The BoC-GEM-Fin: Banking in the Global Economy

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- *The 2007–09 financial crisis demonstrated the significant interdependence between banks and the real economy. To capture this relationship, policy models must take into account the role of financial shocks and the influence of the banking system on the propagation and amplification of real shocks.*
- *The Bank of Canada's Global Economy Model with Financial Frictions (BoC-GEM-Fin) is a multi-regional dynamic stochastic general-equilibrium model of the world economy that features a banking system, including an interbank market and cross-border lending. Analysis based on the model helps us understand and quantify*
  - *the impact of shocks to the U.S. banking sector on credit conditions and real economic activity in Canada.*
  - *the observed positive co-movement between consumption and investment within each economy and across economies. Explaining the latter is notoriously difficult for models that rely only on traditional trade linkages.*
  - *the short-term impact on output of changes in the regulatory limits to bank leverage in Canada.*

The 2007–09 financial crisis dramatically demonstrated the interdependence between the financial sector and the real economy and the interconnectedness of the global economy. It became apparent that the existing policy models, which treat the banking sector as a passive element in the economy—simply intermediating funds from savers to borrowers—could not explain the causes and effects of the crisis, nor indicate the appropriate policy response.

The crisis triggered a wave of studies aimed at incorporating an active banking system into standard macroeconomic models

Indeed, the crisis triggered a wave of studies aimed at incorporating an active banking system into standard macroeconomic models. This article describes one such initiative, the Bank of Canada's version of the Global Economy Model with Financial Frictions (BoC-GEM-Fin).[1]

The two key-features of the model are (i) a multi-regional dimension and (ii) the explicit modelling of the interaction between the banking system and the real economy. A multi-region model captures the spillover of shocks across economies. With all of the regional blocks connected by bilateral trade, exchange rates and financial linkages, the international transmission of shocks is an important propagation mechanism. In addition, rather than being a frictionless bridge between savers and

1 Other studies conducted at the Bank, even prior to the financial crisis, that highlight the importance of financial channels for the macroeconomy include Christensen and Dib (2006), Meh and Moran (2010) and Christensen, Meh and Moran (2010).

borrowers, banks in the BoC-GEM-Fin play two important roles: propagating, even amplifying, the effects of real shocks; and serving as sources of financial shocks. Cross-border lending by banks provides an additional mechanism for the international transmission of shocks. These features not only add realism to the model, but also permit the study of the international transmission of shocks (including banking sector shocks), monetary policy in the presence of banking-system distress and the macroeconomic effects of bank regulation.

The article is organized as follows. First we describe the model, focusing on the banking sector. We then present the response of selected Canadian and U.S. macroeconomic variables to a "credit crunch" (i.e., an exogenous reduction in the supply of loans) in the United States and discuss recent related research based on BoC-GEM-Fin. We conclude with a look at future development and applications of the model.

BoC-GEM-Fin

The BoC-GEM-Fin follows the Bank's long tradition of using state-of-the-art economic models as analytical tools in the policy-decision-making process.[2] The model is a multi-sector dynamic stochastic general-equilibrium (DSGE) model in which economic agents make consumption, savings, pricing and production decisions based on optimizing behaviour. In this class of models, the supply and demand profiles for goods, labour, capital and financial assets are explicitly modelled, implying endogenous paths for prices that clear those markets.

The model is a multi-sector DSGE model in which economic agents make decisions based on optimizing behaviour

The model features a multi-region world economy in which bilateral trade and exchange rates are fully endogenous.[3] The five regional blocks are Canada, the United States, emerging Asia, the commodity-exporting countries and the rest of the world.[4] The prices of oil and non-energy commodities are determined in global markets, providing an important mechanism for the transmission of foreign shocks, particularly to commodity-oriented economies, such as Canada. Each regional block consists of households; a multi-tiered production sector, which includes risk-neutral entrepreneurs, capital producers, monopolistically competitive retail firms and perfectly competitive wholesale firms; and a fiscal and a monetary authority.[5, 6]

The calibration of the model's parameters—to map the model to the data—is described in more detail in Lalonde and Muir (2007) and de Resende et al. (forthcoming). In general, calibration is based on the statistical properties of relevant data, as well as on values estimated in microeconomic studies and used in other DSGE models.

This article focuses on two key changes in the BoC-GEM-Fin, relative to the previous version of the model (BoC-GEM); namely the introduction of (i) the so-called "financial-accelerator mechanism" (Bernanke, Gertler and Gilchrist 1999) and (ii) active banks that interact in an interbank market and lend to domestic and foreign entrepreneurs, based on Dib (2010 a, b). Below, we briefly describe the changes introduced to the real side of the economy, focusing on households and entrepreneurs—where the supply and demand of credit originate, respectively—and then describe the banking sector—where supply and demand of credit meet.

This linkage between households' savings and loans to entrepreneurs is one of the important changes relative to the previous version

Households work, consume final goods and save. Savings can be held in domestic and U.S. government bonds, domestic bank deposits and domestic bank capital. Deposits and bank capital are the primary source of funds for intermediation in the banking system, where they become loans to finance investment projects. This linkage between households' savings and loans to entrepreneurs—through the banking system—is a major component of the supply

2 See Duguay and Longworth (1998).
3 The model builds on a previous version, BoC-GEM (Lalonde and Muir 2007, 2009), which itself is based on the original GEM developed at the International Monetary Fund. See Pesenti (2008).
4 The residual economy represents the European Union (EU), Japan and Africa. A six-region version of the model, with a separate block for Japan, is currently under development.
5 The government levies taxes and spends on non-tradable, consumption and investment goods, while the monetary authority follows a Taylor-type rule in reaction to core inflation.
6 The production structure is essentially the same as that in the BoC-GEM.

of credit in the BoC-GEM-Fin and one of the important changes relative to the previous version.

