

Modelling the Asset-Allocation and Liability Strategy for Canada's Foreign Exchange Reserves

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- Canada's official international reserves are held with the objective of aiding in the control and protection of the external value of the Canadian dollar, and are managed to provide foreign currency liquidity to the federal government.
- Unlike in many other countries, Canada's foreign exchange reserves are owned by the federal government and managed jointly by the government and the Bank of Canada.
- Canada's use of an asset-liability-matching (ALM) framework limits exposure to interest rate and exchange rate risks.
- To enhance the policy advice that supports the management of the foreign exchange reserves portfolio, the Bank has developed an ALM portfolio model that quantifies the trade-offs between risk, return, liquidity and funding costs in asset and liability decisions.

The 2007–09 global financial crisis led to rapid accumulation of foreign reserves in both developed and emerging countries and triggered discussions of how these reserves should be managed.¹ While efforts to reassess and improve the management of Canada's reserves date back to before the crisis, recent events have highlighted the need for appropriate tools to aid policy-makers in their management of the reserves.

Canada's foreign exchange reserves help to promote orderly conditions for the Canadian dollar in foreign exchange markets, if required, and provide foreign currency liquidity to the federal government. These reserves are not included on the balance sheet of the central bank; instead, they belong to the federal government and are held primarily in the Exchange Fund Account (EFA). Unlike many other countries, the assets held in the EFA are funded by Government of Canada liabilities denominated in, or converted to, foreign currencies. The Bank of Canada acts as the fiscal agent for the government in the management of the EFA and works with the Department of Finance to advise the Minister of Finance on the funding and investment of Canada's foreign exchange reserves.

¹ For a detailed discussion, see IMF (2011).

This article describes an analytical tool recently developed at the Bank, which, combined with other information, guides policy advice on the management of Canada's foreign exchange reserves and the liabilities used to finance them. We begin by discussing the objectives of the EFA, its governance framework and its investment principles. We then examine the portfolio-management model developed to help policy-makers achieve the EFA's objectives in an efficient and fiscally responsible manner. Finally, we present some of the insights gained from this tool.

The Exchange Fund Account

The objective of the EFA, as stipulated in the Currency Act, is to assist in the control and protection of the external value of the Canadian dollar. The Currency Act confers upon the Minister of Finance the authority to acquire, borrow, sell or lend assets held in the EFA in accordance with the Statement of Investment Policy (SIP) for the Government of Canada.² The SIP specifies operational measures to achieve the EFA's objective, elucidates principles of investment that govern its management and specifies risk-exposure limits based on prudential asset-management practices.

The SIP requires that EFA assets be invested in a combination of liquid and safe short-term instruments and high-quality medium- and long-term instruments that help to achieve the highest possible level of return without jeopardizing liquidity and capital-preservation objectives. The SIP also requires the EFA to be managed in a cost-effective, transparent and accountable manner, following leading risk-management practices, and outlines an oversight and governance structure to ensure adherence to investment principles.

EFA assets comprise primarily liquid foreign currency securities (largely government treasury bills and bonds); deposits with commercial banks, central banks and the Bank for International Settlements; special drawing rights (SDRs);³ and a small holding of gold.⁴ The SIP specifies that the Government of Canada liabilities that fund the liquid securities be matched as closely as possible in currency and duration to the interest and principal receipts and payments on EFA assets in order to minimize the government's exposure to currency and interest rate risks.⁵ These matching requirements—referred to as the asset-liability-matching (ALM) framework—are relatively unique among managers of sovereign reserves.

The size of the EFA has increased steadily since 1998. As of February 2013, it had over US\$65 billion in assets, and, as shown in **Chart 1**, securities holdings were its most important component.⁶ The spike in assets in 2009 was the result of the allocation of SDRs to Canada as part of the International Monetary Fund's program to supplement the SDR positions of member countries. As of February 2013, U.S.-dollar assets accounted

◀ *Liabilities that fund the Exchange Fund Account are matched as closely as possible in currency and duration to the interest and principal receipts and payments on EFA assets*

