Preliminary and Incomplete

The Flight from Maturity*

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Abstract

Why did the failure of Lehman Brothers make the financial crisis dramatically worse? Our answer is that following the initial runs on repo and asset-backed commercial paper, the financial crisis was a process of a build-up of risk *during* the crisis. We produce a chronology of the crisis which formalizes the dynamics of the crisis. We test for common breakpoints in panels, showing the date of the subprime shock and the dates of runs in the secured and unsecured money markets. During the crisis market participants tried to preserve the "moneyness" of money market instruments by shortening their maturities – the flight from maturity. The failure of Lehman Brothers was the tipping point of this build-up of systemic fragility.

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of the global financial system" (Bernanke, 2009). Thus the widespread view of the crisis is that it was caused by the disorderly liquidation of Lehman Brothers, the view that informs the Dodd-Frank legislation. Some economists attributed this to policy failure: the Fed should not have let Lehman fail.[3]

In this paper, we argue that this view of the crisis is not accurate. Rather, the crisis was an ongoing build-up of fragility starting before August 2007 and continuing, finally resulting in the Lehman failure, in effect caused by this build-up of fragility. The build-up was the result of market participants trying to recreate moneyness by, among other things, shortening maturities. A crisis is a dynamic process in which "shocks" are to an important extent endogenous.

Understanding the dynamics of the crisis requires determining the timing of important events. We provide a chronology of the crisis by locating structural breaks in panel data sets, based on the methodology of Bai (2010). Our chronology dates the first structural break in panels of spreads on subprime-related instruments, secured money market instruments (repo), unsecured money market instruments, CDS measures of the risk in financial firms, and price-based measures of real economic activity.

The chronology of the crisis is very important because it allows us to formalize the notion of a financial crisis. What is a crisis? A financial crisis can be defined as a common breakpoint in the different forms of bank-produced money. In a crisis short-term bank debt becomes suspect and banks are unable to satisfy demands for cash. But, individual crisis episodes have unique features and it has been impossible to formalize the notion of a crisis to date. For example, Boyd, De Nicolò, and Loukoianova (2011) point out that it has been difficult to date the start of crises, or even to determine whether there has been a crisis in some cases. Existing data sets of international crises do not agree on start dates or on crisis episodes. We seek to formalize the crisis dating for the events of 2007-2008 and, in the process, understand crises.

We date the subprime shock and the resulting financial crisis, coming some months later. The crisis was first located in the money markets, and emanated outwards. We show that the repo market was the first money market to be disrupted, followed by the other money markets. But, this was only the beginning. We trace subsequent breakpoints as well to determine the dynamics of the crisis. We find that repo shows a second breakpoint a month *before* Lehman, and then again on the date of the

[3] For example, Taylor (2009) and Meltzer(2009) have articulated this view.

Lehman failure. The unsecured money market instruments show a second breakpoint coincident with Lehman. We subsequently make this precise.

Once bank money becomes suspect, the dynamics of the crisis depend upon the response of market participants. As the final step in our analysis, we document the build-up of fragility by showing that the maturities of money market instruments shortened starting in July 2007. In the case of commercial paper (CP), there is issuance data that can be used to directly examine maturity. We show how the maturity of CP declined during the crisis. Due to a lack of issuance data, however, we also look at the term structure of money market spreads during the crisis. The "spread" refers to the particular money market rate minus the "riskless" rate for a given maturity. The "term structure of spreads" refers to the spreads at different maturities. During normal times the spreads are all very low and the term structure of spreads is flat (as we document), corresponding to money market instruments being near-riskless.

Low spreads on money market instruments is consistent with money markets being integrated. This is important for monetary policy. The Federal Reserve acts to move the federal funds rate towards the fed funds target rate and other money market rates follow, via arbitrage. Although the money markets have different clienteles, some large U.S. banks can trade in federal funds, LIBOR, commercial paper, and sale and repurchase (repo) markets to keep the rates in line. If money market instruments are "money," then the acceptable maturities in the market should be a matter of indifference to participants, and the term structure of spreads should be flat. We find that in the pre-crisis period this was, in fact, the case.

During the crisis this changes. If there is a desire by borrowers to borrow at longer maturities and a desire by lenders to lend at shorter maturities then the term structure of spreads will become upward sloping. On the other hand, banks want to lock-in funding and so they offer to pay a higher rate for longer maturity borrowing, and a lower rate for shorter maturities. But, lenders are only willing to lend short. In other words, lenders care about shortening the maturity – the flight from maturity-- when they are concerned about being in a position to get their cash at very short notice. An upward sloping term structure of spreads is an indication of these concerns on the parts of borrowers and lenders. During the financial crisis spreads widen and the term structures of spreads steepen dramatically. The steepening of the term structures of spreads indicates an increase in fragility as lenders position themselves to demand cash at very short notice.

Privately-produced money market instruments are designed to be as close to riskless as privately possible, so that they can function as money, as discussed below. Money market instruments often have maturities of overnight or a few days, weeks, or sometimes months, and are either secured by collateral or can only be issued by high-quality borrowers.

Repo involves providing specific collateral to depositors who are lending money. The collateral might be government bonds or privately-created "high quality" bonds, such as asset-backed securities. Depositors must agree with borrowers on the type of collateral and its market value, and then depositors/lenders take possession of the collateral.[5] If the counterparty fails, then the non-defaulting party can unilaterally terminate the transaction and sell the collateral (or keep the cash). In other words, in the U.S. repo is carved out of the bankruptcy process. This facilitates its use as money.

Unsecured money issuers are screened; they must be high-quality so the backing assets are viewed as near riskless. Commercial paper (CP) issuers are screened by the investors and rating agencies. Only high quality financial and nonfinancial firms can issue CP. CP does not have explicit insurance or specific collateral, but access to the CP market is reserved for low-risk issuers with strong credit ratings. CP is also backed up by a bank line of credit (see, e.g., Moody's (2003), Nayar and Rozeff (1994)). Hence CP appears to have very low default risk. CP issuers are high quality, and if they deteriorate there is "orderly exit." When a firm's credit quality drops, perhaps as indicated by its rating, it cannot issue new CP because investors will not buy it. The firm may instead draw on its bank line. This process of "orderly exit" from the commercial paper market maintains the high quality of the issuers. Because of the possibility of exit occurring firms must maintain back-up lines of credit.[6] "Orderly exit" is discussed by Fons and Kimball (1991) and Crabbe and Post (1994).

Asset-backed commercial paper (ABCP) conduits are a special type of CP issuer. Such a conduit is a special purpose vehicle (a legal entity) that buys asset-backed securities, financing this by issuing commercial paper. See Covitz, Liang, and Suarez (2009) and Acharya, Schnabl and Suarez (2011). The activities of ABCP conduits are circumscribed by their governing documents, required to obtain the necessary ratings. One important feature of asset-backed commercial paper is that the conduits must

[5] The collateral is valued at market prices. During the period of the repo, there may be margin required to maintain the value of the collateral exactly. Overcollateralization, that is a loan for less than the value of the collateral, is referred to as a "haircut." For example, if a lender deposits $90 million and the collateral is worth $100 million, then there is said to be a 10 percent haircut.

[6] The back-up lines were introduced after the Penn Central failure led to a crisis in the CP market; see Calomiris (1989, 1994) and Calomiris, Himmelberg and Wachtel (1995).

Table 2 presents the intercepts from the regressions of the spreads on the calendar dummies, for different subsamples: prior to the crisis, during the crisis, and for three different stages of the crisis (corresponding to subsequently estimated breakpoints in the series). Table 2 allows us to see the relative ability of the private sector to produce "money."

Focusing first on the period prior to the crisis, the following is clear. All spreads are less than 11 bps. Also, note that the spreads on GC repo, A1/P1 financial CP, A1/P1 nonfinancial CP, and repo backed by the highest rated corporate bonds are significantly negative, that is they are below the target federal funds rate. Federal funds are unsecured, but banks are overseen by the Fed. GC repo is collateralized by U.S. Treasuries, so it is better collateral than federal funds, which is backed by a bank's portfolio. And, banks are examined, that is, screened. By screening issuers, the spreads on the highest quality CP and are negative. Similarly, repo backed by the highest quality corporate bonds shows negative spreads.

Relative to federal funds, it is hard for the private sector to replicate the moneyness of the best instruments. The other money market instruments are of lower quality in that the collateral is of lower quality or the issuers are of lower quality. Spreads on these categories are all positive, relative to the federal funds target rate. Finally, note that LIBOR is significantly higher than federal funds. Perhaps global banks are not screened as well as U.S. banks.

The categories with the highest spreads are repo backed by asset-backed securities with lower ratings and A2/P2 nonfinancial commercial paper. A2/P2 is the lowest (worst) rating for commercial paper and it had an average spread of 8.97 basis points.. Also, repo which uses asset-backed securities (ABS), residential mortgage-backed securities (RMBS), or commercial mortgage-backed securities (CMBS), which have a rating below AA, had an average spread of 10.16 basis points.[15] After these two categories come LIBOR with a spread of 5.33 basis points. Prior to the crisis LIBOR was widely believed to correspond to AA risk. Next is repo with the same collateral, but rated AA or higher, at 5.16 basis points, and collateralized loan obligations rated AA or higher which has the same spread.

The spreads intuitively correspond to the quality of the money. There are clearly degrees of "moneyness" reflected in the spreads. It is apparent that not all privately-created money is the same.

[15] The largest asset types in ABS are student loans, car loans, and credit card receivables. Subsequently, we use ABS to indicate all types of securitizations. See Gorton and Metrick (2011) for details about securitization.

We do not know how much money of each category was being used, but in order for there to be data, there must have been some significant amount. The picture that emerges is one in which the private sector creates money of different quality and some types of money have spreads which may in part be risk premia.

What happened to the money markets in the crisis? We take as the crisis period the period following the first breakpoint in repo (discussed below). This is the column called "During the Crisis" in Table 2.[16] Note that money market instruments that are "high quality" show *reduced* spreads. These include federal funds, general collateral repo, and A1/P1 commercial paper, both financial and nonfinancial. This is the flight to quality, where some instruments are perceived as better money. But, all the other money market instruments' spreads show very large increases. Figure 1 displays the spreads (intercepts) before and during the crisis.

The other instruments, all privately-produced, show large spikes in their spreads; see Figure 1. For example, repo backed by residential mortgage-backed securities or commercial mortgage-backed securities, rated lower than AA, increase from 10.16 to an average of 98.59 basis points during the crisis. A1/P1 asset-backed CP rises from an average of 1.5 basis points in normal times to 40.28 basis points during the crisis.

