as improving the distribution assumptions in the CaR exercise.

One limitation associated with the current simulation technology and summary techniques is their time inefficiency. Another limitation is that there is currently no practical method through which historical data can be input into the simulation, limiting backcasting exercises, which could test for model risk.

SECTION 1. OBJECTIVES AND SCOPE OF THE PROJECT

This report examines the Government's policy of targeting a higher fixed rate structure, currently two-thirds fixed, in the context of two general objectives:

- To provide stable, low-cost funding for the Government; and
- To maintain a well-functioning market for Government of Canada securities.

It examines current policy documents including Debt Management Report 2000-2001 and Debt Management Strategy 2001-2002.

Section 2 provides a review of the government's objectives with two questions in mind. First, how do the Government's objectives compare to those reported for other countries? Second, what secondary policy objectives are considered in the debt management literature, and how can they influence debt management in Canada?

Section 3 reviews current quantitative methodologies and indicators. The review is formulated in terms of comparing Canada's methodologies against best practices, as identified in Gottesman (2002). Hence, Section 3 provides an assessment of the extent to which each indicator is consistent with best practices identified in the review of the academic literature and practice. It also includes a study of Cost-at-Risk methodology examining internal studies conducted by the Department of Finance against the benchmark of best practices. Section 3 is organized around three questions. First, what should the Government hedge? Second, how should the Government's exposure to interest rate risk be measured? Third, how are interest rates and Government budgets modelled and simulated?

Finally, Section 4 ends this report with a set of conclusions.

SECTION 2. REVIEW OF POLICY OBJECTIVES

In this section, a review of the policy objectives followed by Canada's debt strategy managers is provided. The consultant conducted the review in the context of best practices/recent developments in both the academic literature and with other sovereign debt managers as determined in a related study by Gottesman (2002).

According to Department of Finance Canada's Debt Management Report 2000-2001 (2001), the fundamental objectives of debt strategy management are to:

- Provide stable, low-cost funding for the government
- Maintain a well-functioning market for Government of Canada securities.

To review these policy objectives, we focus on two key issues. First, we compare Canada's policy objectives to the policy objectives of other countries. Second, we consider secondary policy objectives discussed in the debt management policy literature.

2.1. Canada's policy objectives compared to other countries

As reviewed in Gottesman (2002), each of the following four policy objectives are considered when formulating debt management policy:

- Ensure government financing requirements
- Minimize borrowing cost

- Keep risks at an acceptable level
- Support domestic capital markets

Canada's two stated objectives, namely the provision of stable, low-cost funding for the government and the maintenance of a well-functioning market for Government of Canada securities, effectively span all four objectives considered in the survey.

2.2. Secondary policy objectives in debt management policy literature

Besides the stated objectives considered in the previous subsection, the theoretical literature discusses a number of additional goals associated with debt management policy. Like the Government of Canada's stated objectives, those below are not mutually exclusive, with respect to either each other or to the stated objectives. Instead, they are secondary objectives that governments may wish to consider when formulating and practicing debt management.

Averting a confidence crisis: Debt-holders who fear debt monetization (or default) on the part of a government that issued nominal debt will require a higher nominal rate of interest. This type of "confidence crisis" may increase the probability of a policy regime shift occurring. How can a confidence crisis be averted? Two arguments are as follows:

- Through indexation, as there is no incentive to monetize. Hence debt-holders will not require a higher nominal rate of interest (Calvo, 1988, 1990).
- Due to the positive relationship between the cost to the Government due to a change in expectations and the amount of debt to be rolled over at any given time, the Government is more likely to monetize when more debt is rolled over. Hence, the

confidence crisis can be reduced through spreading the amount of debt to be rolled over evenly through time (Giavazzi and Pagano, 1990). This is consistent with setting a significant portion of debt as fixed rate.

Maturity structure and economic growth: As reviewed by Gottesman (2002), an early study by Tobin (1963) argues that substituting short-maturity debt for long-maturity debt will stimulate investment demand. Additional empirical research on U.S. data provides evidence of a weak relation between changes in the maturity composition of public debt and the expected rate of return on corporate stock. However, the results confirm the idea that a substitution of short- for long-maturity debt reduces the expected rate of return on corporate stock, though the magnitude of this effect is small (See Roley, 1982, Friedman, 1981, 1985, and 1986, Frankel, 1985, and Agell and Persson, 1992).

