The Large-Value Payments System: Insights from Selected Bank of Canada Research

*Neville Arjani and Walter Engert, Department of Monetary and Financial Analysis**

- *A well-functioning payments system is fundamental to the soundness of the financial system and the broader economy.*
- *The Bank of Canada has a strong interest in the safe and efficient operation of Canadian clearing and settlement systems and formally oversees those systems that are judged to have the potential to pose systemic risk.*
- *As well, the Bank maintains a rigorous research agenda with a view to informing payments system policy and oversight, both domestically and in international forums.*
- *This article summarizes some recent research conducted at the Bank of Canada regarding the Large Value Transfer System (LVTS), the core payments system in Canada.*

Every day, individual Canadians, businesses, and governments use various payment instruments to purchase goods and services and to make financial investments. These instruments include cash, cheques, debit and credit cards, e-money, and large-value electronic payment orders. All of these payment instruments, except cash, involve a claim on a financial institution that provides transferable deposit services, such as a bank, credit union, or caisse populaire. For all of these transactions to be completed, financial institutions need a reliable way to transfer funds between each other. That function is provided by a payments system, which is the set of instruments, rules, and technologies that facilitate the clearing and settlement of funds transfers among system participants.[1]

The Bank of Canada and the Payments System

The Bank of Canada has a strong interest in the safe and efficient operation of major clearing and settlement systems, for several reasons. For example, the system used to settle large-value payments among financial institutions, the Large Value Transfer System (LVTS), also provides the setting in which the Bank conducts monetary policy.[2] In addition, since clearing and settlement systems underpin virtually all of the transactions undertaken in the economy, their safe and efficient operation is important to the sound func-

* The authors thank Jason Allen, James Chapman, Allan Crawford, Pierre Duguay, Clyde Goodlet, Dinah Maclean, Sean O'Connor, and Michael Hoganson (of the Canadian Payments Association) for helpful comments.

1. Clearing is the daily process by which system participants exchange payment orders and related items, and the net amounts owed to each participant are determined. Settlement is the process by which participants fulfill their net financial obligations to one another, which involves the transfer of funds.

2. For a discussion of the implementation of monetary policy in Canada, see Howard (1998).

tioning of the economy. Disruptions in major systems can have serious implications for participants that can extend to the financial system and to the economy more generally. For these reasons, the Bank of Canada oversees those systems that are judged to have the potential to generate systemic risk.[3] (Box 1 provides an overview of the Bank of Canada's approach to the oversight of major clearing and settlement systems.)

Research on clearing and settlement issues informs policy development and oversight and supports the Bank's work in multilateral forums, such as the Bank for International Settlements' Committee on Payment and Settlement Systems. This forum brings together major central banks to consider payments systems issues of mutual interest. A well-founded and rigorous research program is also important for the Bank to attract, retain, and develop staff.

This article provides an overview of some of the research conducted at the Bank of Canada on the payments system, with particular attention to work on the LVTS, which is a central component of the Canadian financial system. The work discussed here deals with both the risk and efficiency of the LVTS, and taken together, paints a picture of a payments system that is both safe and efficient.

3. Systemic risk is the risk that the failure of one system participant to meet its obligations will lead to the failure of another participant to meet its obligations, and so on, with broader adverse effects for the economy.

The LVTS, Certainty of Settlement, and Loss Allocation

The LVTS, which is the core payments system in Canada, is a real-time electronic system for processing large-value or time-sensitive payments and is subject to

Box 1: The Bank of Canada's Oversight Strategy

In the conduct of its oversight of systemically important clearing and settlement systems, the Bank of Canada focuses on several key principles to frame its oversight strategy and to guide the conduct of its oversight activities.

- The Bank judges whether a designated clearing and settlement system meets its minimum standards, but it does not specify or decide how a system should meet these standards. System owners and operators determine how to meet the Bank's standards, which leads to efficient solutions.
- The Bank promotes a co-operative approach for voluntary action by a designated system to meet its concerns.
- The Bank stresses transparency. The Bank aims to develop policies that are well founded, clear, and publicly available.

Essentially, the Bank of Canada's oversight strategy is to establish minimum standards that condition the behaviour of designated systems to control systemic risk. Private sector system operators, in turn, find the most efficient way of meeting these constraints. In addition, as a system evolves, Bank staff review the design and rule changes proposed by system operators to satisfy themselves that systemic risk continues to be well controlled. The Bank also periodically confirms that systems are operating as expected to mitigate systemic risk, for example, through audits.

