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). Other important linkages may include those between the Canadian financial system and the rest of the economy, as well as those with the international environment, including the international financial system. This section summarizes some of the Bank's recent work.*

Governance and Financial Fragility examines, from a general cross-country perspective, the channels through which governance (broadly defined as the rules and institutions that govern economic activity) affects the stability of the financial system. There is a growing body of evidence that weak governance can contribute to periods of volatile financial activity and, in extreme cases, to a financial crisis. Specific aspects of governance that are most likely to contribute to the robustness of the financial system are identified.

Income trusts have experienced rapid growth as an investment vehicle for Canadians over the past several years. In *Income Trusts: Understanding the Issues*, the structure of this market is described, including factors that affect the valuation of income trusts.

The third article, *Valuation of Canadian- versus U.S.-Listed Equities: Is There a Discount?* examines to what extent the equity of firms listed on Canadian markets trades at a discount relative to that of comparable firms listed on U.S. markets. Although the authors present evidence indicating that there is indeed a discount, they conclude that further research will be required to fully understand its sources.

The Large Value Transfer System is one of Canada's key clearing and settlement systems. To support their payments activity in the LVTS, participants are required to pledge collateral. In *Excess Collateral in the LVTS: How Much Is Too Much?* the authors develop an approach to help determine whether the collateral held in the LVTS is consistent with a simple cost-minimization model. The results suggest that, in aggregate, this generally appears to be the case.

Governance and Financial Fragility

*Michael Francis**

After a period of financial turbulence during the last half of the 19th and the early 20th centuries, the world experienced relative stability. This was a period in which global financial markets were heavily regulated and controlled. As Allen and Gale (forthcoming) point out, reliance on such severe intervention came at the cost of economic efficiency. The subsequent period of financial deregulation, while contributing to efficiency gains, has also revealed weaknesses in many financial markets and has coincided with a period of financial instability around the globe. Authorities are consequently searching for the sources of financial fragility, in the hope of eliminating the costs associated with financial crisis without the burden of excessive regulation.[1]

This note examines the relationship between governance (the rules and institutions that govern economic activity) and financial fragility (a situation in which the willingness of creditors to finance investment opportunities is highly sensitive to shocks). Drawing upon evidence from the literature and new empirical research, the focus is on domestic financial markets. It is argued that governance can play an important role in improving the stability of financial systems by mitigating unnecessary fluctuations

in investment financing and reducing the likelihood of a systemic banking crisis.[2]

Note that the definition of governance used here is much broader than that of corporate governance alone. It is intended to capture the wider set of arrangements (i.e., rules and institutions) that support economic and financial activity.

Governing Financial Relationships

Governance is increasingly cited as playing an important role in determining economic outcomes.[3] The reason is simple. In addition to relative prices, it is the system of governance that determines the set of incentives facing economic agents. While the price mechanism alone could be expected to guide agents to a good economic outcome if property rights were well defined and respected, these criteria may not be satisfied in many markets. This is especially true for financial markets where there are extreme asymmetric information problems between the borrower and creditor.

From a creditor's viewpoint, the lack of credible information about the behaviour of borrowers and their intentions to repay can lead to a situation in which a creditor may have no basis for believing that a borrower is committed to repaying. In such circumstances, creditors may be unwilling to supply credit to borrowers. To overcome problems like this, societies tend to develop rules and institutions that, among other things, act to align the incentives for

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1. That financial crises can have enormous costs is well documented. For example, Honohan (1997) estimates that just the public sector costs of resolving banking crises in developing countries between 1980 and 1995 amounted to US$250 billion. Other private economic costs include foregone investment and social costs.

* This note draws on a recently published Bank of Canada working paper (Francis 2003).

2. This note is concerned with financial fragility. Although financial fragility is a widely used term, it is used here to describe the vulnerability of the banking system to a crisis (as in Mishkin 1997) and the magnitude of accelerator effects as described by Bernanke and Gertler (1989).

3. See, for example, IMF (2003).

borrowers so that they are committed to repaying creditors. Without a well-developed set of rules and institutions, financial development in an economy is likely to be poor.

Clearly, governance mechanisms, ranging from the absence of corruption through to specific laws such as those covering bankruptcy, can play an important role in fostering an environment where borrowers will commit themselves to repaying creditors (La Porta et al. 1998). However, governance mechanisms such as these have the complication of linking the provision of credit to the borrowers' commitment to repay rather than to the returns on investment.[4] Consequently, the value of a firm's assets and the quality of governance are important features of the financing decisions that firms take, and, thereby, are important for determining the aggregate level of credit provision and investment. Not surprisingly, one might also expect the quality of governance to affect the degree of financial stability.

