

# CREDIT CRUNCH IN THE U.S. INTERBANK MONEY MARKET 2007-2008: ISSUES IN BANK FUNDING MARKETS AND FEDERAL RESERVE RESPONSES

Economics  
Master's thesis  
Elina Suutala  
2009

**Department of Economics**  
HELSINGIN KAUPPAKORKEAKOULU  
HELSINKI SCHOOL OF ECONOMICS



HELSINKI SCHOOL OF ECONOMICS  
Department of Economics



**CREDIT CRUNCH IN THE U.S. INTERBANK MONEY MARKET 2007-2008:  
ISSUES IN BANK FUNDING MARKETS AND FEDERAL RESERVE RESPONSES**

Master's Thesis in Economics  
Elina Suutala  
Spring Term 2009

Approved by the Head of the Economics Department \_\_\_/\_\_\_ 200\_\_\_ and awarded the grade

---



This study discusses the interbank money market credit crunch in the United States in 2007-2008. The objective is to answer to the question of whether or not the actions of the Federal Reserve were effective and accurate in solving the crisis in the U.S. interbank money market based on the evaluations made in the academic community.

The study presents some theory on the liquidity and credit crunches and then moves on to explaining the issues in the interbank money markets and motives of the market operators during the time period examined. Finally the Federal Reserve responses to the problems in the interbank money markets are summarized and their effectiveness and accuracy is analyzed.

The methodology used in this study is a literature review with a graphical analysis and simple calculations regarding certain money markets based on data retrieved from varied sources of the Federal Reserve and other institutions. The review limits itself to the interbank money market funding in the United States and to the time period between June 2007 and June 2008. The instruments analyzed have a maturity of three months and lower.

The main result was that according to the evaluations, the Federal Reserve responses were in some cases effective although they were not strong enough to prevent the credit crunch from continuing. Cuts of the main policy interest rate were considered inflationary and ineffective to address the issues in the interbank money market. The arguments concerning the bailout of Bear Stearns, repo operations and central bank swap lines were mainly positive. The econometrical analysis is not extensive yet but the research made thus far suggest that the effects of new lending facilities (Term Auction Facility, Term Securities Lending Facility and Primary Dealer Credit Facility) have controversial results on the LIBOR-OIS spread but reduced spreads in the repo market. The main concern regarding the institution bailouts and accepting low-grade collateral was the increasing the risk of moral hazard, thus the irresponsible decision-making.

Keywords: credit crunch, financial crisis, liquidity, interbank market, Federal Reserve, monetary policy



Tämän tutkielman aiheena on luottolama pankkien välisillä rahamarkkinoilla vuosina 2007-2008. Tavoitteena on vastata kysymykseen olivatko Yhdysvaltain keskuspankin toimenpiteet tehokkaita ja oikeita kriisin ratkaisuun USA:n pankkien välisillä rahamarkkinoilla. Tarkastelu perustuu akateemisiin lähteisiin.

Tutkielma esittää likviditeetin ja luottolamojen teoriaa sekä siirtyy sitten tarkastelemaan pankkien välisiä rahamarkkinoita ja markkinaoperaattoreiden päätösten motiiveja tutkittavalla aikaperiodilla. Viimeisenä käsitellään Yhdysvaltain keskuspankin ratkaisuja pankkien välisten rahamarkkinoiden ongelmiin sekä analysoidaan niiden tehokkuutta ja oikeellisuutta.

Tutkimus on kirjallisuuskatsaus, joka sisältää graafisen analyysin ja yksinkertaisia laskelmia rahamarkkinoista perustuen aineistoon, joka on kerätty Yhdysvaltain keskuspankkien ja muiden instituutioiden lähteistä. Katsaus rajoittuu tarkastelemaan pankkienvälistä rahamarkkinaa USA:ssa kesäkuusta 2007 ja kesäkuuhun 2008. Analysoitavien instrumenttien maturiteetti on kolme kuukautta tai pienempi.