The spread for fed funds is the average difference between the effective fed funds rate and the target rate. In Table 2 it is clear that during the crisis it became harder for the Federal Reserve System to keep the fed funds rate close to the target. Before the crisis the spread is less than half a basis point, at 0.32. But, during the crisis this rises to 8.06 basis points. And, in particular, during the period labeled "Stage 2," it reaches a high of an average of 37 basis points. This is consistent with the results of Bech, Klee, and Stebunovs (2012) who show that the relation between the GC repo rate and the federal funds rate weakens during the crisis (in an error-correction model).

The table also shows the results for subperiods corresponding to the other breakpoints. The subperiods are (1) Pre-Crisis: prior to the crisis onset (the first breakpoint in repo discussed below); (2) Pre-Lehman: the crisis from the onset to Lehman (the second breakpoint in repo discussed below); (3) Lehman: the aftermath of Lehman until December 2008; and (4) After December 2008. The middle period of the crisis, which brackets the failure of Lehman Brothers, was the height of the crisis in terms of spreads.

[16] As before, the table shows spreads calculated with regressions including the calendar dummies, as in Appendix Table A1.

common breakpoints in panel data.[17] For our study, basing the breakpoints on panel data offers several important advantages. First, it is possible to consistently estimate breakpoints using a panel, while there may be little or no power to looking at individual time series when there is not much data covering the crisis regime. In other words, in a univariate setting there may be little hope of detecting a regime switch when a single observation that may be an outlier can have a large effect on the estimate, or when one regime consists of only a few observations in time. In our setting the crisis period is short and comes at the end of the sample.

Second, and more importantly, it is quite natural that a financial crisis would result in common breakpoints. The concept of a crisis means, at least intuitively, that a number of series show a common breakpoint, though the date of the breakpoint is not known. A definition of a financial crisis is that it is a common breakpoint in money and banking. And this crisis then is followed by real effects. We seek to formalize this and, in the process, understand crises.

We follow the estimation approach of Bai (2010). The idea is to consider a panel of N series, as follows:

$$Y_{it} = \mu_{i1} + \sigma_{i1}\eta_{it}, \quad t = 1,2, \ldots, k_0$$

$$Y_{it} = \mu_{i2} + \sigma_{i1}\eta_{it},, \quad t = k_0+1, \ldots T$$

$$i = 1,2, \ldots, N$$

where $E(\eta_{it})=0$ and $var(\eta_{it})=1$, and for each i, η_{it} is a linear process; there are other assumptions as well, see Bai (2010). The breakpoint, k_0 in means and variances is unknown. Consistent estimation requires that there are breakpoints in either the means or the variances (or both). Assuming a common breakpoint is more restrictive than assuming random breakpoints in the different series in the panel. But, the assumption results in more precise estimation. The basic idea of Bai's approach is to exploit the cross-section information, sort of "borrowed power" relative to the non-panel approach.

There may be multiple breakpoints, so that after the first breakpoint is located, the two subsamples can be investigated further for other breakpoints, and so on. As yet the econometric theory does not exist for determining the number of breakpoints. We stop at four breakpoints and present three, as discussed later.

[17] On breakpoint estimation in general, see Perron (2005) and Hansen (2001). Bai (2010) provides the references to the other papers on the estimation of breakpoints in panels.

The breakpoint is estimated with quasi-maximum likelihood (QML). Let

$$\hat{\sigma}_{i1}^2(k) = \frac{1}{k}\sum_{t=1}^{k}(Y_{it} - \bar{Y}_{i1})^2,\ \hat{\sigma}_{i2}^2(k) = \frac{1}{T-k}\sum_{t=k+1}^{T}(Y_{it} - \bar{Y}_{i2})^2.$$

The QML objective function for series i is:

$$k\ log\ \hat{\sigma}_{i1}^2(k) + (T-k) log\ \hat{\sigma}_{i2}^2(k),$$

multiplied by one half. Analogously, for N series:

$$U_{NT}(k) = k\sum_{i=1}^{N} log\ \hat{\sigma}_{i1}^2(k) + (T-k)\sum_{i=1}^{N} log\ \hat{\sigma}_{i2}^2(k).$$

The breakpoint estimator is $\hat{k} = argmin_k U_{NT}(k)$. Bai (2010) Theorem 5.1 shows that the breakpoint in this case can be consistently estimated.

Our approach is to group the data series into five different panels with recognizable economic content: (1) the real sector of the economy; (2) the subprime housing sector; (3) financial firms; (4) the unsecured money markets; and (5) the secured money markets. We further divide the financial firms to consider including and excluding Lehman. We also consider subsets of the real sector and subprime, as well.

The real sector is represented by the S&P 500 index return, the VIX index (the Chicago Board Options Exchange Market Volatility Index), the JP Morgan High Yield Bond Index, and the Dow Jones CDX.IG index of investment grade credit derivative premia. The subprime sector is represented by the spreads on tranches of the ABX index (an index of derivative premia linked to subprime bonds), and two series of subprime bond spreads. The financial sector is represented by an equally-weighted index of CDS premia on ten banks, including Lehman Brothers (see Table 1). Finally, there are the returns on thirteen money market instruments, including four categories of commercial paper, fed funds, LIBOR, and the rates on seven categories of repo, including general collateral. The returns on the money market instruments are annualized overnight returns. We split the money market instruments into secured (repo), unsecured, and GC repo. Later, we also look at some individual money market series.

It is not restrictive to use prior economic reasoning to form the different panels. The methodology can still result in finding the same common breakpoint for different panels. In terms of the number of series in a panel, precision is improved with a larger number of series. Clearly, the confidence intervals depend on N. But, as a practical matter N can also be small. Bai (2010) provides a sense of the precision with Monte Carlo experiments where the number of series, N, in the panel ranges from one to 100.

Looking at the average issuance it is clear that the two nonfinancial CP categories (A2/P2 and AA) are the smallest issuers by far while ABCP is the largest and rises up until Lehman before collapsing. The other important category is AA financial. This is much smaller than ABCP. AA financial issuance shrinks during the crisis in the pre-Lehman period, recovers a bit, and then shrinks again.

Table 5 also shows the percentage of average issuance in each subperiod that has maturities in the maturity buckets shown. For a given category of issuer, looking down the column shows the trend in the maturity structure of the CP issued in that subperiod. The most important categories of issuer of CP in terms of amounts are ABCP and AA financial firms. Figure 4 is a bar chart which summarizes the trend in issuance of CP with maturities in the 1-4 day bucket, as a percentage of average issuance over the subperiod. ABCP shows a rising trend, even before the crisis. In the pre-crisis period 60 percent of the ABCP was 1-4 days maturity. During the crisis it rises in the pre-Lehman subperiod, and again during the Lehman subperiod. It then subsides. AA financial firms' issuance of 1-4 day CP declines over the first three subperiods. Then it rises when Lehman collapses.

The figure is suggestive. But, we now turn to a more careful look at the data. Table 6 shows the results of testing for breakpoints with regard to the maturity structure of the outstanding paper. The table examines the short/long ratio which is the ratio of the amount of CP issued with a maturity of less than 20 days (over a 30 day window) divided by the amount of CP issued with a maturity of 20 days or greater (over a 30 day window). The table shows that the first breakpoint occurs June 13, 2007 *before the break in repo rates*. In other words, maturities are shortening as concerns build-up. This is evidence of a build-up of fragility prior to our dating of the run on repo.

The second breakpoint occurs in the immediate aftermath of the Lehman bankruptcy (September 15, 2008) on September 26, 2008. Figure 5 shows the short/long ratio for AA-rated ABCP. The two breakpoints are clearly visible.

Figure 6 shows a measure of interbank credit risk, the LIBOR minus overnight index swap (OIS) rate spread, together with the 30-day rolling short/long ratio. The LIBOR minus OIS spread is the most common measure of interbank counterparty risk. The pattern is remarkable. The tendency for the ABCP maturity to shorten moves very closely with counterparty risk, as bank counterparties become riskier, their conduits are kept on a much shorter leash in terms of maturity in the CP market.

Table 8 shows the spreads for overnight, one month, and three-month maturities for the different money market instruments during different subperiods.[21] Table 8 can be viewed by looking at the spreads for different maturities across a specific subperiod, or by looking at a given maturity and looking down across the subperiods.

Some highlights from Table 8 are as follows. First, in the case of overnight federal funds, the actual (average) federal funds rate deviates from the target by the most in the aftermath of Lehman. As noted before, this is some evidence that it was becoming harder for the Fed to control money markets via intervention in the federal funds market.

With regard to GC repo, note that because GC repo uses U.S. Treasuries as collateral, it is safer than federal funds and so the GC repo spread is negative at all maturities prior to the crisis. In the pre-Lehman crisis period, there appears to be a flight to GC repo as the spread becomes much more negative, but is roughly flat across maturities. But, in the aftermath of Lehman note that the overnight GC repo spread becomes very negative(-56.32 bps), and the spread for one-month and three-month GC repo become positive, suggesting that lenders are scared of these maturities. This positive slope persists after December 2008.

The LIBOR spread curve is slightly positive in the pre-crisis period, but steepens during the crisis, and even more so after Lehman. The commercial paper spread curves are near flat or slightly upward sloping prior to the crisis, but then steepen. AA financial CP and AA nonfinancial CP have larger negative overnight spreads which peak (at their highest negative values) after Lehman. These curves become very steep.

In the case of repo backed by private collateral, Panel C, the repo term structure of spreads is essentially flat in the pre-crisis period. During the crisis, the spreads are higher for longer maturities; the slope of the term structure rises. Looking down a column, the overnight spread is monotonically increasing for each repo backed by private collateral except for the cases where the collateral is corporate bonds. In the cases of one-month and three-month maturities, the spreads peak during the Lehman aftermath.

We now look directly at slopes of different points on the term structures of spreads. The slope measure is the difference between the one-month and one-day spreads, the difference between the three-month

[21] When the maturity is longer than one day, we use OIS rather than the federal funds target rate as the benchmark to determine the spread.

and one day spreads, and the difference between the three-month and one-month spread. For example, the slope is:

[Rate at one month – OIS rate for one month] minus [rate overnight – FF target overnight.

The other points on the slope are similar; for longer maturities where there is no federal funds (FF) target, we use the OIS rate for that maturity. Table 9 shows different measures of the slope of the term structure of spreads at points on the term structure for the different money market instruments during different subperiods.

