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An Assessment of the Bank of Canada's Term PRA Facility

by Emanuella Enenajor, Alex Sebastian, and Jonathan Witmer

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Abstract

This paper empirically assesses the effectiveness of the Bank of Canada's term Purchase and Resale Agreement (PRA) facility in reducing short-term bank funding pressures, as measured by the CDOR-OIS spread. It examines the behaviour of this spread around both term PRA announcement dates and term PRA operation dates, using an event-study methodology to control for developments in other money markets (i.e., using the U.S. LIBOR-OIS spread) as well as proxies for Canadian banking sector credit risk. Overall, there is robust evidence that the term PRA announcements reduced bank funding costs at both 1-month and 3-month terms, whereas we find no evidence of an impact from term PRA operations. However, given the small number of term PRA announcements in our sample, caution should be taken in attributing the reduction in the CDOR-OIS spread solely to the term PRA announcements, since other concurrent events (including other announcements by the Bank of Canada) may have also contributed to a compression in the CDOR-OIS spread.

JEL classification: E58, G12, G18
Bank classification: Financial markets; Financial stability

Résumé

Les auteurs évaluent empiriquement l'efficacité du mécanisme de prise en pension à plus d'un jour de la Banque du Canada pour réduire les pressions sur les marchés du financement bancaire à court terme, en prenant pour mesure l'écart entre le taux CDOR et le taux des swaps indexés sur le taux à un jour. Ils analysent le comportement de l'écart autour des dates d'annonce et des dates d'exécution des opérations menées dans le cadre du mécanisme, en utilisant une approche événementielle qui permet de tenir compte de l'évolution des autres marchés monétaires (en suivant l'écart entre le taux LIBOR et le taux des swaps indexés sur le taux à un jour aux États-Unis) ainsi que des mesures approchées du risque de crédit du secteur bancaire canadien. Dans l'ensemble, les résultats montrent de façon concluante que les annonces des opérations de prise en pension à plus d'un jour ont fait diminuer les coûts de financement des banques à un mois aussi bien qu'à trois mois, alors que rien n'indique d'effet imputable à l'exécution des opérations. Comme l'échantillon ne comporte qu'un petit nombre d'annonces, toutefois, on ne saurait sans précaution attribuer à elles seules la compression de l'écart entre le taux CDOR et le taux des swaps indexés sur le taux à un jour, puisque d'autres événements survenus aux mêmes dates (y compris d'autres annonces de la Banque) peuvent également avoir contribué à cette compression.

Classification JEL : E58, G12, G18
Classification de la Banque : Marchés financiers; Stabilité financière

1 Introduction

In 2007, pressures began to mount in Canadian short-term bank funding markets. These funding pressures were evidenced by a number of factors, most notably an increase in the spread between banks' unsecured wholesale funding rates and expected overnight rates (proxied by the CDOR-OIS spread).[1] A widening in this spread reflects either an increase in Canadian bank credit risk, heightened funding liquidity risk, or some combination of the two.[2]

In response to pressures in term funding markets, on 12 December 2007, the Bank of Canada announced its term Purchase and Resale Agreement (term PRA) facility as part of a broader initiative of similar programs by global central banks to alleviate pressures in short-term funding markets.[3] This facility was designed to provide short-term (but longer than overnight) collateralized funds to counterparties - initially Primary Dealers and later to all direct participants in the Large Value Transfer System (LVTS) in addition to Primary Dealers.[4] The term PRA facility differs from the Bank of Canada's Special Purchase and Resale Agreements (SPRA) facility in that it extends beyond one business day, a broader list of securities is eligible for the term PRA, and the rate is set by auction rather than being set at the target overnight rate.

Zorn, Wilkins, and Engert (2009) suggest: "…the availability of all of the Bank's extraordinary liquidity facilities may have mitigated market stresses and helped to restore well-functioning markets." In this paper, we judge this assertion empirically by addressing one key question: Has the Bank of Canada's term PRA facility had an impact on reducing funding pressures, as measured by the CDOR-OIS spread? We answer this question in three parts. First, we provide a summary of events since August 2007 and discuss how the program changed over time in response to evolving funding conditions and other considerations related to monetary policy. Second, we examine whether there was any change in the behaviour of participants in the term

[1] This is the spread between the Canadian Dealer Offered Rate (CDOR) and the Overnight Index Swap (OIS) rate. CDOR is widely used by market participants as a benchmark for bankers' acceptances (BAs) with terms of one month to one year. Bid BA rates are surveyed daily from a pool of nine market makers and after excluding the lowest and highest rates, a simple average is calculated to form the CDOR setting. At times, CDOR may differ from banks' posted offer BA rates by as much as 15 bps. The Canadian OIS rate provides a measure of market expectations of the overnight rate over the period of the OIS contract. It is a short term interest rate swap for which the floating rate is based on the expectations of the geometric average of the Canadian Overnight Repo Rate Average (CORRA), – a measure of collateralized overnight funding which closely tracks the Bank's target for the overnight rate – over the duration of the swap. Please see Appendix A for a fuller discussion of OIS.

[2] Refer to Wu (2008) for a decomposition of LIBOR into credit and liquidity components.

[3] The focus of this note is on the Bank's term PRA facility. For a description of other facilities introduced by the Bank during the crisis, refer to: http://credit.bank-banque-canada.ca/facilities/liquidityfacilities. The Bank had conducted term PRAs in the past for balance sheet operations.

[4] The terms of these transactions are as follows: the Bank of Canada purchases securities from the counterparty, with an agreement to re-sell the securities back to the counterparty at the maturity date of the agreement. This transaction is economically equivalent to a collateralized loan. The funds from the term PRA operations are allocated by a competitive auction process in which the counterparties submit the yield they are willing to pay on the borrowed cash. Funds are allocated in descending order of submitted yields. The highest bid will receive its full allocation (each firm is subject to a maximum of 25% of the funds to be auctioned). Thereafter, the next highest bid will be allocated, and so on until the cut-off yield is reached. All bids at the cut-off yield are proportionally allocated.

PRA operations since the facility's introduction. Some of the data we use in the latter investigation, including the securities financed by participants and bidding behaviour at the auctions, also provide insight into bank funding pressures.

Third, this note assesses empirically whether the introduction of term PRAs had any impact on reducing funding pressures in Canadian money markets. In particular, we will evaluate the effect of the Bank of Canada's term PRA on the CDOR-OIS spread through an econometric study similar to those that have evaluated the Term Auction Facility (TAF), the Federal Reserve's (Fed's) equivalent of the term PRA.

Although funding pressures as measured by LIBOR-OIS[5] and CDOR-OIS spreads were lower in Canada than in the U.S. (and other countries), we feel it is important to assess what impact term PRA operations and announcements had on the CDOR-OIS spread, abstracting from the indirect influence of general changes in the LIBOR-OIS spread.

After controlling for several factors affecting the CDOR-OIS spread, we find an average reduction of 9 bps in the 3-month CDOR-OIS spread around the five term PRA announcement days we identify, which are defined as days when information is publicly released pertaining to expansions of the minimum auction size, range of acceptable collateral, terms of liquidity provision, counterparties, or schedule of 3-month term PRAs. However, given that some of the term PRA announcements occurred concurrently with other announcements by the Bank of Canada, caution should be taken in attributing said reductions in the 3-month CDOR-OIS spread solely to the term PRA announcements.

2 History

To put our empirical results in context, we examine the history of the term PRA facility since its introduction in December 2007 and examine how its evolution relates to changes in funding conditions as measured by the CDOR-OIS spread.[6] We examine the CDOR-OIS spread rather than CDOR since the latter reflects not only liquidity and credit premiums, but also expectations for the overnight rate over the duration of the loan. We remove these expectations from observed CDOR by subtracting the OIS rate.[7] This spread can be used as a proxy for Canadian bank credit risk, as well as funding liquidity risk.[8,9]

[5] The U.S. analogue of the CDOR-OIS spread.

[6] A more thorough discussion of the history of the Bank's liquidity facilities (including the term PRA) over the crisis is discussed in Zorn, Wilkins, and Engert (2009).

[7] The liquidity premium will fluctuate based on the volume of cash available in the market, as well as the banks' expectations of the relative ease of borrowing in the future. The credit premium will fluctuate based on markets' perceptions of the default risk of the worst bank; this is because CDOR submissions are for bid rates on BAs issued by any schedule I bank. However, it is generally agreed that the liquidity of key funding markets and the credit risk of banks are difficult to separate since the two variables exhibit co-dependence.

[8] Liquidity factors that may have an impact on the CDOR-OIS spread include disruptions in the arbitrage process which should keep CDOR and OIS reflective of true underlying risk, which in turn may be due to the scarcity of room on bank balance sheets.

In August 2007, amidst an increase in funding pressures in other countries and a freeze in Canada's non-bank Asset-Backed Commercial Paper (ABCP) market, the 3-month CDOR-OIS spread increased about 40 bps above its historical average of 7 bps (See Figure 1). At that time, the Bank of Canada was providing liquidity in response to funding pressures in the overnight market by extending collateralized overnight funding through its SPRA facility, and via an increase in the level of daily settlement balances.[10]

After the CDOR-OIS spread declined throughout October and November 2007, they began widening again in December as concerns about funding pressures related to the approach of the calendar year-end for international financial institutions spilled over into the Canadian market. The term PRA facility was first announced on 12 December 2007, in concert with similar facilities being introduced by other central banks in order to address the ongoing stress in the short-term funding markets. At this time, the 3-month CDOR-OIS spread was about 40 bps.