Minimizing the tax impact of economic shocks: Conventional financial instruments can be used to minimize the risk of tax-rate adjustments in response to shocks that adversely affect the government budget. Generally, academic studies conclude that the choice of debt instruments depends on the types of shocks and their persistence. Some specific arguments, as reviewed by Gottesman (2002), are as follows:

- Nominal debt is a superior hedging instrument for the government during periods of productivity and public spending shocks, while price-indexed debt is a superior hedging instrument during periods of monetary disturbance and real (non-spending related) shocks to aggregate demand (Bohn, 1988).
- Foreign debt is superior to nominal debt when hedging against domestic output fluctuations, insofar as it provides insurance for the budget from monetary shocks to the domestic economy (Bohn, 1990).

- A larger share of fixed-rate debt is required when supply shocks are more persistent than demand shocks, as the impact on permanent output is stronger (Hawbesky and Wright, 1997). As we discuss below, Canada’s fixed-rate debt is proportionally smaller than that of most other OECD countries. This suggests that Canada’s debt profile is less prepared for supply shocks than other countries.

Influencing future government policy: Some argue that the maturity structure of debt can be chosen such that future governments cannot change debt strategy management policy (Lucas and Stokey, 1983, and Persson et al., 1984 and 1987). Such maturity structure of debt will ensure time-consistency because the chosen maturity structure will eliminate subsequent governments’ incentive to depart from the policy the current government has optimally chosen. While not an explicitly stated consideration in the Government of Canada’s debt management policy, this objective may be seen as long-term promotion of market stability.

2.3. Summary of review of policy objectives

Canada’s current policy objectives are to “provide stable, low-cost funding for the government and maintain a well-functioning market for Government of Canada securities”. These primary objectives are consistent with international best practices, and span four primary objectives shared by others.

The literature review identifies a number of secondary objectives that expand on the primary policy objectives. Many of these objectives are outside the scope of this study. (For example, the role of inflation indexation in lessening the probability of a confidence crisis.) Setting these aside, the secondary objectives are consistent with

current practice. They amplify the primary objectives, and should be considered when formulating government debt management policy.

SECTION 3: REVIEW OF CURRENT QUANTITATIVE METHODOLOGIES AND INDICATORS

3.1. Overview

Comparing Canada's practices against best practices, as identified in Gottesman (2002), suggests that Canada's strategy is consistent with best practices. There are, however, a number of areas in which the range of quantitative methodologies can be broadened, applications developed further, and limitations of techniques more explicitly recognized. In this section, we review and comment on the current methodologies and indicators used by the federal government to assess the debt structure. These include: fixed-floating ratio, average term to maturity, duration and Cost-at-Risk under various interest rate scenarios. In particular, this review includes:

- An assessment of the extent to which each indicator is consistent with best practices identified in the review of the academic literature and practice.
- A study of Cost-at-Risk methodology examining internal studies conducted by the Department of Finance against best practices.

This review primarily focuses on assessing the appropriateness of the techniques currently employed by the Department looking forward. For this reason, the quantitative work is limited to examining the appropriateness of model assumptions and robustness of results.

3.2. Framework for Evaluation

The present model used to target a particular fixed-floating ratio arose from answering a number of questions about policy goals and model design. Here we focus on three key questions. For each we indicate how current practice has answered the question along with possible extensions and a critique. The goal is to identify any biases arising from current practice and to make recommendations for improvements.

3.2.1. What should the Government hedge?

Current Practice

The Government's current debt strategy implements a prudent debt structure with the objective of keeping debt costs low and stable over time in various interest rate scenarios. Modelling addresses the trade-off between costs and risk, where costs are measured by expected annual debt charges, and risk is measured by the volatility in annual debt charges. Risk tolerance is measured by the size of the contingency reserve or other, related, measures of loss. Cost at risk is used as a measure of practices relative to this risk tolerance.