Financial Fragility

The view that governance is important for financial stability makes sense when it is acknowledged that if the quality of governance is poor, then the collateral value of assets determines the availability of financing for working capital and investment. In such a situation, because the value of a firm's assets may depend on the expected level of investment, a shock that reduces the willingness of lenders to extend credit can lead to a vicious circle in which the reduction in investment produces a fall in asset values resulting in a further reduction in the supply of credit and investment.[5] If the view that governance is an important factor in determining the magnitude of these "accelerator effects" is correct, then it follows that both financial systems and the level of investment are less stable in countries with

relatively weak governance than in those with relatively effective governance.
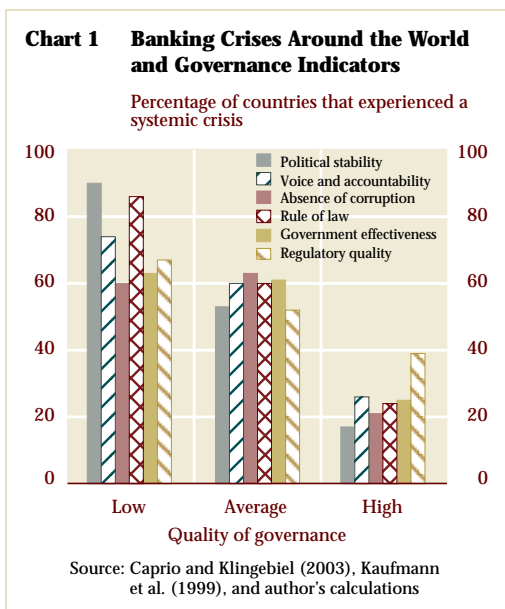
Evidence

Financial fragility is difficult to quantify. At one level, it can be considered as the likelihood of a systemic failure in the financial system, while at a less dramatic level, it can be considered as the sensitivity of the financial system to relatively small shocks. With the first measure, the most obvious indicator of financial fragility is a systemic banking crisis. The most recent research on this topic suggests that pecuniary externalities (e.g., the collapse in market asset prices triggered by the failure of a borrower) are a fundamental part of the story behind systemic banking crises (Allen and Gale 2003). These externalities, and the associated accelerator effect, provide the mechanism through which a small shock involving one bank can lead to a sharp drop in asset values and, ultimately, to a systemic collapse. More generally, however, other measures, such as investment volatility, may also provide quantifiable measures of the size of these accelerator effects and therefore the extent of financial fragility. In either case, by reducing the magnitude of accelerator effects, good governance can be expected to mitigate financial fragility.

Chart 1 supports this view. The graph indicates that a significantly higher proportion of countries with poor governance experienced a banking crisis during the 1984–2001 period when compared with those countries having a higher quality of governance—a finding that holds across a wide range of governance indicators.[6] For example, 86 per cent of countries, where respect for the rule of law was ranked as low, experienced banking crises during the period, whereas only 24 per cent of countries experienced a crisis if respect for the rule of law was regarded as high. Interestingly, the relationship is true not only for those measures that are likely to be closely linked with protection of property rights, but also for other measures, ranging from the absence of corruption through to the quality of public service (government effectiveness) and the accountability of the government to the people.

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4. It should be noted that the credibility of the borrower's commitment to repay is conceptually different from the intrinsic risk associated with the investment project. The former is at the heart of the moral hazard problem and can be mitigated (at least partially) by appropriate governance, while governance can do nothing about the latter.

5. For a theoretical development of accelerator effects in financial markets, see Bernanke and Gertler (1989) and Kiyotaki and Moore (1997) among others.

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6. The dataset consists of 90 developing and industrialized countries of which 47 experienced at least one crisis between 1984 and 2001.

Chart 1   Banking Crises Around the World and Governance Indicators

Percentage of countries that experienced a systemic crisis

Source: Caprio and Klingebiel (2003), Kaufmann et al. (1999), and author's calculations

Similarly, indicators of the quality of governance perform well in explaining the volatility of investment.[7] Using country-specific measures of investment volatility for a wide range of industrialized and developing countries over the period 1980 to 2000, one finds that countries with poor governance generally experience more volatility in investment than those with good governance. The results hold for a wide range of governance indicators and are consistent with the findings for the banking crises described above. These results suggest that, as discussed previously, governance has a role to play in reducing the size of accelerator effects.

