# Introducing Multiple Interest Rates in ToTEM

*José Dorich, Rhys R. Mendes and Yang Zhang, Canadian Economic Analysis Department*

- *Standard dynamic stochastic general-equilibrium (DSGE) models, including the first version of ToTEM, typically incorporate a single domestic interest rate. In these models, time variation in term premiums and risk spreads is not an important determinant of macroeconomic fluctuations.*
- *Empirical evidence suggests that both short- and long-term rates, as well as the risk spreads faced by households and firms, have significant effects on aggregate demand.*
- *The Bank of Canada has developed a new version of ToTEM that incorporates multiple interest rates, as well as several other modifications.*
- *This new structure allows Bank staff to use ToTEM to study a broader array of policy questions than was previously possible. For example, staff recently employed the model to assess the macroeconomic impact of higher requirements for bank capital and liquidity.*

Until recently, in keeping with standard practice in DSGE macroeconomic modelling, the Bank of Canada's main model for projection and policy analysis, ToTEM, had a single domestic interest rate.[1] This short-term rate was treated as the instrument of monetary policy, and its current value and expected future path were key determinants of the behaviour of economic agents in the model. However, the events of the recent global financial crisis highlighted the role that changes in credit market conditions, including risk spreads, can play in macroeconomic developments. This has led to accelerated work on multiple interest rate models at the Bank of Canada and elsewhere. This article provides an overview of the introduction of multiple interest rates in ToTEM.

Economic models are simplified representations of reality, designed to assist the understanding and analysis of economic outcomes. Economists choose the dimensions along which they simplify their models to render them tractable, but still useful. Judicious choice of the simplifications allows the model to provide insights into the functioning of the economy without obscuring the analysis with unnecessary detail. One common simplification is to abstract from the variety of different interest rates that prevail in practice, by adopting a single interest rate.

In reality, however, households, firms and the government all face different interest rates. That is, there are time-varying spreads between the interest rates available to private agents and those available to the government. Changes in these spreads can influence macroeconomic developments. Moreover, the expected future path of short-term interest rates is

1 Two key antecedents of large macroeconomic models like ToTEM are those of Christiano, Eichenbaum and Evans (2005) or Smets and Wouters (2007). For textbook models see Woodford (2003) and Galí (2008).

not a perfect proxy for long-term rates. Thus, variations in the term premium—the difference between long-term rates and the expected path of short-term rates—may have implications for the macroeconomy.

Consequently, Bank staff developed a new version of ToTEM (ToTEM II) that includes a richer interest rate structure in addition to several other changes (see **Box**).[2] In particular, ToTEM II includes both long- and short-term rates, as well as different risk spreads that lead to differences in the interest rates faced by households, firms and the government. These changes broaden the range of policy questions that the model can address and improve its ability to explain the data.

The article begins with a description of the changes to the interest rate structure in ToTEM II. The implications of shocks to risk spreads and term premiums during the recent financial crisis are then reviewed. Finally, as an example, the new model is used to examine the macroeconomic implications of changes to the requirements for capital and liquidity in the banking sector.

## Interest Rates and Aggregate Demand

In standard DSGE macroeconomic models, including the first version of ToTEM, aggregate demand is affected by the evolution of just one interest rate: the short-term, risk-free real interest rate. This one interest rate determines the degree of intertemporal substitution by firms and households in their decisions to invest, spend, save and work. For example, a relatively high interest rate provides households with an incentive to postpone consumption. Instead, they will tend to save more in order to take advantage of the higher interest rates. Relatively low interest rates have the opposite effect.

In ToTEM, as in most other DSGE macroeconomic models, short- and long-term, risk-free assets are assumed to be perfect substitutes. This implies that the expected rates of return on these two types of asset will be equalized by arbitrage. Suppose the long-term asset under consideration has a maturity of 5 years (20 quarters), while the short-term asset has a maturity of 1 quarter. The long-term interest rate ($i_t^L$) will be equal to the average of the expected short-term rate ($i_t$) over the subsequent 20 quarters:[3]

$$i_t^L = \frac{1}{20}\sum_{j=0}^{19} E_t i_{t+j}.$$

A long-term rate that is exactly equal to the average path of expected future short-term rates is said to be consistent with the *pure expectations theory of the term structure*.