The private sector's central role in designing and operating systems, subject to minimum standards established by the Bank of Canada, is important for achieving both safe and efficient systems. For example, significant private sector involvement is an important reason why Canada's large-value payments system (the LVTS) is based on the netting of payment orders, as opposed to real-time gross-settlement (RTGS) principles.[1] More generally, the Bank's approach to oversight provides incentives for the safe and efficient operation and evolution of systemically important clearing and settlement systems.

For more on the Bank of Canada's role in the oversight of major clearing and settlement systems, see Engert and Maclean (2006).

1. RTGS refers to the continuous (real-time) settlement of funds or securities transfers individually, on an order-by-order basis. Netting refers to the process whereby individual obligations among system participants are offset against one another (over a day, for example) to produce a single net payable or receivable balance for each participant. This considerably reduces the number and value of obligations to be settled, which, in turn, can reduce risks and costs. However, netting systems are more complex analytically and from a legal perspective, than RTGS-based systems. For more on netting, see Engert (1992, 1993).

oversight by the Bank of Canada.[4] This system is used by participating financial institutions to discharge payment obligations on their own account and on behalf of their customers. Owned and operated by the Canadian Payments Association (CPA), the LVTS began operations in February 1999. It is used to settle about 20,000 payments each day, with a total daily value of $160 billion. Some of these payments are time-sensitive, because the LVTS is used to settle funds transfers from other important clearing and settlement systems, such as those for securities transactions and also for the Canadian-dollar leg of foreign exchange transactions.

In the LVTS, electronic payment messages are processed during the day in real time, while settlement of participants' corresponding obligations to the system occurs on a multilateral net basis at the end of the day. Payments processed by the LVTS are final, so that recipients of payments can use these funds immediately upon receipt without any risk of the payment being reversed later. The LVTS contains two payment streams, Tranche 1 and Tranche 2, which have different characteristics and risk controls. Participants can use either stream to send payments through the system, subject to each stream's risk controls.

In Tranche 1, a participant cannot incur an overall net debit (payable) position that exceeds its Tranche 1 Net Debit Cap (T1NDC) when sending payments through the system. A participant's T1NDC is determined by the amount of eligible collateral that it has pledged in the system for this purpose. In this way, participants collateralize their own obligations, and Tranche 1 is therefore referred to as a "defaulter-pays" payment stream.

In Tranche 2, bilateral credit limits and multilateral net debit caps are used to limit risk. A bilateral credit limit (BCL) constrains exposures between any pair of system participants. Specifically, each participant in the LVTS can provide a BCL to any other participant, and this limit determines the maximum payment obligation that the recipient of a BCL can owe to the provider of the BCL. In addition, a "multilateral cap" limits exposures that each participant can present to the system as a whole. A participant's multilateral cap, called its Tranche 2 Net Debit Cap (T2NDC), is calculated as the sum of all the BCLs it has received, multiplied by a fixed proportion (called the "system-wide parameter"), which is currently equal to 0.24.[5]

In Tranche 2, a collateral pool also helps to manage risk and facilitate settlement of the LVTS in the event of a participant default. Each participant must pledge collateral to the system equal to the largest BCL that it has provided to any other participant, multiplied by the same system-wide parameter, 0.24. Since the collateral pool is funded by all participants, and losses from default are allocated to participants, Tranche 2 is referred to as a "survivors-pay" payment stream.

Early payments system research at the Bank of Canada showed that the LVTS design would meet international standards for risk control.

An early example of payments system research at the Bank of Canada is Engert (1993), which explored the robustness of these risk-control mechanisms when the LVTS was under development. This work showed that total Tranche 2 collateral would always be at least as large as the single largest possible net debit (payable) position in the system. As a result, in the event of the default of any single participant, the system would be able to settle, which is the internationally accepted standard for risk control in such systems (Goodlet 2001).[6] As well, this work demonstrated that each participant would individually pledge sufficient collateral in Tranche 2 to cover the largest possible loss it would sustain in the event of any single participant failure. In effect, participants prepay their potential losses, which are proportional to the BCLs that they have provided to other participants. In turn, this provides

4. While the average value of payments processed by the LVTS is $8.5 million, participants can submit payments of any size to the system, including small-value payments.

5. The value of 0.24 for the system-wide parameter is determined by the effectiveness of the netting in the system. That is, the multilateral netting of a given set of bilateral transactions leads to a multilaterally netted balance that is a fraction of the underlying bilateral positions; the system-wide parameter corresponds to this fraction. For more on the rudiments of netting, see Engert (1992, 1993).