The Government measures its exposure to interest rate risk using a fixed-floating ratio, with supplementary use of average time to maturity and duration. Canada's two-thirds fixed-floating ratio is slightly lower than the average for OECD countries. Finally, exposure is quantified through calculating Cost at Risk and comparing it to the contingency reserve. These measures are consistent with best practices in other countries as well as relatively simple to employ and to understand.

Extensions and Critique

A number of authors and jurisdictions propose an asset-liability-management (ALM) framework in which the duration of the debt portfolio is matched to the duration of the Government's asset portfolio. Two countries that have considered an ALM approach are New Zealand and Sweden:

- *New Zealand:* New Zealand Debt Management Office has examined the use of an asset-liability management (ALM) framework in sovereign debt management (Anderson, 1999 and Bierwag, Fooladi and Roberts, 2000). The main objective was to reduce the vulnerability of New Zealand's balance sheet to shocks, through creating a portfolio of liabilities with similar financial risk characteristics as the assets.
- *Sweden:* The Swedish National Debt Office is developing an Asset and Liability Management (ALM)-inspired approach for analyzing the risks in central government debt management (Swedish National Debt Office, 2001). They argue that risk should be defined in terms of how the debt portfolio contributes to fluctuations in the budget balance and the central government debt. However, the ALM approach is still under development in Sweden.

Duration has two conceptual advantages. First, it is an endogenous benchmark and not set exogenously (and possibly arbitrarily) as is the dollar amount of the contingency reserve or related measures of fiscal prudence. Second, the ALM framework accounts for shifts in the market value of debt. This can be important if assets are to be sold or debt retired early. The duration approach focuses on the market value of the government's balance-sheet surplus. While this measure is a natural one for shareholder-

owned financial institutions, it is open to debate when applied to government. A related criticism is that market value measures like duration fluctuate daily, raising the question of how often and with which tools to rebalance. A further disadvantage associated with ALM that asset value assessment may be difficult, due to the illiquidity and unusual nature of Government assets.

In the case of Canada, the second advantage of duration is largely moot because privatizations remaining are small, relative to the size of the budget. Further, frequently rebalancing duration can militate against the goal of well-functioning markets, because the size of debt sales or repurchases may be large relative to the appetites of market participants. A further difficulty is that such rebalancing is a stochastic strategy as it depends on the evolution of interest rates over time. For this reason, the Government's strategy is unknown to market participants, increasing uncertainty.

Similar problems can arise with the use of derivatives to rebalance. Other jurisdictions, such as France and Spain *do* use interest rate swaps for this purpose. These precedents may be less useful as government debt is relatively smaller in these countries than in Canada. Still, the use of derivatives can be useful at the margin and is worthy of further study.

3.2.2. How should the Government measure its exposure to interest rate risk?

Current Practice

Exposure policy is set through a fixed-floating ratio with supplementary use of average term to maturity and duration. Exposure is quantified through calculating Cost at Risk and comparing it to the contingency reserve. These simulations are summarized using a customized model provided by Algorithmics Incorporated.

Extensions and Critique

Fixed-floating ratio and Cost at Risk consistent with current practice internationally: *Fixed-floating ratio:* The fixed-floating ratio is fairly easy to compute and understand. Given the normal, upward-sloping yield curve, debt-servicing costs increase (decrease) and interest-rate and rollover risks decrease (increase) with a higher (lower) fixed-floating ratio.

As noted in Gottesman (2002), the target fixed-floating ratio in Canada was increased to two-thirds on October 1998. This ratio is slightly lower than the average fixed-floating ratio of OECD countries in 1998. However, even though a two-thirds fixed-floating target debt structure gives rise to higher debt service costs than a lower fixed-floating target, such a target is likely to ensure that unexpected changes in interest rates over a five-year horizon will not disrupt the fiscal plan.

Cost at Risk: Cost at Risk can be easily understood as it clearly specifies a given increase in financing costs and the probability of such an increase over a given period. The increase in costs can be compared directly to the size of the contingency reserve. Sensitivity analysis and stress testing can be used to determine how Cost at Risk is sensitive to different assumptions. Further, Cost at Risk is based on Value at Risk, which is widely used by financial institutions.