Looking down a column for a given money market instrument shows how the spread difference changed at that point on the term structure over the different subperiods. For example, in Panel A federal funds at the one month minus one day point saw the difference increase dramatically in the pre-Lehman and Lehman phases of the crisis. The same pattern appears for GC repo and LIBOR, also in Panel A. This same pattern holds for CP (Panel B) and repo (Panel C). It also holds for the middle column, the difference between the 3-month and overnight spreads, which also rise dramatically. Less dramatic is the 3-month minus 1-month spread difference.

It is perhaps easier to see what is going on with figures. Figures 7-10 display the term structure of spreads for LIBOR, federal funds, A2/P2 nonfinancial CP, and repo backed by ABS/RMBS/CMBS collateral rated less than AA. The LIBOR spread term structure progressively steepens during the crisis, as does the federal funds term structure of spreads. A2/P2 nonfinancial commercial paper dramatically steepens by December 15, 2008. Repo backed by ABS/RMBS/CMBS collateral rated less than AA shows the most dramatic increase in the term structure of spreads.

Table 10 shows the breakpoints for the slopes, where the slope is measured as the one-month/overnight spread. The breakpoint for the repo slope is July 23, 2007, the same date as the breakpoint in the repo spreads. Unsecured money market instruments' slopes break on August 8, 2007, also the same as the breakpoint for their spreads. The subsequent breakpoints are also the same, that is, they are coincident with the breakpoints for their respective spreads.

Overall, the quantity and price data point in the same direction, namely, that maturity shortens during the crisis.

same time that dealer banks are shocked. This is the start of the crisis. On August 8, 2007, the other money market instruments are affected. Their spreads spike and their maturities start to shorten. Repo haircuts significantly increase on October 24, 2007. The real economy is affected starting on January 3, 2008.

The crisis evolution is shown in Panel B, where repo shows a second breakpoint August 14, 2008, also the date at which the repo term structure of spreads increases, i.e., there more maturity shortening. This is followed by the second breakpoint in repo haircuts, prior to Lehman. Subsequent to Lehman money markets essentially fall apart, with their spreads diverging as lenders flee some markets and pile into others (Treasuries and GC repo) in a flight to quality.

The chronology raises a number of questions, some of which we can answer and some of which we can only speculate about. Here, we briefly discuss these questions.

First, if the subprime shock occurred in the first quarter of 2007, why did it not result in financial market difficulties until the third quarter of 2007? We can only speculate about the answer to this question. One thing to keep in mind is that over-the-counter markets, like credit derivative markets for example, do not work like stock markets. Stock markets have centralized trading and readily observable prices. But over-the-counter markets have pairwise trading without centralized pricing. The price is only observed by the two counterparties. So, the price does not aggregate the information in the same way in OTC markets as in stock markets. It may simply take longer to percolate through markets. This is an issue for future research.

A second question is: Why was repo the first money market instrument to show a break? In the repo markets lenders became concerned about the quality of the bonds offered as collateral. Haircuts rose and repo market spreads also rose. See Gorton and Metrick (2012). Asset-backed commercial paper also faced runs but asset-backed commercial paper conduits were bailed out by their sponsors. Commercial paper spreads only showed a break later.

In 2007 Q2-Q3 ABCP conduits could not roll their CP (see Liang et al (2012)). Instead, they drew on their liquidity lines or financed via repo instead of CP. Liquidity lines were usually provided by the sponsoring banks of the ABCP conduits, so “drawing on the liquidity line” meant that banks ended up with the ABCP conduits’ assets on their balance sheet. For example, HBOS announced on August 21, 2007 that its conduit Grampian would no longer issue CP, but that instead it would use liquidity facilities provided by HBOS. See Fitch (August 23, 2007).

the financial system on a shorter and shorter leash. This is the build-up of systemic risk. Ultimately, this did not work, and then there are withdrawals from the banking system in the form of refusals to continue funding or increases in repo haircuts. This process is one of building fragility *during the crisis* which itself has already started. Lehman was a result of this build-up of fragility. In this sense systemic risk is endogenous. A crisis is a dynamic process.

Appendix A: Seasonals in Money Market Spreads

In this appendix we briefly discuss the calendar effects or "seasonals" in money market spreads.

Appendix Table A1 shows regressions of the money markets spreads on calendar dummies, and shows that "seasonals" are important in money market spreads. There are spikes in many of the spreads at certain calendar dates. Just before the quarter end (five days before to the day before) and the date of the quarter-end and day after, show the largest increases. But, note that the largest increases on those dates are in the repo markets. Repo using all categories of private securities as collateral show significant spikes in spreads around the quarter-end. For example, repo that uses collateralized loan obligation tranches rates AA-AAA spikes by 77 basis points the day of the quarter-end and the next day. Repo backed by asset-backed securities composed of auto loans, credit card receivables, or student loans rated AA-AAA also spikes by 71 basis points on those days. Unsecured money market instruments show much lower increases on those dates. For example, LIBOR goes up 4 basis points, A1/P1 Financial CP goes up by 8 basis points, and A1/P1 asset-backed commercial paper goes up by 9 basis points.

There is more seasonal pressure on repo markets. A seasonal increase in the spread in repo suggests that borrowers are willing to pay more for cash at these seasonal dates than at other dates to finance the collateral. But, the depositors/lenders, on the other hand, appear to want their cash (and not the collateral) at these dates.

Why is there a large demand for cash at these dates? Large movements of cash which go from one party to another, especially if one party is the government so cash leaves the economy, could cause these spikes in spreads. In the period before the Federal Reserve System there were seasonal spikes in interest rates when cash had to move from cities to rural areas for planting season and then later for harvesting season. Indeed, such spikes were viewed as creating fragility in the system and were a major motivation for the founding of the Federal Reserve System.[25]

In the modern era since the founding of the Federal Reserve System there are several possible candidates for explaining seasonals. One candidate for large cash movements is the payment of estimated taxes by corporations. Another possibility is quarter-end "window dressing," which might show up for example in the excess reserves of banks, if they are engaged in window dressing.

[25] On seasonals in the money markets prior to the Fed see Kemmerer (1911). On seasonals and fragility prior to the Fed see Miron (1986). And, on the elimination of some of the seasonals in interest rates once the Fed comes into existence, see Mankiw, Miron and Weil (1987).

We examine these issues in Table A2. The table contains the intercepts on each money market instrument with no controls, in the first column, and also with the date dummies from Table A1, in the second column. The next two columns show the change in the intercept when two tax variables are (separately) used in the panel regression. The two variables are the same. In both columns, we report the fitted values. We first estimate the parameters for tax flow process. Then we use the average tax flow to replace the actual tax flow and calculate the fitted value. For the variable "Tax, all days average", we assume tax flow equals the average tax flow across all days. For the variable "Tax, Normal days", we assume that tax flow equals the average tax flow across normal days, excluding quarter-end, beginning, middle and end of each month. The second average tax flow is smaller than the first one.

The last column includes U.S. commercial banks' excess reserves. The intercept is adjusted for these variables by estimating the coefficient on the variable and then adding or subtracting the coefficient times the average of that variable. So, for example, in column 3 the coefficient times the average inflow of taxes to the government, averaged over all (business) days, shows no effect, as the intercepts change very little. When the middle of the month is excluded, the intercept does go down in most cases, but not by much.

Inclusion of the excess reserves variable does reduce the intercept for repo categories, but not by as much as the calendar dummies that we started with.

These calendar effects are a subject for future research.

Appendix B: Chronology Breakpoints

In this appendix we briefly discuss the ordering of breakpoints.

As explained briefly in the main text, the Bai procedure finds a breakpoint for the given panel. The second breakpoint looks at the two subperiods defined by the first breakpoint and minimizes the sum of squared residuals over the whole sample using QML. The second breakpoint we find is usually after the date of the first breakpoint, but need not be. This means that we do not condition on the first breakpoint. In other words, the second breakpoint could be before the first breakpoint. Similarly, the third breakpoint is determined by looking at the ALL the subperiods determined by the first and second breakpoints.

The issues are illustrated by Figure B1, which shows two possible Bai orderings. The first breakpoint in both panels, A and B, is the crisis date. This is true in the data. In Panel A, the first three breakpoints occur at the crisis date and then chronologically in order. But, breakpoint four is before the crisis date. In general we are only interested in the first three breakpoints. However, we always calculate the fourth breakpoint because sometimes the ordering looks more like what is shown in Panel B.

In Panel B, the fourth breakpoint occurs during the crisis, and comes before the second breakpoint. But, the third breakpoint is before the crisis onset.

In order to understand the sensitivity of the procedure, particularly given the seasonals, we show the ordering according to the Bai algorithm and the chronological ordering. Table B1 provides examples for the most important panels. It illustrates the differences between the breakpoints found by the Bai algorithm and the chronological ordering of the breakpoints. In the table “Algorithm Order” equal 1 means that is the first breakpoint fund by the Bai procedure. “Chronological Order” means that after we found four breakpoints we sorted them chronologically and labeled them 1 through 4.

These issues are shown in Table B1.