In models such as ToTEM, households and firms are forward looking, which implies that their consumption and investment decisions are influenced not only by the current interest rate, but also by the entire expected path of rates. This result, combined with the assumption of perfect asset substitutability, made it redundant to explicitly model the long-term interest rate in ToTEM.

*The new model allows long-term interest rates to play a meaningful role in economic decisions*

Models with a single interest rate cannot be used to address questions about the effects of changes in term premiums or risk spreads.[4] ToTEM II has been designed to permit analysis of these issues. The new model allows long-term interest rates to play a meaningful role in economic decisions, over and above the traditional role of short-term rates. ToTEM II also includes the risk spreads faced by households and firms on long- and short-term interest rates. These risk spreads are assumed to be exogenous and are defined as the difference between the effective interest rate facing firms and households and the risk-free rate.[5]

2 For a description of ToTEM, see Murchison and Rennison (2006). Fenton and Murchison (2006) provide a non-technical overview of ToTEM. For information on the new features introduced in ToTEM II, see Dorich et al. (forthcoming).

3 The relationship given in the main text is a linear approximation. The underlying non-linear relationship requires the gross long-term rate ($1+i_t^L$) to be equal to the expectation of the *geometric* average of current and future gross short-term rates. This relationship also holds only when all accrued interest is paid at maturity, i.e., a zero-coupon security.

4 Because the original version of ToTEM did not incorporate multiple interest rates, the impact of shocks to interest rate spreads and term premiums could not be identified; it was confounded with the impact of other shocks. Nevertheless, through the use of judgment, at times informed by alternative models, Bank staff did take account of such shocks. Moreover, during the financial crisis, a prototypical version of the interest rate structure described in this article was incorporated into ToTEM. This modified version was used to analyze the impact of spread shocks, among other things.

5 The risk-free rate is the rate of interest on an asset that is free of default and other types of risk. In practice, no asset may be completely free of risk, and the risk-free rate is usually equated with the interest rate on government securities or a rate related to the central bank's policy rate.

## ToTEM II: An Updated Version of the Bank of Canada's Quarterly Projection and Policy Analysis Model

The Terms-of-Trade Economic Model, or ToTEM, has served as the Bank's main projection and policy analysis model since December 2005 (Murchison and Rennison 2006; Fenton and Murchison 2006). An updated version of the model (ToTEM II) replaced ToTEM in June 2011. The model has been improved along a number of dimensions, including the introduction of multiple interest rates. Changes related to interest rates are described in detail in the main text. Here, we briefly summarize some of the other new elements of ToTEM II. The features of ToTEM II are fully documented in Dorich et al. (forthcoming).

### Estimation

In ToTEM II, a substantial number of the model's parameters have been estimated using Classical Maximum Likelihood methods. This is in contrast to ToTEM's parameter values, which were all chosen manually so that ToTEM could replicate selected moments of the data or stylized facts. This change has considerably improved the model's forecasting behaviour.

### Introduction of variables for residential and inventory investment

ToTEM did not include explicit variables for investment in residential structures and inventories. In practice, "consumption" was treated as a conglomerate, defined as the sum of three components of the National Income and Expenditure Accounts (NIEA): consumption, residential investment and inventory investment. Thus, residential and inventory investment entered ToTEM through this conglomerate consumption variable. This practice was a continuation of the approach adopted when the Bank introduced the Quarterly Projection Model (ToTEM's predecessor) in 1993.

ToTEM II includes separate variables for NIEA consumption, residential investment and inventory investment. Demands for these three goods are treated separately, with their own shocks and interest elasticities. ToTEM II also accounts for the relevant stock-flow relationships. These changes permit analysis of a wider range of shocks.

### Changes to price- and wage-setting behaviour

Both ToTEM and ToTEM II have sticky nominal prices and wages (all nominal prices and wages are not re-optimized every period). In ToTEM, when a firm re-optimized its nominal price, it did so in a fully rational, forward-looking manner. In ToTEM II, some firms behave in a forward-looking manner, while others follow a simple rule of thumb in the spirit of Galí and Gertler (1999). Analogous changes were also made to the structure of wage determination in ToTEM II. The presence of rule-of-thumb agents gives staff the flexibility to estimate the extent of forward-looking behaviour in price and wage setting.[1]

### Use of a closure condition on household net wealth

In ToTEM, as in many other small-open-economy DSGE models, the country-specific interest rate risk premium is a function of Canada's net foreign asset (NFA) position relative to its steady state. This ensures a stationary dynamic path for the NFA-to-GDP ratio since the risk premium will move the exchange rate to whatever level is required to return the NFA-to-GDP ratio to its steady state.

