



BANK OF CANADA  
BANQUE DU CANADA

# Financial System Review

June 2007

## ***The Financial System Review and Financial Stability***

The financial system makes an important contribution to the welfare of all Canadians. The ability of households and firms to confidently hold and transfer financial assets is one of the fundamental building blocks of the Canadian economy. As part of its commitment to promoting the economic and financial welfare of Canada, the Bank of Canada actively fosters a safe and efficient financial system. The Bank's contribution complements the efforts of other federal and provincial agencies, each of which brings unique expertise to this challenging area in the context of its own institutional responsibilities.

The financial system is large and increasingly complex. It includes financial institutions (e.g., banks, insurance companies, and securities dealers); financial markets in which financial assets are priced and traded; and the clearing and settlement systems that underpin the flow of assets between firms and individuals. Past episodes around the world have shown that serious disruptions to one or more of these three components (whether they originate from domestic or international sources) can create substantial problems for the entire financial system and, ultimately, for the economy as a whole. As well, inefficiencies in the financial system may lead to significant economic costs over time and contribute to a system that is less able to successfully cope with periods of financial stress. It is therefore important that Canada's public and private sector entities foster a financial system with solid underpinnings, thereby promoting its smooth and efficient functioning.

The *Financial System Review* (FSR) is one avenue through which the Bank of Canada seeks to contribute to the longer-term robustness of the Canadian financial system. It brings together the Bank's ongoing work in monitoring developments in the system and analyzing policy directions in the financial sector, as well as research designed to increase our knowledge. The strong linkages among the various components of the financial system are emphasized by taking a broad, system-wide perspective that includes markets, institutions, and clearing and settlement systems. It is in this context that the FSR aims to

- improve the understanding of current developments and trends in the Canadian and international financial systems and of the factors affecting them;
- summarize recent work by Bank of Canada staff on specific financial sector policies and on aspects of the financial system's structure and functioning;
- promote informed public discussion on all aspects of the financial system, together with increased interaction on these issues between public and private sector entities.

The FSR contributes to a safe and efficient financial system by highlighting relevant information that improves awareness and encourages discussion of issues concerning the financial system. The Bank of Canada welcomes comments on the material contained in the FSR.

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June 2007

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# Contents

<b>Developments and Trends .....</b>	<b>1</b>
<i>Financial System Risk Assessment .....</i>	3
Overall Assessment .....	3
<i>The Macroeconomic Environment.....</i>	5
The international environment .....	5
Highlighted Issue: Recent developments in the U.S. subprime mortgage market and their impact on the Canadian financial system.....	6
Canadian developments.....	9
<i>The Financial System.....</i>	16
Financial markets .....	16
Financial institutions .....	17
Highlighted Issue: What is driving the current low spreads on risky assets?	18
Highlighted Issue: Structured finance: The changing nature of credit markets .....	20
<i>Important Financial System Developments.....</i>	23
Amendments to the Financial Institutions Legislation.....	23
The Mortgage Insurance Market .....	23
Highlighted Issue: Asset-backed commercial paper: Recent trends and developments.....	24
<b>Reports .....</b>	<b>29</b>
Introduction .....	31
Bank of Canada Oversight Activities during 2006 under the Payment Clearing and Settlement Act .....	33
An Overview of Risk Management at Canadian Banks .....	39
Sectoral Default Rates under Stress: The Importance of Non-Linearities .....	49
<b>Research Summaries .....</b>	<b>55</b>
Introduction .....	57
Stress Testing the Corporate Loans Portfolio of the Canadian Banking Sector .....	59
Modelling Payments Systems: A Review of the Literature .....	63
The Impact of Electronic Trading Platforms on the Brokered Interdealer Market for Government of Canada Benchmark Bonds .....	67
Price Formation and Liquidity Provision in the Markets for European and Canadian Government Securities.....	71

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# Developments and Trends

## Notes

The material in this document is based on information available to **31 May 2007** unless otherwise indicated.

The phrase “major banks” in Canada refers to the six largest Canadian commercial banks by asset size: the Bank of Montreal, CIBC, National Bank, RBC Financial Group, Scotiabank, and TD Bank Financial Group.

## **Assessing Risks to the Stability of the Canadian Financial System**

The *Financial System Review* is one vehicle that the Bank of Canada uses to contribute to the strength of the Canadian financial system. The Developments and Trends section of the *Review* aims to provide analysis and discussion of current developments and trends in the Canadian financial sector.

The first part of this section presents an assessment of the risks, originating from both international and domestic sources, that could affect the stability of the Canadian financial system. Key risk factors and vulnerabilities are discussed in terms of any potential implications for the system's overall soundness. The second part of the Developments and Trends section examines structural developments affecting the Canadian financial system and its safety and efficiency; for example, developments in legislation, regulation, or practices affecting the financial system.

The current infrastructure, which includes financial legislation, the legal system, financial practices, the framework of regulation and supervision, and the macroeconomic policy framework, significantly influences the way in which shocks are transmitted in the financial system and in the macroeconomy, and thus affects our assessment of risks.

Our risk assessment is focused on the vulnerabilities of the overall financial system, and not on those of individual institutions, firms, or households. We therefore concentrate on risk factors and vulnerabilities that could have systemic repercussions—those that may lead to substantial problems for the entire financial system and, ultimately, for the economy. In examining these risk factors and vulnerabilities, we consider both the likelihood that they will occur and their potential impact.

Particular attention is paid to the deposit-taking institutions sector because of its key role in facilitating financial transactions, including payments, and its interaction with so many other participants in the financial system. For instance, these institutions assume credit risks with respect to borrowers such as households and non-financial firms. Thus, from time to time, we assess the potential impact that changes to the macrofinancial environment may have on the ability of households and non-financial firms to service their debts.

Risk factors and vulnerabilities related to market risks are also examined. The potential for developments in financial markets to seriously affect the financial position of various sectors of the economy and, ultimately, to disrupt the stability of the Canadian financial system is assessed.



# Financial System Risk Assessment

**T**his section of the Review presents an assessment of the risks arising from both international and domestic sources bearing on the stability of the Canadian financial system. The objective is to highlight key risk factors and vulnerabilities in the financial system and to discuss any potential implications for the system's overall soundness.

## Key Points

- The financial positions of the Canadian financial, non-financial corporate, and household sectors remain solid, supported by favourable macroeconomic conditions.
- The possibility of an abrupt slowing of the U.S. economy remains a key risk.
- Other risks include a significant decline in the price of risky assets and a disorderly resolution of global imbalances.
- The Canadian financial system appears to be well placed to withstand the impact of such potential shocks.

## Overall Assessment

As in December, our assessment is that the Canadian financial system is sound and is likely to remain so for the foreseeable future. The financial positions of the Canadian household and corporate sectors remain strong, reflecting years of solid economic expansion, which have contributed to healthy corporate and household balance sheets. The financial system appears to be well positioned to withstand the three potential risks that have been identified: an abrupt slowing of the U.S. economy, a marked

deterioration in the prices of risky assets, and a disorderly resolution of global imbalances.

Economic developments have been largely supportive of this favourable assessment of financial stability for Canada, unfolding much as was expected at the time of the December *Financial System Review* (FSR). First, domestic demand in Canada has been strong, supported by sturdy employment growth and by gains in real income and net wealth, owing partly to rising world demand for, and prices of, commodities. Second, as discussed in the April 2007 *Monetary Policy Report*, the U.S. economy is projected to grow at a moderate rate, although the slowdown in the U.S. housing sector appears likely to be more prolonged and deeper than had been expected. Third, the somewhat slower pace of economic growth in the United States is being largely offset by stronger growth in Europe and Asia, including Japan. This suggests that the projected rotation of domestic demand needed for an orderly resolution of global imbalances is under way.

Financial market developments have also been largely favourable. Although there was a brief period of volatility in financial markets in February/March, this volatility has subsided, and risk premiums have since contracted towards the historically low levels observed prior to that period. The exception has been the U.S. subprime mortgage market, where a combination of weakness in the housing market and questionable underwriting practices at some institutions contributed to a decline in the credit quality of some U.S. mortgages and certain related credit market instruments.

## Potential risks

This continued favourable assessment is based on a projection of ongoing solid economic growth in Canada and abroad. We continue to see three risks to this assessment: an abrupt

slowing of the U.S. economy, a marked deterioration in the prices of risky assets, and a disorderly resolution of global imbalances. Overall, the probability of these risks is not significantly different from that in December.

While the possibility is remote, a much sharper slowdown in the U.S. economy could materialize if there were to be a further weakening in housing and business investment and if consumption were to decelerate sharply as a result of a tightening of credit conditions, a more widespread decline in housing prices, or a deterioration in consumer sentiment.

Given the strong economic and financial links between the Canadian and U.S. economies, such a slowdown would have both direct and indirect effects on Canadian financial institutions. Canadian banks have only a limited direct exposure to U.S. businesses and consumers, as well as to U.S. banks that might be adversely affected by a deterioration in credit quality. Canadian banks would be affected indirectly, however, since a sharp deceleration of the U.S. economy would affect many export-related sectors in Canada, some of which have been experiencing financial stress for several years. Banks would also see a deterioration in the quality of their loans to households, as employment and incomes in export sectors suffered. Nonetheless, with their strong profit and capital positions, the major Canadian banks are relatively well placed to withstand this shock, although some smaller institutions may be more exposed to a sharper-than-expected slowdown in the U.S. economy.

In the spring of 2006 and in February/March of this year, concern about the health of the U.S. economy contributed to brief periods of declining prices for risky assets. On both occasions, markets remained liquid, and prices for risky assets rebounded after a brief period of turbulence. Nevertheless, if there were to be a sharp slowing of the U.S. economy, there could well be a more significant, persistent, and widespread decline in the prices of risky assets than has occurred to date. The adverse consequences of widening credit spreads could thus amplify a U.S. slowdown. A sudden adjustment in the prices of risky assets in Canada and abroad could have repercussions for the net worth of individuals, institutional investors, and firms; for the availability of credit and the terms on which it could be obtained; and for the near-

term growth of the global and the Canadian economies.

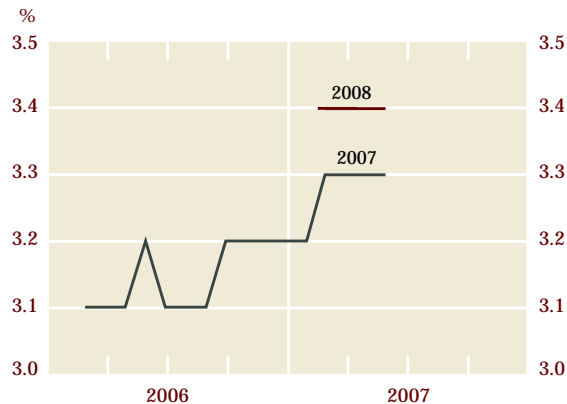
An abrupt slowing in the U.S. economy and a repricing of risk in financial markets could also lead investors to reduce their holdings of U.S. securities and could contribute to increased exchange rate volatility. If this were the case, the risk of a disorderly resolution of global imbalances might well increase. Such a disorderly adjustment could entail lower global economic growth and rising protectionism. This could adversely affect the Canadian export sector and, thus, employment and incomes in Canada.

Widening credit spreads could also be triggered by factors unrelated to a sharp U.S. economic slowdown. Spreads have narrowed to very low levels over the past few years. As discussed in the Highlighted Issue on page 18, while structural and cyclical factors are largely responsible, it is also possible that there is currently some mispricing of risk, perhaps partly because the use of structured products and their complexity may have made it more difficult for market participants to evaluate risk and to determine if risks are properly priced. There are also signs that competition among global intermediaries has led to some erosion of counterparty standards. The longer these trends persist, the more mispricing could be built into the system. And the greater the mispricing, the greater is the risk of an abrupt correction.

### **Canadian financial situation**

Major Canadian banks recorded strong profits in 2006 and the first half of 2007. Their capital ratios remain high. Credit quality continues to be good and, as is discussed in an article in this Review, these banks have made significant progress in developing their risk-management practices. The market's assessment is that banks remain in a strong financial position. All this suggests that banks would be well positioned to withstand adverse shocks.

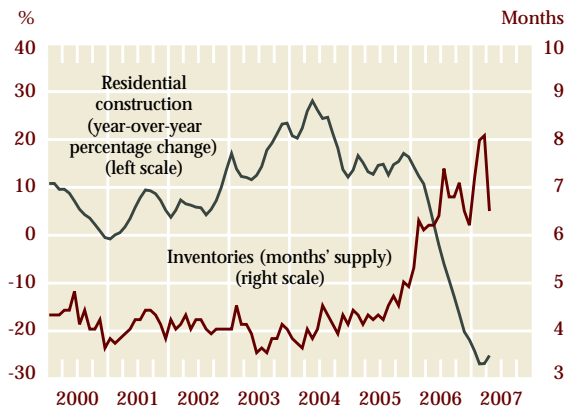
The Canadian non-financial corporate sector is also in very good shape. Profitability continued to be at a high level in early 2007. In general, corporate balance sheets remain strong, with the leverage ratio of the sector at a low level. Our indicators suggest that the credit quality of the corporate sector remains good. The strong balance sheets and the generally favourable economic conditions are reflected in very low

**Chart 1 Evolution of Consensus Estimates for Annual Global Economic Growth in 2007 and 2008\***

\* This estimate covers 46 countries. Country weights are determined using country GDPs converted at 2005 market exchange rates.  
Source: Consensus Economics Inc.

rates of arrears on bank loans, bond defaults, and business bankruptcies.

The household debt-service ratio has started to move upwards, reflecting the increase in household indebtedness through 2006 and the rise in interest rates in the first half of that year. Although there has been a steady increase in the proportion of households with both debt-to-asset and debt-service ratios above critical levels, microdata suggest that most households are in relatively good financial shape. Mortgage loan arrears and personal bankruptcies remain at low levels. The subprime mortgage market is not a concern in Canada at this time, given that lending has been largely confined to near-prime borrowers and that there has been little use of exotic features in subprime loans.

**Chart 2 U.S. Residential Construction and Inventories of Unoccupied New Single-Family Homes**

Source: U.S. Census Bureau

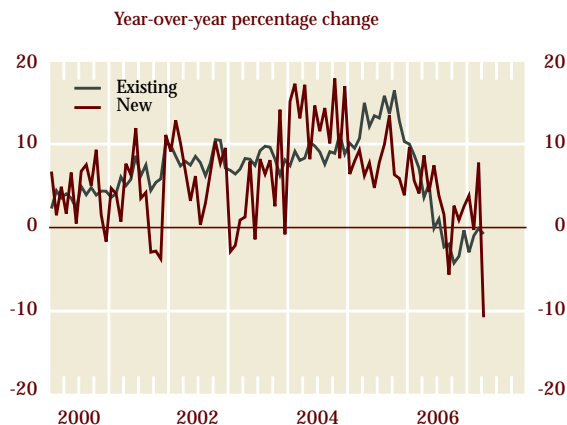
## The Macrofinancial Environment

### The international environment

The outlook for global economic growth in 2007 has been revised up slightly since December 2006 (Chart 1), although a deceleration from 2006 rates is still expected.

In the United States, the economic slowdown has been somewhat more pronounced than expected. The U.S. housing market has slowed, with lower sales of new and existing homes, higher inventories of unsold homes, and builders reducing construction of homes (Chart 2).<sup>1</sup> This contraction in housing activity has also been accompanied by declines in house prices (Chart 3). Business investment has also been surprisingly weak recently. As discussed in the April *Monetary Policy Report*, U.S. GDP growth is likely to remain modest in 2007 before picking up next year.

Nevertheless, there is a risk, albeit remote, of an abrupt slowdown in the U.S. economy. This could occur if the current slowdown in the U.S. housing sector were longer and more pronounced than currently expected; if this led to a larger slowdown in consumption (for example, as a result of a tightening in credit conditions, a more widespread decline in housing prices, or a deterioration in consumer sentiment); and if

**Chart 3 U.S. Median Selling Price for Housing**

Note: The new homes series covers only single-family homes, while the existing homes series includes condominiums.  
Source: National Association of Realtors and U.S. Census Bureau

1. The decline in residential investment subtracted one percentage point from the annualized growth rate of U.S. GDP in the second half of 2006.

there was a more pronounced slowing in investment.

Whereas growth in the U.S. economy is projected to be relatively modest, expectations for growth in other areas of the world have firmed. The ongoing rotation in global demand away from the United States supports our view that the likelihood of an orderly resolution of global imbalances has increased since the publication of the December FSR. Indeed, it increasingly appears that the U.S. current account deficit may have peaked (Chart 4).

## Highlighted Issue

### Recent developments in the U.S. subprime mortgage market and their impact on the Canadian financial system

*Prepared by William Barker, Jim Day, Ilan Kolet, and Virginie Traclet*

Rising delinquencies on subprime mortgages in the United States have recently gathered significant attention.<sup>2</sup> Although these developments should have no direct impact on the Canadian financial system, since domestic financial institutions have little or no direct exposure to this market,<sup>3</sup> they could have indirect effects through their impact on the U.S. economy and on international financial markets.

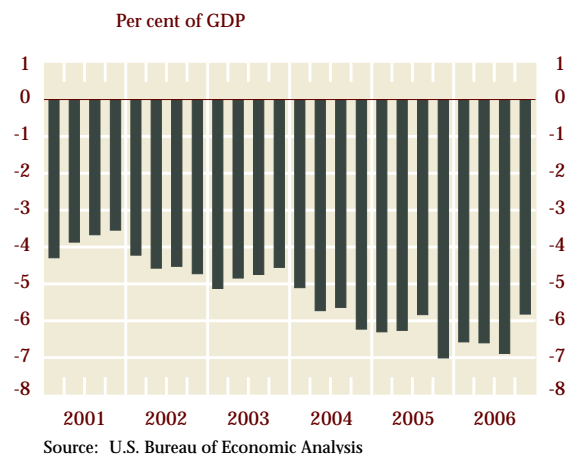
#### *Deteriorating conditions in the U.S. subprime market*

An increase in subprime mortgage lending (partly because of increased financial innovation), low real U.S. mortgage rates, and a general easing in lending standards boosted U.S. housing demand over the past decade (Chart 5).

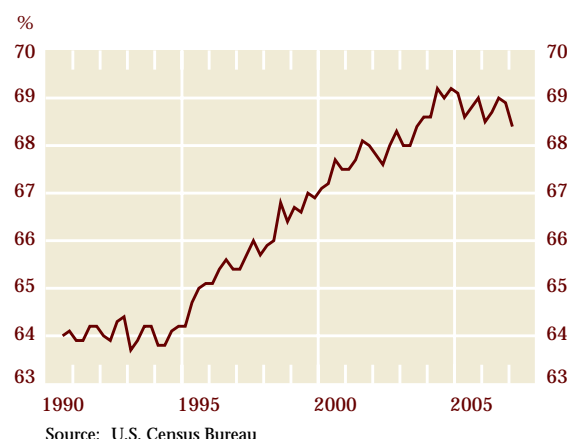
Estimates suggest that subprime mortgages accounted for over 22 per cent of new mortgage originations in 2006, up from 7 per cent in 2001 (Chart 6). Furthermore, many subprime loans were extended to borrowers on initially

2. The term “subprime” refers to loans extended to borrowers with a tarnished or incomplete credit record and/or a lack of income documentation.
3. Only three of the major Canadian banks offer residential mortgages in the United States, and virtually all of these are prime. In 2006, these loans accounted for less than 2 per cent of their total loans and acceptances, net of specific allowances.

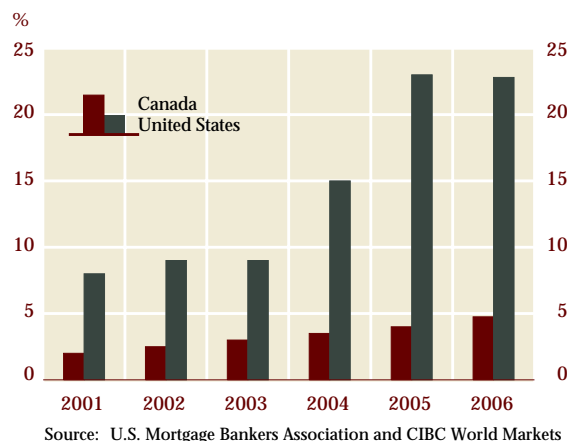
**Chart 4 U.S. Current Account**



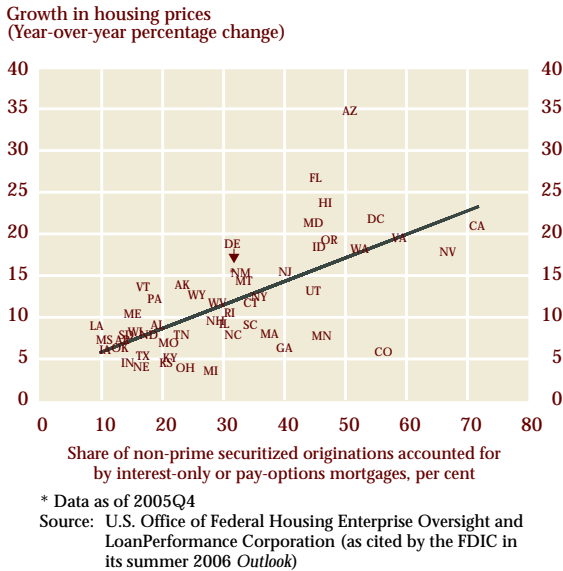
**Chart 5 U.S. Home Ownership Rates**



**Chart 6 Subprime Share of Mortgage Originations**



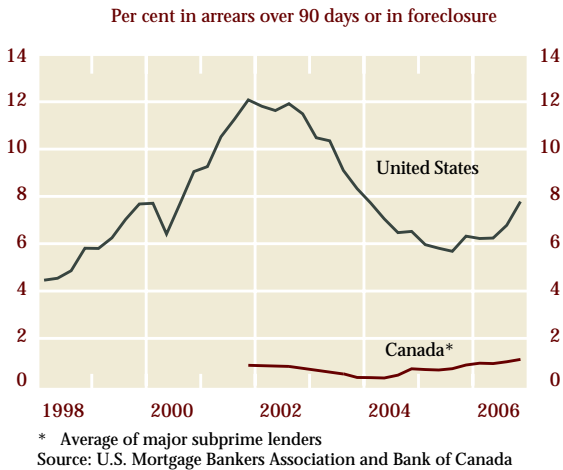
**Chart 7 United States: Non-Traditional Mortgage Products by State\***



generous terms, using a variety of “affordability” features that typically lowered the monthly payments early in the life of the loan in return for higher payments later.<sup>4</sup> These non-traditional mortgage products have been particularly popular in those markets in which housing prices have been increasing the most (Chart 7). These loans are, however, particularly sensitive to rising interest rates and/or declining housing prices.<sup>5</sup> Loan volumes were also maintained by relaxing the documentation requirements imposed on borrowers, with the result that less was known about the capacity of these borrowers to carry debt. The U.S. situation is in sharp contrast to that in Canada (Box 1).