6. In the extremely unlikely event of several participants defaulting on their LVTS settlement obligations on the same day, it is possible that such defaulted obligations could exceed available LVTS collateral. In this case, the Bank of Canada would advance funds on the security of the available collateral to guarantee settlement of the system and could become an unsecured creditor of the defaulting institutions. This provision is part of the Bank of Canada's lender-of-last-resort policy; see Daniel, Engert, and Maclean (2004–2005).

incentives to participants to manage their exposures in the LVTS prudently, an issue considered in more detail in the next section.

Taken together, these various elements provide for “certainty of settlement,” whereby the LVTS is guaranteed to settle at the end of the day. Accordingly, participants and their customers can (and do) treat payment messages sent and received over the LVTS as final, thus reducing risk for participants and their customers. These features also mitigate the potential for the LVTS to pose systemic risk.

How Large Are Potential Losses in the LVTS?

When the LVTS began operations in early 1999, it was clear that the system would provide for certainty of settlement and that loss-allocation rules would work if necessary in the event of a default, as discussed above. However, the size of the potential loss to each surviving participant in the event of a failure was uncertain. This is essentially an empirical matter, depending on the behaviour of system participants. Put differently, while LVTS rules ensure that the *system* is robust to defaults, the system’s rules do not ensure that *individual participants* are robust to defaults.

To assess this empirical question, two recent papers, McVanel (2005) and Ball and Engert (forthcoming), consider actual daily LVTS payment data (courtesy of the CPA) to measure potential losses to participants. Specifically, these papers analyze unanticipated defaults in the LVTS using a payments system simulator (Box 2). The defaults are simulated in the following manner: Each LVTS participant’s net payment positions (Tranche 1 plus Tranche 2) throughout each day of the sample period are determined. From these positions, each participant’s largest daily net debit (payable) position is identified, and considered to be a default. Each such default position is then compared with the participant’s collateral available to offset the default. If collateral is

Box 2: Simulation Analysis at the Bank of Canada

An important innovation in payments system research has been simulation analysis. Simulation models are useful tools because they can often be calibrated to replicate a specific large-value payments system environment. These models can then be used to assess the impact of changes in the structural arrangements and decision parameters of a payments system without causing any costly disruption to the operation of the actual system. An early example of this kind of work at the Bank of Canada is Northcott (2002).

There is growing interest among central banks in using simulation analysis to conduct research on payments systems. As a contribution to this initiative, the Bank of Finland has developed a general simulation application, called BoF-PSS2, and is offering this software to other central banks free of charge. The BoF-PSS2 is currently being used by over thirty central banks. The Bank of Canada has recently adopted the BoF-PSS2 and has collaborated with the Bank of Finland, the Bank of England, the Federal Reserve Bank of New York, and MSG Inc. (a Finnish software development company) to refine and improve the simulator. Indeed, the current version of the simulator provides a reasonably complete representation of the LVTS environment.

The BoF-PSS2 operates in a similar fashion to the LVTS. Payments are submitted for processing based on their time of entry. A submitted payment is processed by the simulator provided that the appropriate risk-control test is passed. Payments that are not processed upon submission can be temporarily stored in the simulator’s queue, or can be rejected outright, depending on the user’s preference. For queued payments, the BoF-PSS2 offers users a choice of various release algorithms representing alternative queuing arrangements typically available in large-value payments systems.

The BoF-PSS2 generates a variety of time-series output data when a simulation is completed. These data include statistics on the number and value of processed and unprocessed payments. Data on the use of credit limits, as well as the number and value of queued transactions, can also be observed. BoF-PSS2 users can choose the frequency at which these output data are generated. For instance, output statistics can be reported daily, as well as on an intraday basis, in intervals ranging from one to sixty minutes. Moreover, these output data are available at the aggregate system level and also at the individual participant level.

not sufficient to cover a net debit position, then a loss is identified, which is allocated to other participants following LVTS rules (in proportion to the BCLs extended to the defaulter). In this way, a large number of defaults and loss allocations are simulated. For example, Ball and Engert (forthcoming) consider daily payment data from April 2004 to April 2006 and simulate over 7,000 defaults and over 43,000 loss allocations.

Results from these two papers, which consider different sample periods, are very similar. Over the period from April 2004 to April 2006, average simulated losses to participants amount to only 0.4 per cent of regulatory tier 1 capital, and the average of participants' largest simulated losses is only 7 per cent of their tier 1 capital (Ball and Engert forthcoming). Two small participants peak at relatively large losses of over 20 and 30 per cent of tier 1 capital, respectively; while significant, these values would not be solvency-threatening on their own.