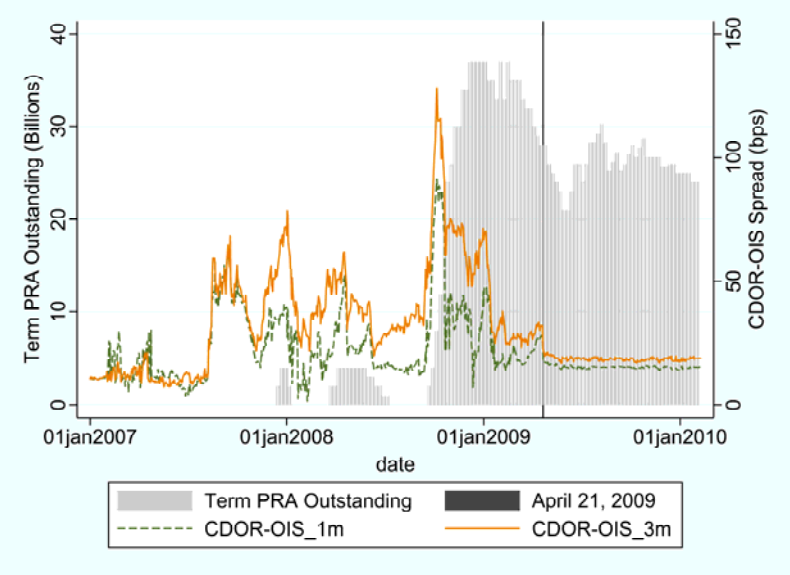
The initial term PRA announcement consisted of two auctions of $2 billion apiece, with maturities of about two weeks and about one month designed specifically to provide funding over the calendar year-end.[11] When these liquidity operations matured in January 2008, the determination was made that the program was no longer necessary on the basis that the year-end "event risk" had passed and conditions in short term funding markets had improved significantly. The facility was re-introduced on 11 March 2008, as part of a coordinated action by G10 central banks to calm funding markets in response to heightening funding pressures in the lead-up to the collapse of Bear Stearns. From late March through mid-May 2008, the Bank of Canada renewed 1-month operations as they matured, with the amount of term PRA outstanding stable at $4 billion, before letting the facility wind down again throughout June and early July in response to improved funding conditions – evidenced by a decline in the CDOR-OIS spread from 60 basis points to about 30 basis points.

[9] Because there is no exchange of principal in an OIS swap contract and because OIS markets are relatively liquid, OIS rates contain minimal credit and liquidity risk. See Appendix A for a fuller discussion of OIS rates.

[10] For more information on settlement balances and their monetary policy implications, please see http://www.bankofcanada.ca/en/lvts/lvtsmp3.pdf.

[11] The original range of eligible securities included those issued or guaranteed by the Government of Canada, securities issued or guaranteed by provincial governments, and bankers' acceptances and bearer deposit notes with remaining maturities of less than 180 days.

Figure 1: CDOR-OIS spreads and Term PRA Outstanding



After a relatively calm summer, funding markets seized up again in September 2008. This market turmoil witnessed the collapse of Lehman Brothers on 15 September 2008, which was quickly followed by the near failure of AIG, the take-over of Merrill Lynch by Bank of America, and the conversion of the remaining 2 large U.S. investment banks – Morgan Stanley and Goldman Sachs – into commercial banks. This series of events caused bank funding spreads to balloon to unprecedented levels in most markets globally. In early October, the 3-month CDOR-OIS spread topped out above 120 bps. Conditions were even worse in the U.S. where 3-month LIBOR-OIS spreads exceeded 360 bps.

In response to these developments, on 18 September 2008, the term PRA facility was reintroduced. Subsequently, on 23 September, the range of eligible collateral was increased and the maximum duration of operations was extended to 3 months.[12] On 25 September, the frequency of operations was increased from bi-weekly to weekly, and on 3 October 2008, the bank began temporarily accepting affiliated bank-sponsored ABCP as collateral with a 22.5% margin requirement.[13]

As part of the G7 Action Plan, on 14 October, the Bank of Canada significantly expanded the maximum size of term PRA operations to $10 billion (it would later reach $12 billion), and extended eligible counterparties to include all direct LVTS participants (whereas previously only

[12] The range of eligible collateral was increased to include all securities that were eligible as collateral for the Bank's Standing Liquidity Facility (SLF), including certain issues of commercial paper, bankers' acceptances of longer maturities, bank-sponsored unaffiliated asset-backed commercial paper, and municipal bonds and corporate bonds with ratings higher than A-. For a full list of the eligible collateral announced on this date, refer to: http://www.bankofcanada.ca/en/notices_fmd/2008/not230908.html

[13] Unaffiliated ABCP is where the party financing the ABCP at the term PRA operation is not the sponsor, the financial services agent, an administrative agent or similar service provider, or a provider of liquidity support to the program. For more information on this announcement, refer to http://www.bankofcanada.ca/en/notices_fmd/2008/not031008_pra.html

Primary Dealers were eligible for this facility). Over the subsequent 4 month period, the size of total term PRA operations outstanding peaked at $37 billion on a number of occasions, the first being 4 December. This peak figure represents 2.3% of Canadian GDP and 1.2% of the assets of the Canadian banking system.[14] To put these figures into perspective, the peak amount outstanding at the Fed's TAF was $493 billion (USD)[15]; this represents 3.5% of U.S. GDP and 2.7% of the assets of the U.S. banking system.

In early 2009, conditions in money markets improved markedly. The three-month CDOR-OIS spread fell below 40 bps in early April, from over 70 bps in early January. On 21 April, the Bank of Canada reduced the overnight rate to the effective lower bound of 25 bps and made a commitment to keeping the overnight rate at this level until 2010 Q2, conditional on the outlook for inflation. To reinforce this conditional commitment, the Bank of Canada rolled over a portion of its existing stock of 1- and 3-month term PRAs into 6- and 12-month terms with minimum and maximum bid rates corresponding to the target for the overnight rate (25 bps) and the Bank Rate (50 bps), respectively. It was at this time that the term PRA facility became as much a monetary policy tool as it was a liquidity facility. The maturities of the longest-dated term PRAs were scheduled to approximately match the end of the Bank of Canada's conditional commitment. This shift to longer-term operations while maintaining a weekly frequency temporarily increased the volume of term PRAs outstanding (since longer issues do not roll over as frequently). As funding conditions continued to improve, and the end of the conditional commitment approached, the Bank of Canada gradually reduced the size, term and frequency of operations. On 20 April 2010, in conjunction with the removal of their conditional commitment, the Bank of Canada announced the end of the term PRA facility, the final operation having been conducted on 12 April 2010.[16] The final term PRA operation is projected to mature 21 July 2010.

3 Term PRA Auction Results and Interbank Funding Pressures

We use a number of details of the term PRA operations to gauge funding pressures in the Canadian wholesale bank funding market as well as demand for the term PRA facility. These include bidding behaviour (e.g., coverage ratio and range of bids at each auction) and securities financed in the auctions. We also examine whether changes to parameters of the auction, such as accepting a bank's own ABCP as collateral, had an impact on behaviour at the auctions. However, since observations of these series are only available each day an auction occurs, we examine how they have evolved over the life of the term PRA program, rather than attempting to

[14] Including other term lending facilities, namely the Term Loan Facility and the term PRA Facility for Private Sector Money Market Instruments, the total amount of term liquidity extended by the Bank of Canada over this period peaked at just over $41 billion.

[15] http://www.federalreserve.gov/releases/h41/hist/h41hist4.pdf

[16] Total volume outstanding at this point was $22 billion.

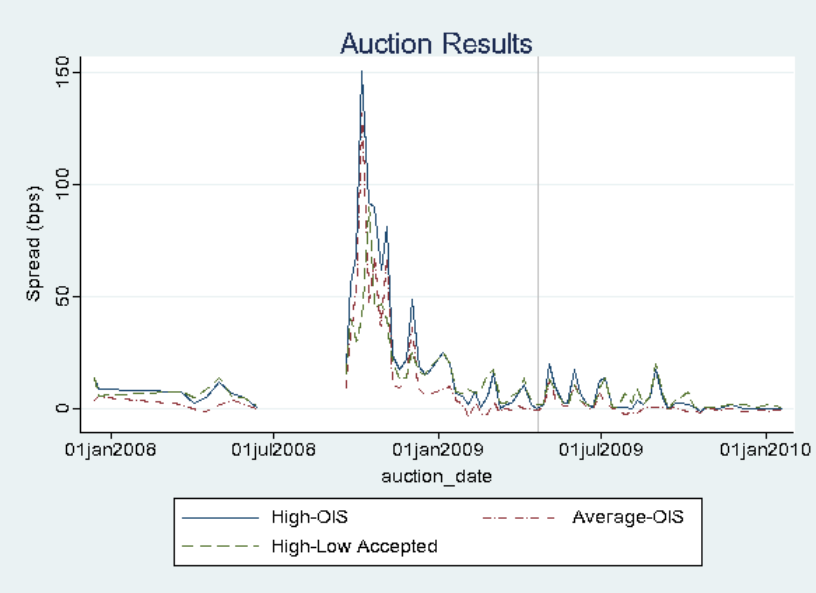
empirically assess whether operations had an impact on these measures. We will examine each of these measures individually below.