Entrepreneurs purchase capital using their own resources—*entrepreneurial net worth*—and bank loans. They rent the purchased capital to firms, where it will be used to produce goods. While the link from savings to loans is important for the supply of credit, the entrepreneurs' decisions determine the demand for credit.[7] Because capital purchases require some external funding (bank loans), the demand for credit in the BoC-GEM-Fin is directly tied to the entrepreneurs' demand for capital. Any disruption to the credit supply reduces the funds available to entrepreneurs, depressing investment and output.

The loan contract between entrepreneurs and banks reflects a source of *financial friction*, namely *asymmetric information*. In particular, entrepreneurs experience shocks to investment projects that only they—not the banks—observe. Thus, borrowing entrepreneurs know the return on their investment, but banks do not. This lack of information is costly for banks because when an adverse shock is severe enough—an unsuccessful investment project—entrepreneurs may default on bank loans. Banks can pay a monitoring cost (e.g., credit-risk specialists) to help identify the threshold level of the shock that triggers default and, in the event of default, pay agency costs (e.g., lawyers) to retrieve part of the principal plus the liquidation value of the unsuccessful project.

A contract that resolves the problem of asymmetric information must constrain the amount of loans desired by entrepreneurs, while fully compensating the banks for the risks involved. Note that, for a given value of entrepreneurial net worth, a greater desire to purchase capital implies that entrepreneurs must rely increasingly on loans to fund their projects. From the bank's viewpoint, this increases the risk associated with the loan. In the BoC-GEM-Fin, the loan contract implies a risk premium that depends inversely on the entrepreneurs' leverage ratio, i.e., the ratio between loans and internal funding (net worth).[8]

The banking system

The banking sector within the BoC-GEM-Fin is based on Dib (2010a, b) and features two types of optimizing, monopolistic competitive banks: *deposit banks* and *lending banks*. These two types of banks may be thought of as single banks, each having two distinct profit-maximizing operational divisions. One division acts purely as a deposit bank, collecting fully insured deposits from households, paying a deposit interest rate and optimally allocating the deposits into two types of assets: risky interbank loans or government bonds. The second division, a corporate loans division, acts as a lending bank, using the funds borrowed from its own depositors and other domestic banks, together with bank capital raised from households, to supply loans to entrepreneurs (domestic and foreign), and charging a lending interest rate.

Deposit banks allocate deposits between domestic interbank lending and domestic government bonds. Given their asset portfolio, the rate of return earned by deposit banks is a weighted average of the risk-adjusted interbank rate and the rate on government bonds. The financial frictions affecting deposit banks are the monitoring and agency costs associated with potential default on interbank loans. The monopoly power of individual banks determines the deposit rate as a markdown over the net marginal return on their assets. The distortions introduced by the probability of default and the monopoly power of banks create a wedge between the deposit rate and the interbank rate. Optimization motivates deposit banks to allocate a higher share of deposits to risky interbank loans when the interbank rate increases relative to the rate on government bonds, and as either the probability of default on interbank loans or the marginal costs associated with monitoring and agency issues decrease.

Lending banks borrow in the interbank market and raise bank capital. Banks use these funds to provide loans to entrepreneurs. From the viewpoint of households, bank capital is a risky asset whose return is uncertain because the gross return is known only after the investment decision takes place, and lending banks may divert their profits to non-productive activities (e.g., large bonuses for bank managers) instead of paying the expected return to investors. During intermediation, lending banks optimally decide the lending rate, the share of borrowed funds that will not be repaid (default on interbank loans), the fraction of the return on bank capital that will be diverted, the demand for bank capital and the supply of loans.[9]

7 Entrepreneurs are solely responsible for the demand for credit in the economy. Future versions of the model will include credit to households.

8 The relationship between the risk premium and net worth is captured by a reduced-form equation, following Dib (2010a, b).

9 The BoC-GEM-Fin, unlike the previous version, provides implications for multiple interest rates: deposit, lending, interbank and policy rates.

As with deposit banks, some degree of monopoly power allows lending banks to set rates as a markup over their marginal cost (i.e., the costs of interbank borrowing and raising bank capital). Financial frictions also apply to lending banks when deciding (i) the optimal share of interbank loans to be defaulted and (ii) the optimal fraction of the return on bank capital to be diverted. These decisions may result in legal costs and fees that increase with the amounts involved. The higher these penalties are, the less the likelihood of default and/or diverted returns. However, a higher policy interest rate increases the net benefit of default and the likelihood of profits being diverted. These distortions generate a wedge between the interbank rate and the lending rate, and affect the propagation of shocks in the model.