Ball and Engert also explore simulated losses to the Bank of Canada. As a participant in the LVTS, the Bank routinely extends a BCL to each participant equal to 5 per cent of the sum of all BCLs received by the participant.[7] In doing so, the Bank undertakes risk related to loss allocations as well. Ball and Engert find that the average simulated loss to the Bank of Canada is only $24.1 million, and the single largest loss is $121.7 million. To put this into context, the Bank's net revenue in 2005 was $1.7 billion (Bank of Canada 2006).

Notwithstanding the small size of simulated losses, the methodology followed in these papers generates losses that are almost certainly larger than would actually be experienced, as stressed in McVanel (2005). There are several reasons for this. First, the simulated losses are based on the largest possible (or peak) daily exposures, given actual LVTS payments, and participant failure is assumed to occur at the time of peak exposure during LVTS operating hours. In practice, however, regulators would probably try to close a failing institution after LVTS operating hours, if possible. Second, defaults are assumed to be unexpected (i.e., surprises). Therefore, participants do not take steps to reduce potential losses by decreasing BCLs to potential defaulters. Doing so would reduce a suspect participant's Tranche 2 Net Debit Cap, and hence its capacity to generate losses. Similarly, the analysis assumes that prudential supervisors do not take measures to mitigate loss (notwithstanding the early-intervention regime that characterizes the federal safety net).[8] Finally, it is assumed that surviving participants do not recover any of their losses from the estate of the defaulter. Consideration of these factors would lead to smaller losses than those reported above.

Losses from a participant failure in the LVTS are very likely to be small. The risk controls of the system allow and encourage participants to keep their potential losses manageable.

Overall, then, these papers conclude that losses from a participant failure in the LVTS are very likely to be small and readily manageable. In the case of one or two small participants, under worst-case assumptions, losses could be significant, but not solvency-threatening on their own. In sum, the risk controls of the LVTS allow and encourage participants to keep their potential losses manageable.

Is Collateral in the LVTS Excessive?

So far in this article, we have discussed how the design of the LVTS provides for certainty of settlement and loss allocation, and provides incentives that encourage participants to manage their exposures prudently, which, in turn, mitigates systemic risk. In this regard, the evidence indicates that potential losses in the LVTS are small. A central part of the LVTS risk-control mechanisms, as discussed above, is the use of high-quality collateral to secure exposures. Early in the operation of the LVTS, it appeared that participants pledged an amount of collateral in the system that was in excess of requirements. Accordingly, Bank researchers have examined whether collateral use in the LVTS is efficient, or if collateral pledged to the system is somehow excessive.

LVTS payments sent and received by each participant can vary significantly from day to day, hour to hour,

7. The Bank follows this mechanical rule to avoid giving rise to conflicts of interest (real or apparent), in light of its access to confidential prudential information. The 5 per cent value has been in place since the LVTS began operating in February 1999 and was based on an estimate of daily Government of Canada payments sent to the Bank by LVTS participants. (The Bank of Canada is the federal government's banker.) The Bank can increase its BCL to a participant as a contingency measure under exceptional circumstances; this has never been done (Arjani and McVanel 2006.)

8. For more on the prudential safety net in Canada, see Engert (2005).

and even minute to minute.[9] Participants know in advance many of the payments they will receive and be required to send. They cannot, however, always synchronize these flows. They may have to make large payments before they receive incoming funds, sometimes unexpectedly. In such instances, when LVTS risk controls limit a participant's payment-sending capacity, a buffer of collateral in the system can support an increase in the participant's Tranche 1 Net Debit Cap, which, in turn, would allow the participant to complete the timely delivery of payments. As well, an LVTS participant may occasionally require an unusually large advance at the end of the day from the Bank of Canada, perhaps because of an operational problem.[10] A buffer of collateral can also serve to back any large advances that may be required in such a situation. In sum, if participants do not hold sufficient collateral for LVTS purposes, large-value, time-sensitive, or systemically important payments could be delayed, with attendant costs, including disruption of payments systems and delays to clients of LVTS participants.

On the other hand, if an LVTS participant does not minimize the costs associated with holding and managing collateral, excessive costs could be passed on to its clients, who could pay more for sending LVTS payments than would be optimal. If they are systematically deterred from sending payments via the LVTS, clients may choose payments systems that are less well protected against risk. It follows from this discussion that the efficiency with which collateral is used in the LVTS can have broader effects that extend beyond the payments system.