Conclusion

The findings presented here suggest that financial fragility can arise, in part, when there is a lack of appropriate governance to support a well-developed financial sector. While it is easy to understand that governance can affect economic outcomes, it is more difficult to determine which forms of governance promote financial stability. Nevertheless, the findings here, and those of the International Monetary Fund (2003), suggest the following criteria. First, institutions that protect property rights and promote law and order are important. Second, appropriate regulations, an effective bureaucracy, and a stable government are all associated with less fragility, suggesting that the quality of public service and good public sector management can play an important role in promoting economic stability. Third, to the extent that many of these institutions involve rules and constraints on individual behaviour (substituting authority for the market), it is not surprising that institutions that reduce corruption (the use of the market to circumvent authority) are also important for ensuring that financial markets are well functioning and stable. Fourth,

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7.   The volatility that this note is concerned with is not that which arises from adjustments to shocks, such as technological change, or from changes in relative prices. In a well-functioning economy, this type of volatility is a necessary and important element in the efficient allocation of resources. However, the accelerator effects described here are a source of volatility that arises because of market failures associated with problems such as asymmetric information in financial markets. Good governance can mitigate these problems and lead to a reduction in economic volatility and an improvement in economic efficiency.

it is perhaps not surprising that, given the important role that governments play in regulating and participating in financial markets, mechanisms that increase government accountability play an important role in creating a stable financial system.

From a policy perspective, the findings presented here suggest that financial stability around the world could be improved through continued attention to improving the institutional infrastructure within which domestic financial systems operate.

References

Allen, F. and D. Gale. 2003. "Financial Fragility, Liquidity and Asset Prices." Working Paper No. 01-37-B, Wharton Financial Institutions Center, University of Pennsylvania.

———. Forthcoming. *Understanding Financial Crises.* Chapter One. Oxford University Press.

Bernanke, B. and M. Gertler. 1989. "Agency Costs, Net Worth, and Business Fluctuations." *American Economic Review* 79: 14–31.

Caprio, G. and D. Klingebiel. 2003. "Episodes of Systemic and Borderline Financial Crises." World Bank Research Dataset.

Francis, M. 2003. "Governance and Financial Fragility: Evidence from a Cross-Section of Countries." Bank of Canada Working Paper No. 2003-34.

Honohan, P. 1997. "Banking System Failures in Developing and Transition Countries: Diagnosis and Prediction." Bank for International Settlements Working Paper No. 39.

International Monetary Fund. 2003. "Growth and Institutions." *IMF World Economic Outlook* (April): 95–128.

Kaufmann, D., A. Kraay, and P. Zoido-Lobatón. 1999. "Governance Matters." Policy Research Working Paper 2196. The World Bank Institute.

Kiyotaki, N. and J. Moore. 1997. "Credit Cycles." *The Journal of Political Economy* 105: 211–48.

La Porta, R., F. Lopez de Silanes, A. Shleifer, and R.W. Vishny. 1998. "Law and Finance." *The Journal of Political Economy* 106: 1113–55.

Mishkin, F. 1997. "The Causes and Propagation of Financial Instability: Lessons for Policy Makers." In *Maintaining Financial Stability in a Global Economy.* Proceedings of a Symposium sponsored by the Federal Reserve Bank of Kansas City, Jackson Hole, Wyoming.

Income Trusts: Understanding the Issues

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An income trust is an investment vehicle that distributes cash generated by a set of operating assets in a tax-efficient manner. The sharp rise of income-trust valuations, the large supply of new issues, and the complexity of their legal structure have led to increased scrutiny of this asset class. To explore whether the cash returns from income trusts are in line with the risks, the structure of a typical income trust is compared with that of a typical corporate entity. The legal, regulatory, and governance issues introduced by these differences are then raised. Finally, business and market-related issues are discussed.

Structure and Valuation

An income trust is a special-purpose entity that sells equity to the public in the form of units and uses the proceeds to purchase an operating company that holds a set of income-generating assets. Legally, income trusts are a subset of the broader category of "mutual fund trusts" within the meaning of the Income Tax Act (Canada). The term "income trust" may be used broadly to cover a variety of businesses and models, or narrowly to refer to a segment of this asset class. Here, it refers to royalty trusts, real estate investment trusts, and trusts based on various businesses (also called hybrid trusts or business-income trusts).

As an asset class, income trusts have experienced phenomenal growth over the past two years. Income trusts had a total market capitalization of $45 billion at the end of 2002 and represented about 6 per cent of the stock market capitalization of the Toronto Stock Exchange. This total represents a dramatic rate of growth when compared with the $29.5 billion of total market capitalization at year-end 2001 and $2 billion at

year-end 1994. The exceptional growth of this asset class has been driven by appreciation in the value of outstanding income trusts, the issuance of units through initial public offerings, and the subsequent sale of additional units by existing income trusts.

An income trust is designed to maximize the cash distributions from a set of revenue-generating assets, with these distributions typically paid to unitholders on a monthly basis. The cash distributions from an income trust are maximized by minimizing or eliminating the corporate tax paid by the operating company that holds these assets. In other words, an income trust is a "flow-through" vehicle that allows income to flow through it and be taxed at the investor level.