When lending banks decide their optimal demand for bank capital and the amount of loans supplied to entrepreneurs, they are, in fact, determining their desired *bank leverage ratio*, defined as the ratio of loans to bank capital. The optimal bank leverage ratio decreases as the lending rate rises (less demand for loans in equilibrium) and increases with the marginal cost of raising bank capital (less bank capital in equilibrium). In the BoC-GEM-Fin, lending banks must satisfy a maximum leverage ratio (or minimum capital requirement) established by regulators. Agents use this regulatory cap on bank leverage to benchmark banks' current capital ratio, so that well-capitalized banks (i.e., less leveraged) can issue equity at a lower cost. Thus, banks have an incentive to keep a "capital buffer" above the minimum required by regulation. As well, the upper limit on leverage becomes an additional instrument available to policy-makers, and changes in that limit have important implications for bank behaviour, affecting the supply of loans, interest rates, investment and output. If banks exceed that limit, they must deleverage, either by reducing risky loans or by raising additional bank capital.[10]

In the BoC-GEM-Fin, the banking sector also plays an important role in the international transmission of shocks. Without the banking system, shocks originating in one region propagate to another region exclusively through bilateral trade flows, adjustments in exchange rates and changes in the prices of oil and non-energy commodities. The presence of cross-border lending in the BoC-GEM-Fin means that changes in credit conditions in one region will affect borrowing costs in another region, with consequences for investment and output beyond those related to the trade channel.[11]

In the BoC-GEM-Fin, the banking sector also plays an important role in the international transmission of shocks

The demand for credit depends heavily on entrepreneurial net worth. Wealthier entrepreneurs require fewer bank loans for their projects. However, the lower cost of external financing because of greater net worth induces a higher demand for loans. Net worth has two important properties: (i) it is procyclical; i.e., it tends to increase with profits and asset prices, which in turn, rise during economic booms and fall during recessions; and (ii) it is persistent, since it takes time to accumulate. Given the loan contract described earlier, these properties imply movements in the risk premium that are countercyclical and long lasting, contributing to the amplification and propagation of shocks. Consider, for example, a demand-driven economic boom that increases consumption, output and profits, and leads to greater entrepreneurial net worth. New loan contracts reflect the reduction in the banks' exposure to risk, and entrepreneurs pay lower risk premiums. As external funding becomes more affordable, entrepreneurs invest more, inducing a second-round boost to aggregate demand, output and net worth, which reduces the risk premium even further, and so on. The initial demand shock is amplified through the interaction of banks and entrepreneurs. This is the **financial-accelerator mechanism**.

The **debt-deflation mechanism** is another channel affecting the demand for credit and the propagation of shocks in the BoC-GEM-Fin. Since all debt contracts, including bank loans, are denominated in nominal terms, unanticipated price-level increases depress the real value of debt. Wealth is transferred from creditors to debtors. Therefore, higher unexpected inflation increases the net worth of indebted entrepreneurs, reduces the risk premium and increases investment and output. Notice that

10 The gain from keeping more capital than required by the regulation of leverage ratio, as well as the agency and monitoring costs, in the banking system of the BoC-GEM-Fin is captured in a reduced form, following Dib (2010a, b).

11 The international financial channels may still not be fully captured in the current version of the model, which features only direct cross-border lending to entrepreneurs but not lending between banks in different regions. Bank staff are working on a future version that will incorporate international interbank lending.

this channel reinforces the financial-accelerator mechanism following demand shocks that drive up both output and inflation, but dampens its effect after a positive supply shock that raises output but reduces inflation.

On the supply side of credit, the main mechanism at work is the **bank-capital channel**. Shocks that affect asset prices also alter the value of bank capital. To keep their capital-adequacy ratio within regulatory limits and adjust the desired capital buffer, banks optimally change their actual leverage ratio. This has implications for the supply of loans, which in turn, will affect investment and output.

Model Properties and Policy Experiments

Shocks to the U.S. banking sector

To illustrate some of the models' properties, we examine the response of selected variables to an exogenous persistent fall in the supply of loans in United States.[12] The shock can be interpreted as an exogenous tightening of credit standards in the United States, as observed during the recent financial crisis—a "credit crunch." Our discussion focuses on the responses of the U.S. and the Canadian economies.

In the United States, such a drop in the supply of loans leads to increases in both the U.S. lending rate and the risk premium, a fall in investment and a recession (**Chart 1**). Since borrowing becomes more expensive, entrepreneurs reduce their purchases of capital goods. The corresponding decline in investment leads to lower economic activity and inflation. As household income falls, consumption follows. With less demand for goods and lower sales, the demand for capital decreases, and entrepreneurial net worth starts falling, inducing a second-round increase in the risk premium (financial-accelerator mechanism). In addition, the unanticipated decrease in U.S. inflation raises the real value of entrepreneurs' bank loans (debt-deflation mechanism), reinforcing the initial fall in net worth and adding to the initial increase in the risk premium. Both mechanisms amplify the decline in economic activity.[13]

The tighter credit conditions in the United States are transmitted to Canada (and other regions) through three channels (**Chart 2**). First, the decline in U.S. economic activity reduces U.S. imports from all regions, negatively affecting output abroad—the traditional trade channel. This is especially true for Canada, given its close trade relationship with the United States. Second, slower economic activity in the United States and in the rest of the world reduces the demand for oil and non-energy commodities. The prices of these commodities fall, creating a negative wealth effect in commodity-exporting regions like Canada. This commodity-price channel exacerbates the decrease in Canadian consumption and output. These two channels reduce the net worth of Canadian entrepreneurs, triggering the financial-accelerator mechanism, which generates negative second-round effects on Canadian investment and output. As inflation falls in Canada, the debt-deflation mechanism further amplifies the economic downturn. Note that the larger decrease in U.S. output (and inflation) relative to that in Canada leads to a larger drop in U.S. policy rates. This difference in interest rates causes the Canadian dollar to appreciate in real terms against the U.S. dollar in the short term. Eventually, the effect of lower commodity prices dominates, implying a real depreciation of the Canadian dollar.

