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The Flight from Maturity

Gary B. Gorton

Andrew Metrick

Lei Xie

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Gary Gorton
Yale School of Management and NBER

Andrew Metrick
Yale School of Management and NBER

Lei Xie
AQR Capital

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Abstract

Why did the failure of Lehman Brothers make the financial crisis dramatically worse? The financial crisis was a process of a build-up of risk *during* the crisis *prior to* the Lehman failure. During the crisis market participants tried to preserve an option to withdraw by shortening maturities --- the "flight from maturity". This flight from maturity was manifested in a steepening of the term structures of spreads in money markets. With increasingly short maturities, lenders created the possibility of fast exit. The failure of Lehman Brothers was the tipping point of this build-up of systemic fragility. "Tail risk" is endogenous.

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> "The Lehman episode was not just a disaster for Lehman. It was a disaster for our country. And like any calamity, it should be subjected to careful, independent scrutiny." Timothy Geithner, written testimony before the House Financial Services Committee, April 20, 2010.

1. Introduction

How could a firm the size of Lehman Brothers, holding $600 billion of assets, go bankrupt over a weekend? The answer is that by the date of the bankruptcy filing, September 15, 2008, Lehman financed much of its balance sheet with short-term repo, more than $200 billion a day.[1] Lehman was short $4.5 billion in cash on September 15, 2008 because lenders refused to roll their repo.[2] But, Lehman did not start out the year 2007 with so much short-term financing. Lenders increasingly shortened the maturity of their repo loans as the crisis went on. In this paper, we show that this maturity shortening not only occurred for Lehman, but was a general phenomenon of the crisis, affecting all large financial firms and all money market instruments. This means that fragility built up *during the crisis*, so that an enormous amount of debt became overnight debt, a hair trigger or exit option for lenders. This systemic risk was endogenous. The Lehman failure was the result.

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[1] See In re Lehman Brothers Holdings Inc., et al., Chapter 11 Case No. 09-13555, Report of Anton R. Valukas ("The Valukas Report"), footnote 10, p. 3.

[2] The Valukas Report, footnote 48, p. 12. "Repo" is short for sale and repurchase agreement. Under a repo contract the lender deposits (i.e., lends) money to the borrower (the bank) for a short period of time at interest and receives bonds as collateral to ensure the safety of the deposit. The collateral is marked-to-market. The return on the bonds used as collateral accrues to the borrowing bank. Repo was central to the crisis; see Gorton (2010), and Gorton and Metrick (2012).

The notion that maturities of all money market instruments shortened during the crisis is not new. Krishnamurthy (2010), for example, writes that "The maturity contraction . . . appears to have taken place across many different financing arenas. . ." (p. 18). This shortening is also noted by Brunnermeier (2009) and Shin (2010), and Reinhart and Rogoff (2011), and others. And evidence of maturity shortening during the crisis in the case of asset-backed commercial paper comes from Covitz, Liang and Suarez (2013) and for sale and repurchase agreements used by money market mutual funds by Krishnamurthy, Nagel, and Orlov (2014). In theory, He and Wei (2011) present a model in which creditors have an incentive to shorten debt maturity to protect themselves from other creditors. Also see Brunnermeier and Oehmke (2013). The shortening of maturities has not, however, been formally tested.

The crisis was a run on money market instruments, in particular asset-backed commercial paper (ABCP) and sale and repurchase agreements (repo), and subsequently on money market funds; see Covitz, Liang and Suarez (2013), Gorton and Metrick (2012) and McCabe (2010). In order for there to be a run, these instruments must be very short maturity (or demandable). Money market instruments are not demandable like demand deposits, so a run can only happen if the maturity of repo and ABCP is overnight or a few days. Maturity shortening is central to understanding the crisis. In this paper, we test the hypothesis of maturity shortening across all major money market instruments and show the link to increasing fragility. We characterize the dynamic process of shortening as the crisis progressed. We argue that the financial system became increasingly fragile *during* the crisis due to maturity shortening, so that even a small shock would have led to a large response *at that point in the crisis*.

A "crisis" refers to a breakpoint in the characteristics of money market instruments as a group (e.g., spreads, volumes, maturities). We empirically trace the dynamic process of the build-up of fragility during the crisis by testing for breakpoints in different panels of the term structure of spreads, e.g., for secured money market instruments (repo) and unsecured money market instruments (defined below), based on the methodology of Bai (2010). A breakpoint in a panel of money market instruments is a definition of a financial crisis; there are runs on these short-term debt instruments as a group. The breakpoints formally define regimes in which the crisis is becoming worse as maturities shorten. Based on these regimes, we then use differences-in-differences panel regressions to show that the maturity shortening is associated with increasing fragility, as measured by bank CDS premia.

We first analyze the commercial paper (CP) market because data on the outstanding and issuance volumes at each maturity exist for commercial paper, but there is no such data for the other money market instruments. The maturity of CP declined during the crisis even though the average quality of the issuers was improving because lower quality borrowers were forced out of the market. This is shown in Figure 1, which graphs the 30-day rolling short/long ratio of 20 days and under maturities to over 20 days for asset-backed commercial paper (ABCP) issuance rated AA.[3] The figure shows the decline in maturity starting in August 2007, even for the issuers that remained in the market. Figure 1 also shows a measure of interbank credit risk, the LIBOR minus overnight index swap (OIS) rate spread (effectively a riskless rate). The LIBOR minus OIS spread is the

[3] Asset-backed commercial paper (ABCP) is commercial paper that is issued by ABCP conduits. Such a conduit is a special purpose vehicle (a legal entity) that buys asset-backed securities, financing this by issuing commercial paper.

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. The measure of interbank risk is an indicator of the likelihood that the bank sponsors of the ABCP conduits will rescue their conduits should the need arise. The link between the short/long ratio and LIBOR-OIS reflects the increasing fragility of the banks, which we seek to test more formally.

We show that the maturity shortening in commercial paper is manifested in a steepening of the CP term structure of spreads. The "spread" refers to the particular money market (annualized) rate minus the "riskless" rate for the given maturity. The "term structure of spreads" refers to such spreads at different maturities. During normal times the spreads are all very low and the term structure of spreads is flat (as we show below), corresponding to money market instruments of different maturities being near-riskless, and hence the same.[4] An increase in the term structure of spreads reflects the differing concerns of borrowers and lenders. During a crisis banks want to lock-in longer term funding and so they offer to pay a higher rate for longer maturity borrowing, and a lower rate for shorter maturities. But, lenders prefer to lend short because of their concerns about the solvency of borrowers; they want an exit option which means a short maturity. In other words, lenders care about shortening the maturity – the flight from maturity-- since they are concerned about being in a position to get their cash at very short notice. An upward sloping term structure

[4] This is, of course, by design. The longest maturity is the horizon over which the instruments are close substitutes for shorter maturities.

of spreads is an indication of these concerns on the parts of borrowers and lenders.[5]

During the crisis the term structures of spreads became increasingly positively sloped, reflecting the desire of lenders to lend short and the desires of the borrowers to borrow long. For example, Figure 2 shows the term structure of spreads of LIBOR loans at three dates (corresponding to the breakpoints in the data that we find below based on Bai (2010)). The increasingly positive tilt of the term structure of spreads is apparent.

In the case of CP, we show in a differences-in-differences framework the relationship between CP maturities shortening and the term structure of CP spreads. The upward tilt of the term structure of spreads is associated with maturity shortening. We also show that the shortening of maturities is associated with an increase in the banks' average CDS premia, as they become increasingly fragile.

In other money market instruments, where there is no volume data by maturity, we also observe the same steepening of the term structure across these money market instruments. And, by this indicator, the shortening of maturities is also associated with an increase in the banks' CDS.

Using the Bai (2010) procedure we find that, following the onset of the crisis, successive breaks occur at two more dates *prior* to Lehman.[6] The breakpoints correspond to increasingly high slopes of the term structure of spreads implying that the debt structure of the banks is increasingly fragile because of the

[5] For all the money market instruments except CP, we cannot say what the equilibrium outcomes were in terms of volumes at different maturities because of a lack of data.
[6] Gorton, Metrick and Lei (2014) find the date of the onset of the crisis: July 2007.

maturity shortening. This is the buildup of risk. Finally, the build-up reaches a finale when lenders exit from Lehman—the run. Thus, we show that a "crisis" is not just a "shock." The run on Lehman was the result of an endogenous buildup of risk.

Our argument, that fragility is endogenous, conflicts with the standard "two shock" view of the recent crisis. In this view, a "crisis" corresponds to a "large shock." As expressed for recent events, the financial crisis of 2007-2008 involved two distinct phases, corresponding to two distinct shocks, the "subprime shock" and the "Lehman shock," e.g. Mishkin (2011). First, the argument goes, there was the period from July 2007 to August 2008 which started with a shock to subprime residential mortgages due to house price declines and a disruption in financial markets, but real GDP continued to rise. Some economists predicted a mild recession.[7] Fed Chairman Bernanke said that the problems with subprime mortgages were "likely to be contained".[8] But, a year later, in mid-September 2008, the failure of Lehman Brothers caused a much more virulent global financial crisis—"the imminent collapse 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.[9]

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[7] For example, Lucas (2009, p. 67) wrote that, "Until the Lehman failure the recession was pretty typical of the modest downturns of the post-war period . . . After Lehman collapsed and the potential for crisis had become a reality, the situation was completely altered."

