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The Financial Crisis of 2008 in Fixed Income Markets

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Abstract: We explore how a relatively small amount of heterogeneous securities created turmoil in financial markets in much of the world in 2007 and 2008. The drivers of the financial turmoil and the financial crisis of 2008 were heterogeneous securities that were hard to value. These securities created concerns about counterparty risk and ultimately created substantial uncertainty. The problems spread in ways that were hard to see in advance. The run on prime money market funds in September 2008 and the effects on commercial paper were an important aspect of the crisis itself and are discussed in some detail.

JEL classification: G01, G21, G23, G28

Key words: financial crisis, contagion, collateralized debt obligations, ABX, money market funds

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The Financial Crisis of 2008 in Fixed Income Markets

Introduction

Financial turmoil began in the summer of 2007 and has continued for some time. It was no more than a conjecture at the time of the JIMF Global Finance conference in March 2009 that it was over, in the sense that developments merely will be reasonably predictable consequences of prior events. As of this writing in July 2009, it still is a conjecture, even if a more plausible one. The turmoil progressed through several phases and affected nearly every global asset market. In this paper we present an overview of fixed-income markets during the turmoil and the crisis in September and October 2008. We are not attempting a final summary. Most particularly, we do not examine the relative importance of illiquidity and credit losses for the declines in securities prices.

In this paper, we summarize the development of the turmoil and provide some institutional detail on important events.[1] The paper includes:

1) a conceptual analysis of the drivers of the financial contagion including heterogeneity in subprime collateralized debt obligations (CDOs) plus a lack of transparency resulting in counterparty risk in these securities;

2) a look at the structure of CDOs and the ABX index including the role of falling house prices in the run up to the turmoil;

3) a summary of events and markets affected between August 9, 2007 and the middle of 2009;

[1] Our analysis has more in common with Gorton (2008) than Gorton (2009). For reasons evident in the paper, we think the events are better characterized as financial turmoil in 2007 and 2008 followed by a financial crisis in September and October 2008 rather than "the panic of 2007". Developments in 2007 were a prelude to the main event in 2008. The events in 2008 are a financial crisis even in the relatively restrictive terminology favored by Anna Schwartz (1986).

4) an analysis of the funding crisis in the fall of 2008 and the roles of the Lehman Brothers bankruptcy, the AIG resolution and money market mutual funds;

5) a discussion of the evolution of government policy throughout the crisis.

Contagion: It's a Small World After All

Figure 1 shows the behavior of housing prices in the United States from January 2000 through March 2009. While these two indexes of housing prices show different increases and decreases due to differences in coverage and methodology, the overall picture is the same: increases in housing prices until Summer 2006 or Spring 2007 followed by decreases.[2] This fall in housing prices occurred in the context of rising and then falling housing prices in many other parts of the world.

The fall in housing prices in the U.S. had widespread effects on assets markets through a particular class of mortgage, subprime residential mortgages.[3] Subprime mortgages are mortgages made to borrowers who are less creditworthy than prime borrowers.

While small relative to worldwide markets, this part of the mortgage market had widespread effects on financial institutions in the U.S. and around the world. Figure 2 shows that securitized U.S. subprime mortgages are small relative to financial markets around the world. Only about $1 billion in late 2006, securities based on subprime mortgages are less than one percent of our rough and probably incomplete estimate of $138 trillion in assets traded in securities markets around the world.

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[2] The Case-Shiller index is an index of housing prices in 20 metropolitan regions. The OFHEO index is an index of housing prices in the U.S. using mortgages purchased or securitized by Fannie Mae or Freddie Mac.

[3] There is no precise agreed-upon definition of these mortgages. The general definition of a subprime mortgage is a mortgage to an owner-occupier of a house with more credit risk than a prime mortgage. This definition obviously is circular.

How did problems in this tiny market spread to all other asset categories represented, from corporate bonds and government debt to global equities and bank deposits? In this section, we present a summary analysis of the contagion, drawing a conceptual path of the important dynamics.

Perhaps the first feature to note is that U.S. subprime mortgage assets were overwhelmingly securitized, especially during the rapid expansion after 2003. Originating mortgages to distribute them spread the risk of default among market participants. When originators of mortgages held mortgages until their payoff, the risk of default was concentrated in the originator. With securitization of the mortgages, any losses in value due to rising delinquency and foreclosure rates would be borne across investor groups around the world including hedge funds, insurance companies, pension funds and individual investors. In and of itself, this diversification of risk is a positive development because risk is diversified and not concentrated. It also can reduce systemic risk. Systemic risk often implicitly focuses on a concentration of risks within one large, interconnected institution, an entity that cannot be quickly and easily resolved should it fail. The spreading of risk might have been thought to reduce the systemic risk posed by losses on subprime loans, because no one institution would sustain much loss on this relatively small class of assets. The events of the last two years indicate that this is an overly simplistic and ultimately misleading way to think about systemic risk. But why didn't the diversification of risk help mitigate systemic risk, and could it have actually enhanced it?

The securitization of mortgages was only the first step in the financial engineering of residential mortgage-backed securities (RMBS). RMBS then were packaged into collateralized

debt obligations (CDOs).[4] The slicing and dicing of risk achieved via a CDO spread risk even further. The first payment tranche of a CDO was engineered to earn a AAA rating from a Nationally Recognized Statistical Rating Organization (NRSRO) and hence to become part of the investable universe for institutions with credit quality constraints on their portfolios (insurance companies, mutual funds, etc.). As the next section details, however, CDOs are far from homogeneous securities, both in terms of the underlying RMBS and the contractual structure of the CDO itself. The result was the proliferation of highly individualized CDO securities spread out among a global market of investors.

The heterogeneity of CDOs then led directly to opacity in security valuation. The value of a particular CDO security can be modeled in a variety of ways, but all models rely on knowledge of the implications of the entire CDO's structure plus knowledge or assumptions about the characteristics of the underlying RMBS and their underlying mortgages.[5]

Reliance on ratings of CDOs seemed an efficient form of informational intermediation in this market, at least until subprime mortgages began experiencing higher delinquency and default rates than predicted. This translated into losses in junior CDO tranches and called into question the probability of losses on higher-rated tranches. Left without confidence in the securities' ratings, financial institutions began finding it difficult to value both their own securities and those for sale in the market. In addition to creating a challenge for risk management within institutions and a general lack of liquidity for these securities, the opacity also contributed to concerns about exposure to counterparty risk.

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[4] These are CDOs of asset-backed securities, which are distinguishable from CDOs of other assets such as corporate bonds. Our analysis focuses on CDOs of subprime-mortgage-backed securities. Apparent issues with these CDOs do not necessarily apply to other CDOs.

[5] Characteristics of mortgages that generally matter are the creditworthiness of borrowers and the loan-to-value ratio. More recently, the geographic location of the house used as collateral matters.

Financial institutions interact in a variety of different markets and engage in all sorts of transactions and arrangements, many of which involve exposure to counterparty risk. A simple example is unsecured lending by commercial paper, but these transactions also include repo activity, credit default swap trading, interbank lending, the provision of liquidity backstops, and many others. Since CDOs are not standardized and trade in the OTC market, the exposure of any counterparty to CDOs in general was largely unobservable (except by general "common knowledge"). This opacity combined with the difficulty in assessing the value and risk of any particular CDO holdings increases the level of counterparty risk in these transactions.

In a world in which the identity of trading parties matters and counterparty as well as other risks have increased, it is not particularly surprising to find that liquidity suffers as well. When the ratings of CDOs came into question, trading in these securities declined substantially. This decrease in trading was not confined to the mortgage-backed CDO market and spilled over into other asset markets and into funding markets. For example, the market for asset-backed student loans was affected.

Brunnermeier and Pedersen (2008) present an interesting model of such a connection between market liquidity and funding liquidity, highlighting the role of speculators' capital constraints. In another paper, Adrian and Brunnermeier (2008) consider the spillovers of risk across financial institutions when some institutions are in distress. We see evidence of such complex interconnectedness in the recent period, but the professional literature is just beginning to develop research to flesh out the propagation mechanisms by which liquidity, counterparty risk, and opacity feed back into each other and drive systemic risk.

At some point it seems, financial markets tipped from attempting to manage risk into a struggle to operate under uncertainty and this, perhaps, has made all the difference in how the financial crisis evolved. The distinction between risk and uncertainty is due to Frank Knight (1921) who stated that "a measurable uncertainty, or 'risk' proper, as we shall use the term, is so

far different from an unmeasurable one that it is not in effect an uncertainty at all." The contrast between measurable, manageable risks and the world of unforeseen contingencies is understood by non-academics as well. In the words of former Defense Secretary Donald Rumsfeld (2002):

> … as we know, there are known knowns; there are things we know we know. We also know there are known unknowns; that is to say we know there are some things we do not know. But there are also unknown unknowns -- the ones we don't know we don't know.

How do market participants respond to conditions of uncertainty with many unknown unknowns? When the uncertainty relates to market interactions, one response is to withdraw from those interactions and reduce exposure to the uncertainty. The quest for safety can be seen as an amplification of standard responses to an increase in risk aversion. In terms of financial markets this translates into a "flight to quality" in which capital flows to the safest assets, for example U.S. Treasuries, and investments out of relatively risk free assets are delayed, sometimes described as capital being "on the sidelines". Since August 2007, we observed this phenomena in widening risk premia (especially in markets which historically have had little fundamental risk such as interbank lending), markedly decreased trading in markets involving counterparty risk exposure, and the virtual shutdown of the issuance of new securities.

Finally, the uncertainty spread to "Main Street" investors as equity market participants took full account of the opacity regarding the financial condition of major institutions and the rapidity with which an institution could find itself unable to continue operations. For example, prior to March 2008, the problems at Bear Stearns were well known. Bear had closed 2 hedge funds in early Summer 2007 due to heavy subprime losses; its CEO, Jimmy Cayne, had stepped down in January 2008 after the firm experienced an $800 million loss in the fourth quarter of 2007; and it had been reported for months that the firm was a takeover candidate (Moyer 2008).

The next sections of the paper outline three periods in the evolving financial turbulence:

the initial events related to the deterioration of the subprime market, the ensuing financial turmoil that spilled over into other markets and across institutions, and the precipitous financial crisis following the bankruptcy of Lehman Brothers in fall 2008. The first period, which we can call the "Prelude", ran from early 2007 or before to August 9, 2007. The second period, the "Main Act" ran from August 9, 2007 to September 16, 2008. The climax ran from September 16, 2008 to some time early in 2009. The final, fourth period, the "Denouement," is not covered in this paper in any detail, but the effects of the crisis continue. The last section of the paper returns to the conceptual discussion to discuss in broad terms the various policy responses and how they relate to the underlying drivers of heterogeneity, opacity, counterparty risk and uncertainty.

Prelude

Figure 3 shows mortgage originations by type in the U.S. from 2001 through 2007. Total mortgage origination peaked in 2003 and the composition of originations changed substantially with prime mortgages declining in importance and subprime and alt-A mortgages increasing in importance along with home-equity lines of credit.

Some put this increase in subprime lending at the doorstep of the creation of Collateralized Debt Obligations (CDOs), which may be partly correct. It is important to note that two government-sponsored enterprises – Fannie Mae and Freddie Mac – became substantial buyers of subprime and alt-A mortgages at the same time, thereby also increasing the demand for these mortgages (Wallison and Calomiris 2008).

Collateralized Debt Obligations

As the previous section mentioned, and as this section will outline, heterogeneity both of the underlying mortgages and also the specifics of CDO's security tranching create a lack of standardization in these instruments and contribute to opacity. This leads directly to the difficulty of valuing such securities.

Collateralized debt obligations (CDOs) are securities based on pools of securities. While these underlying pools of securities can be leveraged loans or corporate bonds, we focus the discussion on CDOs made up of subprime residential mortgage-backed securities (RMBSs) because it was the deteriorating value of these securities that triggered the financial turmoil.

