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Working Paper/Document de travail
2007-11

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Bank of Canada Working Paper 2007-11

February 2007

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ISSN 1701-9397

Acknowledgements

We would like to thank Maxime Éric Beaudin-Véronneau for excellent technical assistance and we gratefully acknowledge comments from Toni Gravelle, Stéphane Lavoie, Sean O’Connor, Christian Upper, Eric Tuer, and seminar participants at the Bank of Canada. Any remaining errors are our own.

Abstract

Loan-level data on the uncollateralized overnight loan market is generated using payment data from Canada's Large Value Transfer System (LVTS) and a modified version of the methodology proposed in Furfine (1999). There were on average just under 100 loans extended in this market each day from March 2004 to March 2006 for a total daily value of about $5 billion. This makes the market slightly larger than the brokered repo market but only about one-tenth of the estimate for the direct trade repo market. The implied uncollateralized overnight rate was found to be remarkably stable relative to other measures of the overnight rate. Loan rates are found to vary with market conditions, the size of the loan, and the type (big vs. small) of the borrower and lender.

JEL classification: E44, E50, G12
Bank classification: Financial markets; Interest rates

Résumé

En se fondant sur les données relatives aux paiements du système canadien de transfert de paiements de grande valeur (le STPGV) et sur une variante de la méthode proposée par Furfine (1999), les auteurs génèrent un ensemble de données concernant les transactions conclues sur le marché des prêts à un jour non garantis. En moyenne, un peu moins de 100 prêts ont été consentis chaque jour sur ce marché entre mars 2004 et mars 2006, et le montant quotidien total de ces prêts avoisinait les 5 milliards de dollars. La taille de ce marché est ainsi légèrement supérieure à celle du marché des opérations de pension effectuées par l'entremise d'un intermédiaire, mais ne représente qu'environ un dixième de la taille estimée du marché des opérations de pension directes. Le taux des prêts à un jour non garantis calculé à partir de l'ensemble de données des auteurs se révèle remarquablement stable par rapport à d'autres indicateurs du taux du financement à un jour. Les taux des prêts varient selon les conditions du marché, la taille du prêt et le type d'emprunteur et de prêteur (gros ou petit).

Classification JEL : E44, E50, G12
Classification de la Banque : Marchés financiers; Taux d'intérêt

Uncollateralized Overnight Loans Settled in LVTS

1.0 Introduction

The overnight money market is used by participants with a temporary surplus or shortage of funds to lend or borrow until the next business day. The benchmark rate, the overnight rate target, is set by the Bank of Canada within its monetary policy role. The actual rate charged on overnight loans varies according to the type of overnight financing instrument used and its inherent risks as well as the market supply and demand conditions. There are various instruments which allow market participants to obtain overnight financing. The most commonly used are term deposit receipts, repurchase agreements (repos), swapped foreign exchange funds and uncollateralized interbank loans. [1]

Interbank loans, swapped foreign exchange funds and term deposit receipts are all forms of uncollateralized loans. In this study, however, we examine the microstructure of a subset of the uncollateralized overnight market consisting of overnight loan transactions settled through Canada's Large Value Transfer System (LVTS). LVTS is used by participants to settle payment obligations, either on their own behalf or on behalf of their clients. On average, 18,000 payments totaling $145 billion are settled through LVTS every day. We describe and later apply a methodology that allows us to identify overnight loan transactions among the payments settled through LVTS. The identified overnight loans are uncollateralized[2] but exclude loans between financial institutions and their own clients (i.e. term deposit receipts) since these loans are not settled through LVTS. Overnight financing instruments that require an exchange of securities (i.e. repos) are not captured in our data because these transactions are cleared through a separate system operated by the Canadian Depository for Securities Limited (CDS). Unless otherwise noted, the rest of the discussion refers to uncollateralized overnight loans (hereafter overnight loans).

The unique set of transaction-level data on overnight loans provides us an opportunity to describe the features of the uncollateralized overnight market in Canada that have not yet been formally documented. We find that the six big banks in Canada are the most active players, borrowing 90 per cent of all loans by volume (92 per cent by value). We also uncover the intraday behaviour of borrowers and lenders and learn that a large majority of trades occur in the late afternoon while the morning hours are characterized by illiquid markets and generally higher and more volatile overnight rates. Perhaps the most valuable finding is that during the two year sample period, the uncollateralized overnight rate displays little volatility and very small deviations from the target overnight rate.

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[1]. For further information on the overnight market in Canada see Lundrigan and Toll (1997) and Reid (2007).

[2] Occasionally, there may be a few late-day collateralized loan payments sent via the LVTS but this is done infrequently and only when CDS is unable to process the trade before the close of the day.

A brief overview of the related literature is in section 2. Section 3 describes the data and the methodology used in identifying overnight loans from LVTS transactions. The descriptive features of the overnight loans data are presented in section 4 while section 5 explores the microstructure determinants of the uncollateralized overnight rate. Lastly, section 6 concludes.

2.0 Related Literature

The first paper to describe the overnight market in the U.S. by compiling a transaction-level data set of federal funds transfers was Furfine (1999). Furfine also documents the methodology he used to identify federal funds loans from Fedwire (U.S. large value payment system). He identified candidate federal funds sales as all payments whose amounts are greater than $1 million and rounded to the nearest $100,000. If, for example, Bank A sent Bank B $1 million, then the next business day's transactions are searched for a payment from Bank B to Bank A in an amount equal to $1 million plus a "reasonable" interest rate payment. The reasonable rates of interest ranged from 50 bps below the lowest of the reported rates (which are the 11:00 a.m. rate, the closing rate, the effective rate and the FOMC's target rate) to 50 bps above the maximum of the four reported rates. With this unique transaction-level data set, Furfine describes the microstructure of the federal funds market. He finds that the federal funds market accounts for roughly 24% of total daily Fedwire payments value. Larger institutions are more active in the market and the average size of their buy and sell transactions is much larger than that of the small institutions. He also confirms the well-documented fact that small institutions tend to be net sellers much more frequently than net buyers in the funds market. In fact, 319 of the 400 smallest institutions are always net sellers. However, contrary to the common conception, Furfine's data shows that the largest banks are net sellers of funds quite frequently (41.9% of the time) and only slightly more likely to be net-buyers (52.6% of the time). The federal funds market is also quite concentrated with the largest 10 net sellers (net buyers) accounting for nearly half of all funds sold (bought). Despite the large number of participants (over 1,000) most of the transactions are exchanged with only a few counterparties. It is not uncommon for small and some medium-sized banks to have just one counterparty but, generally, the larger the participant the more counterparties it has. This is explained by the fact that larger participants may request large loans that an individual party may not be in a position to supply. Establishing multiple relationships ensures that the transaction will be completed even if there are several lenders.