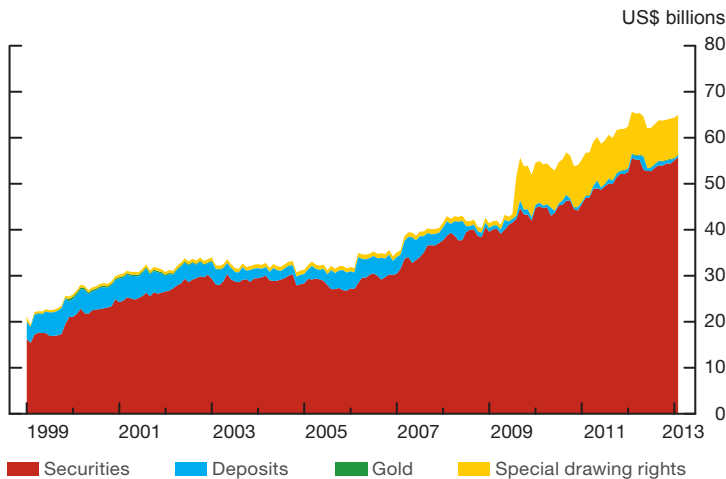
² The latest SIP is in Annex 1 of the *Report on the Management of Canada's Official International Reserves* at <http://www.fin.gc.ca/activity/oirrep/oir-rol-12-eng.asp#toca1>.

³ An SDR is an international reserve asset created by the International Monetary Fund (IMF). Its value is defined by a weighted basket of the U.S. dollar, the euro, the British pound and the Japanese yen.

⁴ Canada's official international reserves, the majority of which are in the EFA, also include Canada's reserve position at the IMF. This position, which represents Canada's investment in the activities of the IMF, fluctuates according to IMF drawdowns and repayments.

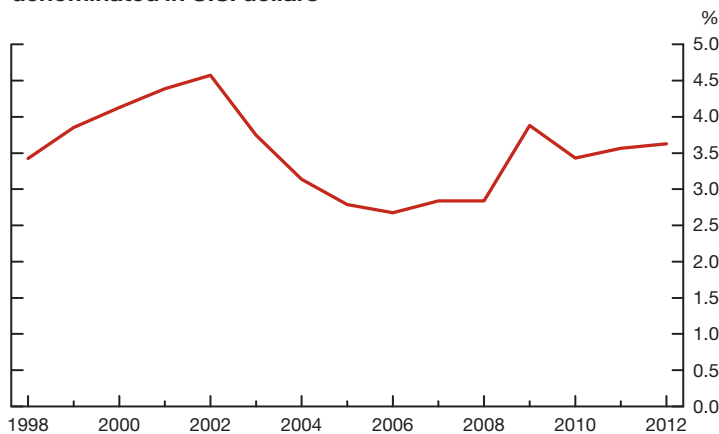
⁵ "Duration matching," also known as "duration immunization," is a strategy in which the durations of assets and liabilities are matched so that changes in interest rates have similar offsetting effects on the values of both assets and liabilities, thereby making a portfolio insensitive to small changes in interest rates.

⁶ These assets were funded by dedicated foreign currency borrowings with a par value of US\$51 billion as of 31 March 2012.

Chart 1: Composition of the Exchange Fund Account

Source: Department of Finance, *Report on Management of Canada's Official International Reserves*

Last observation: 28 February 2013

Chart 2: Exchange Fund Account as percentage of nominal Canadian GDP denominated in U.S. dollars

Sources: Department of Finance, *Report on Management of Canada's Official International Reserves*; World Bank National Accounts Data (for 1998–2011 GDP data); and Statistics Canada (for 2012 GDP data)

Last observation: 31 December 2012

for over 66 per cent, and euro-denominated assets about 33 per cent, of the EFA's securities holdings and deposits, with the remaining 1 per cent invested in assets denominated in the Japanese yen.

The EFA must be ready to satisfy potential foreign exchange liquidity needs—in other words, to meet a “call on reserves”—by selling foreign-denominated assets. The government, in its prudential liquidity plan, stipulates that overall liquidity levels must cover at least one month of net projected cash flows, including coupon payments and debt-refinancing needs. The size of the EFA relative to Canadian gross domestic product (GDP) ranged between 2.7 per cent and 4.6 per cent during the 1998–2012 period, and was at 3.6 per cent in 2012 (Chart 2), in line with the government's goal of maintaining the level of liquid foreign exchange reserves at or above 3 per cent of nominal GDP (see Box 1 for details on the use of the EFA).⁷

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⁷ Details of the prudential liquidity plan are included in Annex 2 of the 2011 federal budget, available at <http://www.budget.gc.ca/2011/plan/anx2-eng.html>. IMF (2011) reviews approaches to determining reserve adequacy and discusses considerations to be taken into account before determining an appropriate level of reserves.