Ad hoc and non-unique measures: The fixed-floating ratio and Cost at Risk are ad hoc and not unique. One solution is to add duration and average term to maturity. This moves in the direction of a portfolio benchmark for debt with three features: fixed-floating ratio, duration and average maturity. This can be extended to add or substitute other measures such as currency mix and inflation indexing, as developed in the literature

review. A related issue is the simplistic assumption that 20% of retail debt is fixed. Since retail debt includes a put option, there is room for more sophisticated measures of its fixed component. There is not likely to be a large, practical payoff for such modelling, however, because retail debt is a small and shrinking component of total Government debt.

Once other measures are introduced, a related issue is how they are weighted in the decision and evaluation.

Limitations of Cost at Risk: Should we measure debt risk through cash flow variability as Cost at Risk does, or should we measure changes in market value? Policy is to use the former because variability in costs is considered more important than shifts in market values. However, various sources recognize that this is oversimplified because the Government may sell assets and thus be concerned with market values. Further, asset sales might mean that a blip in redemptions in a future year reduces risk if it coincides with the asset sale. These market-value effects are not captured in Cost at Risk.

There are a number of disadvantages associated with duration as well. As noted earlier, while duration is a natural measure for shareholder-owned financial institutions, it is open to debate when applied to a government. As well, market value measures like duration fluctuate daily, raising questions of how often and with which tools to rebalance.

Further, Cost at Risk is a risk measure from the Value at Risk (VAR) family. As discussed in detail in the Gottesman (2002) literature review, such measures are widely used because they are readily understood. Nonetheless, VAR measures can produce misleading risk assessments due to technical limitations. As explained in the literature review, the principal limitations are the assumptions of normality of shifts in interest rates

and constant parameters. While stress testing partially addresses these limitations, it is not rigorous, and therefore further exploration of the limitations of Cost at Risk is appropriate. One approach would be to investigate possible applications of extreme value theory that removes the need for normality assumptions. We discuss a more promising approach driven by the economic model in Section 3.2.3 below.

As Gottesman notes, the Bank of Canada does not assume a normal distribution in its CaR measure. Instead, Bank analysis implements a two-factor CIR model, based on two stochastic Markov processes with non-central Chi-squared transitional densities. Further, the Bank of Canada's measure of CaR is percentile-based and thus is not explicitly conditional on any distributional assumption.

Other dimensions of risk: Other dimensions of risk include rollover risk and investor confidence. Rollover risk is different from Cost at Risk. In an extreme case, the Government could be unable to rollover debt. This issue is raised in earlier Canadian materials with respect to disruptive events, and is also raised by the IMF.

In addition, the literature review discusses studies that link Government policies on debt management to investor confidence in the stability of capital market conditions. This link may be important in light of stated policy and it appears to be explored in depth in current material on implementation.

Current policy does address rollover risk implicitly when the fixed-floating ratio is set. A given fixed-floating ratio implies a given percentage of debt is subject to refinancing and rollover risk. The relationship between the fixed-floating ratio and rollover risk suggests that one way to determine best practice is to compare fixed-floating

ratios across countries. Canada maintains a lower-than-average fixed-floating average, and therefore has higher rollover risk than average.

The CaR framework also addresses the implications of rollover risk. Specifically, policymakers know if they are comfortable with the rollover risk / liquidity implications of a particular fixed-floating ratio through explicit rollover/maturity profile analysis.

3.2.3. How are interest rates and government budgets modelled and simulated?

Current Practice

The current interest rate model uses a CIR two-factor model over a five-year horizon. The term structure is dynamic as it shifts over a path over the horizon. There are no links between the term structure and the government deficit or surplus. The financing strategy is fixed and does not evolve in a stochastic manner.

Extensions and Critique

Model building: While the treatment of the term structure appears consistent with best practices for term structure modelling, there is room for improvement in model estimation techniques.

One econometric technique frequently used in the estimation of interest rate models is the Generalized Method of Moments (GMM). As discussed in Gottesman (2002), advantages associated with this method include the following:

- Freedom from the assumption of normal distribution of interest rate changes
- Estimators and their standard error provided by the GMM approach are consistent, when using discrete-time econometric specification.
- Supportive empirical tests.