[8] Bernanke's statement came in testimony before the Joint Economic Committee of Congress: http://www.federalreserve.gov/newsevents/testimony/bernanke20070328a.htm .

[9] For example, according to Blinder (2009), "everything fell apart after Lehman . . . After Lehman went over the cliff, no financial institution seemed safe. So lending froze, and the economy sank

Our results suggest that this two shock view of the crisis is not accurate. Rather, the crisis was an ongoing build-up of fragility as the maturities of money market instruments shortened, starting around July 2007 and continuing, finally resulting in the Lehman failure, which was feasible because of this build-up of fragility. In order for Lehman to fail suddenly, enough creditors had to be in the position to not renew their loans, i.e., a very large amount of Lehman financing had to be in the form of, say, overnight repo. Short maturity is a necessary condition for a run. This has important implications for detecting systemic risk prior to crises.

The paper proceeds as follows. In Section 2 we review the design of money market instruments, present the data, and introduce the econometric procedure for finding breakpoints in panels of data. In Section 3 we analyze the commercial paper market, linking the maturity shortening to the term structure of spreads and to the increase in bank CDS. In Section 4 we analyze the other money market instruments. Our conclusions are in Section 5.

2. The Money Markets

Money market instruments serve as short-term stores of value for financial and nonfinancial firms, and for investors, like pension funds, institutional money managers, hedge funds, and money market funds. Money market instruments are not insured, but otherwise resemble demand deposits in important ways. In particular, they offer a fairly safe store of value and easy access to the cash because of their short maturities. In this section we briefly review the relevant

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like a stone. It was a colossal error, and many people said so at the time" (Blinder 2009). Also, see Krugman (2012).

money market instruments and introduce the data that we will subsequently analyze.[10]

A. Description of the Instruments

Privately produced money market instruments include secured instruments, namely sale and repurchase agreements, which are backed by explicit collateral and unsecured instruments that are backed by the issuer's portfolio of assets, usually in the form of a portfolio of bonds of a financial firm or of a managed special purpose vehicle.

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.[11] If the counterparty fails, then the non-defaulting party can unilaterally terminate the transaction and sell the collateral (or keep the cash). This is because 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 investors and rating agencies. 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. And CP is also backed up by a bank line of credit (see, e.g.,

[10] We omit consideration of bankers' acceptances and wholesale certificates of deposit because we do not have daily data on their rates.

[11] The collateral is valued at market prices. During the period of the repo contract, there may be margin required to maintain the value of the collateral exactly.

Moody's (2003), Nayar and Rozeff (1994)). If CP issuers' ratings deteriorate then 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 to pay off its maturing CP. This process of "orderly exit" from the commercial paper market maintains the high quality of the issuers.[12]

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, and they are required to obtain high ratings. One important feature of asset-backed commercial paper is that the conduits must have back-up liquidity facilities in case they cannot renew issuance of their commercial paper. These liquidity facilities cover the inability of the conduits to roll CP for any reason. In most cases these facilities are sized to cover 100 percent of the face amount of outstanding CP. They are typically provided by banks rated at least as high as the rating of the CP. See Fitch (August 23, 2007). Such a liquidity agreement is usable immediately if the commercial paper cannot be remarketed (rolled). If a conduit draws on its liquidity facility, the provider of the liquidity facility, usually the sponsoring bank, purchases bonds from the conduit or loans money to the conduit to purchase commercial paper in the case that the commercial paper cannot be issued.

[12] "Orderly exit" is discussed by Fons and Kimball (1991) and Crabbe and Post (1994). 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).

We also examine the two largest interbank money markets, the London interbank market (the "Euro-dollar" or "LIBOR" market) and the U.S. federal funds market. In the LIBOR market banks deposit excess U.S. dollars with other banks, sometimes referred to as "Eurodollar deposits," and earn interest at the London interbank offered rate (LIBOR).[13] The Eurodollar or LIBOR market involves large global banks, which are monitored by their domestic bank regulators. The LIBOR and federal funds markets are unsecured, but both rely on screening and monitoring by bank regulators.

Each money market has different clienteles. Regulated banks are the participants in the LIBOR and federal funds market. Only U.S. commercial banks can participate in the federal funds market. All financial institutions can borrow in the repo market, a larger group than commercial banks, including most notably the old U.S. investment banks and large foreign banks. Non-financial firms and non-bank financial firms can issue commercial paper.[14] These money markets are connected because the largest U.S. banks can eliminate arbitrage opportunities across these markets. Consequently, the four money markets would display the same near-money-like riskless qualities; their spreads should normally be "low," and the term structure of spreads should be flat, as shown in Figure 2.

B. Data

[13] LIBOR interest rates are based on a survey by the British Bankers' Association. The rate is the simple average of the surveyed bank rates excluding the highest and lowest quartile rates. The rates are announced by the BBA at around 11.00 am London time every business day. Such rates are estimated for maturities of overnight to up to 12 months and for 10 major currencies. The Intercontinental Exchange (ICE) took over the administration of LIBOR on February 1, 2014. See http://www.bba.org.uk/bba/jsp/polopoly.jsp;jsessionid=aAEWKNo02dUf?d=103 .

[14] CP issuance by nonfinancial firms is small as shown below.

The data series and their sample periods are listed in Table 1. There are thirteen money market instruments, including four categories of commercial paper, fed funds, LIBOR, and seven categories of repo, including general collateral repo (GC).[15] We analyze spreads, where the spread is the promised contractual rate minus the federal funds target rate. All spreads are annualized. For the spread calculation, other candidates are the Treasury bill rate or the overnight index swap rate (OIS) rate. Treasury rates were unusually low during the crisis due to a flight to quality, but results are not significantly different if we use the OIS rate instead of the target federal funds rate.

In examining spreads one issue that we must contend with is the presence of "seasonal effects" noted by previous researchers in some money market instruments and in commercial bank balance sheets. In this paper we are not focusing on these seasonal effects. The spreads are deseasonalized by regressing the spreads during normal times on calendar dummies for "seasonals," that is quarter-end dummies, first, 15th and last day of month dummies, and Monday and Friday dummies. This is discussed in Gorton, Metrick and Xie (2015).

C. Panel Breakpoint Methodology

To learn about the dynamics of the crisis and, in particular, the shortening of maturities, we seek breakpoints in panels of data on money market instruments: secured and unsecured, starting in January 2007. It is quite natural that a financial crisis would result in common breakpoints in panels of data. In fact, a definition of a financial crisis is that it is a common breakpoint in many money

[15] "General collateral" is the range of assets that are accepted as collateral in the repo market, usually U.S. Treasuries.

and banking time series. We follow the estimation approach of Bai (2010) who shows how to find breakpoints in panels of data where a breakpoint is in the mean and/or the variance. This is discussed in Gorton, Metrick and Xie (2015). Assuming a common breakpoint is more restrictive than assuming random breakpoints in the individual 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.[16]

Our approach is to group the money market spreads into the unsecured money markets (six series) and the secured money markets (seven series). 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 the number of series in the panel, N. But, as a practical matter N can also be small, even one. 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. It is also worth emphasizing that during the crisis spreads do not become more highly correlated. Just the opposite, as market participants distinguish different degrees of moneyness among the different instruments. (See Gorton, Metrick and Xie (2015).)

Although it need not be the case, in fact, in the data, we find that the first breakpoint in the term structure of spreads, for all panels, is the start of the crisis. The first breakpoint divides the panel into two sub-panels, on each side of

[16] Note that Bai's procedure is not testing sudden breaks against the alternative hypothesis of gradual or smooth structural changes. Chen and Hong (2012), for example, propose a test for smooth structural changes in time series, but not panels. The Bai procedure and the tests for smooth changes both test against the alternative of no change, and we cannot test to determine whether the change is sudden or gradual.

the first breakpoint. We then apply Bai to the each of the two subseries, on the two sides of the first breakpoint. The second breakpoint is the one that gives the larger reduction in the sum of squared residuals, when comparing the break found in each of the two subseries. The second and third breakpoints are not necessarily ordered chronologically, but we show them chronologically. So, if the Bai algorithm order is 1, 3, 2, then this means that that when we order the points chronologically, the third breakpoint came second in chronological time. Table A shows the Bai algorithm ordering and the chronological ordering for all the series.

3. The Flight from Maturity: Commercial Paper

In this section we examine commercial paper and document the flight from maturity. We show how it progressed during the crisis resulting in increased fragility.