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Table 1: Data Sources and Sample Periods				
Variable	**Source**	**Sample Periods**		**Description**
		Beginning	**End**	
VIX	CBOE	2000/1/1	2009/4/30	CBOE Volatility Index
S&P 500	Standard & Poor's	2000/1/1	2009/4/30	Standard & Poor's 500 Index return
JPM HY Index	Dealer Bank	2003/4/10	2009/4/30	J.P. Morgan High Yield Index
DJ CDX.IG	Dealer Bank	2003/4/10	2009/4/30	Dow Jones CDX Index (Investment grade)
ABX	Dealer Bank	2006/1/19	2009/4/30	Markit ABX.HE Index, 2006-1. AAA, BBB and BBB-
HEL	Dealer Bank	2006/1/19	2008/1/3	Home Equity Loan ABS spreads, AAA and BBB ratings
Financial CDS	Bloomberg	2002/11/6	2009/4/30	5 Year CDS for Bank of America, JP Morgan, Citigroup, Wells Fargo, Wachovia, Goldman Sachs, Merrill Lynch, Morgan Stanley, Lehman Brother and Bear Stearns.
Interbank Money Markets				
Fed Fund	Bloomberg	2001/12/20	2009/4/30	Effective Federal Fund rate
LIBOR	Bloomberg	2001/12/20	2009/4/30	LIBOR
OIS	Bloomberg	2001/12/20	2009/4/30	Overnight indexed swap
Commercial Paper				
A2/P2 Nonfinancial	Federal Reserve	2001/12/20	2009/4/30	SIC code: 100-5999, 7000-9999. Programs with at least one "2" rating but no ratings other than "2"
AA Asset-backed	Federal Reserve	2001/12/20	2009/4/30	SIC code: 6189. Programs with at least one "1" or "1+" rating but no ratings other than "1"
AA Financial	Federal Reserve	2001/12/20	2009/4/30	SIC code: 6000-6999, excluding 6189. Programs with at least one "1" or "1+" rating but no ratings other than "1"
AA Nonfinancial	Federal Reserve	2001/12/20	2009/4/30	SIC code: 100-5999, 7000-9999. Programs with at least one "1" or "1+" rating but no ratings other than "1"
Repo Categories				
GC	Bloomberg	2001/12/20	2009/4/30	General collateral repo rate
<AA ABS-RMBS / CMBS	Dealer Bank	2005/10/3	2009/4/30	Residential mortgage-backed security (RMBS) or commercial mortgage-backed security (CMBS) with ratings less than AA
A-AAA ABS-Auto / CC / SL	Dealer Bank	2005/10/3	2009/4/30	Asset-backed securities (ABS) comprised of auto loans, credit-card receivables, or student loans, with ratings between A and AAA, inclusive.
AA-AAA ABS-RMBS / CMBS	Dealer Bank	2005/10/3	2009/4/30	Residential mortgage-backed security (RMBS) or commercial mortgage-backed security (CMBS) with ratings between AA and AAA, inclusive.
AA-AAA CLO	Dealer Bank	2005/10/3	2009/4/30	Collateralized loan obligations (CDO) with ratings between AA and AAA, inclusive.
AA-AAA Corporates	Dealer Bank	2005/10/3	2009/4/30	Corporate bonds rated between AA and AAA, inclusive.
BBB+ / A Corporates	Dealer Bank	2005/10/3	2009/4/30	Corporate bonds rated between BBB+ and A, inclusive.

Table 2: Overnight Spreads Comparison

	Before the Crisis	During the Crisis	Crisis: Pre-Lehman	Crisis: Lehman	Crisis: After Dec 2008
	Intercept	Intercept	Intercept	Intercept	Intercept
Federal Funds	-0.32	-8.06	-3.32	-37.04	6.97
	(-1.54)	(-4.3)	(-2.44)	(-6)	(5.46)
GC Repo	-3.83	-22.49	-23.27	-56.32	11.02
	(-14.38)	(-7.7)	(-6.96)	(-7.53)	(6.76)
LIBOR	5.33	15.46	16.76	13.85	13.37
	(33.06)	(4.65)	(10.76)	(1.03)	(7.55)
A2/P2 Nonfinancial CP	8.97	80.03	47.52	172.89	87.34
	(24.46)	(15.66)	(28.27)	(11.53)	(17.33)
AA Asset-backed CP	1.47	40.28	37.52	50.78	38.4
	(8.34)	(12.98)	(27.49)	(5.05)	(16.13)
AA Financial CP	-1.51	-9.11	-5.9	-35.51	7.3
	(-8.65)	(-5.3)	(-6.59)	(-6.1)	(4.83)
AA Nonfinancial CP	-1.9	-7.47	-3.01	-36.53	7.73
	(-10.98)	(-3.89)	(-3.33)	(-5.44)	(4.75)
<AA ABS-RMBS / CMBS	10.16	98.59	49.12	136.94	207.36
	(8.36)	(17.18)	(13.07)	(8.9)	(74.21)
A-AAA ABS-Auto / CC / SL	3.23	56.7	30.07	83.06	108.9
	(3.07)	(12.9)	(8.51)	(5.09)	(34.65)
AA-AAA ABS-RMBS / CMBS	5.16	79.75	37.96	110.39	173.64
	(4.24)	(15.13)	(10.65)	(7.01)	(70.07)
AA-AAA CLO	5.16	93.18	45.75	125.99	202.31
	(4.24)	(16.45)	(11.8)	(8.38)	(74.11)
AA-AAA Corporates	-0.82	15.16	11.58	19.18	21.65
	(-0.92)	(3.71)	(3.71)	(1.02)	(8.73)
BBB+ / A Corporates	1.91	25.71	18.45	35.82	37.11
	(2.04)	(6.27)	(5.67)	(1.94)	(13.14)

Table 3: Crisis Chronology

Panel A: Common Break Points

Description	Num. of Securities	Break Point	Lower bound	Upper bound	Frequency	Beginning	End
Real Sector: VIX and S&P 500	2	2008/9/12	2008/9/12	2008/9/15	Daily	2000/1/1	2009/4/30
Real Sector: VIX, S&P 500, JPM HY Index, DJ CDX.IG	6	2008/1/3	2008/1/3	2008/1/10	Weekly	2003/4/10	2009/4/30
Subprime: ABX only	3	2007/1/25	2007/1/24	2007/1/29	Daily	2006/1/19	2009/4/30
Subprime: HEL only	2	2007/3/22	2007/3/22	2007/3/29	Weekly	2006/1/19	2008/1/3
Subprime: ABX & HEL	5	2007/1/4	2007/1/4	2007/1/11	Weekly	2006/1/19	2008/1/3
Financial CDS: Include Lehman	10	2007/7/23	2007/7/23	2007/7/24	Daily	2002/11/6	2008/9/12
Financial CDS: Exclude Lehman	9	2007/7/25	2007/7/25	2007/7/26	Daily	2002/11/6	2009/4/30
Money Market: CP, Fed Fund, GC, LIBOR, Repo	13	2007/7/23	2007/7/23	2007/7/24	Daily	2005/10/3	2009/4/30
Money Market: Repo	6	2007/7/23	2007/7/20	2007/7/25	Daily	2005/10/3	2009/4/30
Money Market: CP, Fed Fund, GC, LIBOR	7	2007/8/8	2007/8/8	2007/8/9	Daily	2005/10/3	2009/4/30

Panel B: Multiple Break Points								
Description	**Breaks**	**Number of Securities**	**Break Point**	**Lower bound**	**Upper bound**	**Frequency**	**Beginning**	**End**
CP, Fed Fund, GC, LIBOR, Repo	First	13	7/23/2007	7/23/2007	7/24/2007	Daily	10/3/2005	4/30/2009
	Second	13	8/14/2008	8/14/2008	8/15/2008	Daily	10/3/2005	4/30/2009
	Third	13	12/15/2008	12/15/2008	12/16/2008	Daily	10/3/2005	4/30/2009
CP, Fed Fund, GC, LIBOR	First	7	8/8/2007	8/8/2007	8/9/2007	Daily	10/3/2005	4/30/2009
	Second	7	9/12/2008	9/12/2008	9/16/2008	Daily	10/3/2005	4/30/2009
	Third	7	12/15/2008	12/15/2008	12/16/2008	Daily	10/3/2005	4/30/2009
Repo	First	6	7/23/2007	7/20/2007	7/25/2007	Daily	10/3/2005	4/30/2009
	Second	6	8/14/2008	8/14/2008	8/15/2008	Daily	10/3/2005	4/30/2009
	Third	6	12/15/2008	12/12/2008	12/17/2008	Daily	10/3/2005	4/30/2009
All CP	First	13	7/27/2007	7/26/2007	7/31/2007	Daily	10/3/2005	4/30/2009
	Second	13	9/12/2008	9/11/2008	9/17/2008	Daily	10/3/2005	4/30/2009
	Third	13	12/15/2008	12/15/2008	12/16/2008	Daily	10/3/2005	4/30/2009
Unsecured (Excluding ABCP)	First	7	8/6/2007	8/3/2007	8/8/2007	Daily	10/3/2005	4/30/2009
	Second	7	9/12/2008	9/11/2008	9/17/2008	Daily	10/3/2005	4/30/2009
	Third	7	12/15/2008	12/15/2008	12/16/2008	Daily	10/3/2005	4/30/2009

Table 4: Spread Break Detail

Description	Breaks	Number of Securities	Break Point	Lower bound	Upper bound	Frequency	Beginning	End
ABCP	First	1	7/27/2007	7/20/2007	8/6/2007	Daily	10/3/2005	4/30/2009
	Second	1	9/12/2008	9/5/2008	10/3/2008	Daily	10/3/2005	4/30/2009
	Third	1	10/16/2008	10/16/2008	10/17/2008	Daily	10/3/2005	4/30/2009
GC	First	1	8/13/2007	8/1/2007	8/24/2007	Daily	10/3/2005	4/30/2009
	Second	1	9/12/2008	9/4/2008	10/6/2008	Daily	10/3/2005	4/30/2009
	Third	1	12/15/2008	12/1/2008	1/12/2009	Daily	10/3/2005	4/30/2009

Table 6: Multiple Break Points For CP Issuance, Short/Long Ratio (30 day Rolling)

Description	Number of Securities	Break Point	Lower bound	Upper bound	Frequency	Beginning	End
First Break	4	2007/6/13	2007/6/12	2007/6/15	Daily	2005/10/3	2009/4/30
Second Break	4	2008/9/26	2008/9/26	2008/9/29	Daily	2005/10/3	2009/4/30
Third Break	4	2009/1/26	2009/1/23	2009/1/28	Daily	2005/10/3	2009/4/30

Table 7: Multiple Break Points For CP Issuance Level

Description	**Breaks**	**Number of Securities**	**Break Point**	**Lower bound**	**Upper bound**	**Frequency**	**Beginning**	**End**
	First	4	5/31/2007	5/30/2007	6/4/2007	Daily	10/3/2005	4/30/2009
Overnight	Second	4	9/19/2008	9/18/2008	9/23/2008	Daily	10/3/2005	4/30/2009
	Third	4	12/31/2008	12/31/2008	1/2/2009	Daily	10/3/2005	4/30/2009
	First	4	9/24/2007	9/14/2007	10/3/2007	Daily	10/3/2005	4/30/2009
One-month	Second	4	12/31/2007	12/6/2007	1/25/2008	Daily	10/3/2005	4/30/2009
	Third	4	9/12/2008	9/5/2008	9/22/2008	Daily	10/3/2005	4/30/2009
	First	4	3/8/2007	2/28/2007	3/19/2007	Daily	10/3/2005	4/30/2009
Three-month	Second	4	12/4/2007	11/16/2007	12/20/2007	Daily	10/3/2005	4/30/2009
	Third	4	9/16/2008	9/11/2008	9/22/2008	Daily	10/3/2005	4/30/2009