Demirlap, Preslopsky, Whitesell (2004) refine Furfine's methodology for the U.S. by introducing a filter on implied interest rates, widening the acceptable interest rate range and the range of acceptable loan sizes and by examining alternative algorithms for selecting overnight loan transactions. Their final data set is divided into three distinct groups; the one-to-one group where each identified loan can be matched to only one repayment, the N-to-N group where there are equal number of identical loans and

candidate loan repayments, and an N-to-M group where the number of identical loans is different from the number of qualifying repayments. Each of these groups produces a slightly different characterization of the overnight market. Demirlap et al. (2004) also contribute to the literature by characterizing the identified loans as brokered uncollateralized federal funds trades and "other loans" which include direct trades of federal funds, Eurodollar transactions, and tri-party repurchases. Using multiple regression analysis and data for each of the: brokered federal funds, repo, Eurodollar and "other loans" rate, they find day-of-the-maintenance period effects and other calendar-specific effects. Spreads of the benchmark rate (from the Fedwire data) over other rates show significant calendar effects, as high as 5 to 6 basis points at quarter- and year-ends, suggesting incomplete arbitrage among these markets. Arbitrage possibilities were also found to exist among other market rates. The spread of the Eurodollar rate over the brokered fed funds rate is 9 to 10 basis points higher on quarter- and year-ends than what is expected on such days.

Several other studies have used Furfine's methodology, or some variation of it, to describe different aspects of the overnight market microstructure. For example, Millard and Polenghi (2004) use CHAPS Sterling (UK large value payment system) transactions data to derive the unsecured overnight loans transactions, calculate the daily average loan rate and compare it to the unsecured brokered overnight rate average (Sterling overnight indexed average (SONIA)). They find the correlations in the level of their calculated rate and SONIA to be 0.97 and the correlation in the changes in the levels of the two rates to be 0.94 suggesting that the algorithm is successful in identifying unsecured overnight loans. Unsecured loans average about £22 billion daily (or including the repayments value, 22% of daily value in CHAPS Sterling). Roughly half of the £22 billion market consists of brokered trades and the rest are direct trades. Most of the loans are exchanged among 4 settlement members (out of a total of 13, excluding the Bank of England). Payments seem to be fairly evenly spread throughout the day but there is a slight peak in the activity in the last hour and a half of the CHAPS day when 25% of value is transacted.

2.1 Canadian Overnight Market

The types of overnight loans in the Canadian overnight market differ with respect to legal format, collateral arrangements (if any), and transaction costs involved. Some of the most commonly used sources of overnight funding are term deposits, repos, swapped foreign exchange funds and uncollateralized loans.

Term deposits are believed to be the largest source of overnight funding for deposit-taking financial institutions.[3] Unfortunately, the data on these loans are unavailable since financial institutions settle these transactions most often with their own clients and are not asked or required to disclose this information. Overnight repo transactions can be described as collateralized loans where one party sells securities (collateral) in exchange

[3] This information was communicated to the Bank of Canada during the meetings with major financial market players in Canada which took place between April and May 2006.

for funds, with the agreement that they will repurchase the same securities the following day at a higher price. This higher price covers the principal repayment amount and one day's interest equivalent to the repo rate. Repos account for a large segment of the overnight market and are used primarily by firms that are not actively involved in deposit-taking but are active in securities markets.[4] An overwhelming majority of repos are General Collateral (GC) repos although any other type of collateral may be exchanged.[5] Some repos are arranged through brokers and are therefore subject to broker fees and hence higher transaction costs. The average daily value of brokered repos is approximately $2.25 billion.[6] An even larger value of repos, estimated to be between $45 and $55 billion a day, are direct trades.[7] Foreign exchange swaps constitute a much smaller overnight market share. They are considered a form of an uncollateralized loan whereby parties agree to exchange streams of payments denominated in different currencies, and calculated using different interest rates. At the inception of a foreign exchange (currency) swap, the principal amount is swapped with the counterparty for the equivalent foreign currency amount. Interest rate payments are exchanged for the duration of the swap (1 day in case of overnight swaps) and at the termination of the swap, principal amounts are again exchanged using the spot exchange rate prevailing at the inception of the swap. And lastly, the uncollateralized loan market, the focus of this study, is described in more detail in subsequent sections.

The Bank of Canada compiles two different measures of the overnight rate. The most commonly used measure of the overnight market conditions is the overnight money market financing (OMMF) rate. It reflects the average cost of overnight financing reported to the Bank of Canada by major investment dealers and major banks. Another measure of overnight market conditions is calculated from the reported brokered GC repo rates and is referred to as Canadian overnight repo rate average or CORRA.[8] As mentioned earlier, overnight loans identified in the LVTS data are necessarily going to be uncollateralized loans and therefore not captured in either of the two Bank of Canada measures. The identified loans also do not represent the entire uncollateralized overnight market since any loan entered directly on the books of a counterparty (i.e. between a bank and its client) will not be in LVTS data. Only loans that involve an interbank transfer of a payment through the LVTS will potentially be captured in our data set. To the best of our knowledge, this is the first empirical study of the uncollateralized overnight market in Canada.

[4] See Reid (2007).
[5] When the repo trade does not differentiate between specific Government of Canada securities, it is part of the General Collateral repo market.
[6] There are between 5 and 15 brokered repo trades each day. This implies a range of $150-$450 million for the size of a typical repo transaction.
[7] See Reid (2007).
[8] CORRA is used by market participants in determining the floating rate of an overnight index swap (OIS). For further information on both rates please see <http://www.bankofcanada.ca/en/rates/monmrt.html>.

3.0 Data and Methodology

We have LVTS transaction-level data spanning the two-year period between March 2004 and March 2006. In October 2004, State Street Bank joined the list of LVTS participants, bringing the total number to 14, excluding the Bank of Canada. Among the LVTS participants are Canada's six largest chartered banks as well as some smaller financial institutions including credit unions and foreign bank subsidiaries. Appendix Table A1 contains the complete list of LVTS participants.

For each payment in the data set, we have information on the date, time, value, as well as sender and receiver of the payment. The time stamp tells us when the payment was processed by the LVTS, thereby becoming final and irrevocable. Some delay exists between when an overnight loan is negotiated and when the payment is processed by LVTS but we are currently unable to estimate average delay times.

The methodology we use is based on Furfine (1999) but modified to impose additional filters that allow us greater accuracy in identifying overnight loans in Canadian data. Since there are only 14 participants and a very large number of payments, the filters help us reduce the number of random matches.