3.1 Bidding Behaviour

Bidding behaviour in auctions is indicative of funding pressures, since more aggressive bidding relative to expected overnight rates and a higher bid-to-cover ratio in the presence of a minimum bid rate, suggests greater need for funding by auction participants. As evident in Figure 2, the three different measures of bidding behaviour derived from the auction results are highly correlated. The highest bid less OIS, the average accepted bid less OIS, as well as the range of bids are highly correlated and spiked in the post-Lehman period, when term PRAs were re-introduced and substantially increased in size. At this point, the highest bid was 150 bps over the OIS rate of an equivalent maturity and the average bid reached more than 130 bps over said OIS rate.

Since mid-January, 2009 bidding in term PRAs with maturities of 3 months or less was in a tight range close to the OIS rate. In the 23 operations of 3 months or less over the period from 20 January 2009 through 14 September 2009, only two operations (3 March and 6 April) witnessed a spread between the high bid and OIS which exceeded 10 bps.[17]

Figure 2: Auction Results



Beginning 4 May 2009, the Bank began conducting the longer-term 6-month to 1-year operations. Spreads over OIS rates were higher in these longer operations. The spikes in spreads

[17] Also, it is expected that these metrics would move in a narrower range after 21 April 2009 when the Bank introduced minimum and maximum bid rates, since the maximum range (high-low) possible during this period is 25 bps.

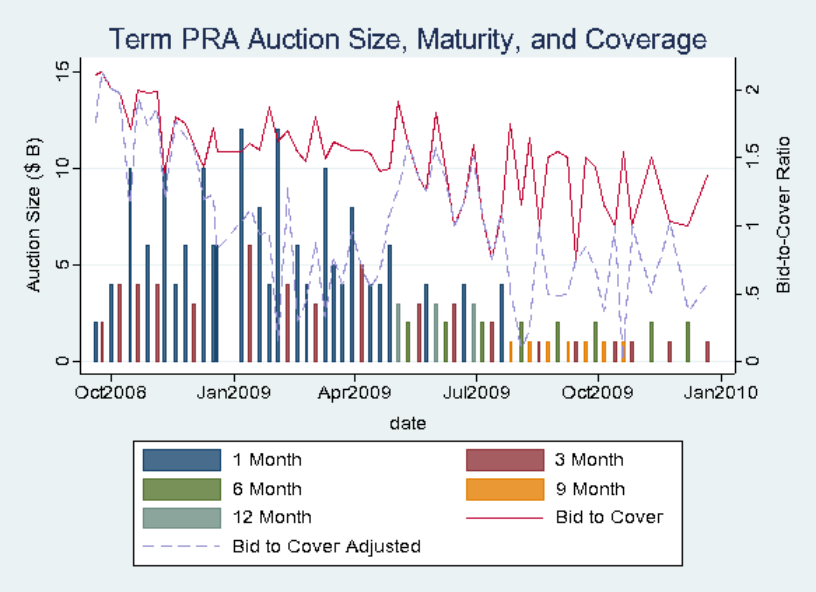
over OIS since the introduction of longer term operations correspond to auctions with a term greater than 3 months (see Figure 2). These observations are not surprising, since auction participants should be willing to pay a premium to secure longer-term funds, given that there is less liquidity in longer-term repo markets – even in normal times.

Another measure of bidding behaviour is the bid-to-cover (or coverage) ratio, which is obtained by dividing the total volume of bids submitted at an auction by the amount the Bank of Canada offered to lend at that operation.[18] However, as previously mentioned, until 21 April 2009, there was no minimum bid rate and participants could bid for funding below the OIS rate. Hence, until this date, the bid-to-cover ratio is not a good metric of the true demand for funding at or above market rates and cannot be directly compared to the coverage ratios of operations conducted thereafter. As an alternative measure, we calculate an adjusted coverage ratio which excludes bids which are below the indicative OIS rate. It is worth noting that this measure may underestimate the demand for funds at a particular auction because participants that submitted bids below OIS rates may have bid at or above OIS rates in the presence of a minimum bid rate.

Taken together, these two metrics put an upper and lower bound on the bidding demand at auctions. Figure 3 shows the evolution of these two measures since term PRAs were introduced in December 2007. The difference between the two lines represents the volume of bids (scaled by operation size) that were below OIS rates. From September 2008, when term PRAs were re-introduced, until April 2009, there was a downward trend in the adjusted coverage ratio and an increase in the difference between the adjusted and unadjusted coverage ratios, reflecting more bidding below OIS rates as a result of reduced funding pressures. Following the announcement on 21 April 2009, these two measures converged given that OIS rates were close to the 25 bps minimum bid rate introduced on that date. The increase in the adjusted ratio also likely reflects more demand for longer-term operations. However, since July 2009, a spread between the expected overnight rates and the minimum bid rate (especially at longer-term auctions) has allowed participants to again bid for funding below OIS rates, and as a result their bids are eliminated from our adjusted coverage ratio. This explains the divergence witnessed between the adjusted and the unadjusted coverage ratios.

[18] Technically, the amounts of both the operation and the bids submitted by participants are expressed in terms of par value of securities sold, not in terms of dollar amount lent. So the coverage ratio is really calculated by dividing the total par value amount of securities offered by auction participants by the maximum par value amount of securities the Bank is prepared to purchase against cash at that operation. This technicality does not impact our general conclusions.

Figure 3: Auction Size, Maturity and Coverage Ratio



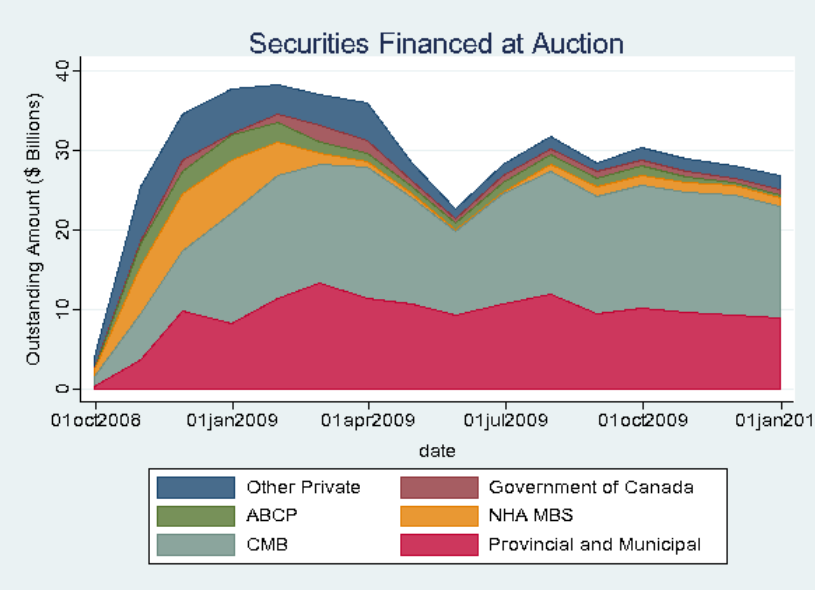
3.2 Securities Financed in the Auctions

The type of securities financed through the term PRA facility has also changed significantly over time, reflecting the ease with which the types of securities can be funded in private markets, changes in auction parameters, and the composition of participants' balance sheets. With the exception of securities issued by the Government of Canada (which are the most liquid and can be most easily funded in the private markets), all classes of eligible securities were financed at the term PRA facility in significant volumes when the facility was reintroduced and its size significantly increased in the fall of 2008 (see Figure 4). Initially, ABCP, National Housing Association Mortgage-Backed Securities (NHA MBS), Canada Mortgage Bonds (CMBs), Provincial and Municipal bonds, as well as other private securities all represented a significant portion of the total securities financed at the term PRA facility. Shortly after the Bank altered its list of eligible securities to include ABCP (among others), the total ABCP financed at the term PRA facility peaked in mid-November 2008 at just over $4B, representing about 8% of the total ABCP market at that point. Toward the end of 2008, the distribution of securities financed at the term PRA facility began shifting considerably. As the Canada Mortage and Housing Corporation (CMHC) began purchasing NHA MBS from the banks under the Insured Mortgage Purchase Program (IMPP)[19], NHA MBS as a percentage of total securities financed dropped from a high of 35% to settle in a range of 0-5%. Conversely, CMBs pledged at the facility consistently climbed from about 18% of total assets financed to settle consistently at about 50%. Finally, Provincial and Municipal bonds (the vast majority of which are Provincial bonds) also

[19] The first IMPP operation was conducted on 16 October 2008. Briefly, the mechanics of the program are as follows: the CMHC purchases NHA MBS from the banks, with financing provided by issuance of Treasuries by the Federal government.

steadily climbed from an inital 10-15% range to more recently consistently representing about 35% of the assets financed at the facility.

Figure 4: Securities Financed at Auction



4 The Effect of Term PRAs on CDOR-OIS Spreads

This section examines the impact of the Bank of Canada's term PRA Facility on the liquidity premiums in Canadian bank funding costs, using the CDOR-OIS spread as a proxy for funding costs.

4.1 Methodology

We evaluate the effect of term PRAs on daily CDOR-OIS spreads over the period from 1 January 2007 to 13 September 2009 using an "event study" methodology (i.e., by regressing the CDOR-OIS spread on a set of control variables as well as a term PRA dummy variable). This is broadly the same empirical methodology employed by many studies that test for an effect of the Fed's TAF on the LIBOR-OIS spread. The common theme among the majority of these studies is the focus on determining the liquidity facility's effectiveness in reducing the liquidity and credit default components of LIBOR-OIS spreads, with the hypothesis that the TAF is likely to have a direct effect on the liquidity component, but much less likely to directly affect the credit component.

