Research Summaries

Introduction

Bank 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

Stress 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).[1] 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.[2] 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,

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

where π^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.[3]

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

π_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

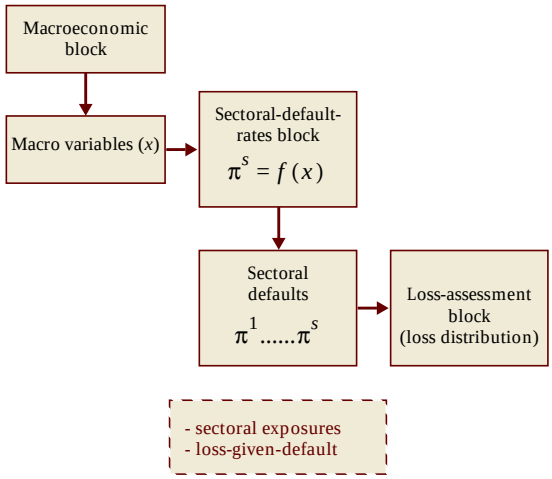
l_t^s is loss-given-default (LGD) in industry *s* at time *t*.

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.[4]

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.[5]

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Virolainen, K. 2004. "Macro Stress Testing with a Macroeconomic Credit Risk Model for Finland." Bank of Finland Discussion Paper No. 18/2004.

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.[1]

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.[2] 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. Koeppl, 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

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

that act as their settlement agents and their monitors.[3]

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.[4] 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.[5] 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

This 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).[1] However, alternative theories suggest that a lack of transparency may lead to lower initial spreads[2] 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).

The existing literature suggests that the impact of greater transparency depends on the structure of a particular market.[3] 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.[4]

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.[5] This created a natural experiment providing the opportunity to study the relationship between transparency and liquidity for Canadian government securities. Because of data limitations,

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.
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 ATSs 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.[6]

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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

Chris D'Souza, Ingrid Lo, and Stephen Sapp

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.[1] 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.[2] Markets are strongly efficient if all public and private information is reflected in prices.[3]

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.[4] The imposition of quoting requirements may also reduce an individual dealer's inventory risks.[5]

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.[6] 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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