To gain a better understanding of the efficiency of collateral use in the LVTS, and the associated trade-offs, McPhail and Vakos (2003) study whether participants pledge cost-minimizing levels of collateral in the system. As already discussed, there are two payment streams in the LVTS, Tranche 1 and Tranche 2, and the latter accounts for about 85 per cent of the payment value sent over the LVTS. Tranche 2 uses collateral so efficiently that only a few billion dollars of collateral are needed to support about $140 billion per day in payments. As well, since collateral requirements for Tranche 2 payments change relatively little from one day to the next, there is little need for participants to hold a large buffer of collateral to accommodate changes in Tranche 2 collateral requirements. For these reasons, McPhail and Vakos (2003) focus on Tranche 1 payment flows to assess the efficiency of collateral usage.

Tranche 1 payments currently account for about 15 per cent of the value sent over the LVTS—about $20 billion per day. Tranche 1 payments must be financed, dollar for dollar, by Tranche 1 funds already received or by intraday credit, which must be fully secured by eligible collateral. It is therefore much more expensive for participants to send Tranche 1 payments than Tranche 2 payments, and so Tranche 1 tends to be reserved for situations in which insufficient credit is available for a time-critical payment to pass through the Tranche 2 risk controls. To study collateral-use efficiency in the LVTS, McPhail and Vakos consider data from February 1999 (when the system began operations) to May 2003. Over this period, daily Tranche 1 payments sent by financial institutions averaged $6 billion.

The authors build a theoretical model that generates the demand for collateral by LVTS participants under the assumption that they minimize the cost of collateral management. Their model predicts that the optimal amount of collateral pledged by each LVTS participant depends on the opportunity cost of collateral, the transactions costs of acquiring assets eligible as collateral and transferring them in and out of the LVTS, and the distribution of a participant's payment flows in the LVTS.[11] McPhail and Vakos use estimates for the opportunity cost of collateral and transactions costs to apply their model to LVTS participants. They find that their model of optimal collateral demand, which is based on benchmark values for the various relevant costs, explains the aggregate amount of collateral pledged to the LVTS quite well, despite the fact that these costs may vary among participants. Specifically, the authors find that when one LVTS participant with an apparently lower opportunity cost of collateral is excluded, aggregate actual collateral is within 5 per cent of the level predicted by their model.

As expected, the opportunity cost of collateral is particularly important in explaining the amount of collateral pledged to the LVTS. Sensitivity analysis of the model indicates that, as this cost of collateral increases, the amount of collateral that participants hold would be greatly reduced. The analysis also indicates that, for about 90 per cent of the time, the level of

9. For a discussion of intraday payment flows in the LVTS, see Cheung (2002).

10. Such advances occur under the Bank of Canada's standing liquidity facilities; see Daniel, Engert, and Maclean (2004–2005).

11. The authors define the opportunity cost of collateral as the spread between the rate of return on assets pledged as collateral and the rate of return on assets likely to be held in the absence of collateral requirements in the LVTS.

collateral demand predicted by the model is sufficient to cover daily Tranche 1 payment activity. That is, participants would have to pledge additional collateral to the LVTS to meet their Tranche 1 payment obligations about 10 per cent of the time. McPhail and Vakos note that this creates the possibility that time-sensitive or systemically important payments could be delayed, since participants must try, possibly on short notice, to obtain and pledge additional collateral to meet unexpectedly large payments needs. These occasions would be rare, however.

The evidence indicates that collateral (liquidity) use in the LVTS is cost efficient.

The authors conclude that there does not appear to be an excessive amount of collateral pledged in the LVTS. On the contrary, the aggregate level of collateral in the system corresponds well with the optimal cost-minimizing behaviour indicated by their model.

What Is the Trade-Off between Liquidity and Payment Delay?

The preceding section focused on the efficiency of collateral use in the LVTS, with particular attention to Tranche 1. This section discusses recent Bank of Canada research on the nature of the trade-off between the amount of liquidity in Tranche 2 (secured by collateral) and the capacity of the system to process payments expeditiously—which is captured by the notion of "payment delay."[12] Also discussed are innovations that might improve this trade-off by providing for reduced liquidity and collateral requirements while simultaneously improving payment-processing capacity.

In the LVTS, as in other large-value payments systems, intraday credit is an important source of the liquidity that participants need to process payments. As discussed above, participants routinely grant bilateral credit lines to each other in Tranche 2, and pledge collateral proportional to the largest BCL that they extend as part of the risk controls. Of course, this is costly, given that collateral in the LVTS consists of highly liquid and marketable securities.