After about three years of sustained declines, delinquencies on U.S. subprime mortgages picked up recently as interest rates rose and housing prices decreased in some areas (Chart 8).<sup>6</sup> Of note, although delinquency rates on subprime mortgages are below their previous peak at the end of 2001, these mortgages now comprise a much larger share of outstanding mortgages than they did then.<sup>7</sup> At the same time, the quality of prime mortgages (the bulk of mortgages)

**Chart 8 Delinquencies on Subprime Mortgage Payments**



4. This subset of loans includes hybrid loans, where interest rates are fixed for a certain period before changing; interest-only loans, which contain no principal portion for a set period; and negative amortization loans, which allow the borrower to pay only a portion of the full monthly carrying cost of the mortgage, with the remaining amount added to the principal portion of the loan, thereby increasing the size of the liability during the life of the loan.
5. As mortgage rates rise, some mortgages will be reset to higher rates. The “resets” will increase the carrying cost of the mortgages and the associated financial burden. Declining housing prices could also mean that some mortgagors might have negative equity in their houses, especially in the case of mortgages in which the size of the liability rises over the life of the loan.
6. Following the recent rise in subprime mortgage delinquencies, some financial institutions have tightened their lending conditions.
7. Subprime mortgages accounted for approximately 14 per cent of total mortgages outstanding in the United States in 2006, compared with 2.6 per cent in 2001.

has not been characterized by such a deterioration (Chart 9).

The recent increase in delinquencies has led to a sharp rise in the credit spreads associated with the riskier segment of the mortgage-backed securities market.<sup>8</sup> For instance, the spread on the riskiest (i.e., BBB- tranche) of the ABX.HE index, composed of credit default swaps based on bonds consisting of subprime mortgages, has widened by close to 1,000 basis points from roughly 400 basis points in early January 2007.<sup>9</sup> This widening, in turn, reflects reduced demand among investors for product backed by subprime mortgages. This has reduced the incentives for investment banks to restructure mortgages into structured products and make loans to mortgage originators. The combination of increased collateral requirements and reduced credit availability has led to a spike in bankruptcies and to consolidation among originators of subprime mortgages.

Nearly three-quarters of U.S. subprime mortgages are originated by mortgage brokers, specialized finance companies, or the mortgage finance units of bank holding companies. Most of these are subsequently repackaged into mortgage-backed debt securities (MBS) or more complex debt instruments, such as multi-tranche collateralized debt obligations (CDOs). (See the Highlighted Issue on structured finance.) These repackaged mortgage-based debt securities are sold to institutional investors, which are the ultimate bearers of the risk. This credit-risk-transfer mechanism should help to moderate the systemic risk of rising mortgage delinquencies.

### Impact on the U.S. economy

Developments in the subprime mortgage market could exacerbate the current slowdown in the U.S. housing sector by restraining demand, as financial institutions tighten their lending standards in reaction to the rise in delinquencies,

8. Given the rapid growth of the subprime market, credit-risk models may have been based on limited data, with the result that mortgage originators may have underestimated the risk involved with these loans.
9. The ABX.HE index consists of 20 of the largest subprime home equity asset-backed securities in the United States, and is broken down into five sub-indexes, ranging from AAA to BBB-, based on their exposure to default.

### Box 1

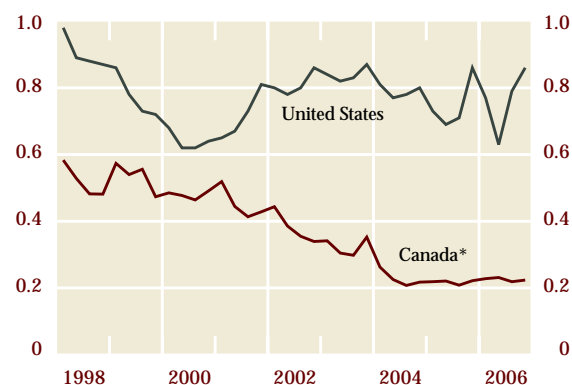
## Differences in the Canadian and U.S. subprime mortgage markets

Compared with the U.S. subprime mortgage market, the Canadian market is in its infancy.<sup>1</sup> It is estimated that subprime mortgage originations accounted for only 5 per cent of total mortgage originations in Canada in 2006 (Chart 6), and that subprime loans currently represent less than 3 per cent of total mortgage loans outstanding. Furthermore, while delinquency rates on subprime loans have recently increased sharply in the United States, this has not been the case in Canada (Chart 8).<sup>2</sup> Canadian subprime lenders have been focusing mainly on near-prime and Alt-A customers,<sup>3</sup> and have not offered subprime loans with the types of features that have contributed to rising delinquencies among U.S. subprime mortgages. In addition, the Canadian housing market has not faced the same situation as the U.S. market, and various indicators suggest that a major widespread reversal in Canadian housing prices is unlikely. (See the section on Canadian housing prices on p. 12.) Therefore, the Canadian subprime mortgage market is not a source of concern for the Canadian financial system at this time.

1. For an extensive discussion of the Canadian subprime mortgage market, see the December 2005 Bank of Canada *Financial System Review*, pp. 17–18.
2. All figures quoted for Canada are based on limited available statistics.
3. Near-prime customers are borrowers that are just outside the comfort zone of major financial institutions. Alt-A customers are borrowers with a good credit history but a lack of income documentation.

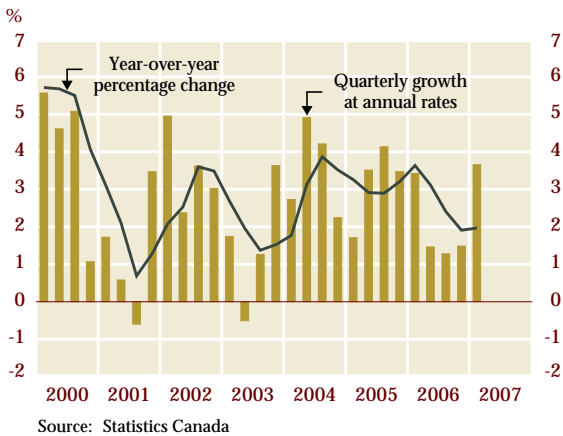
**Chart 9 Delinquencies on Prime Mortgage Payments**

Per cent in arrears over 90 days or in foreclosure



\* At Canadian commercial banks only

Source: U.S. Mortgage Bankers Association and Bank of Canada

**Chart 10 Real GDP Growth: Canada**

and by adding to supply in the market for existing homes. Less affordable credit, coupled with the wealth and income effects from the ongoing contraction in the housing sector (including house prices), could dampen consumer spending. Therefore, the ongoing slowing in the U.S. economy could be more prolonged and deeper than expected.

#### *Implications for the Canadian financial system*

Weaker-than-anticipated growth in the U.S. economy would affect Canada's export sector. This would likely have an adverse impact on the credit quality of Canadian banks' loan portfolios. As well, if the developments in the U.S. subprime mortgage sector were to cause an increase in risk aversion in financial markets, the value of some assets held by Canadian banks could decrease. However, with Canadian banks currently well capitalized and highly profitable, the overall impact on the health of Canadian financial institutions is likely to be limited.

## **Canadian developments**

### *Canadian economy*

As described in the April *Monetary Policy Report*, growth of the Canadian economy slowed in the second half of 2006, largely reflecting the deceleration of the U.S. economy (Chart 10). Despite some slight slowing, domestic demand continued to rise at a solid pace, and the economy remained in excess demand. In recent months, inflation has been somewhat higher than expected.

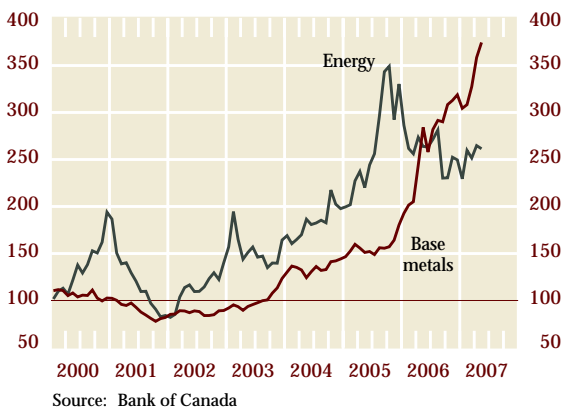
The projection in the April *Monetary Policy Report* was for some pickup in economic growth in Canada through 2007 to a pace close to the rate of growth of potential, once excess demand is absorbed. The main driver is expected to be domestic demand. While exports will benefit from generally solid growth in the global economy and relatively high commodity prices (Chart 11), some sectors will continue to be affected by the U.S. economic slowdown. In fact, growth in Canada picked up strongly in the first quarter of 2007 and was higher than estimated in April.

### *Non-financial corporate sector*

The overall financial position of the non-financial corporate sector remains robust. The return

**Chart 11 Bank of Canada Commodity Price Index**

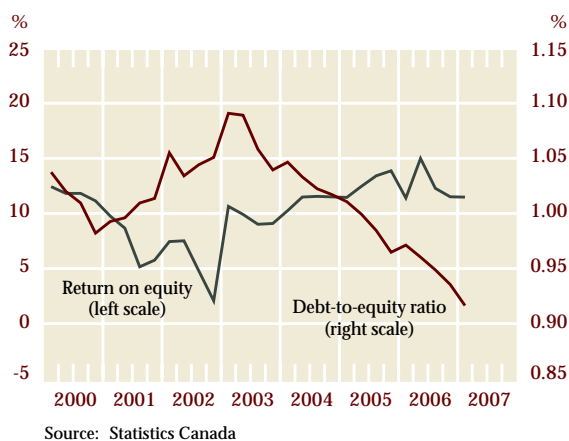
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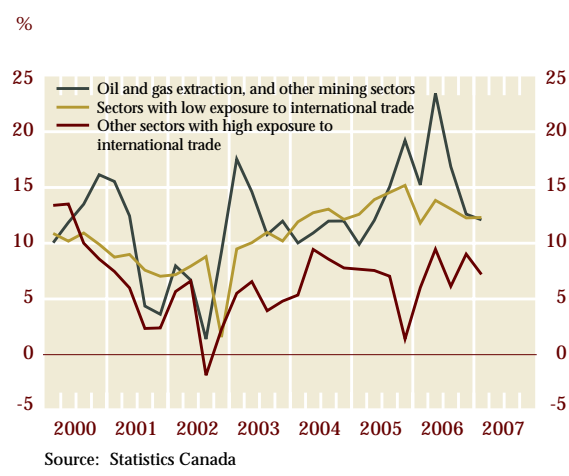
on equity remains at a very high level, while the ratio of debt to equity continued to fall through 2006 and into early 2007 (Chart 12). The corporate sector continues to adjust to relatively high prices for a wide range of commodities, the rise in the Canadian dollar, and strong competition from emerging-market economies. Over the past year, it has also been affected by weak U.S. demand. These factors are reflected in the performance of individual sectors (Chart 13). Profits remain high in most sectors with a low exposure to international trade and in some resource-based sectors (such as oil and gas extraction and primary metal manufacturing). Profits in a number of other sectors with high exposure to international trade remain relatively weak.

Our microdata and contingent claims approach (CCA) indicators suggest that the credit quality of the corporate sector remains good overall (Chart 14). The microdata indicator<sup>10</sup> showed some improvement in credit quality in 2006. More specifically, the share of assets concentrated in companies considered to have weak profit margins, liquidity ratios, and leverage ratios fell to below 8 per cent. This improvement was spread across most industries. The principal exceptions were the consumer goods manufacturing sector and retail sales, where credit quality deteriorated significantly between 2005 and 2006. The CCA indicator also points to an improvement in credit quality. As discussed in previous issues of the FSR,<sup>11</sup> this indicator signalled a possible increase in risk in the non-financial corporate sector over 2005 and 2006. This increase was driven primarily by rising volatility in the oil and gas industry and, to a lesser degree, by a modest increase in risk in several other industries.<sup>12</sup> Based on recent

**Chart 12 Financial Position of the Canadian Non-Financial Corporate Sector**



**Chart 13 Rate of Return on Equity for Selected Sectors**



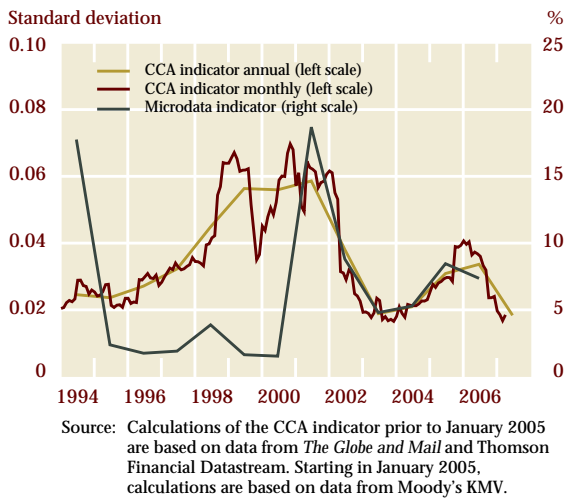
10. The microdata indicator was described in a Report in the December 2005 issue of the FSR, pp. 37–42.

11. Details of the contingent claims approach (CCA) were outlined in the June 2006 *Financial System Review* (pp. 43–51). The CCA indicator was updated in the December 2006 FSR, pp. 8–9.

12. The CCA indicator is the variance of the portfolio of all assets (at market value) of the Canadian corporate sector. Thus, this metric incorporates any available diversification benefits within the Canadian corporate sector. As a result, the CCA indicator can be seen as a proxy for non-diversifiable risk in the Canadian corporate sector.



**Chart 14 Microdata and CCA Indicators**



monthly data, the CCA indicator suggests that risk in the non-financial corporate sector decreased in late 2006 and early 2007 as volatility in the oil and gas sector subsided.<sup>13</sup> The level of risk in most other industries also declined over the same period. Thus, the CCA indicator has returned to the low level seen in 2004.

*Industry*

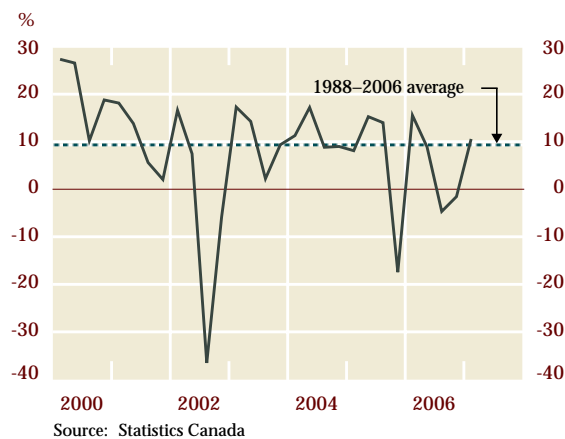
The U.S. slowdown over the past year has particularly affected Canadian exports of building materials and automobiles, sectors that were already suffering from the appreciation of the Canadian dollar and strong competition from foreign producers. Part of the Canadian auto sector is also being affected by the shift in demand for autos away from the three large North American producers.

The auto manufacturing industry in Canada, after experiencing a loss in the second half of 2006, saw profitability recover markedly in the first quarter of 2007 (Chart 15). However, further restructuring of operations (especially by Ford, Chrysler, and many auto parts companies) is under way, as the Big Three adjust their North American capacity and employment levels downwards to better align them with expected long-term sales.

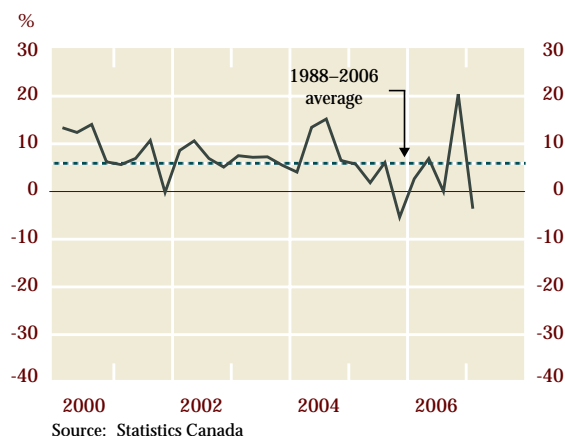
The wood and paper products industry had a loss in the first quarter of 2007, following a temporary surge in profitability in the preceding quarter with the refund of about 80 per cent of U.S. softwood lumber duties (Chart 16). The slowdown in the U.S. housing market is having a significant adverse impact on lumber prices and export volumes. Lumber producers have also been paying an export charge in recent months, since lumber prices have been below the threshold for export taxes under the Canada-U.S. agreement ending the softwood lumber dispute. Paper producers, especially newsprint manufacturers, have also continued to reduce output as they restructure their operations in response to structural reductions in demand. The difficulties in the wood and paper products sector have been particularly marked in Quebec, Ontario, and British Columbia.

Rates of return in the electronics and computer manufacturing industry eased towards the end

**Chart 15 Return on Equity: Automotive Manufacturing**



**Chart 16 Return on Equity: Wood and Paper Manufacturing**



13. The CCA indicator now includes data up to, and including, April 2007.

of 2006 and into early 2007 as competitive pressures continued to be intense in global markets (Chart 17). Consolidation and restructuring is under way, especially in the telecommunications component of the Canadian industry.

Financial prospects for grains producers have improved markedly since last autumn. Global grains and oilseeds prices have risen substantially, and part of this increase is expected to persist, owing to the increase in the demand for biofuels. On the other hand, the financial condition of the livestock industry, especially that of hog producers, has remained under strain in recent months, owing to rising input costs. The federal government has recently announced that it will allocate \$1 billion for improvements to national farm income programs.

While a number of companies in these affected industries continue to face serious financial risks, it appears unlikely that their problems would have significant adverse effects on the Canadian financial system, since the exposure of Canadian banks to these sectors is limited.

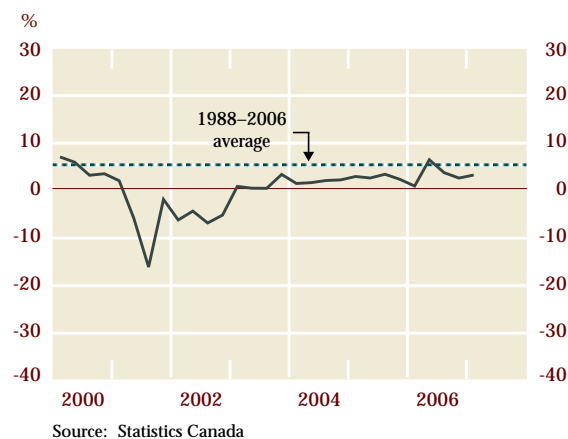
### Housing prices

Housing prices across Canada have continued to increase, fuelled by sustained income growth, strong employment, and interest rates that are still relatively low. However, the pace of the price increases has slowed recently, after about two years of acceleration (Chart 18). This moderation is relatively widespread, although regional differences persist—with higher rates in Western Canada where sustained income growth, job creation, and in-migration continue to support housing demand (Chart 19). This widespread moderation results from a general improvement in supply in both the market for new houses and the resale market.

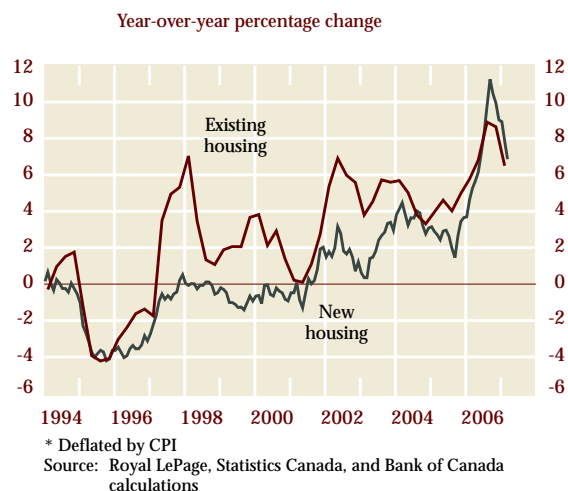
A number of indicators suggest that a major widespread reversal in housing prices is unlikely. Indicators of excess supply in most cities remain below historical averages—and well below the peaks of the early to mid-1990s (Chart 20). Demand for housing remains strong, especially in Western Canada. Finally, affordability has improved in most markets as a result of the slower growth in housing prices coupled with rising incomes and stable mortgage rates.

Overall, recent indicators support the view that the Canadian housing market does not pose a

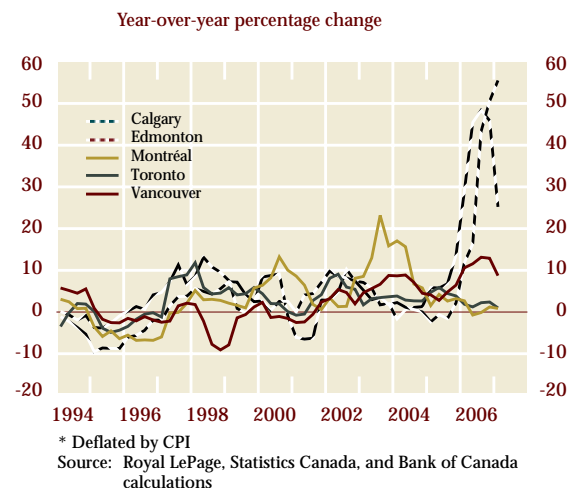
**Chart 17 Return on Equity: Electronics and Computer Manufacturing**

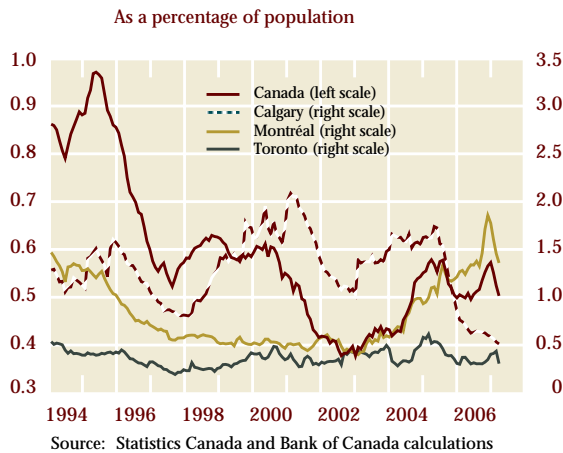


**Chart 18 Real Prices for Housing in Canada\***



**Chart 19 Real Prices for Existing Houses by City\***



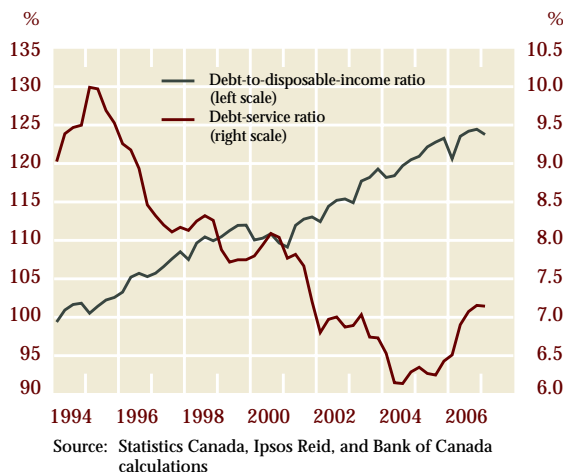
**Chart 20 Recently Completed Unoccupied Dwellings**

major threat to the stability of the Canadian financial system.