Another technique is the Kalman filter methodology. As discussed in Gottesman (2002), an important advantage associated with this method is that it allows the underlying state variables that determine changes in interest rates to be handled, correctly, as unobservable.

Also useful would be model enhancement to create analytical links among the surplus or deficit position of the government, the evolution of the term structure and general economic conditions. Studies reviewed suggest that spikes in interest rates may be associated with economic downturns (as in the early 1990s) and increased government deficits. This suggests that the present model, which ignores this link, may have an optimistic bias. Alternatively, the bias may be pessimistic. For example, consider an economic downturn that leads to a decline in government revenues and is accompanied by a decline in interest rates. The resulting decline in debt charges due to the lower rates partially offsets the decline in government revenues. This effect would not be captured in the model, suggesting a pessimistic bias.

The present, conservative, assumption is that the budget will be balanced. An alternative would be to make the model stochastic, and allow short-term deficits if shocks occur within the context of mean-reverting deficits with a mean of zero. Current research in the Department and Bank addresses a model in which the economy shifts between two states, boom and recession, following a Markov process. It should be possible to introduce a third, disaster scenario. Such a model would allow decision-makers to set the probability of the disaster scenario, thus bringing stress testing within the context of the formal analysis.

Such an approach would also allow study of how correlations and other parameters shift in market crashes. This would address another shortcoming of the CaR approach noted earlier. As discussed in a study by Horngren (1999), reviewed in Gottesman (2002), the Swedish National Debt Office uses regime-switching models. In its first stage, the regime-switching model simulates switches between economic upswings and downturns. Then, depending on whether the economy is in a boom or a recession, the model simulates the time series of values for a number of variables, such as exchange rates, inflation and the borrowing requirement. These variables also serve as a basis for the creation of term structures of interest rates, which, in turn, serve as input data for cost and risk calculation.

The use of regime-switching models can assist in overcoming difficulties associated with CaR. As noted earlier, the assumption of normal distributions does not fully parallel the empirical evidence. Instead, empirical returns distributions tend to have fatter tails than those provided by the normal distribution assumption. The use of a regime-switching model allows for more empirically accurate distribution assumptions.

Current policy correctly recognizes these as areas for further development. Once this future development is in hand, the Government will have a better understanding of the robustness of the techniques employed.

Simulation techniques and execution: The simulation technique involves inputting scenario variables and portfolio scenarios, running a simulation, and performing a risk/cost analysis of the output. The following variables are used as inputs to the simulation:

- State of the economy

- Canadian yield curves
- U.S. yield curves
- Canadian/U.S. exchange rates
- Financial requirements

The portfolio consists of the following debt programs:

- Bond program
- Bill program
- Real return debt program
- Retail debt program
- Non-market debt program

The above variables and portfolio scenarios are inputted into the simulation engine. Present simulation technology and summary technique are limited in that the simulation currently requires eight hours to run. The output is a risk/cost analysis, including the following measures:

- Fixed-floating ratio
- Average term to maturity
- Duration
- Shape of the redemption profile
- Running Yield at Risk
- Cost at Risk

A drawback associated with the existing simulation techniques is the absence of a practical method through which historical data can be inputted into the simulation. These factors appear to have limited staff from conducting a backcasting exercise. Backcasting

is widely used in financial modelling as a method of validating models and forming believable stress testing scenarios. Backcasting cannot be used to test policy, as policy is inherently forward-looking. Rather, backcasting is a test for model risk, to ensure that the model is free of error before it is used in forward-looking scenario simulations.

The current simulation addresses rollover risk through two measures: the fixed-floating ratio and the shape of the redemption profile. Together, these measure the proportion of debt that is subject to rollover risk in any period. To measure rollover risk further, the Government analyzes the amount of liquid assets required to cover a certain period of maturities. Rollover risk is worthy of closer scrutiny because the review of practices in different countries reveals that Canada's fixed-floating ratio is lower than average. While this suggests that Canada is more exposed to rollover risk, it would be useful to confirm this observation by conducting a comparative survey of redemption profiles across countries.

SECTION 4. CONCLUSIONS

This section presents the conclusions of the present study.