In ToTEM II, the closure condition on net foreign assets is replaced by a closure condition on household net wealth. A household's discount factor in ToTEM II depends on the ratio of household net wealth to disposable income relative to its steady state. Thus, households become more patient when their net wealth is low relative to the desired level, and vice versa. Household net wealth is derived from the household's budget constraint and incorporates housing wealth, holdings of government debt, stock market wealth evaluated at the "fundamental" shadow value of capital (assuming that equity prices move proportionately with expected earnings), and net claims on foreign assets. As a result, developments in the housing market, such as house-price movements, have a direct impact on consumption via this net-wealth gap.

1 For a discussion of the implications of rule-of-thumb behaviour for the discounting of future economic conditions, see Amano, Mendes and Murchison (2009).

In order to allow long-term interest rates to have an independent effect on aggregate demand in ToTEM II, Bank staff made two modifications: (i) they abandoned the traditional assumption of perfect asset substitutability, and (ii) they introduced a subset of households who participate only in the long-term asset market. The first change breaks the perfect link between long-term rates and the expected path of short-term rates, while the second change ensures that some households always base their decisions on long-term rates.

Imperfect asset substitutability, in the spirit of Tobin (1969), was introduced in ToTEM II using the approach suggested by Andrés, López-Salido and Nelson (2004). Households are modelled as viewing short- and long-term securities as imperfect substitutes. They incur some disutility from holding long-term assets and therefore demand a premium to do so.[6] This breaks the perfect arbitrage between the two assets and allows the long-term rate to deviate from the level implied by the pure expectations theory of the term structure. This deviation is the term premium ($tp_t$). The relationship between long- and short-term rates in ToTEM II is given by:

$$i_t^L = \frac{1}{20}\sum_{j=0}^{19} E_t i_{t+j} + tp_t.$$

The presence of the term premium implies that long-term rates can vary independently of the expected path of short-term rates.

Nevertheless, as mentioned earlier, this modification alone is not enough to allow long-term interest rates to have an independent effect on aggregate demand: households can simply sidestep the market for long-term assets and implement their consumption plans by trading in a sequence of short-term assets. The term premium merely compensates households for the marginal disutility associated with holding long-term assets, leaving them indifferent between returns on the two types of assets.

For this reason, ToTEM II includes a subset of households who participate only in the market for long-term assets. These households can be thought of as a proxy for agents who save primarily through vehicles such as pension funds (which invest heavily in long-term assets), or who borrow through longer-term instruments such as fixed-rate mortgages. The presence of households with restricted asset market participation ensures that the consumption decisions of this subset of households are driven by long-term rates. This, in turn, implies that the consumption equation in ToTEM II depends on both short- and long-term interest rates.[7]

The importance of long-term rates in the ToTEM II consumption equation is not presumed, but estimated. This weight has been estimated using several different econometric techniques, including the full-information techniques used to estimate other parameters in ToTEM II, as well as techniques using the generalized method of moments for single-equation linear models. All of these estimates indicate that long-term rates have a significant effect on consumption, independent of the expected path of short-term rates.

The effective interest rates faced by households are modelled as functions of the risk-free rates and risk spreads:

$$i_{H,t} = i_t + stsp_t,$$

$$i^L_{H,t} = i^L_t + ltsp_t,$$

where $i_{H,t}$ and $i^L_{H,t}$ are the short- and long-term rates applicable to households, $stsp_t$ is an exogenous risk spread on household short rates, and $ltsp_t$ is an exogenous risk spread on long rates.

The short-term and long-term rates faced by firms are related to the risk-free rate and the exogenous risk spreads in the same way as those for households. However, the risk spreads on firms' debt are allowed to differ in magnitude from those associated with households.