A CDO is a legal structure that permits the structuring of risk exposures from the RMBSs. Suppose that the RMBSs in the pool have a credit rating of BBB.[6] By legal subordination, it is possible to take the payoffs from these BBB-rated securities and create a set of securities, called tranches, which can have ratings from AAA to BBB- and a remaining piece that is below investment grade, which is called the equity tranche. At its most basic, the tranches are created by a waterfall of the payments from the underlying securities. In this waterfall, the AAA tranche is paid first, the AA tranche is paid second, and so forth with the equity tranche paid last. If there are insufficient funds to pay a tranche its promised payment, then tranches lower down the waterfall get nothing. Interpreted in inverse order, the equity tranche is the first-loss tranche, the BBB- is the second-loss tranche, etc. Commonly, the AAA tranche comprises on the order of 80 to 85 percent of the total value of the securities.

CDOs are idiosyncratic securities, with differing terms across deals. The actual non-standardized structure of a CDO is noticeably more complicated than the simple example in the last paragraph. For example, some of the loans in an RMBS will be paid off early and CDOs can differ in how they allocate these prepayments. The allocation rule is important because the risk of prepayment is borne by the tranche which is paid first, but that tranche bears less risk of non-payment of principal in later years.[7] CDOs can also have various embedded options which affect

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[6] The term CDO often is used to mean two different things: 1. A security created by structuring; and 2. The trust formed to hold the securities and manage the cash flows. We will use the term "special purpose vehicle" to describe the trust created to hold the securities.

[7] For subprime mortgages, the best credits commonly prepay at the end of the first couple of years because the mortgage is refinanced into a prime mortgage.

their structure and payouts. For example, some CDOs have options for the equity tranche to dissolve the special purpose vehicle. Dissolution can be profitable when the CDO's value is greater than the value of the underlying securities.[8]

The characteristics of the securities underlying a particular CDO are specified in the trust agreement which sets up the special purpose vehicle that owns the underlying securities. For example, agreements commonly specify the average credit rating of the mortgages, the average loan-to-value ratio and similar loan-based characteristics. Often, these characteristics are specified in the prospectus for the deal and much of the funds for the securities are committed before the underlying mortgages are acquired.

CDOs can differ in more ways. CDOs can be based on passive trusts or they can be managed. Synthetic CDOs can hold no underlying RMBS securities, instead using credit default swaps to replicate the cash flows from the securities. Furthermore, some tranches of CDOs have been used as the underlying securities in yet other CDOs, termed CDOs-squared.[9]

CDOs are traded over the counter, not on any organized exchange. Given their idiosyncrasies, it is not obvious that trading in any particular deal would be sufficient for an exchange to provide more liquidity than an over-the-counter market. In response to demand for a tradable instrument that represents the market for subprime CDOs more generally, the ABX index was created.

The ABX index is a readily available measure of the value of CDOs from the vendor Markit. It is an index based on a basket of CDOs of underlying subprime mortgages. The ABX trades on the basis of the index value, which is commonly and misleadingly called the "price". [10]

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[8] Such dissolutions are not so common in the last couple of years.

[9] Whetten (2005) provides a very nice summary of these complex instruments and their payoff characteristics. It is interesting that these instruments originated in Europe.

[10] No one pays the "price." In fact, trades based on the ABX are trades of related credit default swaps and there is an embedded loan for 100 minus the "price" which changes hands on execution of a trade.

The ABX is not invariant over time but is created from vintages of mortgages. At initiation, the ABX index is an equally-weighted index based on twenty deals in the prior six months. For example, the January 2006 index started as an equally-weighted index of 20 of the largest sub-prime home equity ABS programs from July through December 2005. To help make the index representative of the universe of deals, the index includes no more than four deals from the same loan originator and no more than six deals from the same master servicer.

The initial deals must have reference obligations in each of the ratings categories, AAA, AA, A, BBB and BBB- and the deals' tranches themselves must be rated by both Moody's and Standard and Poor's, with the lower of the two ratings applying. In addition, to be included, at least 90 percent of the underlying mortgages must be first-lien mortgages and the weighted-average FICO score must not be less than 660. Each tranche has a weighted average life between four and six years on issuance, except the AAA tranche which has a weighted average life greater than 5 years. Finally, the tranches bear interest at a floating rate based on LIBOR.[11]

Emerging Difficulties in Subprime Loans

Figure 4 shows the values of the ABX indices from the start of trading through March 23, 2009.[12] Index values are determined by Markit based on quotes from dealers since the underlying securities are traded over the counter. The vintages issued to date are those for 2006 and 2007 because there have not been enough qualifying deals to issue an index since. Values of all of the vintages have decreased. Furthermore, the more recent vintages have decreased more. This is so even though the later vintages carry higher coupon rates, "fixed rates" in terms of the underlying credit default swaps. The BBB and BBB- tranches of the ABX 07-2 vintage started trading below the par value of 100, which is not particularly surprising; their fixed rates were set

[11] Dungey, Dwyer and Flavin (2009) provide detail on how the ABX trades.

[12] CDOs generally have more than one AAA tranche. There is an additional index for the penultimate AAA tranche of the AAA tranches of all vintages which was introduced in May 2008. CDOs can have additional tranches.

at the maximum of 500 basis points.

The tranches of the 2006 vintage, denoted 06-1, traded initially at the par value of 100 and even above par. In fact, all tranches of the 06-1 vintage traded above 100 for the entire year of 2006 except for the BBB- tranche, which traded below 100 for 10 days, and the BBB tranche, which traded below 100 for one day. The second 2006 tranche, denoted 06-2, traded lower by the end of 2006, but not by amounts that seriously forewarned of extraordinary future problems. At the close of trading in 2006, all of the tranches of the 06-1 vintage were trading above 100 and the tranches of the 06-2 vintage were trading at 99.27 for the AAAs, 100.09 for the AAs and As, 96.5 for the BBBs and 95.25 for the BBB-s.[13]

In 2007, the prices in the market started falling shortly after the start of the year. The 06-2 vintage traded at 92.28, 98.44,99.38, 75.52 and 66.23 by the end of February.[14] The 07-1 vintage which started trading on January 19, 2007 at 100.01, 100.04, 100.03, 98.35 and 97.47 was at 92.00, 99.19, 99.38, 70.50 and 64.46 by the end of February. It is interesting to note that prices fell well before any common dating of the subsequent financial turmoil. It also is evident in Figure 4 that later vintages fell more than earlier ones for all the ratings.[15]

There are at least two likely explanations for these falls. First, the quality of work at origination may have fallen as some have alleged. Second, the subprime mortgages backing these securities may have been adversely affected by the fall in housing prices. This explanation is particularly cogent because these mortgages were at least sometimes used by borrowers to get a prime mortgage later contingent on continued appreciation, or at least no depreciation, in

[13] From this point on, we simply quote index values as a set of five values, going from highest rating to lowest.

[14] It may seem odd that a lower rating can have a higher index value than a higher rating, but recall that the index value is based on a fixed rate that is lower for the higher index value. Hence, the change in price reflects information about losses relative to the time of initial creation of the CDO.

[15] This is so even though the later vintages had higher fixed rates, or roughly speaking, coupons.

housing prices. The underlying subprime loans often had a structure in which the initial rate for subprime mortgages was adjustable and well above the rates for prime mortgages. This adjustable rate was fixed for the first two or three years and there was a prepayment penalty for refinancing the mortgage during that period. At the end of this period, the adjustable rate would adjust, generally upwards and by a substantial amount. These provisions are consistent with a particular borrowing strategy. After receiving a subprime loan, a borrower's credit rating would improve if house payments were made on time. In addition, if housing prices went up, the borrower's equity in the house would increase. At the end of two years, the subprime borrower could refinance out of the subprime mortgage and into a lower-rate prime mortgage, possibly with a second mortgage if the house price did not rise 25 percent or more.

This strategy for refinancing at the end of two years could run into trouble in various ways, and in particular, the realization of falling house prices would make it impossible to refinance without adding funds from outside to pay off the principal that represented a loss in the house's value. This is an improbable solution for many subprime borrowers whose low credit ratings go hand in hand with little in the way of assets.

Housing prices peaked in July 2006 according to the Case-Shiller index and in April 2007 according to the OFHEO index. This timing is consistent with decreases in the ABX indexes in 2007 foreshadowing the trouble brewing for the underlying subprime loans. Falling house prices spelled more trouble for more recent subprime loans, which did not have a cushion of equity based on the prior rise in price. As Figure 4 shows, the prices of the later indices fell more, and substantially more for the higher rated tranches. Even though there is no organized trading in CDOs, the problems were becoming evident. The decline in ABX index values certainly suggested problems with the underlying securities and loans.

The problems also surfaced in the business for subprime lenders, indicating problems with some recently issued mortgages. Mortgage delinquencies on subprime mortgages were

increasing. A common provision in securitization agreements is an option for the purchaser to sell the mortgage back to the originator if payment problems arise within a set time after issuance (the warrantees mentioned earlier). Ownit Mortgage filed for bankruptcy on January 2, 2007 because it did not have the funds to repurchase subprime mortgages which it was obligated to repurchase. (Keoun, 2007). In addition to this bankruptcy filing, subprime lenders MLN, ResMae, People's Choice and New Century Financial filed for Chapter 11 before the middle of the year while South Star, another subprime lender, filed for Chapter 7.

Financial Turmoil

At first called the "subprime mess" or "subprime meltdown", problems started to become evident on Wall Street and London in June 2007. Two Bear Sterns' highly leveraged mortgage-backed securities funds lost virtually all their value and ultimately filed for bankruptcy due to decreases in the prices of AAA and AA mortgage-backed securities. On June 25, London-based Cheyne Capital Management LLP announced it was writing off 400 million euros from a hedge fund that had investments in subprime-mortgage-backed securities. (England 2007.)[16]

August 9, 2007 is the commonly used date for the start of the financial turmoil. On that date, the largest bank in France, BNP Paribas SA, froze redemptions from three funds with investments in U.S. subprime mortgage-backed securities rated AAA and AA. On that same date, the European Central Bank (ECB) loaned a total of nearly 95 billion euros, the most it had ever provided, to 49 firms; the Federal Reserve increased its lending of reserves for 14-day terms and the Bank of Canada added an extraordinary amount of reserves (Zhou, 2007).

The problems were evident in, or perhaps spread to, financial markets. Figure 5 shows the 30-day London Inter-Bank Offered Rate (LIBOR) and the overnight indexed swap rate (OIS)

[16] The same fund reported difficulties in 2008 due to payment problems with "so-called non-conforming mortgages" in the U.K. (Unmack 2008).

for dollar loans.[17] LIBOR is the inter-quartile average of rates at which each bank in a panel of banks "could borrow funds, were it to do so by asking for and then accepting inter-bank offers in reasonable market size" (British Bankers Association, 2002).[18] The 30-day overnight indexed swap rate is the fixed rate on an interest rate swap of fixed for floating over the next 30 days. From January 2, 2002 to August 9, 2007, the spread between LIBOR and OIS never exceeded 36 basis points and averaged only 9 basis points.[19] On August 9, LIBOR rose nine basis points and OIS fell by nine basis points. The spread continued to widen in following days, reaching a local peak of 63 basis points on August 16 and a higher peak of 95 basis points on September 9, 2007.

These higher rates for LIBOR relative to Treasury bills are not just an issue for some banks in the U.K. or Europe. Derivative contracts typically have payments and prices set off LIBOR and, in fact, many subprime mortgages in the U.S. have adjustable rates based on LIBOR.

While undoubtedly there were counterparty concerns about lending to firms with unknown positions in subprime mortgages, the problems also spread to other markets through a flight to quality. Figure 6 shows the interest rates on 30-day U.S. Treasury bills and 30-day commercial paper. The commercial paper rates are AA rates for financial, non-financial and asset-backed commercial paper and for A2/P2/F2 commercial paper.[20] The rate on 30-day

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[17] Another common measure of stress in these markets is the TED spread, which is measured by LIBOR over Treasury rates. This spread is broadly similar to the LIBOR-OIS spread for this period.

[18] The method for determining LIBOR became controversial when it rose so dramatically, with some of the skepticism probably due to the rates being based on a survey rather than actual transactions. After study of the concern, the British Bankers Association and, we understand, the Financial Services Authority believe that the rates are representative as intended.

[19] In 2007 before August 9, the LIBOR-OIS spread averaged 6 basis points with a maximum spread of 12 basis points.