Päätuloksena voidaan sanoa, että osa Yhdysvaltain keskuspankin toimenpiteistä oli tehokkaita vaikka ne eivät olleet tarpeeksi voimakkaita estääkseen luottolamaa jatkumasta. Ohjauksen laskuja pidettiin inflaationaarisina ja tehottomina käsittelemään ongelmia pankkien välisillä rahamarkkinoilla. Argumentit, jotka koskivat Bear Stearns –investointipankin pelastamista, repo-operaatiota ja keskuspankkien swap-sopimuksia olivat pääasiassa positiivisia. Ekonometrinen analyysi aiheesta ei ole vielä kattava, mutta tehtyjen tutkimusten mukaan uusien lainaohjelmien (Term Auction Facility-, Term Securities Lending Facility- ja Primary Dealer Credit Facility –ohjelmat) vaikutukset LIBOR-OIS –sprediin ovat tulosten mukaan ristiriitaisia, mutta niiden on todettu kaventavan spredeja repo-markkinoilla. Suurimpana ongelmana Yhdysvaltain keskuspankin toteuttamissa pankkien pelastusoperaatioissa ja huonolaatuisten vakuuksien hyväksymisessä pidettiin haitallisen valinnan ongelmaa, eli pankkien rohkaisua vastuuttomaan päätöksentekoon.

Avainsanat: luottolama, taluskriisi, likviditeetti, pankkien väliset markkinat, Yhdysvaltain keskuspankki, rahapolitiikka

## Contents

LIST OF ABBREVIATIONS .....	1
CONCEPTS.....	1
1 INTRODUCTION .....	2
1.1 Background and motivation .....	2
1.2 Objectives of the research and the research question .....	4
1.3 Methodology and limitations .....	4
1.4 Structure of the study.....	5
2 BACKGROUND OF THE CRISIS .....	6
2.1 Macroeconomic environment.....	6
2.2 Changes in the U.S. housing market.....	7
2.3 Securitization.....	9
2.4 Impacts to interbank lending.....	10
2.5 Causes for moves in the LIBOR-OIS spread summarized.....	12
3 THEORY OF CREDIT CRUNCHES AND INTERBANK LIQUIDITY.....	14
3.1 Previous research on credit crunches.....	14
3.1.1 Definitions .....	14
3.1.2 Causes of credit crunches .....	15
3.2 Funding vs. market liquidity .....	18
3.3 The interbank liquidity models .....	19
3.3.1 Liquidity freezes.....	20
3.3.2 Monetary policy in liquidity provision .....	20
4 ISSUES IN THE INTERBANK MONEY MARKET .....	22
4.1 Bank funding markets.....	22
4.1.1 Interbank market .....	22
4.1.2 Commercial paper market.....	25
4.1.3 Repo market.....	29
4.1.4 Certificates of deposit market.....	32
4.1.5 Federal Funds market.....	33
4.1.6 Treasury bill market.....	37
4.1.7 The discount window .....	39
4.1.8 Issues in money market securities summarized .....	42
4.2 Market operators: motives and consequences.....	44
4.2.1 The interbank money market operators and motives .....	45
4.2.2 Consequences of market freezes .....	46
5 THE FEDERAL RESERVE RESPONSES IN THE INTERBANK MONEY MARKET ...	49
5.1 Traditional monetary policy tools and responses.....	50
5.1.1 Federal Funds rate cuts .....	50
5.1.2 Adjustments to Discount Window Program.....	52
5.1.3 Bear Stearns bailout .....	52
5.2 New monetary policy tools and responses .....	54
5.2.1 Central Bank Liquidity Swap Lines.....	55
5.2.2 Term Auction Facility.....	55
5.2.3 Single-Tranche Open Market Operations Program.....	58
5.2.4 Term Securities Lending Facility.....	59

5.2.5	Primary Dealer Credit Facility .....	63
5.3	Tools and responses of the Federal Reserve summarized.....	64
6	CONCLUSIONS .....	67
	REFERENCES.....	71