The assumption of *exogenous* risk spreads is an important limitation of the interest rate structure in ToTEM II. We would expect risk spreads to be related to endogenous variables such as leverage ratios. Modelling such relationships would allow macroeconomic shocks and policies to affect risk spreads, and may therefore have implications for the policy prescriptions that emerge from the model. Other authors have modelled risk spreads as endogenous, but only in environments without an independent

6 The disutility associated with holding long-term assets represents the increased risk and the lower liquidity associated with these assets that are not explicitly modelled but that would lead to a time-varying term premium.

7 One alternative to this approach would be to directly assume that certain components of demand (e.g., durable consumption and residential investment) are affected primarily by longer-term rates.

role for long-term rates.[8] Bank staff are currently exploring the introduction of endogenous interest rate spreads in ToTEM II.

## The impact of shocks to interest rate spreads during the crisis

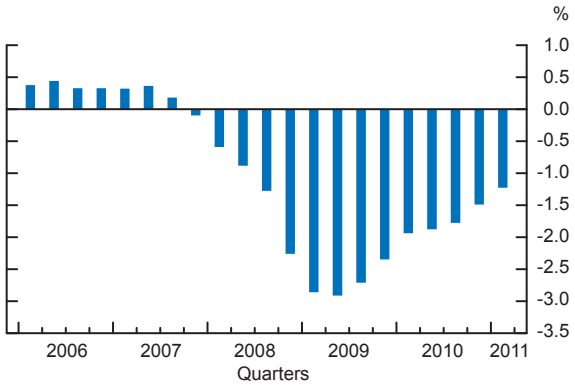
In the United States and many other economies, a large and persistent tightening of credit market conditions played a key role in transmitting the recent global financial crisis to the real economy. Credit market conditions also tightened in Canada. This general tightening included a widening of interest rate spreads during the crisis. ToTEM II provides a lens through which to assess the impact of these higher spreads on the Canadian economy.

We use ToTEM II to simulate the effects of the shocks to spreads that occurred during the crisis. The model suggests that the widening of spreads did not play a major role in generating the economic downturn in Canada. Nevertheless, it is important to bear in mind that many potential linkages between the financial sector and the real economy are not explicitly modelled in ToTEM II. In particular, the model does not include a banking sector, nor does it embed the possibility of quantity restrictions or changes in the non-price terms and conditions of credit. The analysis in this section captures only the effects of changes in spreads. Financial shocks that are not explicitly modelled in ToTEM II will be subsumed in the identified effects of other shocks. For example, quantity restrictions on credit could be a contributing factor underlying the identified negative shocks to domestic demand.

We would expect changes in spreads to have their greatest impact on the most interest-sensitive components of aggregate demand: business and residential investment. **Chart 1** and **Chart 2** show the change in these variables (relative to trend) that ToTEM II attributes to spread shocks. In both cases, the estimated impact of the spread shocks is modest.

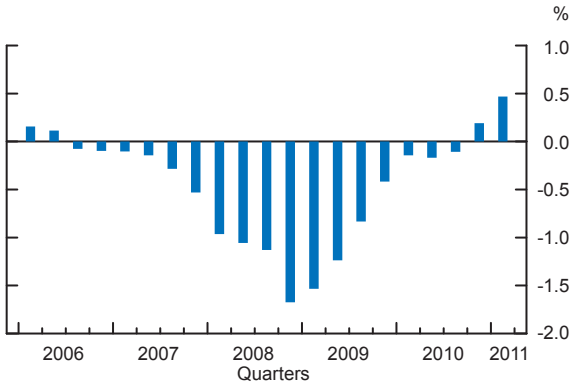
According to ToTEM II, widening spreads are estimated to have caused business investment to decline to around 3.0 per cent below trend, before starting to recover. During the recession, however, actual business investment fell to more than 20 per cent below trend. Thus, our calculations suggest that less than one-fifth of the decline in business investment can be attributed to greater spreads.

**Chart 1: Business investment**
Deviation from trend




Source: ToTEM II simulations

**Chart 2: Residential investment**
Deviation from trend




Source: ToTEM II simulations

The fraction of the decline in residential investment caused by increased spreads is similarly small. The increases in spreads are estimated to have caused residential investment to decline to around 1.5 per cent below trend. In contrast, actual residential investment fell to more than 16 per cent below trend.