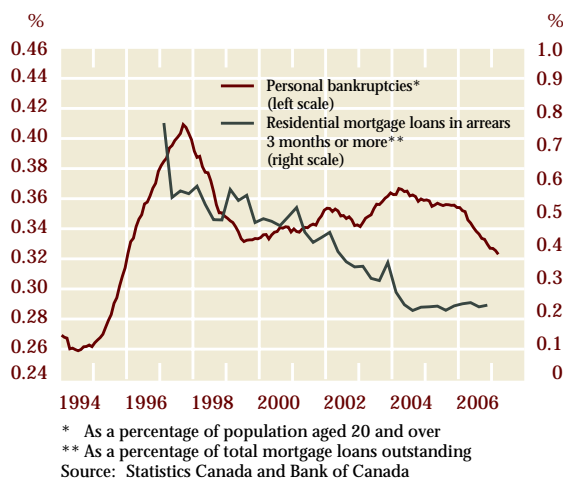
### Household sector

Canadian households continued to accumulate debt at a strong pace, although not quite at the peak rate seen in mid-2006. Rising housing prices are supporting credit demand, since households are increasingly using mortgage re-financing to extract equity from their homes.

The rate of increase in household debt surpassed that of income through 2006, leading to a further rise in the debt-to-income ratio. In the first quarter of 2007, however, there was a slight decline in this ratio to 123.7 per cent. The upward trend in this ratio over much of the past year, together with higher interest rates, resulted in an increase in the household debt-service ratio, to 7.15 per cent in 2007Q1 from 6.9 per cent in 2006Q2 (Chart 21).<sup>14</sup> The Canadian household sector appears sound, however, as illustrated by indicators of household financial stress. The personal bankruptcy rate has decreased sharply over the past year, while mortgage loans in arrears have remained at historically low levels (Chart 22).

**Chart 21 Household Sector: Indebtedness Indicators**

An update of the analysis of the distribution of debt across households presented in the December 2006 FSR indicates that the proportion of vulnerable households (i.e., households that have a debt-service ratio (DSR) above certain vulnerability thresholds) and the proportion of debt owed by these households remain slightly below the averages calculated over the sample period (1999–2006) despite rising debt.<sup>15,16</sup> At the same time, however, the debt owed by households that have both a DSR and a debt-to-asset ratio (DAR) above vulnerability thresholds is increasing, but it accounts for less than 3 per cent of total household debt, using the 23 per cent DSR vulnerability threshold, and less than 0.7 per cent of total household

**Chart 22 Household Sector: Financial Stress Indicators**

14. See Box 2 in the December 2006 FSR for a description of the revised estimate of the aggregate debt-service ratio. Note that this measure does *not* include principal repayments.
15. This updated analysis is based on microdata for the whole year 2006. The analysis in the December FSR was based on data for only the first half of 2006.
16. For information on how these vulnerability thresholds were chosen, see the December 2006 FSR, pp. 15–16.

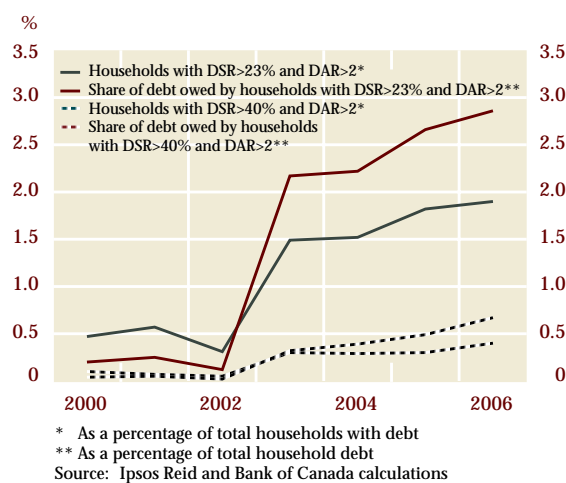
debt, using the 40 per cent DSR threshold (Chart 23).

The current relatively low level of the household aggregate DSR is indicative of the good financial position of the Canadian household sector. If the DSR were to increase sharply, some households would likely become more vulnerable. It is thus important to assess the impact that rising interest rates and/or rising indebtedness would have on the DSR, and thus on the financial position of the Canadian household sector. While, ideally, we would like to be able to project over time the change in the proportion of households whose DARs and DSRs would exceed the vulnerability thresholds, projections of the aggregate DSR can also illustrate what might happen under hypothetical scenarios. Thus, we run simulation exercises using a method similar to that used previously,<sup>17</sup> but using the revised DSR estimate presented in the December 2006 FSR.<sup>18</sup> Under the revised assumptions, the historical data have been revised downwards. The simulation period is 2007Q2 to 2013Q1.

*Impact of rising indebtedness on the debt-service ratio*

Since the debt-to-income ratio has been steadily rising over the past two decades (recall Chart 21), we can expect further increases in this ratio. To study the impact of rising indebtedness on the DSR, we use a scenario in which the overnight interest rate remains unchanged at its current level (4.25 per cent), while the debt-to-income ratio rises. In this scenario, consumer debt and mortgage debt continue to increase at their average annual growth rates over the 2000Q1–2007Q1 period,<sup>19</sup> and disposable income continues to increase at a trend rate of 5 per cent. As a result, the debt-to-income ratio rises from 124 per cent in 2007Q1 to 138 per cent

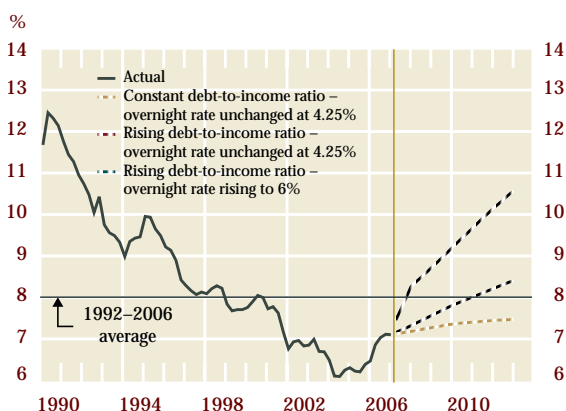
**Chart 23 Proportion of Vulnerable Households and Debt Owed by Those Households**



17. For details on the simulation methodology, see Box 1 in the December 2004 FSR.

18. See Box 2, p. 12 in the December 2006 issue of the FSR.

19. For simplicity, it is assumed that all the components of consumer debt increase at the same pace as total consumer debt (8 per cent annually) and that all the components of mortgage debt increase at the same pace as total mortgage debt (6 per cent annually). As a result, over the simulation period, total debt increases by 48 per cent.

**Chart 24 Debt-Service Ratio, Various Scenarios**

Source: Statistics Canada, Ipsos Reid, and Bank of Canada calculations

in 2013Q1.<sup>20</sup> Such an increase in the debt-to-income ratio would also be consistent with a number of other scenarios; for example, one with lower growth rates of both income and debt. As illustrated in Chart 24, with such an increase in the debt-to-income ratio, the DSR would rise above its historical average to reach 8.4 per cent by 2013Q1. In contrast, if the debt-to-income ratio were to remain at its current level, the DSR would rise by less than 40 basis points to 7.5 per cent in 2013Q1, as some loans that come up for renewal during the simulation period are renewed at rates above those at which they were initially contracted.

#### *Impact of rising interest rates on the debt-service ratio*

To assess the impact of interest rate changes on the DSR, we consider a scenario in which interest rates increase sharply. Specifically, the overnight rate increases to 6 per cent, a level well above its 10-year average (3.74 per cent), within four quarters and remains at this level for the rest of the simulation period.<sup>21</sup> As in the previous scenario, the debt-to-income ratio rises from 124 per cent in 2007Q1 to 138 per cent by 2013Q1. This scenario can be viewed as unlikely, since it assumes that debt continues to increase at the same pace over the simulation period despite significantly higher interest rates, whereas higher rates would likely be accompanied by some slowing in debt accumulation. With both an increase in interest rates and in the debt-to-income ratio, the DSR would rise sharply, reaching 10.6 per cent by 2013, higher than the 10 per cent peak reached in 1995. This would significantly reduce the ability of some households to weather shocks to income or interest rates.

20. The debt-to-income ratio is projected to increase by 14 percentage points over the 6 years of the simulation period; it also increased by 14 percentage points over the past 6 years.
21. In this scenario, the term premiums between yields on government bonds of different maturities and the overnight rate (and thus the term premiums for interest rates on household debt) are assumed to rise from their current level to their average historical yield spread for each maturity within four quarters, as the overnight rate increases to 6 per cent. Term premiums then remain unchanged for the rest of the simulation period. Consequently, the yield curve goes back to a more typical positive slope during the simulation period, from its current flat-to-slightly inverted slope.

### Conclusion

While the financial position of the Canadian household sector does not currently pose a threat to the stability of the Canadian financial system, this simulation exercise suggests that the household sector is becoming more vulnerable to shocks over time, as the debt-to-income ratio continues to increase. These simulations also suggest that some vulnerabilities could build up in the household sector if interest rates were to rise significantly.

## The Financial System

### Financial markets

Global financial markets experienced increased volatility in asset prices in February and early March, albeit from historically low levels. While this general decline in the prices of risky assets was partly triggered by a less certain U.S. economic outlook, including developments in the U.S. subprime mortgage market (see Highlighted Issue, p. 6), the decline also reflected an environment where risk premiums are at, or near, historically low levels. Similar to the episode in May and June 2006, the market turbulence was relatively minor and short-lived, with the prices of many risky assets subsequently regaining most of the losses sustained over this period.

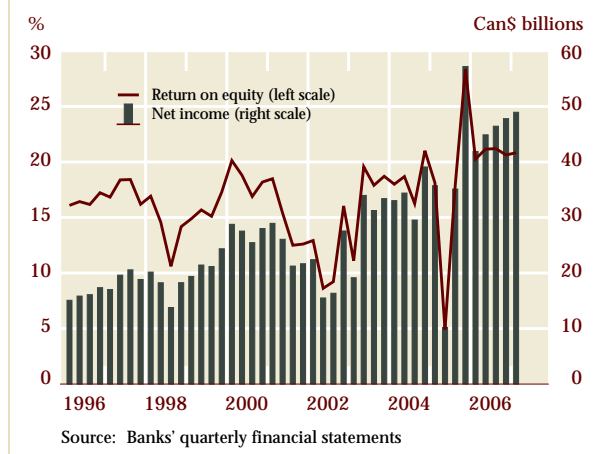
Overall, while both structural and cyclical factors are contributing to the historically low levels of risk premiums (see Highlighted Issue on spreads on risky assets, p. 18), there remains some concern that market risk may be underpriced (see Highlighted Issue on structured finance, p. 20). Numerous indicators suggest that market participants' appetite for risk remains strong. These indicators include the implied volatility on the S&P 500 (VIX) and spreads on emerging-market bonds, which have fallen back to historically low levels. Taken together, the episodes of market turbulence in 2006 and 2007 suggest that the increased dispersion of risk facilitated by developments in structured finance has made it easier for financial markets to absorb idiosyncratic shocks. Notwithstanding these improvements, however, a risk remains that a large macroeconomic shock could result in a rapid rise in risk premiums, leading to a widespread and significant decline in asset prices.

Furthermore, there is some unease about indications that the strong competition for hedge

#### Box 2

### Financial Stability Forum Report on Highly Leveraged Institutions

The Financial Stability Forum (FSF) was established by the G-7 finance ministers and central bank governors in 1999 to promote international financial stability through the exchange of information and through international co-operation in financial market supervision and surveillance. At the request of the G-7 ministers and central bank governors, the FSF recently updated its 2000 *Report on Highly Leveraged Institutions*. On 19 May 2007, it released this report, which offers recommendations on financial stability issues related to hedge funds and other highly leveraged institutions. The report calls on supervisors to act so that core intermediaries continue to strengthen their counterparty risk-management practices and improve their robustness to the potential erosion of market liquidity. It also calls on counterparties and investors to strengthen market discipline by seeking more information about risk exposures. Finally, it calls on the hedge fund industry to develop sound practice benchmarks for hedge fund managers.

**Chart 25 Profits of Major Banks**

fund business may have eroded counterparty standards. The Financial Stability Forum recently issued a report recommending action by supervisors, counterparties, investors, and hedge fund managers to strengthen protection against systemic risk. (See Box 2.)

In a recent review of the major Canadian banks' exposure to hedge funds, OSFI found that this exposure was relatively small and that Canadian banks were taking a cautious approach to hedge funds. This being an area where ongoing vigilance is required, OSFI has said that it will continue to evaluate the banks' activities with regard to hedge funds as part of its ongoing supervisory process.<sup>22</sup>

### Financial institutions

The major Canadian banks continue to be very profitable and well capitalized. In the first half of 2007, profits of the major banks remained firm, with the average return on equity in the 20 per cent range (Chart 25). This strength continues to be broad-based. The domestic personal and small business side of the banks' operations has continued to deliver a strong performance and underlying growth in revenues of 12 to 15 per cent. Growth in corporate loans remains firm. Operations in capital markets contributed significantly to profitability, reflecting high levels of underwriting and merger and acquisition activity. However, trading losses of \$680 million (\$327 million after tax) at one bank adversely affected profits over the period.

The banks continue to benefit from very firm credit quality in both their retail and wholesale loan portfolios. However, while new loan-loss provisions remain at very low levels, banks are no longer benefiting from loan recoveries to the extent that they did earlier in the credit cycle. As noted in the Highlighted Issue on the U.S. subprime mortgage market, exposure of the Canadian banks to the subprime mortgage market in the United States is reported to be minimal. Capital ratios remain well above the regulatory benchmarks, giving banks the financial flexibility to continue to increase dividends and repurchase shares. The Bank's CCA

22. Remarks by Julie Dickson, Acting Superintendent of Financial Institutions to the Senate Standing Committee on Banking, Trade and Commerce, 31 January 2007.

indicator continues to show that markets view Canadian banks as financially healthy (Chart 26).

The three largest Canadian life and health insurance companies registered record profit levels in 2006, with returns on equity in the range of 14 to 16 per cent. The companies recorded strong operating results in both their protection (individual and group) and wealth-management products, the latter enjoying the benefits of generally favourable markets in 2006. They have also been benefiting from the strong global economy because of their geographical diversification. The life and health insurance companies continue to be well capitalized and enjoy strong credit quality in their fixed-income portfolios.

In 2006, the Canadian securities industry had a record year, with an operating profit of \$5.8 billion, exceeding the previous record established in 2005 by 33.6 per cent. Commission, trading, and investment banking revenues were boosted by strong equity markets and the robust environment for mergers and acquisitions. Despite the record activity, the industry managed to hold the increase in its operating expenses to 8 per cent.

## Highlighted Issue

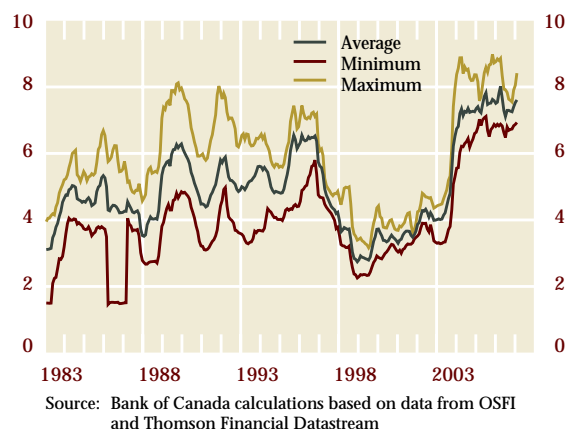
### What is driving the current low spreads on risky assets?

*Prepared by Stacey Anderson, Jim Armstrong, William Barker, Chris Graham, and Graydon Paulin*

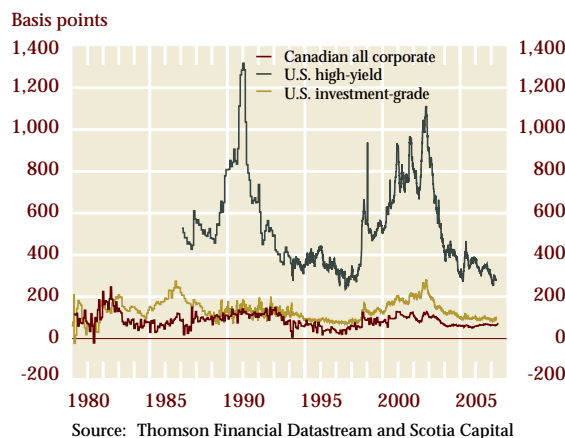
#### Introduction

Over the past several years, borrowers in global markets have experienced easy financing conditions, as is apparent from the historically narrow credit spreads on risky assets. For example, corporate borrowers in the United States rated below investment grade, as well as emerging-market borrowers, have been able to issue debt at, or near to, record low spreads relative to yields on U.S. Treasuries (Charts 27 and 28). Equity market performance, particularly for emerging-market equities, has been strong, thus facilitating equity financing (Chart 29). Market volatility, as measured by that on U.S. equity markets (S&P 500), has remained low (Chart 30).

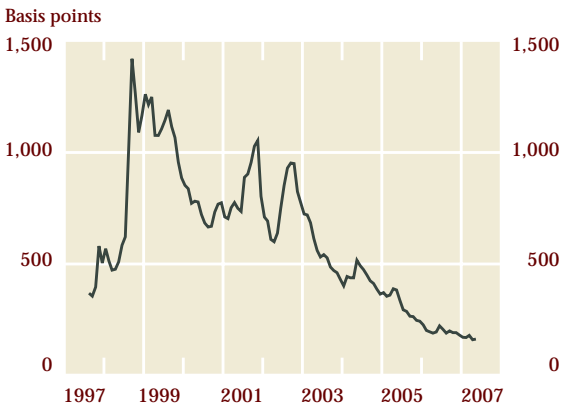
**Chart 26 Distance to Default for Major Banks**



**Chart 27 Corporate Bond Spreads**





**Chart 28 Emerging-Markets Sovereign Bond Spread (EMBI+)**

The persistence of such easy conditions has raised questions as to whether risk is currently being priced appropriately. The purpose of this Highlighted Issue is to briefly review the structural and cyclical factors that have contributed to low spreads in recent years. Structural factors would tend to have an enduring impact on the reduction in spreads; cyclical factors would not. Thus, at least part of the decline (i.e., that caused by cyclical influences) could be reversed.

#### *Factors contributing to low spreads*

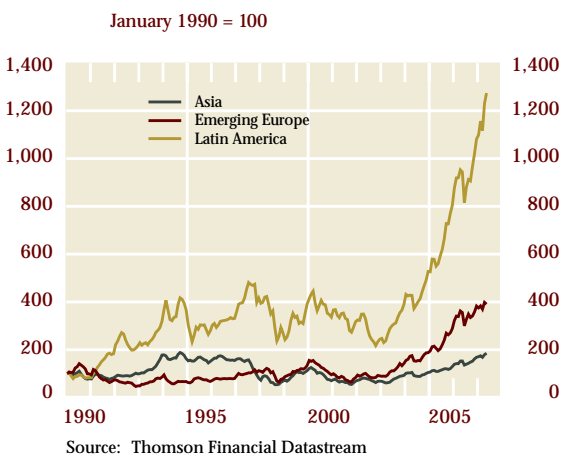
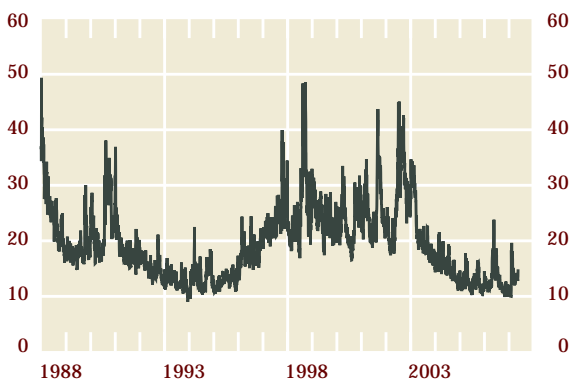
It can be difficult, at any given time, to untangle the effect of the various factors and to determine whether a particular development is cyclical or structural in nature.

The recent performance of the global macro-economy has been very supportive of financial markets: real economic growth has been robust, and inflation has generally been low and stable. Part of this is undoubtedly related to improved monetary policy, but part of this economic stability also comes from a very favourable conjuncture.

Rates on risk-free assets have remained historically low. In addition to the low-inflation environment, the main factors contributing to low interest rates have been high savings in many emerging-market economies, oil-producing countries in the Middle East, and Russia, as well as low levels of investment and strong corporate balance sheets in the United States.

Low real interest rates may, in turn, have triggered a widespread search for yield, as well as an increasing risk appetite, which has contributed to the current low spreads. A prominent example of the greater risk appetite of global investors has been the rapid growth of the “carry trade” in which funds borrowed in currencies with low interest rates (such as the Japanese yen or the Swiss franc) are used to invest in markets with higher rates of return.

Another influence on spreads is the increased financial integration of emerging-market economies with the rest of the world. Given the potential for higher returns, some of these economies have become important recipients of investment flows as investors have acquired financial assets in these countries at a faster pace, and private equity firms have become

**Chart 29 Stock Market Indexes****Chart 30 Equity Volatility\***

\* VIX: Implied volatility of the S&P 500  
Source: Bloomberg

more active in these countries.<sup>23</sup> This has contributed to the relatively low risk premiums on emerging-market sovereign securities (Chart 28) and to the substantial increases in equity valuations in some emerging markets (Chart 29).