[20] A2/P2/F2 commercial paper is commercial paper issued by lower-rated, second-tier, firms as determined by Standard and Poor's, Moody's and Fitch respectively. Despite the series name, the data are not based on the F2 rating after June 18, 2007. On that date, the Board of Governors of the Federal Reserve System which provides the data announced that "On June 18, 2007, the Federal Reserve Board stopped using Fitch Investors Service as a credit rating source.

Treasury bills fell from 4.70 percent per year on August 9 to 2.47 percent on August 20. At the same time, rates on non-prime commercial paper rose 35 basis points on AA asset-backed commercial paper and 40 basis points on A2-P2 commercial paper. The rates on AA financial paper and non-financial paper changed relatively little over the same eleven days, falling 5 basis points and 7 basis points respectively. Before the markets opened on August 17, the Federal Reserve announced a surprise inter-meeting 50 basis point decrease in the Federal Funds rate.[21]

One measure of the distress that financial institutions were suffering, and the risk their counterparties were facing, is the rate on credit default swaps (CDS) for selected banks shown in Figure 7. These CDS spreads clearly show concerns about the solvency of the institutions, with local peaks appearing on August 16 for Washington Mutual and Countrywide, banks affiliated with firms heavily involved in making subprime loans and subject to the risk of delinquent subprime loans being put back to them.

By November, more than 80 subprime lenders had closed their doors (*Wall Street Journal*, 2007). While options to put purchased mortgages back to the lender help to create incentive-compatible contracts under originate-to-distribute banking, these options lose their value if the lender closes its doors.

As with BNP Paribas and Cheyne, the problems were not limited to the U.S. Two state-owned banks in Germany ran into financial difficulties in July and August 2007 due to subprime investments (Reuter 2007). In addition, four small towns in northern Norway acquired positions in asset-backed commercial paper created by Citigroup (Berglund 2007).

It is easy to characterize this as a problem entirely exported from the U.S. to the rest of the world. This claim fails on two facts. The rise in housing prices was world-wide and housing

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Classification as AA or A2/P2 for rate calculations and classification as Tier-1 or Tier-2 for outstanding calculations are done using Moody's Investors Service and Standard & Poor's." (Board of Governors, 2007).

[21] This decrease is too small to explain all of the fall in the Treasury rate and, in any case, is not mirrored in the commercial paper rates.

prices subsequently fell in much of the world. Furthermore, borrowers in countries such as the U.K., Australia and Ireland were not financing their houses by obtaining subprime mortgages from U.S. lenders. In fact, it is worth noting that Collateralized Mortgage Obligations (tranched mortgage-backed securities similar to CDOs) originated in Europe, and CDOs were issued by originators of mortgages outside the U.S. Furthermore, the first financial institution in serious trouble was Northern Rock in the U.K.

Northern Rock

Northern Rock had trouble with its overnight funding and could not determine how to fund an impending securitization of its own mortgages in the changed circumstances after August 9. Northern Rock began operation as a U.K. savings bank and became a joint-stock bank in 1997. After its demutualization, it continued its reliance on mortgage loans on the asset side of its balance sheet. It expanded its liabilities in no small part by overnight funding from other institutions, with a ratio of deposits to loans of 31 percent at the end of 2006. In addition, Northern Rock funded mortgages by securitization. Such an asset and liability structure is problematic: it runs counter to long-standing banking advice to not fund long-lived assets by deposits redeemable on demand; overnight funding is even more tenuous.

A planned periodic securitization by Northern Rock in September 2007 was put in doubt by the turmoil in the market for mortgage-backed securities on August 9. (Milne and Wood 2008; Congdon 2009). It was evident that the "frozen" state of financial markets meant difficulties for Northern Rock, and the bank's management immediately started to work with the Financial Services Authority (FSA) in the U.K. to resolve the issue. Between August 10 and mid-September, Northern Rock and the Tripartite Commission (the Chancellor of the Exchequer, the Chairman of the FSA and the Governor of the Bank of England) were in constant communication. The Tripartite Commission pursued three options not taken to resolve Northern Rock's problems. These were for Northern Rock 1. to obtain funds from the money market or

securitize debt; 2. to be taken over by another bank; and 3. To receive funds from the Bank of England which would be guaranteed by the government. In the event, none of these options was taken.

Instead, a support operation by the Bank of England without government guarantees was selected on September 10. On September 13, rumors of the operation spread and the outline of the program was aired on national news that evening. A run on deposits began that evening and continued on Friday, September 14 and Monday, September 17.[22] This run was perfectly understandable: deposit insurance in the U.K. did not fully guarantee deposits above two thousand pounds. On the following Monday at 5 p.m., the Chancellor of the Exchequer announced that deposits in Northern Rock were guaranteed in full. (Milne and Wood 2008).

Some aspects of these developments are due to happenstance in addition to poor choices, but the end result was the general public's increased sensitivity to the possibility of losses on deposits in financial institutions. This was true not only in the U.K.: images of lines of depositors withdrawing deposits were shown on television around the world.

Government Investment Pools

This run on Northern Rock was mirrored in concerns about government investment pools in the U.S. – including a run on at least one of them. Government investment pools are run by state governments with investments by various local governments located in the state. These pools otherwise are similar to money market mutual funds and sometimes are called "2-a7 like" (Standard and Poor's, 2008).[23] The fund operated by the state of Florida is typical.[24] The Florida Local Government Surplus Funds Trust Fund Investment Pool invested in short-term assets and

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[22] Deposits were withdrawn over the phone, over the Internet and by regular mail.

[23] This is a set of SEC rules that have made it possible for money market mutual funds since their development to keep an unchanging net asset value. This is explained in more detail in the text below on the run on money market funds and in Dwyer and Samartin (2009).

[24] There were runs on funds in other states at the same time. (Karmin and Barr 2007). To the best of our knowledge, these runs did not result in closure of the funds or losses to participants.

maintained a stable redemption value of $1.00. On June 30, 2007, it held asset-backed commercial paper rated A-1/P-1 or better and other highly-rated investments with a total value of $25.5 billion (Florida State Board of Administration, 2007b). Some of the commercial paper was issued by structured investment vehicles (SIVs) that held mortgages. As of July 31, 2007, the Florida pool had investments in securities by 28 CDOs and SIVs.

Local government finance officers around Florida were concerned and were receiving periodic updates on the portfolio. The Florida State Board of Administration issued an update on the fund's financial position on November 10 (Florida State Board of Administration 2007a). Most of the issuers of paper had made good on the promised payments due to non-required payments by sponsors or by extending the paper's maturity with coupon enhancement. Four of the issuers, however, did not make promised payments. On November 15, David Evans at Bloomberg wrote an article (Evans, 2007) in which he claimed:

> What ... municipal finance managers ... across the country still haven't been told – is that state-run pools have parked taxpayers' money in some of the most confusing, opaque and illiquid debt investments ever devised. These include so-called structured investment vehicles, or SIVs, which are among the subprime mortgage debt-filled contrivances that have blown up at the biggest banks in the world.

The hyperbole aside, a run on the Florida government investment pool ensued with governments across the state withdrawing funds (Huntley 2007). The funds invested fell about 8 percent on November 18 and 20 percent on November 19. In November, pool deposits fell 46.7 percent, dramatically greater than the largest prior monthly net outflow of 11.7 percent (Florida State Board of Administration 2008, p. 6). On November 29, the fund was closed to withdrawals.

The state of Florida had no legal obligation to make up for losses on the assets held by the pool, and the governor announced during the run that the state would not do so. A later

accounting revealed that four investments accounting for 3.4 percent of the portfolio had weighted-average losses of 5 percent as of November 17. All but a small part – 1.27 percent – of even this paper was backed by prime and alt-A mortgages. The loss on the total portfolio before the run was 0.17 percent.

This was small comfort to the remaining investors. After closure of the existing fund, distressed assets were put in a fund now called Fund B and other assets were used to start a new fund called Fund A. As of this writing, Fund B has not been wound down and has acquired some of the mortgage collateral behind the commercial paper held by the fund in early November, 2007.[25]

Other Manifestations of Problems

The turmoil was widespread and frequently appeared in what had been sleepy parts of financial markets and in arcane instruments known mostly to specialists.

Monoline Insurance Companies

So-called monoline insurance companies were involved in the securitization of mortgages. These companies' long-term business had been insuring state and local governments' debt. For example, an A-rated state could buy insurance from a AAA-rated monoline insurance company on the bonds and the bonds would be rated AAA. States and local governments bought such insurance when the premium was less than the difference in the rates on their bonds before and after the insurance.

Monoline insurance companies became involved in selling insurance on CDOs and other structured products. As the value of the CDOs fell, a contingent liability for the insurance became more likely to result in a payment, and the monoline insurers' ratings became more

[25] Some Florida finance officers commented to Dwyer that larger cities and counties withdrew funds and the primary losers tended to be smaller governmental entities. A news report suggested that the Florida hurricane insurance fund also suffered losses (Evans 2007b).

dubious as the payouts increased relative to the insurers' capital. In late 2007 and early 2008, the monoline insurers' ratings were downgraded, which resulted in immediate downgrades of the insured municipal securities. By the end of 2008, differences in yields on insured and uninsured bonds were nil because the prices of insured securities had fallen, and consequently municipalities' costs of issuing debt had increased.

Auction Rate Securities Market

The failure of the auction rate securities market was another consequence of the difficulties. Auction rate securities are securities issued for long terms but the rates reset in frequent auctions of the securities, commonly weekly or monthly. Issuing such debt can be advantageous to an issuer if the interest rate is similar to rates on short-term debt and the average cost of long-term debt is less than the average cost of short-term debt. These securities are issued by state and local governments and reportedly fund student loans in the U.S. as well.

These auctions provide the holders of the security with the option of selling at par value on a regular basis at the auction. In September 2007, auctions began to fail. While the investment-bank sponsors of the securities typically would have become residual bidders, they did not do so in September 2007. As a consequence, holders of these securities found themselves stuck holding illiquid claims on the issuers instead of holding cash-equivalent securities that paid interest marginally more than similar highly liquid instruments.[26]

Auction failures dealt another blow to municipalities, the primary issuers of auction rate securities. While the contracts were idiosyncratic, most auction rate securities provided for a "penalty" interest rate to be paid to investors if an auction were to fail – a form of ex post illiquidity premium. Municipalities, such as the Port Authority of New York, saw their weekly interest rate expenses climb to rates over 20 percent per year. Not surprisingly, most such issuers

[26] Subsequently, several auction rate security sponsors did purchase the illiquid securities from their customers.

refinanced their existing auction rate debt into more traditional longer term municipal bond issues.

Episodic Development of Stress

There is some reason to expect a certain amount of seasonality to the stress in inter-bank lending markets if one of the underlying issues is opacity related to the sizes of portfolio losses for various banks. As the time comes to reveal quarterly earnings with mark-to-market valuation of assets, information is likely to leak about losses and lenders are likely to be more concerned at this time about having loans on their balance sheets to institutions that have difficulties.

Figure 5 shows some loose, suggestive evidence of seasonality of the stress in the LIBOR market on a quarterly basis. Figure 5 has the local peaks tabulated in Table 1. While the peaks in September 2007, December 2007 and March 2008 are three months apart, the peak a month later in April 2008 and the relative stability for the next six months are not especially consistent with this proposition. While the facts probably could be made to fit the proposition, that does not seem like a particularly appealing strategy to us. We tentatively conclude that the episodic financial stress was not primarily seasonal due to the resolution of balance sheet uncertainty.

The Role of Money Market Mutual Funds in the Crisis of Fall 2008

The announcement of Lehman Brothers' bankruptcy on September 15, 2008 set off a chain of events which led to a true "crisis" in global financial markets (Schwartz 1986). This section details the role played by money market mutual funds in these unfolding events and the specific policy responses by the US and foreign central banks. Prior to the Lehman bankruptcy, speculation regarding the consequences of a failure of a systemically important financial institution focused on the complexity and far-reaching nature of the institution's network of counterparties. Perhaps the largest direct effect of the Lehman bankruptcy was due, however, to the effect the bankruptcy announcement had on a single counterparty, the Reserve Primary Fund,

which held Lehman's outstanding short-term paper. Reserve Primary Fund was not particularly important in its own right but, as we argue in this section, the actions of its management and investors threatened to trigger a run on the entire money market mutual fund industry. While a run on money market mutual funds as a whole did not materialize, the response of individual funds to the threat affected access to short term funding for both financial and non-financial firms.