We begin by selecting each transaction greater than $1 million, and rounded to the nearest dollar, sent by Bank A to Bank B and try to match it to a transaction (repayment) sent on the following business day from Bank B to Bank A in an amount equal to the original payment plus a "reasonable" interest rate. We define the upper bound on the "reasonable" rate to be 50 basis points above the target overnight rate and the lower bound to be 50 basis points below the target rate. Thus, the maximum difference between the low and high rate is 100 basis points (or 1 percentage point). This interval includes the Bank's operating band which is a symmetric 50 basis point band around the target rate. The upper and lower bounds of the operating band are respectively the lending and deposit rate applied to overnight balances held by LVTS participants in their Bank of Canada accounts. Due to the 50 basis point difference in the lending and deposit rates, LVTS participants have an incentive to lend to and borrow from each other at rates that fall within the operating band. Nevertheless, due to a number of risk factors including counterparty credit and market risk, we cannot rule out the possibility that a small percentage of overnight loans will lie outside the operating band. This is why our "reasonable" rate band is ±25 basis points wider than the operating band.

Anecdotal evidence suggests overnight rates are generally not quoted in increments smaller than half of a basis point. As a result, one of the filters that we impose is that the implied interest rate is at half basis point increments. For example, a loan with an implied interest rate of 2.505% would pass the filter but a loan with an interest rate of 2.506% would not. As an additional check, the calculated repayment amount based on the rounded implied interest rate must exactly match the actual repayment amount which is rounded to the nearest cent.

Many payments in the LVTS data appear to be Canadian dollar (CAD) equivalents of US dollar (USD) purchases or sales. These transactions are typically in million USD increments and when converted to CAD, they are at least rounded to the nearest 100 CAD since foreign exchange rates are typically quoted to 4 decimal places. Thus, with the exchange rate of 1.3233 for example, one million USD is equivalent to 1,323,300 CAD. Given the typical day-to-day movements in the CAD-US exchange rate there were many pairs of CAD-USD transactions that were identified as overnight loans. In order to eliminate as many such payments from being falsely identified as loans, we adopt the following foreign exchange (FX) filter to identify and exclude probably FX transactions. [9] Given we only have the timing of the LVTS payment and not the timing of the original transaction, we do not know the appropriate level of the exchange rate to convert Canadian dollar payments into US dollars. As such, we convert the loan amount (i.e. the LVTS payment) to its USD equivalent using the high and low of the exchange rate for that day and discard the loan if this interval includes a million dollar multiple. For example, a payment of 1,323,300.00 CAD from March 11, 2004 converted to USD using the high (1.3250) and low (1.3182) exchange rate quoted on that day gives an interval ([998717, 1003869]). Since this interval includes 1 million, it is more likely to be a FX transaction than a loan and so we discard this transaction. As the loan amounts get larger, the interval calculated using the daily high and low levels of the exchange rate also gets much wider (up to several million dollars for large payments) which increases the probability that some large-value transactions are falsely excluded by the FX filter. As a result, the FX filter is applied only to payments less than 10 million dollars[10].

The same FX filter would normally be implemented on both the loan and the repayment amount. However we choose to eliminate all loan repayments rounded to the nearest dollar. The main reason is the observation that there are a disproportionately large number of repayments with zero cents; an observation that cannot be justified given a random distribution of loan size. Moreover, the implied interest rates for these repayments are typically at a particular rate that is close to but rarely exactly at the target rate. Eliminating these repayments reduces the number of potential loans but it also reduces the number of random matches since there are a very large number of even dollar LVTS transactions. Since all our payments are above 1 million dollars and exchange rates are quoted to at most four decimals, there is no need to implement the same FX filter on repayment amounts.

Most of the loans have a unique repayment match (40,070 out of 50,488). But for those loans where more than one qualifying repayment exists, we select the repayment with an implied overnight rate closer to the target. This, on theoretical grounds at least, is more likely to be the true repayment since the target overnight rate should be the dominant rate in the overnight market.

[9] The data is only filtered for USD transactions as they comprise the vast majority of Canadian FX transactions. Other currency FX transactions are infrequent and could not be identified with any reliability.
[10] D'Souza (2006) finds that the average transaction in the CAD-USD market is 2,000,000 USD with very little variation around this value.

When there are several identical loans that could be paired up with several different qualifying repayments, we employ two different algorithms for matching. The main difference between these methods is that with the "first-loan-to-first-repayment" algorithm, the earliest loan is matched to the earliest repayment closest to the target overnight rate, while "last-loan-to-last-repayment" algorithm will first match the latest loan sent to the latest repayment closest to the target overnight rate. The two algorithms will produce different results on loan duration and time-of-day statistics.

The implementation of the first-loan-to-first-repayment algorithm leads to a significant "forward bias" in that loans are sent on average much earlier in the day compared to the uniquely-matched set of loans. Last-loan-to-last-repayment loans show similar "time of day" characteristics as the uniquely-matched loans so we choose it over first-loan-to-first-repayment. Another reason why last-loan-to-last-repayment may be more accurate is because late-day (and especially after 6 p.m.) transactions are more likely to be overnight loans for the purposes of achieving a desired end-of-day balance in LVTS.

Nevertheless, the average rate deviation from the target and the loan amount are equal regardless of which algorithm is chosen except in the case when two loans are of similar size so that they can both be matched to the same repayment. This occurs very rarely (we find only 1 instance) since it requires the loan amounts to differ by a very small amount and it appears that overnight loans are rounded off at least to the nearest $1000.

3.1 Methodological Drawbacks

Although every effort is made to mitigate any possible drawbacks in our methodology, our calculations are only estimates that may lead to slightly biased results. For example, we may be underestimating the number of loans by requiring that a repayment amount is not rounded to the nearest dollar. Conceivably, certain interest rates, applied to certain loan amounts result in repayments that are rounded to the nearest dollar. Similarly, when selecting potential loan amounts, we exclude all payments smaller than one million dollars and payments not rounded to the nearest dollar. However, either of these amounts is likely to be quite uncommon and therefore the resulting bias should be negligible.

Some loan-repayment matches could be purely coincidental, arising from the fact that there are large number of payments and a small number of participants. The number of such "coincidental matches" where both the loan and the repayment are incorrectly identified is likely to be very small. For example, in an experiment where we used the same methodology but set the target rate to be five percentage points above the true target rate, we found only 155 loans (compared to 50,488 using the actual target rate), or one loan every three to four days. For this reason, we believe that there are very few coincidental matches in our data set.

However, a small bias toward overnight rates closer to the target rate may exist. This bias is introduced when choosing among the multiple repayment matches since we explicitly impose that the repayment closest to the target rate is the true match.

In the case when there are multiple possible repayments of the same value, and multiple identical loan amounts, whether we choose last-loan-to-last-repayment or first-loan-to-first-repayment algorithm is not going to affect the interest rate calculation. But specific loans will be associated with different repayment times, thereby affecting the loan duration. In any case, extra care must be taken when interpreting any calculations based on submission times (such as loan duration) since, as mentioned earlier, submission time records when a loan was processed by the LVTS, and not when it was negotiated or finalized.