Box 1

Evolution of the Government's Policy Toward Intervention in the Foreign Exchange Market

Canada's policy toward intervening in the foreign exchange market has evolved over the past 15 years. Until September 1998, to maintain orderly conditions for the Canadian dollar in the foreign exchange market, intervention was generally predictable and automatic—selling foreign currency and buying Canadian dollars when there was downward pressure on the exchange rate, and vice versa when there was upward pressure on the value of the Canadian dollar. As Canada's foreign exchange market matured and became increasingly liquid, policy-makers decided that such an intervention policy was no longer required. Since September 1998, the policy of the Department of Finance and the Bank of Canada has been to consider intervening if there are signs of a serious near-term market breakdown indicating a severe lack of liquidity in the market for the Canadian dollar, or if extreme currency movements seriously threaten the conditions that support sustainable long-term growth of the Canadian economy. In addition, the current intervention policy allows for Canada's

participation in coordinated interventions with other central banks to influence the value of a foreign currency. As of early 2013, there have been only two interventions since 1999, and both were coordinated actions with other central banks. The first was to support the euro by purchasing US\$97 million worth of that currency in September 2000, and the second was to stabilize the Japanese currency market by selling yen equalling US\$124 million in value in March 2011, as agreed by the G-7 ministers of finance.¹

¹ Details of official interventions are included in the annual *Report on the Management of Canada's Official International Reserves*. The Financial Review section of the *Exchange Fund Account Annual Report* for 1999 (available at http://www.fin.gc.ca/efa-cfc/efa1999_1-eng.asp) and the Bank of Canada backgrounder *Intervention in the Foreign Exchange Market* (available at http://www.bankofcanada.ca/wp-content/uploads/2010/11/intervention_foreign_exchange.pdf) discuss the rationale for the change in Canada's intervention practices implemented in September 1998. Management reports beginning in 2000 reflect the modified criteria under which an intervention in the foreign exchange market might be considered.

The Minister of Finance governs the EFA, approves key initiatives such as strategic plans and investment policies, and provides an annual report on the operations of the EFA to Parliament.⁸ The design of key strategies and policies, the oversight of operations, and the coordination of funding, investment and liquidity-management activities are delegated to the EFA's Funds Management Committee, to which the Risk Committee and the Asset Liability Management Committee provide advice. Officials from the Bank of Canada and the Department of Finance form all three committees. Policy-analysis tools developed by the Bank, of which the ALM portfolio model is one, are intended to help organize the discussion among policy-makers, who could use them in conjunction with their judgment and risk preferences. The EFA's day-to-day investment and funding transactions are executed by the Bank of Canada.⁹

The Modelling Approach

The Bank recently developed the ALM portfolio model to enhance the quality of the policy advice provided to the committees managing the foreign exchange reserves. The model determines the combinations of assets and liabilities with the same duration and currency that maximize the returns (net of funding costs) for each possible level of portfolio risk, while also satisfying the preference for liquid assets.

A target portfolio could then be determined using output from the model, risk preferences and professional judgment, including considerations of overall risk measures (such as value at risk, among others).¹⁰ This

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⁸ The electronic versions of these reports for recent years are archived at <http://www.fin.gc.ca/purl/efa-eng.asp>.

⁹ The Funds Management Governance Framework (available at http://www.fin.gc.ca/treas/Goveev/pdf/FMGF_e.pdf) describes the roles and responsibilities of officials at the Department of Finance and the Bank of Canada, and of the committees established to govern funds-management activities.

¹⁰ A review of the asset-allocation framework conducted in 2012 recommended incorporating enhanced portfolio-management methods into the EFA's decision-making process. The incorporation and use of quantitative tools in the investment-management process are in response to the recommendations of that review. Details of the report are available at <http://www.fin.gc.ca/treas/evaluations/eaafefa-ecraccf-eng.asp>.

multi-stage decision-making process can help reduce modelling risks, while also benefiting from policy-makers' knowledge of financial markets. The model also helps to evaluate the costs of the matching requirements for currency and duration, as well as other guidelines set out in the SIP.

Two particular characteristics of the EFA determine the modelling approach. The first is that its main objective is to provide foreign currency liquidity to the government, if and when required. The preference for liquid assets is therefore a key component of the model. The second is that, in contrast to the management of most liability-driven funds in which the level of liabilities is fixed, policy-makers can choose the size and composition of both assets and liabilities, as long as the interest rate and exchange rate risks are managed according to the ALM framework.

To clarify the ALM model, we first provide separate explanations of the trade-offs involved in the asset-allocation and funding-mix decisions. The EFA's asset-allocation decision involves risk-return and liquidity trade-offs; the funding-mix decision includes liability cost and risk trade-offs. We then show how the ALM model allows policy-makers to evaluate both sets of trade-offs simultaneously.