## Figures

Figure 1:	US Household net saving rates, 6/2007-6/2008.....	6
Figure 2:	Changes in US household debt, %, 6/2007-6/2008 .....	7
Figure 3:	OFHEO Seasonally-Adjusted House Price Index for USA, Q1/1999-Q2/2008.....	8
Figure 4:	One-month USD Libor minus overnight index swap rate, 2007-2008.....	11
Figure 5:	Liquidity spirals .....	19
Figure 6:	USD LIBOR rates, 6/2007-6/2008, %.....	23
Figure 7:	Asset-backed, financial and nonfinancial commercial papers in the U.S., outstanding amount, \$ million, 6/2007-6/2008.....	25
Figure 8:	Discount rate spread*, basis points, 6/2007-6/2008 .....	27
Figure 9:	AA Asset-backed Commercial Paper Rates for different maturities in the U.S., 6/2007-6/2008, %.....	28
Figure 10:	U.S. 3-month Repo spread*, 2004-2008, %.....	30
Figure 11:	General Collateral Repo, Libor and OIS* rates in the US, in the Euro area and in the UK, 3-month maturity, % .....	30
Figure 12:	Average general collateral repo-OIS spreads*, in the US, in the Euro area and in the UK, % .....	31
Figure 13:	1-month and 3-month Certificates of Deposit Rates, 6/2007-6/2008, secondary market rate, % .....	33
Figure 14:	Federal Funds Target Rate, Primary Credit Rate, Secondary Credit Rate, 6/2007-6/2008, %.....	35
Figure 15:	Federal Funds Rates, 6/2007-6/2008, % .....	36
Figure 16:	Treasury Bills, 6/2007-6/2008, secondary market rates, % .....	38
Figure 17:	Discount rates of Federal Reserve Bank of New York, %, 6/2007-6/2008 .....	40
Figure 18:	Discount window borrowings of depository institutions and primary dealers*, 6/2007-7/2008, \$ billion .....	41
Figure 19:	The Development of Overnight Money Market Rates and periods of severe liquidity strains 6/2007-6/2008, % .....	43
Figure 20:	The Development of 1-month Money Market Rates and periods of severe liquidity strains, 6/2007-6/2008, %.....	44
Figure 21:	Writedowns of major U.S. Financial Institutions, 6/2007-6/2008.....	46
Figure 22:	Financing Spreads and the TSLF.....	62



## Tables

Table 1: Standard deviations for changes in USD LIBOR rates for different maturities, basis points, 6/2006-6/2008 .....	24
Table 2: Standard deviations for rate changes of AA Asset-backed commercial papers for different maturities in the U.S., basis points, 6/2006-6/2008 .....	29
Table 3: Changes in Federal Funds target rate, 6/2007-6/2008 .....	36
Table 4: Effective federal funds rate, deviations, 6/2006-6/2008 .....	37
Table 5: Timeline of the Federal Reserve responses 6/2007-6/2008 .....	49
Table 6: New liquidity facilities .....	54
Table 7: TAF Auctions 12/2007-6/2008 .....	57
Table 8: TSLF Auctions, 3/2008-6/2008 .....	61

## LIST OF ABBREVIATIONS

ABCP	Asset-backed commercial paper
CDO	Collateral Debt Obligation
FRB	Federal Reserve Board
LIBOR	London Interbank Offered Rate
MBS	Mortgage-backed security
TAF	Term Auction Facility
TSLF	Term Securities Lending Facility
PCDF	Primary Dealer Credit Facility
SPV	Special Purpose Vehicles
GSE	Government Sponsored Enterprise
OIS	Overnight Index Swap