Background on Money Market Mutual Funds

Money market mutual funds are open end mutual funds organized under Rule 2a-7 of the Investment Company Act of 1940. This rule allows money market mutual funds, in contrast to other types of open end mutual funds, to maintain a stable daily net asset value of $1 per share by using amortized cost valuation or penny-rounding pricing. This stable pricing makes money market mutual funds a close substitute for other cash management products such as demand deposits at banks and is important for the demand for these products by both retail and institutional investors.[27] In order to make use of the stable price exemption, money market mutual fund portfolios are restricted to: 1) maintain a dollar-weighted average maturity of 90 days or less and hold no securities with a maturity of greater than 397 days; 2) hold 95 percent or more of their assets in securities which are rated in the two highest short term rating categories by two NRSROs; and 3) hold less than 5 percent of the portfolio assets in securities of any one issuer.[28] Finally, any money market mutual fund whose name suggests that it holds a portfolio

[27] As of December 2008, households held 75 percent of their total $7.7trillion of cash products within the banking system. In contrast, institutional investors held 40 percent of their $5.2trillion in money market mutual funds, 40 percent in the banking system and the remaining 20 percent in cash pools and offshore money funds. See Report of the Money Market Working Group, ICI, 3/17/2009. The greater usage of bank deposits by individual investors may be due to the FDIC insurance on these products. Money market funds have no such guarantee.

[28] This description is a simplified version of full requirements under Rule 2a-7. For example, there are exceptions to the 397 day maturity restriction for certain adjustable rate government securities and variable and floating rate securities and exceptions to the concentration of issuer restriction for funds that invest in the municipal securities issued by entities of a single state.

of US government securities faces the further restriction that it must hold at least 80 percent of its assets in U.S. government securities.

To meet these requirements, taxable fund managers typically hold a variety of instruments including U.S. Treasury bills, bank CDs and notes, cash, short term corporate notes, Eurodollars, repo transactions and commercial paper. On average, taxable general purpose (i.e., non-Treasury) fund managers hold approximately 32 percent of their portfolios in commercial paper and these holdings account for a reported 40 percent of the commercial paper outstanding as of summer 2008. Except for U.S. Treasury securities, these holdings of commercial paper are the funds' most liquid assets should funds want cash for redemptions.

The Lehman Bankruptcy and the Reserve Primary Fund

The Reserve Primary Fund was a taxable general purpose money market mutual fund offered by the Reserve Funds advisory complex. On September 16, 2008, in the wake of the Lehman bankruptcy, the Reserve Primary Fund became the first retail money market fund to "break the buck" when the net asset value of its shares fell to $0.97.[29] Ironically, Reserve Funds had been the innovator in the industry, introducing the first retail money market mutual fund in 1971. Once again, actions by Reserve Fund managers would have far reaching implications for both the money market fund industry and funding markets worldwide.

The connection between Lehman's bankruptcy and Reserve Primary Fund's breaking the buck was the $785 million of Lehman commercial paper and medium-term notes held by the Reserve Primary Fund on September 15, 2008. These holdings were part of a broader change in the fund's portfolio strategy begun in the middle of 2007 in which holdings of commercial paper

[29] In September 1994, an institutional government fund offered by Community Bankers Mutual Fund, Inc. broke the buck due to large holdings of adjustable rate securities. This, first ever, instance of breaking the buck did not set off a similar chain of events to what will be described here regarding the Reserve Primary Fund. This was likely largely due to the relatively smaller use of money market funds by institutions at that time.

went from 1 percent in June 2007 to over 50 percent by the end of December. [30] When Lehman declared bankruptcy, Reserve Primary Fund marked its commercial paper holdings to zero. This loss in value, along with significant redemptions by institutional investors, roughly 37 percent of the fund's net assets on September 15 alone, reduced the fund's net asset value to $0.97, thereby imposing a 3 percent loss on investors remaining in the fund. Not surprisingly, the redemption requests escalated and by September 17 amounted to 90 percent of the fund's total assets at the start of the run. On September 22 the SEC granted the fund the power to suspend redemptions and postpone payment of redemption proceeds for longer than the allowed regulatory period of seven days.

This run on the Reserve Primary Fund threatened to spill over and trigger a run on the entire mutual fund industry. While no other money market funds broke the buck, redemption pressure was widely felt and, perhaps even more important, feared.[31] In the week ending September 17, investors, predominantly institutions, withdrew $169 billion from money market funds, 5 percent of total industry assets. Moreover, there was a substantial flight to quality. While $240 billion of industry assets were withdrawn from general purpose funds during that week and another $156 billion the following week, Treasury funds experienced inflows of $242 billion.[32] Figure 8 illustrates the dramatic change in the composition of industry assets.

As a result, general purpose money market funds attempted to both fund redemptions and increase liquidity in order to hedge against the possibility of yet more redemptions. The strategy of fund managers as a whole was to shorten the maturity of their portfolios, sell off liquid assets such as commercial paper, and reduce credit risk by tightening standards on commercial paper

[30] The details here come from a thorough and interesting look at the recent management of the Reserve Primary Fund in the Report of the Money Market Working Group, ICI, March 17, 2009.

[31] According to Crane Data, Inc., as of October 29, 2008, 25 fund advisors had officially disclosed capital support agreements to protect the $1 share price of their money market mutual funds due to direct and indirect exposure to the Lehman bankruptcy.

[32] This is based on ICI Weekly Money Market data.

and shifting assets to U.S. Treasuries.[33] Commercial paper of financial institutions was of particular concern.

The failure of Lehman and the bridge loan to AIG later the same week left all market participants, not just money market fund managers, with high uncertainty about government policy and the likely fates of other large financial institutions. Anecdotal evidence indicates that there was particular concern regarding Wachovia's commercial paper, widely held by money market funds, would be treated by the FDIC if Wachovia were to fail.

Not surprisingly, given the economic importance of money market funds in the commercial paper market and similar concerns by other holders of the paper, spreads on commercial paper products widened quickly and dramatically, as Figure 6 shows. At the same time, Figure 9 shows that the maturity structure of outstanding commercial paper shortened noticeably. While roughly 65 to 70 percent of commercial paper issuance had been in the 1-4 day maturity range, this percentage spiked to over 80 percent in late September and issuance of 80+ day paper fell from 5 to 10 percent to less than 1 percent. Significant tiering is visible in the response of commercial paper spreads during this time as well. Non-top tier A2/P2 paper rates increased by 300bps, followed by asset-backed paper with increases of 250bps and AA financial paper rates increasing 100bps. In addition, there is anecdotal information that firm-specific tiering of risk premia also took place.

Money market funds earlier had been affected by the onset of the financial turmoil in late 2007.[34] As Figure 6 shows, rates on 30-day commercial asset-backed paper increased dramatically in August 2007 and then again around the turn of the year. The first episode was

[33] ICI data indicate that commercial paper holdings by taxable money market funds declined $151 billion in September and the average maturity declined from 48 days to 41 days.

[34] The increase in commercial paper rates later in the year likely reflected concerns about funding over the turn of the year. Recall that this was also the time that the Federal Reserve announced the introduction of the Term Auction Facility to extend term funding to institutions eligible for primary credit (i.e. depository institutions). Money market funds experienced no discernible pressures during this time.

directly related to the subprime market due to the prevalence of asset-backed commercial paper funding of SIVs holding subprime RMBS. Credit concerns had prompted many money fund managers to reduce or eliminate holdings of asset-backed commercial paper. This development had no significant effect on the issuance of longer term commercial paper or commercial paper rates of high-grade financial and non-financial firms. At least 20 advisory firms did step in with capital support agreements to protect the $1 share price of their funds during this period.[35]

The effects of stress on money market mutual funds were not limited to the United States. As of mid-2008, the fifteen largest general purpose money market funds, which account for 40 percent of total general purpose fund assets, held an average of 22 percent of their commercial paper holdings in paper issued by European banks (Baba, McCauley and Ramaswamy 2009). Fund investments in bank CDs, bank notes and repo transactions were even more heavily invested in Europe; the percentages were 78 percent, 33 percent and 51 percent respectively. By the end of November, these same 15 funds still had half of their investments in non-US banks while their total assets had fallen by 14 percent. In 2008, European banks received approximately $1 trillion from U.S. money market mutual funds, which was about one-eighth of their total dollar funding. The response of U.S. money market fund managers detailed above created a large demand for dollar funding by European banks and contributed to the dramatic spike in LIBOR rates during this period (Baba, McCauley and Ramaswamy 2009).

Policy Responses – A Run Averted

Several policy actions on the part of the Federal Reserve and the U.S. Treasury averted a run on the money market industry. The most direct action to stem the run was the Treasury's Temporary Guarantee Program for Money Market Mutual funds. This program was created on September 19, 2008 using Presidentially-authorized funding from the Exchange Stabilization Fund. Under the terms of the program, all investments in participating 2a-7 money market

[35] This is documented by the news archives on Cranedata.com for April 2008.

mutual funds as of the close on September 19 were guaranteed a redemption value of $1 per share. By eliminating the rational incentive on the part of investors to be the first in line to withdraw funds, this program likely disrupted the dynamics of a larger-scale run.[36] Given the liquidity problems in the markets, however, investors could not be sure of their ability to redeem and receive their assets in a timely manner. This residual risk, which likely loomed larger for institutions than for individual investors, was addressed by policy actions taken in the following weeks.[37]

To aid money market mutual funds in managing their liquidity demands and to address the consequent disruption in the commercial paper market, the Federal Reserve Board created three credit facilities: 1. The Asset Backed Money Market Liquidity Facility (AMLF); 2. The Commercial Paper Funding Facility (CPFF) and 3. The Money Market Investor Funding Facility (MMIFF). The AMLF allows banks to borrow from the Federal Reserve at the primary credit rate in order to purchase high-grade asset-backed commercial paper from money market funds.[38] The MMIFF is a facility into which money market funds can sell bank CDs and notes and high-grade commercial paper issued by 50 different financial institutions. The CPFF directly targets the commercial paper market by providing a facility into which commercial paper issuers can sell new issues of 3 month paper at penalty rates.[39]

As Figure 10 shows, the AMLF was introduced early in the crisis period and immediately attracted nearly $150 billion in loans (roughly the amount of pull back by the money market funds). Participation in the AMLF trailed off in the remaining months of the year. Market

[36] However, the amount of funding available in the Exchange Stabilization Fund was not enough to fully guarantee the $1.9 trillion of investor assets in all general purpose funds.
[37] Consistent with this conjecture, ICI data indicates that individual investors exhibited a flight to quality that was much smaller in terms of total asset values and much slower than that displayed by institutional investors.
[38] The “primary credit rate” is more popularly known by its former name of “discount rate”.
[39] For example, asset backed commercial paper can be issued into the CPFF at the overnight indexed swap rate plus 300 basis points.

participants report that this is due to the passing of the spike in redemption concerns, but the facility still was viewed as an important source of insurance should the industry experience another episode of stress. The CPFF was brought on line slightly later; it was announced on October 7 and became operational on October 27. Given the spreads on commercial paper and the anecdotal evidence of difficulties issuing paper, the CPFF attracted $225 billion in its first two weeks of operation and accounted for 75 to 80 percent of the 81+day issuance. The CPFF later contracted: only half of this initial paper was rolled over inside the CPFF when the paper matured in late January 2009. The MMIFF has not yet been used by money market funds.[40]

The AMLF and the CPFF appear to have been successful in averting a run on money market funds and providing a liquid secondary market to keep the longer term 81+Day commercial paper funding markets accessible. The effect of the CPFF in particular can be seen in the earlier chart showing the maturity structure of commercial paper issuance. The large increase in the percentage of 81+Day paper and the large decrease in the percentage of 1-4 day paper in October 2008 and late January 2009 reflect usage of the CPFF. In addition, private market rates on 3-month commercial paper decreased below the CPFF penalty rates.[41] Moreover, privately placed paper extended its average maturity. For example, 55 percent of 81+Day paper issuance went to the private market in January 2009.