Optimizing the asset allocation

To find a mix of assets that balances the policy-makers' preferences, the ALM model augments the traditional mean-variance analysis (Markowitz 1952) with a preference for liquidity. Mean-variance analysis captures the risk-return trade-off between assets (riskier assets usually promise higher expected returns), while emphasizing diversification, which lowers the portfolio's risk by avoiding excessive concentration in any one asset.

The model finds the best combinations of assets by balancing the preferences for liquidity and returns. Generally, highly liquid assets have lower transaction costs, but also lower returns. These assets remain liquid during times of financial distress, and their transaction costs vary less between good and bad economic conditions (Rivadeneira 2012).

Another critical dimension of the asset-allocation problem is maintaining the liquidity of the portfolio after a call on reserves (Romanyuk 2010). The model balances the transaction costs associated with meeting a call on reserves with the need to ensure that the remaining assets are sufficiently liquid to meet potential calls on reserves in the future at a reasonable cost. If a manager minimized the immediate cost of a call on reserves by selling the assets with the lowest transaction costs (for example, U.S. Treasury securities), this would leave a higher concentration of assets that are less liquid in the EFA. Any subsequent calls on reserves would require selling large amounts of these assets, which would be disproportionately more expensive than spreading the sales over several episodes. Taking the costs of meeting future calls on reserves into consideration, the model recommends that the initial call on reserves be met with a diversified selection of assets, thus preserving the liquidity of the remaining portfolio, and that the initial choice of assets held in the EFA be tilted toward highly liquid assets.

The outputs of the model are, for each level of risk, the optimal asset weights and a liquidation strategy that satisfies a call on reserves. An additional benefit of this approach is that it quantifies the cost of maintaining a highly liquid portfolio by comparing the expected returns of the model with those of a traditional allocation based on mean-variance analysis.

Optimizing the funding mix

Reserve assets are funded mainly by converting Canadian-dollar liabilities issued by the government into foreign currency liabilities through cross-currency swaps and by direct issuance of foreign currency securities. Cross-currency swaps are derivatives contracts with private financial institutions through which the Bank of Canada, on behalf of the Government of Canada, exchanges the principal and future interest payments of a liability denominated in Canadian dollars for a liability denominated in one of the EFA currencies.¹¹

Finding the optimal mix of funding for the EFA is similar to other public debt-management practices that attempt to balance objectives to minimize cost and risk (Missale 2000). Canada typically obtains more cost-effective foreign currency funding using cross-currency swaps; however, these transactions carry counterparty risk, which could induce volatility in the government's budgetary position (Rivadeneira and Dissou 2011).¹² The importance of counterparty risk is reinforced by the observation that counterparty credit losses could materialize during episodes in which a call on reserves may occur. The model incorporates this risk through a credit charge for issuing cross-currency swaps that increases with exposure to a particular counterparty. Likewise, the model incorporates rollover risk, which arises from concentrating the funding in a particular part of the term structure, by including charges on funding plans that concentrate issuance in a narrow range of maturities. These charges are calibrated using judgment and past experience.

The model output is the optimal mix across different instruments and maturities that minimizes the funding cost (interest paid on the liabilities), subject to restrictions placed on risk measures. One of the main insights from the model is that most of the mark-to-market volatility in the asset-liability gap comes from the total share of cross-currency swaps in the funding of the EFA. A second insight is that the composition of the asset portfolio has a significant impact on the optimal funding mix, since it constrains the liabilities to a specific duration. This highlights the need to consider the asset and liability decisions together, and reinforces the importance of the ALM framework under which Canada's foreign exchange reserves are managed.

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Combining decisions on asset allocation and funding mix

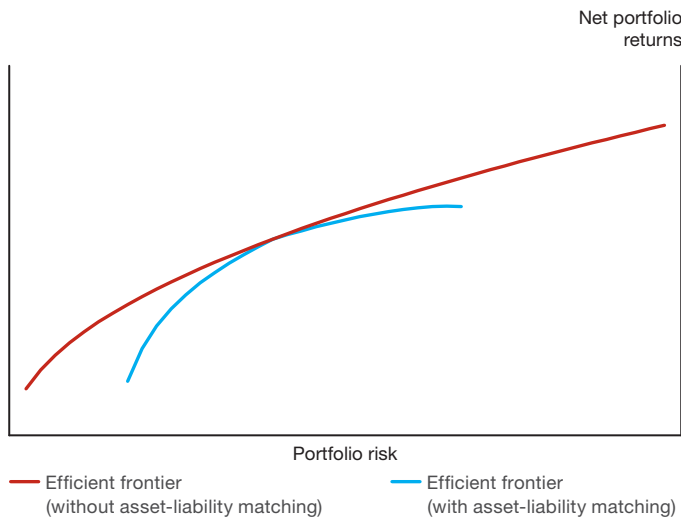
The ALM model combines the analyses of the individual decisions regarding the optimal asset allocation and funding mix subject to the constraint to match the duration and currency of assets and liabilities. Its output is the efficient frontier, or the potential combinations of EFA assets that provide the maximum level of return for a given level of risk and the corresponding liabilities used to fund these assets.