A. Commercial Paper: Issuance and Maturity Structure

Commercial paper is the only money market instrument where we can analyze the maturity structure of the paper issued using daily issuance data, but this is problematic because the mix of issuers is changing, as discussed below.[17] The Federal Reserve opened the Commercial Paper Funding Facility on October 7, 2008, after the Lehman failure. Since we are interested in the period prior to Lehman, this will not affect results. [18]

[17] The Federal Reserve System has repo data divided into overnight and term repo (greater than overnight). But, the data do not give the composition of the collateral, which likely changed during the crisis.

[18] This program allowed the Fed to purchase three-month unsecured and asset-backed commercial paper. Even so, we saw in Figure 1 that even the firms that could issue CP still had to shorten their maturities.

Issuance of commercial paper for various types of issuers and for different maturities is shown in Table 2. The table shows the average daily issuance of commercial paper for the categories of issuer shown. The table also divides the data by time period. 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.

There are five time periods shown: before 2007, 2007 before the crisis, the crisis before Lehman, the run on Lehman, and the aftermath subsequent to December 2008. 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. ABCP is the most important category because it faced runs during the crisis. In the table, the important comparison is the issuance for ABCP comparing the period Crisis: Pre-Lehman to Crisis: Lehman. Here ABCP increases in the 1-4 day bucket from 67% to 74% and in the pre-crisis period it was 61%. Meanwhile the longer bucket maturities, i.e., 21-40 days, 41-80 days and greater than 80 days, all show declines.

ABCP is the most important category of commercial paper. Figure 3 shows the evolution of ABCP issuance and outstanding during the crisis. The amounts of commercial paper issued by ABCP conduits and by financial firms declined dramatically during the crisis. Between August 2007 and July 2008 the amount of ABCP issued fell by 37%. Twenty-seven ABCP conduits exited the market (see Moody's (2009), Keogh (2007) and Anderson and Gascon (2009)). Commercial

paper issued by nonfinancial firms was less affected but was never quantitatively as important as ABCP and CP issued by financial firms.

B. CP Issuance and Screening

The figure and table are suggestive. As mentioned above, the mix of issuers was changing, with weaker and weaker borrowers forced out of the market during the crisis. We briefly investigate this in this subsection.

The unsecured money markets are based on screening. In addition to maturity shortening there may have been tightened screening of issuers. We find some suggestive evidence on this. First, we look at the changes in S&P short-term credit ratings for 176 financial firms and report the results in Table 3. During the crisis of 2007-2009, a considerable proportion of these firms were downgraded. For example, 39% of firms with A-1+, the highest short-term rating, before the crisis were downgraded to A-1. And 36% of the firms rates A-1 were downgraded by one or more notches. Correspondingly, financial firms were forced to reduce their reliance on commercial paper. Figure 1 is then more remarkable, as even the best firms increasingly issue at shorter maturities.

C. Maturity and the Term Structure of Spreads in the CP Market

In this subsection we turn to finding breaks in the maturity structure and relate this to the breakpoints in the term structure of spreads. We start with the breakpoints and then look at regression evidence.

Table 4 shows the breakpoints for overnight CP issuance, one-month CP issuance, and three-month CP issuance. Table 4 shows the first break in overnight issuance was on May 31, 2007. This is consistent with anecdotal

evidence that maturities were shortening as lenders were becoming nervous in the spring and summer of 2007. For one-month issuance the first breakpoint is September 24, 2007. And for three-month issuance the first breakpoint is March 8, 2007. Overnight issuance was increasing and three-month issuance was decreasing. The one-month issuance third breakpoint and the third breakpoint of the three-month issuance are within each other's confidence intervals and are pre-Lehman. The second breakpoint of overnight issuance is just post-Lehman.

Table 4 shows the breakpoints in CP issuance at different maturities. This can be summarized with the short/long ratio, 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). Table 5 shows the breakpoints in the short/long ratio for four series of CP. The breaks in this ratio first occur in August 2007. And the second break is two days after Lehman.

We now look the relation between maturity and the slope of the term structure of spreads in a simple regression context. We want to check that these are related: maturity shortening is reflected by an upward tilt of the term structure of spreads. The short/long ratio at date t is defined as the average of the previous three days' 1-4 day CP issuance divided by the average of the previous 30 days' 20-40 day CP issuance. We then take the average for each week and then calculate the weekly change. Then the change in short/long ratio (SLR) equals the average of SLR in week t minus the average of SLR in week t-1. This is the dependent variable. We define the change in the slope similarly; the change in the slope (1month minus -1 day) equals the average of the slope (1m-1d) in week t minus average of slope (1m-1d) in week t-1.

Table 6 Panel A shows how the changes in the short/long ratio change with the change in 1-month-1 day slope change. Shown is the period prior to Lehman, the period of interest; did maturities shorten leading up to Lehman? We look at the change in the ABCP short/long ratio in the first column and the change in the AA Financial CP in the second column. In both cases, an upward tilt in the term structure of spreads is associated with an increase in the short/long ratio.

Intuitively, a shortening of maturities makes the financial firms increasingly fragile. This is examined in Panel B of Table 6. The left-hand side variable is now the change in the average CDS spread for financial firms.[19] An upward tilt of the term structure of spreads is associated with an increase in the CDS spread for the average financial firm.

We can confirm the relationship between the maturity structure of issuance and the term structure of spreads using a differences-in-differences approach, regressing a measure of the change in the ABCP maturity structure on the change in the term structure of ABCP spreads' slope, interacted with regimes identified using Bai's procedure on repo spreads. Repo spreads correspond to phases of runs. The idea is to see if there is a link between the tilting upwards of the term structure of spreads and the shortening of maturity.

We examine the period prior to Lehman since the hypothesis is that maturities were shortening prior to Lehman. We indicate two different regimes, indicated by two dummy variables, R0 and R1, which correspond to two regimes divided by repo breaking points based on Bai (2010) (see Gorton, Metrick and Xie

[19] "Financial CDS" refers to an equally-weighted index of the 5-year credit default swaps (CDS) on U.S. financial institutions, including some commercial banks and dealer banks.

(2015)). Specifically, R0: prior to July 23, 2007 and R1: July 23, 2007 to Aug 14, 2008. The regime R1 is our focus. This is the period from the start of the crisis until one month prior to Lehman. We look at the same variables as in Table 6, but now we look at differences-in-differences, where the change in the slope of the term structure of spreads is interacted with the regime dummies.

The slope of the spread term structure is flat in the regime R0, prior to July 23, 2007, and we do not expect significance of the interaction term. The financial crisis starts on July 23, 2007 (see Gorton, Metrick and Xie (2015)), therefore, during R1 (July 23, 2007 to Aug 14, 2008) we expect to see the term structure of spreads steepening corresponding to a decline in maturity. The results are shown in Table 7 Panel A. The first two column looks at ABCP and the second column look at AA Financial CP. The left-hand side variable in Panel A is the short/long ratio. The right-hand side shows the change in the ABCP slope of the term structure of spreads and the change in the AA Financial CP term structure of spreads. Panel B is the same as Panel A except that the left-hand side variable is the change in the CDS spread on the financial firms. Again, the logic of Panel B is that if maturities are shortening average CDS spreads should be increasing.

In both cases, the ABCP short/long ratio and the AA Financial short/long ratio, the interaction term is significant, consistent with the notion that there is a significant association between the term structure of spreads tilting to positive and maturities shortening in the period prior to Lehman. If so, this should be a problem for financial firms. In Panel B, it is shown that that this is indeed the case.

4. Maturity Shortening of Other Money Market Instruments

Unfortunately, we do not have issuance data for other money markets instruments. So, next we turn to examining the term structure of money market spreads for evidence of maturity shortening prior to and during the crisis.

A. Term Structures of Spreads

We focus on the 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 and one day spreads, and the difference between the three-month and one-month spread. For longer maturities where there is no federal funds (FF) target, we use the OIS rate for that maturity.

It is perhaps easier to see what is going on with figures. As with Figure 2 above, Figures 4-6 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. (The Online Appendix 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.)

B. Maturity Shortening and Fragility

In the case of commercial paper we can directly look at issuance and see the maturity shortening. This shortening occurred even though some weaker borrowers left the market and even though, later, the Federal Reserve introduced the CPFF. The slope of the term structure of spreads reflects the maturity shortening. We can see this directly for ABCP. The other money market instruments do not have issuance data by maturity. However, the figures above showed the same upward tilting of the term structure of spreads. In this subsection we indirectly confirm this.

A shortening of maturities of money market instruments makes the financial firms more fragile; lenders are putting them on a short leash and may exit. In analyzing commercial paper we showed that a positive tilting of the term structure of spreads was associated with a higher average CDS spread. See Table 7, Panel B. This should also be true for the other money market instruments as well if the positive tilt in their term structures of spreads corresponds to shortening maturities.