4.0 Descriptive Statistics

An average of 18,000 payments, worth about $145 billion, are processed through the LVTS every day. In our data set we examine the interval between 6 a.m. and 6:30 p.m. during which time overnight loans and repayments, along with other payments, are sent and received. A 30-minute time period at the end of the day, between 6:00 p.m. and 6:30 p.m. is allocated specifically for LVTS participants' own payments (i.e. not those on behalf of their clients) to allow participants to achieve a desired end-of day balance. Using the same methodology described above, we find that around half of all transactions sent after 6 p.m. are interbank overnight loans[11]. Virtually all of them are exactly at the target overnight rate. Nevertheless, since the rates are almost always equal to the target rate, we choose to exclude all loans sent after 6 p.m. from the rest of the analysis as they are not reflective of the general overnight market conditions. This modification leads us to drop 1608 identified loans which leaves us with 50,488 overnight loans over the two-year period (523 days), or about 97 per day.

The overnight rate is on average less than 1 basis point below the target overnight rate. Overnight loan rates range between 50 basis points above the target to 50 basis points below the target rate with a standard deviation of 4.86 basis points. Chart A1 in the Appendix plots the distribution of rates that are within 25 bps from the target rate (99.6% of loans). Slightly more than half of the loans (55%) are transacted exactly at the target overnight rate and 20% are at a rate five basis points below the target. The third highest frequency is for loans at one basis point above the target but it accounts for only 7% of loans. Only a small fraction (0.4%) are loans at rates outside the operating band with about equal number above the upper bound and below the lower bound.[12] Thus, 99.6% of

[11] The true number of overnight loans during this period is probably larger since some transactions are "clean-up" loans allowing a participant to achieve a zero closing balance. These loans are usually not rounded to the nearest dollar which is one of the criteria we use in selecting potential loans.

[12] The fact that we have loans at interest rates equal to the upper and lower bounds of our permissible range implies that there may be overnight loans that are being excluded by the interest rate criteria. We do not believe, however, that this is a significant risk or bias given the small number of loans already observed between 25 and 50 basis points above or below the target.

identified loans are within 25 bps of the target rate even though our acceptable interest rate range is twice as wide. Additionally, almost all of the loans are rounded to the nearest thousand dollars, which agrees with anecdotal evidence, even though this is not one of the filters. These are encouraging results.

The average loan amount is around 50 million dollars (median is 18 million). Slightly more than half of all the loans are under 20 million dollars although some loans as large as 1 billion dollars are also present in the data (see Table 1a). Thus the typical uncollateralized overnight loan is much smaller than the estimate of an average repo transaction ($150-$450 million). The average daily value-weighted overnight rate spread from the target rate is only 0.02 bps (the median is -0.04 and the standard deviation is 0.5) suggesting that the two rates are close and that the overnight rate is not consistently above or below the target rate (see Table 1b). The data also reveal that the daily average value of this segment of the overnight market was $4.89 billion which is slightly larger than the $2.25 billion brokered repo market but much smaller than the estimate for the direct trade repo market of $ 45 billion.

Table 1a: Overnight loans: March 2, 2004- March 30, 2006

N = 50,488 loans	Average Loan Value (millions $)	Overnight Rate (bps spread from target)
Average	50.63	-0.785
Median	18.00	0
Maximum	1000.00	50.00
Minimum	1.00	-50.00
Std. Dev	86.45	4.86

Table 1b: Daily statistics on overnight loans sent: March 2, 2004- March 30, 2006

N = 523 days	Volume	Average Loan Value (millions $)	Total Value (billions $)	Value-Weighted Overnight Rate (bps spread from target)	Std. Dev. of Overnight Rate Spread from Target (bps)
Average	96.54	51.11	4.89	0.0168	4.60
Median	96.00	48.34	4.72	-0.0372	4.35
Maximum	132.00	103.06	8.97	3.98	9.76
Minimum	65.00	24.92	2.43	-2.46	2.08
Std. Dev	11.69	12.43	1.13	0.503	1.47

As shown in Chart 1, uncollateralized overnight rate deviations from the target tend to fluctuate closely around the 0 mark. An apparent outlier occurs late in the sample on the day that the weighted average overnight rate was 3.98 bps above the target. A very large loan at 50 bps above the target rate contributed to this result. Chart A2 in the Appendix provides additional details regarding the overnight loan volume and value. We note that

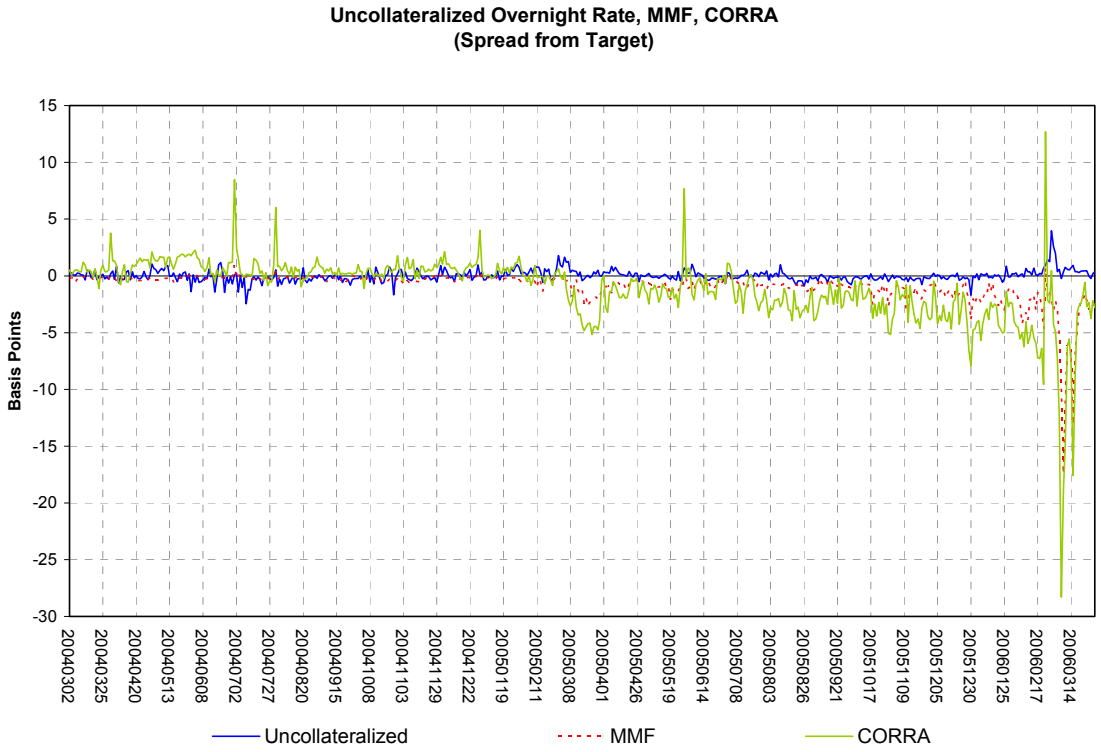
the number of loans declined slightly but the average value per loan increased in the second half of the sample.