The valuation of an income trust is similar to the valuation of any other equity security. Investors discount the future stream of cash flows that are expected to accrue to unitholders using a discount rate that reflects the uncertainty of the business and the capital structure. Three steps are fundamental to the valuation of an income trust: an analysis of the distributable cash, an understanding of the capital structure, and a comparison of one income trust with others in the same industry sector or business. To get an accurate picture of risks and returns, existing income trusts must be valued relative to others in the same industry, using multiples of cash flow that take into account the leverage in the capital structure, the uncertainty of the business, and the tax treatment of different types of distributions.

Firms and investors have benefited from the development of income trusts. Firms have been able to realize significant gains on the sale of assets through this market. They have therefore been able to raise significant amounts of capital by selling off mature assets and either returning the proceeds to shareholders or investing them

in potentially more profitable growth opportunities. This avenue of raising capital has particularly benefited small firms or firms that did not have access to Canadian equity markets on attractive terms. For their part, investors have earned high cash returns from income trusts over the past few years—a period when Canadian stock markets suffered significant losses, and interest rates declined to historically low levels. Higher cash payouts reduce the need to monitor management, because investors make the decision on how to reinvest the earnings rather than leaving these funds in the hands of management.

Issues Raised by Income Trusts

Investors should consider several issues when valuing an income trust. These issues can be classified into four broad categories—legal and regulatory issues, corporate governance issues, operational issues, and market issues.

Legal and regulatory issues include the potential personal liability of unitholders, the possibility of a change in tax treatment, and the treatment of unitholders in the event of bankruptcy. The issue of unitholder liability is being addressed in some provinces. For example, the Ontario government has introduced legislation that would limit the liability of Ontario-based unitholders under the Trust Beneficiaries' Liability Act 2003 (Government of Ontario 2003).[1] Hayward (2002) addresses the tax implications of this asset class.

While they resemble corporate entities, income trusts fall under a different code of law with different requirements for corporate governance. Unitholders in an income trust are represented by a trustee, whose responsibilities are laid out in a trust indenture. The assets owned by the income trust may be managed by full-time internal managers similar to a corporation, but this task may also be contracted to a management company under a management agreement. Investors need to scrutinize these documents in order to understand the staffing of these positions, the incentives for the trustee and managers, their compensation arrangements, and the level of disclosure required for factors such as

potential conflicts of interest. Unitholders should also be aware that their legal rights are more limited than those of shareholders in a corporate entity.

Operational issues relate to the subordination of the unitholder's claim on the operating assets to secured bank loans or other debts, the sustainability of expected cash flows from these assets, and the degree of leverage in the operating company's capital structure. Not every business model is viable as an income trust. For example, this structure is suited to businesses that generate a steady stream of cash distributions and require minimal capital expenditure to maintain the productivity of the assets. Given the proliferation of income trusts in various business sectors, investors need to question the key assumptions regarding cash distributions to ensure that these distributions are sustainable in the long run.

Finally, market issues involve the sensitivity of income-trust valuations to changes in the level of interest rates, the level of risk premiums, and secondary market liquidity. While market conditions have been favourable for income trusts over the past two years, the change in the external environment in the fourth quarter of 2002 led to a decline in their valuation. In 2003, the wide variation in the performance of different income trusts reflects a greater differentiation by investors concerning their future prospects.

These investment issues led Standard & Poor's to introduce a new product in 1999 called stability ratings. These ratings are intended to reflect the "sustainability and variability in distributable cash flow generation in the medium to long term" (Standard & Poor's 2002). A stability rating is voluntary, and income trusts must pay Standard & Poor's to receive one. As of year-end 2002, only 25 Canadian income trusts had been rated.

Conclusion

A better understanding of the issues raised by income trusts will allow investors to seek the appropriate return for a given level of risk. The mixed performance of this asset class over 2003 suggests that income trusts are evolving and have reached a new phase of consolidation with slower growth expected in the future.

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1. Passage of this legislation was delayed by the Ontario election.

References

Government of Ontario. 2003. "The Right Choices Act (Budget Measures), 2003." March. Photocopy. Available at <http://www.gov.on.ca/FIN/english/media/2003/bke-budbill.htm>.

Hayward, P. 2002. "Income Trusts: A 'Tax-Efficient' Product or the Product of Tax Inefficiency?" *Canadian Tax Journal* 50: 1529–69.

King, M. 2003. "Income Trusts—Understanding the Issues." Bank of Canada Working Paper No. 2003-25.

Standard & Poor's. 2002. "Canadian Stability Ratings: Methodological Framework." 26 September.