Panel B: Commercial Paper				
Series	Periods	Overnight	One-month	Three-month
A2/P2 Nonfinancial CP	Pre-crisis	8.97	16.41	18.54
		(24.46)	(36.2)	(28.27)
	Crisis: Pre-Lehman	47.52	77.1	89.6
		(28.27)	(31.11)	(36.19)
	Crisis: Lehman	172.89	351.97	361.65
		(11.53)	(13.12)	(8.94)
	Crisis: After Dec 2008	87.34	122.49	144.01
		(17.33)	(6.44)	(7.68)
AA Asset-backed CP	Pre-crisis	1.47	3.27	2.86
		(8.34)	(21.99)	(13.6)
	Crisis: Pre-Lehman	37.52	67.37	74.87
		(27.49)	(20.65)	(27.64)
	Crisis: Lehman	50.78	139.06	176.49
		(5.05)	(9.85)	(13.35)
	Crisis: After Dec 2008	38.4	40.08	66.32
		(16.13)	(21.98)	(8.84)
AA Financial CP	Pre-crisis	-1.51	-0.57	0.13
		(-8.65)	(-4.21)	(0.69)
	Crisis: Pre-Lehman	-5.9	26.27	51.52
		(-6.59)	(17.95)	(27.71)
	Crisis: Lehman	-35.51	88.39	135.27
		(-6.1)	(10.58)	(11.01)
	Crisis: After Dec 2008	7.3	17.58	46.38
		(4.83)	(14.03)	(6.81)
AA Nonfinancial CP	Pre-crisis	-1.9	-2.85	-0.08
		(-10.98)	(-15.72)	(-0.26)
	Crisis: Pre-Lehman	-3.01	7.01	11.71
		(-3.33)	(7.89)	(7.13)
	Crisis: Lehman	-36.53	16.94	76.08
		(-5.44)	(6.01)	(9.95)
	Crisis: After Dec 2008	7.73	1.46	12.25
		(4.75)	(1.72)	(7.32)

Panel C: Repo				
Series	Periods	Overnight	One-month	Three-month
<AA ABS-RMBS / CMBS	Pre-crisis	10.16	10.8	9.26
		(8.36)	(33.33)	(68.28)
	Crisis: Pre-Lehman	49.12	92.06	111.52
		(13.07)	(30.53)	(34.84)
	Crisis: Lehman	136.94	303.66	346.8
		(8.9)	(16.92)	(19.21)
	Crisis: After Dec 2008	207.36	238.79	312.3
		(74.21)	(147.24)	(172.87)
A-AAA ABS-Auto / CC / SL	Pre-crisis	3.23	4.82	4.26
		(3.07)	(15.87)	(31.35)
	Crisis: Pre-Lehman	30.07	73.58	91.23
		(8.51)	(27.47)	(34.2)
	Crisis: Lehman	83.06	219.67	266.07
		(5.09)	(13.34)	(16.5)
	Crisis: After Dec 2008	108.9	118.17	192.13
		(34.65)	(65.71)	(81.12)
AA-AAA ABS-RMBS / CMBS	Pre-crisis	5.16	6.8	6.26
		(4.24)	(20.99)	(46.16)
	Crisis: Pre-Lehman	37.96	81.95	102.2
		(10.65)	(29.26)	(35.29)
	Crisis: Lehman	110.39	277.03	320.17
		(7.01)	(15.91)	(18.31)
	Crisis: After Dec 2008	173.64	205.1	278.62
		(70.07)	(148.22)	(153.48)
AA-AAA CLO	Pre-crisis	5.16	6.8	6.26
		(4.24)	(20.99)	(46.16)
	Crisis: Pre-Lehman	45.75	89.22	113.12
		(11.8)	(27.21)	(33.84)
	Crisis: Lehman	125.99	292.47	335.23
		(8.38)	(15.83)	(17.99)
	Crisis: After Dec 2008	202.31	233.76	307.28
		(74.11)	(144.43)	(170.74)
AA-AAA Corporates	Pre-crisis	-0.82	-2.7	-2.24
		(-0.92)	(-11.39)	(-18.62)
	Crisis: Pre-Lehman	11.58	54.4	72.15
		(3.71)	(25.36)	(35.25)
	Crisis: Lehman	19.18	155.36	202.09
		(1.02)	(10.62)	(14.65)
	Crisis: After Dec 2008	21.65	31.09	105.05
		(8.73)	(23.48)	(51.83)
BBB+ / A Corporates	Pre-crisis	1.91	0.64	1.47
		(2.04)	(1.89)	(10.17)
	Crisis: Pre-Lehman	18.45	61.58	79.64
		(5.67)	(26.05)	(35.58)
	Crisis: Lehman	35.82	172.07	218.79
		(1.94)	(11.54)	(15.49)
	Crisis: After Dec 2008	37.11	46.4	120.36
		(13.14)	(35.63)	(53.5)

Panel B: Commercial Paper				
Series	Periods	1m/1d	3m/1d	3m/1m
A2/P2 Nonfinancial	Pre-crisis	7.42	9.37	1.92
		(23.53)	(18.21)	(5.23)
	Crisis: Pre-Lehman	29.57	41.36	12.94
		(12.72)	(18.5)	(9.04)
	Crisis: Lehman	179.08	200.91	35.16
		(9.31)	(7.31)	(3.2)
	Crisis: After Dec 2008	35.14	50.39	9.76
		(2.26)	(3.16)	(0.78)
AA Asset-backed	Pre-crisis	1.79	1.38	-0.4
		(9.1)	(5.54)	(-3.13)
	Crisis: Pre-Lehman	29.85	37.4	7.4
		(10.35)	(16.26)	(5.41)
	Crisis: Lehman	88.27	125.7	37.42
		(8.14)	(10.58)	(5.07)
	Crisis: After Dec 2008	2.15	28.39	26.24
		(0.92)	(4.19)	(3.52)
AA Financial	Pre-crisis	0.94	1.67	0.7
		(4.64)	(7.04)	(5.54)
	Crisis: Pre-Lehman	32.18	57.43	25.24
		(17.69)	(26.67)	(19.44)
	Crisis: Lehman	122.77	154.72	39.58
		(11.64)	(10.38)	(5.56)
	Crisis: After Dec 2008	10.27	40.05	29.41
		(5.84)	(5.9)	(4.25)
AA Nonfinancial	Pre-crisis	-0.96	1.71	1.31
		(-4.12)	(4.72)	(6.55)
	Crisis: Pre-Lehman	10.05	15.27	3.5
		(7.59)	(6.91)	(2.99)
	Crisis: Lehman	52.27	113.83	56.95
		(6.34)	(7.82)	(8.39)
	Crisis: After Dec 2008	-5.11	6.54	12.45
		(-4.58)	(4)	(6.84)

Panel C: Repo				
Series	Periods	1m/1d	3m/1d	3m/1m
<AA ABS-RMBS / CMBS	Pre-crisis	0.63	-0.9	-1.54
		(0.63)	(-0.76)	(-5.7)
	Crisis: Pre-Lehman	42.84	62.23	19.45
		(11.57)	(17.2)	(14.65)
	Crisis: Lehman	165.75	209.16	43.14
		(5.51)	(6.89)	(15.98)
	Crisis: After Dec 2008	31.51	104.99	73.51
		(13.12)	(33.18)	(51.18)
A-AAA ABS-Auto / CC / SL	Pre-crisis	1.57	1.02	-0.55
		(1.78)	(0.99)	(-2.24)
	Crisis: Pre-Lehman	43.53	61.01	17.65
		(11.73)	(16.83)	(16.33)
	Crisis: Lehman	136.2	182.73	46.39
		(4.75)	(6.3)	(14.9)
	Crisis: After Dec 2008	9.35	83.26	73.96
		(3.04)	(23.5)	(41.92)
AA-AAA ABS-RMBS / CMBS	Pre-crisis	1.63	1.09	-0.54
		(1.62)	(0.92)	(-2)
	Crisis: Pre-Lehman	43.92	64.1	20.25
		(11.83)	(17.77)	(15.78)
	Crisis: Lehman	165.75	209.16	43.14
		(5.51)	(6.89)	(15.98)
	Crisis: After Dec 2008	31.53	105.02	73.51
		(13.4)	(33.3)	(50.53)
AA-AAA CLO	Pre-crisis	1.63	1.09	-0.54
		(1.62)	(0.92)	(-2)
	Crisis: Pre-Lehman	43.27	67.11	23.89
		(11.56)	(18.23)	(16.46)
	Crisis: Lehman	165.37	208.4	42.76
		(5.53)	(6.9)	(15.73)
	Crisis: After Dec 2008	31.53	105.02	73.51
		(13.4)	(33.3)	(50.53)
AA-AAA Corporates	Pre-crisis	-1.87	-1.42	0.45
		(-2.34)	(-1.67)	(2.49)
	Crisis: Pre-Lehman	42.81	60.41	17.75
		(11.65)	(16.83)	(17.14)
	Crisis: Lehman	136.2	183.06	46.72
		(4.75)	(6.33)	(15.04)
	Crisis: After Dec 2008	9.49	83.4	73.95
		(3.3)	(24.62)	(39.02)
BBB+ / A Corporates	Pre-crisis	-1.27	-0.44	0.83
		(-1.52)	(-0.48)	(2.97)
	Crisis: Pre-Lehman	43.14	61.02	18.05
		(11.7)	(16.99)	(17.34)
	Crisis: Lehman	136.2	183.06	46.72
		(4.75)	(6.33)	(15.04)
	Crisis: After Dec 2008	9.35	83.26	73.96
		(3.04)	(23.5)	(41.92)

Table 10: Multiple Break Points for Slopes

Description	Breaks	Number of Securities	Break Point	Lower bound	Upper bound	Frequency	Beginning	End
CP, Fed Fund, GC, LIBOR, Repo	First	13	7/23/2007	7/23/2007	7/24/2007	Daily	10/3/2005	4/30/2009
CP, Fed Fund, GC, LIBOR, Repo	Second	13	8/14/2008	8/14/2008	8/15/2008	Daily	10/3/2005	4/30/2009
CP, Fed Fund, GC, LIBOR, Repo	Third	13	12/15/2008	12/15/2008	12/16/2008	Daily	10/3/2005	4/30/2009
CP, Fed Fund, GC, LIBOR	First	7	8/8/2007	8/8/2007	8/9/2007	Daily	10/3/2005	4/30/2009
CP, Fed Fund, GC, LIBOR	Second	7	9/12/2008	9/12/2008	9/16/2008	Daily	10/3/2005	4/30/2009
CP, Fed Fund, GC, LIBOR	Third	7	12/15/2008	12/15/2008	12/16/2008	Daily	10/3/2005	4/30/2009
Repo	First	6	7/23/2007	7/20/2007	7/25/2007	Daily	10/3/2005	4/30/2009
Repo	Second	6	8/14/2008	8/14/2008	8/15/2008	Daily	10/3/2005	4/30/2009
Repo	Third	6	12/15/2008	12/12/2008	12/17/2008	Daily	10/3/2005	4/30/2009