As previously mentioned, one of the overnight rate measures published by the Bank of Canada is the overnight money market financing rate (OMMF). This rate is the value-weighted average rate of various types of overnight financing instruments and it is obtained daily through Bank of Canada's communication with major dealers. OMMF is not directly comparable with our value-weighted uncollateralized rate since it includes rates on collateralized overnight financing instruments, but it is plotted in the chart to serve as a reference. In the latter half of the sample, OMMF is consistently below the target rate and below the uncollateralized rate. Both rates are anchored by the target overnight rate but their fluctuations around the target are largely uncorrelated.

Another segment of the overnight market monitored by the Bank of Canada is the overnight repo market. The average overnight repo rate (known as Canadian overnight repo rate average or CORRA) is calculated from brokered repo transactions which are a fraction of the overall repo market. The repo rate is expected to be somewhat lower (since these are collateralized loans) and more volatile due to a smaller number of transactions than the uncollateralized rate that we compile. Indeed, CORRA is more volatile throughout the sample period but it is consistently lower (with a few exceptions) than the uncollateralized rate only in the second half of the sample. Both the OMMF and CORRA display a substantially increased amount of volatility and larger negative deviations from the target rate in the latter half of the sample period (starting in March 2005)[13]. The volatility increased even more in the last few months. Throughout this period the uncollateralized rate remained relatively stable (see Chart 1).

[13] See Reid (2007) for a more complete analysis of the recent developments with respect to the movements in OMMF and CORRA.

Chart 1



Additionally, while the correlation between daily OMMF and CORRA is quite high (0.83), as expected, the uncollateralized rate appears to be contemporaneously uncorrelated with these measures (correlation rates of -0.14 and -0.014 respectively). The uncollateralized market behaves fundamentally differently than the section of the overnight market measured by the OMMF and CORRA. Despite this difference, Granger causality tests across the three rates reveal bidirectional causality in each pairing. Therefore, there are important interdependencies among the three sectors of the overnight market considered.

4.1 Big vs. Small Lenders and Borrowers

Transaction-level loans data allow us to examine the behaviour of lenders and borrowers. However, we cannot differentiate between loans that a LVTS participant makes to another participant and those between a participant and the client of another participant. Nevertheless, we note that the behaviour of the big and small LVTS participants is different. The 14 participants are divided into the big banks, consisting of Canada's 6 largest banks by asset size (which account for over 90 per cent of the banking industry assets), and small participants, comprising the remaining 8 LVTS participants (see Table A1 in the Appendix).

Summary statistics for daily loans data for big and small participants are presented in Table 2. The big banks lend on average about 79 loans each day while small banks lend around 18 loans every day. In contrast, the average loan size for small participants is $77 million while it is only $45 million for big banks. Furthermore, average and median rates charged by big banks are slightly below the target rate while the rates charged by small participants are on average about half a basis point above the target rate. Thus, big banks lend more in total value and frequency and at lower rates; however, the loans are on average smaller.

Table 2: Daily statistics on overnight loans sent: March 2, 2004- March 30, 2006

N = 523 days	Volume	Average Loan Value (millions $)	Total Value (billions $)	Value-Weighted Overnight Rate (bps spread from target)	Std. Dev. of Overnight Rate Spread from Target (bps)
Big Participants					
Average	78.77	45.21	3.51	-0.22	4.09
Median	78.00	42.91	3.46	-0.22	3.89
Maximum	111.00	85.24	6.17	2.47	9.33
Minimum	48.00	20.37	1.55	-24.78	1.94
Std. Dev	10.84	11.80	0.812	1.20	1.29
Small Participants					
Average	17.76	76.88	1.38	0.57	4.83
Median	17.00	69.71	1.25	0.49	3.98
Maximum	36.00	209.7	4.66	9.44	24.19
Minimum	5.00	26.02	0.246	-2.79	0.30
Std. Dev	5.14	32.44	0.715	0.79	4.08

In aggregate terms, the big 6 banks collectively lent 82 per cent of all loans (72 per cent in value). As previously mentioned, they lend at rates on average slightly below the target rate, to both big and small participants. The big banks are also more active as borrowers. They borrowed 90 per cent of total loan volume (92 per cent in value). The 8 small participants lend to everyone at average rates slightly above the target rate but the intraday volatility of the rates charged is higher than that of the big banks.

In terms of their participation rates, each of the big banks either borrows or lends on each day. The average participation rate for small participants is lower, at 83 per cent with greater variation around that value. In contrast to the results of Furfine (1999), we do not find any of the participants (big or small) to be always net lenders or net borrowers on the days that they participate in the market. Nevertheless, aggregating across the large banks, we find that they are net borrowers of funds from small institutions on 95 per cent of the days in the sample. This replicates the overall flavour of the results that Furfine (1999)

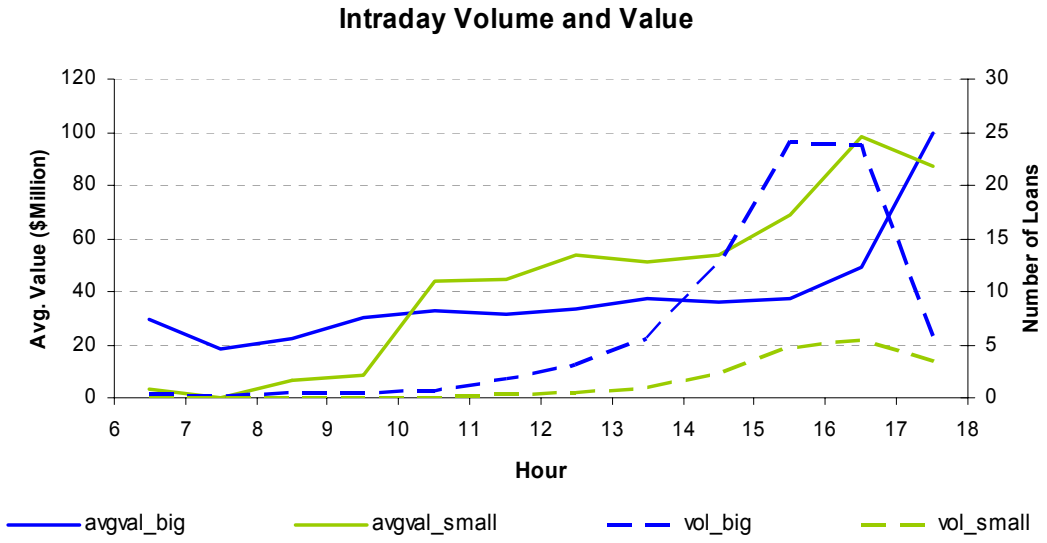
found for the U.S. Small institutions are, on average, liquidity providers for larger banks in the overnight market. As in the U.S., smaller institutions tend to specialize more in deposit taking and less in the securities business. As such, they are typically a source of funds to the overnight market.