However, while these papers generally try to answer the same question, they have different conclusions which are likely due to differences in the econometric methodologies they employ. On the one hand, Wu (2008); McAndrews, Sarkar, and Wang (2008); Abbassi and Schnabel

(2009); and Christensen, Lopez, and Rudebusch (2009) find evidence for a significant effect (cumulatively, between 44 bps and 75 bps) of the TAF in reducing the liquidity component of LIBOR-OIS spreads. On the other hand, Taylor and Williams (2009) do not find any "robust" evidence of an effect of the TAF on LIBOR-OIS spreads.[20]

An "event study" methodology is useful when attempting to isolate the impact of term PRAs while controlling for other factors.[21] However, we do not employ the methodology of Wu (2008), who regresses the *level* of LIBOR-OIS on a set of control variables and a TAF dummy which is set to 1 for all trading days since the inception of the program. The power of event studies generally decreases with the length of the event window (MacKinlay, 1997), and in an event window of several months, there were likely other factors affecting LIBOR-OIS spreads. Therefore, with a long event window, it is more important to have a correctly-specified model with the appropriate control variables.

To mitigate the risk of erroneously attributing to term PRA events the impact of other factors which may have decreased the CDOR-OIS spread since the inception of the term PRA program, we use a short, 1-day event window and regress the *change* in the CDOR-OIS spread on a set of control variables and term PRA dummy variables which take on a value of 1 for term PRA event days. We use the change rather than the level because the level exhibits a unit root and also because the regression of the level on a term PRA event dummy variable makes the implicit assumption that the effect of the term PRA is temporary (see McAndrews et al).

This approach generally follows the empirical setup of McAndrews, Sarkar, and Wang (2008). The drawback of this methodology, given the small number of term PRA events in our sample, is that other unrelated but concurrent developments affected the CDOR-OIS spread. We mitigate this risk by choosing the smallest event window possible given the available data (1-day) and by including RHS variables that can help to control for other factors that may influence the CDOR-OIS spread. We perform our event study tests using several different specifications, given the absence of a structural model for CDOR and the relative scarcity of credit data in Canada. Our results do not change under different specifications and this is generally consistent with single day event studies using equity returns, which are generally insensitive to the choice of model since the marginal explanatory power of additional factors is small (Brown and Warner, 1985;

[20] Baba and Packer (2009) perform a similar analysis on central bank dollar swap lines and their effect on overseas dollar funding costs.

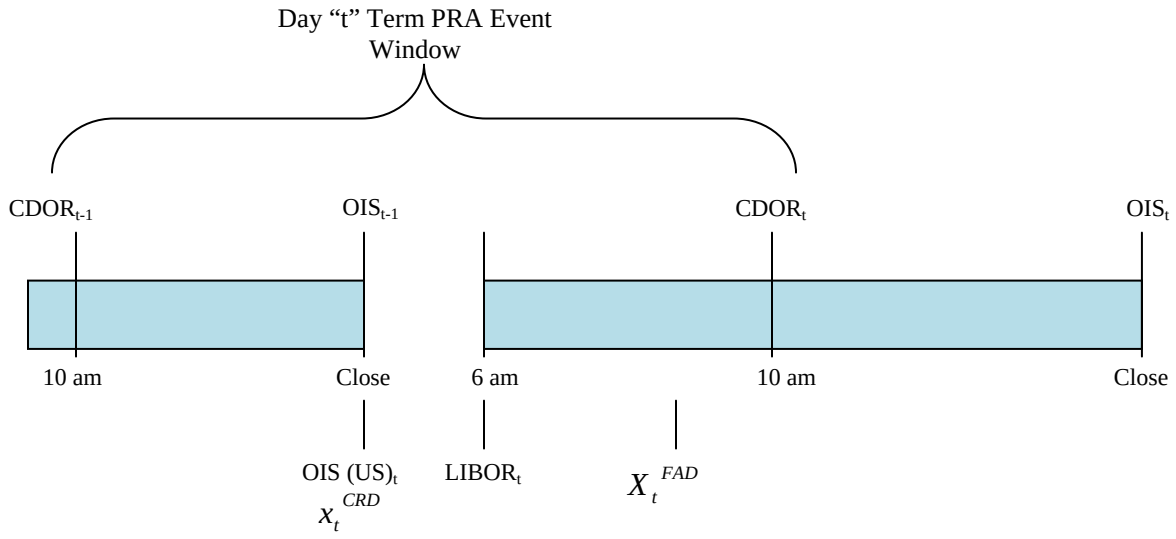
[21] A methodology that we do not consider for our study is a dynamic term structure model as in Christensen, Lopez, and Rudebusch (2009) which decomposes movements in the funding rate into components which include credit premiums and interbank liquidity premiums. Although this methodology may allow for a more fulsome description of the funding rate dynamics, it would require a structural model of CDOR-OIS spreads to determine what 3-month CDOR would have been absent the introduction of the term PRAs, combined with testing the hypothesis that the variable parameters of the structural model experienced a regime change since the inception of the term PRAs. We choose not to use this framework because it would be difficult to establish that the term PRAs alone caused parameter changes since many other significant events (which cannot be controlled for in this framework) occurred that could have led to a lower actual path of CDOR relative to the counterfactual rate.

MacKinlay, 1997). Our sample includes data from the beginning of 2007 until 13 September 2009.

4.2 Description of variables

***CDOR-OIS spreads*:** Our dependent variable is the daily change in the 3-month CDOR-OIS spread, a proxy for interbank funding costs. This spread primarily contains factors reflecting credit and liquidity risk premiums (as the term risk and interest rate risk in CDOR are eliminated by subtracting the OIS rate). We focus on the 3-month term in our study because 3-month CDOR is the most relevant economically as it is widely used as a benchmark for Canadian short-term lending and borrowing rates. We calculate today's CDOR-OIS spread by subtracting today's closing OIS rate from today's 10 am CDOR setting. Also, we consider day "t" events to have occurred between the collection of CDOR on day "t-1" and day "t" (See Figure 5).[22]

Figure 5



We base the division of our event window for a given day on CDOR collection times in order to avoid erroneously measuring the impact of a day "t" event occurring after 10 am on that day's CDOR (which has already been collected). While neither methodology is perfect because CDOR and OIS are collected at different times in both, we differ from the McAndrews et al. methodology because most important economic data releases in Canada occur at 7 am or 8 am, before the setting of CDOR, which may result in a distorted CDOR-OIS measure if the previous day's closing OIS rate is used. However, the drawback to our approach is that we expect economic or market events that occur after the collection of CDOR on a given day to impact the following day's OIS rate (not the current day's OIS rate). This may distort our results, and in our

[22] McAndrews, Sarkar, and Wang, on the other hand, calculate today's U.S. LIBOR-OIS spread by subtracting today's closing OIS rate from tomorrow's 6 am LIBOR.

robustness section, we show how sensitive the results are to a setup more similar to McAndrews et al.[23]

Control Variables: We include several control variables in our regression to account for factors that can help explain or predict what the change in the CDOR-OIS spread would have been absent any term PRA events. We select variables that should be unaffected by the term PRA events, although this is already accomplished by construction since there is a lag between the measurement of CDOR and the measurement of our other control variables, with the latter generally preceding term PRA announcements. Given that the CDOR-OIS spread is composed primarily of liquidity and credit factors, we select control variables that capture either or both of these factors. We also select another control variable to account for possible measurement error in the spread around FADs.

(i) Canadian banking sector credit risk: The CDOR-OIS spread contains a component reflecting the credit risk of Canadian banks that we wish to control for. Our first choice for a credit proxy would be an index of Canadian bank CDS spreads, but since no such measure exists in Canada, we use an alternative: the changes in the difference between the option adjusted spread (OAS) of the Merrill Lynch Canadian Financials index and the BBB index, represented by x_t^{CRD}.[24] Assuming the changes in the liquidity component of the spreads on these two indexes are similar, an increase in this spread would imply an increase in the perceived credit risk of financial bonds relative to BBB bonds. Additionally, since this credit proxy is collected at the end of day "t-1" while most term PRA events occur in the morning of day "t", this credit measure on most days is independent of the impact of term PRAs on credit premiums.

(ii) U.S. LIBOR-OIS spreads: Given the interconnectedness of the U.S. and Canadian financial markets, we expect that movements in both the credit and liquidity components of the CDOR-OIS spread may also be driven by movements in the U.S. LIBOR-OIS spread, reflecting banking sector credit risk, U.S. funding liquidity premiums, and the impact of the Fed's liquidity operations. To control for these factors we include changes in the 3-month LIBOR-OIS spread, a measure of interbank funding costs in the U.S. represented by x_t^{LIB}. The LIBOR-OIS spread is unlikely to be impacted by Canadian term PRA operations and announcements and, more generally, Canada-specific liquidity risk. For this reason, we view the 3-month LIBOR-OIS spread as an appropriate control variable for spillover effects from U.S. funding markets.

[23] A regression of $CDOR_t$ on OIS_t and OIS_{t-1} yields a positive coefficient on OIS_t and a negative coefficient on OIS_{t-1}, indicating that $CDOR_t$ may be more related to OIS_t than OIS_{t-1} (as implied by the first date-count convention).

[24] This spread is not a perfect proxy for Canadian banking sector credit risk since only about 60% of the ML Financials Index is made up of securities issued by Canadian banks. Moreover, 4% of the ML BBB Index is made up of securities issued by financial institutions.