Thus, in Canada, the declines in business and residential investment were not primarily due to the increases in interest rate spreads faced by households and firms. Rather, ToTEM II attributes an important role to domestic-demand shocks and the decline in economic activity in the rest of the world. The sharp contraction of the global economy had a substantial impact on Canada by causing a deterioration in net exports and the terms of trade. This, in turn, reduced the incomes of Canadian households and firms and contributed to weaker business and residential investment.

8 For example, Bernanke, Gertler and Gilchrist (1999) derive a model in which the risk spread a firm must pay to borrow is a function of its leverage ratio. Similarly, Basant Roi and Mendes (2007) assume that the risk spread faced by a household depends on the household's ratio of debt to housing wealth.

Domestic-demand shocks also played a key role. In ToTEM II, the shocks to consumption and investment demand are modelled as shocks to household preferences and shocks to the production technology, respectively. In practice, these shocks were probably substitutes for unmodelled financial shocks, as well as shocks to uncertainty and confidence. In particular, the severity of the financial crisis in the rest of the world may have had an adverse impact on confidence and uncertainty among Canadian households and firms. The confidence and uncertainty effects, in turn, may have been a drag on consumption and investment. But regardless of their microeconomic interpretation, shocks to domestic demand made important contributions to the decline in aggregate demand.

Overall, the story that emerges from ToTEM II suggests that the recession was not primarily the result of changes in risk spreads in Canada.[9] Rather, according to the model, shocks in the rest of the world played a central role, as did shocks to domestic demand (possibly including the effects of unmodelled financial shocks).

## Application: Assessing the Macroeconomic Impact of Higher Bank Capital and Liquidity Requirements

The recent international banking crisis has sparked renewed interest in issues of macroprudential regulation. For instance, in 2010, the Basel Committee on Banking Supervision (BCBS) proposed an increase in the minimum required levels of capital and liquidity for the banking system.[10] This proposal aimed to reinforce the stability of the banking sector, thereby reducing the probability of a banking crisis in the future.[11] However, the benefits of a less-leveraged and more liquid banking system must be weighed against the associated economic costs. For instance, during the transition toward tighter capital and liquidity requirements, banks could reduce the supply of credit or increase interest rate spreads—actions that would have a negative impact on economic activity.

To help determine the appropriate calibration of the BCBS proposal, the Financial Stability Board and the BCBS conducted two studies to evaluate the macroeconomic impact of higher capital and liquidity requirements. These studies assessed the benefits and costs of the new standards over (i) the longer-term period when the proposals are fully implemented, and (ii) the initial transition period, during which the new standards will be introduced. Bank of Canada staff participated in both international studies. The Bank also carried out its own assessment of the implications of these new standards for the Canadian financial system and economy.

In this section, we review how ToTEM II was used to assess the transitional macroeconomic impact of higher steady-state capital and liquidity requirements for the Canadian banking system. Two different proposals were considered: (i) an increase of 1 percentage point in the banks' capital ratio, and (ii) an increase of 25 per cent in the liquid asset ratio.[12] We examine the impact of these proposals under the assumption that they are implemented over a four-year period.

Since the structure of ToTEM II does not directly incorporate a banking sector, a two-step approach proposed by the Macroeconomic Assessment Group of the Bank for International Settlements was followed to assess the macroeconomic impact of tighter regulation.[13] First, the impact of higher capital and liquidity requirements on the interest rate spreads faced by households and firms was estimated using linear regression models.[14] The paths of the spreads implied by the regression models were then imposed in ToTEM II to generate simulated paths for key macroeconomic variables.

Before turning to the results, it is important to re-emphasize that the BCBS proposals are envisaged as part of a coordinated set of international regulatory changes. In the results presented below, however, we assume that regulatory requirements in the rest of the world remain unchanged. Global tightening of regulatory requirements could amplify the effects of the changes in Canada. De Resende and Lalonde (2011) use the BoC-GEM-FIN model to examine the effects of global tightening of regulatory requirements for Canada in an article in this issue of the *Review*.

9 It is possible, however, that the credit market effect is not fully captured by the increase in spreads. Banks and other lenders may have also restricted quantitative access to credit. Insofar as they did ration credit, the ToTEM II analysis may understate the full impact of financial developments.