1. Each of Canada's objectives ((1) ensure government financing requirements; (2) minimize borrowing cost; (3) keep risks at an acceptable level; (4) support domestic capital markets) is comparable to the objectives reported for other countries.
2. Secondary objectives discussed in the debt management literature include averting a confidence crisis, the relationship between maturity structure and economic growth; minimizing the tax impact of economic shocks; and influencing future government policy. In relation to minimizing the tax impact of economic

shocks, we note that Canada's fixed-rate debt is proportionally smaller than that of most other countries, suggesting that Canada's debt profile is less prepared for supply shocks than other countries. In relation to influencing future government policy, while not an explicitly stated consideration in the Government of Canada's debt management policy, this objective may be seen as the long-term aspect of promoting market stability. In general, we conclude that the secondary objectives are consistent with current practice. They amplify the primary objectives, and should be considered when formulating government debt management policy.

3. The study compares Canada's debt management strategy against best practices internationally, as reviewed in Gottesman (2002). Canada's methods and systems are consistent with best practices. In several areas, however, there is room to extend quantitative methodologies and their applications as well as to recognize more explicitly the limitations of techniques employed. Conclusions 4 –11 cover these in detail.
4. Current Government hedging policy addresses the tradeoff between costs (annual debt charges) and risk (debt charge volatility) employing Cost at Risk (CaR). An alternative measure is the asset-liability-management (ALM) framework used by New Zealand and Sweden. An ALM approach has certain advantages: the benchmark is endogenously derived from the Government's balance sheet. Further, the approach accounts for shifts in the market value of debt. This can be important in practice if assets are to be sold or debt retired early. There are also offsetting disadvantages: First, the conceptual applicability of ALM to governments is not well established. Second, it requires rebalancing (either

5. Canada's use of derivatives in debt management is currently confined to currency swaps. Expanding derivatives use to include interest-rate swaps and related products would be a worthwhile step to augment the tools available to the Government.
6. The Government measures its exposure to interest rate risk using a fixed-floating ratio, with supplementary use of average time to maturity, duration and maturity profiles. Canada's two-thirds fixed-floating ratio is slightly lower than the average for OECD countries. Finally, exposure is quantified through calculating Cost at Risk and comparing it to the contingency reserve. These measures are consistent with best practices in other countries, and relatively simple to employ and to understand.
7. Cost at Risk is open to criticisms typically applied to Value at Risk. These criticisms include the assumptions of normality of shifts in interest rates and constant parameters. Consistent with best practices, the Government currently employs stress testing to mitigate these limitations. It is also conducting a promising study into an approach driven by extensions to the economic model.

- This should prove an important possible extension to current practice. The Bank of Canada does not assume normal distribution in its CaR measure. Further, the Bank of Canada's measure of CaR is percentile-based and thus is not explicitly conditional on any distributional assumption.
8. Alternative measures of risk include rollover risk and investor confidence. While the literature links Government policies on debt management to investor confidence that capital market conditions will remain stable, the CaR framework fails to address the implications of rollover risk. While the Government analyzes the amount of liquid assets required to cover a certain period of maturities, rollover risk is worthy of closer scrutiny because Canada's fixed-floating ratio is lower than average. In particular, it would be useful to confirm this observation by conducting a comparative survey of redemption profiles across countries.
 9. Consistently with best practices, interest rates are modelled using a Cox-Ingersoll-Ross (CIR) two-factor model over a five-year horizon. We believe there is room for improvement in model estimation techniques and a current Government study is moving in this direction. In particular, the Generalized Method of Moments (GMM) along with the Kalman filter should be incorporated into term structure estimation.
 10. Beyond the term structure, there are important opportunities to enhance the economic model behind the simulation by creating analytical links among the surplus or deficit position of the government, the evolution of the term structure and general economic conditions. Avenues for improvement include relaxing the assumption of a balanced budget within the framework of the present

deterministic model, and (more ambitiously) introducing a stochastic, regime-switching model in which short-term deficits are possible. Current policy correctly identifies these model enhancements as important in order to eliminate possible bias in the present approach. Further advantages that could derive from model improvements include incorporating a disaster scenario to endogenize stress testing as well as improving the distribution assumptions in the CaR exercise.