(iii)FAD dummy variable: There may be a possibility for measurement error in the CDOR-OIS spread on FAD announcement days given that CDOR is measured shortly after FAD announcements, while the corresponding OIS is measured at the end of the day (or at the end of the previous day using an alternative measurement method discussed in our robustness section). To control for variation in the CDOR-OIS spread which is the result of FAD announcements, we include a FAD dummy variable, X_t^{FAD} which is assigned a value of "1" on FAD days and "0" otherwise.

Term PRA dummy variables: The impact of 3-month term PRAs on the 3-month CDOR-OIS spread is measured using a term PRA dummy variable.[25] $X_t^{TermPRA}$ is assigned a value of "1" for days in which a 3-month term PRA event occurs and "0" otherwise. As in McAndrews et al, a term PRA event includes not only term PRA operations, but also the related announcements (see Table 1 for a detailed list of key announcement dates related to 1-month and 3-month term PRAs).[26] Given that Taylor and Williams (2009) find the McAndrews et al. results for TAF announcements are not robust to different definitions of the event window, we account for the possibility of a one-day and two-day transitory impact in the term PRA effect by including the variables $X_{t-1}^{TermPRA}$ and $X_{t-2}^{TermPRA}$. A test of a linear combination of the term PRA dummy variable coefficients allows us to measure whether the impact of term PRAs persists over a 2-day or 3-day event window.

4.3 Regression Analysis

McAndrews et al. argue that the levels specification in Taylor and Williams (2009) only captures a transitory effect of TAF auctions since the level of LIBOR-OIS spreads contains a unit root. Therefore, they perform a regression using changes in LIBOR-OIS spreads and interpret the results assuming that the TAF effect is permanent. However, this assumption may overestimate the cumulative TAF effect if this effect is in fact, not permanent. We elected to perform regressions using changes in the CDOR-OIS spread ($y_t^{CDOR} = Y_t^{CDOR} - Y_{t-1}^{CDOR}$) since a Dickey-Fuller test (not reported) indicates a unit root in the level of the CDOR-OIS spread. To examine the persistence of this effect, we include lags of the term PRA dummy variable.

The change in the 3-month CDOR-OIS spread is assumed to depend on the change in the 3-month U.S. LIBOR-OIS spread (x_t^{LIB}), a measure of Canadian banking sector credit risk (x_t^{CRD}), a FAD dummy variable (X_t^{FAD}) and an effect of the term PRA dummy variable ($X_t^{TermPRA}$):

$$y_t^{CDOR} = \alpha + \beta_{LIB} x_t^{LIB} + \beta_{CRD} x_t^{CRD} + \beta_{FAD} X_t^{FAD} + \beta_{TermPRA} X_t^{TermPRA} + \varepsilon_t \qquad (1)$$

[25] For robustness we also examine the impact of 1-month term PRA events on the 1-month CDOR-OIS spread.
[26] 3-month term PRA operations include operations with maturities of 3 months or greater, likewise, 1-month term PRA operations include operations with maturities of 1 month or greater.

We depart from previous studies by allowing the error term to follow a GARCH process because OLS estimates are inefficient when residuals are heteroskedastic.[27] Based on Akaike Information Criterion and white noise tests, we model the errors to follow a GARCH(1,1) distribution with an AR(1) term of the structural disturbance included in the model.[28]

As illustrated in Table 2, the coefficient corresponding to changes in LIBOR-OIS is statistically significant at the 1% level, indicating that about 16% of the change in LIBOR-OIS is reflected in changes in the 3-month CDOR-OIS spread. The coefficient on our credit proxy, the change in the Merrill Lynch Financial – BBB OAS spread, is positive as expected and is also statistically significant, indicating that the CDOR-OIS spread increases by 0.7 bps for every 10 bps increase in the credit proxy.[29] FAD dates appear to reduce the CDOR-OIS spread at the 5% level of statistical significance; however, the economic significance of this impact is small.[30]

[INSERT TABLE 2 HERE]

In column (1), only the level of the term PRA dummy variable is included, which is similar to the setup in McAndrews et al., and measures the one-day term PRA impact. Term PRAs appear to have a statistically significant contemporaneous effect in reducing the CDOR-OIS spread at the 10% level as seen in column (1). Lags of the term PRA event dummy $X_{t-1}^{TermPRA}$ and $X_{t-2}^{TermPRA}$ are not statistically significant when included in the regression, as shown in columns (2) and (3). A linear combination test of the coefficients on the contemporaneous and lagged term PRA event dummies indicates that over a 2-day and 3-day event window, the effect of term PRAs on CDOR-OIS is no longer statistically significant.

4.3.1 Separating the Impact of Term PRA Operations and Announcements

Given the results in Table 3 column (1), which indicate weak evidence that term PRAs reduce the 3-month CDOR-OIS spread, we focus on breaking down the impact of $X_t^{TermPRA}$ into announcements X_t^{Ann} and operations X_t^{Ops} to examine whether either of these factors separately are associated with a reduction in the CDOR-OIS spread. In efficient markets, credible announcements of information can cause price changes. We define term PRA announcements as any publicly released information pertaining to expansions of the minimum auction size,

[27] The Ljung-Box Test for white noise on the squared standardized residuals of the GARCH(1,1) specification yields a p-value of approximately 97%, whereas with OLS the p-value is < 0.000%. McAndrews, Sarkar and Wang (2008) do not address the possible presence of heteroskedasticity in their residuals.

[28] A GARCH(1,2), GARCH(2,2), and OLS (using Newey-West standard errors) framework broadly yield the same results as the GARCH(1,1) model.

[29] The Merrill Lynch Financial – BBB OAS spread is negative throughout the sample, hence an increase in the spread implies a less negative spread (i.e. due to an increase in perceived risk in financial bonds). In our robustness section, we examine alternative proxies for credit risk in Canada.

[30] We calculate an R-squared measure using OLS and find that it is approximately 13% (similar to the R-squared measures obtained in McAndrews et al. of around 10%).

collateral, counterparties, term of liquidity provision, as well as announcements related to the extension of program.[31] Term PRA operations refer to:

i. The setting of auction conditions[32]
ii. The implementation of term PRA auctions[33]

We also include the lagged term PRA variables X_{t-1}^{Ann}, X_{t-1}^{Ops} and X_{t-2}^{Ann}, X_{t-2}^{Ops} in order to determine whether the term PRA impact persists beyond one day.

[INSERT TABLE 3 HERE]

Similar to McAndrews et al, term PRA announcements appear to be the key factor reducing the CDOR-OIS spread as seen by the coefficient of X_t^{Ann} in column (1). Under the assumption that X_t^{Ann} is permanent, the cumulative drop in the 3-month CDOR-OIS spread associated with term PRA announcements is estimated as $\sum_{t=1}^{T} \beta_{Ann} X_t^{Ann}$ = 46 bps.

This is a considerable figure when taking into account that the CDOR-OIS spread peaked at around 128 bps during the height of the crisis. The results are robust to the inclusion of the lagged dummy variables as seen in column (2) and column (3), although the inclusion of these variables slightly reduces the statistical significance of the term PRA announcements over a 3-day window. Furthermore, the results remain statistically significant when we exclude any individual announcement from the term PRA announcement dummy variable, implying that the results are not driven by any single term PRA announcement. Although term PRA operations are not significant in reducing the CDOR-OIS spread empirically, the execution of term PRA operations as announced is necessary in order for related announcements to be credible (and hence, to have an impact). Thus, one may argue that the combination of term PRA announcements and operations reduce the CDOR-OIS spread, with the reduction observed on the announcement date.

Care should be taken in attributing the reduction in the CDOR-OIS spread on announcement days solely to the term PRA announcements, as on some of these days the Bank of Canada also made other announcements that could have had an effect on the CDOR-OIS spread. For example, on 14 October 2008, as part of the G7 Action Plan, the Bank also announced that it would accept a general assignment of portfolios of non-mortgage loans as collateral in the LVTS. Presumably, this usage of otherwise non-marketable collateral may have freed up marketable securities to be used for other funding purposes and thereby reduced funding

[31] A regression of the levels (not the change) of the 3-month CDOR-OIS spread on the term PRA variable may raise endogeneity concerns, if term PRA announcements are made in reaction to high levels of CDOR-OIS. This effect is muted, if not altogether absent when examining the change in the CDOR-OIS spread.
[32] We include only days when the auction amount is set above the minimum.
[33] We do not include the public notification of results (as in McAndrews et al.) because it consistently occurs after 10:30 am every auction day, i.e. after the setting of CDOR and because participants know immediately following the auction whether their bid won (around 9:30).