## CONCEPTS

counterparty risk	the risk that the counterparty of the agreement does not pay the debt, also default risk
depository institutions	banks, savings banks, S&Ls and credit unions who are allowed to take monetary deposits from the consumers
general collateral	the collateral used in GC repo agreements, consists of a variety of Treasury and other related securities
haircut	the difference between the security's price and its value as collateral if the trader uses a different asset as collateral
margin	the difference between the security's price and its value as collateral
market risk	the risk of the movements in the value of asset due to situation in the market
primary dealers	banks and securities broker-dealers that trade directly with the Federal Reserve and are the counterparties of the open market operations conducted by the Federal reserve
repurchase agreement	an agreement where the borrower of funds gives securities as collateral to the lender with a promise to repurchase them back at a given date with a given price

# 1 INTRODUCTION

## *1.1 Background and motivation*

The financial crisis in the United States that showed first signs in the summer 2007 is said to be the largest since 1920s Great Depression. It began with problems in the U.S. but later turned into a global crisis. As several times before in history, the crash was preceded by a period of fairly steady growth. The bursting of the so called Internet bubble in the start of the decade gave a setting for increased consuming, investing and presumably risk taking. However, the prospects started to get bleaker when the house prices started to decline. That meant consequences for the debtors, the lenders and the investors who had obtained the mortgage-backed securities. The subprime loans, the loans granted to individuals with high default risk, showed signs of high delinquency rates.

*The subprime crisis* was the name given when large financial institutions started to report losses on their investments with subprime connections. Eventually the doubt about the value of the mortgage-backed securities spread to the other sections of structured markets inducing banks to deleverage their positions which decreased the value of the instruments even more. The subprime crisis developed into a credit crisis, or into *a credit crunch*, as is discussed in this study. The banks reduced and halted their lending due to the counterparty, market, and liquidity risk that were perceived high. To continue with their operations, the banks were in desperate need of liquidity. However, the banks with excess liquidity were not willing to give it up even for the high risk premiums in the products.

The situation in the markets required the central banks, including the Federal Reserve, to make decisions to improve the functioning of financial markets. It used and modified the traditional monetary policy tools such as policy interest rate cuts, repurchase agreements and institution bailouts. Also unconventional lending facilities (Term Auction Facility, Term Securities Lending Facility and Primary Dealer Credit Facility<sup>1</sup>) for the depository institutions and primary dealers

---

<sup>1</sup> Unconventional lending facilities are discussed in section 5.2.

were invented in response to liquidity issues in the money markets. The efficiency of the Federal Reserve operations evoked much discussion and also some critical arguments were given.

It can be noted that the credit crunch can be roughly divided into two phases: the time period between summers 2007 and 2008 and the time period after that in which the trouble spread also to the real economy. This study focuses on the first phase, thus time period between June 2007 and June 2008. Currently, in spring 2009, the U.S. money market credit crunch is not over yet. Even positive assessment about the situation in the markets occurred in early summer 2008 but the crisis continued later in September with failures of major U.S. financial institutions. The Federal Reserve has been forced to expand the monetary policy tool kit regarding the distribution of liquidity and to resort to bailouts of financial institutions. However, at this point it is possible to analyze the developments in the money markets during the first phase of the crisis and the motives for the behavior of the operators. In addition, the initial actions of the Federal Reserve can be put under scrutiny providing information on the efficiency of the procedures and several dilemmas regarding the implementation of monetary policy.

This study analyses the interbank credit crunch in the U.S. money market. It focuses on the main issues in the bank funding markets and the Federal Reserve responses to the credit crunch. Examination the credit crunch is needed because it provides information on the motives behind bank lending and reasons for reducing credit. It can even help to see the signs of upcoming turmoil earlier and therefore precautionary actions could be taken. Also recognizing the actions of the Federal Reserve and their efficiency and accuracy can assist in planning the monetary policy in the future.

As a result, the Federal Reserve's attempt to abate the strains in the U.S. interbank money market was not a total success, since it did not stop the crisis altogether. The opinions regarding the Federal Reserve responses were varied and some critical views were also given especially regarding the interest rate cuts. New lending facilities were considered to help in relieving strains especially in the repo market. The critical opinions concerned the institution bailouts and accepting lower-grade collateral since they would induce the problem of moral hazard among banks. Nonetheless, few arguments provided better options for the monetary policy decisions.