Table 11: Changes in Short-term Ratings for Financial Firms during the Crisis

	Total	A-1+	A-1	A-2	A-3	B	C	D	No Rating
A-1+	48	29	19						
		-0.6	-0.39						
A-1	60	4	36	14	1	3			2
		-0.06	-0.6	-0.23	-0.01	-0.05			-0.03
A-2	46		3	30	4	5			4
			-0.06	-0.65	-0.08	-0.1			-0.08
A-3	13			1	8	3			1
				-0.07	-0.61	-0.23			-0.07
B	8				1	3	2		2
					-0.12	-0.37	-0.25		-0.25
D	1							1	
								-1	

This table reports the changes in S&P short-term credit ratings for financial firms during the crisis of 2007-2009. Financial firms are defined as the firms with SIC code from 6000 to 6999. To be included in the sample, the firms must have a S&P short-term credit rating before June 30th 2007. The first two columns present the number of firms for different ratings on June 30th 2007. The third to eighth column shows the number of firms for different ratings on June 30th 2009. The transition probabilities are presented in parentheses.

Table 12: The Liability Structure of Financial Firms: 2007 to 2008

(in millions)	2007		2008	
Total Debts	6,558,396	100.00%	5,670,953	100.00%
Total Commercial Paper	564,364	8.60%	421,032	7.40%
Total Revolving Credit	65,221	1.00%	138,133	2.40%
Total Senior Bonds and Notes	2,818,906	43.00%	2,551,541	45.00%
Total Subordinated Bonds and Notes	225,657	3.40%	271,893	4.80%
Total Term Loans	212,892	3.20%	400,264	7.10%
Total Trust Preferred	102,538	1.60%	119,890	2.10%
Total Capital Leases	2,582	0.00%	2,611	0.00%
Other Borrowings	2,577,771	39.30%	1,772,505	31.30%

This table reports the aggregated debt structure for financial commercial paper issuers from 2007 to 2008. To identify the financial commercial paper issuers, we first get the list of firms which have received short-term credit ratings from Moody's or Standard & Poor's before 2007. Then we restrict our attention only to financial firms and identify 229 financial firms that have short-term ratings. The debt data is from Capital IQ. We are able to find the debt data for 77 of these 229 financial firms. And 13 of the 77 firms have never issued any commercial paper since 2001. So the final sample includes 64 financial firms, which cover most important commercial banks, investment banks and insurance firms in U.S.

Table 13: Breaks in Repo Haircuts

	Break point	Lower bound	Upper bound
First Break	2007/10/23	2007/10/23	2007/10/24
Second Break	2008/2/6	2008/2/6	2008/2/7
Third Break	2008/9/15	2008/9/15	2008/9/16

Table A1: Overnight Spreads, Before the Crisis

	Intercept	Quarter-end, Day (-15,-11)	Quarter-end, Day (-10,-6)	Quarter-end, Day (-5,-1)	Quarter-end, Day (0,1)	Quarter-end, Day (2,5)	Calendar Day, 1st	Calendar Day, 15th	Calendar Day, 30th or 31th	Monday	Friday
Fed Fund	-0.32	0.64	-0.02	1.76	6.56	0.19	2.75	5.88	4.99	2.48	0.16
	(-1.54)	(0.99)	(-0.03)	(2.83)	(5.88)	(0.27)	(3.09)	(7.2)	(6.06)	(6.46)	(0.44)
GC	-3.83	0.84	-2.42	-1.58	-2.1	0.24	4.3	6.83	4.69	2.2	-0.61
	(-14.38)	(1.02)	(-2.97)	(-1.98)	(-1.48)	(0.27)	(3.8)	(6.59)	(4.49)	(4.52)	(-1.29)
LIBOR	5.33	0.53	-0.36	4.16	12.76	1.22	1.19	5.92	6.61	1.57	-0.17
	(33.06)	(1.06)	(-0.72)	(8.26)	(14.73)	(2.19)	(1.71)	(9.46)	(10.25)	(5.13)	(-0.6)
A2/P2 Nonfinancial	8.97	1.24	-0.26	6.11	10.63	2.56	1.91	6.99	6.31	2.5	0.92
	(24.46)	(1.1)	(-0.23)	(5.6)	(5.45)	(2.04)	(1.22)	(4.9)	(4.34)	(3.68)	(1.42)
AA Asset-backed	1.47	1.07	-0.32	4.8	9.34	1.7	2.95	7.31	6.65	2.37	0.33
	(8.34)	(1.97)	(-0.6)	(9.15)	(9.84)	(2.82)	(3.92)	(10.65)	(9.5)	(7.25)	(1.06)
AA Financial	-1.51	0.56	-1.61	3.42	8.07	1.73	3.15	6.96	6.46	2.51	-0.25
	(-8.65)	(1.03)	(-3.01)	(6.57)	(8.66)	(2.88)	(4.23)	(10.2)	(9.29)	(7.72)	(-0.82)
AA Nonfinancial	-1.9	1.12	-0.27	4.67	6.99	1.64	3.33	7.09	6.55	2.53	0.34
	(-10.98)	(2.1)	(-0.5)	(9.1)	(7.62)	(2.77)	(4.55)	(10.56)	(9.57)	(7.93)	(1.13)
<AA ABS-RMBS / CMBS	10.16	1.3	13.52	67.8	77.07	-1.12	-2.64	-0.29	2.28	-1.96	5.88
	(8.36)	(0.32)	(3.45)	(19.8)	(6.11)	(-0.31)	(-0.52)	(-0.06)	(0.51)	(-0.85)	(2.71)
A-AAA ABS-Auto / CC / SL	3.23	0.63	10.97	54.64	71.28	-1.28	-2.53	-0.09	2.06	-1.43	5.1
	(3.07)	(0.18)	(3.24)	(18.46)	(6.54)	(-0.41)	(-0.58)	(-0.02)	(0.54)	(-0.72)	(2.72)
AA-AAA ABS-RMBS / CMBS	5.16	1.3	13.52	67.8	77.07	-1.12	-2.64	-0.29	2.28	-1.96	5.88
	(4.24)	(0.32)	(3.45)	(19.8)	(6.11)	(-0.31)	(-0.52)	(-0.06)	(0.51)	(-0.85)	(2.71)
AA-AAA CLO	5.16	1.3	13.52	67.8	77.07	-1.12	-2.64	-0.29	2.28	-1.96	5.88
	(4.24)	(0.32)	(3.45)	(19.8)	(6.11)	(-0.31)	(-0.52)	(-0.06)	(0.51)	(-0.85)	(2.71)
AA-AAA Corporates	-0.82	1.57	8.56	37.64	25.98	-1.66	-2.24	0.16	1.55	-1.08	2.46
	(-0.92)	(0.53)	(2.96)	(14.88)	(2.79)	(-0.62)	(-0.6)	(0.04)	(0.47)	(-0.63)	(1.54)
BBB+ / A Corporates	1.91	2	10.78	56.46	48.69	-1.46	-2.65	0.2	2.17	-1.92	4.02
	(2.04)	(0.64)	(3.58)	(21.43)	(5.02)	(-0.52)	(-0.68)	(0.05)	(0.64)	(-1.09)	(2.41)

Table A2: Intercept Comparison

	No Control	Date Dummies	Tax, all days average	Tax, Normal days	Excess Reserve, Normal days
Fed Fund	0.89	-0.32	0.89	0.66	0.80
GC	-3.24	-3.83	-3.22	-3.43	-3.03
LIBOR	6.56	5.33	6.56	6.34	6.32
A2/P2 Nonfinancial	10.86	8.97	10.84	10.60	10.53
AA Asset-backed	3.10	1.47	3.09	2.80	2.84
AA Financial	-0.20	-1.51	-0.22	-0.48	-0.41
AA Nonfinancial	-0.28	-1.9	-0.30	-0.58	-0.52
<AA ABS-RMBS / CMBS	16.44	10.16	16.49	16.53	13.88
A-AAA ABS-Auto / CC / SL	8.40	3.23	8.44	8.45	6.41
AA-AAA ABS-RMBS / CMBS	11.44	5.16	11.49	11.53	8.88
AA-AAA CLO	11.44	5.16	11.49	11.53	8.88
AA-AAA Corporates	2.45	-0.82	2.51	2.62	1.01
BBB+ / A Corporates	6.84	1.91	6.92	6.99	4.73