One structural influence that may have tended to drive down spreads is financial innovation, such as the rapid development of derivatives, asset securitization, and structured credit products. This has greatly increased the ability of investors to unbundle, restructure, price, and disperse investment risks. (See the Highlighted Issue on structured finance.) These innovations have also increased the ability of institutions to create and take on leverage. Indeed, leveraged institutions with a strong appetite for risk, such as hedge funds and private equity funds, have grown rapidly in importance and have become active participants in credit markets.

In addition, improved risk-management capabilities have arguably facilitated the ability of global investors to underwrite riskier investments. (See the article by Aaron, Armstrong, and Zelmer in this *Review* on commercial bank risk-management practices.) In some instances, this may have contributed to an increase in risk appetite.

The modest consequences of the recent episodes of market turbulence may suggest that the broader dispersion of risk and improvements in risk management have improved the resilience of financial markets. Yet, notwithstanding these improvements, the risk remains that a large macroeconomic shock could result in a rapid increase in risk premiums, resulting in widespread and significant declines in asset prices.

### *Conclusion*

A number of factors help to explain the current low premiums on risky financial investments. The persistence of these low spreads raises the issue of their sustainability. In other words, is risk being appropriately priced? There is little in the way of criteria that can be used to gauge whether or not current levels of risky spreads are

appropriate, relative to the underlying risks. But experience teaches us that vulnerabilities frequently develop during periods of persistently low spreads which, when they are brought to light, trigger an abrupt repricing of risk.

## **Highlighted Issue**

### **Structured finance: The changing nature of credit markets**

*Prepared by William Barker*

The extraordinarily rapid growth in the use of structured finance has led to tectonic shifts in the nature of credit markets, with major implications for market liquidity, the role of banks in the financial system, and the nature of systemic financial risk. Broadly defined, structured finance is any financial arrangement that results in a transfer of credit risk through the capital markets. There are two principal means of accomplishing this transfer: credit derivatives transactions and asset securitization.

*Credit derivatives* are financial contracts with a payoff based on the occurrence of predefined credit events (such as bankruptcy). In general, the buyer of a credit derivative protects himself by entering into a contract to hedge that risk at the expense of periodic premiums to the protection seller, who assumes the credit risk of the underlying debt. The variety and sophistication of credit derivatives has developed rapidly, allowing the risk exposures transferred to the protection seller to be customized to meet investor objectives. This ability to flexibly transfer credit risk has proven extremely popular with market participants. As a result, the outstanding notional amount of credit derivatives has doubled every year since the start of this decade to reach US\$34.5 trillion globally by year-end 2006.<sup>24</sup>

*Asset securitization* describes the process of isolating designated financial assets from the lender's balance sheet, usually through their transfer to a legally separate special-purpose

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23. While emerging-market countries have actually become net exporters of capital as a group, large net capital flows into certain emerging-market countries are having an impact on local markets, including some relatively new markets. A disruption of flows could have significant financial repercussions in these markets.

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24. Source: International Swaps and Derivatives Association. Precise estimates on notional amounts outstanding are difficult to come by and vary between sources. But all sources agree that growth in the use of credit derivatives has been extremely rapid and that derivatives markets now greatly exceed the size of underlying asset markets.

vehicle (SPV) and then issuing securities against these assets. The originator of the loan thereby converts the original assets into cash and transfers the credit risk of the borrower but, nonetheless, maintains the loan-servicing relationship. The asset-backed securities (ABS) created by this process can be relatively simple instruments. Alternatively, a portfolio of ABS can be held by an SPV, which then structures the collective cash flows from the ABS into complex multi-tranche instruments known as collateralized debt obligations (CDOs).<sup>25</sup> CDOs offer enormous flexibility in terms of structuring financial risks and returns, allowing the tranches to be customized to the risk appetites and yield objectives of individual investors. As with credit derivatives, this flexibility has proven to be extremely popular: CDOs have been the fastest-growing area of structured finance, with global issuance exceeding US\$2 trillion in 2006.<sup>26</sup>

The extraordinary growth of structured finance reflects the transformation of credit-risk management away from a bilateral relationship between borrower and lender. Prior to these innovations, it was almost impossible to separate the credit risk of the debt from the debt itself, or to assume a short position in credit risk. Structured finance removes these constraints by unbundling the credit risk from the underlying debt and transforming it into a tradable exposure that is priced and transferred through global capital markets. With this innovation, it has now become routine for market participants to adjust their exposure to credit risk to attain their desired objectives and to express opinions on the relative value of debts.

This transformation of credit risk into a tradable asset class has attracted a broad array of new participants to credit markets, especially credit-

focused hedge funds and “real money” accounts (such as pension funds) that are investing in credit risk as an alternative asset class. These non-traditional participants in the credit market are often extremely well funded and have a defined need to invest assets. Structured financial products provide an efficient conduit into credit markets for these investors. This broadening of credit market participation has contributed to increased market liquidity, as measured both by the risk premiums on financial assets and by the magnitude of capital flows. Indeed, the demand for credit products by investors has accelerated the compression of credit spreads over government bond yields towards historically low levels.

As the importance of non-traditional participants in credit markets grows, the role of traditional participants (primarily banks) has also been changing. Whereas banks traditionally focused on funding loans and managing credit risks, their credit operations have increasingly shifted towards a flow-based, fee-oriented business model based on the origination, securitization, structuring, and distribution of debt. The provision of liquidity to credit markets and the management of financial risk exposures have increasingly passed from banks to non-traditional credit market participants.

Structured finance has created both opportunities and challenges for credit markets. On one hand, it has led to more complete capital markets by allowing optimal credit-risk exposures with much lower transactions costs: risks can be unbundled, repackaged, and efficiently transferred to other market participants through structured financial products. In particular, structured finance allows risks to be broadly dispersed throughout global capital markets rather than concentrated on the balance sheets of entities unable or unwilling to bear them. In principle, this should lead to lower systemic risk to the global financial system.

At the same time, however, structured financial products can be highly complex, difficult to price accurately, illiquid, and opaque in regard to their risk characteristics. It is important to recognize that structured financial products only transfer risks, they do not eliminate them—the risks must ultimately rest somewhere, although it may now be more difficult to determine whether these risks are properly priced or unduly concentrated. As the ongoing

25. When the SPV holds a portfolio of bank loans, the resulting instrument is known as a collateralized loan obligation.

26. Estimates of issuance and outstanding amounts in this notoriously opaque sector vary widely between sources. The Bank for International Settlements estimates that global issuance of CDOs approached US\$1 trillion in 2006 (*BIS Quarterly Review* March 2007). However, this figure excludes private CDO deals. Some sources that estimate private CDO activity suggest that total global CDO issuance in 2006 may be as high as US\$2.8 trillion (*Financial Times* 12 January 2007). As with credit derivatives, CDO issuance is growing rapidly.

turmoil in the U.S. subprime mortgage market illustrates, mispriced risks can sometimes be transferred through structured financial products to market participants who are not fully aware of their risk exposure or who are not as efficiently hedged as they believed.

# Important Financial System Developments

**T**his section of *Developments and Trends* examines structural developments affecting the Canadian financial system and its safety and efficiency.

## Amendments to the Financial Institutions Legislation

On 29 March 2007, royal assent was given to Bill C-37, An Act to amend the law governing financial institutions and to provide for related and consequential matters. This bill resulted from the review of this legislation that is required every five years. The majority of the provisions in C-37 came into force on 20 April 2007, including the sunset provisions in the various acts governing financial institutions. The amendments had three key objectives: to increase legislative and regulatory efficiency; to adapt the regulatory framework to new developments; and to enhance the interests of consumers.

To improve regulatory efficiency, the legislation eliminates some approvals previously required for transactions, streamlines the approval process for some other transactions, and shifts some approvals from the Minister of Finance to the Superintendent of Financial Institutions. It also permits near banks (foreign entities not regulated as banks in their home jurisdiction) to undertake certain financial services in Canada without regulatory approval. To address new developments, the legislation provides an enabling framework for financial institutions to use electronic cheque images in the cheque-clearing system. Because of the growing size of financial institutions, the equity threshold for large banks (which must be widely held) was increased from \$5 billion to \$8 billion, while that for “medium-sized” banks, trust and loan companies, and insurance companies (which can be closely held, but which must have a minimum public float of voting shares of 35 per cent) was increased from \$1 billion to \$2 billion. The

legislation also makes it easier for credit unions to establish co-operative credit associations by reducing the number of credit unions that must participate in such associations. The residency requirement for boards of directors of Canadian-owned financial institutions was relaxed: the proportion of directors required to be Canadian residents has been reduced to a majority from the previous two-thirds.

Initiatives to enhance the interests of consumers include harmonizing online and in-branch disclosure requirements, and requiring financial institutions to make their complaint-handling procedures available in branches, on websites, and to any person requesting them.

Finally, the new legislation raised the threshold loan-to-value ratio beyond which mortgage insurance is required to 80 per cent from 75 per cent.

## The Mortgage Insurance Market

There have recently been several other new developments in the Canadian mortgage insurance market.

A new private mortgage insurer, AIG United Guaranty Canada, started operations in the autumn of 2006, and two other insurers recently received federal regulatory approval to commence and carry on business.

Meanwhile, there have been further product innovations in this market.<sup>27</sup> CMHC introduced a mortgage insurance product specifically designed for self-employed people who have difficulty documenting their stated income.<sup>28</sup>

27. Past innovations include an increased maximum amortization period for insured mortgages, insurance for interest-only mortgages, and insurance products for non-prime borrowers.

28. Previously, CMHC had been absent from this market segment (often described as Alt-A), while Genworth Financial had offered its “Business For Self” mortgage insurance product since early 2006.

There is also some evidence that insured mortgages with longer amortization periods are proving popular.

To the extent that these recent innovations allow new borrowers into the mortgage market, they add to housing demand at a time when housing demand is already putting pressure on capacity. They also contribute to rising household indebtedness, at a time when the aggregate household debt-to-income ratio is already at a historical high.

## Highlighted Issue

### Asset-backed commercial paper: Recent trends and developments

*Prepared by Nadja Kamhi and Eric Tuer*

Over the past two years, the market for Canadian asset-backed commercial paper (ABCP) has experienced strong growth. The amount of ABCP outstanding has increased from about \$65.4 billion at the end of 2004 to \$106.7 billion at the end of 2006. As such, ABCP has become an important source of short-term financing for Canadian and global corporations. While Toovey and Kiff (2003) provide an overview of the general features of the Canadian ABCP market, this highlighted issue provides an update of recent market developments concerning the structure and credit-rating criteria for Canadian ABCP programs.

#### *What is asset-backed commercial paper?*

The ABCP market brings together investors wishing to invest in highly rated short-term money market debt securities and firms looking for an alternative source of debt financing, potentially at lower cost than traditional commercial paper (CP) and bankers' acceptances.

Asset-backed commercial paper is a form of asset securitization. (See the Highlighted Issue on structured finance.) Firms sell financial assets to a legally separate entity known as a special-purpose vehicle (SPV)<sup>29</sup> or "conduit" in return for cash. The purchase of these assets by the SPV is financed by the issuance of commercial paper with a term to maturity typically between

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29. Special-purpose vehicles are structured to be "bankruptcy remote" or legally separate from their sponsor, which could be a commercial bank, an affiliate of the bank, or a non-bank-affiliated entity.

30 and 90 days. The types of underlying financial assets that are acquired by these conduits may include receivables generated from credit cards or trade receivables, auto and equipment loans and leases, mortgages and, more recently, collateralized debt obligations (CDOs). There are several different types of conduits, but the most prevalent are multi-seller conduits that provide funding to a number of unaffiliated originator/sellers by combining their assets in a diversified portfolio.<sup>30</sup> A typical ABCP program structure is presented in Figure 1.

#### *A new class of underlying securities: Collateralized debt obligations*

An increasingly popular financial asset class included in Canadian ABCP conduits is CDOs.<sup>31</sup> CDOs are structured finance securities that reference (in a similar way to ABCP) a pool of underlying debt obligations. CDO notes are generally sold in tranches with varying credit-risk profiles, ranging from the least risky, AAA-rated super senior notes, to the most risky, unrated equity notes. The underlying or referenced debt obligations in a CDO may include corporate bonds, asset-backed securities, mortgage-backed securities, or credit derivatives. When the underlying assets of CDOs are credit derivatives, such as credit default swaps (CDS), instead of the actual security, they are called synthetic CDOs.<sup>32</sup> These vehicles have accounted for most of the recent growth in the issuance of structured financial assets.

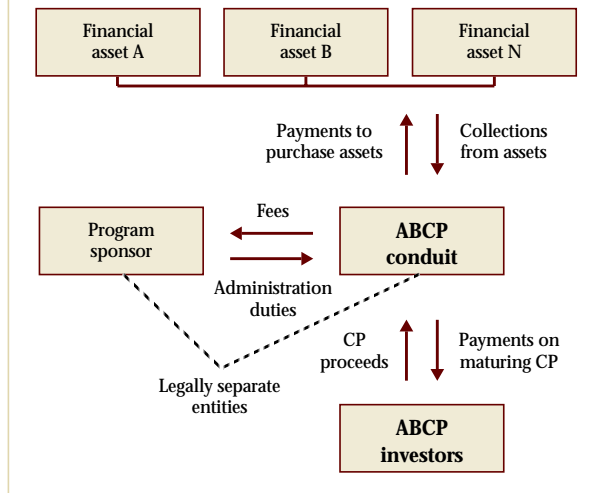
Recently, leveraged super senior CDO (LSS-CDO) structures (which are typically created from synthetic CDOs) have been the most popular type of ABCP conduits that make use of CDOs. As the name implies, these structures allow the conduit to take on a leveraged position in the highest-rated tranche of a CDO by partially funding its obligation, while at the same time receiving the same premium payments as if it had fully funded its exposure. Because of its leveraged position, the value of an LSS-CDO structure is sensitive not only to the number of defaults incurred in the pool of underlying debt instruments, but also to conditions in credit markets (i.e., fluctuations in credit

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30. See Toovey and Kiff (2003) for more information on multi-seller ABCP.

31. See Armstrong and Kiff (2005) for more details on CDOs.

32. See Reid (2005) for details on credit default swaps.

**Figure 1 Typical Multi-Seller ABCP Program Structure**

spreads). As such, these LSS-CDO structures may experience greater price (and yield) volatility than typical asset-backed securities. The portfolio structure of an ABCP conduit based on an LSS-CDO is therefore crucial to its viability and to the determination of the necessary credit protections that help it maintain its rating.

#### *Characteristics of the Canadian ABCP market*

Over the past two years, the Canadian ABCP market has experienced strong growth, largely because of the funding of synthetic CDO assets. Underlying this expansion has been the phenomenal growth of the global CDS market, which has greatly facilitated the construction of synthetic CDOs.<sup>33</sup> Given the relatively small volume of CDS based on Canadian debt securities, a significant portion of the credit risk associated with these CDOs is foreign based.<sup>34</sup>

According to data from DBRS Limited, the proportion of the total Canadian ABCP market composed of multi-seller ABCP conduits with CDOs as the underlying assets increased from 8.6 per cent in 2004 to 19.9 per cent in 2005. This share increased to approximately 28 per cent of the ABCP market as of December 2006, making it the largest asset class backing ABCP, followed by auto loans and leases (25 per cent) and residential mortgages (20 per cent).

Since the underlying assets are of a longer maturity than the ABCP instruments financing them, most ABCP conduits that issue short-term commercial paper require a liquidity facility (i.e., liquidity backing), which helps mitigate rollover risk,<sup>35</sup> in order to receive a credit rating. Liquidity facilities in Canadian ABCP programs provide funding to the conduit if there is a general market disruption (GMD)<sup>36</sup> in the ABCP market that would prevent the rolling over of notes. Without proper liquidity

33. See the Highlighted Issue on p. 20.

34. As a result, it appears that much synthetic CDO-based Canadian ABCP represents a strict funding arbitrage investment and does not involve the dispersion of the balance sheet risk of Canadian firms (as in the case of a more traditional form of asset securitization).

35. Rollover risk refers to the ability to refinance by issuing new debt to replace maturing debt.

36. In Canada, GMD refers to the situation where issuers of commercial paper are unable to issue it despite the fact that there has been no change in the credit quality of the conduit from its original level.

support, a conduit that is unable to roll over its ABCP may not be able to repay its ABCP holders in full or on time.

One feature that differentiates the Canadian ABCP market from those in most other countries is the nature of the liquidity facilities that are acceptable to credit-rating agencies. Most liquidity facilities in Canada can be triggered only under the narrowly defined conditions of a GMD and are typically not available if the credit quality of the underlying assets is impaired. By comparison, most liquidity facilities for similar securities in the United States are available to deal with a wider array of disruptions, including, in some cases, those that arise from credit risk (i.e., deterioration of the underlying asset). The narrowly defined liquidity facilities typical of Canadian ABCP avoid the imposition of regulatory capital charges on the providers of the liquidity facility. The difference in liquidity provisions implies that investing in a rated Canadian ABCP may entail somewhat higher risk than investing in a similarly rated U.S. ABCP; this higher risk is reflected in the higher yield of Canadian ABCP.

*Revisions to credit-rating criteria affecting Canadian CDO-based ABCP and their implications*

An increase in the complexity of the new underlying structured financial assets and a desire for greater transparency caused DBRS to revise the criteria for rating Canadian ABCP programs that fund structured financial assets. The revisions were introduced in January 2007 and apply only to new ABCP programs that fund structured financial assets, of which CDOs are the most prevalent.<sup>37</sup>

The new criteria include a requirement that these types of newly issued ABCP programs be supported by approved liquidity facilities not restricted to use only under GMD conditions and that conduits limit their exposure to any one industry and to non-investment-grade entities. Moreover, DBRS will require that CDO-based ABCP programs disclose more information to investors so that the risk of the structures can be better assessed.<sup>38</sup> Despite these

revisions, DBRS reiterated that all existing CDO-related ABCP programs were deemed to be of high quality and consistent with assigned ratings. As a result, there was no discernible change in the yields.<sup>39</sup>

The changes to the liquidity facilities requirement mean that the provider of the liquidity facility (usually a large bank) will incur additional regulatory capital charges. The imposition of a higher regulatory capital charge is likely to increase the cost of this type of ABCP program, making it less attractive to the issuer. Recent anecdotal evidence suggests that the growth in this segment of the ABCP market has slowed considerably, especially when compared with that of the past few years.

Lastly, another implication of the criteria revisions is that U.S. credit-rating agencies may now become more involved in rating Canadian CDO-based ABCP programs. To date, they have not rated such programs because of their concerns over Canadian GMD-style liquidity facilities. The entrance of more credit-rating agencies into the market will lead to increased competition for rating ABCP programs. In addition, ABCP programs with more than one credit-rating assessment may attract a wider investor base. These developments would be positive from the perspective of capital market efficiency.

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37. These revisions also apply to extendable ABCP and medium-term notes that fund structured financial assets.

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38. See Buzanis and Loke (2007) for more details.

39. This lack of yield movement may reflect the fact that most sophisticated investors in the money market understood the previous DBRS framework and the financial risks involved.



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# Reports



# Introduction

**R**eports address specific issues of relevance to the financial system (whether institutions, markets, or clearing and settlement systems) in greater depth.

The report on **Bank of Canada Oversight Activities during 2006 under the Payment Clearing and Settlement Act** covers the Bank's role in 2006 with respect to the three systems designated in accordance with that act (the Large Value Transfer System, CDSX, and the CLS Bank). This annual report by Clyde Goodlet also reviews other Bank activities that support this role. The report is an elaboration of the discussion that appears in the Bank's *Annual Report*.

In the report **An Overview of Risk Management at Canadian Banks**, Meyer Aaron, Jim Armstrong, and Mark Zelmer review current and evolving risk-management practices at Canadian banks and highlight some related issues and concerns. This report is partly based on interviews with major Canadian banks conducted by Bank of Canada officials in early 2007. The Bank of Canada is interested in developments in risk management at Canadian banks because of the critical role that banks play in the Canadian financial system. The report highlights how the changing business of banks—particularly their growing exposures to markets and complex instruments—has created new challenges for risk management. The report contains a review of the major categories of risk and how banks are dealing with them. Some important techniques, such as VaR and stress testing, are discussed. The report concludes with a discussion of some of the major challenges ahead, including model risk and the integration of risk management across the institution.

In the report **Sectoral Default Rates under Stress: The Importance of Non-Linearities**, authors Miroslav Misina and David Tessier examine the impact of the introduction of non-linearities on predicted default rates and illustrate their arguments with a series of experiments that focus on the recession in Canada in the early 1990s. The report also provides a detailed description of the proxies for sectoral default rates for the 1988–2005 period constructed by the authors.



# Bank of Canada Oversight Activities during 2006 under the Payment Clearing and Settlement Act

*Clyde Goodlet*

**T**he Payment Clearing and Settlement Act (PCSA) formally requires the Bank of Canada (the Bank) to exercise oversight of clearing and settlement systems that could be operated in a manner that could pose systemic risk.<sup>1</sup> Systemic risk is defined in the PCSA as the risk that the default of one participant in a clearing and settlement system could, through the operation of the system, lead to the default of other participants in the system or other systems. A clearing and settlement system is the set of instruments, procedures, and rules governing the transfer of funds or other assets among system participants. Typically, there is agreement among the participants on the technical infrastructure to be used by the system.

The purpose of this report (the second in an annual series) is to review the Bank of Canada's oversight activities under the PCSA during 2006, as part of its efforts to be transparent and accountable for its activities in this area.<sup>2</sup>

Under the PCSA, the Bank identifies clearing and settlement systems in Canada that could be operated in a manner that could pose systemic risk. Once identified, and provided the Minister of Finance agrees that it is in the public interest to do so, these systems are designated for oversight by the Bank and must satisfy the Bank that they have appropriate risk controls in place to deal with any concerns related to systemic risk. Three such systems have been designated by the Bank: the Large Value Transfer System (LVTS), the CDSX, and the CLS Bank.