11. Related to the current simulation technology and summary techniques, one limitation is that the simulation currently requires eight hours to run. Another limitation is that there is currently no practical method through which historical data can be input into the simulation, limiting backcasting exercises. Backcasting is a standard technique in financial modelling and would be desirable both to validate future extensions to the model and to assist in forming realistic stress testing scenarios. Backcasting is a test for model risk, to ensure that the model is free of error before it is used in forward-looking scenario simulations.

SECTION 6. REFERENCES

Agell, J., and M. Persson. 1992. Does debt management matter? *Institute for International Economic Studies Seminar Paper* No. 442, University of Stockholm, 1989; repr. in J. Agell, M. Persson and B.M. Friedman (eds.), *Does Debt Management Matter?* Oxford; Oxford University Press

Anderson, P. 1999 Sovereign debt management in an asset-liability management framework, *The Second Sovereign Debt Management Forum*, World Bank

Bierwag, G.O., I.J. Fooladi, G.S. Roberts. 2000. Risk management with duration: potential and limitations. *Canadian Journal of Administration Sciences*, 17, 126-142

Bohn, H. 1988. Why do we have nominal government debt? *Journal of Monetary Economics*, 21, 127-140

— . 1990. A positive theory of foreign currency debt. *Journal of International Economics*, 29, 273-292

Calvo, G. 1988. Servicing the public debt: the role of expectations. *American Economic Review*, 78, 647-661

Calvo, G. 1990. Controlling inflation: the problem of non-indexed debt. in S. Edwards and F. Larrain (eds), *Debt adjustment and recovery: Latin America's prospects for Growth and development*, New York: Basil Blackwell

Department of Finance Canada., 2001, Debt Management Report: 2000-01. Discussion paper.

Frankel, J.A. 1985. Portfolio crowding-out empirically estimated. *Quarterly Journal of Economics*, 100

Friedman, B.M. 1981. Debt management policy, interest rates and economic activity. *NBER Working paper*, 830; reprs. in J. Agell, M. Person and B.M. Friedman (eds.), *Does Debt Management matter?* Oxford; Oxford University Press

—.1985. Crowding out or crowding in? Evidence on debt-equity substitutability, *NBER Working Paper*, 1565

—. 1986. Implications of government deficits for interest rates, equity returns, and corporate financing. in B.M. Friedman (ed.), *Financing Corporate Capital Formation*. Chicago; University of Chicago Press

Giavazzi, F., and M. Pagano (1990). Confidence crises and public debt management. in R. Dornbusch, and M. Draghi (eds), *Public Debt Management: Theory and History*. New York; Cambridge University Press

Gottesman, A.A., 2002, Review of Best Practices in Government Debt Strategy Management, Department of Finance Canada.

Hawkesby, C., and J. Wright. 1997. The optimal public debt portfolios for Nine OECD countries: A tax smoothing approach. Mimeo, University of Canterbury, New Zealand

Horngren, L. 1999. Methods for analyzing the structure of the central government debt. Riksgalds Kontoret. The Swedish National Debt Office.

Lucas, R.E., and N.L. Stokey. 1983. Optimal fiscal policy and monetary policy in an economy without capital. *Journal of Monetary Economics*, 12, 55-93

Persson, T., and E.O. Svensson. 1984. Time-consistent fiscal policy and government cash flow. *Journal of monetary economics*, 14, 365-374

Persson, M., T. Persson, and E.O. Svensson. 1987. Time-consistency of fiscal and monetary. *Econometrica*, 55, 1419-1431

Roley, V.V. 1982. The effect of federal debt-management policy on corporate bond and equity yields. *Quarterly Journal of Economics*, 97, 645-648

Swedish National Debt Office. 2001. Guidelines for central government debt management in 2002. Discussion paper.

Tobin, J. 1963. An essay on the principles of debt management. In *Fiscal and Debt Management Policies*, prepared for the Commission on Money and Credit, Englewood Cliffs; Prentice-Hall; repr. In J. Tobin. *Essays in Economics*, i. Amsterdam: North-Holland, 1971.