Valuation of Canadian- versus U.S.-Listed Equities: Is There a Discount?

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T here is a perception that the equity of Canadian-listed firms trades at a discount relative to the equity of comparable firms listed on exchanges in the United States. If there are systematic differences in valuation between Canadian and U.S. equity markets, Foerster and Karolyi (1999) argue that firms will have an incentive to adopt financing strategies to reduce any negative effects. Such decisions by individual firms could affect the overall depth and liquidity of a country's financial markets, as well as the future viability of those markets.

Our study tests this hypothesis by examining the valuation ratios assigned to the equity of firms listed in these two markets. We find that Canadian-listed firms traded at a discount to U.S.-listed firms over the 1991–2000 period, based on a range of valuation measures. This discount exists even though the median Canadian-listed firm has, on average, a lower cost of equity and higher profitability over the past decade than its U.S.-listed peers. Based on a comparison of Canadian interlisted firms that report under both Canadian and U.S. GAAP, our study rejects accounting differences between Canada and the United States as the source of this discount.

The study focuses on book-to-market and earnings-to-price ratios, and finds that, in line with financial theory, part of the discount is explained by company-specific factors, such as size, industry membership, cost of equity, and profitability. Valuation is also affected by the characteristics of the market where the share is listed. A country discount persists after controlling for company-specific and market-specific factors. This finding is consistent with previous research, which suggests that Canadian and U.S.

financial markets remain segmented (Doukas and Switzer 2000; Jorion and Schwartz 1986).

Methodology

The analysis uses annual company accounts data and monthly pricing data on Canadian- and U.S.-listed firms for the period 1990 to 2000. Data were provided by Standard & Poor's Compustat and the Canadian Financial Markets Research Centre. The sample consists of close to 10,000 firms, of which about 7 per cent are Canadian-listed firms and the remainder are U.S.-listed firms. Cross-listed Canadian firms were dropped from the sample in order to focus on country-specific effects.

Factors Affecting Valuation

Differences in valuation for the equity of any given company relative to that of its peers may be explained by company-specific, market-specific, and country-specific factors. Company-specific factors include company size, industry, cost of equity, profitability, the dividend policy of a firm, and secondary-market liquidity. Market-specific variables capture differences in the features of the equity markets that affect all firms listed and traded on a given stock exchange, such as the relative performance of the overall stock market. Finally, country-specific factors capture those institutional features of the financial markets that affect all firms listed and traded within a given jurisdiction, such as the accounting systems used to prepare financial statements.

Evidence of a Country Discount

To test for the existence of significant differences in the valuation of Canadian- and U.S.-listed equities, we compare the valuation of firms

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listed either exclusively in Canada or in the United States and exclude interlisted firms. Each Canadian firm is matched with comparable U.S.-listed firms based on industry sector and the Canadian firm's size. The valuation of the Canadian-listed firm is then compared with the median of its U.S.-listed counterparts based on four valuation ratios. The valuation ratios are: book-to-market, earnings-to-price, free cash flow-to-enterprise value, and earnings before interest, taxes, depreciation, and amortization (EBITDA)-to-enterprise value.

On average, the median Canadian-listed firm traded at a discount to comparable U.S.-listed firms across a range of valuation measures, despite the fact that the average Canadian-listed firm was more profitable. The differences between Canadian-listed firms and their U.S. counterparts are both statistically significant and economically important. For example, the average Canadian firm traded at a multiple of book value that was 8 per cent lower than its U.S.-listed peers, despite having a return on equity that was higher by 1.5 per cent. Canadian-listed firms had a cost of equity that was higher from 1991 to 1995 by as much as 2 per cent, but they enjoyed a lower cost of equity from 1996 onwards.

The Effect of Accounting

Differences in cross-border valuation may result from differences between Canadian and U.S. generally accepted accounting principles (GAAP). This hypothesis is tested by considering the valuation of roughly 160 Canadian firms that interlist on a U.S. exchange. These firms provide financial results under Canadian GAAP, as well as a reconciliation of financial accounts under U.S. GAAP. The valuation and profitability ratios are calculated for each cross-listed Canadian company using both sets of results. The comparison shows that Canadian and U.S. GAAP are close substitutes, consistent with previous research (Bandyopadhyay, Hilton, and Richardson 2002). There is no statistical difference in return on equity, return on assets, or earnings-to-price between Canadian listings and U.S. listings. The differences in the other valuation measures based on Canadian versus U.S. GAAP were either not economically important or showed no consistent pattern. This comparison suggests that accounting differences do

not explain the discount of Canadian-listed firms against their U.S.-listed peers.