## The Large Value Transfer System

The LVTS is owned and operated by the Canadian Payments Association (CPA). It began operations in February 1999. It currently processes about 19,000 transactions per day, worth approximately \$166 billion. Since its inception, there have been very few changes to the design or rules of the LVTS that could raise concerns about systemic risk, and this pattern continued in 2006. However, some important changes were made to the system's rules last year to reduce certain potential sources of operational risk. These changes addressed the responsibilities of participants in the testing of changes to the LVTS, the adequacy of contact information, and the procedures to follow should the LVTS Direct Network be used to initiate a payment.<sup>3</sup>

Integral to the Bank's oversight process is the use of Memoranda of Understanding (MOUs) with operators of designated systems. MOUs describe the roles and responsibilities of both parties under the PCSA and set out how they intend to work together to meet those responsibilities. They address such topics as the Bank's exercise of its oversight responsibilities and powers, as laid out in the PCSA, confidentiality of information, time frames for review of significant system changes, and the use of minimum standards. A major accomplishment in this regard was the conclusion of intensive discussions with the CPA and the signing of an MOU covering the oversight of the LVTS in November 2006. The MOU reflects the collaborative and co-operative nature of the oversight process that the Bank prefers to follow. It has added clarity to the relationship between the Bank and the CPA and has enhanced the oversight process.

1. The PCSA came into force in 1996. Prior to that time, the Bank carried out this responsibility on an informal basis.  
2. See Engert and Maclean (2006) for a discussion of the general oversight strategy and processes used by the Bank.

3. See Goodlet (2006) for a description of the use of the Direct Network to address certain types of operational risk.

For example, the CPA will now provide advance written notice of any significant change to the LVTS bylaws or rules, so that the Bank can determine if the proposed changes raise any concerns about systemic risk.

## CDSX

CDSX is a system for the clearing and settlement of securities transactions in Canada. The system, which is owned and operated by CDS Clearing and Depository Services Inc., processes, on average, about 390,000 trades daily, worth \$230 billion.

During 2006, the most important issue dealt with by the Bank and The Canadian Depository for Securities Ltd. (CDS) involved the corporate restructuring of CDS. The purpose of the restructuring is to gain operational efficiencies by aligning various functions with corporate subsidiaries of CDS. This includes the separation of the clearing and settlement activities of CDS from its other activities.

From the perspective of systemic risk, one benefit of this separation is that it largely addresses the Bank's concern that, in very unlikely circumstances, the non-regulated activities of CDS could result in CDS being unable to make and receive payments in CDSX, thus compromising the ability of CDSX to settle payment obligations in a timely fashion. This situation could arise if, for example, the non-regulated activities of CDS were to cause its insolvency or result in legal actions that would prevent CDS from performing its role as central counterparty.

A new legal entity, called CDS Clearing and Depository Services Inc. (created on 1 November 2006), now acts as system operator and central counterparty in CDSX, and its ability to act will not be compromised, directly or indirectly, by the design and operation of services other than the clearing and settlement of securities transactions and associated activities. The Bank considers this step to be an enhancement of the risk proofing of the CDSX system.<sup>4</sup> The

restructuring involved much work by many parties (CDS staff, CDSX participants, and its regulators), and the smooth transition to the new corporate structure is a testament to their collaborative and co-operative approach.

An important aspect of the new structure is that the entity operating and serving as the central counterparty in CDSX also operates its cross-border services, which link CDSX or CDSX participants to foreign securities settlement systems. To deal with the potential systemic risk impact on CDSX, the Bank has clearly specified its information needs and the areas to be examined for possible risks when considering any future cross-border linkages involving the new operating entity. This specification is based on extensive discussions with CDS.

Another important development during 2006 was the self-assessment carried out by CDS concerning its compliance with international standards in its role as a central counterparty. CDS and the Bank have been strong supporters of the work in this area. Consequently, CDS made a presentation to the Bank for International Settlements Committee on Payment and Settlement Systems (which developed the standards) on the process and the results of the self-assessment. The Bank has also encouraged CDS to keep its financial-risk model current. CDS has now put in place processes to do this, which will facilitate the ability of the Bank and other parties to systematically examine potential risks arising from proposals for new clearing and settlement services.

A valuable component of the Bank's oversight process with regard to CDSX is the bilateral meetings between the Bank and CDS that examine a range of topics related to the operation of CDSX. These meetings provide the Bank and CDS with an opportunity to explore any concerns or questions related to proposed changes to CDSX on a timely and efficient basis. The Bank is thus alerted to possible changes very early in the process and can raise any concerns that it may have so they can be dealt with efficiently by CDS in the process of developing system changes. During 2006, the Bank held two such meetings with CDS.

The Bank approved 35 changes to CDSX rules and procedures during the year.

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4. The Bank also arranged with the Department of Finance for an Order-in-Council to designate the new entity as a securities and derivatives clearing house under Section 13.1 of the PCSA, which provides the continuation of important legal protections in the event of the failure of a CDSX participant. An Amendment to the PCSA to include the name of the new operating entity came into effect in April 2007.



## The CLS Bank

CLS Bank, which began operations in 2002, now clears and settles foreign exchange transactions in 15 currencies, including the Canadian dollar, with an average daily value of US\$2.7 trillion. The average daily value of Canadian-dollar transactions in 2006 was US\$60 billion. Since CLS Bank operates transnationally, the Bank of Canada, as well as a number of other central banks, has oversight responsibilities or interests in the operation of the system. Most of the developments with regard to CLS Bank in 2006 involved its overall operations, since there were no specific changes to the arrangements used to settle the Canadian-dollar portion of foreign exchange transactions.

The Federal Reserve, which is the lead supervisor of CLS Bank, reviews the liquidity and capital policies of the CLS as they relate to the supervisory standards set for CLS Bank. The results of this review, as well as other supervisory information, are shared with the central banks whose currencies settle in CLS Bank. This is part of the co-operative oversight arrangement for CLS Bank that facilitates the sharing of information among central banks (subject to confidentiality requirements), the discussion of common oversight policies and approaches, and the coordination of oversight activities.

As CLS Bank has evolved, the addition of new currencies and the expansion of the types of settlement services it offers have been a major focus of the analytical work of the co-operative oversight group. Since CLS Bank has a very robust process for settling transactions across borders, it continues to search for opportunities to spread the significant fixed costs associated with this process across a greater volume of transactions in existing or new types of business. With regard to the settlement of foreign exchange transactions, CLS Bank modified the prices for its services during 2006 to help increase the volume of transactions that it processes. In addition, CLS Bank is exploring the processing of new types of transactions on its existing platform by offering the financial sector a means of reducing risks or costs associated with current practices. The Bank of Canada believes that the fundamental principle guiding the oversight group in considering these issues should be that the addition of new currencies or new business should comply with the core

principles for systemically important payments systems and, in particular, should not impair the risk-mitigation arrangements employed by CLS Bank to deal with foreign exchange settlement risk.

During 2006, the central banks with CLS-eligible currencies carried out a survey of the management of foreign exchange settlement risk at major banks in their countries. The survey results and an analysis of the data are expected to be published by the Bank for International Settlements. With the decision of a fourth large Canadian bank to use CLS Bank for its eligible transactions, Canadian banks are recognizing that the CLS arrangement is increasingly being considered best practice for mitigating foreign exchange settlement risk.

## Other Oversight Activities

Following an extensive review of its oversight processes conducted in 2005, the Bank made a number of changes in 2006 to better align these processes with the ongoing operations of designated clearing and settlement systems. These included the implementation of more formalized internal processes, including those for handling system changes and conducting annual audits. The Bank and the Department of Finance reviewed the operation of the Payment Advisory Committee, resulting in a clearer mandate and oversight processes. In addition, the Bank continued to enhance its oversight resources to provide for greater analytical capability and better backup for important staff functions.

Internationally, during 2006, the Bank became a member of a BIS working group examining the cross-border interdependencies among clearing and settlement systems and their participants. In particular, the group is interested in the potential for systemic disruptions and contagion across borders should a major clearing and settlement system experience a serious disruption.

The Bank is also increasingly involved in the co-operative oversight arrangement for the Society for Worldwide Interbank Financial Telecommunication (SWIFT). SWIFT is the principal payment messaging service provider for financial institutions around the world and for critical systems, such as the LVTS and CLS Bank. In 2004, the G-10 central banks established a joint Oversight Group for SWIFT under the leadership of the National Bank of Belgium. This

Group monitors and assesses the extent to which SWIFT maintains appropriate governance arrangements, structures, processes, risk-management procedures, and controls to effectively address any potential concerns it may pose to financial stability.

Since 2002, SWIFT has been the subject of subpoenas issued by the U.S. Treasury Department for access to information on global payments using SWIFT messaging services. These subpoenas were imposed on SWIFT as part of a global scrutiny of terrorism financing. Knowledge of these subpoenas became public in 2006 and raised privacy concerns in several countries, including Canada, about the nature of the payments information being requested. The National Bank of Belgium issued a press release on behalf of the SWIFT Oversight Group and the G-10 Governors indicating that such issues were beyond the Oversight Group's mandate, which covers the financial stability implications of SWIFT services to systemically important systems. Moreover, the Oversight Group does not have the authority either to approve or prohibit SWIFT's compliance with such subpoenas. Privacy commissions in a number of countries conducted investigations into the actions of SWIFT. The Office of the Privacy Commissioner in Canada recently completed its investigation and concluded that SWIFT did not contravene Canada's Personal Information Protection and Electronic Documents Act when it complied with lawful subpoenas served outside of Canada.

During 2006, the Bank continued to work with the operators and participants of systemically important Canadian clearing and settlement systems to enhance arrangements for continuity of operations. These systems are at the centre of Canada's financial system, and serious economy-wide repercussions could arise if their operations were not extremely reliable. In 2006, the working group that was created to address systemic issues related to business-continuity planning (BCP), and to examine the coordination of BCP among system operators and participants and the Bank of Canada, completed the second phase of its work. The major findings of the phase II report of the Joint Working Group were: (i) the CPA and CDS had reduced their operational risk, with split operations initiatives accounting for much of the improvement; (ii) their BCP practices compared favourably with those of similar organizations in other

countries, although it was recognized that benchmark practices continue to evolve rapidly; and (iii) efforts to achieve a priority-recognition status with federal and provincial organizations with responsibilities for emergency management have yet to yield positive results. Recognition of the priority to access the supply of essential inputs such as hydro, diesel fuel, or municipal services during a seriously disruptive event is an important component of these systems and of the Bank's BCP work. The next phase of the group's work will be to involve the participants in the LVTS and CDSX to examine their roles in dealing with potential systemic BCP risks and the coordination of BCP efforts. The Bank is working actively with the CPA and CDS to facilitate this process.

The Bank has also been involved in groups addressing preparations for a possible flu pandemic. It has worked with the federal Department of Finance to review the BCP arrangements of federal agencies with responsibilities for the financial sector with a particular emphasis on a flu pandemic scenario. Similarly, the Joint BCP Working Group also gave special emphasis to this scenario. Internally, the Bank is re-examining its program for business-continuity planning with regard to any particular changes that might be necessary should a flu pandemic materialize.

During 2005, the Bank completed its three-year program to improve the ability of its backup site to respond effectively to serious operational disruptions. IT and business-recovery testing during 2006 revealed some shortcomings in meeting the Bank's objectives for internal recovery time. Most of these gaps have now been addressed and tested. Testing of further refinements is planned for 2007. The multi-year redevelopment of a high-availability system for providing banking services to financial institutions and critical clearing and settlement systems was expected to be completed in 2006. However, extended testing has resulted in a significant delay in the implementation of the system. The Bank of Canada remains committed to improving its ability to deliver its unique services to major clearing and settlement systems on a high-availability basis.

## Published Research Relevant to the Bank's Oversight Function

During 2006, the Bank published the following staff work related to clearing and settlement systems:

- Arjani, J.N. 2006. "Examining the Trade-Off between Settlement Delay and Intraday Liquidity in Canada's LVTS: A Simulation Approach." Bank of Canada Working Paper No. 2006-20.
- García, A. and R. Gençay. 2006. "Risk-Cost Frontier and Collateral Valuation in Securities Settlement Systems for Extreme Market Events." Bank of Canada Working Paper No. 2006-17.
- Kamhi, N. 2006. "LVTS, the Overnight Market, and Monetary Policy." Bank of Canada Working Paper No. 2006-15.
- Lai, A., N. Chande, and S. O'Connor. 2006. "Credit in a Tiered Payments System." Bank of Canada Working Paper No. 2006-36.
- McVanel, D. 2006. "The Impact of Unanticipated Defaults in Canada's Large Value Transfer System." Bank of Canada *Financial System Review* (June): 69–72.

Research summaries of the papers by Lai, Chande, and O'Connor, and García and Gençay were also published in the December 2006 issue of the Bank's *Financial System Review*.

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# An Overview of Risk Management at Canadian Banks

*Meyer Aaron, Jim Armstrong, and Mark Zelmer*

**T**he Bank of Canada is interested in developments in risk management at Canadian banks because of the critical role that banks play in the Canadian financial system.

This report provides a brief overview of risk-management practices at Canadian banks. It is based, in part, on recent interviews conducted with some Canadian and foreign banks.

The business of banks has changed noticeably over the last 15 or 20 years (Calmès 2004). Although deposit taking and lending continue to be key business lines, banks have expanded into other areas, including investment banking and trading, insurance, trusts, brokerage, and mutual funds. An important consequence of this shift has been an increase in the exposure of banks to financial markets.

In light of this exposure, banks have adopted sophisticated risk-management practices. Boards of directors now play a more active role in ensuring that risks are well understood and in overseeing risk exposure. They also ensure that management has appropriate strategies, systems, and controls in place to manage risk. Indeed, banks have adopted sophisticated risk management as a core function, and risk-management principles are now used across banking organizations to allocate capital, price products, and invest in new markets.

## Managing the Major Risks

### General trends

Like any other business, banking involves taking calculated risks to generate profits. Today, Canadian banks face a diverse range of risks. In this report, we focus on credit risk, market risk, liquidity risk, and operational risk.

Canadian banks have always faced these categories of risk. But the underlying complexity and importance of certain risks has increased as a result of market pressures and the business strategies adopted by the banks. For example, market risk has grown in importance and has become more complicated to manage. Back offices and other parts of banks are facing challenges in keeping up with the pace of innovation in front offices.<sup>1</sup>

This trend towards increasing complexity, coupled with advances in information technology, is driving the rapid adoption of quantitative models, where appropriate, and a move towards a more integrated approach to risk management within banks.<sup>2</sup> But the day-to-day choices in risk management essentially depend on the type of risk, the availability of instruments to transfer or mitigate the risk, and where the risk resides on the balance sheet.

A bank's balance sheet—together with off-balance-sheet arrangements—can be divided into financial instruments that make up its trading book and those that make up its banking book. The trading book includes instruments held for shorter-term trading and other financial market activities. The banking book includes most loans and securities held for longer investment horizons. Both “books” normally contain similar types of financial instruments and risks. They tend to be managed differently, however, because of their differing time horizons.

1. Part of this complexity arises from the growing importance of very complex legal documentation governing transactions, as well as from issues of whether the trade on the books matches the trade outlined in the confirmation.
2. Sometimes referred to as enterprise-wide risk management or ERM (Standard & Poor's 2006).

## Credit risk

Credit risk refers to the potential for loss if a borrower or a counterparty to a transaction fails to meet its obligations as they fall due. Credit risk remains the most important risk that banks have to manage. Large banks tend to allocate roughly half of their economic capital to this risk.

Historically, credit risk was lodged mainly in the banking book. However, with the growth in holdings of corporate securities and derivatives, credit risk in the trading book has increased.

Diversification is a first line of defence against major credit losses. In the banking book, diversification is used to avoid concentration of credit risk with a particular borrower, or group of borrowers, or with a particular industry or region.

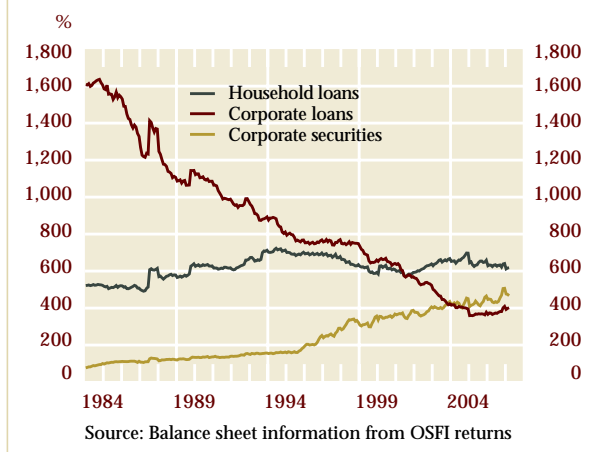
The trading book houses both credit risk related to the issuers of securities and counterparty risk incurred from derivatives contracts. The former is mitigated through single-name and sector limits, as well as, more recently, credit derivatives. The latter is mitigated through various arrangements, such as netting agreements and collateral. Similarly, diversification across counterparties and products avoids the concentration of credit risk in the trading book.

Banks have systems in place to monitor their exposure to any one group or related set of counterparties/borrowers to ensure that this exposure does not exceed chosen limits relative to their capital base. Exposures to single names and sectors are managed largely on a consolidated basis, regardless of whether the risk arises from different instruments or from different books (banking or trading). Chart 1 presents the trend in major categories of bank credit exposure relative to capital. In recent years, bank lending to the household sector has risen relative to corporate lending.<sup>3</sup> However, holdings of corporate securities have also risen; these are held mainly in the trading book.

### *Exposure to households and small business enterprises (SMEs)*

Management of exposure to households and SMEs involves numerous borrowers that, taken

**Chart 1 Trend in Bank Major Asset Categories Relative to Tier 1 Capital**



3. The risk involved in some of this lending to households is mitigated through mortgage insurance.

as a portfolio, have fairly uniform credit-risk properties. This permits banks, because of “the law of large numbers,” to rely on statistical models that incorporate certain key risk variables to assess borrower creditworthiness.<sup>4</sup> This helps to streamline the process for credit approval and enforce uniform standards across the many lending offices of large institutions.<sup>5</sup>

Banks also securitize some of their household assets, such as residential mortgages, consumer loans, and credit card loans, to shed balance sheet assets and reduce exposure to these sectors, while retaining a relationship with household or small business clients.

### *Exposure to large corporations and institutions*

Large exposures to corporate credit and to other institutions are more “lumpy” and, thus, less amenable to assessment through basic statistical models. Consequently, banks continue to rely on in-depth credit analysis of individual borrowers to assess their creditworthiness, with results graded by probability of default and loss-given-default. This is similar to the approach of the credit-rating agencies.

The larger the exposure, the more scrutiny it attracts within the bank, with the largest exposures reviewed and approved by the board of directors. Part of credit-risk management has traditionally been through the terms and conditions associated with individual loans. These may include pledging of securities for collateral. There may also be various performance covenants that help banks monitor the creditworthiness of borrowers over time and that trigger renegotiations if credit quality deteriorates.

Recent developments in markets for credit-risk transfer (CRT) have enhanced the ability of banks to better manage large corporate exposures through financial instruments, while allowing them to maintain client relationships. CRT techniques include securitizations, loan syndications, secondary loan sales and, more recently, credit derivatives (Reid 2005). Canadian banks have expertise in these techniques,

although banks tend to be more active in using them in offshore markets—notably those in the United States—given the relatively small size of these markets in Canada.<sup>6</sup>

There have been important developments in modelling the credit risk of large corporate exposures. The emergence of Credit VaR (Value at Risk) models and other techniques, such as the Moody’s KMV approach (based on the Merton model), provide banks with a quantitative framework for calculating the economic capital required to backstop their exposure to credit risk.<sup>7</sup> Banks have invested considerable time and effort in ensuring that their internal ratings process is more formalized and documented so that they can easily defend how they arrived at an internal rating decision. This has been reinforced by Basel II with its emphasis on risk-based capital (Box 1).

Growth in market-based activities has increased large credit exposures in the trading book, arising from holdings of credit instruments and from counterparty exposures.<sup>8</sup> Chart 2 shows the trend in trading book assets and liabilities. Banks employ both derivatives and offsetting transactions in cash markets (such as short selling of similar securities) to manage credit risk in the trading book.

This has resulted in a growing reliance on collateral to mitigate the counterparty risk involved in derivatives contracts and other financial transactions. Collateral takes the form of cash or high-grade securities, like government debt, that have low credit risk and are very liquid. This has led to increased demand for high-grade securities, which has occasionally affected the liquidity of underlying markets. This has likely contributed to a broadening out in the range of eligible collateral beyond government securities, particularly the use of cash collateral (very short-term instruments), which is now the

4. The subprime segment of the mortgage market has proven to be less amenable to the same modelling techniques. But this market is small in Canada. See Highlighted Issue on page 6.

5. The use of credit-scoring models is a fairly recent development in Canada.

6. The securitization technique is relatively well developed in Canada.

7. Credit VaR is typically defined as an estimate of the loss related to credit-rating transitions, over a given horizon (usually one year), that is statistically unlikely to be exceeded at a given probability level.

8. OSFI recently conducted a review of bank exposures to hedge funds and concluded that banks’ exposures are relatively small and that risk-management practices are adequate (OSFI 2007).

## Box 1

## Basel II and Bank Risk Management

In June 2004, the Basel Committee on Banking Supervision released its report titled “International Convergence of Capital Measurement and Capital Standards: A Revised Framework” (Basel II). The revised Basel II framework will be implemented for Canadian banks effective 1 November 2007, following a one-year parallel run with the existing capital-adequacy regime. Basel II is designed to achieve a closer alignment of regulatory capital requirements with underlying risks by introducing significant changes to the treatment of credit risk, as well as by introducing a new capital charge for operational risk. The underlying principles of the new framework are intended to be suitable for application to banks of varying levels of complexity and sophistication. The framework will allow qualifying banks to determine capital levels consistent with the manner in which they measure, manage, and mitigate risk.

Basel II rests on three pillars: minimum capital requirements, supervisory review, and market discipline. Risk management is given a key role in the first pillar of the new framework—minimum capital requirements—in terms of emphasizing the measurement and management of risks, and providing banks with incentives to adopt more advanced risk-management techniques. The new framework provides a spectrum of methodologies, from simple to advanced, for the measurement of both credit and operational risk. (Those applied to market risk are largely unchanged from the 1996 market-risk amendment to the original Basel Capital Accord.)

For credit risk, banks may choose between the standardized approach, the foundation IRB (internal-ratings-based) approach, and the advanced IRB approach. Under the standardized approach, banks use risk weights based on ratings assigned by a recognized external credit-assessment institution, such as a rating agency, to calculate required regulatory capital.

Under the two IRB approaches, banks use their own internal assessments and risk models to arrive at the key risk drivers needed to calculate capital risk weights, to varying degrees. For banks using the foundation IRB approach, probability of default (PD) must be internally generated with other risk factors provided by supervisors. By contrast, banks using the advanced IRB approach are required to estimate probability of default, loss-given-default (LGD), exposure at default (EAD), and maturity (M) for each exposure.