After the damage had been done with lack of regulation and incorrect instrument ratings, among others, one can say that the Federal Reserve actions were the best it could accomplish in the face of the crisis of a large magnitude.

## ***1.2 Objectives of the research and the research question***

The research has two objectives. Firstly, the goal is to present the interbank credit crunch in the money market by presenting data on interest rates of different instruments in the United States. Secondly, the objective of this thesis is to evaluate the actions of the Federal Reserve during the credit crunch including the new innovations of monetary policy tools.

The research question of this thesis is the following: were the actions of the Federal Reserve accurate in the crisis situation according to experts and academic community? The study attempts to answer whether or not the Federal Reserve responded correctly to the liquidity problems and eased the situation in the troubled interbank money market.

## ***1.3 Methodology and limitations***

The research method used in this thesis is a literature review. The market data is analyzed with graphs and simple calculations regarding mostly the volatility of instruments' market rates.

Limitations are made in the time period and in the maturity of the instruments which are analyzed. The research focuses on the time period from the beginning of June 2007 to the end of June 2008 in the U.S. money market. The reason for making the limitation of examining only the "first phase" of the crisis is because the interest is on the pure effects and responses to the dry-up of liquidity without the aspects of real economy effects which occurred during the "second phase". For example, the actions of the Federal Reserve are affected by the real economy since its goals are "to promote effectively the goals of maximum employment, stable prices, and moderate long-term interest rates" as mentioned in the Federal Reserve Act.

The instruments that are analyzed have a maturity of 3 months or lower since it seems that the largest differences in market rates and investor behaviour occurred in those maturities. For example, the overnight credit was more easily obtained than the term funding for one or three months.

#### ***1.4 Structure of the study***

The study consists of six sections in which section 1 serves as the introduction. In section 2 the background and the events leading up to the credit crunch are shortly described. The focus is on the characteristics of the U.S. housing market and securitization. In section 3, the theory of credit crunches and interbank liquidity models is described, referring mostly to previous research. In section 4, the issues in the U.S. interbank money market in 2007-2008 are described in detail and the reasons for the market dry-up are recognized. Section 5 gets in to the research question. It answers to the question of whether or not the responses of the Federal Reserve were correct in solving the crisis in the interbank money market. In section 6, conclusions are made about the results of the study.