The Effect of Market-Specific Factors

Differences in the valuation of Canadian- and U.S.-listed firms may be due to the impact of market-specific factors, such as the characteristics or performance of the stock exchange where a share is listed. This hypothesis is examined using a series of multivariate regressions. The dependent variable for these regressions is book-to-market in one specification and earnings-to-price in a second specification. Each regression includes company-specific variables that have been shown to affect valuation; namely, company size, industry sector, profitability, cost of equity, and earnings retention rate. The inclusion of these variables controls for their impact so that the contribution of market-specific factors can be measured.

Two market-specific variables are included in each regression. The impact of a company's shares having greater liquidity is controlled by including a measure of share turnover. Differences in the risk-adjusted equity returns between Canada and the United States are controlled by including a variable that captures any premium valuation of U.S.-listed firms that may be due to "irrational exuberance." This variable measures the risk-adjusted excess return of each stock market, using a Sharpe ratio. The objective of this specification is to see if a country dummy included in the regression has any incremental power for explaining a firm's valuation. The company-specific and market-specific variables are significant with the correct sign. More importantly, the country dummy is also significant, despite the presence of these other variables, and confirms that Canadian-listed firms trade at a discount to their U.S.-listed peers.

Conclusion

This study finds that Canadian-listed firms are not valued as highly as their U.S.-listed peers, based on comparisons across a series of valuation measures. Variables such as cost of equity, secondary market liquidity, and the risk-adjusted return of the overall stock market did explain part of the discount, but when these factors

were controlled for, Canadian-listed firms still exhibited a systematic discount.

These results confirm earlier studies suggesting that Canadian and U.S. equity markets are not perfectly integrated as theory would suggest. Investors do not view Canadian- and U.S.-listed equities as perfect substitutes but assign a risk premium to Canadian listings. The existence of systematic differences in valuation creates incentives for Canadian firms to access U.S. equity markets. Given the findings of this paper, more research is needed to identify the sources of this market segmentation.

References

Bandyopadhyay, S., A. Hilton, and G. Richardson. 2002. "A Re-Examination of Reconciling Items between Canadian and United States GAAP." *Managerial Finance* 28: 37–56.

Doukas, J. and L. Switzer. 2000. "Common Stock Returns and International Listing Announcements: Conditional Tests of the Mild Segmentation Hypothesis." *Journal of Banking and Finance* 24: 471–502.

Foerster, S. and G. Karolyi. 1999. "The Effects of Market Segmentation and Investor Recognition on Asset Prices: Evidence from Foreign Stocks Listing in the United States." *Journal of Finance* 54: 981–1013.

Jorion, P. and E. Schwartz. 1986. "Integration vs. Segmentation in the Canadian Stock Market." *Journal of Finance* 41: 603–14.

King, M. and D. Segal. 2003. "Valuation of Canadian- vs. U.S.-Listed Equity: Is There a Discount?" Bank of Canada Working Paper No. 2003–6.

Excess Collateral in the LVTS: How Much Is Too Much?

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Canada's Large Value Transfer System (LVTS) is the payment system used to make large-value or time-sensitive payments, on a final and irrevocable basis. Thirteen financial institutions (and the Bank of Canada) are direct LVTS participants. The LVTS requires these participants to pledge to the Bank of Canada enough collateral to cover the default of the participant with the single largest net debit position. In the extremely remote event of multiple defaults and insufficient collateral, the Bank of Canada guarantees that the LVTS will settle. Sufficient collateral thus facilitates the safe and continuous flow of payments throughout the day and ensures that the LVTS can complete settlement at the end of the day.[1]

Payments sent through the LVTS and received by each participant can vary significantly from day to day, hour to hour, and even minute to minute. Although participants know in advance many of the payments they will receive and send, they cannot always synchronize these flows. They may have to make large payments before receiving incoming funds. From time to time, they can be faced with making unexpectedly large payments. By holding a buffer of collateral for LVTS purposes, participants can accommodate all of these factors without impeding the timely delivery of payments. A participant with sufficient collateral can also meet its clients' payment needs on a more timely basis, compared with a participant with significantly less collateral. The first participant can therefore provide a higher level of service to its clients.

If an LVTS participant does not minimize the costs associated with holding and managing collateral for LVTS purposes, excessive costs could be passed on to its clients, who could end up paying more for sending LVTS payments than would be optimal. In such a case, clients of this financial institution may be deterred from sending payments via the LVTS. They may instead choose payment systems that are not as well protected against risk. Alternatively, they may choose another financial service provider.

If participants do not hold sufficient collateral for LVTS purposes, one would expect to see an excessive number of occasions when large-value, time-sensitive, or systemically important payments are delayed because of insufficient collateral. This would disrupt payment systems and could inconvenience the clients of LVTS participants.