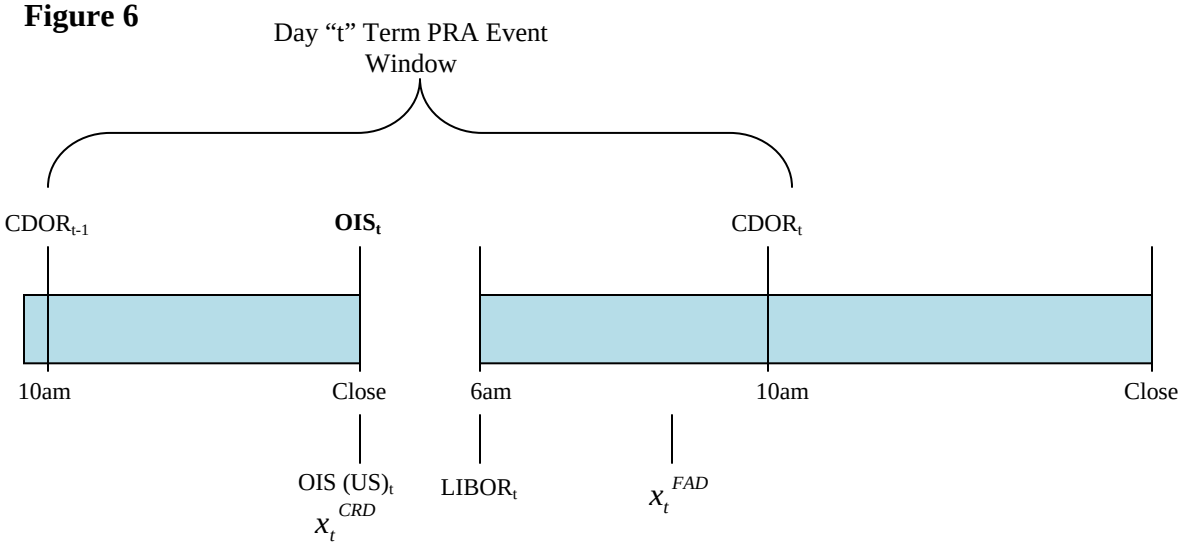
pressures. On 21 April 2009, the Bank also announced a reduction in interest rates, committed to keep the overnight rate at 25 bps through June 2010, and changed the operating framework for implementing monetary policy at the lower bound, increasing the target for the daily level of settlement balances to $3 billion. These announcements unrelated to the term PRA facility may have contributed to reductions in the CDOR-OIS spread observed on those days. Additionally, other global events occurring on or around the term PRA announcement days may have also impacted the CDOR-OIS spread; however, we expect that these factors are largely controlled for by the inclusion of the U.S. LIBOR-OIS spread.[34]

4.4 Robustness Tests

4.4.1 Alternative Date Count Method

An alternative date-count convention is used to calculate today's CDOR-OIS spread by subtracting yesterday's closing OIS rate from today's 10 am CDOR rate. This methodology is more similar to McAndrews et al. who combine the current day's U.S. OIS rate with the LIBOR rate collected at 6 am the following day. Figure 6 presents a timeline illustrating the alternative date-count convention.

Figure 6



The timing of our control variables relative to measurement of CDOR on a given day is still intuitively appealing under this specification. However, our dependent variable is the CDOR-OIS spread calculated using today's CDOR and yesterday's OIS rate. This alternative method for

[34] On 25 September 2008, the FDIC announced it would be backing a JPMorgan purchase of Washington Mutual. Also, on 2 October 2008 the purchase of Fortis Group's Dutch operations was announced by the Dutch government. Finally, on 14 October 2008 the Federal Reserve announced additional details on the Commercial Paper Funding Facility (CPFF) and the FDIC announced its guarantee of senior debt of FDIC-insured bank holding companies.

measuring CDOR-OIS introduces the possibility of considerable measurement error as any economic releases occurring on a given morning would not have been reflected in the previous day's OIS rate. When we re-estimate the primary regression using this alternative date count convention, our results imply that term PRA announcements appear to reduce the 3-month CDOR-OIS spread as seen in Table 4 column (1). However, the one-day effect of term PRA announcements is markedly larger under this specification. This result is due to the fifth Term PRA announcement which occurs on 21 April 2009, a FAD, which witnessed significant declines in both the CDOR and OIS rates. This alternative date count method captures the reduction in the CDOR that day, but fails to capture the decrease in the OIS rate. Including the lag of the announcement variable corrects for this measurement error as displayed in columns (2) and (3), as the impact of term PRA announcements over a two-day and 3-day event window is nearly identical as under the conventional day-count method. However, the presence of measurement error in this day-count method contributes to a reduction of statistical significance in the results.

[INSERT TABLE 4 HERE]

4.4.2 Quarter-end and Year-end effects, CDOR-OIS trend effects

We also attempted to better control for funding pressures by including bank quarter-end and year-end effects in our regression analysis.[35] In unreported results, bank year-end pressures are not statistically significant; however, bank quarter-end pressures appear significant at the 10% level. The inclusion of either variable does not impact the main results. Also, we include two dummy variables to indicate periods of broad increases and decreases in the CDOR-OIS spread to measure the impact of term PRAs on the CDOR-OIS spread over and above its broad trends. This is a difficult hurdle to pass, as it conservatively assumes that broad declines in CDOR-OIS are independent of the term PRA events. Our results are robust to the inclusion of these dummy variables, indicating that the term PRAs had an impact in reducing the CDOR-OIS spread over and above its broad trends.[36]

4.4.3 Robustness to Credit Measures

The Merrill Lynch Canadian Financials – BBB OAS spread is used as the primary measure of Canadian banking sector credit risk but we would like to examine other suitable proxies for banking sector credit risk. We consider the following three variables as suitable candidates for use in our regression analysis:

i. The daily returns on the TSX Banks Index

[35] The quarter-end dummy variable has a value of "1" for the three days before a bank quarter end (end of January, April, July, and October) The year-end dummy variable takes on a value of "1" for the three days before a bank year end (end of October).

[36] As a further robustness check we include the VIX to control for the risk environment; however, it is not statistically significant in our sample. Nor is the 5-year CMB spread statistically significant, which we include as a proxy for the liquidity premium.

ii. The change in the spread between the OAS of the Canadian Merrill Lynch Financials index and the Merrill Lynch Provincials index[37]
iii. The change in the spread between the bank subordinated-debt and senior-deposit note[38]

As seen in Table 5, the coefficient on credit risk proxy (i) is not statistically significant but is negative, as anticipated. In contrast, the coefficient on credit proxy (ii) is both the correct sign, and statistically significant. Finally, the coefficient on credit risk proxy (iii) is neither statistically significant nor is it of the expected sign. This lack of statistical significance could be attributable to a change made by credit rating agencies in their assumptions of systemic support for bank subordinated debt during our sample period. Ultimately, the general tenor of the regression results is unchanged regardless of which credit proxy is chosen. In fact, the results are also robust to the exclusion of a credit proxy as seen in Table 5 column (1).

[INSERT TABLE 5 HERE]

4.4.4 Impact of Term PRAs on 1-month CDOR-OIS

Although the focus of our analysis has been the impact of term PRAs on the 3-month CDOR-OIS spread, we also examine the impact of term PRA announcements and operations on the 1-month CDOR-OIS spread. Term PRA announcements appear to reduce the 1-month CDOR-OIS spread, as detailed in Table 6. On many of these announcement days, information was released regarding not only operations of 1-month but also 3-month liquidity provision (Table 1), so liquidity provision at these longer terms likely contributed to the decrease in liquidity premiums embedded in 1-month funding costs. Similar to the 3-month CDOR-OIS findings, term PRA operations do not appear to have any significant impact on the 1-month CDOR-OIS spread.

[INSERT TABLE 6 HERE]

4.4.5 Effect of Term PRA Auction Amounts on CDOR-OIS Spreads

Our main results provide evidence that term PRA announcements, not operations, are associated with reductions in the CDOR-OIS spread. However, the binary term PRA operations dummy variable may be too imprecise or blunt, omitting important information regarding the amount auctioned on a given day, or the magnitude of a surprise upward revision in auction conditions that is set just prior to the auction. Thus, to capture this information we replace the term PRA operations dummy variable with the following two variables:

[37] The provincial bond index rate (of a similar maturity) is subtracted from the rate on the Merrill Lynch Financials Index in order to purge the financials rate of the liquidity compensation component. We assume that the provincial bonds face broadly similar liquidity risks as the bank bonds.

[38] Calculated as a simple average of the spread for the securities issued by the [5] largest Canadian banks. The measure for each institution is calculated as the spread between the rate of interest on the bank's subordinated debt and a corresponding senior deposit note. Assuming similar liquidity conditions of both financial products, the key factor driving any spread changes is assumed to be credit-related.

i. A variable that measures the amount auctioned (in billions) on auction days and zero otherwise.

ii. A variable that measures the magnitude of any upward revisions to the auction amount (above the previously announced minimum amount) on days when the auction conditions are set, and zero otherwise.

Auction amounts and quantities of upward revisions to auction amounts are not statistically or economically significant in reducing the 1-month or 3-month CDOR-OIS spread (as detailed in table 7). The term PRA announcement dummy variable is negative and statistically significant (for both 1-month and 3-month regressions) as found in our main results. Thus, even after taking into account quantitative information regarding the size of term PRA auctions or associated upward revisions to minimum amounts, term PRA operations remain statistically and economically insignificant in explaining movements in the CDOR-OIS spread.

[INSERT TABLE 7 HERE]

5 Conclusion

This paper discusses the conditions in Canadian short-term bank funding markets since mid-2007, when pressures began to mount in these markets. As well, it documents the many dimensions along which the Bank of Canada's term PRAs have changed since they were first introduced in December 2007 in response to these pressures, including expansions in the list of acceptable collateral and eligible counterparties, increases in the size and frequency of the term PRA operations, and changes in the purpose and minimum bid rates of the term PRAs.