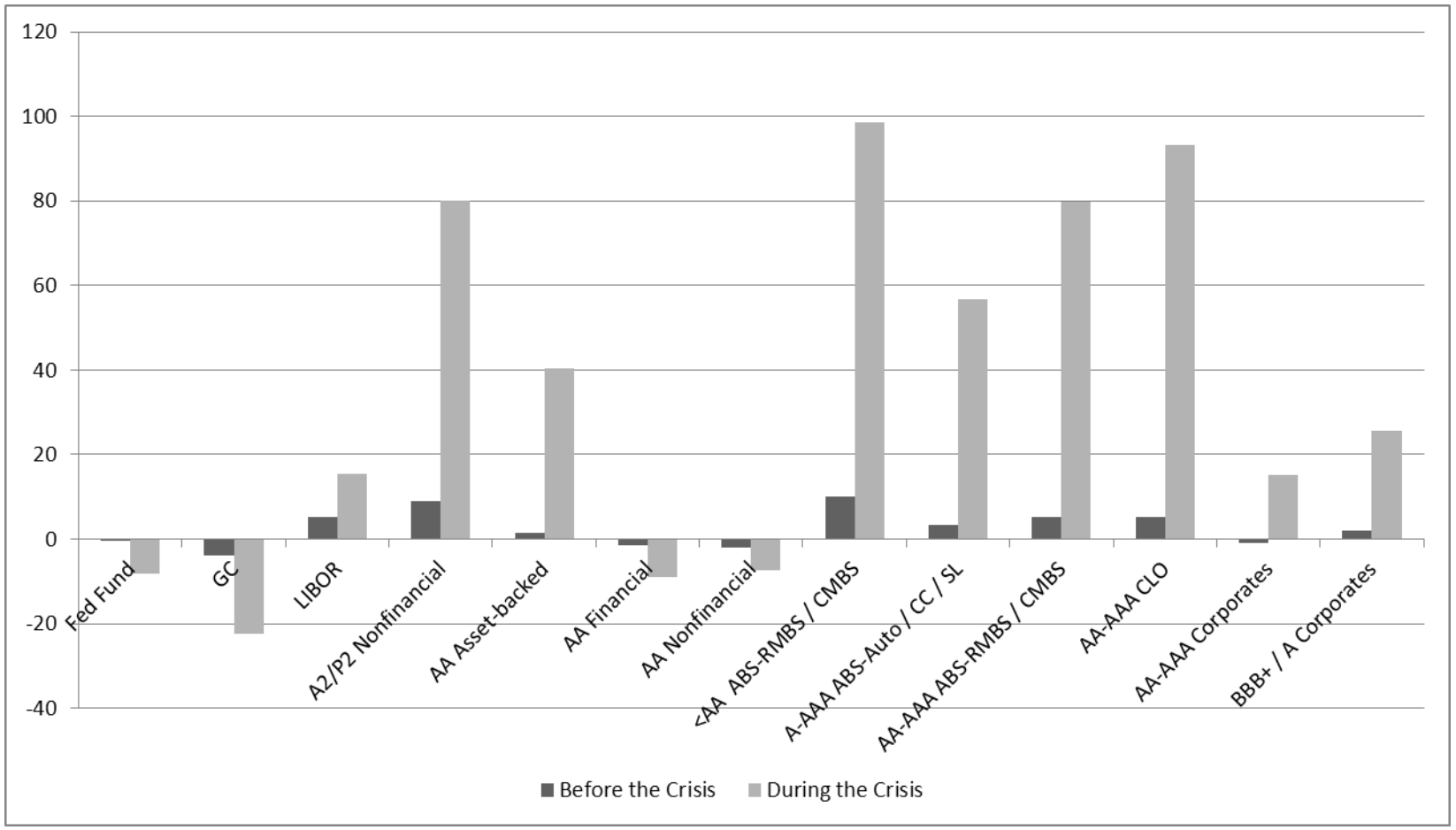
Table B1: Breakpoint Ordering

Panel A: Spreads				
CP, Fed Fund, GC, LIBOR, Repo				
Algorithm Order	Chronological Order	Breakpoint	Lower Bound	Upper Bound
1	1	7/23/2007	7/23/2007	7/24/2007
2	2	8/14/2008	8/14/2008	8/15/2008
3	4	12/15/2008	12/15/2008	12/16/2008
CP, Fed Fund, GC, LIBOR				
Algorithm Order	Chronological Order	Breakpoint	Lower Bound	Upper Bound
1	1	8/8/2007	8/8/2007	8/9/2007
2	2	9/12/2008	9/12/2008	9/16/2008
3	4	12/15/2008	12/15/2008	12/16/2008
Repo				
Algorithm Order	Chronological Order	Breakpoint	Lower Bound	Upper Bound
1	2	7/23/2007	7/20/2007	7/25/2007
4	3	8/14/2008	8/14/2008	8/15/2008
3	4	12/15/2008	12/12/2008	12/17/2008
All CP				
Algorithm Order	Chronological Order	Breakpoint	Lower Bound	Upper Bound
1	1	7/27/2007	7/26/2007	7/31/2007
2	2	9/12/2008	9/11/2008	9/17/2008
3	4	12/15/2008	12/15/2008	12/16/2008
Unsecured (Excluding ABCP)				
Algorithm Order	Chronological Order	Breakpoint	Lower Bound	Upper Bound
1	1	8/6/2007	8/3/2007	8/8/2007
2	2	9/12/2008	9/11/2008	9/17/2008
3	4	12/15/2008	12/15/2008	12/16/2008
ABCP				
Algorithm Order	Chronological Order	Breakpoint	Lower Bound	Upper Bound
1	1	7/27/2007	7/20/2007	8/6/2007
2	2	9/12/2008	9/5/2008	10/3/2008
3	4	10/16/2008	10/16/2008	10/17/2008
GC				
Algorithm Order	Chronological Order	Breakpoint	Lower Bound	Upper Bound
1	2	8/13/2007	8/1/2007	8/24/2007
4	3	9/12/2008	9/4/2008	10/6/2008
2	4	12/15/2008	12/1/2008	1/12/2009

Panel B: Haircut				
Algorithm Order	Chronological Order	Breakpoint	Lower Bound	Upper Bound
1	1	2007/10/23	2007/10/23	2007/10/24
3	2	2008/2/6	2008/2/6	2008/2/7
4	3	2008/6/30	2008/6/30	2008/7/1
2	4	2008/9/15	2008/9/15	2008/9/16

Panel C: 1 Month/ Overnight Spread Slopes				
Panel A: Spreads				
CP, Fed Fund, GC, LIBOR, Repo				
Algorithm Order	Chronological Order	Breakpoint	Lower Bound	Upper Bound
1	1	7/23/2007	7/24/2007	7/23/2007
2	2	8/15/2008	8/18/2008	8/15/2008
3	4	12/19/2008	1/2/2009	12/19/2008
CP, Fed Fund, GC, LIBOR				
Algorithm Order	Chronological Order	Breakpoint	Lower Bound	Upper Bound
1	1	8/8/2007	8/9/2007	8/8/2007
2	2	9/12/2008	9/16/2008	9/12/2008
3	4	12/19/2008	1/2/2009	12/19/2008
Repo				
Algorithm Order	Chronological Order	Breakpoint	Lower Bound	Upper Bound
1	1	7/23/2007	7/25/2007	7/20/2007
3	2	8/14/2008	8/15/2008	8/14/2008
2	4	12/17/2008	1/5/2009	12/11/2008
All CP				
Algorithm Order	Chronological Order	Breakpoint	Lower Bound	Upper Bound
1	1	8/8/2007	8/10/2007	8/7/2007
2	2	9/12/2008	9/17/2008	9/11/2008
3	4	12/19/2008	1/2/2009	12/19/2008
Unsecured (Excluding ABCP)				
Algorithm Order	Chronological Order	Breakpoint	Lower Bound	Upper Bound
1	1	8/8/2007	8/10/2007	8/7/2007
2	2	9/12/2008	9/16/2008	9/12/2008
3	4	12/19/2008	1/2/2009	12/19/2008
ABCP				
Algorithm Order	Chronological Order	Breakpoint	Lower Bound	Upper Bound
1	1	8/9/2007	8/20/2007	8/1/2007
3	2	9/12/2008	9/18/2008	9/10/2008
2	4	1/2/2009	1/27/2009	11/25/2008
GC				
Algorithm Order	Chronological Order	Breakpoint	Lower Bound	Upper Bound
1	1	8/10/2007	8/23/2007	7/31/2007
3	2	9/12/2008	9/17/2008	9/11/2008
2	4	12/18/2008	1/27/2009	11/19/2008

Figure 1: Money Market Spreads Before and During the Crisis (bps)



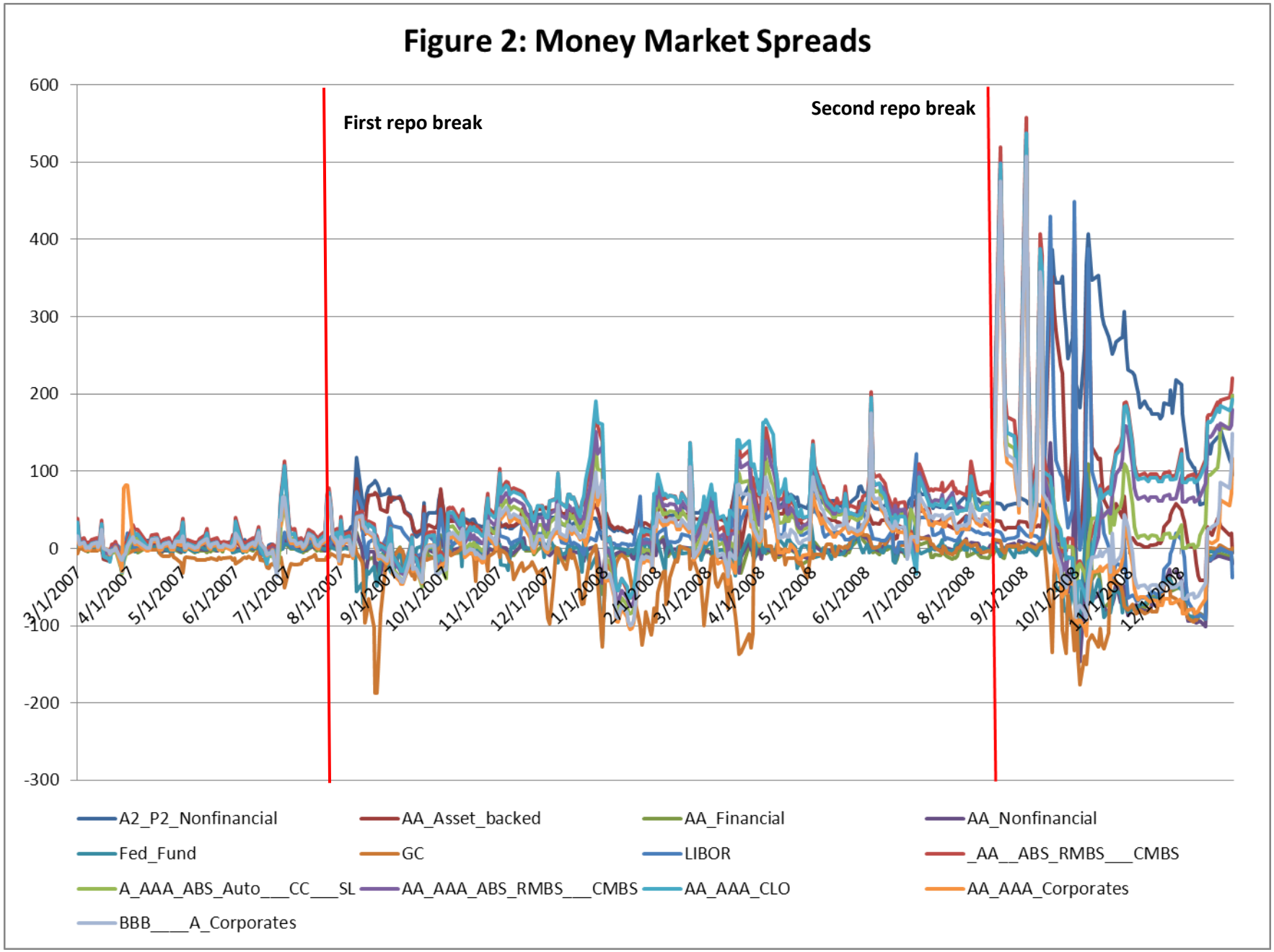
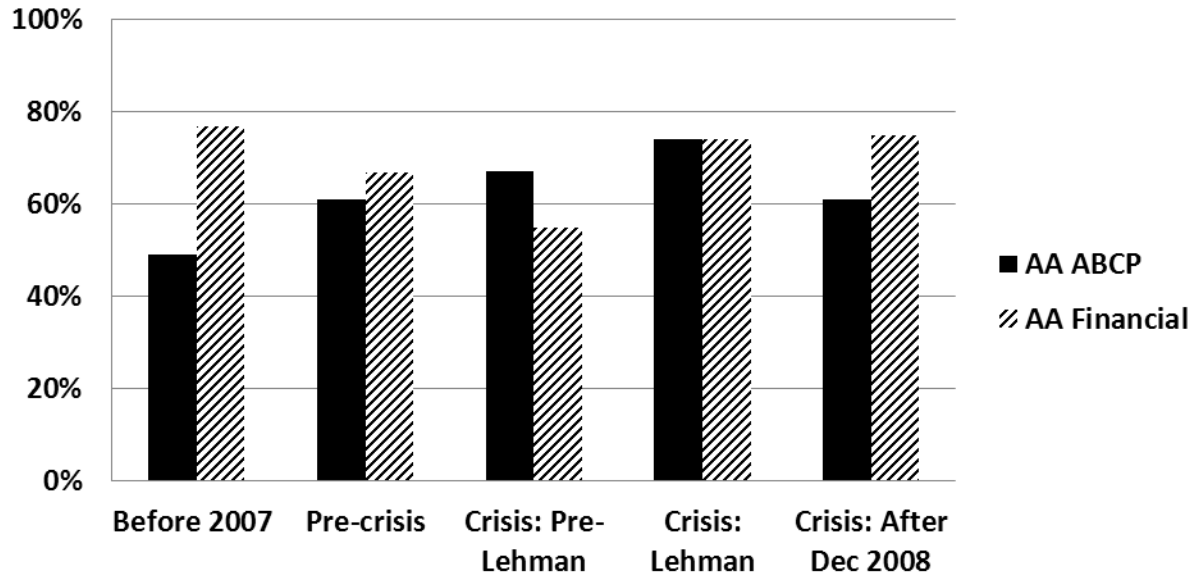