10 See BIS (2010).

11 There have also been other proposals aimed at strengthening the stability of the banking sector. For instance, Basel III considers the adoption of countercyclical capital buffers. Meh (2011) examines how such an initiative would affect the transmission and propagation of shocks in an article in this issue of the *Review*.

12 Details on the methodology used to evaluate the macroeconomic impact of higher capital and liquidity requirements can be found in Dorich and Zhang (2010).

13 For details on this two-step approach, see BIS (2010).

14 For details on the regression methodology, see Bank of Canada (2010).

## An increase of 1 percentage point in the capital ratio

The increase in the capital ratio generates an increase in the spreads on short- and long-term interest rates faced by households and firms. According to the regression models, an increase of 1 percentage point in the capital ratio ultimately leads to an increase of 14 basis points in the spreads as banks adjust their lending behaviour (**Table 1**).

**Table 2** presents the transitional impact of this change in the capital ratio on output, consumption, investment, exports, imports, the policy rate and core inflation.[15] The increase in interest rate spreads causes an increase in the effective interest rates faced by households, which gives households an incentive to postpone consumption. This leads to a 0.7 per cent decrease in consumption, relative to its baseline level, four years after implementation.[16]

**Table 1: Impact of regulatory policies on interest rate spreads**
Measured in basis points

| | Years after implementation | | | | |
|---|---|---|---|---|---|
| | 0.5 | 1.0 | 2.0 | 4.0 | 6.0 |
| Capital target increases 1 percentage point | 1.1 | 2.6 | 6.1 | 13.1 | 14.0 |
| Liquidity ratio increases 25 per cent | 1.1 | 2.8 | 6.4 | 13.9 | 14.9 |

**Table 2: Impact of a 1-percentage-point increase in the capital ratio**

| | Years after implementation | | | |
|---|---|---|---|---|
| | 0.5 | 1.0 | 2.0 | 4.0 |
| Output | -0.1 | -0.1 | -0.2 | -0.3 |
| Consumption | -0.3 | -0.4 | -0.6 | -0.7 |
| Investment | -0.3 | -0.5 | -0.6 | -0.7 |
| Exports | 0.3 | 0.4 | 0.6 | 0.4 |
| Imports | -0.2 | -0.3 | -0.4 | -0.5 |
| Policy rate (bps) | -5.5 | -5.0 | -2.0 | -2.0 |
| Inflation (bps) | -2.3 | -1.0 | 1.0 | 0.0 |

Note:
1. All quantity variables are expressed as a percentage deviation from the baseline.
2. The policy rate is expressed as a basis-point deviation from the baseline at an annual rate.
3. The inflation rate is expressed as a basis-point deviation from the baseline of the year-over-year basis-point change in the level of core consumer prices.

15 The availability of alternative sources of financing for non-financial corporations may weaken the impact of changes in the banking sector on economic activity. In the simulations presented here, it is assumed that the higher spreads will be passed on to all households and firms. However, large corporate firms could issue debt in capital markets at a lower cost.

16 The baseline level refers to the level that would prevail without any new regulatory measure.

The increase in spreads affects investment through two different channels. First, the effective rate at which firms discount future real profits increases. This means that the net present value of future profits is reduced and, consequently, the demand for investment is reduced. Second, the reduction in the demand for consumption reduces the demand for capital by firms that produce consumption goods and services. These two effects cause investment to drop 0.7 per cent below its baseline level after four years.

In the model, the decline in consumption and investment puts downward pressures on output and prices. This, in turn, leads to a small temporary reduction in the policy rate in order to stabilize inflation during the transition. On the trade side, the reduction in the policy rate generates a depreciation in the real exchange rate, making Canadian exports cheaper for the rest of the world. Exports consequently increase by 0.4 per cent four years after implementation. Moreover, the real depreciation of the Canadian dollar, combined with decreased consumption and investment demand, causes imports to decrease by 0.5 per cent over four years.

The decrease in consumption and investment, partially offset by the increase in net exports, leads to a decrease of 0.3 per cent in the gross domestic product, relative to the baseline, four years after the implementation of the new capital ratio. If, however, the regulatory changes are implemented globally, then the impact on output could be greater because of a weaker offset from net exports. De Resende and Lalonde (2011) discuss the implications of global implementation in greater detail.