Charts 2 and 3 give the intraday breakdown of the volume and value information for big and small participants. One has to be particularly careful in interpreting intraday information as there is likely to be some delay between when a loan is negotiated and the time at which the loan is processed by LVTS. We only have information on the latter. Nevertheless, some interesting patterns are revealed by examining the intraday data. We find that the volume of loans sent by big participants gradually increases throughout the day, peaks between 3 p.m. and 5 p.m. and then sharply declines in the last hour of trading (see chart 2). The pattern is similar for small participants except that the drop in volume at the end of the day is not as large. This time-of-day pattern is different from that associated with general payments flowing through LVTS but it agrees with the expected payment flow management decisions. Namely, the low level of activity in the morning hours can be explained by the high level of uncertainty with respect to incoming and outgoing payments and the resulting cash managers' unwillingness to lend and borrow funds. As the end of the day nears, this uncertainty diminishes and adjustments to the projected end-of-day balances are made by lending and borrowing funds in the uncollateralized overnight market. This increased activity explains the peak in the late afternoon which is unique to the segment of the uncollateralized overnight market that we analyze here. More generally, however, overnight market activity is highest in the morning, especially for the overnight collateralized (repo) market. After 4 p.m. at which point CDS is closed, same-day settlement of collateralized loans is no longer possible which may further contribute to the increased trade volumes of uncollateralized loans late in the day. [14]

Small participants lend larger loans, on average, during the busiest hours of trading, between 10 a.m. and 5 p.m. Although not shown in the graph, the time-pattern for loan repayments is the same as for loans.

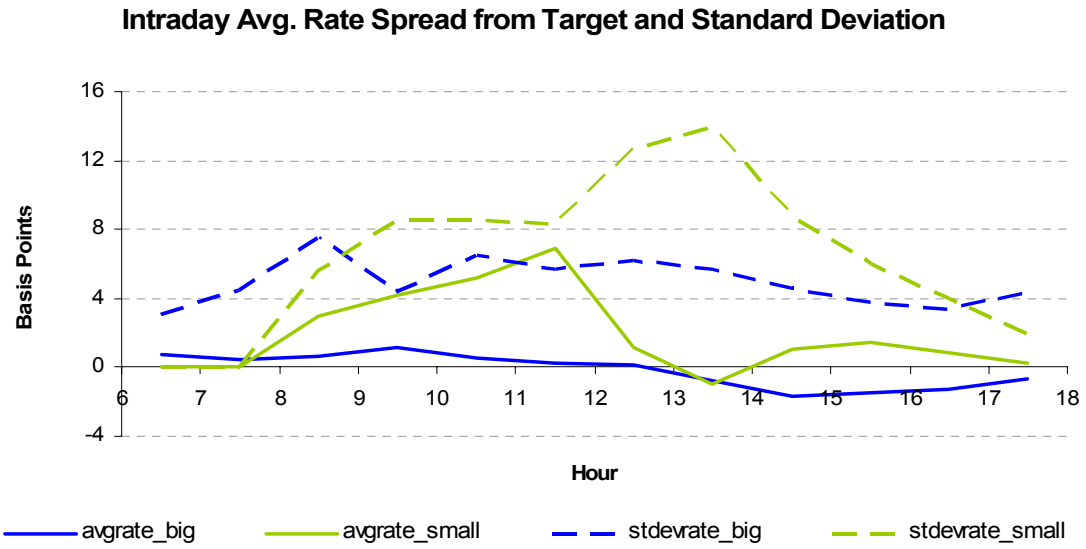
Chart 2

[14] There is still the possibility of collateralized trades after 4pm using the pledge function in CDS. This involves pledging securities in CDS against a flow of funds in LVTS.



As shown in Chart 3, average (unweighted) rates charged by big participants are below the target rate and lower than the rates charged by small participants for each one hour interval except between 7 a.m. and 8 a.m. when small participants are not very active in the market. The standard deviations of the overnight rate are also very large for small participants, notably between noon and 2 p.m.

Chart 3



4.2 Fixed Announcement Dates (for the Target Overnight Rate)

The Bank of Canada makes decisions with respect to the level of the overnight rate target and its monetary policy stance on pre-determined dates, 8 times a year. These decisions are announced via an official press release at 9 a.m. on the fixed announcement date (FAD). Our transaction-level data set allows us to examine transactions on each of the FADs in order to describe any change in the behaviour when there is uncertainty with respect to the future target overnight rate. This uncertainty is the highest from the start of the LVTS cycle (6 a.m.) until the official target rate announcement at 9 a.m. There were 17 FADs in our sample period of which 8 were "no change" announcements, 2 were 25 basis point decreases and 7 were 25 basis point increases.

Table 4 presents the average volume, values and rate deviations from target on FADs and non-FADs. Since the new target rate becomes official at 9 a.m. all loan deviations before 9 a.m. on the day of the FAD are measured against the old target rate. As illustrated in Table 3, the volume and value of pre-9 a.m. loans on the days when the target rate is changed (+/- 25 bps) is somewhat smaller than on other days, as expected given the extra uncertainty. However on the FADs when there was no target rate change the values and volumes are in fact slightly larger than on other days between 6 a.m. and 9 a.m. Although the sample size (8 days) is very small, the observation is puzzling given the expected increased amount of uncertainty on FADs before the 9 a.m. announcement Additionally, on the days when rates were increased by 25 bps, loans transacted before 9 a.m. traded on average 20 basis points above the old target rate and hence much closer to the anticipated new target than the actual target rate. Similarly, on the FADs when the rate declined by 25 bps (only 1 loan traded before 9 a.m.) the rate was exactly at the new overnight rate target before it was announced. Both the median forecasts of the Bloomberg survey of economists as well as the Bank of Canada's measures of market expectations suggest that during the sample period examined, there were no market surprises with respect to interest rate announcements. Accordingly, some market participants were willing to negotiate loans at the expected new rates even before they were officially announced.

Table 3: Comparison of non-FAD and FAD loans between 6 a.m. and 9 a.m.

	Non-FADs (506 days)	FADs (17 days)		
Target Rate Change	N/A	--	+25 bps	-25bps
Number of Loans	512	11	7	1
Number of Days	506	8	7	2
Average Volume	1.01	1.38	1.0	0.5
Average Value (millions $)	23.91	29.17	20.07	20.00
Average Deviation from Target (bps)	0.77	0.91	19.57	-25

5.0 Microstructure Analysis

The rates charged on uncollateralized loans are likely to vary according to the loan amount, counterparty credit risk, time of day when the loan is finalized, the prevailing market conditions and other factors specific to each loan. Our data allows us to explore some of these relationships and the (uncollateralized) overnight interest rate determinants through regression analysis. The estimates are presented in Table 4.