Figure 2: Money Market Spreads
First repo break
Second repo break
600
500
400
300
200
100
0
-100
-200
-300
3/1/2007
4/1/2007
5/1/2007
6/1/2007
7/1/2007
8/1/2007
9/1/2007
10/1/2007
11/1/2007
12/1/2007
1/1/2008
2/1/2008
3/1/2008
4/1/2008
5/1/2008
6/1/2008
7/1/2008
8/1/2008
9/1/2008
10/1/2008
11/1/2008
12/1/2008
A2_P2_Nonfinancial
AA_Asset_backed
AA_Financial
AA_Nonfinancial
Fed_Fund
GC
LIBOR
_AA__ABS_RMBS___CMBS
A_AAA_ABS_Auto___CC___SL
AA_AAA_ABS_RMBS___CMBS
AA_AAA_CLO
AA_AAA_Corporates
BBB____A_Corporates

Figure 4: CP 1-4 Day Maturity Issuance by ABCP Conduits and AA Financial Firms, as a percentage of average issuance



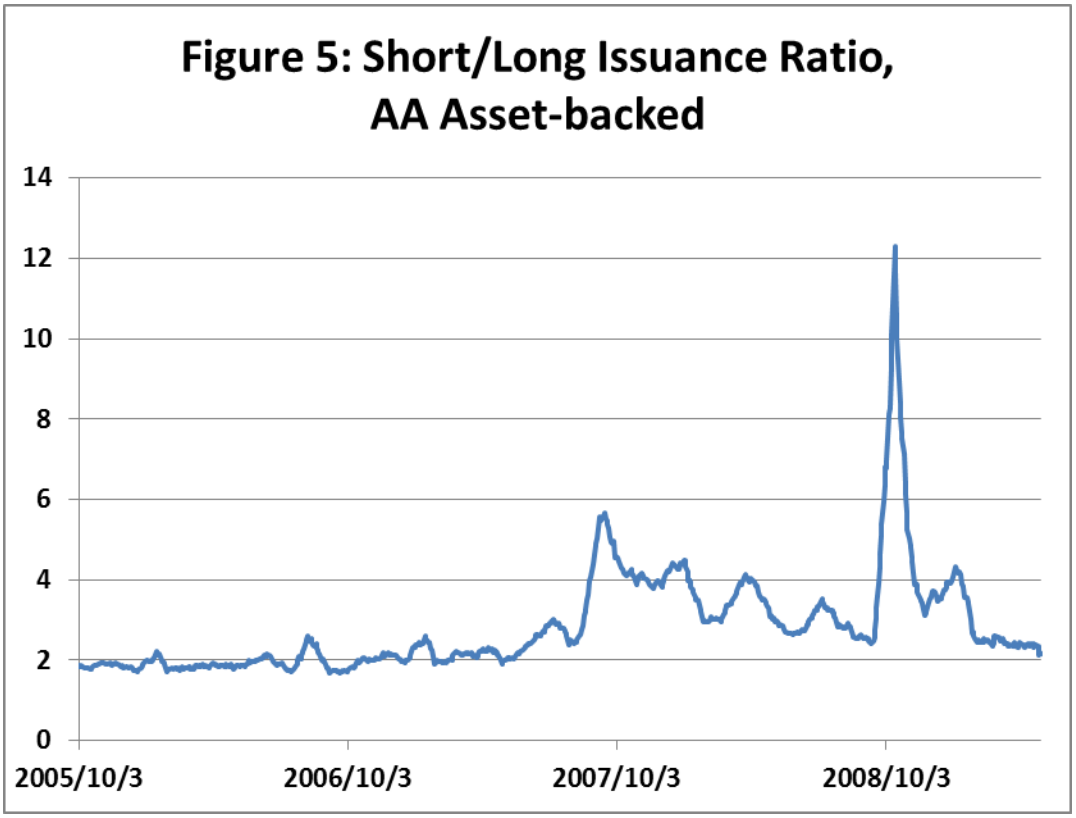


Figure 5: Short/Long Issuance Ratio,
AA Asset-backed
14
12
10
8
6
4
2
0
2005/10/3
2006/10/3
2007/10/3
2008/10/3

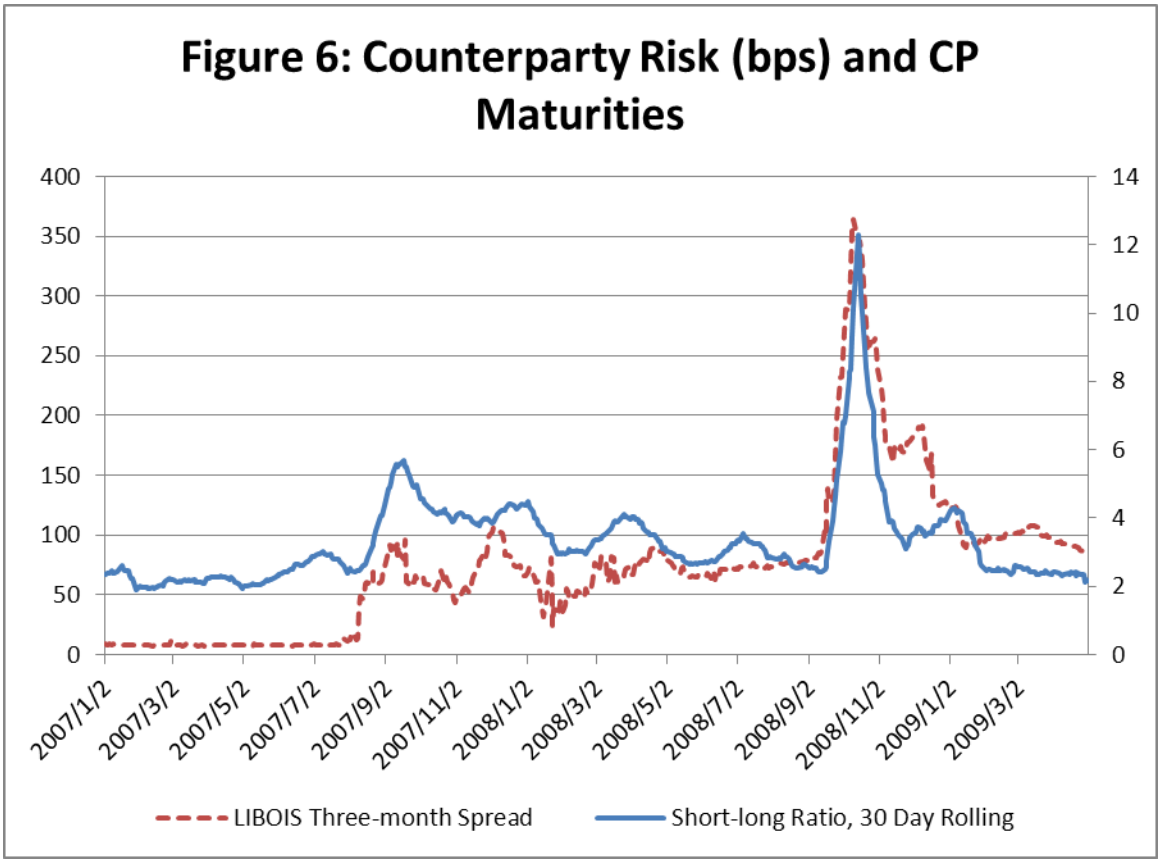


Figure 6: Counterparty Risk (bps) and CP Maturities
400
350
300
250
200
150
100
50
0
14
12
10
8
6
4
2
0
2007/1/2
2007/3/2
2007/5/2
2007/7/2
2007/9/2
2007/11/2
2008/1/2
2008/3/2
2008/5/2
2008/7/2
2008/9/2
2008/11/2
2009/1/2
2009/3/2
LIBOIS Three-month Spread
Short-long Ratio, 30 Day Rolling