Smaller BCLs in Tranche 2 would reduce collateral requirements (and related costs). However, this could also lead to delays in the intraday processing of payment messages, since participants' ability to send payments would be constrained by tighter bilateral and multilateral Tranche 2 risk controls. When a participant has insufficient intraday liquidity in Tranche 2, payments are held and are not released for processing until the participant sending the payment message has sufficient liquidity to do so, or decides to send the payment through the more expensive Tranche 1.

In turn, delays in processing payments raise other costs. For example, a participant could be expecting to receive payments by a certain time of day, such that any delay in payment will lead to a shortfall in its intraday funds position and, hence, to a possible shortfall in fulfilling its obligations to its customers. The participant may then have to incur additional liquidity costs to replace these funds on short notice. It follows that a payment delay created by one participant could spread to others in the system. There might also be other system-wide implications. For example, the prolonged or routine delay of payments might increase potential losses associated with other risks in the financial system, such as operational or systemic risk.

To understand better the trade-off between liquidity and payment delay in Tranche 2 of the LVTS, Arjani (2006) simulates this relationship using three months of data (July–September 2004) on daily Tranche 2 credit limits and payments (courtesy of the CPA). The author finds that, as intraday liquidity is decreased, payment delay escalates at an increasing rate.[13] That is, as shown in Chart 1, this work estimates a convex relationship between Tranche 2 liquidity (horizontal axis) and a measure of payment delay (vertical axis). The measure of payment delay in Chart 1, the percentage value of unsettled transactions, indicates the percentage of the value of total payments submitted to the system that remain unprocessed at the end of the day.

A simulated reduction in the system-wide parameter, from its current value of 0.24 to 0.18, increases unsettled daily payments by only a very small amount. At the same time there is a corresponding reduction of the collateral needed in the system, of about $750 million

12. Payment delay refers to the lag between the time of a participant's submission of a payment to the LVTS for processing and the time when the payment is actually processed by the system with finality.

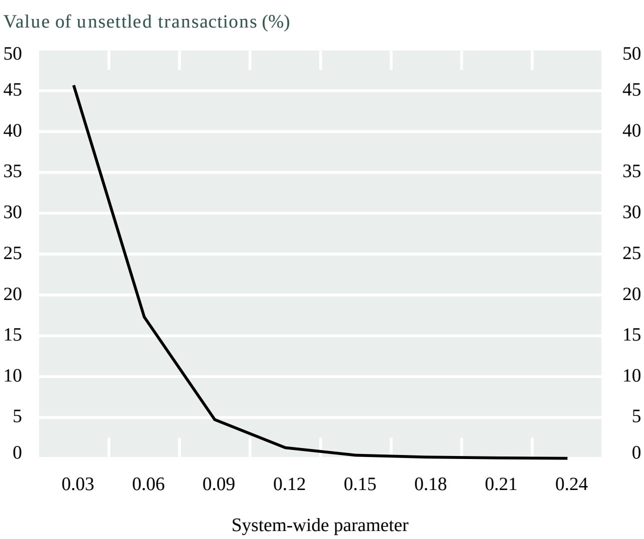
13. The reduction in intraday liquidity is simulated by decreasing the system-wide parameter (discussed above). This, in turn, directly reduces participants' Tranche 2 net debit caps (T2NDCs) and thereby reduces their capacity to send payments over the LVTS.

per day on average, representing a savings of 25 per cent of Tranche 2 collateral. As the amount of simulated liquidity in the system declines further, however, the percentage of unsettled payments rises sharply, as shown in Chart 1.

Arjani (2006) also examines a potential improvement in the trade-off between Tranche 2 liquidity and payment delay. Specifically, the author examines how to achieve a reduction in payment delay for any given amount of intraday liquidity by making more intensive use of "centralized queuing" in the LVTS; that is, restrictions that currently exist on the use of the LVTS central queue are assumed to be relaxed. The LVTS has a complex queuing algorithm that can offset batches of queued (delayed) payments against one another (on a multilateral basis) throughout the day. More intensive use of such algorithms could lead to lower liquidity needs and faster processing of payments. Under current LVTS rules, however, participants are generally discouraged from using the central queue.[14] Instead of relying on the central queue when payments are delayed, LVTS participants currently hold their delayed payments in their own internal queues.