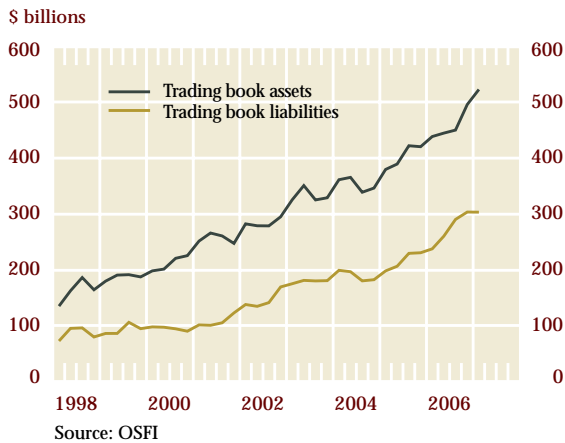
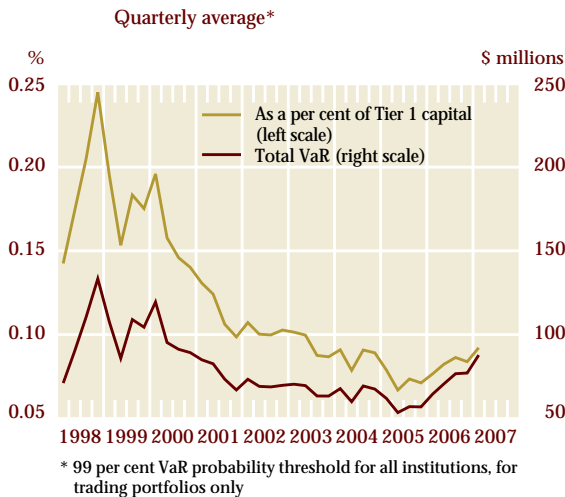
Similarly, for operational risk, Basel II offers three progressively more complex methods: the basic indicator approach, the standardized approach, and the advanced measurement approach (AMA). Most major Canadian banks are planning to adopt the advanced IRB approach for credit risk and the standardized approach for operational risk.

The second pillar of Basel II focuses on the supervisory review process. It allows banking supervisors (Office of the Superintendent of Financial Institutions in Canada) to set minimum capital requirements that exceed those outlined in Pillar 1, depending on the risk profile of the bank. This assessment process may involve reviews of bank risk-management processes and stress tests. Meanwhile, the third pillar is aimed at strengthening market discipline by requiring enhanced disclosure of risk information by banks in Canada and abroad.<sup>1</sup>

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1. In Canada, advanced IRB and AMA banks will be required to meet advanced disclosure requirements in 2008.



**Chart 2 Trend in Bank Trading Book****Chart 3 Trend in Bank VaRs**

primary collateral instrument in over-the-counter derivatives markets (BIS 2007).

## Market risk

Market risk represents the potential for adverse changes in the prices or volatility of financial assets and liabilities.<sup>9</sup> While market risk is typically not the largest risk that Canadian banks face, it has risen in importance over the past two decades and poses unique challenges, given the complexity of the financial instruments from which it is derived and the markets where they trade. The complexity of new products and strategies derived from market activities has increased the banks' reliance on quantitative methods that employ a number of assumptions and sophisticated statistical theory to price products and manage their exposures.

Most banks continue to use the toolkit of model technology generically referred to as value at risk (VaR) for measuring and managing their exposure to market risk at the portfolio level. Technically, VaR represents the maximum expected dollar loss that could be experienced, given a specified confidence level, over a specified time horizon.<sup>10</sup> While originally developed to measure market risk in the trading book, this approach has, to some extent, been extended to other areas, such as market risk in the banking book and even credit risk.

Chart 3 shows the recent trend in bank VaRs, calculated as an aggregate of the major Canadian banks. Note that reported VaRs tend to be small compared with the gross value of trading book assets reported in Chart 2. This is because the VaR reflects the netting of various offsetting balance sheet and off-balance-sheet items and can be reduced by diversification.

The reported VaR numbers have recently started to rise, reversing the declining trend that had been in place since the start of the decade. Given the declining trend in volatility, the rising VaRs are likely driven by larger exposures. However, the chart shows that VaRs remain at a low

9. Market risk is normally considered to include foreign exchange risk, interest rate risk, equity risk, and commodity risk.

10. For example, suppose a bank reported 1-day VaR of \$10 million at 99 per cent. This means that, 99 days out of 100, the trading portfolio should not lose more than \$10 million.

proportion of Tier 1 capital. Reported VaRs of major Canadian banks tend to be smaller than those of many of their global peers.

A review of bank annual reports suggests that the majority of their trading book assets and liabilities (excluding derivatives) are valued based on observable prices. For the most part, however, over-the-counter derivatives are valued based on modelled prices; exchange-traded derivatives normally have quoted prices. According to the banks, the majority of these modelled values are based on observable parameters (e.g., yield curves or implied volatility on a stock index), with the remainder having significant unobserved parameters (e.g., default correlation). For more on this issue, see CSFI (2006).

### Liquidity risk

Liquidity risk is the risk that a bank cannot meet a demand for cash or fund its obligations because of its inability to liquidate assets or raise funds in a timely manner at a reasonable price. While banks may have access to central bank lender-of-last-resort facilities in extremis, they are expected to make arrangements to meet their liquidity needs in all currencies relevant to their business (Bank of Canada 2004).

Effective management of liquidity risk at banks is essential to ensuring that core businesses continue to function under adverse circumstances. In today's interconnected markets, liquidity risk presents certain challenges from a conceptual and measurement point of view. Indeed, the management of liquidity risk takes on an even greater significance when its interaction with, and potential amplification of, market and credit risk during periods of market stress is considered.<sup>11</sup>

Banks typically manage liquidity on a global consolidated basis. As with other types of risk, diversification of funding sources is one element of managing liquidity risk. Banks diversify these sources across maturities, customer types,

markets, currency, and regions. They monitor the balance between their core deposits (comprising customer accounts and term deposits), which are more stable, and wholesale deposits, which are usually more volatile and for shorter terms.<sup>12</sup> Relatively new techniques, such as securitization, have helped to diversify funding sources.

Banks also set and adhere to limits with respect to the key elements of liquidity risk, such as minimum thresholds for very liquid assets. They maintain contingency plans for liquidity and conduct regular stress testing to gain confidence in their ability to operate under a liquidity crisis.

### Operational risk

Operational risk can be defined as the risk of loss resulting from inadequate or failed internal processes, people, and systems or from external events. It is important to note that these risks have been around for a very long time and are inherent in the way a bank runs its business. However, practices for managing operational risk have assumed a greater profile because of new requirements under Basel II, which inject more formality into the measurement of operational risk, and in the wake of foreign bank failures that occurred as a result of breakdowns in operational controls.

Operational risk can take various forms. It can involve people (incompetence or fraud), system failures (breakdowns in systems or technology), and process failures (i.e., back-office problems).

By its nature, operational risk, which is present in all activities, is difficult to avoid. In contrast to financial risks, such as credit risk and market risk, there are few traded instruments to help mitigate this risk, although in some cases it can be managed through insurance contracts. Operational risk is typically managed through rigorous internal processes and controls. Banks have a long history of extensive and well-documented formal procedures. Moreover, internal audit groups play an active role in testing internal controls, with support from external auditors.

In the course of our interviews, banks indicated that their expansion into various financial markets is demanding more power and

11. It is worth noting some commentary in a recent Bank of England *Financial Stability Report* in the context of the U.K. banking system. "The severe crystallization of credit, market and liquidity risk in combination could lead to a material erosion of UK banks' capital, with potential knock-on effects to supporting markets, institutions and infrastructures" (Bank of England 2006).

12. Wholesale funding entails issuing relatively large deposits to institutional and corporate depositors.

sophistication from IT systems. This, in turn, poses challenges for gathering information from disparate sources and legacy systems that are expensive to replace. Some banks are shying away from some of the most complex financial products, apparently because of the challenges in understanding the associated risks. Instead, they are spending time and resources looking for ways to streamline their supporting infrastructure, including IT.

The recent trend towards strengthening corporate governance, noted earlier, has been very helpful in dealing with operational risk. Examples include the greater involvement of boards of directors and the growing role of independent directors in risk governance. There has also been a growing focus on business contingency planning (BCP) to cope with potential external shocks to business, such as terrorism and pandemics.

Several banks are building databases on various types of operational risk incidents to allow them to better understand and measure this type of risk. Some Canadian banks are actively involved in a banking industry initiative to develop industry-wide databases on operational risk events that can be used to develop more sophisticated measures of operational risk.

## Issues and Challenges

We will now briefly address some important issues and challenges related to bank risk-management practices going forward.

### Limitations of risk models

Quantitative models have limitations that can restrict their scope. They require a large amount of high-frequency data to estimate distributions. Hence, they tend to excel in the management of market risk, given the large amount of data available on financial asset prices. They are more difficult to implement for credit, liquidity, and operational risk.

These models, such as VaR, tend to be very sensitive to model parameters, such as market volatility and correlations between risks (which are difficult to estimate). Certain types of risk, such as liquidity risk, currently can be incorporated in only a rudimentary manner, while other risk factors (such as competitive responses and feedback effects) are difficult to model.

Lastly, most risk models assume that future distributions will be the same as the distributions estimated from historical data. These limitations may make it difficult to apply these models in crisis events that have systemic impacts (Bouchaud and Potters 2003; Danielsson 2002). For example, VaR is “backward looking,” being based on historical experience, and may not accurately capture risk if volatilities and correlations suddenly change in a crisis event.

Banks are well aware of the shortcomings associated with quantitative models. Judgment is always involved to a greater or lesser extent, so that the process never becomes purely mechanical. Given the growing importance of models, banks have well-developed processes in place for managing model risk.<sup>13</sup> These include strict procedures for model development, independent validation (including backtesting and stress testing), and implementation.<sup>14</sup> Banks also have procedures in place to prescribe reserves against model risk.<sup>15</sup>

### The growing importance of stress tests

Banks are also addressing the problems and limitations of quantitative models through a wide variety of stress tests.

Stress testing is used to assess the impact of uncertainties arising from model limitations or data availability. It involves using the models to evaluate the impact on the chosen risk measure of “what if” scenarios involving extreme events.<sup>16</sup> For example, for market risk, it can help to gauge the impact of sudden changes

13. Model risk can be broadly defined as the risk of error in estimates caused by inadequacies in the model or its implementation (Dowd 2005).

14. Backtesting and stress testing are obligatory under Basel I and II. They are among many procedures used by supervisors to evaluate the reliability of bank risk models.

15. With regard to mitigating model risk, it is interesting to note that some banks suggest that a constructive consequence of the growing reliance on collateral to manage counterparty risk is the need for counterparties to mutually agree on collateral valuation, providing an independent form of model validation.

16. The Basel Accord and Basel II require banks to have a program for rigorous stress testing, including significant past events. A summary of the BIS stress-testing survey was included in the June 2005 issue of the *Financial System Review* (p. 21).

from current norms in volatility or correlations. Thus, stress tests frequently contribute to the setting of risk limits.

Stress tests at large Canadian banks tend to vary in terms of degree of development by type of risk. They appear to be most developed with respect to market risk and structural interest rate risk (interest rate risk residing in the banking book) and perhaps less developed for liquidity risk and credit risk. However, stress testing for credit risk is rapidly evolving, propelled by changing international standards, largely related to Basel II, which comes into effect in Canada in late 2007 (Box 1).

Banks run stress tests based on both hypothetical and historical scenarios. Under a hypothetical scenario, one or more risk factors are shocked to simulate extreme events. In a historical scenario, movements in risk factors are based on observations of actual prior periods of financial stress.<sup>17</sup> Banks are not quite at the point where they can reliably take into account correlation effects across the major categories of risk. However, the field continues to evolve.

Banks state that they view the results from these stress tests as valuable for better understanding the risk profile of an institution, for setting risk limits, and as a communication tool to assist management in linking strategic planning with risk management. They are also used in the supervisory process to evaluate the reliability of bank models.

### Integrated risk management

Important challenges remain for Canadian and foreign banks in areas such as moving towards a full-enterprise, risk-management system that links information on different risk types and across the banking and trading books, so that banks can have a holistic perspective on their risk exposures. Like their foreign counterparts, Canadian banks have been working towards—but have not yet achieved—the integration of measures for market risk, credit risk, and liquidity risk through stress tests to obtain a more complete view of total exposure to financial

risk. At this stage, formal macroeconomic models are not widely used.<sup>18</sup>

Clearly, the greater integration of risk management is an important challenge for large and complex Canadian and other global banks going forward, and they continue to devote significant resources to achieving it.

While endeavouring to address the problem of integration, risk models will continue to grow in complexity as banks develop and utilize sophisticated financial products to meet the needs of their clients. The challenge is for risk practices to keep up with rapid changes in products and strategies.

### Conclusion

The competitive pressures in banking are increasing the pace of innovation and the complexity of the business. Like their foreign counterparts, Canadian banks are coping with these pressures in diverse ways and have developed improved governance practices and risk-management infrastructures that meet their differing business strategies.

Interviews with foreign banks suggest that the practices of Canadian banks are broadly in line with those of their global peers. Furthermore, the banks—like their global counterparts—have made significant progress in improving risk-management practices. This has been motivated largely by business needs, but Basel II has also played a role in building momentum for change within the industry. Past experience points to the need for continuous vigilance in internal controls and risk management by the banks.

Risk-management practices are also affecting the global financial system. Over the past decade, the financial system has shown considerable resilience during a number of market and credit episodes, adding credence to the view that risk management has made the financial system more robust (Kohn 2005). This view should, however, be tempered by the reality that these events occurred during a period of largely favourable macroeconomic conditions.

17. Commonly used historical scenarios include the 1987 stock market crash, the 1994 bond-market decline, and the 1998 Russian default/LTCM crisis.

18. However, Canadian banks are participating in a macro stress-test exercise this year as part of an update of the IMF's assessment of the stability of the financial system through the FSAP program.

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# Sectoral Default Rates under Stress: The Importance of Non-Linearities

Miroslav Misina and David Tessier

**T**he purpose of aggregate-level stress testing is to identify the circumstances that could impair the functioning of the financial system and have economy-wide (systemic) implications. In models typically used for stress tests of aggregate credit risk, macroeconomic shocks are assumed to affect financial institutions via their impact on either individual or industry-level default probabilities.<sup>1</sup> Therefore, sound modelling of the relationship between macroeconomic variables and defaults is of considerable importance.

In this report, we examine how the functional form used in the specification of default regressions affects the nature of the responses of default probabilities under stress. In particular, we argue that the assumption of a linear relationship imposes severe restrictions on the responses of default probabilities to macroeconomic shocks. These restrictions are particularly undesirable in stress-testing exercises. To remedy this problem, we introduce non-linearities in a simple, but effective, way and illustrate their impact on responses with a series of examples.

We begin with a general discussion of the nature of the restrictions that linearity implies and their undesirability in the context of stress testing. This is followed by an empirical exercise in which we compare the performance of linear and non-linear models by varying the severity of a recession and the initial state of the economy. In the concluding section, we draw broader implications of our results for stress testing.

## The Importance of Taking Non-Linearities into Account

Let  $\pi$  denote the default probability and  $x$  a set of explanatory variables. The relationship between  $\pi$  and  $x$  can be expressed as

$$\pi = f(x).$$

Specifying  $f$  as a linear function is a simple solution but has a number of undesirable consequences. To see this, consider the following example in which  $\pi = ax$ . The impact of changes in  $x$  is given by

$$\frac{d\pi}{dx} = a.$$

This simple expression makes it clear that the restrictions that linear models impose on responses are rather severe and have the following properties.

- *Symmetry*: the magnitude of the response is the same, regardless of whether the shock is positive or negative.
- *Proportionality*: the response is proportional to the change in the exogenous variable.
- *History independence*: the response is independent of initial conditions ( $x$ ).

None of these restrictions is appealing in the context of stress-testing exercises, where asymmetry, non-proportionality, and history dependence would seem to be desirable properties. For example, one would expect a negative shock to have a different impact on companies, depending on whether the economy was in recession or in an expansionary phase.

Stress tests generally select scenarios that are severe but plausible, with the result that experimental shocks are usually quite large. With shocks of such magnitude, linear approximations to a possibly non-linear process might prove to be particularly poor.

1. See, for example, Jiménez and Mencía (2007), Virolainen (2004), or Wilson (1997). Misina, Tessier, and Dey (2006), summarized in this *Review*, provides a general description of the structure of these models.

To develop response profiles with features more suitable for stress testing, the assumption of linearity has to be relaxed. This can be done by introducing higher-order terms, while preserving additivity. The following non-linear specification,

$$\pi = ax + bx^2 + cx^3,$$

delivers the response function

$$\frac{d\pi}{dx} = a + 2bx + 3cx^2,$$

which generates asymmetric, non-proportional, and history-dependent responses. This type of response function implies that the impact of shocks would differ in good and bad economic states, both qualitatively and quantitatively.

## Examples

The examples in this section build on the linear specification of default-probability regressions in Misina, Tessier, and Dey (2006). In that paper, regressions on sectoral default probability take the form

$$\ln\left(\frac{\pi_t}{1-\pi_t}\right) = \mu + \sum_{l=1}^L \beta_l X_{t-l} + e_t.$$

The explanatory variables are Canadian macro-economic variables (real GDP and real interest rates) and their lags. One way to introduce non-linearities is to retain additivity but include higher-order terms:

$$\ln\left(\frac{\pi_t}{1-\pi_t}\right) = \mu + \sum_{l=1}^L \beta_l^{(1)} X_{t-l} + \sum_{l=1}^L \beta_l^{(2)} X_{t-l}^2 + \sum_{l=1}^L \beta_l^{(3)} X_{t-l}^3 + e_t$$

The key advantages of introducing non-linearities in this manner are simplicity and flexibility. The addition of other variables and higher-order terms does not present difficulties, since the relationship of the parameters remains linear.

The data used to estimate these regressions are the growth rate of real Canadian GDP, the real interest rate on medium-term business loans,<sup>2</sup> and sectoral default rates as proxies for sectoral default probabilities. The data cover the period 1987Q1 to 2005Q4. Details on constructing sectoral default rates are given in Box 1.

To examine the impact of introducing non-linearities, we focus on the behaviour of predicted sectoral default rates following the Canadian recession of the early 1990s, which peaked between 1990Q4 and 1991Q3. The forecasts are given for the period starting in 1991Q4.<sup>3</sup> Chart 1 contains the paths of historical and predicted default rates, where the latter are estimated using linear and non-linear models.<sup>4</sup> The benefit of non-linearities is particularly evident in this stressful period, when the default rate reached its historical peak. As is clear from the chart, the non-linear model captures the actual default rate over this period much better than the linear model. As the impact of the recession diminishes, the paths developed under these two specifications tend to converge.

To get a better sense of the limitations of the linear model, we perform two sets of experiments: (i) a change in the severity of the recession; and (ii) a change in the initial conditions. The experiments are performed by exogenously changing Canadian GDP over the period 1990Q4 to 1991Q3, and deriving the implications for the GDP and interest rate in the subsequent period using a two-variable vector-autoregression model.<sup>5</sup>

2. The real medium-term rate is equal to the nominal rate minus inflation expectations, where the latter was calculated as a geometric mean of the five-years-ahead realized inflation rate.
3. Our specification includes four lags, which fully take into account the period 1990Q4 to 1991Q3.
4. In this report, we show the results for the manufacturing sector only. The results for other sectors (accommodation, construction, retail) are qualitatively similar.
5. We applied the method proposed in Jordà (2005), which uses a set of sequential regressions of the endogenous variable shifted several periods ahead.



## Box 1

## Constructing a Proxy for Sectoral Default Rates

Default probabilities are a key input in any model of credit risk. To arrive at reliable estimates of the relationship between the macro-economic variables and defaults, a long series of data on historical defaults is required. Although some data are available for large publicly traded companies, a long series with broad coverage is not available for Canada. This box describes the construction of such a data set and the issues involved in this process.

Misina, Tessier, and Dey (2006) used bankruptcy rates (the ratio of bankruptcies in a sector to the total number of establishments in that sector) as a proxy for sectoral default probabilities. Data were obtained from the Office of the Superintendent of Bankruptcy (numerator) and Statistics Canada (denominator).

There are two issues with this choice. First, bankruptcy is not a good proxy for the events that affect banks and their economic capital. Bankruptcy is the last stage of a company's distress. Prior to that, a company would typically go through two stages (missed interest payments, distressed exchange),<sup>1</sup> both of which result in losses to the lender. To capture all these credit events, rating agencies use a broad category of default that includes anything from missed payments to bankruptcy. Use of the number of bankruptcies will lead to an underestimation of the number of credit events that affect the credit risk of banks.

Second, the total number of establishments in a sector does not accurately reflect banks' lending practices. Only the establishments that borrow from the banks are relevant. Use of the total number of establishments will, again,

underestimate the number of credit events that have an impact on the credit risk of banks.<sup>2</sup>

To deal with these issues, we start with the data on bankruptcy rates and construct proxies that better reflect credit events that affect banks.

The adjustment was based on the following considerations:

- Reported data on default events from Moody's for the period 1989 to 2005 indicate that bankruptcies account for roughly one-third of default events.<sup>3</sup>
- Statistics Canada's (2004) "Survey of Financing of Small and Medium Enterprises" (SMEs) indicates that small and medium-sized enterprises account for 99.7 per cent of business establishments in Canada.<sup>4</sup>
- Statistics Canada's (2005) "Survey of Suppliers of Business Financing" offers an exceptionally detailed picture of banks' lending activities to small and medium-sized enterprises in Canada, which includes information on debt financing by authorization size of client businesses (Section B2), as well as debt losses by authorization size of client businesses (Section B6), for the years 2000–05. This information can be used to construct historical default rates for that period.<sup>5</sup>

2. In addition, the number of establishments overestimates the number of companies in a sector. Given that bankruptcies are reported at a company level, use of the number of establishments in the denominator will lead to a further underestimation of the bankruptcy rate.
3. "Default and recovery rates of Canadian corporate bond issuers, 1989–2005" (April 2006). Moody's provides the data on default rates as well, but the rates are computed relative to the number of companies they cover. That number is quite small, especially for the period prior to the mid-1990s, resulting in large fluctuations in default rates driven by a very small number of default events.
4. <http://strategis.ic.gc.ca/epic/site/sbrp-rppe.nsf/en/rd00999e.html>, Table 2.
5. Data prior to 2000 do not exist, since the first survey was conducted in that year. ([http://sme-fdi.ic.gc.ca/epic/site/sme\\_fdi-prf\\_pme.nsf/vwapj/SurveyofSuppliersTables\\_Eng.pdf/\\$FILE/SurveyofSuppliersTables\\_Eng.pdf](http://sme-fdi.ic.gc.ca/epic/site/sme_fdi-prf_pme.nsf/vwapj/SurveyofSuppliersTables_Eng.pdf/$FILE/SurveyofSuppliersTables_Eng.pdf))

1. This refers to a situation in which the issuer offers bondholders a new security or a package of securities that amount to a diminished financial obligation, with the purpose of helping the borrower avoid default.