The model demonstrates that the ALM framework requirement to match currency and duration restricts the range of potential portfolios and reduces net expected returns (Figure 1). The reduction in choice is seen in the shortened span of the efficient frontier when ALM is imposed, and the reduction in expected net portfolio returns is represented by the vertical distance between the curves for a given level of risk.

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¹¹ See De León (2000–2001) for a complete list of the funding sources. The “Debt Management Report” for the 2011–12 fiscal year, available at <http://www.fin.gc.ca/dtman/2011-2012/dmr-rgd1201-eng.asp>, provides additional details on the funding sources.

¹² Counterparty risk can induce budgetary volatility if a counterparty does not fulfill its obligations when the mark-to-market value of the cross-currency swaps favours the government. Mark-to-market value is a measure of the fair value of an asset based on its current market price, or the market price of a similar asset.

Figure 1: The efficient frontier and the costs of asset-liability matching

Source: Bank of Canada

The model shows that the main reason for the reduction in expected net returns under the ALM framework is an increase in funding costs, instead of a decrease in asset returns. This is because when ALM is imposed, minimizing funding costs is subject to the constraint that the asset portfolio and the mix of liabilities have the same duration. The liability mix cannot attain the lowest total cost—achieved by balancing more expensive long-term liabilities with less expensive short-term liabilities that have higher rollover risks—since the lowest-cost mix will not have the same duration as that of the optimal asset portfolio for all levels of risk. The lower net returns under the ALM framework shown in **Figure 1** are the result of most asset portfolios along the frontier being funded with a more expensive liability mix.¹³ The liability structure under the ALM model limits the range of possible duration and, in turn, the range of the portfolio's risk, thus restricting the span of the optimal frontier.

An additional feature of the ALM model is that it helps to quantify the costs of managing risks that arise in the presence of an asset-liability gap in the foreign currency reserves, i.e., when the value of assets is different from that of the liabilities. This gap may result either from temporary differentials in the mark-to-market value of assets and liabilities, or from a call on reserves that requires selling assets, thus making their value fall below that of the liabilities. Depending on movements in exchange rates or interest rates, an asset-liability gap exposes the government to risk, since it would need to budget additional public funds to cover the gap. The model quantifies the trade-offs involved in maintaining the ALM framework under these conditions. It shows that duration immunization creates a tension between holding longer-duration assets and holding assets with high liquidity and returns, especially after a call on reserves.

By providing a rigorous framework to conduct scenario analysis, the ALM model also allows for an examination of how the optimal asset and funding outcomes vary in response to changes in economic conditions.

◀ *The ALM model also helps to quantify the costs of managing risks that arise in the presence of an asset-liability gap in the foreign currency reserves*

¹³ The two efficient frontiers in Figure 1 coincide at the point where the optimal assets have the same duration as that of the lowest-cost mix of liabilities.

By quantifying the trade-offs involved in managing the EFA and providing analyses that supplement experienced economic judgment, the model could help policy-makers to make better decisions.

Conclusion

Greater uncertainty in global financial markets and the accompanying increase in sovereign risks have led to a reassessment of the framework for the EFA asset-allocation and funding-mix decision. The ALM portfolio model developed by the Bank of Canada is part of a renewed decision-making process that places Canada at the forefront of countries using the ALM approach to manage their foreign exchange reserves.

The ALM model helps to evaluate the attractiveness of some asset classes for the EFA by quantifying their contribution to the returns and risks of the portfolio. The model can also quantify changes in the relative costs of different funding sources, allowing policy-makers to effectively manage the recent increase in counterparty risks.

The Bank of Canada is engaged in a process of continuous improvement of its policy advice. New portfolio-management models—incorporating methods generated by academic research, along with lessons learned from the use of the ALM model—are being developed to better meet the objective of the EFA, while reducing operating costs and improving its governance.

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