Simulations with the BoC-GEM-Fin suggest that the transmission of shocks originating in the U.S. banking sector to the global economy—particularly Canada—is very important

The third transmission channel is the bilateral flow of bank loans. Since Canadian entrepreneurs finance some of their capital acquisition by borrowing from U.S. lending banks, the U.S. credit crunch directly affects their access to external funding.[14] Beaton, Lalonde and Snudden (2010) show that this channel typically explains roughly 20 per cent of the fall in Canadian output that follows the reduction in U.S. loans.[15] Consistent with the observations of the recent financial crisis, simulations with the BoC-GEM-Fin suggest that the transmission of shocks

12 For a detailed description of the response of the model to other stylized shocks, see de Resende et al. (forthcoming).

13 The reaction of monetary policy to lower inflation—a reduction in interest rates—partially offsets the full impact of the credit crunch.

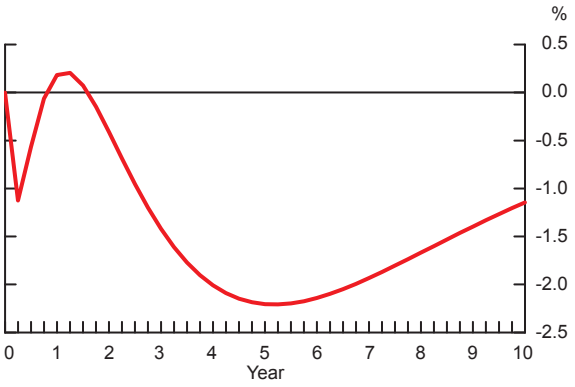
14 Because the shares of loans demanded by domestic entrepreneurs from domestic and foreign banks are currently fixed, Canadian banks do not make up for the loss in loans supplied by foreign banks. A future version of the model will allow those shares to be optimally decided.

15 In this case, the fall in Canadian output is about two-thirds of that in U.S. output.

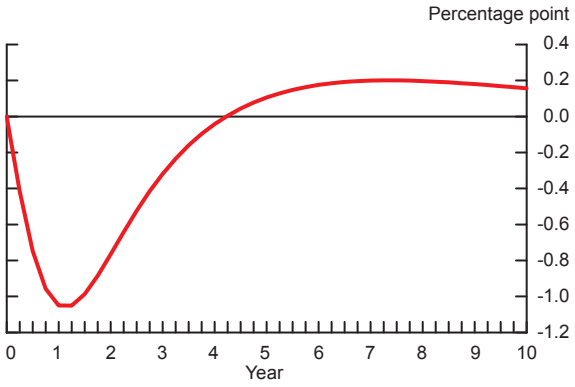
Chart 1: Effects on the United States of an exogenous reduction in U.S. bank loans