## An increase of 25 per cent in the liquid asset ratio

The increase in the liquid asset ratio translates into wider interest rate spreads faced by households and firms. According to the linear regression models, an increase of 25 per cent in the liquid asset ratio results in an increase of 15 basis points in spreads in the long run. The magnitude is roughly speaking equal to the impact of higher capital requirements on spreads. The impact of greater liquidity requirements on interest rate spreads is estimated to be very similar to the impact of tighter capital requirements. Hence, the estimated macroeconomic impact of these two regulatory measures is quantitatively very similar.

### Comparing costs and benefits

In this article, we have considered only the transitional costs of higher capital and liquidity requirements. A complete assessment of the proposals requires the transitional costs to be added to the long-term costs and then weighed against the expected benefits. The benefits come in the form of a reduced probability of future financial crises, as well as a decrease in the severity of any future crises, smoother economic cycles and lowered risk of overinvestment problems. Based on conservative estimates of the costs of financial crises, Bank of Canada (2010) finds that the benefits of the proposed regulatory changes would outweigh the costs. This is true even if the only source of benefits is a reduced probability of crises.

## Conclusions

The introduction of a richer interest rate structure in ToTEM has made it possible to study a broader range of policy questions in the model. It has also contributed to improved empirical performance in ToTEM II. Nevertheless, Bank staff are currently exploring avenues for further enhancing linkages between financial developments and the real economy in ToTEM II. In the short run, the staff plan to investigate the possibility of making the risk spreads depend on endogenous variables.

## Literature Cited


Amano, R., R. Mendes and S. Murchison. 2009. "Endogenous Rule-of-Thumb Price Setters and Monetary Policy." Bank of Canada Manuscript.

Andrés, J., D. López-Salido and E. Nelson. 2004. "Tobin's Imperfect Asset Substitution in Optimizing General Equilibrium." *Journal of Money, Credit and Banking* 36 (4): 665–90.

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).

Basant Roi, M. and R. Mendes. 2007. "Should Central Banks Adjust Their Target Horizons in Response to House-Price Bubbles?" Bank of Canada Discussion Paper No. 2007-4.

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.

Christiano, L., M. Eichenbaum and C. Evans. 2005. "Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy." *Journal of Political Economy* 113 (1): 1–45.

de Resende, C. and R. Lalonde. 2011. "The BoC-GEM-Fin: Banking in the Global Economy." *Bank of Canada Review* (this issue): 11–21.

Dorich, J., M. Johnston, R. Mendes, S. Murchison and Y. Zhang. Forthcoming. "ToTEM II: An Updated Version of the Bank of Canada's Quarterly Projection Model."

Dorich, J. and Y. Zhang. 2010. "Assessing the Macroeconomic Impact of Stronger Capital and Liquidity Requirements in Canada: Insights from ToTEM." Bank of Canada Manuscript.

Fenton, P. and S. Murchison. 2006. "ToTEM: The Bank of Canada's New Projection and Policy-Analysis Model." *Bank of Canada Review* (Autumn): 5–18.

Galí, J. 2008. *Monetary Policy, Inflation, and the Business Cycle: An Introduction to the New Keynesian Framework*. Princeton, New Jersey: Princeton University Press.

Galí, J. and M. Gertler. 1999. "Inflation Dynamics: A Structural Econometric Analysis." *Journal of Monetary Economics* 44 (2): 195–222.

Meh, C. 2011. "Bank Balance Sheets, Deleveraging and the Transmission Mechanism." *Bank of Canada Review* (this issue): 23–34.

Murchison, S. and A. Rennison. 2006. "ToTEM: The Bank of Canada's New Quarterly Projection Model." Bank of Canada Technical Report No. 97.

Smets, F. and R. Wouters. 2007. "Shocks and Frictions in US Business Cycles: A Bayesian DSGE Approach." *American Economic Review* 97 (3): 586–606.

Tobin, J. 1969. "A General Equilibrium Approach to Monetary Theory." *Journal of Money, Credit and Banking* 1 (1): 15–29.

Woodford, M. 2003. *Interest and Prices: Foundations of a Theory of Monetary Policy*. Princeton, New Jersey: Princeton University Press.