It is therefore interesting to consider the amount of collateral pledged to the LVTS. To examine this issue, we build a theoretical model that generates the demand for collateral by LVTS participants under the assumption that they minimize the cost of holding and managing collateral for LVTS purposes. Our fairly simple model predicts that the optimal amount of collateral held by each LVTS participant for this purpose depends on the opportunity cost of collateral, the cost of transferring collateral in and out of the LVTS, and the distribution of an LVTS participant's payment flows in the system. We compare the predictions of our model with actual levels of collateral held in the LVTS.[2] We also estimate regressions using panel data to determine how collateral varies in response to changes in factors affecting the demand for collateral.

A Brief Description of the LVTS

In the first five months of 2003, an average of about 16,000 payments totalling about $125 billion flowed through the LVTS each day. The LVTS has two payment streams: Tranche 1 (T1) and Tranche 2 (T2). T2 payments account for 98 per cent of payment volumes and about $110 billion per day. T1 payments account for 2 per cent of volumes and about $15 billion in value.

T2 is supported largely by intraday credit. It uses collateral so efficiently that about $110 billion in payments can be supported by only a few billion dollars of collateral. Participants' collateral requirements for T2 payments change little from one day to another. Hence, there is little need for participants to hold a large buffer of collateral for LVTS purposes to accommodate changes in T2 collateral requirements. We therefore focus on T1 payment flows.

T1 payments must be financed, dollar for dollar, by T1 funds already received or by collateral. It is therefore much more expensive in terms of collateral for participants to send T1 payments than T2 payments. T1 payments tend to be reserved for situations in which insufficient credit is available for a payment to pass through T2 risk controls.[3]

T1 payments averaged $15 billion per day in the first five months of 2003. Of these, about $7 billion were sent by financial institutions, and the remainder were sent by the Bank of Canada. T1 payments sent by the Bank are not collateralized, and so are not considered here.

We use data from February 1999 (when the LVTS began operations) up to May 2003. Over this period, daily T1 payments sent by financial institutions averaged $5.7 billion.

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3. For example, most payments made to the Bank of Canada to support participants' operations in Canada's securities settlement system, CDSX, or in the foreign exchange settlement system, the CLS Bank, rely on T1. For more on these systems, see Box 6 on page 29 of this *Review.*

# A Model of the Demand for Collateral in the LVTS

The daily management of collateral by LVTS participants involves making sure that the collateral required to support T1 payments will be available promptly. For LVTS participants, having sufficient collateral for LVTS purposes is analogous to managing an inventory to meet demand. For collateral to be managed efficiently it must be managed at minimum cost. The model used is a simple precautionary demand for collateral.

We assume that participants know the probability distribution of their T1 payments, but do not know their value until the beginning of each day. The distribution of payments is highly skewed—on many days payments are relatively small, and on a few days payments are extremely large.

Participants base the collateral that they pledge to the LVTS on three factors. Each participant chooses an optimal "normal" level of collateral to hold in the LVTS. One dollar of normal collateral has an opportunity cost (defined as i) of 5 basis points. Once payments are known, if normal collateral is insufficient to meet the day's payments, the participant will bring additional collateral into the system. Collateral is then returned to its normal level at the end of the day. The fixed cost of increasing collateral (and of subsequently returning it to its normal level) (defined as a) is $80. The interest foregone when collateral must be added to the LVTS (defined as j) is 43 basis points times the value of the additional collateral. We assume that participants face a higher cost of collateral if that collateral is obtained at short notice. The benchmark values 5 basis points, 43 basis points, and $80 are based on anecdotal evidence but, in practice, may differ considerably among LVTS participants.

To minimize the expected total cost of collateral, participants balance the additional cost of holding a higher normal level of collateral for LVTS purposes against the reduction in transactions cost and the reduced need to acquire extra collateral at premium prices (when payments are large). This determines the optimal level of normal collateral.

Chart 1   Determination of Optimal Normal Collateral
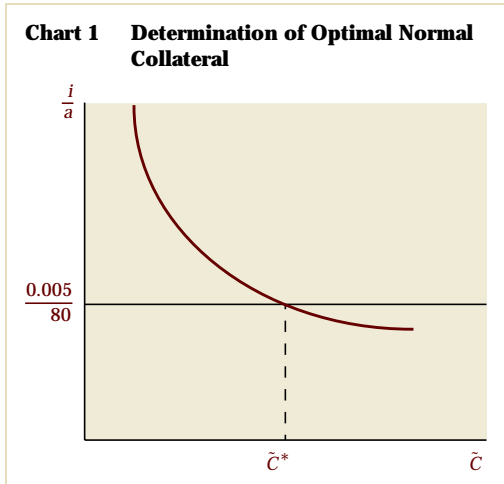
The equilibrium relationship is shown in Chart 1.