We can investigate this be replicating the differences-in-differences regressions of Table 7, but now including dummy variables for each of the money market instrument, interacted with the regimes and slope change. The results are shown in Table 8. To save space, only the coefficients for the interaction terms are shown. They are all significant. In the regression, the CDS spreads are in basis points. So, the coefficient of 0.3 for repo backed by <AA ABS_RMBS means that a 50 basis points increase in the slope is related to 15 bps increase in average CDS spread. But this is relative to GC repo, which has a -0.14 coefficient,

which means if we run this regression for <AA ABS_RMBS alone, we would get a coefficient of about 0.16, with roughly the same t-stats.

The results in Table 8 confirm, albeit indirectly, that the maturities of all the non-CP instruments were also shortening prior to Lehman. Overall, the quantity and price data point in the same direction, namely, that maturity shortened during the crisis leading up to Lehman.

5. Conclusion

In a financial crisis a financial firm fails when it cannot me its debt obligations. In order for this to be possible a necessary condition is that the firm's debt be sufficiently short. Lehman was in a position to fail because by September 15, 2008 a large amount of its funding was overnight repo. Their funding had shortened in the months leading up to the failure. We show that this was a general phenomenon during the crisis. We document the build-up of fragility by showing that the maturities of money market instruments shortened starting in July 2007. As maturities shortened, the economy faced a hair trigger in which a small shock could cause a large sudden exit from the money markets. This occurs at the date of the Lehman Brothers failure.[20] This is the key tipping point, and it is endogenously created. Fragility builds up as maturities shorten.

A financial crisis is a dynamic process. Once it starts there is an opportunity for a central bank to stop the process of fragility from building up. Further, the endogeneity of fragility has implications for many proposed methods for detecting systemic risk during normal times. While there is a buildup of risk prior

[20] Note that our argument makes no assumption about whether Lehman's failure was a small or large event in terms of the information conveyed to market participants. Rather, we are arguing that market participants by shortening maturities were in a position to massively react.

to the crisis, it may be harder to detect this risk if most of the buildup occurs during the crisis.

References

Acharya, Viral, Philipp Schnabl, and Gustavo Suarez (2011), "Securitization without Risk Transfer," *Journal of Financial Economics* 107, 515-536.

Anderson, Richard and Charles Gascon (2009), "The Commercial Paper Market, the Fed, and the 2007-2009 Financial Crisis," Federal Reserve Bank of St. Louis *Review* (November/December), 91(6), 589-612.

Bai, Jushan (2010), "Common Breaks in Means and Variances for Panel Data," *Journal of Econometrics* 157, 78-92.

Bernanke, Ben (2009), "Reflections on a Year in Crisis." Speech at the Federal Reserve Bank of Kansas City's Annual Economic Symposium, Jackson Hole, Wyoming, August 21, 2009.

Blinder, Alan (2009), "Six Errors on the Path to the Financial Crisis", *New York Times* January 25.

Brunnermeier, Markus (2009), "Deciphering the Liquidity and Credit Crunch 2007-2008," *Journal of Economic Perspectives* 23, 77-100.

Brunnermeier, Markus and Martin Oehmke (2013), "The Maturity Rate Race," *Journal of Finance* 68, 483-521.

Calomiris, C.W., (1994), "Is the Discount Window Necessary: A Penn-Central Perspective," Federal Reserve Bank of St. Louis *Review*, 76, 31-56.

Calomiris, C.W., (1989), "The Motivations for Loan Commitments Backing Commercial Paper," Journal of Banking and Finance 1, 271-77.

Calomiris, Charles, Charles Himmelberg, and Paul Wachtel (1995), "Commercial Paper, Corporate Finance, and the Business Cycle: A Microeconomic Perspective," *Carnegie-Rochester Conference Series on Public Policy* 42, 203-250.

Chen, Bin and Yongmiao Hong (2012), “Testing for Smooth Structural Changes in Time Series Models via Nonparametric Regression,” *Econometrica* 80, 1157-1183.

Covitz, Daniel M., Nellie Liang, and Gustavo A. Suarez (2013), "The Evolution of a Financial Crisis: Collapse of the Asset-Backed Commercial Paper Market," *Journal of Finance* 68, 815-848.

Crabbe, Leland and Mitchell Post (1994), “The Effect of a Rating Downgrade on Outstanding Commercial Paper,” *Journal of Finance* 49, 39-56.

Fitch Ratings (2007), “Asset-Backed Commercial Paper & Global Banks Exposure—10 Key Questions,” *Special Report* (September 12, 2007).

Fons, Jerome and Andrew Kimball (1991), “Defaults and Orderly Exits of Commercial Paper Issuers, 1972-1990,” *Moody’s Special Report* (January).

Gorton, Gary (2010), Slapped by the Invisible Hand: The Panic of 2007 (Oxford University Press).

Gorton, Gary and Andrew Metrick (2012), “Securitized Banking and the Run on Repo,” J*ournal of Financial Economics* 104, 425-451.

Gorton, Gary, Andrew Metrick, and Lei Xie (2015), “An Econometric Chronology of the Financial Crisis of 2007-2008,” Yale, working paper.

He, Zhiguo and Wei Xiong (2012), “Dynamic Debt Runs,” *Review of Financial Studies* 25, 1799-1843.

He, Zhiguo, Ingu Khang, and Arvind Krishnamurthy (2010), “Balance Sheet Adjustment in the 2008 Crisis,” *IMF Economic Review* 58, 118-156.

Keogh, Bryan (2007), “Asset-Backed Commercial Paper Drops Most in 2 Months,” *Bloomberg*, November 8, 2007.

Krishnamurthy, Arvind (2010), “How Debt Markets Have Malfunctioned in the Crisis,” *Journal of Economic Perspectives* 24(1), 3-28.

Krishnamurthy, Arvind, Stefan Nagel, and Dmitry Orlov (2011), "Sizing Up Repo," *Journal of Finance* 69, 2381-2417.

Krugman, Paul (2012), "It Was Lehman Wot Did It," *New York Times*, February 14, 2012.

Lucas, Robert (2009), "In Defense of the Dismal Science," *The Economist*, August 8:67.

McCabe, Patrick (2010), "The Cross Section of Money Market Fund Risks and Financial Crisis," Federal Reserve Board, Finance and Economics Discussion Series #2010-51.

Moody's Investors Services (2009), "ABCP 2008 Year in Review and 2009 Outlook," *Structured Finance: Special Report*, February 10, 2009.

Moody's Investors Services (2007), "Moody's Update on Bank-Sponsored ABCP Programs: A Review of Credit and Liquidity Issues," International Structured Finance, *Special Report* (September 12, 2007).

Moody's Investors Services (2003), "The Fundamentals of Asset-Backed Commercial Paper," Structured Finance, *Special Report* (February 3, 2003).

Nayar, Nandkumar, and Michael S. Rozeff (1994), "Ratings, Commercial Paper, and Equity Returns," *Journal of Finance* 49, 1431-1449.

Reinhart, Carmen, and Kenneth Rogoff (2011), "From Financial Crash to Debt Crisis", *American Economic Review* 101, 1676-1706.

Shin, Hyun Song (2010), "Macroprudential policies Beyond Basel III," policy memo.

Table 1: Data Sources and Sample Periods

This table summarizes the data used in the paper. Their sources, sample periods and short descriptions are presented.

Variable	Source	Sample Periods		Description
		Beginning	End	
Unsecured Money Market Instruments				
Interbank Money Markets				
Fed Fund	Bloomberg	12/20/2001	4/30/2009	Effective Federal Fund rate
LIBOR	Bloomberg	12/20/2001	4/30/2009	LIBOR
OIS	Bloomberg	12/20/2001	4/30/2009	Overnight indexed swap
Commercial Paper				
A2/P2 Nonfinancial	Federal Reserve	12/20/2001	4/30/2009	SIC code: 100-5999, 7000-9999. Programs with at least one "2" rating but no ratings other than "2"
AA Asset-backed	Federal Reserve	12/20/2001	4/30/2009	SIC code: 6189. Programs with at least one "1" or "1+" rating but no ratings other than "1"
AA Financial	Federal Reserve	12/20/2001	4/30/2009	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	12/20/2001	4/30/2009	SIC code: 100-5999, 7000-9999. Programs with at least one "1" or "1+" rating but no ratings other than "1"
Secured Money Market Instruments				
Repo Categories				
GC	Bloomberg	12/20/2001	4/30/2009	General collateral repo rate
<AA ABS-RMBS / CMBS	Dealer Bank	10/3/2005	4/30/2009	Residential mortgage-backed security (RMBS) or commercial mortgage-backed security (CMBS) with ratings less than AA
A-AAA ABS-Auto / CC / SL	Dealer Bank	10/3/2005	4/30/2009	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	10/3/2005	4/30/2009	Residential mortgage-backed security (RMBS) or commercial mortgage-backed security (CMBS) with ratings between AA and AAA, inclusive.
AA-AAA CLO	Dealer Bank	10/3/2005	4/30/2009	Collateralized loan obligations (CDO) with ratings between AA and AAA, inclusive.
AA-AAA Corporates	Dealer Bank	10/3/2005	4/30/2009	Corporate bonds rated between AA and AAA, inclusive.
BBB+ / A Corporates	Dealer Bank	10/3/2005	4/30/2009	Corporate bonds rated between BBB+ and A, inclusive.