Deviation from control

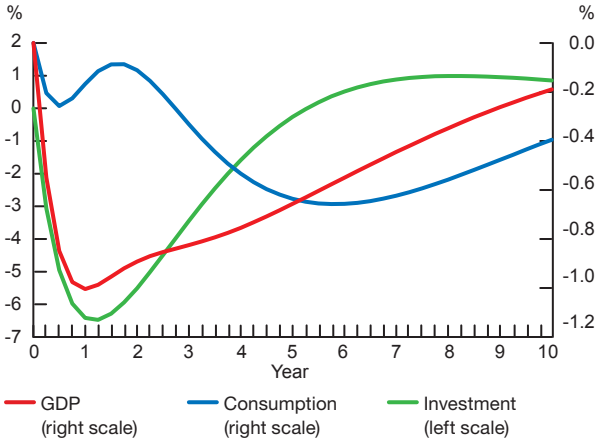
a. Bank loans



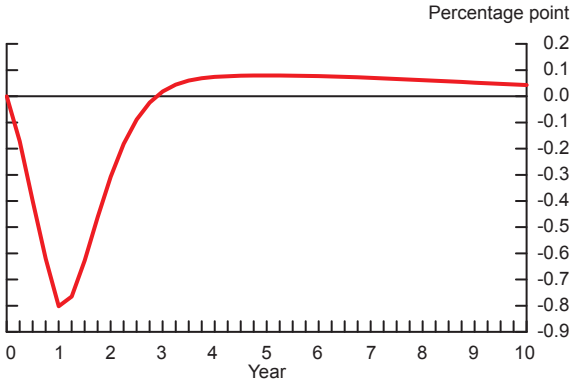
b. Policy rate



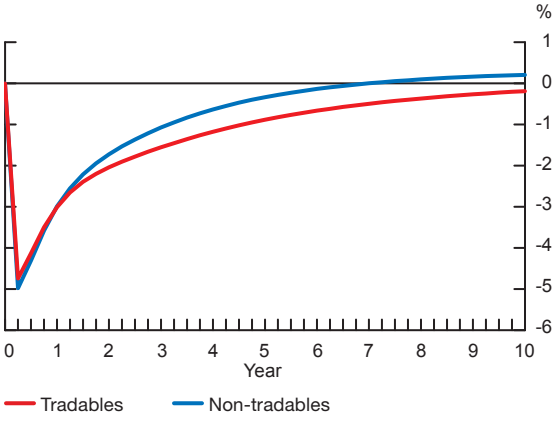
c. Output



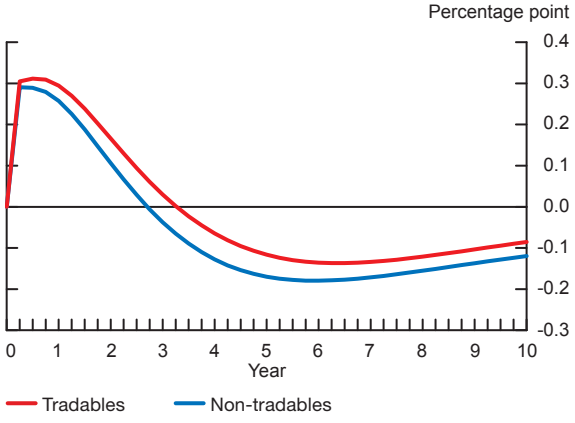
d. Core inflation



e. Net worth



f. Risk premiums

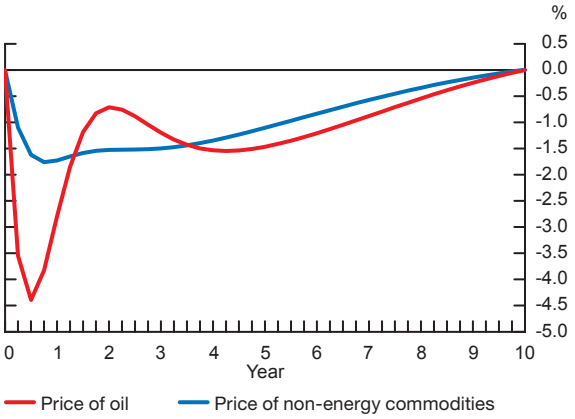


Source: BoC-GEM-Fin simulations

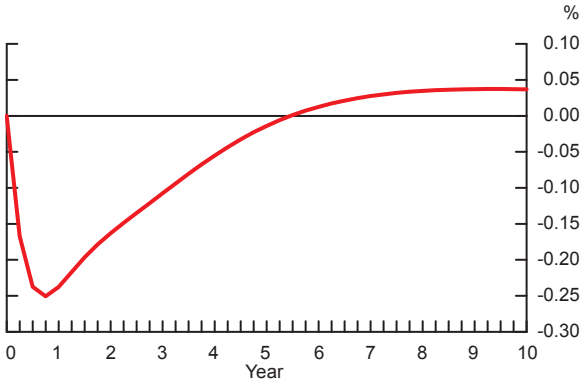
Chart 1: (cont'd)

Deviation from control

g. Price of oil and non-oil commodities



h. Total U.S. imports

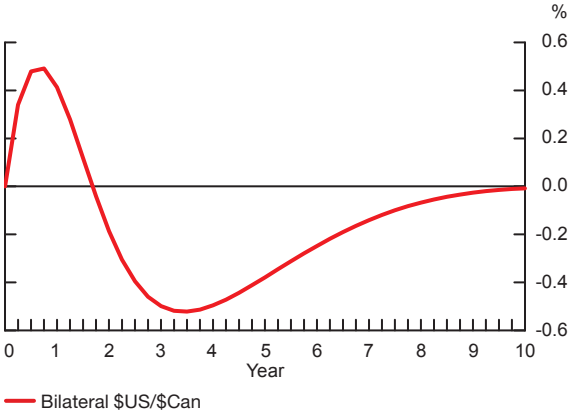


Source: BoC-GEM-Fin simulations

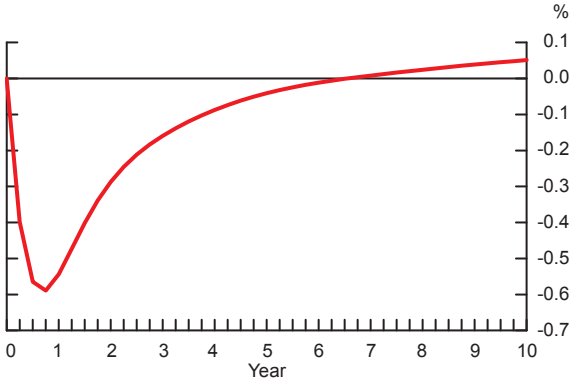
Chart 2: Effects on Canada of an exogenous reduction in U.S. bank loans