Further, we gauge demand for the term PRA facility as well as effects of changes in the term PRA facility using several details of the term PRA operations themselves. These include bidding behaviour, securities financed, and participation in the auctions. After the announcement to accept affiliated ABCP as collateral, we show that the amount of ABCP financed at the auction is significant in relation to the total amount of ABCP outstanding. After the introduction of the IMPP by the government of Canada, there is a decline in the amount of NHA MBS financed at the auction. By the end of 2009, the majority of securities financed at the auction are either Provincial Bonds or CMBs.

We then empirically assess the effectiveness of these term PRA announcements in reducing funding pressures by examining whether there is a reduction in the 3-month CDOR-OIS spread around these announcement dates, over and above any impact originating from similar U.S. facilities given that we also control for changes in the 3-month U.S. LIBOR-OIS spread. Overall, there is robust evidence that term PRA announcements have both transitory and persistent effects on reducing the liquidity premium in bank funding costs at 3-month and 1-month terms. However, care should be taken in attributing the reduction in the CDOR-OIS spread solely to the

term PRA announcements, as some of the term PRA announcements happened concurrently with other announcements by the Bank of Canada which may have also contributed to a compression in the CDOR-OIS spread.

Conversely, it is possible that our results understate the impact term PRAs may have had, as the term PRA announcements and operations may have other, less-quantifiable benefits, such as the positive signalling effect of reassuring markets of the availability of financial system liquidity support.

References

Abbassi, P., and I. Schnabel, 2009, Contagion Among Interbank Money Markets during the Subprime Crisis, Working paper.

Baba, N., and F. Packer, 2009, From Turmoil to Crisis: Dislocations in the FX Swap Market Before and After the Failure of Lehman Brothers, Journal of International Money and Finance 14:5 (July).

Brown, S., and J. Warner, 1985, Using Daily Stock Returns: The Case of Event Studies, Journal of Financial Economics 14.

Christensen, J., Lopez, J., and G. Rudebusch, 2009, Do Central Bank Liquidity Operations Affect Interbank Lending Rates? Federal Reserve Bank of San Francisco Working Paper 2009-13.

MacKinlay, A.C., 1997, Event Studies in Economics and Finance, Journal of Economic Literature 35(1).

McAndrews, J., Sarkar, A., and Z. Wang, 2008, The Effect of the Term Auction Facility on the London Inter-Bank Offered Rate, Federal Reserve Bank of New York Staff Report no. 335.

Michaud, F., and C. Upper, 2008, What Drives Interbank Rates? Evidence from the LIBOR Panel, BIS Quarterly Review, March 2008.

Taylor, J., and J. Williams, 2009, A Black Swan in the Money Market, American Economic Journal: Macroeconomics 1:1, 58-83.

Wu, T., 2008, On the Effectiveness of the Federal Reserve's New Liquidity Facilities, Federal Reserve Bank of Dallas Working Paper 0808.

Zorn, L., Wilkins, C., and W. Engert, 2009, Bank of Canada Liquidity Actions in Response to the Financial Market Turmoil, Bank of Canada Review, Autumn 2009.

Appendix A: Description of OIS

An Overnight Index Swap is a fixed-for-floating interest rate swap. In Canada, the floating rate of the swap is the geometric average of the Canadian Overnight Repo Rate Average (CORRA) observed over the duration of the swap. The CORRA is a weighted average of rates on overnight general collateral repo transactions (i.e. overnight repo transactions involving non-specific Government of Canada securities) conducted through designated interdealer brokers between 6am and 4pm, and is one of two measures of the collateralized overnight rate that the Bank of Canada uses as proxies for the overall average cost of overnight funding. This rate tracks the Bank of Canada target overnight rate closely, so effectively the floating leg of an OIS is the geometric average of the collateralized overnight rate over the duration of the loan. The fixed rate of the swap is the expectation of the geometric average of the CORRA over the duration of the swap. When two financial institutions enter an OIS, they agree to exchange the difference between the quoted fixed rate and the observed geometric average of the CORRA over the duration of the swap, applied to the notional value of the swap. Payments are made at the maturity of the swap term. For example, if institution A agreed to pay institution B a fixed rate of .35% on a notional value of $10M for the next three months, there would be a net cash flow to institution A in three months if the observed floating rate exceeded .35%, and a net cash flow to institution B if it was below .35%. Since there is no exchange of notional swap value, there is very little credit risk in a swap contract. Additionally, since there are no cash flows at the inception of the swap, and three-month contracts trade frequently, these instruments carry minimal liquidity premia. Hence, the three month OIS is a relatively clean measure of market participants' expectations of the overnight rate.

Table 1
Key term PRA announcements.

This table includes term PRA announcements related to both 1-month and 3-month operations. Term PRA announcements include any publicly released information pertaining to expansions of the minimum auction size, collateral, counterparties, or terms of liquidity provision, as well as announcements related to the extension of the term PRA program.

Date	Bank of Canada Announcement	1 Month	3 Month
12/12/2007	BoC announces 1-month term PRA transactions as a part of global CB liquidity provision effort	Y	N
11/03/2008	BoC announces 2 new 1-month term PRA transactions as a part of global CB liquidity provision effort (after a lull in the program)	Y	N
19/09/2008	BoC announces new 1-month term PRA transactions after a lull in the program	Y	N
23/09/2008	BoC introduces 3-month term PRA operations and additional 1-month term PRA transaction and expands counterparty list	Y	Y
25/09/2008*	BoC announces intention to transact additional 1-month and 3-month term PRA transactions	Y	Y
03/10/2008	BoC announces weekly frequency of term PRAs, increases the minimum amount for the 3-month term PRA transactions & expands collateral list	Y	Y
14/10/2008	BoC announces increase in minimum amount for1-month term PRA & expands counterparty list	Y	Y
21/04/2009	BoC introduces 6-month and 12-month term PRA operations for monetary policy purposes and imposes a minimum bid-rate of 25 bps	Y	Y

*As this announcement occurred at 4pm on 25 September 2008, we consider its impact on the 26 September 2008 CDOR-OIS spread**.**

Table 2

CDOR-OIS regressions with term PRA dummy variables.

This table presents a regression of changes in the 3-month CDOR-OIS spread (y_t^{CDOR}) on changes in the 3-month LIBOR-OIS spread (x_t^{LIB}), changes in the Canadian Financials-BBB spread (x_t^{CRD}), a dummy variable for FAD announcement days (X_t^{FAD}), and a dummy variable for 3-month term PRA event days, which includes both announcements and operations ($X_t^{TermPRA}$):

$$y_t^{CDOR} = \alpha + \beta_{LIB} x_t^{LIB} + \beta_{CRD} x_t^{CRD} + \beta_{FAD} X_t^{FAD} + \beta_{TermPRA} X_t^{TermPRA} + \varepsilon_t$$

The error term is assumed to follow a GARCH (1,1) distribution with an AR(1) term of the structural disturbance included in the model. Absolute value of z-statistics in parentheses. *Significant at 10%; ** significant at 5%; *** significant at 1%.

	(1)	(2)	(3)
x_t^{LIB}	0.160 (7.18)***	0.152 (6.91)***	0.148 (6.74)***
x_t^{CRD}	0.074 (3.83)***	0.072 (3.75)***	0.076 (3.97)***
X_t^{FAD}	-0.507 (2.18)**	-0.530 (2.28)**	-0.512 (2.20)**
$X_t^{TermPRA}$	-0.313 (1.65)*	-0.314 (1.74)*	-0.335 (1.88)*
$X_{t-1}^{TermPRA}$		-0.256 (0.72)	-0.266 (0.76)
$X_{t-2}^{TermPRA}$			-0.148 (0.47)
α	0.119 (2.32)**	0.142 (2.81)***	0.152 (3.08)***
Observations	704	704	704
Linear combination test of coefficients:		*j = t-1*	*j = t-2*
$\sum_t^j X_i^{TermPRA}$		-0.57 (1.45)	-0.75 (1.42)

Table 3

CDOR-OIS regressions with term PRA announcement and operations dummy variables.

This table presents a regression of changes in the 3-month CDOR-OIS spread (y_t^{CDOR}) on changes in the 3-month LIBOR-OIS spread (x_t^{LIB}), changes in the Canadian Financials-BBB spread (x_t^{CRD}), a dummy variable for FAD announcement days (X_t^{FAD}), and dummy variables for 3-month term PRA announcements (X_t^{Ann}) and operations (X_t^{Ops}):

$$y_t^{CDOR} = \alpha + \beta_{LIB} x_t^{LIB} + \beta_{CRD} x_t^{CRD} + \beta_{FAD} X_t^{FAD} + \beta_{Ann} X_t^{Ann} + \beta_{Ops} X_t^{Ops} + \varepsilon_t$$

The error term is assumed to follow a GARCH (1,1) distribution with an AR(1) term of the structural disturbance included in the model. Absolute value of z-statistics in parentheses. *Significant at 10%; ** significant at 5%; *** significant at 1%.

	(1)	(2)	(3)
x_t^{LIB}	0.141 (6.93)***	0.136 (6.53)***	0.134 (6.45)***
x_t^{CRD}	0.048 (2.31)**	0.048 (2.48)**	0.050 (2.41)**
X_t^{FAD}	-0.166 (0.62)	-0.184 (0.67)	-0.177 (0.64)
X_t^{Ann}	-9.198 (3.77)***	-9.125 (3.57)***	-9.144 (3.43)***
X_t^{Ops}	-0.165 (0.94)	-0.177 (1.11)	-0.195 (1.22)
X_{t-1}^{Ann}		-0.649 (0.43)	-0.588 (0.44)
X_{t-1}^{Ops}		-0.289 (1.06)	-0.301 (1.11)
X_{t-2}^{Ann}			-0.665 (0.21)
X_{t-2}^{Ops}			-0.099 (0.40)
α	0.128 (2.88)***	0.153 (3.50)***	0.162 (3.75)***
Observations	704	704	704
Linear combination test of coefficients:		*j = t-1*	*j = t-2*
$\sum_t^j X_i^{Ann}$		-9.77 (3.14)***	-10.40 (2.43)**

Table 4

CDOR-OIS regressions with alternative date measure.