Table 2: Commercial Paper Issuance

This table presents the issuance of commercial paper for various types of issuers and for different maturities. The first column shows average total issuance per day and the following columns shows the percentage of issuance for different maturities. The subperiods are as follows: Before 2007: Jan. 1, 2001 to Jan. 1, 2007; Pre-crisis: Jan. 1, 2007 to Jul. 22, 2007; Crisis: Pre-Lehman: Jul. 23, 2007 to Aug. 14, Aug 2008; Crisis: Lehman: Aug. 15, 2008 to Dec. 14, 2008; Crisis: After Dec. 15, 2008 to Apr. 29, 2009. The data is from Federal Reserve H.15 Release, Historical Data.

	Period	Avg. Issuance $ millions	1-4 days	5-9 days	10-20 days	21-40 days	41-80 days	>=80 days
A2/P2 Nonfinancial	Before 2007	4,276.5	65%	8%	7%	13%	4%	1%
	Pre-crisis	6,045.7	77%	7%	5%	8%	3%	1%
	Crisis: Pre-Lehman	7,635.8	78%	7%	6%	6%	2%	1%
	Crisis: Lehman	5,660.3	70%	11%	10%	7%	2%	1%
	Crisis: After Dec 2008	3,222.9	69%	10%	9%	8%	2%	1%
AA Asset-backed	Before 2007	38,107.2	49%	5%	5%	25%	8%	7%
	Pre-crisis	60,945.9	61%	4%	4%	20%	5%	6%
	Crisis: Pre-Lehman	70,064.8	67%	6%	5%	13%	4%	5%
	Crisis: Lehman	71,613.5	74%	5%	3%	8%	3%	6%
	Crisis: After Dec 2008	27,303.6	61%	8%	3%	16%	4%	8%
AA Financial	Before 2007	18,080.0	77%	6%	4%	6%	4%	3%
	Pre-crisis	16,017.1	67%	7%	5%	7%	4%	9%
	Crisis: Pre-Lehman	9,712.8	55%	7%	6%	11%	6%	14%
	Crisis: Lehman	12,403.5	74%	6%	4%	5%	2%	10%
	Crisis: After Dec 2008	8,563.6	75%	5%	3%	7%	3%	8%
AA Nonfinancial	Before 2007	3,165.4	63%	8%	8%	12%	7%	2%
	Pre-crisis	1,475.2	53%	9%	9%	10%	11%	7%
	Crisis: Pre-Lehman	1,452.5	44%	9%	11%	17%	11%	7%
	Crisis: Lehman	1,945.8	38%	6%	10%	21%	18%	8%
	Crisis: After Dec 2008	4,749.0	70%	7%	7%	8%	5%	3%
Total CP	Before 2007	122,613.1	62%	6%	5%	14%	6%	6%
	Pre-crisis	167,143.0	68%	5%	4%	13%	4%	6%
	Crisis: Pre-Lehman	161,196.9	68%	7%	5%	10%	4%	6%
	Crisis: Lehman	158,015.5	71%	6%	4%	8%	4%	7%
	Crisis: After Dec 2008	91,499.4	65%	8%	4%	11%	4%	8%
Total CP(4)	Before 2007	63,629.1	59%	6%	5%	18%	7%	5%
	Pre-crisis	84,483.8	63%	5%	4%	16%	5%	6%
	Crisis: Pre-Lehman	88,866.0	66%	7%	5%	12%	4%	6%
	Crisis: Lehman	91,623.0	73%	6%	4%	8%	4%	6%
	Crisis: After Dec 2008	43,839.1	65%	7%	4%	13%	4%	7%

Table 3: Changes in Short-term Ratings for Financial Firms during the Crisis

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 an 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.

	Total	A-1+	A-1	A-2	A-3	B	C	D	No Rating
A-1+	48	29	19						
		(0.60)	(0.39)						
A-1	60	4	36	14	1	3			2
		(0.06)	(0.60)	(0.23)	(0.01)	(0.05)			(0.03)
A-2	46		3	30	4	5			4
			(0.06)	(0.65)	(0.08)	(0.10)			(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	
								(1.00)	

Table 4: Multiple Break Points for CP Issuance Level

This table presents the common breakpoints for the issuance level of four CP categories. Three breakpoints and the lower and upper bound of their 99% confidence intervals, as well as the number of securities, the data frequency and the sample period for each maturity are reported.

Description	Breaks	Number of Securities	Break Point	Lower bound	Upper bound	Frequency	Beginning	End
Overnight	First	4	5/31/2007	5/30/2007	6/4/2007	Daily	10/3/2005	4/30/2009
	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
One-month	First	4	9/24/2007	9/14/2007	10/3/2007	Daily	10/3/2005	4/30/2009
	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
Three-month	First	4	3/8/2007	2/28/2007	3/19/2007	Daily	10/3/2005	4/30/2009
	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

Table 5: Multiple Break Points for CP Issuance, Short/Long Ratio

This table presents the common breakpoints for the short/long ratio of CP Issuance, which is defined as the sum of previous 3 days' 1-4 day CP issuance divided by the sum of previous 30 days' 20-40 day CP issuance. The short/long ratios for four CP categories used to detect common breakpoints. Three breakpoints and the lower and upper bound of their 99% confidence intervals, as well as the number of securities, the data frequency and the sample period are reported.

Description	Number of Securities	Break Point	Lower bound	Upper bound	Frequency	Beginning	End
First Break	4	8/10/2007	8/9/2007	8/14/2007	Daily	10/3/2005	4/30/2009
Second Break	4	9/17/2008	9/17/2008	9/18/2008	Daily	10/3/2005	4/30/2009
Third Break	4	12/31/2008	12/31/2008	1/2/2009	Daily	10/3/2005	4/30/2009

Table 6: Regressions of Term Structure Slopes on Maturities

This table reports the results for regressions of term structure slopes on maturities. The right hand variables are changes in ABCP or AA Financial CP one-month/overnight slopes. In Panel A, the left hand variable is the difference in short/long ratio for ABCP and AA Financial CP. The short/long ratio is defined as the sum of previous 3 days' 1-4 day CP issuance divided by the sum of previous 30 days' 20-40 day CP issuance. In Panel B, the left hand variable is the difference in Financial CDS spread. T-statistics are reported in parentheses. *, **, *** denote significance at the 10%, 5%, and 1% levels, respectively.

Panel A: CP maturity and slope		
	LHS = dif. in ABCP short/long ratio	LHS = dif. in AA Financial short/long ratio
	RHS = dif. in ABCP slope	RHS = dif. In AA Financial slope
Intercept	-0.001	-0.079
	(-0.02)	(-0.61)
1m/1d Slope change	0.007	0.021
	(2.84***)	(2.01**)

Panel B: Financial CDS spread and CP slope		
	LHS = dif. in Financial CDS spread	LHS = dif. in Financial CDS spread
	RHS = dif. in ABCP slope	RHS = dif. in AA Financial slope
Intercept	1.242	1.256
	(1.08)	(1.08)
1m/1d Slope change	0.200	0.291
	(2.25**)	(2.18**)

Table 7: Difference-in-Difference Regressions

This table reports difference-in-difference regression results. R0 and R1 are two dummies variables that indicate two regimes divided by repo breaking points (from Gorton, Metrick and Xie (2015)). Specifically, R0: prior to July 23, 2007; R1: July 23, 2007 to Aug 14, 2008; The right hand variables also include the interaction terms of difference in one month/overnight CP spread slope and period dummies. In Panel A, the left hand variable is the difference in short/long ratio for ABCP and AA Financial CP. The short/long ratio is defined as the sum of previous 3 days' 1-4 day CP issuance divided by the sum of previous 30 days' 20-40 day CP issuance. In Panel B, the left hand variable is the difference in Financial CDS spread. T-statistics are reported in parentheses. *, **, *** denote significance at the 10%, 5%, and 1% levels, respectively.

Panel A: CP maturity and CP slope		
	LHS = dif. in ABCP short/long ratio RHS = dif. in ABCP slope	LHS = dif. in AA Financial short/long ratio RHS = dif. In AA Financial slope
R0	0.001	-0.133
	(0.01)	(-0.76)
R1	0.009	0.098
	(0.08)	(0.35)
1m/1d Slope change * R0	-0.007	0.023
	(-0.22)	(0.27)
1m/1d Slope change * R1	0.007	0.022
	(2.87***)	(1.98**)
Panel B: Financial CDS spread and CP slope		
	LHS = dif. in Financial CDS spread RHS = dif. in ABCP slope	LHS = dif. in Financial CDS spread RHS = dif. in AA Financial slope
R0	0.764	0.761
	(0.53)	(0.53)
R1	2.593	2.661
	(1.07)	(1.11)
1m/1d Slope change * R0	0.020	0.04
	(0.03)	(0.07)
1m/1d Slope change * R1	0.219	0.318
	(2.26**)	(2.15**)

Table 8: Difference-in-Difference Regressions for All Money Market Instruments

This table reports difference-in-difference regression results for all money market instruments. R0 and R1 are two dummies variables that indicate two regimes divided by repo breaking points (from Gorton, Metrick and Xie (2015)). Specifically, R0: prior to July 23, 2007; R1: July 23, 2007 to Aug 14, 2008. The left hand variable is the difference in Financial CDS spread. The right hand variables include period dummies, instrument dummies and the interaction terms of difference in one month/overnight CP spread slope, period dummies and instrument dummies. The dummy for GC repo is omitted. Only coefficients for the interaction terms are reported. *, **, *** denote significance at the 10%, 5%, and 1% levels, respectively.