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[40] This may be partly because the facility did not come online until November 24, well after liquidity pressure subsided. Industry members also report, however, that the lack of participation is due to an unwillingness to take on the credit-risk exposure inherent in the structure of the MMIFF. While money market funds can sell instruments into the MMIFF, they receive only 90 percent of their value, with the additional 10 percent made up of asset-backed commercial paper issued by the MMIFF to the participating money market fund. This implies that funds would retain some credit-risk exposure to other financial institutions in addition to the financial institution backing the instruments which they sold into the MMIFF.

The MMIFF has 5 SPVs, each allowed to purchase instruments issued by 10 designated financial institutions. Through the equity-financed ABCP portion of the payment, money funds are exposed to the credit risk of, potentially, all 10 institutions in the SPV in which it participates.

[41] This probably reflects some selection effects, with higher quality issuers issuing paper into the private market and lower quality issuers using the CPFF.

To address the demand for dollar funding by European banks during this time, the Federal Reserve greatly expanded its swap lines with the European Central Bank and the Swiss National Bank and instituted a swap line with the Bank of England. On October 13, 2008 the possible sizes of these swap lines became unlimited after the Federal Reserve announced that "sizes of the reciprocal currency arrangements … will be increased to accommodate whatever quantity of U.S. dollar funding is demanded." Baba, McCauley and Ramaswamy (2009) estimate that the swap lines fully met the additional demand for U.S. dollar funding created by the pull-back in funding from money market mutual funds.[42]

The Evolution of Policy Responses

Just as the financial turmoil evolved and spread, so too did the response of various policymakers.

Initial responses of the Federal Reserve to the financial turmoil were predominantly everyday policy actions. Prior to the failure of Bear Sterns, the FOMC reduced the Federal Funds target by 225 basis points and took only one unusual action, the creation of the Term Auction Facility (TAF) in December 2007. The TAF extended the term of Federal Reserve loans but not the institutions eligible to receive them. The TAF auctions initially were consistently oversubscribed and continued to be oversubscribed through the summer of 2008.[43]

March 2008 brought the first instance of the potential failure in the U.S. of a firm judged to be systemically important, Bear Stearns. For the first time since the 1930s, the Federal Reserve invoked authority under Section 13(3) to make secured loans to "individuals, partnerships, and corporations" to create the Primary Dealer Credit Facility (PDCF) which could

[42] BIS Quarterly Review, March 2009, "US Dollar Money Market Funds and Non-US Banks".
[43] In the Fall of 2008, longer term TAF loans were initiated and the amount up for loan at each auction was expanded.

extend loans directly to the 16 Primary Dealers.[44] From this point forward, Federal Reserve policy began targeting what now appear to be the drivers of the turmoil: opacity, illiquidity of certain assets, counterparty risk and uncertainty.

The Term Securities Lending Facility (TSLF) was a first step in targeting the drivers of the turmoil. In March 2008, the Fed announced the TSLF in which the Federal Reserve engages in term asset swaps, lending out liquid Treasury securities in return for collateral that may be low risk but illiquid. Acceptable Schedule 2 collateral in the TSLF includes investment grade mortgage-backed and asset backed securities. Initially, the facility seemed designed to buy time until these collateral assets regained liquidity. Institutions could roll over their swapped positions, use the Treasuries for collateral in their other activities and wait out the turmoil. The continued use of the TSLF throughout the Summer and Fall of 2008 is consistent with the continuing lack of resolution of broader concerns about counterparty risk and opacity related to bank balance sheets. Liquidity of various securities certainly contributed to the turmoil, but breathing room gained by swapping these assets for Treasury securities was not enough to bring stability to financial markets.

The period of crisis following the Lehman bankruptcy initiated a new era in Federal Reserve policy – a series of actions using 13(3) authority to support the funding and liquidity of the money market mutual fund industry and the commercial paper market. These policies deviate from traditional monetary policy by targeting particular financial markets. During this time, concern mounted about a spillover from "Wall Street to Main Street" with distress in financial markets and institutions reducing consumer and business credit.

The underlying cause of the financial turmoil – the doubtful condition of financial institutions due to their ownership of difficult-to-value heterogeneous assets and the counterparty

[44] These firms are 'primary dealers' in the U.S. Treasury market and have extensive transactions with the Federal Reserve through the Open Markets Committee Trading Desk. At the time of its inception there were 20 Primary Dealer Firms.

risk that follows from it – had not resolved itself. Banks had not completely written down the losses on its subprime mortgage-backed securities and related exposures. To be sure, stock prices implied estimates of these losses and the supply of funding to some institutions fell. It seemed increasingly clear that the crisis would subside only once losses on financial institutions' assets were realized and solvent institutions were sorted out from the insolvent ones.

During the peak of the crisis in September 2008, Secretary Paulson requested and obtained approval from Congress to fund a $700 billion Treasury-run Troubled Assets Relief Program (TARP). The initial plan to purchase problematic subprime-mortgage-backed securities became a capital injection program. The troubled assets were to be left with the banking system, but banks would be recapitalized using government funds. This set off a rush by nonbank financial institutions to become bank holding companies.

The $700 billion of TARP funds was nearly all allocated eventually, but as of this writing in July 2009, the banking system appears to be little closer to realizing its losses and restructuring. In Spring 2009, the Treasury introduced stress tests to measure the financial condition of the largest banks and announced a plan with public-private partnerships purchasing troubled assets held by banks. Possibly this plan could get to the heart of the issues of opacity and the reduction of counterparty risk. But unfortunately, the turmoil has a new driver: policy risk.

Policy risk can be defined as risk related to various policy actions that might be taken in the future or the potential repudiation of past policy decisions. There are many dimensions of policy risk in the current environment including, but not limited to,

1) How will losses be allocated between the government and the private sector? Though the broad outlines of a public private partnership have been announced, the details of the plan will determine if it is likely to be successful in getting

banks to sell their assets and private investors to contribute capital. Thus, this policy is still far from clear.

2) How will winners be treated? In the wake of recent Congressional hearings and proposed legislation related to the AIG bonus payments, the uncertainty over whether profits made by private investors will be clawed back remains large.

3) Will there be authority granted to resolve bank holding companies? To whom? How will those resolution decisions be made? Is nationalization a possibility?

The presence of policy risk contributes to the continuation of the financial turmoil as institutions take actions conditional on their changing assessment of future policy. Hypothetically, a clear and credible statement of policy regarding, say, the resolution of insolvent banks, or even their nationalization, could help to resolve uncertainty, set the "rules of the game" and motivate institutions and investors to commit to their own strategies in response. Whether such a policy statement would be credible is not obvious and without credibility, policy risk remains. The more direction that policymakers can give to private agents regarding the menu of future policy actions, the framework in which policy decisions will be made, and the commitment of policymakers to honor past actions, the better. When in a situation characterized by uncertainty, even a bounding of possible outcomes represents a marked improvement.

Conclusion

The drivers of the financial turmoil and the Financial Crisis of 2008 were heterogeneous securities that were hard to value. These securities created concerns about counterparty risk and ultimately created substantial uncertainty. The problems spread in ways that were hard to see in advance.

No doubt, with enough hindsight, the financial crisis could have been avoided. It is not apparent to us that foresight – other than perfect foresight – would have been sufficient to avoid

the crisis. Empirical models to forecast financial crises do well in sample but are much less helpful out of sample.

The Financial Crisis of 2008 raises enough analytical and empirical issues to keep interested economists busy for the foreseeable future.

The big policy issue going forward is the responses to the crisis. A desire for financial stability easily can lead to over-regulation and a moribund financial sector that bears more similarities to a graveyard than a vibrant, growing economy.

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Table 1

Local Peaks of the Libor-OIS Spread

Date	Spread in basis points
September 18, 2007	94.98
December 4, 2007	109.89
March 14, 2008	64.60
April 21, 2008	85.00
October 10, 2008	337.75

Appendix Table 1

Market Events

February 2007 – March 2009

Event	Date
Ownit files Chapter 11	January 3, 2007
MLN files Chapter 11	February 5, 2007
HSBC announces deterioration of mortgage services operation	February 7, 2007
ResMae files Chapter 11	February 13, 2007
Freddie Mac no longer purchases most risky subprime MBS	February 27, 2007
People's Choice files Chapter 11	March 20, 2007
New Century Financial files Chapter 11	April 2, 2007
South Star files Chapter 7	April 12, 2007
Bear Stearns suspends redemptions from Structured Finance Hedge Fund	June 7, 2007
S&P places 612 subprime MBSs on credit watch	July 11, 2007
Alliance files Chapter 7	July 16, 2007
Bear Stearns liquidates MBSs hedge funds	July 31, 2007
German government takes over KfW	August 3, 2007
American Home Mortgage files Chapter 11	August 7, 2007
BNP Paribas halts redemptions on 3 investment funds	August 9, 2007
Failed auctions for auction-rate securities	September 2007-April 2008
Run on Northern Rock	September 2007
Citi, BofA, JPMorgan announce $80 billion Master Conduit plans	October 15, 2007
Run on Florida local government investment pool	November 2007
BofA announces purchase of Countrywide	January 11, 2008
Rating agencies downgrade monoline insurers	January 18, 2008-April 2008
JPMorgan takes over Bear Stearns	March 14, 2008
IndyMac closed by OTS	July 11, 2008
Fannie and Freddie put into conservatorship	September 7, 2008
BofA announces purchase of Merrill Lynch	September 15, 2008
Lehman files for Chapter 11	September 15, 2008
AIG given $85 billion bridge loan by Fed	September 16, 2008

Reserve Primary Fund breaks the buck	September 16, 2008
Goldman Sachs and Morgan Stanley become BHCs	September 21, 2008
WaMu closed by OTS	September 25, 2008
FDIC closes 33 banks	October 2008-March 2009
Wells Fargo acquires Wachovia	October 12, 2008
PNC purchases National City	October 24, 2008
Amex and AmexTravel become BHCs	November 10, 2008
Lincoln National, Hartford & Genworth make acquisitions to get access to TARP	November 17, 2008
CIT Group becomes BHC	December 22, 2008
GMAC and IBFHC become BHCs	December 24, 2008
FHLB Seattle and San Francisco suspend dividend	January 8, 2009
Banks begin returning TARP funds	March 2009