Deviation from control

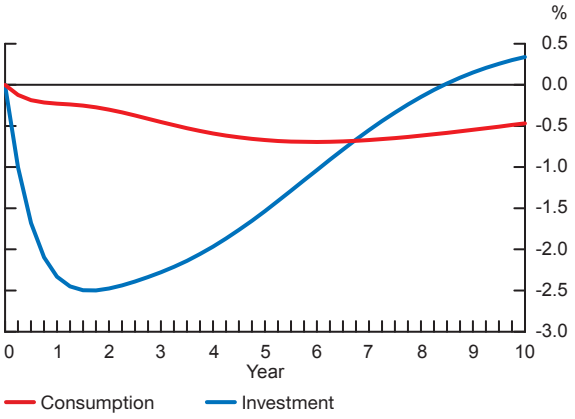
a. Exchange rate



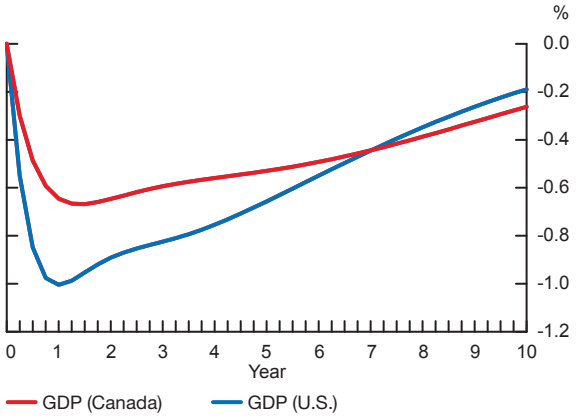
b. Exports



c. Output



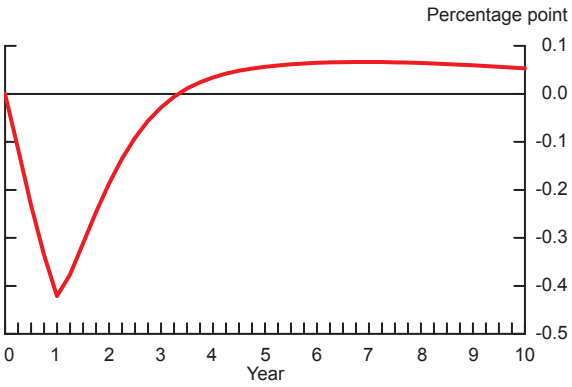
d. GDP, Canada and United States



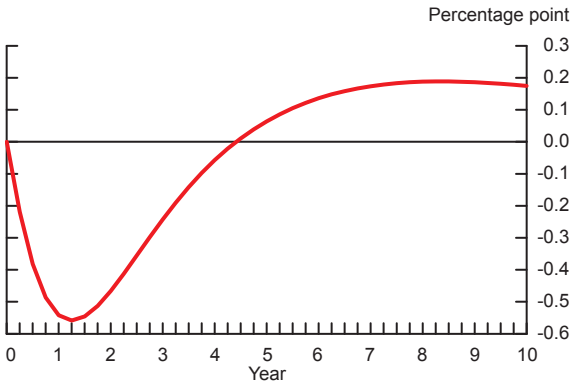
Source: BoC-GEM-Fin simulations

Chart 2: Effects on Canada of an exogenous reduction in U.S. bank loans (cont'd)
Deviation from control

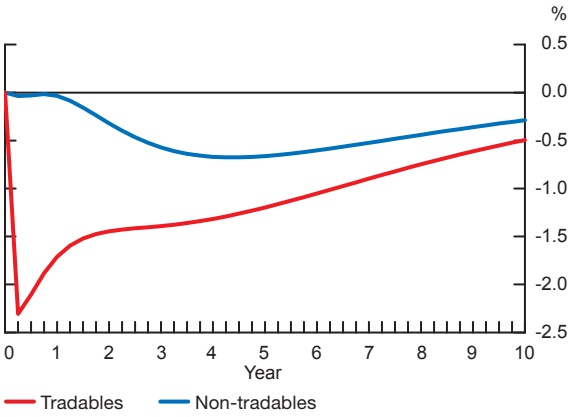
e. Core inflation



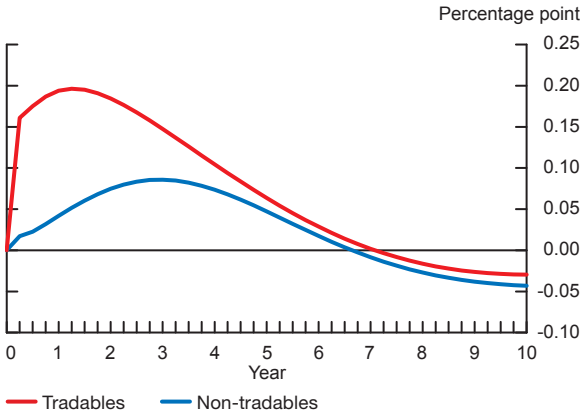
f. Policy rate



g. Net worth



h. Risk premiums



Source: BoC-GEM-Fin simulations

originating in the U.S. banking sector to the global economy—particularly Canada—is very important. Similar conclusions hold for other types of shocks to the U.S. banking sector, such as increases in the probability of default in the interbank market (i.e., the collapse of Lehman Brothers).

Recent applications of the BoC-GEM-Fin

The global economic and financial dimensions of the recent crisis have raised many questions that can be better addressed by a model of the global economy with financial frictions, like the BoC-GEM-Fin.

The role of real-financial linkages in propagating U.S. shocks to Canada

The importance of cross-border financial linkages is illustrated by Beaton, Lalonde and Snudden (2010), who use the BoC-GEM-Fin to address two questions:

1. How are U.S. banking sector shocks transmitted to the Canadian economy?
2. What is the role of financial frictions in the transmission of real shocks originating in the United States to the Canadian economy?