	Coef.	Std. Err.	t-stats
Slope * R1	-0.14	0.10	-1.42
<AA ABS-RMBS / CMBS * Slope * R1	0.30**	0.12	2.48
A-AAA ABS-Auto / CC / SL * Slope * R1	0.29**	0.12	2.44
A2/P2 Nonfinancial * Slope * R1	0.44***	0.15	2.95
AA Asset-backed * Slope * R1	0.36**	0.14	2.59
AA Financial * Slope * R1	0.46**	0.18	2.59
AA Nonfinancial * Slope * R1	0.64***	0.20	3.17
AA-AAA ABS-RMBS / CMBS * Slope * R1	0.30**	0.12	2.44
AA-AAA CLO * Slope * R1	0.29**	0.12	2.44
AA-AAA Corporates * Slope * R1	0.30**	0.12	2.44
BBB+ / A Corporates * Slope * R1	0.29**	0.12	2.43
Fed Fund * Slope * R1	0.12	0.20	0.61
LIBOR * Slope * R1	0.30**	0.13	2.23
R-Squared: 0.05			

Table A: Breakpoint Ordering

This table presents the order of break points obtaining from Bai's (2010) procedure. Algorithm Order is the order of breakpoints identified using Bai's procedure. They are not necessarily consistent with the breakpoints' chronological order. The lower and upper bound of breakpoints' 99% confidence intervals are also reported.

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

Figure 1: Counterparty Risk (bps) and CP Maturities

This figure plots the LIBIR minus overnight index swap three month spread and the short/long issuance ratio for AA asset-backed commerical paper. The ratio is defined as 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).

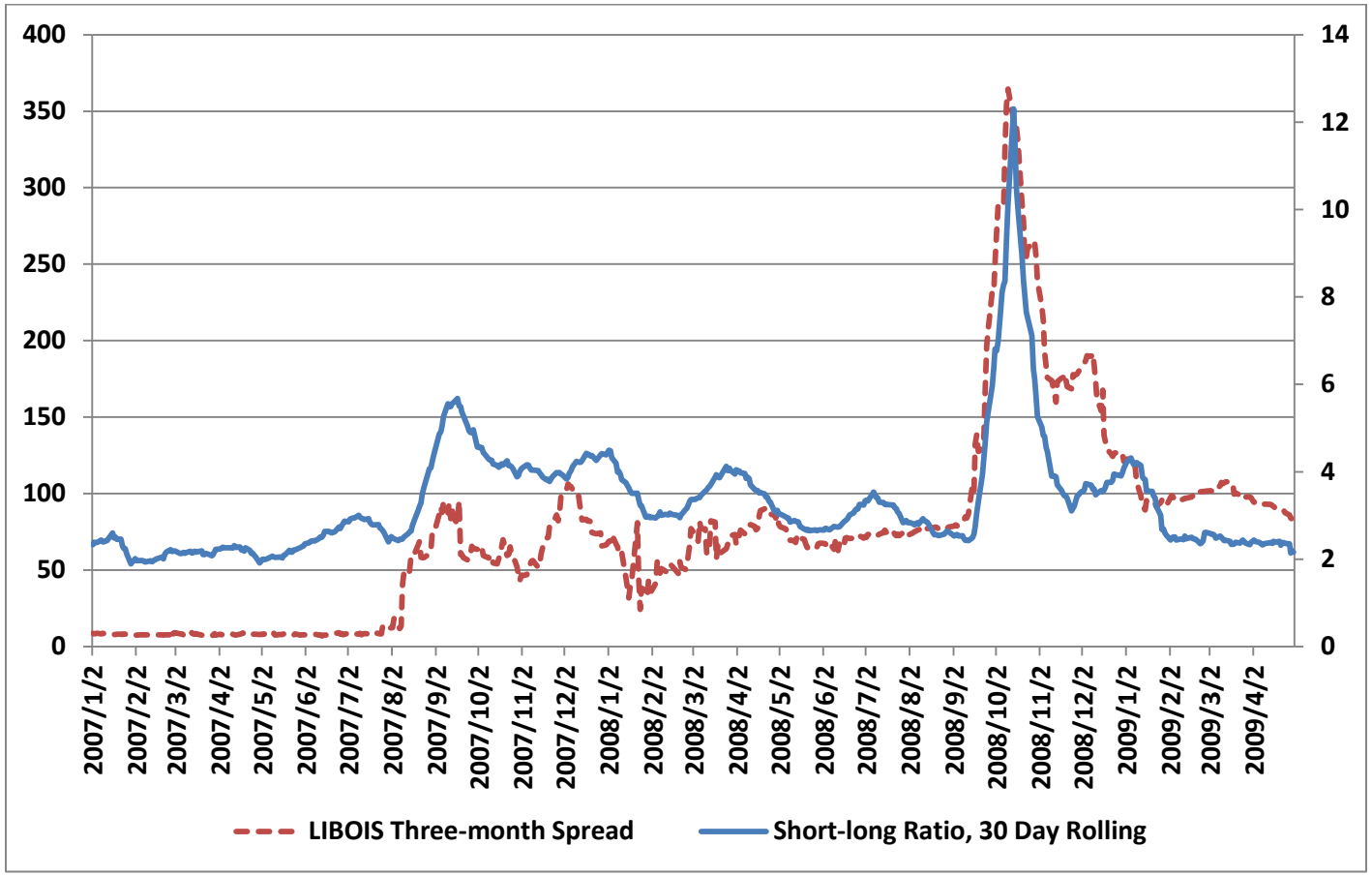
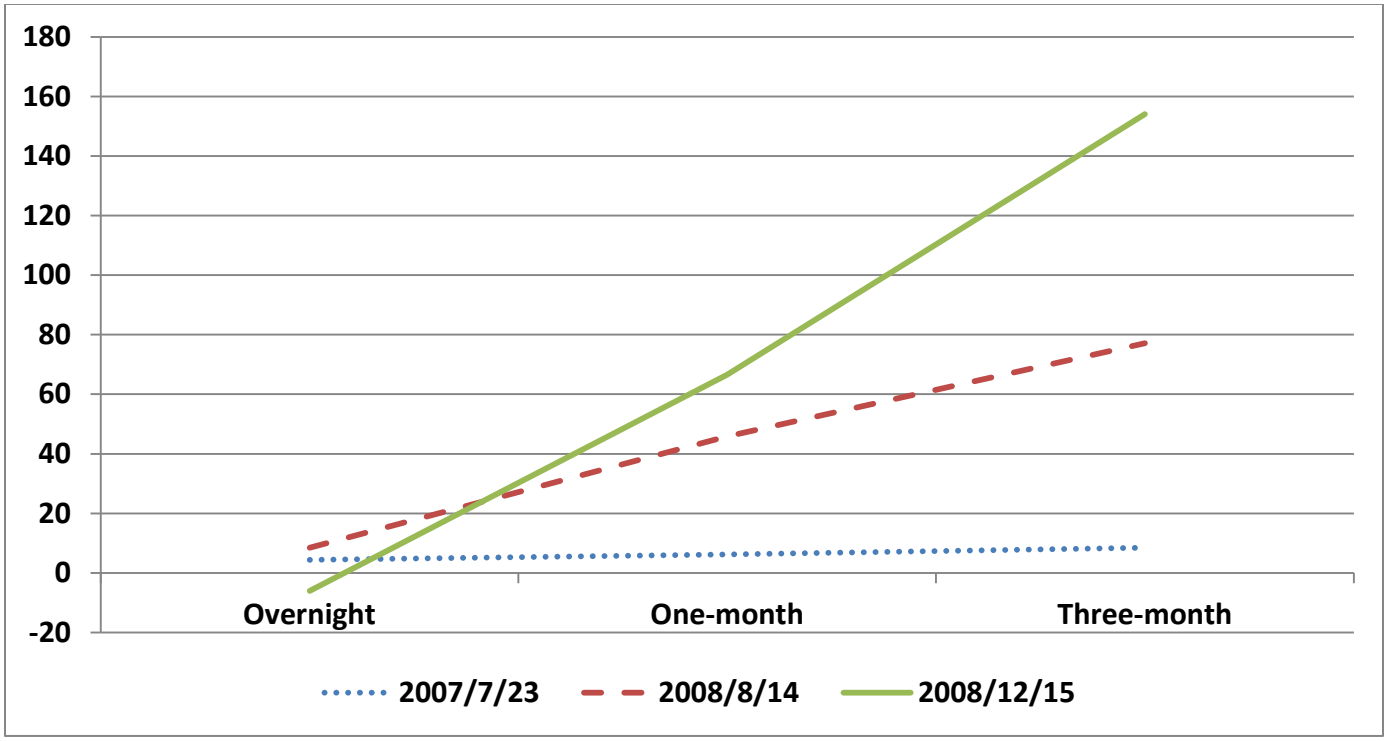


Figure 2: LIBOR Spread Term Structures (bps)

This figure shows the term structure of LIBOR spreads at three different points in time during the crsis.