Appendix Table 2

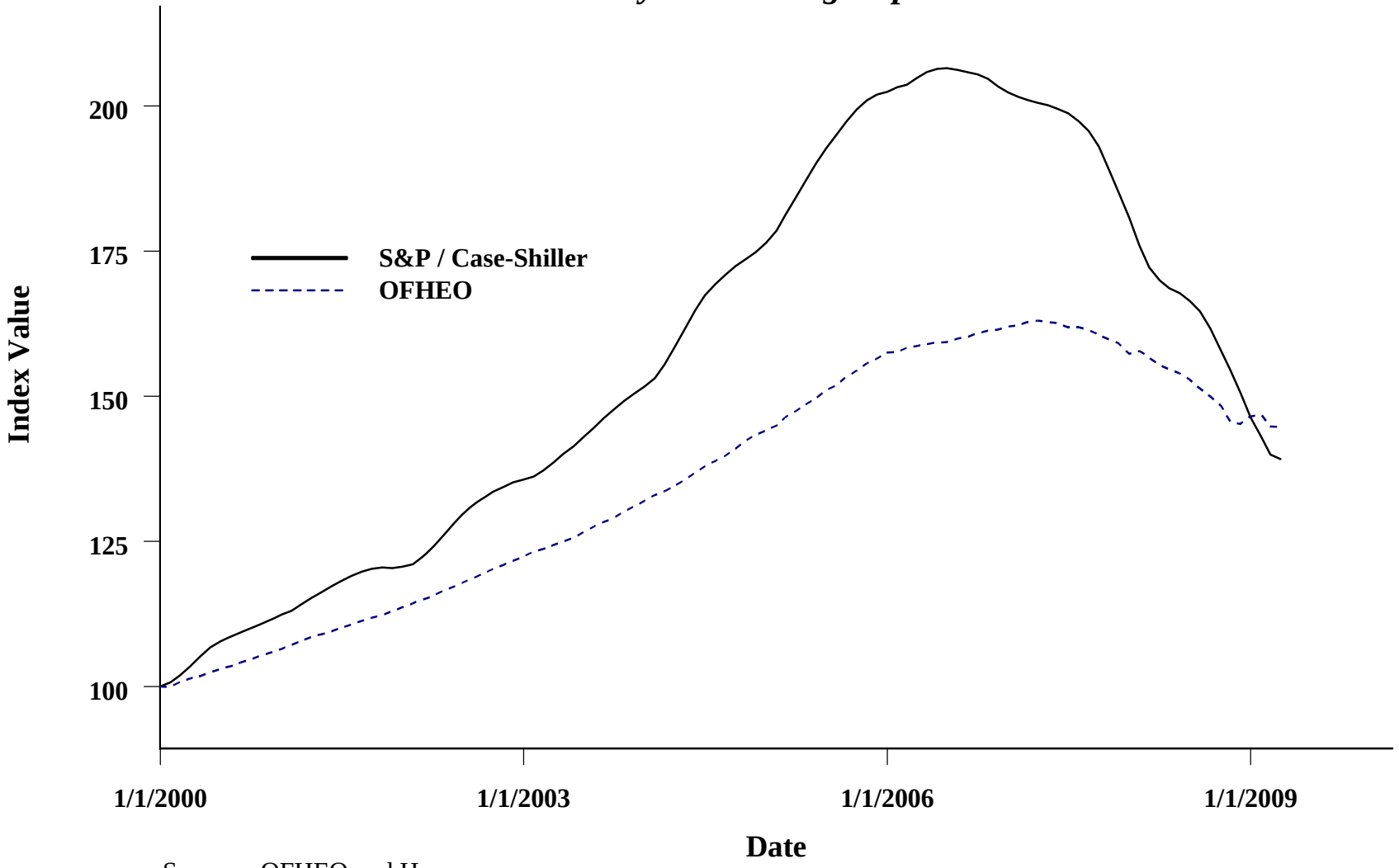
Policy Events
August 2007 – March 2009

Event	Date
Fed reduces discount rate by 50 bps	August 17, 2007
Fed reduces Federal Funds (FF) target by 50 bps	September 18, 2007
Fed reduces FF target by 25 bps	October 31, 2007
Fed reduces FF target by 25 bps	December 11, 2007
Intermeeting: Fed reduces FF target by 75 bps	January 22, 2008
Fed reduces FF target by 50 bps	January 30, 2008
Fed announces TAF and swaplines with ECB and SNB	February 4, 2008
Fed announces TSLF and Term Repo	March 11, 2008
Fed facilitates acquisition of Bear Stearns	March 14, 2008
Fed announces PDCF and reduces penalty rate by 25 bps	March 16, 2008
Fed reduces FF target by 75 bps	March 18, 2008
Fed reduces FF target by 25 bps	April 30, 2008
Fed expands TSLF collateral, swaplines and TAF auctions	May 2, 2008
Fed and Treasury announce lending and equity support for GSEs	July 13, 2008
SEC temporarily halts short sales on GSEs and primary dealers	July 15, 2008
Housing & Economic Recovery Act	July 30, 2008
GSEs enter conservatorship	September 7, 2008
Fed expands collateral in TSLF and PDCF, issues 23A exemptions	September 14, 2008
Lehman Bankruptcy	September 15, 2008
Fed provides $85 billion loan to AIG	September 16, 2008
SEC bans shortselling in all financial firms	September 17, 2008
Swap lines expand to $620 billion	September 18, 2008-October 29, 2008
Fed creates AMLF	September 19, 2008
Treasury announces MMMF guarantee	September 19, 2008
TARP proposal in Congress	September 20, 2008-October 3, 2008
Fed announces IOR policy	October 6, 2008
Fed announces CPFF	October 7, 2008

Fed increases deposit insurance	October 7, 2008
Fed reduces FF target by 50 bps	October 8, 2008
TARP Capital Injections, 200+ Banks	October 14, 2008-March, 2009
FDIC creates TLGP debt guarantee program	October 14, 2008
Fed announces MMIFF	October 21, 2008
Fed reduces FF target by 50 bps	October 29, 2008
GSEs suspend foreclosures	November 20, 2008
Treasury, Fed, and FDIC announce funding for CITI, BofA	November 23, 2008
Fed announces TALF	November 25, 2008
Fed announces purchases of GSE debt and MBS	November 25, 2008
Fed moves to FF rate to 0-25bps range	December 16, 2008
Treasury authorizes loans to GM and Chrysler from TARP	December 19, 2008
Treasury announces Financial Stability Plan	February 10, 2009
U.S. Stimulus Plan	February 17, 2009
TALF implemented	March 19, 2009
FOMC begins Treasury purchases	March 31, 2009
SE/FASB Changes to Fair Value Accounting	March 31, 2009

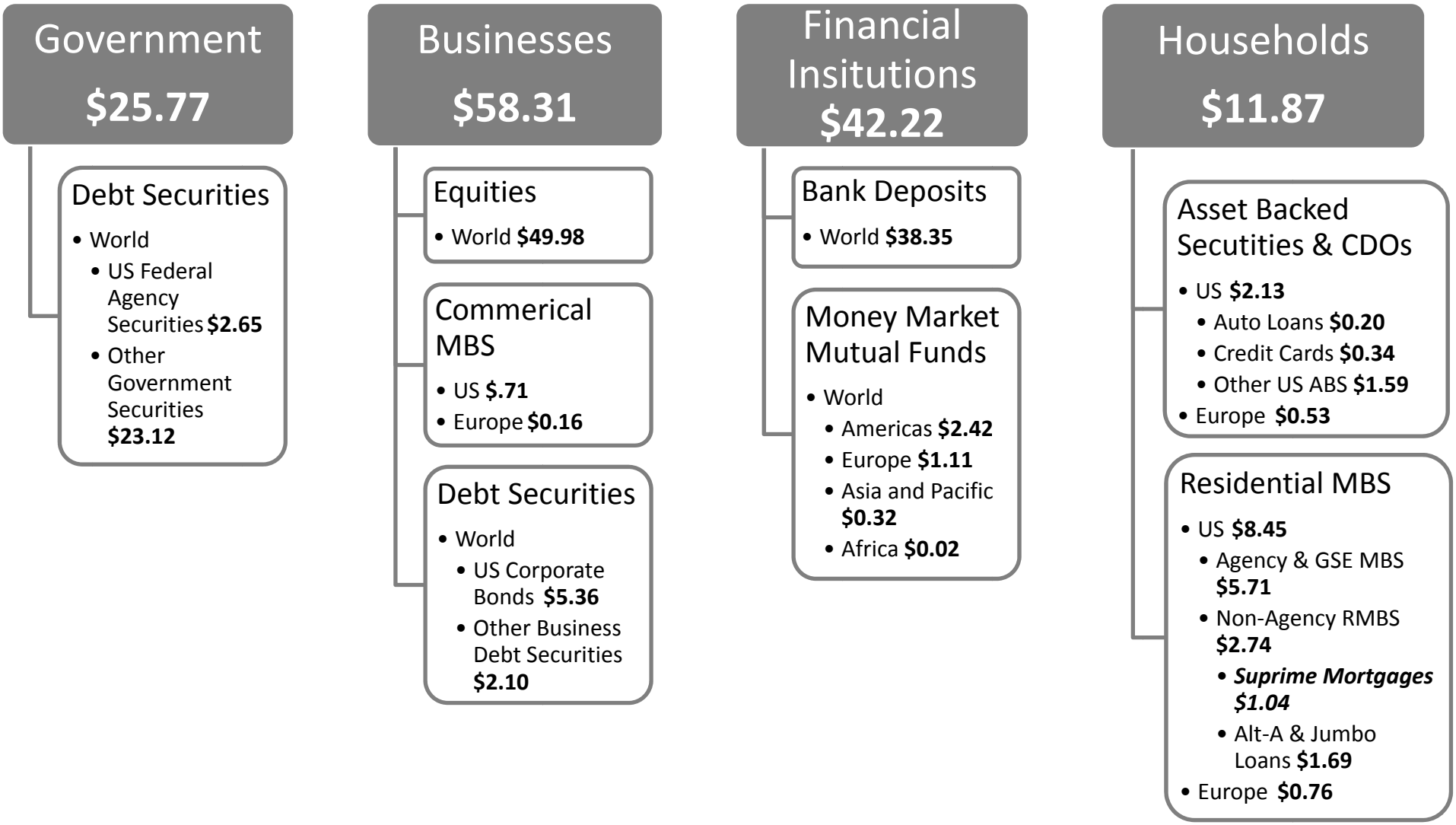
Figure 1. Housing Price Indices

January 2000 through April 2009



Sources: OFHEO and Haver

Figure 2
Size of Financial Markets
December 2006, Trillions of US$

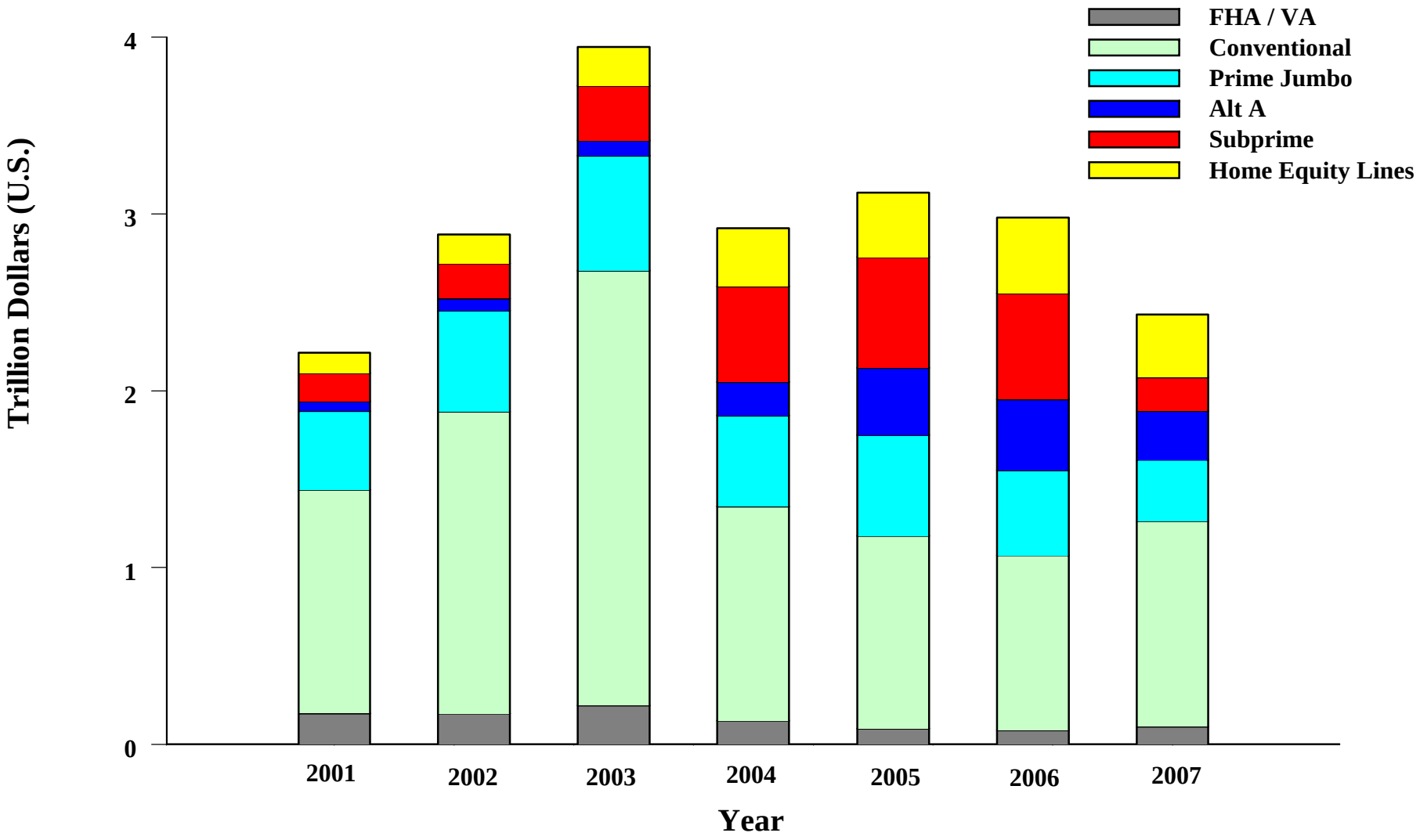


Sources: Bank for International Settlements, Federal Agencies, Bloomberg, European Securitisation Forum, JP Morgan, Commercial Mortgage Alert, SIFMA, World Bank, Investment Company Institute, Thomson Financial, Government Sponsored Enterprises, and Bank of England.