The authors simulate two types of shocks to the U.S. banking sector: (i) a reduction in the supply of bank loans and (ii) an increase in the probability of default in the interbank market. To answer question 2, the authors simulate demand and productivity shocks in the U.S. economy and compare the responses of the U.S. and Canadian economies with those obtained when financial frictions are excluded from the model.

The results suggest that the shocks to the U.S. banking sector have important effects on credit conditions and real activity in Canada. As discussed previously, the response of Canadian output to shocks in the U.S. banking sector is sizable and can be explained by channels associated with the real side of the economy and with the international flow of bank loans. Moreover, financial frictions from the

supply (bank-capital channel) and demand (financial accelerator) of credit can amplify the responses of the U.S. and Canadian economies to all types of shocks that affect U.S. real variables. One final result illustrates how the financial shocks and frictions in the BoC-GEM-Fin help to explain the observed positive co-movement between consumption and investment within each economy and between the two economies. Explaining these co-movements is notoriously difficult with models that rely on only the traditional trade linkages.

Inflation targeting versus price-level targeting: banking sector shocks and the lower bound on interest rates

The Bank of Canada has recently conducted several studies on the merits of the current monetary policy framework based on inflation targeting (IT), relative to a framework based on a price-level target (PLT). These studies (for example, Coletti and Lalonde 2007–08; Kryvtsov, Shukayev and Ueberfeldt 2008) focus mainly on the responses to standard real shocks, and do not consider shocks originating in the banking system. The choice between IT and PLT received renewed interest during the recent crisis, and it has been suggested that PLT might be more successful in limiting the variability in inflation and economic activity when the desired policy rate is close to the zero lower bound (Ambler 2009).

Beaton, Evans and Lalonde (forthcoming) analyze the relative performance of the two regimes in reducing the variance of inflation and the output gap in the presence of shocks to the U.S. and Canadian banking sectors. In light of the recent global crisis, it is crucial to understand the relative merits of IT/PLT under shocks to the banking system, something that could not be accomplished with previous versions of the model.

Their results confirm previous findings that, in the context of monetary policy based on optimized interest rate rules, PLT generates more macroeconomic stability than IT when the economy is hit by shocks that cause inflation and output to move in the same direction, such as demand shocks. Those shocks, like banking sector shocks, imply a more favourable trade-off between inflation and output gap variability faced by the central bank (Coletti and Lalonde 2007–08).

Because the new model incorporates the banking system, the authors consider the best monetary policy response under both IT and PLT in the event of a "banking crisis" that pushes nominal interest rates close to the zero lower bound. Their results suggest that, with PLT, the trough in the output gap and inflation during a banking crisis would be substantially reduced, relative to IT. The explanation is that when nominal interest rates are close to zero, the only practical way to reduce the real interest rate (i.e., the nominal interest rate minus expected inflation) and mitigate the fall in output is by generating higher expected inflation, something more easily achieved under PLT. The lower real interest rate under PLT, relative to IT, reduces the severity of the recession. Finally, depending on the severity of the crisis, the authors find evidence that, under PLT, policy rates need to be maintained at the lower bound for a shorter period.[16] The benefit of PLT in the presence of banking sector shocks is also associated with the fact that PLT is better at minimizing the distortions caused by the debt-deflation mechanism on risk premiums (Dib, Mendicino and Zhang 2008).

Regulation of bank capital

Following the recent financial crisis, policy-makers investigated policies to mitigate the destabilizing effects of excessive leverage in the banking system. One important aspect of the "macroprudential rules" currently being considered is the implementation of tighter bank-capital requirements.[17] Using the BoC-GEM-Fin, de Resende, Dib and Perevalov (2010) study the short-term cost of this type of regulatory policy for Canada. The size of the change and timing of implementation follow the discussions of the Basel Committee on Banking Supervision, Basel III (BCBS 2010; BIS 2010). The authors show that a permanent increase of 2 percentage points in the minimum capital-to-loans ratio (i.e., a lower cap on the banks' leverage ratio) imposed on banks in all regions produces the following results:

- Canadian output falls because of an increase in the risk premium and a decrease in investment. This temporary effect on output reduces the long-term benefits—mainly the lower probability of a severe banking crisis—associated with the tighter regulation.[18]

16 Note that these results are robust to optimized rules that exclude the "smoothing coefficient" (i.e., a response to the lagged interest rate). These results are not unconditional, however, since they hold for the particular type of shock in queston (i.e., the banking sector shock) but not necessarily for other types of shocks. The PLT/IT comparison also abstracts from many of the challenges that PLT might face in practice, for example, credibilty and communicating it to the public.

17 See BCBS (2010), BIS (2010) and Gauthier, He and Souissi (2010)

18 See the interim report by the BCBS (BIS 2010). In addition, Bank of Canada (2010) shows that after subtracting the estimated long-run and transition costs of requiring banks to carry more capital and liquidity, the net gains in present-value terms would be approximately 13 per cent of GDP.