Chart 1

Payment Delay and Liquidity



14. There are good reasons for this. Perhaps most important is a concern that increased use of the central queue could lead to increased credit risk for participants from crediting clients' accounts with expected incoming funds before these payments are processed and received. Of course, that could happen only if participants were aware of all payments in the central queue that were to be sent to them; that is, if queued payments were observable (as is the case in the LVTS).

Arjani simulates increased use of the LVTS queue by assuming that Tranche 2 payments not passing the risk controls become centrally queued, where, unlike the case of internal queuing, all queued payments are subject to multilateral offsetting at regular intervals. The author finds that, under these conditions, payment delay is reduced for each amount of intraday liquidity considered. In addition, the relative benefit of central queuing (in terms of reduced payment delay) increases as intraday liquidity is lowered. For example, with a 75 per cent reduction in system liquidity (a system-wide parameter of 0.06), the simulations suggest that it is still feasible to reduce the value of unsettled transactions by 9 percentage points, or $10 billion, by making more intensive use of the central queuing arrangement. This also implies significant collateral savings.

Research suggests that additional improvements in the efficiency-risk trade-off in the LVTS might be possible.

Arjani (2006) stresses that these results are preliminary and suggests possible extensions. One would be to examine the actual cost of payment delay, so that a direct comparison could be made between this cost and collateral savings resulting from a reduction in the system-wide parameter, or from more intensive use of the LVTS central queue. Another would be to consider participants' reactions to a change in the queuing environment. In this regard, more intensive use of central queuing is likely to alter participants' behaviour with respect to both payment submission and the provision of bilateral credit lines. Such responses could affect (possibly adversely) the net impact of the trade-off between liquidity and payment delay. These extensions, and others, are necessary before firm conclusions can be drawn regarding net benefits from more intensive use of the queuing mechanisms in the LVTS.

Concluding Remarks

The research summarized in this article suggests that the LVTS strikes an effective balance between safety and efficiency, and that further improvements to this balance may be possible. Engert (1993) demonstrates that the design of the LVTS risk-control mechanism meets internationally accepted standards for risk containment and supports the provision of intraday payment finality. One aspect of the LVTS risk-control mechanism is the use of a survivors-pay collateral pool (and loss-allocation rules) to secure intraday credit in Tranche 2. In this regard, the LVTS design may be viewed as accepting risk of loss to stakeholders in the event of a participant default in return for relatively economical daily collateral (or liquidity) requirements. A natural question is: How much risk is accepted to achieve these savings? That is, how large are potential losses to surviving participants, in the event of a default, from this efficient design? Using simulation analysis, McVanel (2005), and Ball and Engert (forthcoming) address this question by assessing the impact of an unanticipated default in the LVTS under worst-case conditions. These authors find that the risk of loss faced by surviving participants generally appears to be small and, in all cases, manageable.

McPhail and Vakos (2003) explore the efficiency of the daily operation of the LVTS by studying whether the amount of collateral pledged by participants for LVTS purposes is efficient from a cost-minimization perspective. Focusing on Tranche 1, the authors find that, in general, their model of optimal collateral demand fits actual behaviour in the LVTS well, suggesting that collateral use in the LVTS is efficient.

Finally, Arjani (2006) employs simulation analysis to examine a fundamental safety-efficiency trade-off—between intraday liquidity and payment delay—in Tranche 2 of the LVTS. Based on the current trade-off, the author finds that substantial liquidity savings, in terms of reduced daily Tranche 2 collateral requirements, could be realized with only a minor increase in payment delay. That is, further efficiency gains might be possible in Tranche 2 without significantly compromising risk control. This work also suggests that more intensive use of the LVTS's centralized queuing mechanism could lead to improvements in the trade-off between payment delay and intraday liquidity, thus further increasing the efficiency of the system.

While the focus of this article is on the LVTS, research at the Bank of Canada on clearing and settlement systems certainly extends beyond that system. For example, Northcott (2002) uses simulation analysis to assess the potential for Canada's Automated Clearing Settlement System (a small-value payments system) to pose systemic risk. This research was influential in the Bank of Canada's decision to not designate this system under its formal oversight authority. Lai, Chande, and O'Connor (2006) build a theoretical model to explore competition and efficiency under particular organizational arrangements common to payments systems around the world (known as "tiering"). McPhail (2003) applies recent advances in the management of operational risk and related academic work to develop a framework to assess and manage operational risk in clearing and settlement systems. Insights from this work have been applied to the Bank of Canada's own operational risk-management framework. Most recently, Chiu and Lai (forthcoming) provide a review of the academic literature on payments-system modelling to inform future research initiatives.