Notes: U.S. RMBS includes CMOs. U.S. CMBS is estimated by applying a growth rate to data from 2004 and 2007. Subprime U.S. RMBS is calculated based on market share.

Figure 3. U.S. Mortgage Originations by Type

2001 through 2007



Source: Bank of England Financial Stability Report

Figure 4. ABX Indices by Vintage

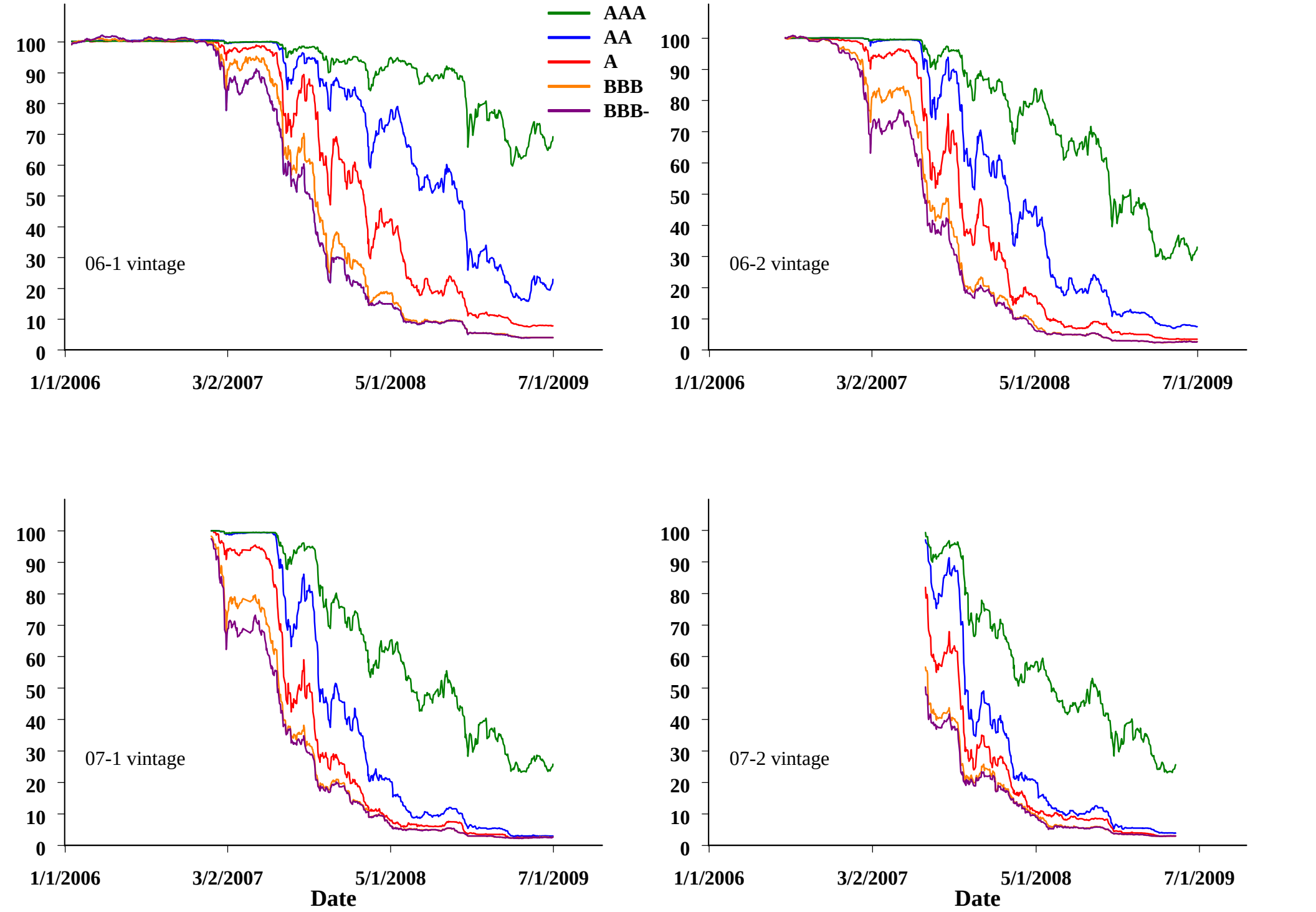


Figure 5. LIBOR less OIS Spread - 30 Days

January 1, 2007 through June 30, 2009

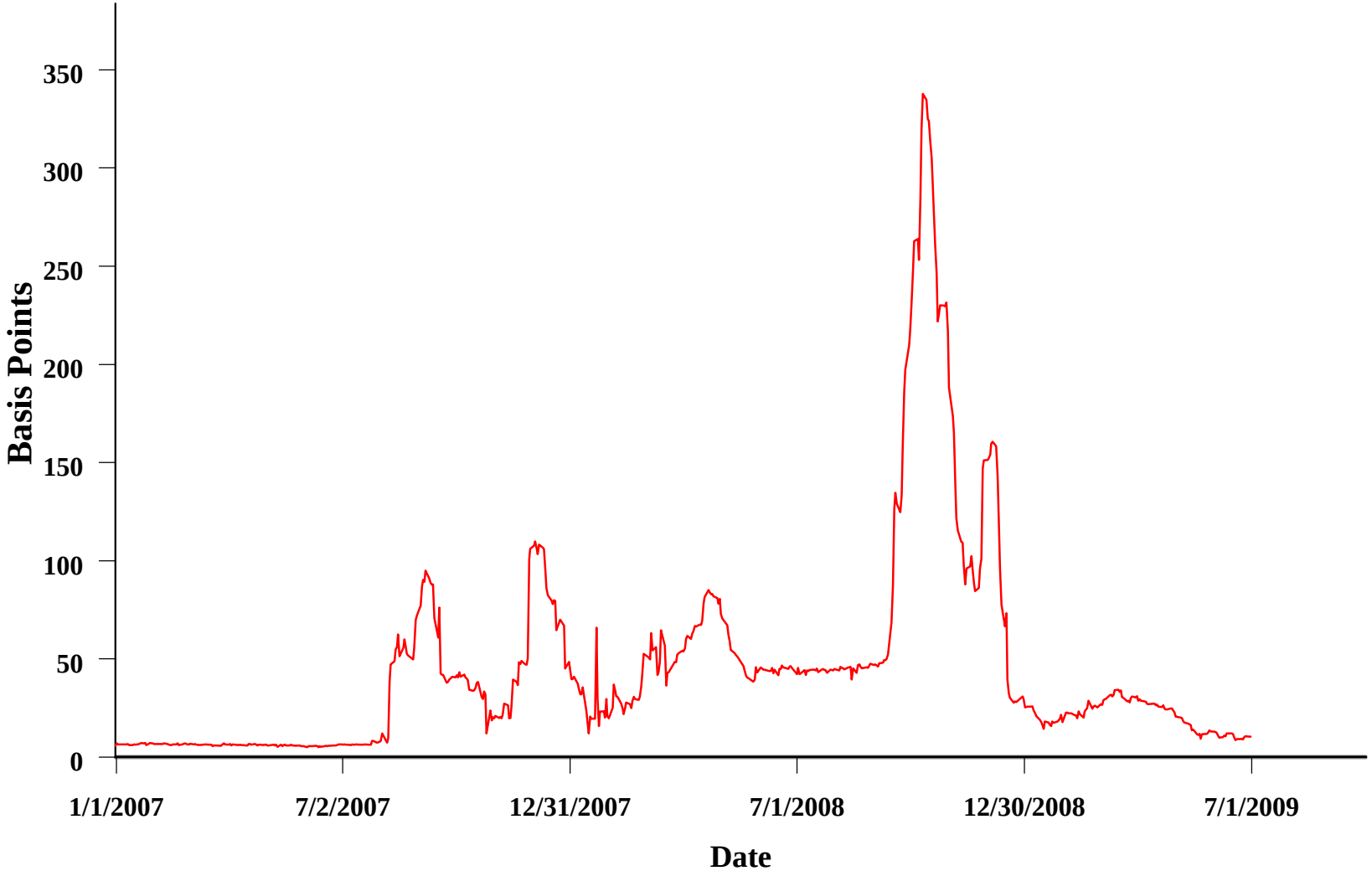


Figure 6. 30 Day Commercial Paper and Treasury Rates