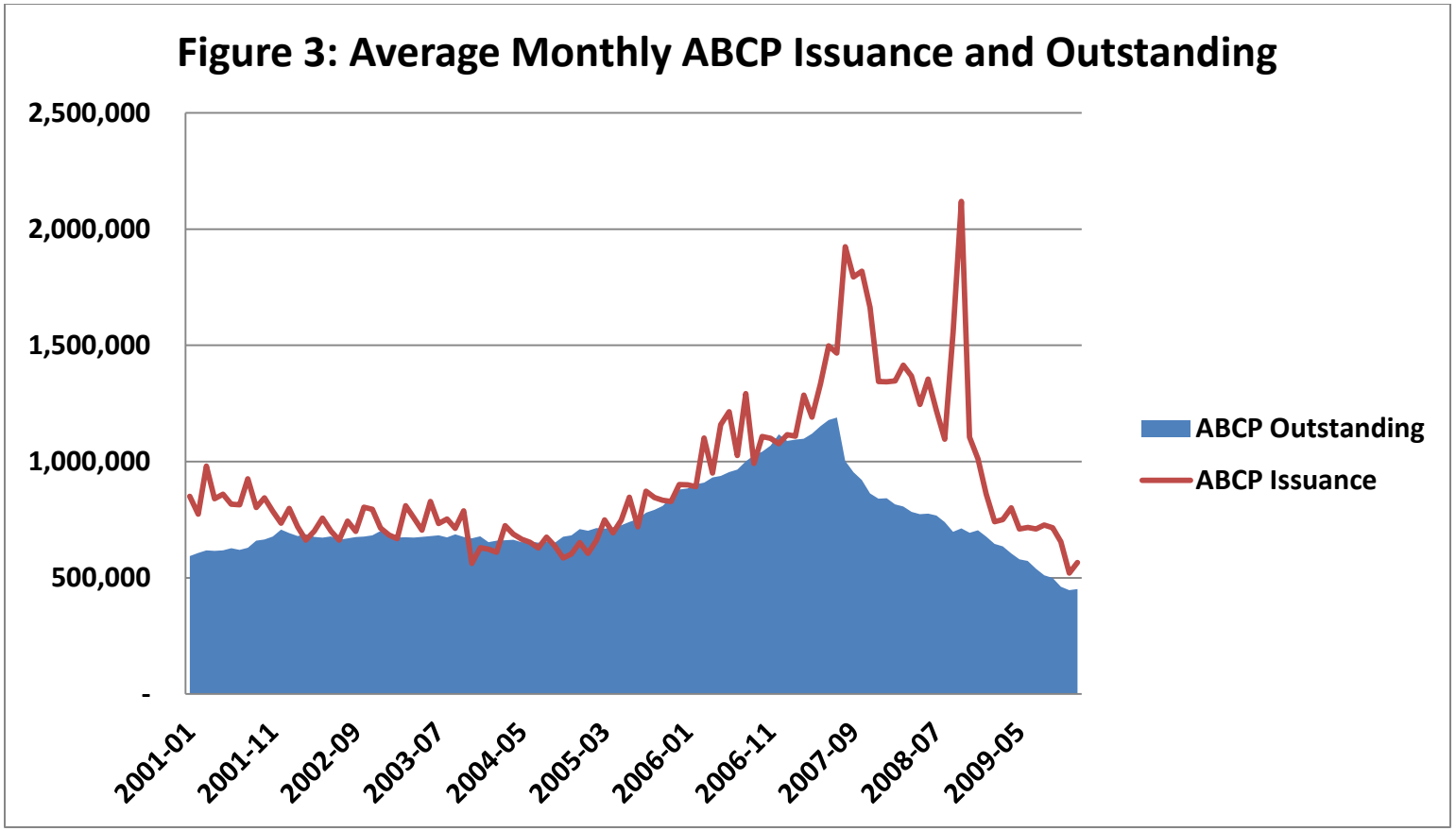


Figure 3: Average Monthly ABCP Issuance and Outstanding
2,500,000
2,000,000
1,500,000
1,000,000
500,000
-
2001-01
2001-11
2002-09
2003-07
2004-05
2005-03
2006-01
2006-11
2007-09
2008-07
2009-05
ABCP Outstanding
ABCP Issuance

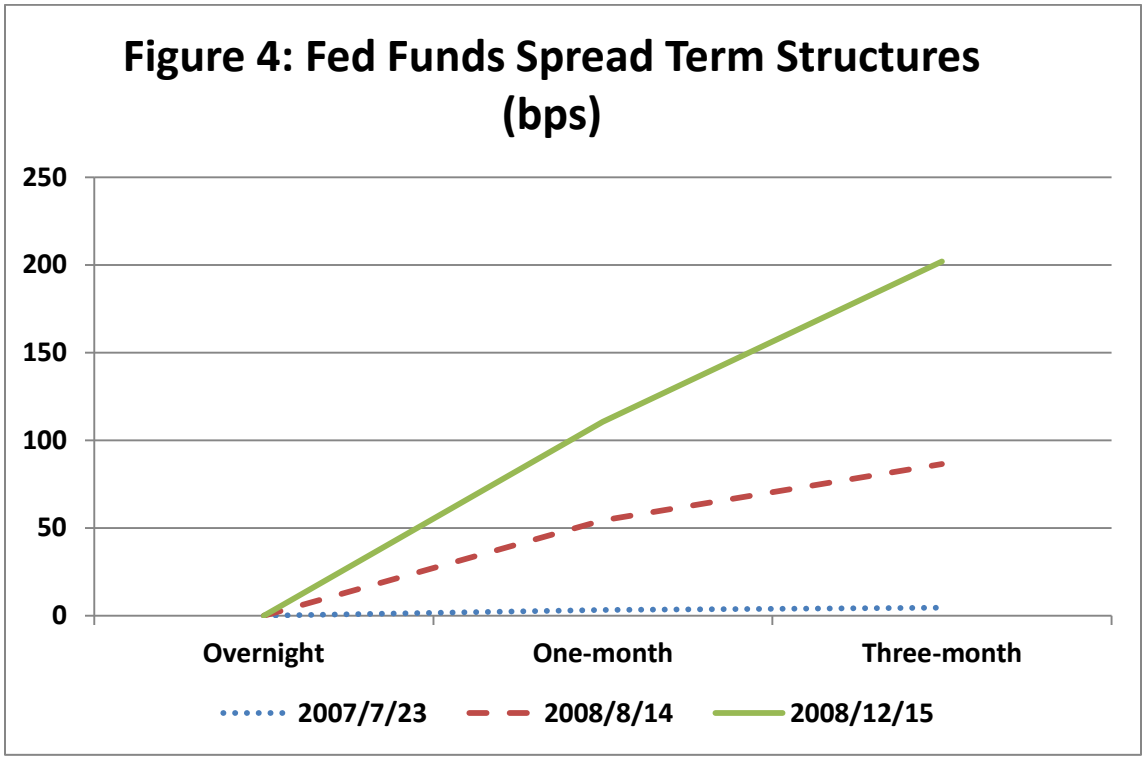


Figure 4: Fed Funds Spread Term Structures (bps)
250
200
150
100
50
0
Overnight
One-month
Three-month
2007/7/23
2008/8/14
2008/12/15