This table uses a different method for accounting for the time lapse between CDOR and OIS rates, as measured in Figure 2. It presents regression of changes in the 3-month CDOR-OIS spread (y_t^{CDOR}) on changes in the 3-month LIBOR-OIS spread (x_t^{LIB}), changes in the Canadian Financials-BBB spread (x_t^{CRD}), a dummy variable for FAD announcement days (X_t^{FAD}), and dummy variables for 3-month term PRA announcements (X_t^{Ann}) and operations (X_t^{Ops}):

$$y_t^{CDOR} = \alpha + \beta_{LIB} x_t^{LIB} + \beta_{CRD} x_t^{CRD} + \beta_{FAD} X_t^{FAD} + \beta_{Ann} X_t^{Ann} + \beta_{Ops} X_t^{Ops} + \varepsilon_t$$

The error term is assumed to follow a GARCH (1,1) distribution with an AR(1) term of the structural disturbance included in the model. Absolute value of z-statistics in parentheses. *Significant at 10%; ** significant at 5%; *** significant at 1%.

	(1)	(2)	(3)
x_t^{LIB}	0.223 (21.94)***	0.225 (21.26)***	0.216 (20.91)***
x_t^{CRD}	0.086 (8.29)***	0.063 (5.33)***	0.069 (6.10)***
X_t^{FAD}	-0.333 (1.24)	-0.413 (1.55)	-0.330 (1.21)
X_t^{Ann}	-14.153 (25.69)***	-17.283 (6.89)***	-17.409 (6.61)***
X_t^{Ops}	-0.156 (0.64)	-0.178 (0.78)	-0.229 (1.11)
X_{t-1}^{Ann}		7.615 (1.08)	7.620 (0.90)
X_{t-1}^{Ops}		-0.068 (0.45)	-0.024 (0.17)
X_{t-2}^{Ann}			-0.042 (0.01)
X_{t-2}^{Ops}			-0.312 (1.27)
α	0.155 (4.59)***	0.181 (5.41)***	0.203 (6.25)***
Observations	704	704	704
Linear combination test of coefficients:		*j = t-1*	*j = t-2*
$\sum_t^j X_i^{Ann}$		-9.67 (1.25)	-9.83 (1.22)

Table 5

CDOR-OIS regressions – credit measure sensitivity.

This table uses a different Canadian bank credit measures. $x_t^{CRD\ (1)}$ is the change in the Merrill Lynch Canadian Financials-BBB spread, $x_t^{CRD\ (2)}$ is the change in the TSX Banks sub-index, $x_t^{CRD\ (3)}$ is the change in the Merrill Lynch Canadian Financials-Provincial spread, and $x_t^{CRD\ (4)}$ is the spread between subordinated debt and senior debt for 5 Canadian banks. It presents regression of changes in the 3-month CDOR-OIS spread (y_t^{CDOR}) on changes in the 3-month LIBOR-OIS spread (x_t^{LIB}), changes in a credit measure ($x_t^{CRD\ (1)-(4)}$), a dummy variable for FAD announcement days (X_t^{FAD}), and dummy variables for term PRA announcements (X_t^{Ann}) and operations (X_t^{Ops}):

$$y_t^{CDOR} = \alpha + \beta_{LIB} x_t^{LIB} + \beta_{CRD} x_t^{CRD} + \beta_{FAD} X_t^{FAD} + \beta_{Ann} X_t^{Ann} + \beta_{Ops} X_t^{Ops} + \varepsilon_t$$

The error term is assumed to follow a GARCH (1,1) distribution with an AR(1) term of the structural disturbance included in the model. Absolute value of z-statistics in parentheses. *Significant at 10%; ** significant at 5%; *** significant at 1%.

	(1)	(2)	(3)	(4)	(5)
x_t^{LIB}	0.142 (6.87)***	0.141 (6.93)***	0.142 (6.80)***	0.131 (6.27)***	0.109 (3.47)***
X_t^{FAD}	-0.183 (0.68)	-0.166 (0.62)	-0.207 (0.77)	-0.155 (0.60)	-0.745 (1.99)**
X_t^{Ann}	-9.165 (3.71)***	-9.198 (3.77)***	-9.231 (3.66)***	-9.240 (3.70)***	-8.331 (3.17)***
X_t^{Ops}	-0.156 (0.91)	-0.165 (0.94)	-0.145 (0.86)	-0.153 (0.90)	-0.227 (0.33)
$x_t^{CRD(1)}$		0.048 (2.31)**			
$x_t^{CRD(2)}$			-2.531 (1.27)		
$x_t^{CRD(3)}$				0.038 (2.15)**	
$x_t^{CRD(4)}$					-0.024 (0.86)
α	0.136 (3.21)***	0.128 (2.88)***	0.140 (3.30)***	0.157 (3.76)***	0.105 (1.19)
Observations	704	704	704	704	420

Table 6

1-Month CDOR-OIS regressions.

This table presents regression of changes in the 1-month CDOR-OIS spread (y_t^{CDOR}) on changes in the 1-month LIBOR-OIS spread (x_t^{LIB}), changes in the Canadian Financials-BBB spread (x_t^{CRD}), a dummy variable for FAD announcement days (X_t^{FAD}), and dummy variables for 1-month term PRA announcements (X_t^{Ann}) and operations (X_t^{Ops}):

$$y_t^{CDOR} = \alpha + \beta_{LIB} x_t^{LIB} + \beta_{CRD} x_t^{CRD} + \beta_{FAD} X_t^{FAD} + \beta_{Ann} X_t^{Ann} + \beta_{Ops} X_t^{Ops} + \varepsilon_t$$

The error term is assumed to follow a GARCH (1,1) distribution with an AR(1) term of the structural disturbance included in the model. Absolute value of z-statistics in parentheses. *Significant at 10%; ** significant at 5%; *** significant at 1%.

	(1)	(2)	(3)
x_t^{LIB}	0.008	0.004	-0.002
	(0.73)	(0.32)	(0.22)
x_t^{CRD}	0.049	0.041	0.038
	(2.80)***	(2.40)**	(2.25)**
X_t^{FAD}	-1.390	-1.381	-1.366
	(3.58)***	(3.62)***	(3.72)***
X_t^{Ann}	-5.593	-5.928	-6.155
	(5.69)***	(5.20)***	(5.40)***
X_t^{Ops}	-0.268	-0.295	-0.414
	(0.54)	(0.58)	(0.87)
X_{t-1}^{Ann}		-1.324	-1.296
		(0.60)	(0.54)
X_{t-1}^{Ops}		-0.250	-0.266
		(0.59)	(0.63)
X_{t-2}^{Ann}			0.146
			(0.04)
X_{t-2}^{Ops}			-0.261
			(0.60)
α	0.169	0.227	0.306
	(2.68)***	(3.65)***	(4.88)***
Observations	704	704	704
Linear combination test of coefficients:		*j = t-1*	*j = t-2*
$\sum_t^j X_i^{Ann}$		-7.25	-7.31
		(-3.46)***	(-2.12)**

Table 7

1-month and 3-month CDOR-OIS regressions with auction amounts.

x_t^{LIB} is the 1-month US LIBOR-OIS spread in the 1-month equations (1 and 2) and is the 3-month US LIBOR-OIS spread in the 3-month equations (3 and 4). X_t^{Ann} is a dummy variable for 1-month term PRA announcements in the 1-month equations and is a dummy variable for 3-month term PRA announcements in the 3-month equations. X_t^{AucAmt} is the term PRA auction amount (in billions) for 1-month term PRA operations in the 1-month equations and is the term PRA auction amount (in billions) for 3-month term PRA operations announcements in the 3-month equations. $X_t^{AmtIncrease}$ is the magnitude of any upward revisions to the auction amount (above the previously announced minimum amount) on days when the auction conditions are set for 1-month and 3-month term PRA operations, respectively. The error term is assumed to follow a GARCH (1,1) distribution with an AR(1) term of the structural disturbance included in the model. Absolute value of z-statistics in parentheses. *Significant at 10%; ** significant at 5%; *** significant at 1%.

	(1) 1 month	(2) 1 month	(3) 3 month	(4) 3 month
x_t^{LIB}	0.011 (1.04)	0.011 (0.96)	0.141 (6.96)***	0.142 (6.79)***
x_t^{CRD}	0.051 (2.87)***	0.052 (2.97)***	0.049 (2.34)**	0.048 (2.31)**
X_t^{FAD}	-1.389 (3.52)***	-1.386 (3.52)***	-0.160 (0.60)	-0.155 (0.58)
X_t^{Ann}	-5.560 (5.61)***	-5.653 (5.76)***	-9.213 (3.76)***	-9.191 (3.74)***
X_t^{AucAmt}	-0.058 (0.64)		-0.113 (1.19)	
$X_t^{AmtIncrease}$		-0.011 (0.04)		-0.257 (0.37)
α	0.148 (2.46)**	0.122 (1.92)*	0.133 (2.96)***	0.115 (2.69)***
Observations	704	704	704	704