- When the changes in regulatory policy are implemented worldwide, the temporary drop in Canadian output is larger than it would be if the changes were introduced only in Canada. These spillover effects may increase the average negative effect on Canadian output by as much as 0.9 percentage point.
- Reducing the phase-in period for implementation of the new regulatory policy from four years to two years implies an additional decrease of 0.3 percentage point in output. Increasing the phase-in to six years reduces the decrease in output by 0.1 percentage point.
- The monetary policy response is very important. If monetary policy does not react to inflation outcomes for one year,[19] such that the policy rate does not fall as fast as it would otherwise, the resulting higher real interest rate increases the negative effect of the change in capital regulation.

19 That is, either by lowering the policy rate or by using quantitative- or credit-easing instruments in response to the decline in inflation resulting from the slowdown in economic activity.

Conclusions and Future Developments

The BoC-GEM-Fin is currently being used to study a number of interesting policy questions, including the relative merits of countercyclical bank-capital requirements—i.e., rules that allow banks to have more leverage during recessions, with stricter requirements during economic booms—as well as the macroeconomic effects of a monetary policy framework based on leaning against financial imbalances.

The BoC-GEM-Fin has already proven to be a very useful analytic tool, and further improvements are being incorporated. These include an international interbank market and household credit. These additional features will provide new channels for the international propagation of real and financial shocks and allow a more in-depth study of the behaviour of household balance sheets in times of financial distress.

Literature Cited

Ambler, S. 2009. "Is It Time for Price-Level Targeting?" *Economic Affairs*, 29 (3): 35–39.

Bank for International Settlements (BIS). 2010. "Assessing the Macroeconomic Impact of the Transition to Stronger Capital and Liquidity Requirements." Macroeconomic Assessment Group Interim Report (August).

Bank of Canada. 2010. "Strengthening International Capital and Liquidity Standards: A Macroeconomic Impact Assessment for Canada." Bank of Canada Report (August).

Basel Committee on Banking Supervision (BCBS). 2010. "An Assessment of the Long-Term Economic Impact of Stronger Capital and Liquidity Requirements." LEI Report (August).

Beaton, K., B. Evans and R. Lalonde. Forthcoming. "The Relative Merits of Inflation Targeting versus Price-Level Targeting: Banking Sector Shocks, Banking Crises and the Lower Bound of Interest Rates." Bank of Canada Discussion Paper.

Beaton, K., R. Lalonde and S. Snudden. 2010. "The Propagation of U.S. Shocks to Canada: Understanding the Role of Real-Financial Linkages." Bank of Canada Working Paper No. 2010-40.

Bernanke, B., M. Gertler and S. Gilchrist. 1999. "The Financial Accelerator in a Quantitative Business Cycle Framework." In *Handbook of Macroeconomics*, edited by J. Taylor and M. Woodford, 1341–93. Amsterdam: North-Holland.

Christensen, I. and A. Dib. 2006. "Monetary Policy in an Estimated DSGE Model with a Financial Accelerator." Bank of Canada Working Paper No. 2006-9.

Christensen, I., C. Meh and K. Moran. 2010. "Bank Leverage Regulation and Macroeconomic Dynamics." Bank of Canada and Université Laval. Manuscript.

Coletti, D. and R. Lalonde. 2007–08. "Inflation Targeting, Price-Level Targeting, and Fluctuations in Canada's Terms of Trade." *Bank of Canada Review* (Winter): 35–43.

Literature Cited (cont'd)

de Resende, C., A. Dib, R. Lalonde and S. Snudden. Forthcoming. "The Bank of Canada's Version of the Global Economy Model with Financial Frictions (BoC-GEM-Fin)." Bank of Canada Technical Report.

de Resende, C., A. Dib and N. Perevalov. 2010. "The Macroeconomic Implications of Changes in Bank Capital and Liquidity Requirements in Canada: Insights from the BoC-GEM-Fin." Bank of Canada Discussion Paper No. 2010-16.

Dib, A. 2010a. "Banks, Credit Market Frictions, and Business Cycles." Bank of Canada Working Paper No. 2010-24.

———. 2010b. "Capital Requirement and Financial Frictions in Banking: Macroeconomic Implications." Bank of Canada Working Paper No. 2010-26.

Dib, A., C. Mendicino and Y. Zhang. 2008. "Price Level Targeting in a Small Open Economy with Financial Frictions: Welfare Analysis." Bank of Canada Working Paper No. 2008-40.

Duguay, P. and D. Longworth. 1998. "Macroeconomic Models and Policy Making at the Bank of Canada." *Economic Modelling* 15 (3): 357–75.

Gauthier, C., Z. He and M. Souissi. 2010. "Understanding Systemic Risk: The Trade-Offs between Capital, Short-Term Funding and Liquid Asset Holdings." Bank of Canada Working Paper No. 2010–29.

Kryvtsov, O., M. Shukayev and A. Ueberfeldt. 2008. "Adopting Price-Level Targeting under Imperfect Credibility: An Update." Bank of Canada Working Paper No. 2008-37.

Lalonde, R. and D. Muir. 2007. "The Bank of Canada's Version of the Global Economy Model (BoC-GEM)." Bank of Canada Technical Report No. 98.

———. 2009. "BoC-GEM: Modelling the World Economy." *Bank of Canada Review* (Summer): 43–53.

Meh, C. and K. Moran. 2010. "The Role of Bank Capital in the Propagation of Shocks." *Journal of Economic Dynamics and Control* 34 (3): 555–76.

Pesenti, P. 2008. "The Global Economy Model: Theoretical Framework." *IMF Staff Papers* 55 (2): 243–84.