A key goal for longer-term research is to improve the modelling of the behaviour of the participants in the payments system.

Looking ahead, a key longer-term goal for future research on clearing and settlement systems is the modelling of participant behaviour so that analysis can explicitly and more rigorously take into account changes in behaviour motivated by, for example, potential design innovations in clearing and settlement systems. Another focus at the Bank of Canada will be continuing collaboration, since Bank staff intend to deepen their relationships with researchers in other organizations sharing these interests. A current example of this is collaboration with staff of the Federal Reserve Bank of New York on the impact of participant operational problems on the functioning of large-value payments systems, including effects on system liquidity and the ability to settle payments. Another example of such collaboration is work with Bank of England staff on fundamental issues concerning the design of large-value payments systems.

The Bank of Canada's research on payments systems has yielded a variety of useful insights and applications. At the same time, it has also stimulated additional questions and new ideas, and the Bank's research efforts in this area are expected to continue for years to come.

Literature Cited

Arjani, N. 2006. "Examining the Trade-off between Settlement Delay and Intraday Liquidity in Canada's LVTS: A Simulation Approach." Bank of Canada Working Paper No. 2006–20. For a summary of this research, see also Bank of Canada *Financial System Review*. 2005. (December): 55–63.

Arjani, N. and D. McVanel. 2006. "A Primer on Canada's Large Value Transfer System." 1 March 2006, available at www.bankofcanada.ca/en/financial/lvts_neville.pdf.

Ball, D. and W. Engert. Forthcoming. "Unanticipated Defaults and Losses in Canada's Large-Value Payments System Revisited." Bank of Canada Discussion Paper.

Bank of Canada. 2006. *Annual Report 2005*. Ottawa: Bank of Canada.

Cheung, L. 2002. "Understanding Intraday Payment Flows in the Large Value Transfer System." Bank of Canada *Financial System Review* (December): 49–52.

Chiu, J. and A. Lai. Forthcoming. "Payments System Modelling: A Review of the Literature." Bank of Canada Working Paper.

Daniel, F., W. Engert, and D. Maclean. 2004–2005. "The Bank of Canada as Lender of Last Resort." *Bank of Canada Review* (Winter): 3–16.

Engert, W. 1992. "An Introduction to Multilateral Foreign Exchange Netting." Bank of Canada Working Paper No. 92–5.

———. 1993. "Certainty of Settlement and Loss Allocation with a Minimum of Collateral." Bank of Canada Working Paper No. 93–14.

———. 2005. "On the Evolution of the Financial Safety Net." Bank of Canada *Financial System Review* (June): 67–73.

Engert, W. and D. Maclean. 2006. "The Bank of Canada's Role in the Oversight of Clearing and Settlement Systems." Bank of Canada *Financial System Review* (June): 57–64.

Goodlet, C. 2001. "Core Principles for Systemically Important Payments Systems and Their Application in Canada." *Bank of Canada Review* (Spring): 19–31.

Howard, D. 1998. "A Primer on the Implementation of Monetary Policy in the LVTS Environment." *Bank of Canada Review* (Autumn): 57–66.

Lai, A., N. Chande, and S. O'Connor. 2006. "Credit in a Tiered Payments System." Bank of Canada Working Paper No. 2006–36. For a summary of this research, see Bank of Canada *Financial System Review* (December 2006): 67–70.

McPhail, K. 2003. "Managing Operational Risk in Payment, Clearing, and Settlement Systems." Bank of Canada Working Paper No. 2003–2. For a summary of this research, see Bank of Canada *Financial System Review* (June 2003): 79–81.

McPhail, K. and A. Vakos. 2003. "Excess Collateral in the LVTS: How Much Is Too Much?" Bank of Canada Working Paper No. 2003–36. For a summary of this research, see Bank of Canada *Financial System Review* (December 2003): 85–88.

McVanel, D. 2005. "The Impact of Unanticipated Defaults in Canada's Large Value Transfer System." Bank of Canada Working Paper No. 2005–25. For a summary of this research, see Bank of Canada *Financial System Review* (June 2006): 69–72.

Northcott, C.A. 2002. "Estimating Settlement Risk and the Potential for Contagion in Canada's Automated Clearing Settlement System." Bank of Canada Working Paper No. 2002–41. For a related article, see C.A. Northcott (2002). "Systemic Risk, Designation, and the ACSS," Bank of Canada *Financial System Review* (December): 29–35.