Market conditions at the time of loan negotiation are expected to affect the negotiated overnight rate and it is the reason for including the first lag of the dependant variable in the regression equation[15] (Table 4, row 2). Various measures of market conditions were tried including a moving average of the last 10 loans and an average rate of all loans sent in the preceding 30 or 60 minutes. These alternatives reduce the number of usable observations yet do not improve the explanatory power of the equation. As one would expect, the previous loan's rate is positively correlated with the rate charged on the next loan. We drop the first loan of each day since it is likely not affected by the previous day's last loan. The coefficient is probably biased downward relative to the true effect of lagged market conditions because our data reveal only the time at which the loan was sent and not the time of loan negotiation.

The results also show that larger loans carry a higher interest rate (row 3). The squared value term (row 4) is negative suggesting that this relationship is non-linear and that at very large loan values, the interest rate declines. This is a plausible finding since very large borrowers are likely to get preferential treatment by the banks as part of an ongoing relationship. All else constant, it is estimated that the interest rate on loans below $306 million rises as the size of the loan increases. Loans above $306 million tend to get less expensive as they get larger. When the same equation is estimated excluding loans at the target rate (column R2 results, Table 4), this "threshold" value increases to $321 million.

The coefficient estimates presented in Table 4 rows 5 though 7 suggest that the most expensive loans are those borrowed in the morning and paid back the following morning. The least expensive are afternoon loans paid back in the afternoon. This can be explained by typical cash management strategies. As the end of the day approaches and the uncertainty with respect to the final balance diminishes, cash managers are more willing to lend loans at lower rates than at the beginning of the day, when the end-of-day balance is still highly uncertain (and higher rates are charged to compensate for the risk of being short at the end of the day). In other words, morning loans are more expensive because there is more uncertainty. The fact that there are fewer trades and thus a less liquid market will also contribute to higher interest rates on morning loans. The most costly of

[15] Reid (2007) finds that the overnight rate derived from partially collateralized morning Receiver General auctions does not have a material impact on CORRA so it's likely to have even less impact on the uncollateralized rate. Therefore, we do not include this measure in our analysis.

all morning loans are paid back earlier in the day since the roll-over cost is relatively more expensive. Loan duration appears to be an insignificant factor in rate determination (note that loans borrowed and paid back in the morning have approximately the same duration as loans borrowed and paid back in the afternoon, yet the former are on average 3.35 basis points more expensive) and it confirms the notion that repayment time is not a factor in the negotiation of overnight loan rates.

Table 4: Regression estimates*

Row No.		R1:Exlcude the first loan of each day N= 49965	R2: Exclude the first loan of each day and all loans at target rate N= 22243
1	C	-1.83 (-57.30)	-3.43 (-52.23)
2	RATE_DEV(-1)	0.126 (10.33)	0.208 (9.14)
3	VALUE_MIL	1.24E-02 (24.75)	2.14E-02 (14.79)
4	VALUE_MIL_SQ	-2.03E-05 (-18.97)	-3.34E-05 (-9.47)
5	AM_TO_AM	3.35 (16.34)	6.21 (16.99)
6	AM_TO_PM	1.24 (5.53)	2.49 (4.49)
7	PM_TO_AM	1.21 (23.77)	2.31 (20.03)
8	BIG_TO_SMALL	-0.79 (-8.61)	-2.16 (-9.75)
9	SMALL_TO_BIG	1.69 (19.18)	3.77 (17.24)
10	SMALL_TO_SMALL	1.08 (21.84)	2.35 (19.56)
11	FAD_PRE9	17.69 (6.59)	14.86 (5.21)
	R^2 **Standard Error**	**0.0818** **4.64**	**0.150** **6.57**

*T-values are in parenthesis. All coefficients have a p-value of 0.

We are able to confirm the observation that we made in section 4 that small participants charge higher rates than big participants (Table 4, row 8-10). The rate is the highest when small participants lend to big banks and the best rates are offered by big banks to small participants. One way to interpret this result is to suggest that small participants have greater bargaining power as the marginal suppliers of liquidity to big banks. But as mentioned before, some loans are extended by LVTS participants on behalf of their clients in which case the rates charged reflect borrower's (client's) credit rating.

The dummy variable for pre-9 a.m. loans on FADs (row 11) controls for the large deviations we observe on the morning of the overnight interest rate target announcement. It is assigned a value of 1 for each loan sent before 9-a.m. on the days the target rate was

increased by 25 bps, and -1 if the target rate was decreased by 25 bps. It has a large positive coefficient which reflects the fact that loans are transacted closer to the new rates even though they are sent before the new rate is announced (see section 4.2).

And finally, although not shown in Table 4, we were unable to find any significant Friday and/or before-holiday effects. Rates are not significantly different at the beginning or end of month either, despite higher than normal LVTS payment flows at those times.

The overall explanatory power of the regression is somewhat low (R^2 is 0.082) but all 11 coefficients have a p-value of 0. Such high level of significance and low R^2 are not unusual for high-frequency data. In column R2, we repeat the above regression but exclude all loans exactly at the target rate (55% of all loans). We hypothesize that loans at the target rate are more likely to be interbank loans while other observations are loans to customers which could exhibit different behaviour. The results show that the R^2 improves significantly, the coefficient values are larger, but all the same conclusions hold. The R^2 would likely be improved further if we knew the identity of the counterparties rather than making an implicit assumption, as we do in this case, that loans at target rate are interbank loans.

6.0 Conclusion

We begin by describing the methodology for identifying overnight loan and loan repayment transactions in LVTS payments data and outline its potential drawbacks. Implementing this methodology allowed us to obtain a set of overnight loan transactions over a two year period. Although we cannot quantify how successful we were in attaining this goal, the small variations in the day-to-day measures of volume, value, and rates relative to the target rate, give us confidence that we have probably accurately captured a large proportion of the overnight loan market settled through LVTS. We find that on average 97 loans worth around 5 billion dollars are transacted every day. Admittedly, the size of this market, relative to the overnight repo market, is small. However, unlike the repo rate where the cost of collateral is implicitly priced-in (resulting in rate fluctuations due to the changes in the demand and supply of collateral), the uncollateralized overnight rate directly reflects the cost of overnight funds. Over the two year sample period, the uncollateralized overnight rate displayed little volatility and very small deviations from the target overnight rate. It is remarkably stable even during periods of large volatility in the collateralized overnight rate.