The horizontal line is the cost of normal collateral, *i*, divided by the transactions cost, *a*. The curve is a function of the shape of the payments distribution, the transactions cost, and the spread between the cost of normal collateral and the higher cost of obtaining collateral at short notice.

The point at which these lines intersect defines the optimal level of normal collateral, $\tilde{C}^*$. This point is calculated for each LVTS participant, and these values are used to compute the average optimal level of collateral, which is then compared with the actual average level of collateral. Aggregate results for the system can be found by summing across all 13 LVTS participants. Using our benchmark values for the opportunity costs and transactions costs, we found that the actual level of collateral was considerably higher than that predicted by our model. One participant, however, appeared to have a lower cost of collateral, and when this participant was excluded from the analysis, predicted collateral was within 5 per cent of actual.

To gauge the sensitivity of our results to the benchmark values chosen for transactions and opportunity costs, we experimented with different values for these parameters. We found that halving the transactions cost, from $80 to $40, had little effect on the optimal normal level of collateral. A 5-basis-point increase in both the opportunity cost of normal collateral and the price paid for collateral obtained at short notice caused the optimal normal level of collateral to fall by about 20 per cent.[4]

Empirical Analysis Using Panel Data Regressions

We estimate a regression using panel data to explain the amount of collateral pledged to the LVTS. The variables used to explain collateral demand are T1 payments, the variance of T1 payments, the skewness of T1 payments, and the opportunity cost of collateral.[5] Since we have no data indicating how the cost of

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4. Note that the relationship is not symmetric—i.e., an equal reduction in the opportunity cost would not lead to a 20 per cent increase in collateral.
5. Collateral, payments, and the variance of T1 payments are expressed as natural logarithms.

obtaining collateral at short notice and transactions costs vary over time, these variables are not included in our regressions. We use a moving 30-day backward window of the variance and skewness of T1 payments. Our opportunity cost is based on the spread between bankers' acceptances and treasury bills. After November 2001, when the list of securities eligible for use as collateral in the LVTS was expanded, we assume the opportunity cost of collateral to be 5 basis points. The fixed effects that capture institution-specific unobservable variables are incorporated by including dummy variables in the equations for each LVTS participant.

The regression results are in line with expectations. Collateral levels vary positively with the level and variance of T1 payments (the skewness measure is not significant). The coefficients, while statistically significant, are nevertheless very small. This is in line with our theoretical model, which predicts that normal levels of collateral held for LVTS purposes should be sufficient to cover all but the largest 10 per cent of daily T1 payments. Collateral varies negatively and statistically significantly with the opportunity cost of collateral, as we would expect. This effect is also quite significant economically, which is consistent with our theoretical model.

Conclusion

Our simple model of collateral demand, based on benchmark values for opportunity costs and transactions costs, explains the aggregate amount of collateral pledged to the LVTS quite well, despite the fact that these costs may vary among participants. We find that when we exclude one LVTS participant that appears to have a lower opportunity cost of collateral, aggregate actual collateral is within 5 per cent of the predicted level. Our panel data regressions broadly support our theoretical model. Thus, in aggregate there does not appear to be an excessive amount of collateral pledged in the LVTS.

Our model suggests that it is unlikely that the clients of LVTS participants would be deterred from using the system because participants passed on to them the costs associated with excessive levels of collateral. Our model indicates that for about 90 per cent of the time the "normal" collateral level in the LVTS is enough to cover daily T1 payments. Occasions may

therefore arise when time-sensitive or systemically important payments are delayed as participants try, at short notice, to obtain collateral to meet unexpectedly large payments. These occasions should be rare.

This study suggests several areas for future work. First, in relation to the application of our theoretical model, the use of Extreme Value Theory (EVT) might strengthen our results. Although we have more than 1,100 observations for each financial institution in our sample, relatively few of these lie in the tail of the payments distribution when payments are very large. Second, more information and a greater understanding of the opportunity costs of collateral that is obtained at very short notice would be helpful, because this extra cost is important to explaining the predictions of the model. Finally, our model assumes that collateral can always be obtained at short notice (i.e., stockouts do not occur), so that there is no cost to LVTS participants from delays in making payments. In practice, participants may face financial penalties or reputational damage if it takes time to obtain collateral needed to back time-sensitive payments. This would suggest that participants would choose to hold more collateral than indicated by the model. Including these factors would make for a richer model.

References

McPhail, K. and A. Vakos. 2003. "Excess Collateral in the LVTS: How Much Is Too Much?" Bank of Canada Working Paper No. 2003-36.