**Box 1**

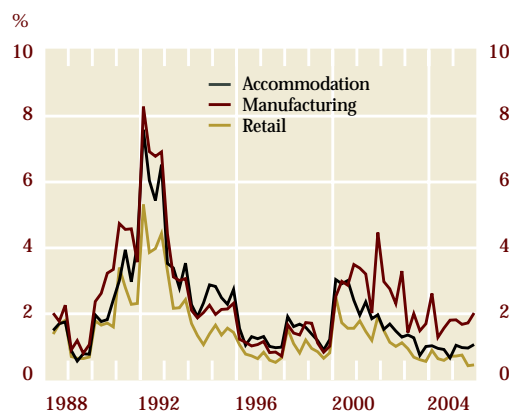
## Constructing a Proxy for Sectoral Default Rates (cont'd)

The adjustment process, then, consists of two steps:

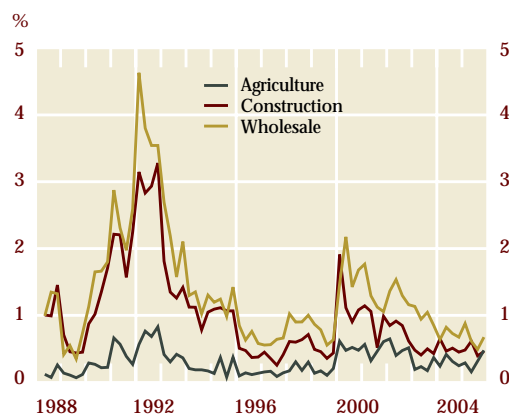
- First, we use the information from Moody's to convert bankruptcies into defaults.<sup>6</sup> The adjustment for each year is done separately by scaling up the bankruptcy rate for that year by the ratio of defaults to bankruptcies for that year, to take into account the difference in dynamics between bankruptcies and defaults.<sup>7</sup>
- We then compare the adjusted series with the observed default rates in 2000–05, and make additional adjustments, as necessary. These adjustments involve scaling the whole series up or down to match the survey data as closely as possible.

Charts A and B contain the adjusted series, and Chart C compares the adjusted rates with the historical default rates for 2000–05. The match over the past five years is quite close, both in year-to-year and average comparisons. Nonetheless, it should be kept in mind that the variable adjustment is based on a small sample of bankruptcies and defaults documented by Moody's.

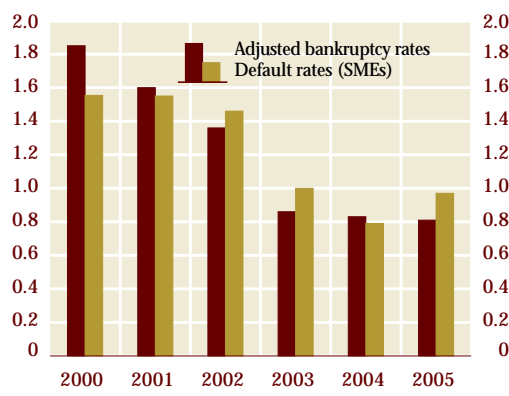
**Chart A Constructed Proxies for Sectoral Default Rates**



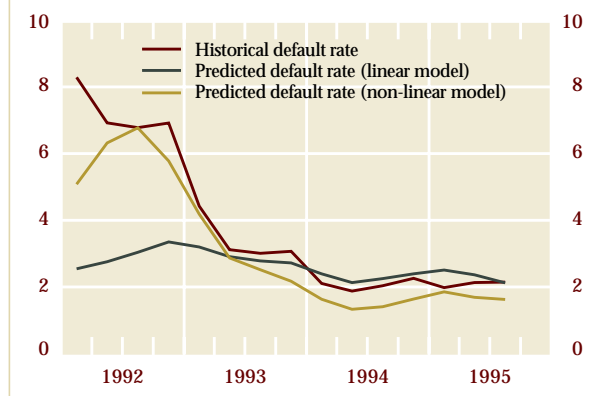
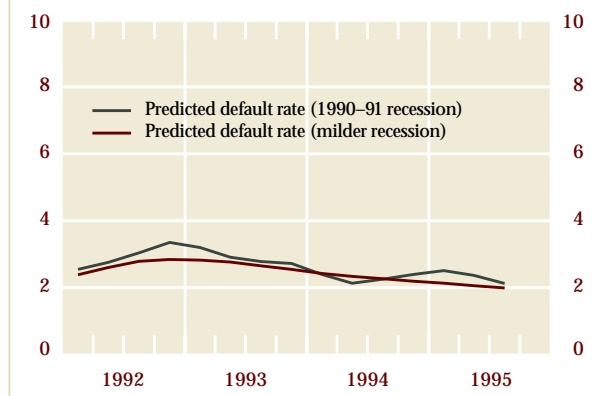
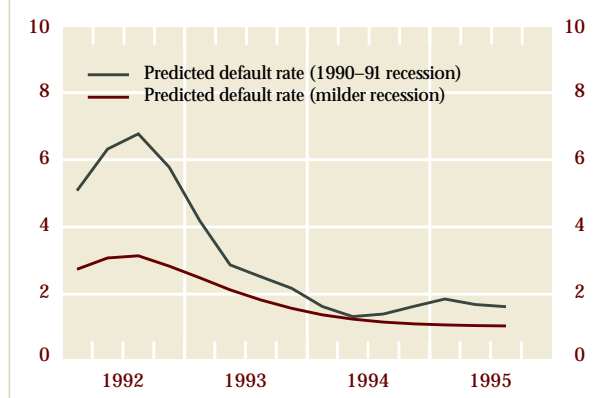
**Chart B Constructed Proxies for Sectoral Default Rates**



**Chart C Comparison of Average Default Rates**



- Given that the Moody's data cover mostly large publicly traded companies, the relationship between bankruptcies and defaults in Moody's data set may not be representative of that relationship more generally. One can argue, however, that the second step of the adjustment process corrects for any biases that might be present here.
- The difference in dynamics is due to the fact that credit events, such as missed interest payments, are much more sensitive to changes in business conditions than bankruptcies, which represent the last stage of distress and typically occur with a lag.

**Chart 1 Historical and Predicted Default Rates: Manufacturing Sector****Chart 2 Impact of a Change in the Severity of Recession on Default Rate: Linear Model****Chart 3 Impact of a Change in the Severity of Recession on Default Rate: Non-Linear Model**

## Change in the severity of recession

In this experiment, we assume that the recession is very mild (10 per cent of the 1990–91 recession). This is done by multiplying the observations of GDP in the 1990Q4–1991Q3 period by 0.1. All else being the same, this should result in a significant decrease in default rates predicted by the model.

Charts 2 and 3 contain the results for linear and non-linear models, respectively. In both charts, we compare the default rate paths predicted under the 1990–91 recession to the paths predicted under our much milder hypothetical recession. The non-linear model is clearly more responsive than the linear one, and the difference is more significant the larger the shock. The key reason is that the non-linear model is not bound by the assumption of proportionality, and therefore the shocks are magnified. This is not the case with the linear model.

## Change in the initial conditions

In this experiment, we change the conditions prior to the recession by converting them from unfavourable (approximately zero per cent GDP growth) to favourable (3 per cent GDP growth). The latter is similar to the conditions in Canada over the past few years. One would expect that, starting from these more favourable conditions, a decline in GDP of the magnitude observed in 1991 would have a much smaller impact than was the case at that time, since favourable economic conditions put companies in a better position to absorb shocks.

Charts 4 and 5 contain the results for linear and non-linear models. In both cases, there is a decline in default rates relative to the original setting, but it is much more significant in the case of the non-linear model. Indeed, this model now predicts only a slight change in default rates, while the responses in the linear model are limited to an approximately parallel shift down.<sup>6</sup> This example highlights the invariance of the shape of the response in the linear specification to changes in initial conditions.

6. The shift would be exactly parallel if the changes in both explanatory variables were fixed exogenously. In our model, the interest rate is determined endogenously.

One implication of this result is that if the initial conditions are favourable, a much larger decline in GDP would be needed to induce a response in the default rates comparable to that observed in the 1991 recession.

## Conclusions

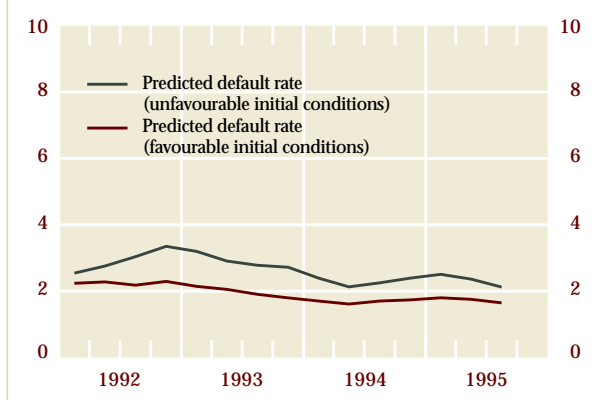
The findings described here raise questions about the suitability of linear models for stress testing. The net result of the limited ability to generate plausible behaviour around extreme events, together with a limited responsiveness to initial conditions, is that these models tend to underestimate the impact of shocks during bad times, and fail to take into account the fact that favourable initial conditions put the economy in a relatively better position to withstand shocks of a given magnitude. Our solution to this problem is to relax the assumption of linearity and replace it with a more plausible alternative.

Of course, the importance of non-linearities will depend on the nature of the sample and the incidence of stressful episodes. Even when there is only one stressful episode in the sample, the non-linear terms may capture it well, but the robustness of the specification might be an issue. To fully assess the extent of the problem, if any, a sample with more than one stressful episode is needed.

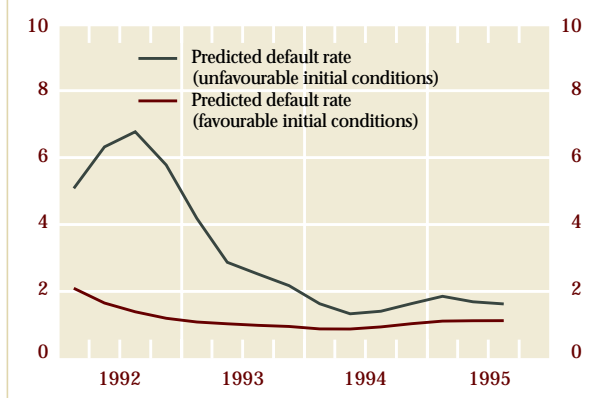
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**Chart 4 Impact of a Change in Initial Conditions on Default Rate: Linear Model**



**Chart 5 Impact of a Change in Initial Conditions on Default Rate: Non-Linear Model**





Research

Summaries



## Introduction

**B**ank of Canada staff undertake research designed to improve overall knowledge and understanding of the Canadian and international financial systems.

*This work is often pursued from a broad, system-wide perspective that emphasizes linkages across the different parts of the financial system (institutions, markets, and clearing and settlement systems), linkages between the Canadian financial system and the rest of the economy, and linkages to the international environment, including the international financial system. This section summarizes some of the Bank's recent work.*

The objective of stress testing is to identify potential vulnerabilities in a component of the financial system under various scenarios. In the paper **Stress Testing the Corporate Loans Portfolio of the Canadian Banking Sector** Miroslav Misina, David Tessier, and Shubhasis Dey examine the impact of various types of macroeconomic shocks on the aggregate business loans portfolio of Canadian banks. This work is the first to perform such aggregate-level stress tests in the Canadian context.

In the article **Modelling Payments Systems: A Review of the Literature** Jonathan Chiu and Alexandra Lai first examine the fundamental frictions that give rise to the use of payments arrangements. They then discuss the tiered structure of payments systems, the potential roles for central banks, and the design of large-value payments systems in light of these frictions.

Further to the Highlighted Issue in the December 2006 issue of the *Financial System Review*, "Lessons Learned from International Experiences with Market Transparency," this FSR contains two summaries of work done at the Bank of Canada in this area.

In the first paper, **The Impact of Electronic Trading Platforms on the Brokered Interdealer Market for Government of Canada Benchmark Bonds**, Natasha Khan studies the impact of increased transparency resulting from the introduction of three electronic trading systems on the brokered interdealer market for Government of Canada benchmark securities. Using the CanPX dataset, the author looks at two measures of liquidity in the market: the bid/ask spread and the estimated impact of changes in the order flow on price. For the 30-year benchmark bond, there is some evidence of decreased bid/ask spreads and price-impact coefficients in the months following the introduction of the electronic platforms. The two indicators were not significantly different in the pre- and post-transparency periods for the 2-, 5-, and 10-year benchmark bonds. Overall, there is little evidence that liquidity was affected by the introduction of the electronic systems.

In the second paper on market transparency, **Price Formation and Liquidity Provision in the Markets for European and Canadian Government Securities**, Chris D'Souza, Ingrid Lo, and Stephen Sapp examine how differences in the structure of European and Canadian markets for government bonds affect how information is reflected in prices in those two markets. The analysis provides evidence that trade and quote dynamics in the European marketplace are affected by quoting obligations and enhanced transparency.





# Stress Testing the Corporate Loans Portfolio of the Canadian Banking Sector

*Miroslav Misina, David Tessier, and Shubhasis Dey*

**S**tress testing identifies potential vulnerabilities in a segment of the financial system under various scenarios. Financial institutions typically perform stress tests to assess possible short-term losses owing to various types of risk (e.g., credit risk, market risk).<sup>1</sup> From a macroprudential perspective, however, the focus of stress testing is on identifying circumstances that could impair the functioning of the financial system and have economy-wide (systemic) implications. The results of these stress tests can be used to assess the resilience of the financial system.

Our work (Misina, Tessier, and Dey 2006) is the first on aggregate-level stress testing in the Canadian context. The approach used builds on Virolainen (2004) but, in contrast to that study, uses sector-level rather than company-level information. The need for less data facilitates implementation, and is an important feature of our approach.

We assess the performance of the Canadian banking sector's aggregate loans portfolio as a function of the changing circumstances in the different industries in which these loans reside. These circumstances are captured by sectoral default rates, which are modelled as a function of a selected set of macroeconomic variables.

This model allows us to assess the historical interrelationship between the macroeconomic environment and sectoral defaults, and to perform a series of tests under various scenarios. The scenarios selected reflect the sources of risk commonly seen as "typical" for Canada, rather than "concerns of the moment." Different scenarios can be easily accommodated within the framework developed.

This article summarizes the key features of the model, the results obtained, and possible extensions, some of which are already under way.

## The Model

The corporate loans portfolio of the banking sector consists of loans to businesses. The key source of risk in that portfolio is that borrowers may default, which would result in losses for the lender. From the viewpoint of financial stability, it is the circumstances under which a large number of borrowers may default that are of interest, since this could have a potentially large impact on financial institutions and/or the economy.<sup>2</sup> The key features of the model are summarized in Figure 1.

### Model of the sectoral default rate

We assume that defaults in the Canadian corporate sector are driven by the level of domestic economic activity and the level of domestic interest rates. A strong economy (higher GDP growth rate) would be associated with fewer defaults. Higher interest rates could affect the ability of borrowers to meet their obligations, possibly resulting in a larger number of defaults. Therefore,

$$\pi^s = f \left( \begin{matrix} GDP_{CAN}, \\ (-) \end{matrix}, \begin{matrix} r_{CAN} \\ (+) \end{matrix} \right),$$

where  $\pi^s$  is the default rate in industry  $s$ . In the empirical part of the work, the default rate is proxied by the bankruptcy rate: the ratio of

1. Aaron, Armstrong, and Zelmer (p. 39 in this issue) survey the risk-management practices of banks.

2. Large losses might be a consequence of defaults by a large number of small borrowers or by a small number of large borrowers. The extent to which the latter can be taken into account in an aggregate-level stress test is debatable. The issue is discussed further in Misina, Tessier, and Dey (2006).

bankrupt companies to the total number of companies in that sector.<sup>3</sup>

### Macroeconomic environment

The evolution of defaults will depend on the dynamics of the macroeconomic variables. We model these using a vector autoregression (VAR) system. Exogenous variables considered include U.S. GDP, U.S. interest rate, and commodity prices. Changes in these variables will affect the endogenous variables (Canadian GDP, Canadian interest rate) that enter the equation[s] for the sectoral default rate.

### Portfolio loss distribution

The expected loss on a portfolio with exposures to  $s$  industries is

$$El_t^S = \sum_{s=1}^S \pi_t^S \times ex_t^S \times l_t^S,$$

where

$\pi_t^S$  is the default rate in industry  $s$  at time  $t$ ,

$ex_t^S$  is the exposure to industry  $s$  at time  $t$ , and

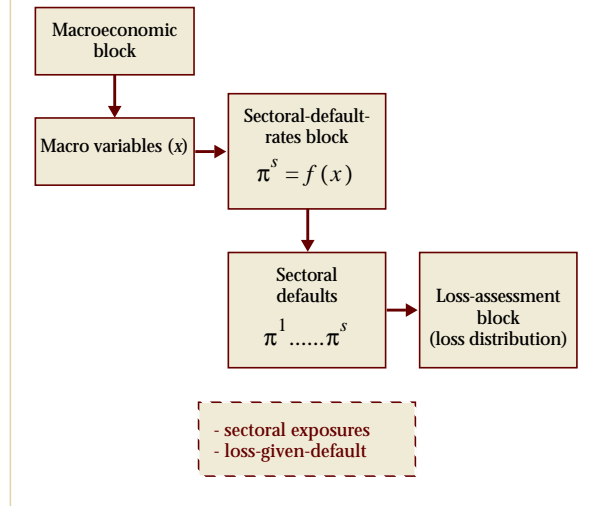
$l_t^S$  is loss-given-default (LGD) in industry  $s$  at time  $t$ .

To arrive at a loss distribution of the loans portfolio, one has to specify exposures and LGD for each industry.

For an individual obligor, LGD at time  $t$  is defined as

$$l_t = 1 - rr_t,$$

**Figure 1 Components of the Stress-Testing Model**



3. An alternative option is to use historical default rates. Defaults, as defined by rating agencies, are broader events than bankruptcies and, in addition to actual bankruptcies, include events such as missed interest payments and “distressed exchanges” (a type of financial restructuring whose purpose is to help the borrower avoid default). Given that all these events affect banks’ economic capital, one could argue that the use of default rates in the context of our exercise is preferable. Unfortunately, the data on defaults of Canadian companies prior to the mid-1990s are based on very limited company coverage.

where  $rr_t$  is the recovery rate: the amount of money that can be recovered on defaulted loans. For a given industry, the recovery rate is the average recovery rate on loans to that industry. The recovery rate for a credit portfolio is defined in a similar manner.<sup>4</sup>

## Scenarios and Results

The key part of the stress-testing exercise is scenario selection. By “scenario” we mean a particular event (e.g., an increase in interest rates), and possibly its broader implications, that could result in significant losses to financial institutions. Scenarios can be based on historical experience or they can be hypothetical. In either case, the objective is to select as scenarios those rare, but plausible, events that have led to problems in the past or could do so in the future.

We perform a series of stress tests under different scenarios, including an increase in the U.S. interest rate, a U.S. recession, a commodity price increase, and a combination scenario (U.S. recession and a commodity price increase). The implications of each scenario for the banking sector are inferred by computing the corresponding loss distribution for the portfolio, the expected loss, as well as the 99 and 99.9 per cent value at risk.

To assess the impact of these losses, it is necessary to consider them in relation to banks’ ability to absorb them. We arrive at a rough assessment by comparing the losses under different scenarios to the average historical loan-loss provisions. This exercise answers the following question: had the worst-case scenario materialized at time  $t$ , would the banks’ provisions at that time have been sufficient to cover the losses arising from that scenario?

Overall, we find that the average historical provisions would have been sufficient to cover

losses, although more work is needed to improve our understanding of both the behaviour of provisions and model results before firm conclusions can be drawn from this exercise.

## Summary and Further Work

In this work, we sought to accomplish two objectives: (i) to describe an approach to aggregate stress testing that is flexible and easy to implement; and (ii) to perform aggregate stress tests to assess credit risk in the loans portfolio of the Canadian banking sector.

While we believe that we have gone some way towards fulfilling the first objective, improvements are needed both in the data and in the methods used, to make this analysis useful for regular assessments.

With regard to the data, we believe that the use of bankruptcy data as a proxy for default rates is not fully satisfactory. Bankruptcy rates will, in general, underestimate default rates, because default events (such as missed interest payments) are more frequent than bankruptcies. In addition, one would expect defaults to be more sensitive to current business conditions than bankruptcies. In the absence of reliable data on defaults, adjustments to bankruptcy rates are needed. Use of the adjusted data will affect the results obtained.

With respect to the methods, we see two major avenues for improvement: changes in the macroeconomic block and the introduction of non-linearities.

In the paper, the interrelationships among the macro variables were summarized using a reduced-form statistical model. Ideally, one would like to have a structural model that would be flexible enough to incorporate all variables of interest.

In addition, linear specification, both in the macroeconomic and the default rate blocks, is quite restrictive, since it implies that responses to shocks will exhibit, among other properties, symmetry (the impact of positive and negative shocks of the same magnitude is the same in absolute value) and history independence (the impact does not depend on the starting point). Our current work suggests that non-linearities in both modules are important and that they deliver more plausible responses.

4. In practice, recovery rates are either assumed to be constant, or are assumed to be stochastic and drawn from a particular distribution. In both cases, recovery rates are assumed to be independent of default rates. The evidence, however, seems to suggest that the recovery rates are not constant and, more importantly, that there is a link between default rates and recovery rates. There seems to have been little work on this issue to date, particularly for Canadian companies.

Improvements along these lines are currently under way in preparation for the forthcoming financial sector assessment (FSAP) exercise.<sup>5</sup>

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5. Work on non-linearities is described in the report on p. 49.