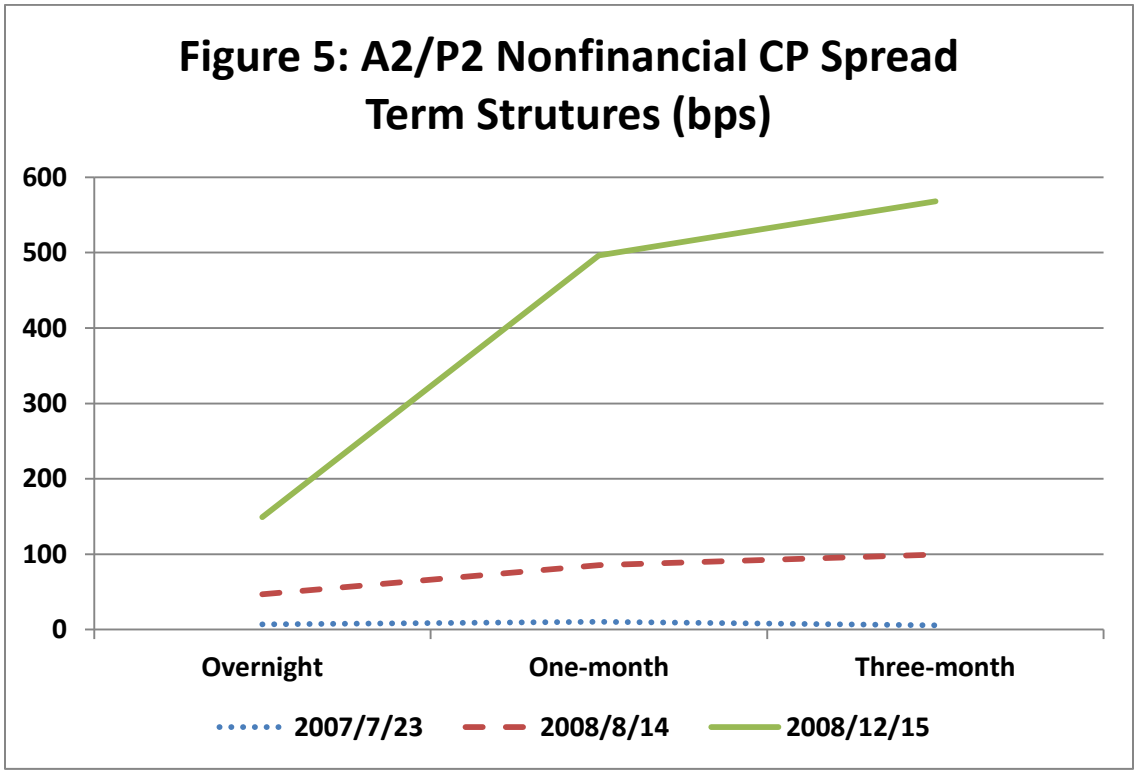


Figure 5: A2/P2 Nonfinancial CP Spread Term Strutures (bps)
600
500
400
300
200
100
0
Overnight
One-month
Three-month
2007/7/23
2008/8/14
2008/12/15

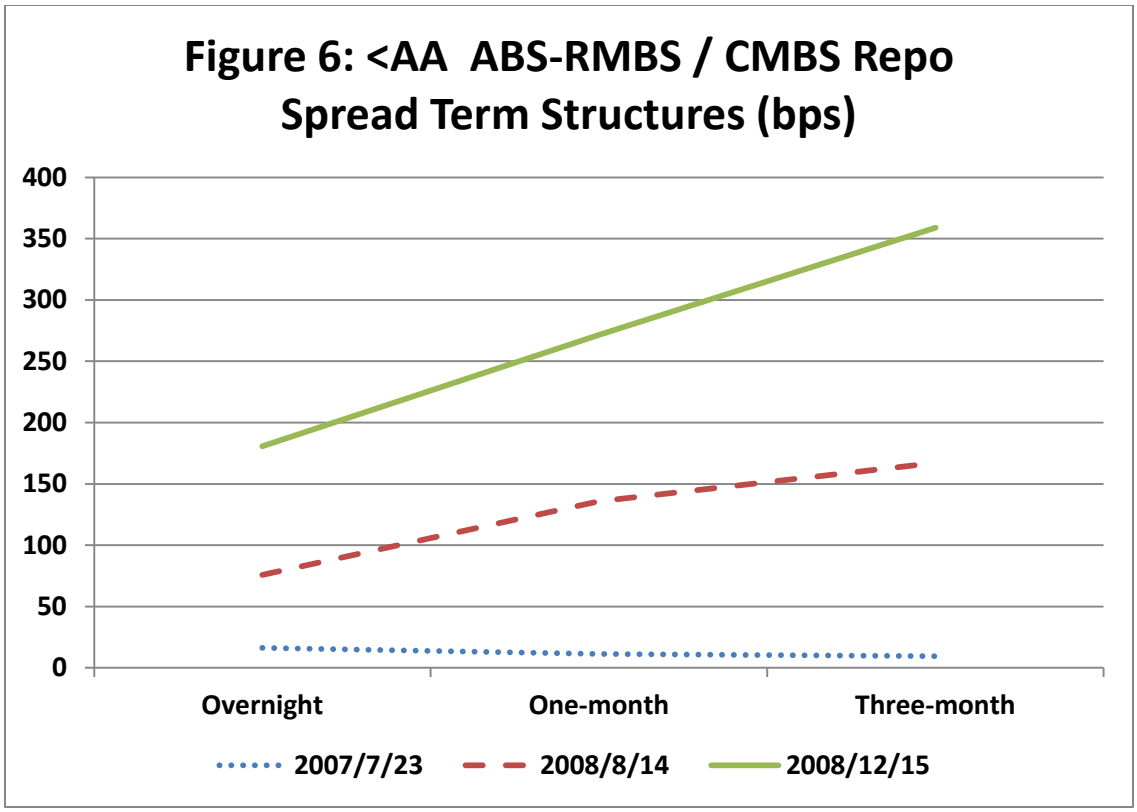


Figure 6: <AA ABS-RMBS / CMBS Repo Spread Term Structures (bps)
400
350
300
250
200
150
100
50
0
Overnight
One-month
Three-month
2007/7/23
2008/8/14
2008/12/15

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Table: The Term Structures of Spreads

This table presents 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. 1m/1d is the difference between one-month and overnight spread. 3m/1d is the difference between three-month and overnight spread. 3m/1m is the difference between three-month and overnight spread. All slopes are adjusted for seasonal effects. Panel A shows slopes for Fed Funds, GC repo and LIBOR. Panel B presents slopes for four categories of commercial paper. Panel C reports slopes for six categories of repo. The subperiods are as follows: Pre-crisis : Jan. 1, 2007 to Jul. 22, 2007; Crisis: Pre-Lehman: Jul. 23, 2007 to Aug. 14, Aug 2008; Crisis: Lehman: Aug. 15, 2008 to Dec. 14, 2008; Crisis: After Dec 2008: Dec. 15, 2008 to Apr. 29, 2009. T-statistics for the null hypothesis slope=0 are reported in parentheses.

Panel A: Fed Funds, General Collateral Repo, LIBOR

Series	Periods	1m/1d	3m/1d	3m/1m
Fed Fund	Pre-crisis	4.46	6.28	1.82
		(18.45)	(25.30)	(23.81)
	Crisis: Pre-Lehman	48.91	69.41	20.50
		(19.53)	(29.39)	(19.72)
	Crisis: Lehman	200.36	262.96	62.60
		(10.87)	(13.82)	(10.77)
	Crisis: After Dec 2008	31.22	98.97	67.57
		(12.27)	(25.49)	(23.65)
GC	Pre-crisis	-2.87	-2.99	-0.12
		(-10.14)	(-9.97)	(-0.76)
	Crisis: Pre-Lehman	5.81	5.89	0.07
		(2.71)	(2.30)	(0.09)
	Crisis: Lehman	59.33	64.9	6.12
		(8.62)	(8.74)	(5.26)
	Crisis: After Dec 2008	-4.23	-2.19	2.04
		(-2.67)	(-1.43)	(4.72)
LIBOR	Pre-crisis	3.31	5.45	2.14
		(17.23)	(27.19)	(28.61)
	Crisis: Pre-Lehman	30.65	48.42	17.87
		(13.19)	(23.24)	(18.62)
	Crisis: Lehman	124.80	167.00	42.31
		(8.25)	(10.75)	(15.26)
	Crisis: After Dec 2008	10.45	84.10	73.68
		(4.53)	(25.48)	(47.45)

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)	(3.20)
	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	-0.40
		(9.10)	(5.54)	(-3.13)
	Crisis: Pre-Lehman	29.85	37.40	7.40
		(10.35)	(16.26)	(5.41)
	Crisis: Lehman	88.27	125.70	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	0.70
		(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)	(5.90)	(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	3.50
		(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)	(4.00)	(6.84)

Panel C: Repo				
Series	Periods	1m/1d	3m/1d	3m/1m
<AA ABS-RMBS / CMBS	Pre-crisis	0.63	-0.90	-1.54
		(0.63)	(-0.76)	(-5.70)
	Crisis: Pre-Lehman	42.84	62.23	19.45
		(11.57)	(17.20)	(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)	(6.30)	(14.90)
	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)	(-2.00)
	Crisis: Pre-Lehman	43.92	64.10	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
		(13.40)	(33.30)	(50.53)
AA-AAA CLO	Pre-crisis	1.63	1.09	-0.54
		(1.62)	(0.92)	(-2.00)
	Crisis: Pre-Lehman	43.27	67.11	23.89
		(11.56)	(18.23)	(16.46)
	Crisis: Lehman	165.37	208.40	42.76
		(5.53)	(6.90)	(15.73)
	Crisis: After Dec 2008	31.53	105.02	73.51
		(13.40)	(33.30)	(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	83.40	73.95
		(3.30)	(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
		(11.70)	(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)	(23.50)	(41.92)