January 2, 2007 through June 30, 2009

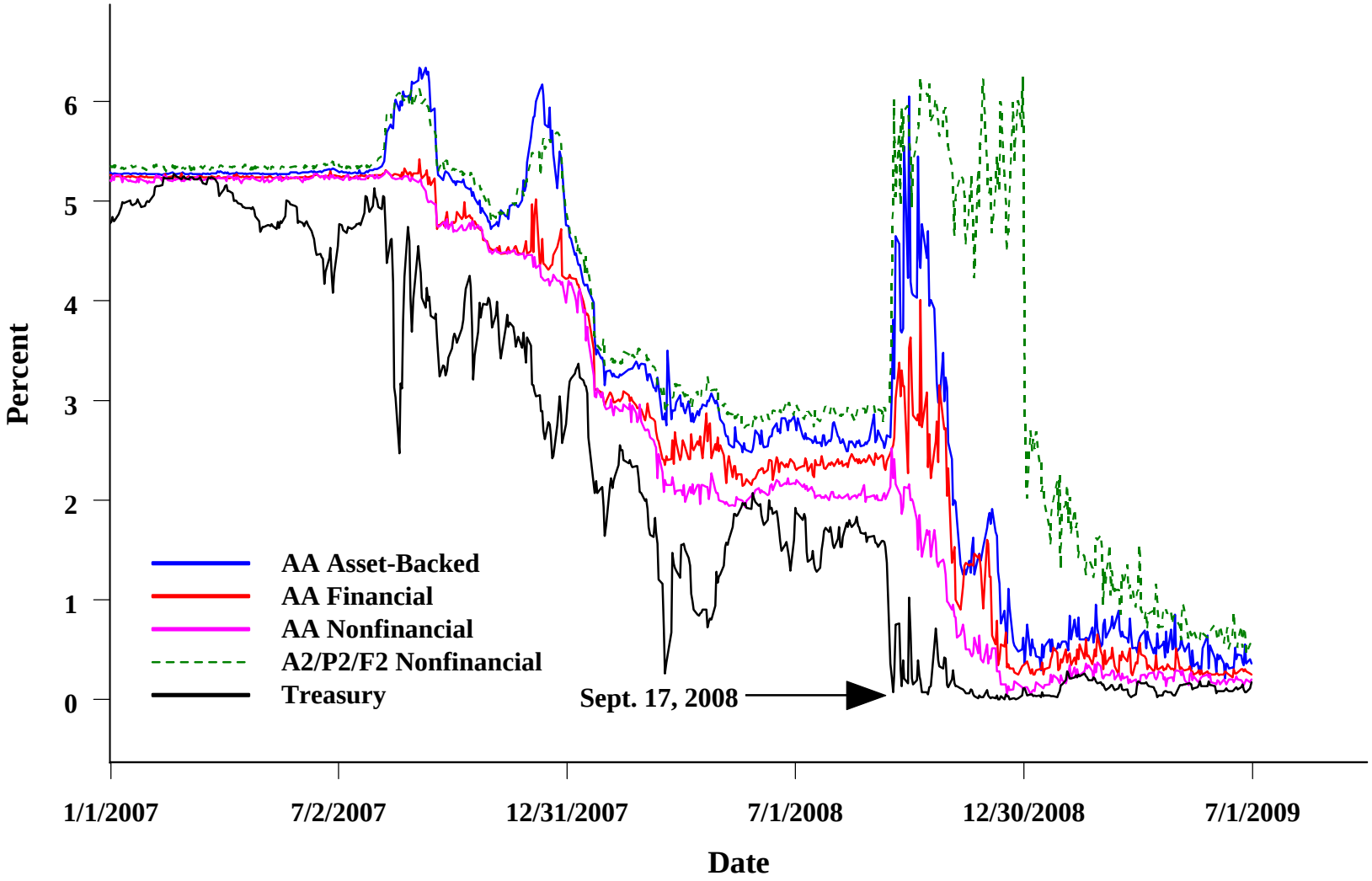


Figure 7. Bank Credit Default Swaps Rates

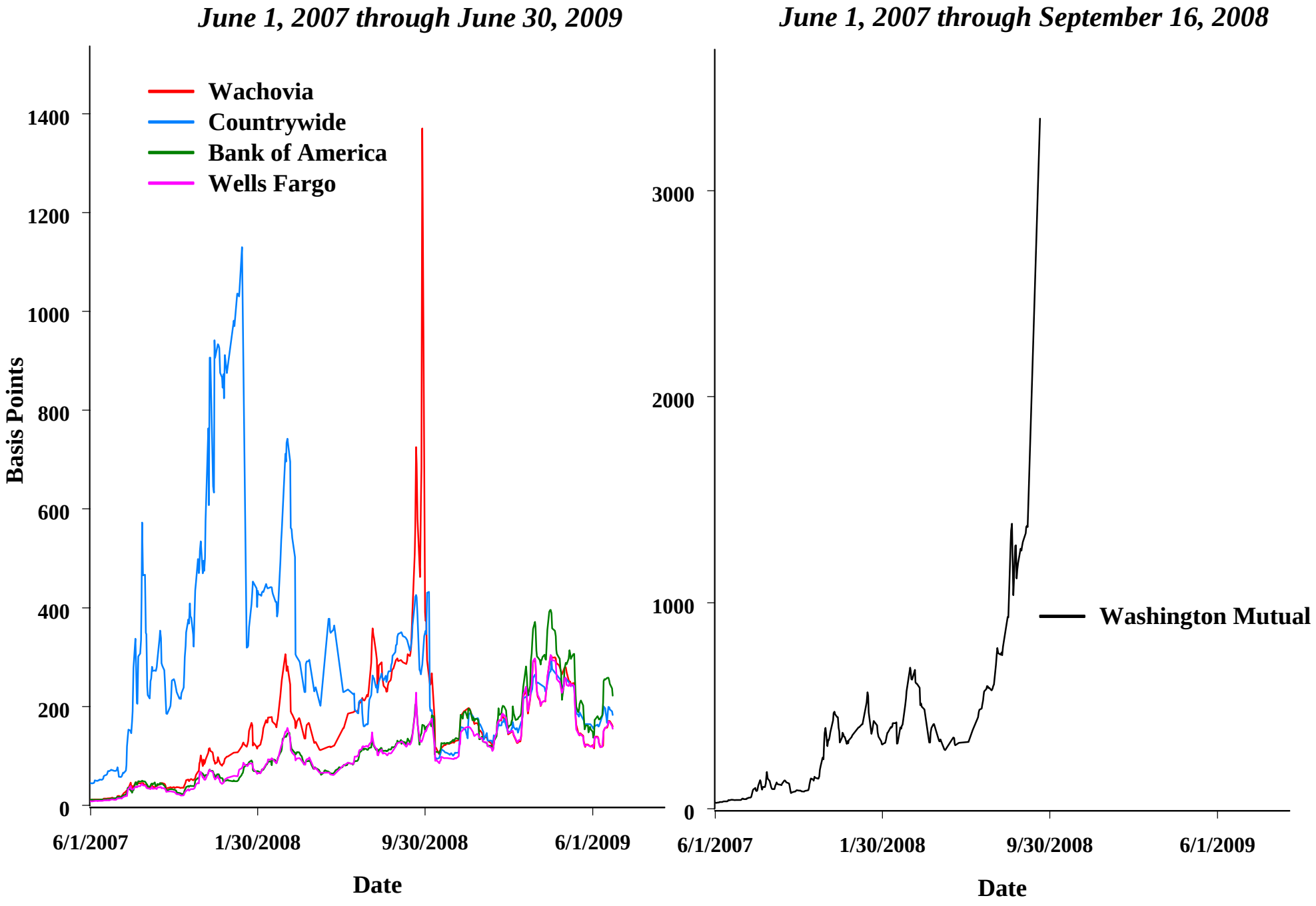
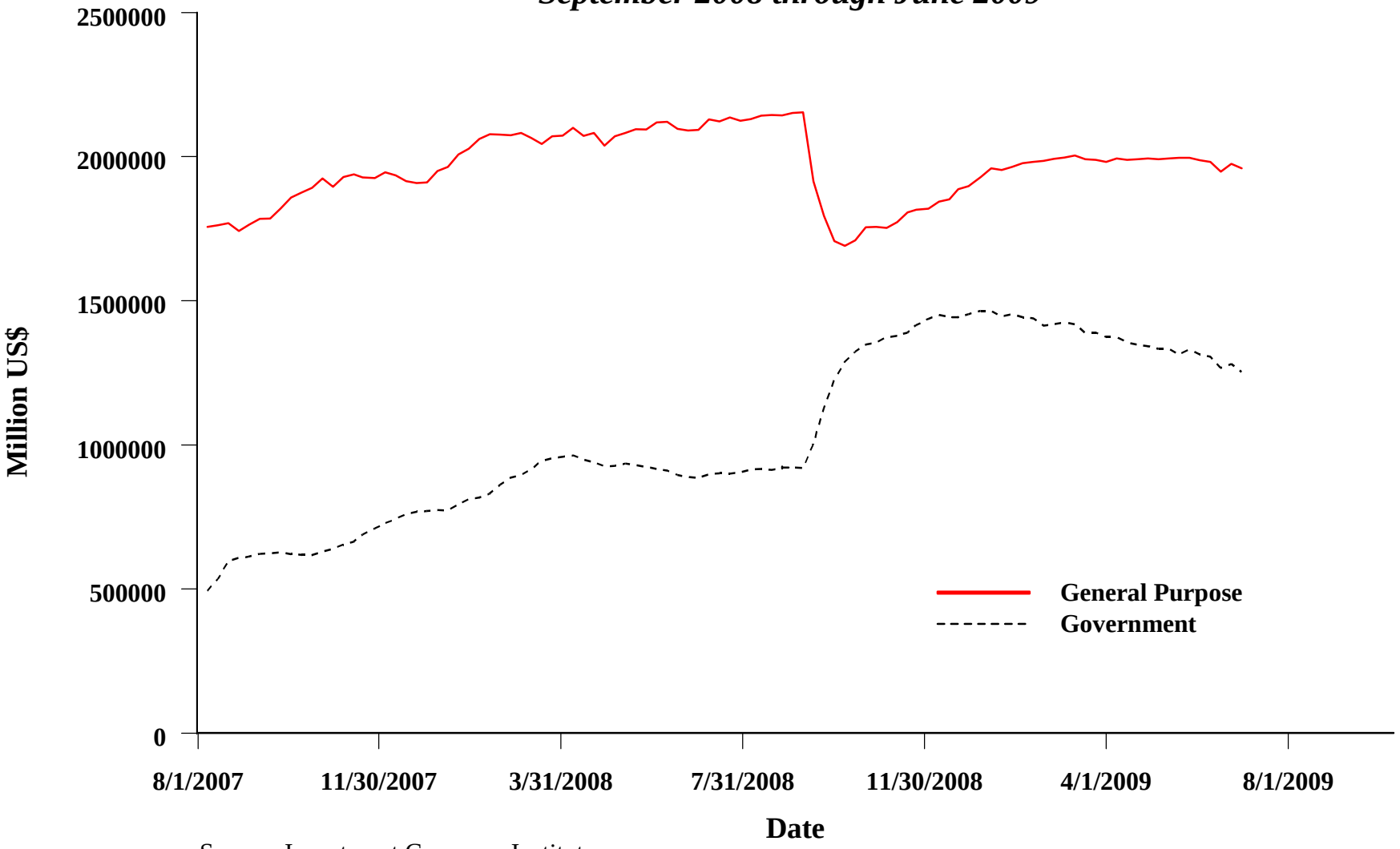


Figure 8. Total Net Assets in Taxable Money Market Funds

September 2008 through June 2009



Source: Investment Company Institute

Figure 9
Maturities of Commercial Paper Issuance
January 2007 to June 2009, Weekly Data

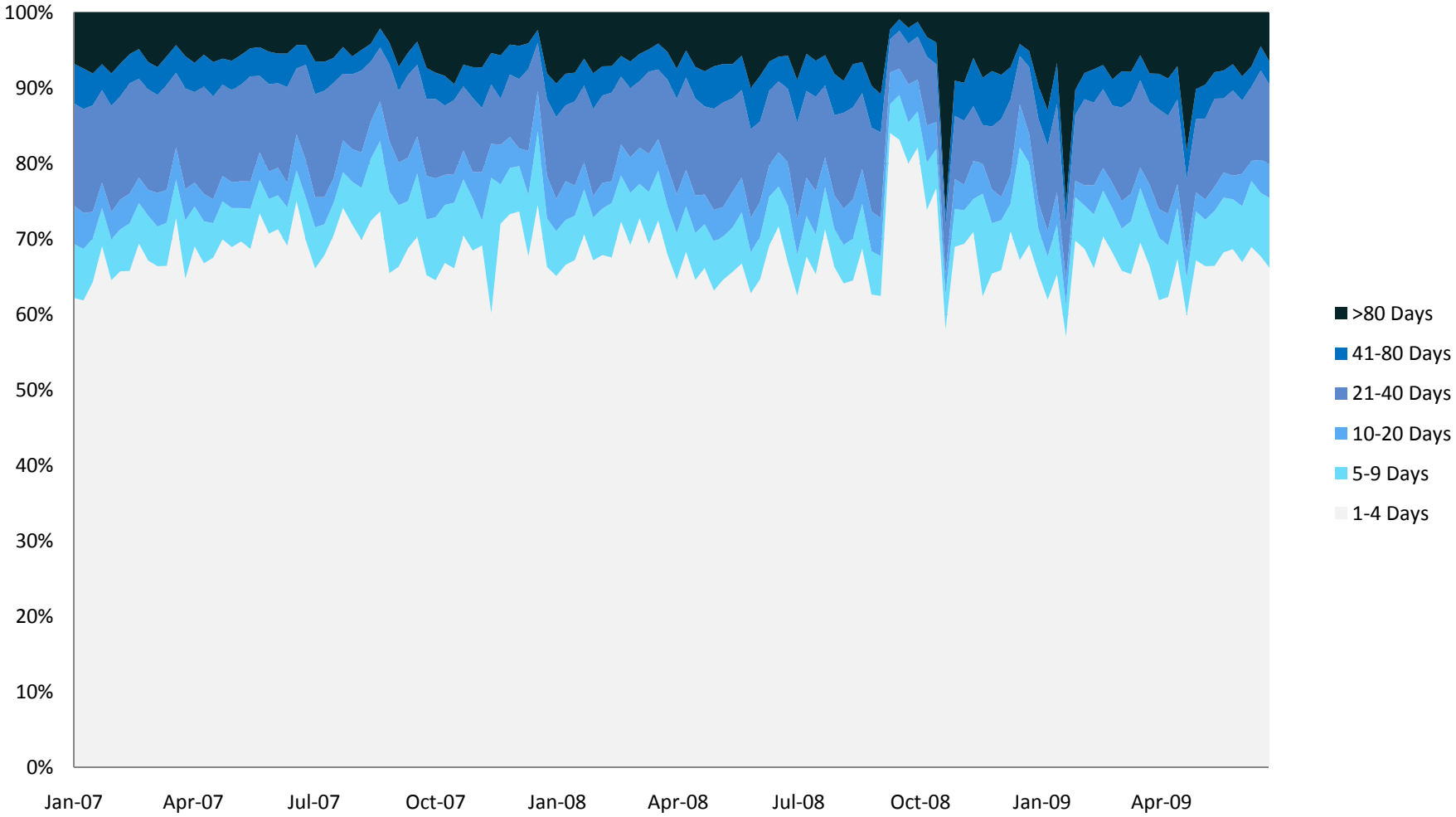


Figure 10. AMLF and CPFF Loans

September 2008 through June 2009