# Modelling Payments Systems: A Review of the Literature

*Jonathan Chiu and Alexandra Lai*

All non-barter economic exchanges have to be settled by a transfer of funds from the buyer to the seller. Payment systems are the infrastructure that facilitates these transfers. While policy-makers care about the efficiency and stability of payments systems, guidance from economic theory has, until recently, been limited. Standard models abstract from the mechanism through which payments take place and, thus, are not suitable tools for studying payments systems. Recently, a large body of economic research, drawing on techniques and insights from existing monetary, banking, and industrial organization theories, has been developed on the modelling of payments systems. A working paper by Chiu and Lai (2007) provides a non-technical review of this literature. This article summarizes that paper.

## Methodology and Questions

Most modern payments systems are characterized by systems of economic transactions settled by payment instruments (such as cash and cheques) and institutions (such as banks and clearing houses) that facilitate the clearing and settlement of these instruments. The nature of payments systems therefore depends upon the instruments chosen and the structure of the institutions. This combined interest in instruments and institutions has important methodological implications. It implies that the use of payment instruments and institutional arrangements should be treated as an endogenous outcome in models of payments systems. For this reason, one of the emerging fields of research attempts to develop internally consistent, general-equilibrium models to analyze the roles of alternative payment instruments and institutions in facilitating trades. These are theories of rational, strategic agents, which explicitly model the underlying transactions of goods or financial

assets that generate the use of the payments system.<sup>1</sup>

What key questions does the existing economic literature address? First, researchers ask, What are the fundamental frictions (such as informational or legal imperfections impeding the functioning of markets) that underlie the use of payment and settlement arrangements? Given those frictions, how should payments systems be structured to mitigate their effects? What efficiency-enhancing roles should central banks play in the payments system? What is the optimal design for large-value payments systems that allow the transfer of large, time-sensitive payments between banks and other financial institutions?

## Fundamental Economic Frictions

The recent literature argues that *limited enforcement* and *limited information* are the two key microeconomic frictions that explain why particular payment arrangements are essential to an economy. Limited enforcement refers to a situation where some agents can default on their obligations at little or no cost. Limited information refers to a situation where some agents have limited or no knowledge about the current and/or past actions of other agents. To understand the consequences of these frictions,

1. In sharp contrast, the “practitioner-oriented” literature, based, for example, on payments-system simulators, takes the historical data on payment submissions as inputs, without modelling the behaviour of system participants. See Arjani (2005), Arjani and Engert (2007), and McVanel (2006) for examples of, and references for, this line of research. The academic literature also contains partial-equilibrium analyses that abstract from the underlying economic activities and focus on the interactions between participants within a payments system. Our literature survey also reviews this latter line of research.

it is useful to examine the reason for the circulation of a commonly used payment instrument—paper money.

Why would a seller be willing to give up valuable goods or services in exchange for an intrinsically worthless piece of paper that does not yield direct consumption or production value? In an ideal world with perfect enforcement and information, all trades could be facilitated by credit arrangements based on trust and reputation, and outside money would have no role. In the absence of enforcement and perfect information, however, trust and reputation cannot be maintained, and the use of money as a payment instrument can facilitate trade and improve welfare. In particular, by offering money to a seller, buyers are able to signal that they have supplied goods or services to other agents in the past. At the same time, sellers are willing to accept money because they anticipate that they will be able to use this instrument in the future to communicate the same information. As an information instrument, money therefore serves as a reliable indicator of a buyer's trading history. Kocherlakota (1998) shows how money plays the role of *memory* in a world of otherwise anonymous buyers and sellers.

The frictions of limited information and enforcement also make periodic settlement of private liabilities essential.<sup>2</sup> The need for periodic settlement is not obvious, since it merely involves the transfer of settlement assets between participants, without actually improving social welfare. In an ideal world with perfect enforcement and information, default would not be a concern, and thus it would be efficient to allow agents to accumulate obligations over time, as long as settlement occurred at some time in the future. In this case, efficient arrangements would not involve periodic settlement other than a lifetime budget constraint. When there are informational and enforcement frictions, however, agents are able to, and may have incentives to, default on obligations. In this environment, periodic settlement helps to reduce the net gain from default by limiting the obligations an agent can accumulate over time. Koepl, Monnet, and Temzelides (2006) illustrate how periodic settlement with sufficiently high frequency can

induce agents to fulfill their payment obligations and improve economic efficiency.

## The Structure of Payments Systems

How should payments systems be structured to deal with these fundamental informational and enforcement frictions? Why do some banks use correspondent services provided by other banks, an arrangement that creates a tiered structure? Such structures are present in the payments systems (large-value as well as retail) of most industrialized countries.

In Canada, both the Large Value Transfer System (LVTS) and the Automated Clearing Settlement System (ACSS) exhibit a high degree of tiering. At the top of the hierarchy are settlement institutions (for example, a central bank) that provide settlement accounts to participants that connect directly to, and clear directly in, this “first-tier” network. Some of the participants that clear directly with the central bank act as settlement agents that operate a “second-tier” network. They provide settlement accounts to downstream institutions that clear and settle payments indirectly in the payments system.

Are there any economic explanations for this tiered structure? While the presence of economies of scale in the provision of payment and settlement services is one potential explanation, the fundamental frictions discussed above may also play a role. Kahn and Roberds (2002) argue that the tiered structure can be an optimal arrangement in an environment with limited enforcement and limited information. In the presence of these frictions, default of obligations is a concern, and some banks may be more likely to default than others. In this case, efficiency requires that either a central bank or private banks perform costly monitoring of risky banks. If private banks incur lower monitoring costs than the central bank, it is efficient for “low-risk” banks to undertake peer monitoring of “high-risk” banks. But since monitoring activity is not perfectly observable, incentives to monitor must be provided by making these low-risk banks bear the burden of defaults by high-risk banks. As a result, it is desirable to have a tiered structure of settlement in which low-risk, first-tier banks settle their transactions directly with the central bank, while high-risk, second-tier banks settle through reliable banks

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2. For example, credit card transactions settle monthly, while interbank transactions settle daily.

that act as their settlement agents and their monitors.<sup>3</sup>

## The Central Bank's Role in Payments Systems

Theory generally suggests that central banks may have a comparative advantage in two main payments system functions. The first is the management of the accounts that participants own and use to settle transactions. Central banks are suited to this role because of their trustworthiness and public policy mandate. The second is the supply of very short-term credit (e.g., intraday credit) to intermediaries to facilitate settlement, or to facilitate the resolution of settlement disruptions. In a world with limited enforcement and information, the provision of cheap central bank credit may distort private sector choices by inducing participants to take excessive risks and overuse central bank credit, leading to the so-called “moral hazard” problem. This potential moral hazard problem may provide a rationale for a certain degree of central bank oversight of the payments system.<sup>4</sup> To deal with this problem, central banks are increasingly requiring collateral for such credit.

## The Design of Large-Value Payments Systems

There is also a growing literature that examines the design of large-value payments systems with regard to settlement rules, pricing, credit policy, and risk control. At the core of these issues is how the system should trade off the cost of liquidity against the risk of settlement failure. For example, some of the theoretical work compares two extreme designs of payments systems: real-time gross settlement (RTGS) and (uncollateralized) deferred net settlement (DNS). In an RTGS system, funds are transferred between participants on a real-time and gross basis. In a

DNS system, funds are transferred with a delay, and gross payments are netted against each other, with only the net balances having to be settled. In general, the literature finds that the key trade-off between these two types of settlement systems is the cost of intraday liquidity and payment postponement associated with RTGS and the cost of potential default and contagion associated with DNS. Furthermore, this trade-off will depend on intraday credit policies and on other system policies, such as risk management and collateral requirements, that affect the cost and size of potential default. Therefore, the optimal design of settlement systems requires joint consideration of these policy instruments.

## Conclusions

The main lesson we have learned from the literature is that payment instruments and institutions emerge in the presence of fundamental informational and enforcement frictions. Therefore, the analysis of payments system policy should take these frictions into account in order to make robust and reliable predictions.<sup>5</sup> Moreover, the behaviour of system participants should not be taken as invariant to changes in policy, information technology, and other aspects of the environment. To study the full effects of policy, we need to better understand the underlying trading and banking activities that generate the use of payments systems.

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3. Another aspect of the tiered structure is the competition between clearing agents and indirect clearers in the retail market for payment services. See Lai, Chande, and O’Connor (2006) for a theoretical model of this issue.

4. Green and Todd (2001) argue that the rationale for more extensive provision of services by central banks will depend on whether or not there are economies of scope between such additional services and the central bank’s basic settlement account function.

5. For example, a policy-maker who intends to regulate the high degree of tiering in a particular payments system should consider the underlying imperfections in enforcement and information, as well as the potential monitoring function provided by this structure.

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# The Impact of Electronic Trading Platforms on the Brokered Interdealer Market for Government of Canada Benchmark Bonds

Natasha Khan

**T**his article summarizes the study by Khan (2007) that analyzed the impact of increased transparency in the market for Government of Canada bonds, following the introduction of electronic trading platforms.

Transparency in capital markets refers to the degree to which information about trading activity, both before a trade occurs (pre-trade) and after a trade occurs (post-trade), is publicly available. Pre-trade transparency refers to the visibility of the best price at which any incoming order can potentially be executed, while post-trade transparency refers to the public visibility of the recent trading history in terms of traded price or volume, or both.

## Competing Hypotheses

Intuitively, it seems that greater transparency should lead to increased sharing of information, which should result in higher efficiency and liquidity (Glosten 1999).<sup>1</sup> However, alternative theories suggest that a lack of transparency may lead to lower initial spreads<sup>2</sup> because dealers compete to get order flow and then use the information they acquire from the order flow to gain profits in subsequent rounds of trading. If information is inexpensive or easily available, dealers will not need to compete through prices to acquire it, resulting in higher spreads (Grossman and Stiglitz 1980; Bloomfield and O'Hara 1999).

1. Market liquidity refers to the ability to rapidly execute large trades without causing a significant movement in prices. See also Bauer (2004) for a detailed discussion of market efficiency.
2. Spread, the difference between buy and sell prices, is a commonly used measure of market liquidity. See D'Souza, Gaa, and Yang (2003) for a detailed analysis of liquidity in the Government of Canada bond market.

The existing literature suggests that the impact of greater transparency depends on the structure of a particular market.<sup>3</sup> For government securities, some degree of transparency seems to improve market liquidity, but there is a point beyond which additional transparency may impair liquidity. For example, if greater transparency forces market-makers to make their trades public before they have had time to unwind or hedge their inventory positions, it will increase the risk that the positions will be unwound at a loss. This higher risk will increase trading costs and decrease liquidity. This suggests a non-linear relationship between transparency and liquidity, implying that there is some optimal level of transparency and that full transparency may not be optimal.<sup>4</sup>

## Change in Transparency Regime

Analyzing the impact of transparency on market liquidity is challenging, because changes in transparency regimes are rare. In Canada, the introduction of three electronic trading platforms, also known as alternative trading systems (ATSs), in mid-2002, increased the level of pre-trade transparency primarily in the customer-to-dealer segment of fixed-income markets.<sup>5</sup> This created a natural experiment providing the opportunity to study the relationship between transparency and liquidity for Canadian government securities. Because of data limitations,

3. See Gravelle (2002) for a detailed discussion of the different dealership markets for government and equity securities. Also see Zorn (2004) for a discussion of the relationship between transparency, liquidity, and market structure.
4. See Casey and Lannoo (2005), FSA (2005 and 2006), and Zorn (2006) for an extensive discussion of the academic literature on market transparency.
5. The three electronic platforms are CanDeal, Collective Bid (CBID), and Bloomberg Bond Trader.

the study is restricted to examining the effect of the transparency change in the customer-to-dealer market on the liquidity in the interdealer market.

## Data and Methodology

This study uses the CanPX dataset for the period 25 February 2002 to 28 February 2003 for the 2-, 5-, 10-, and 30-year Government of Canada benchmark bonds. CanPX, launched in 1999, consolidates feeds from interdealer brokers (IDBs) on one screen and displays anonymous trade and quote data submitted by all participating dealers for actively traded government bonds.

The study uses an event-study methodology and analyzes the impact of increased transparency by comparing liquidity before and after the event. The event period in which the three ATs were introduced is defined as the three-month period, July, August, and September of 2002. The pre-event period is chosen as the four-month period from the beginning of March to the end of June 2002. To give the market time to adjust to the changed transparency regime and reach an equilibrium state, the post-event period is chosen as the five-month period from the beginning of October 2002 to the end of February 2003.

The impact of increased transparency on market liquidity is tested through a series of regressions, where the dependent variable is one of two measures of liquidity and the independent variables include the control measures of trade volume, volatility, and a dummy variable for the pre- and post-event periods. To eliminate the immediate impact of most macroeconomic news events and auctions, the regression analysis uses daily data limited to the 10:10 a.m. to 12:00 p.m. time period for each trading day in the sample.

The first measure of liquidity, the percentage quoted spread, is calculated as the difference between the quoted bid and ask prices divided by the quote midpoint. The second measure, the impact that a change in order flow has on price (the price-impact coefficient), is estimated by using Kyle's (1985) model and regressing log changes in bid/ask midpoint prices on order flow. Order flow contains directional information and affects prices and yields. For instance, a greater number of buyer-initiated trades,

compared with seller-initiated trades, would be expected to put upward pressure on prices. Order flow is measured in two ways: (i) the dollar value of buyer-initiated trades minus the dollar value of seller-initiated trades; and (ii) the number of buyer-initiated trades minus the number of seller-initiated trades.

Wider bid/ask spreads and higher price-impact coefficients imply reduced liquidity and indicate dealers' unwillingness to make markets during periods when prices may change sharply.

## Findings

Overall, this study finds little evidence that liquidity in the interdealer market for Government of Canada bonds was significantly changed by the introduction of the electronic systems. Bid/ask spreads are not significantly different in the pre- and post-transparency periods for the 2-, 5-, or 10-year benchmarks. The 30-year benchmark, however, is the exception, since there is some evidence of decreased bid/ask spreads for this bond in the months following the introduction of the electronic platforms. The price-impact coefficient, using dollar value as a measure of order flow, also decreased in the post-event period for the 30-year benchmark but is not statistically different for any of the other benchmarks.

Since it is difficult to control for factors that may be specific to a particular benchmark, it is possible that factors other than the changed transparency regime may have resulted in lower bid/ask spreads and the lower price-impact coefficient for the 30-year benchmark.

It is important to note that this study analyzes the impact of a change in the dealer-to-customer market on the interdealer market. There is some evidence that the two markets are linked, since dealers use the interdealer market to manage the inventories they acquire trading with customers. However, the test would have been stronger had it been possible to analyze the effect of the change in transparency in the dealer-to-customer market itself on the dealer-to-customer market. This may be driving the results for the 2-, 5-, and 10-year benchmarks in the study. However, there are no data known to us that would allow such an analysis for the Government of Canada bond market.

Finally, it should be noted that this study examines the impact of a change in pre-trade transparency brought about by market innovation, whereas the recent policy debates have been more focused on the effect of post-trade transparency mandated by regulation.<sup>6</sup>

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6. The Canadian Securities Administrators recently extended the current exemption for government securities from transparency requirements until 31 December 2011.



# Price Formation and Liquidity Provision in the Markets for European and Canadian Government Securities

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The trading and quoting decisions of financial market participants are affected by the organization or structure of a given market. In 1999, a “liquidity pact” was introduced on the dominant European interdealer trading platform for government bonds, also known as Mercato Telematico dei Titoli di Stato, or simply MTS.<sup>1</sup> Dealers that are registered to make markets in specific securities must provide certain minimum levels of liquidity. They must post buy and sell limit orders above a minimum size, within a maximum bid/offer spread, for a minimum number of hours each day. These quoting obligations do not exist in Canada. Another important institutional feature of a financial market is its degree of transparency; i.e., the amount of information on quotes and trades available to interested market participants. The MTS platform provides more information about quotes and trade activity than that provided in Canadian interdealer markets.

D'Souza, Lo, and Sapp (2007) examine whether differences in the structure of government bond markets in Europe and Canada affect how fundamental information is incorporated into prices—henceforth referred to as the price-discovery process. In particular, they examine whether markets are more efficient when quoting obligations are imposed on dealers in a transparent market.

## Theory

When securities are thought to be mispriced, participants with this private information will execute trades and post quotes in a manner that

maximizes profits. An optimal strategy will take into consideration the speed with which private information is disseminated in the market and, more generally, the structure of the market. Other market participants will update their information sets as they observe trades and/or changes in quotes.<sup>2</sup> Markets are strongly efficient if all public and private information is reflected in prices.<sup>3</sup>

While transparency will improve the informational efficiency of a market, liquidity may fall. In transparent markets, dealers will find it more difficult to manage their inventories and make profits at the same time.<sup>4</sup> The imposition of quoting requirements may also reduce an individual dealer's inventory risks.<sup>5</sup>

There are a number of variables that can be jointly examined to determine the efficiency of a market. If trades provide a signal to the market about the existence of private information, then order flow (defined as the difference between the number of buyer- and seller-initiated trades over a given period) will also be informative. Green (2004), Brandt and Kavajecz (2004), and Pasquariello and Vega (2006) have all shown that in fixed-income markets, order flow

1. The markets function as an electronic limit order book. Limit and market orders are posted and executed via a limit order book. A limit order is an order to buy or sell a certain amount of an asset at a specified price. Market buy and sell orders are executed immediately against the best limit orders in the market.

2. Kyle (1985) and Glosten and Milgrom (1985) illustrate how dealers revise their expectations when they observe trading in the market.

3. Bauer (2004) gives a precise definition of market efficiency.

4. Zorn (2004) discusses the issue of the appropriate level of transparency. There may be a trade-off between informational efficiency and dealer concerns that increased transparency may limit market-making profitability.

5. In a liquid financial market, participants can rapidly execute large transactions with only a small impact on prices. In an efficient market, asset prices reflect all fundamental information. These two dimensions are fundamentally interrelated and determine a market's overall quality.

captures the arrival of information and has a permanent impact on prices.

Depth and spreads are usually associated with measures of liquidity in the market. Relative depth is calculated as the difference between the quantity of a security available for purchase at the best bid quote in the market and the quantity available for sale at the best offer quote in the market. Spreads are the difference between the best offer and bid quotes.

Recent literature on market microstructure demonstrates that market participants may learn about new information by observing the relative supply of liquidity in the market. Bloomfield, O'Hara, and Saar (2005) illustrate how informed traders will strategically use both market orders and limit orders in a market with an electronic limit order book. Goettler, Parlour, and Rajan (2005) demonstrate how limit orders placed by informed traders reveal new information about the underlying value of an asset. Thus, relative depth and spreads, like order flow, may also convey information and have an impact on the price-discovery process.

## Institutional Structure

The large and unpredictable inventory shocks that dealers typically face in their trades with customers have led to the creation of interdealer bond markets to facilitate inventory management and risk sharing.

In Europe, the most liquid interdealer trading market for government securities is the pan-European Mercato Telematico dei Titoli di Stato.<sup>6</sup> In Canada, dealers can execute anonymous buy and sell orders through an interdealer broker (IDB). Dealers leave firm quotes with a broker, along with the minimum amount that they are willing to trade. The introduction of IDBs has significantly reduced the role of direct interdealer trading in recent years.

Transparency is an important institutional feature of a financial market. The MTS limit order book market is more transparent than Canadian markets. Dealing quotes are centralized, and

market participants observe the top five quotes on either side of the market, in addition to the last transacted price. In Canada, only the best quotes listed by each IDB are observable to the market.

## Methodology and Data

To characterize all aspects of the price-discovery process, the joint relationship between price changes, order flow, the relative depth on the bid and offer sides of the market, and spreads, is modelled across several European and Canadian markets for short-term government securities.

Following the approach of Hasbrouck (1991a, 1991b), D'Souza, Lo, and Sapp examine the efficiency of the markets for European and Canadian government bonds by calculating two statistics derived from the estimates of a vector-autoregression model. Impulse-response functions and variance decompositions of price changes provide a measure of how informative the order flow, spreads, and relative depth are in each market.

Impulse-response functions summarize the permanent impact on prices of a shock to each variable and reflect the private information contained in that variable. A variance decomposition of price changes isolates the relative contribution of each variable to variability. If markets are very efficient, order flow, relative depth, and spreads will be uninformative with respect to prices.

The MTS dataset includes all quotes and the associated quote amounts for each security, in addition to transaction prices and traded quantities. The analysis focuses on the largest markets for short-term government bonds over the period from 1 April 2003 to 31 December 2004.

The Canadian dataset was obtained from CanPX—a data service that consolidates and disseminates to subscribers anonymous trade and quote data submitted by Canada's fixed-income interdealer brokers. The best quotes across all the participating brokers are collected by CanPX. The analysis focuses on the 2-year Canadian bond, since the frequency of quotes and transactions is relatively small for Government of Canada 6- and 12-month bills in the IDB sphere. The CanPX dataset spans the period from 1 October 2003 to 31 October 2004.

6. European government bonds can be listed on a domestic MTS platform (such as MTS France) and/or the EuroMTS electronic trading system. Almost all trading in treasury bills and short-term treasury bonds occurs on the domestic MTS platforms.

## Findings

Order flow is found to be more informative in the Canadian market. This may reflect the fact that restrictions on quotes in European markets allow dealers to cheaply share their inventory risk through the immediate execution of market orders. Consequently, order flow in the European market will reflect both inventory management and private information.

In contrast to the European market, spreads are surprisingly informative in the Canadian market, and may reflect the absence of quoting restrictions and/or the use of the interdealer market to extract information about the underlying relative supply of liquidity in the market. Generally, spreads widen to reflect a fall in liquidity or a risk that private information may exist in the market. Relative depth explains only a limited amount of the variability in prices in either marketplace.

## Conclusion

Adjusting market structures to improve market efficiency can be important to a country's overall economic well-being. Liquid and efficient markets for government securities support optimal savings and investment decisions. They also perform a number of key roles. For example, given their virtually default-free nature, government securities are used as benchmarks for the pricing and hedging of other fixed-income securities.

The results of this study would tend to suggest that market structure is important in the price-discovery process. Findings indicate that in each market examined, private information is incorporated into prices within a couple of hours. According to some measures, however, several markets for short-term European government securities appear to be relatively more efficient than Canadian markets.

There are a number of caveats related to the interpretation of these results. The study has not controlled for either the greater number of market-makers and higher turnover in the MTS fixed-income markets than in Canadian IDB

markets. These attributes could potentially explain differences in the efficiency of European and Canadian markets for government bonds. Finally, the metric used here to measure efficiency does not necessarily take into account the possibility that dealers use the Canadian IDB market for information extraction. This work is left for future research.

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