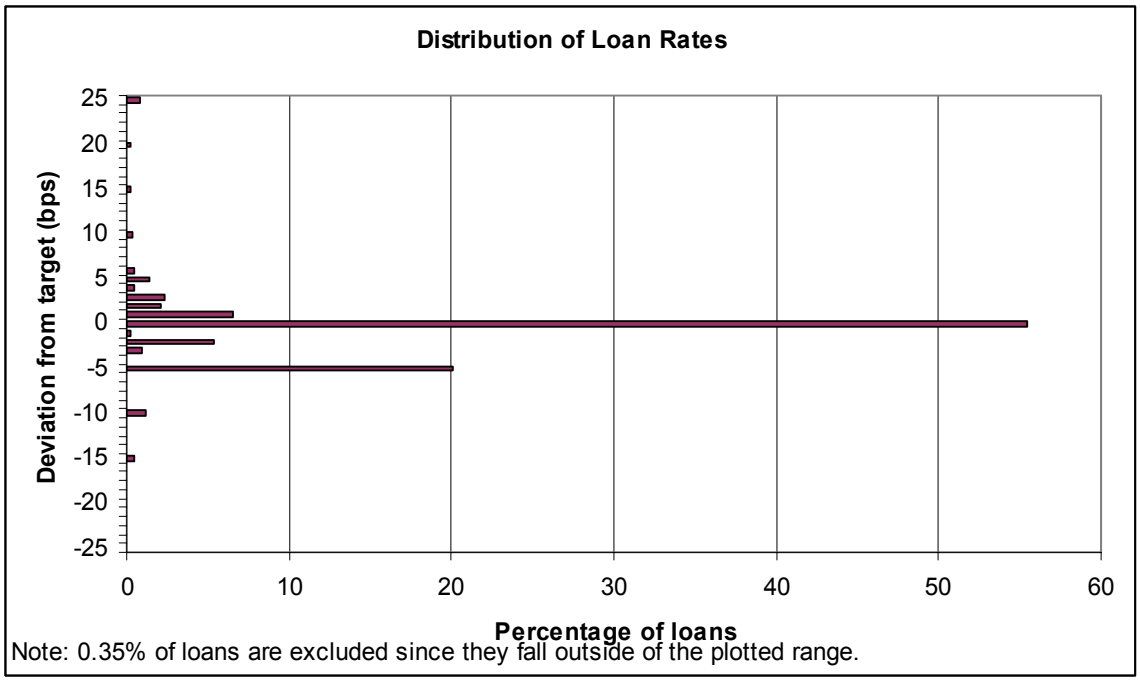
The six big Canadian banks are the most active players. They borrow 90 per cent of all loans by volume (92 per cent by value) and lend 82 per cent of loans by volume (72 by value). The bulk of lending by volume occurs in the afternoon between 2 p.m. and 5 p.m. with the largest loans being sent after 4 p.m. Rates charged by small participants are generally higher and more volatile. Microstructure analysis further reveals that loan rates vary according to the market conditions, measured by the latest available rate, size of the loan and the type of the lender and borrower. As the size of a loan increases the interest rates also increases but for very large loans this effect is reversed.

Appendix

Table A1: LVTS Participants- Big (B) and Small (S)

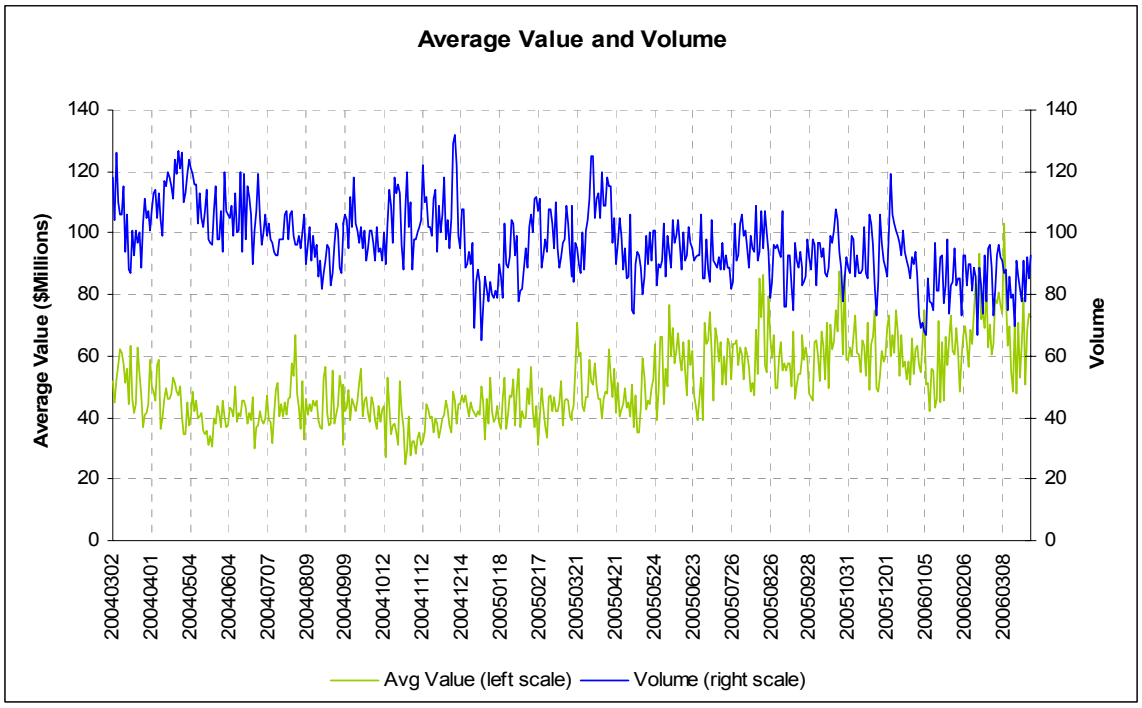
Alberta Treasury Branches	(S)
Bank of America	(S)
Bank of Montreal	(B)
Bank of Nova Scotia	(B)
Banque Laurentienne	(S)
Banque Nationale du Canada	(B)
Banque Nationale du Paribas	(S)
Caisse Centrale Desjardins du Québec	(S)
Canadian Imperial Bank of Commerce	(B)
Credit Union Central of Canada	(S)
HSBC Bank Canada	(S)
Royal Bank of Canada	(B)
State Street Bank and Trust (since Oct. 2004)	(S)
Toronto Dominion Bank	(B)

Chart A1



Note: 0.35% of loans are excluded since they fall outside of the plotted range.

Chart A2


Average Value and Volume
Average Value ($Millions)
Volume
140
120
100
80
60
40
20
0
20040302
20040401
20040504
20040604
20040707
20040809
20040909
20041012
20041112
20041214
20050118
20050217
20050321
20050421
20050524
20050623
20050726
20050826
20050928
20051031
20051201
20060105
20060206
20060308
Avg Value (left scale)
Volume (right scale)

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