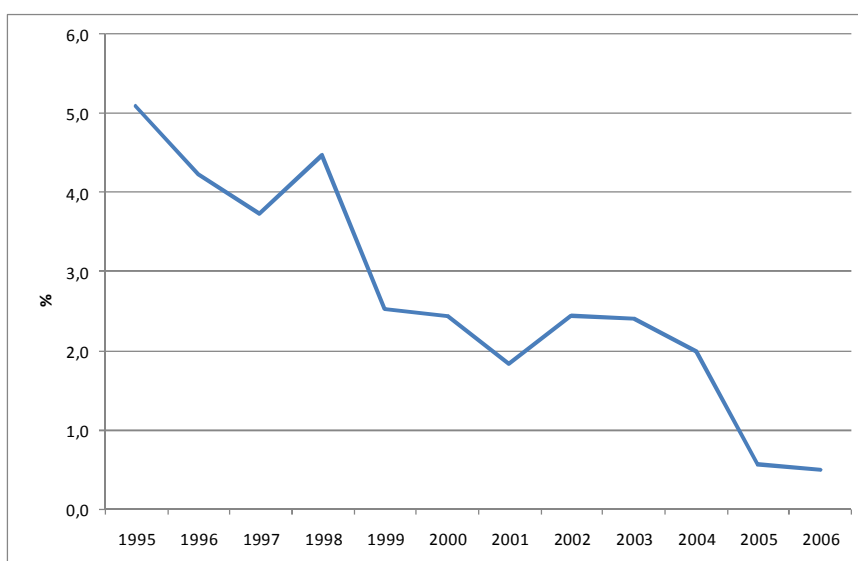
## 2 BACKGROUND OF THE CRISIS

The turmoil of the crisis started in the interbank money market in August 2007 although alarming news concerning the subprime loans had spread already during the spring. The problems in the subprime market spilled over to all markets with structured products and finally affected negatively to the banks' willingness to lend in the money market. In this section, the events leading to a money market credit crunch in the U.S are described and the reasons for the crisis are summarized.

### 2.1 *Macroeconomic environment*

According to some economists, financial crisis and thus the credit crunch stems from the unusual economic situation in the country during the recent decade. United States had experienced a long period of low nominal short-term interest rates, low inflation and fairly steady growth. Also debt to disposable income -ratios were at a high level. Household net saving rates (savings to disposable income) had been falling for a decade and were close to zero in 2006 (Mizen 2008). The decline in the saving rates can be seen in the graph below (Figure 1).

**Figure 1: US Household net saving rates, 6/2007-6/2008**



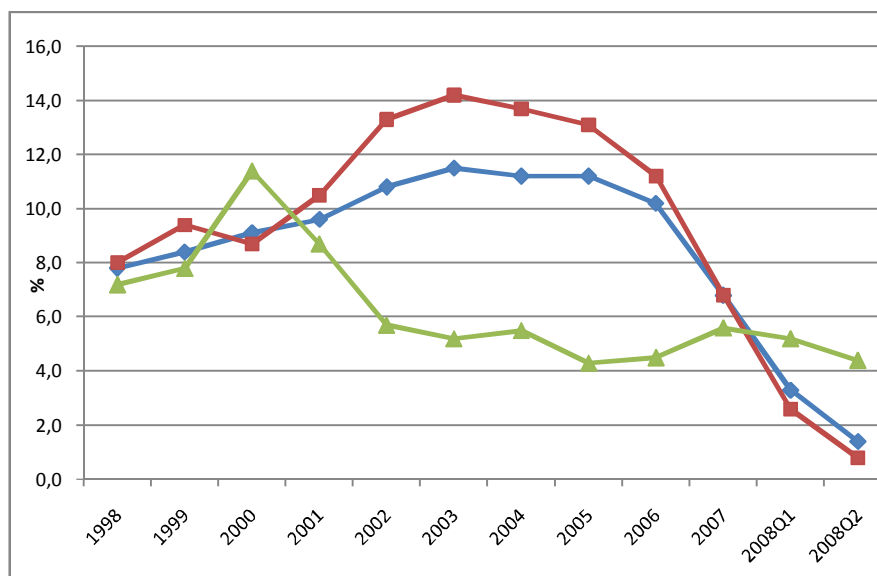
Source: OECD.Stat

## 2.2 Changes in the U.S. housing market

As mentioned in the introduction, the origins of the current financial crisis are in the U.S. housing market, or at least that is the trigger of uncertainty in the market. The problem was actually in mispricing the risk and desire to gain higher yields. In fact, any other high-risk product class could have initiated the crisis.

According to Brunnermeier (2009), there were three factors leading up to the U.S. housing bubble, the two first also relate to the macroeconomic situation in the country. Firstly, especially Asian countries bought huge amounts of U.S. dollars to help their exports and to protect their own currency against dollar. These large capital inflows affected persistency of the period of low nominal short-term interest rates. Secondly, due to the fear of deflationary period after the Internet bubble, the Federal Reserve adopted a lax interest rate policy. Thirdly, the banking system was moved more to a “originate and distribute”-model where banks pooled, tranced and resold loans instead of keeping them until they were repaid which resulted to a decline in lending standards. Securitization of mortgages is discussed more closely in the upcoming chapter.

**Figure 2: Changes in US household debt, %, 6/2007-6/2008**



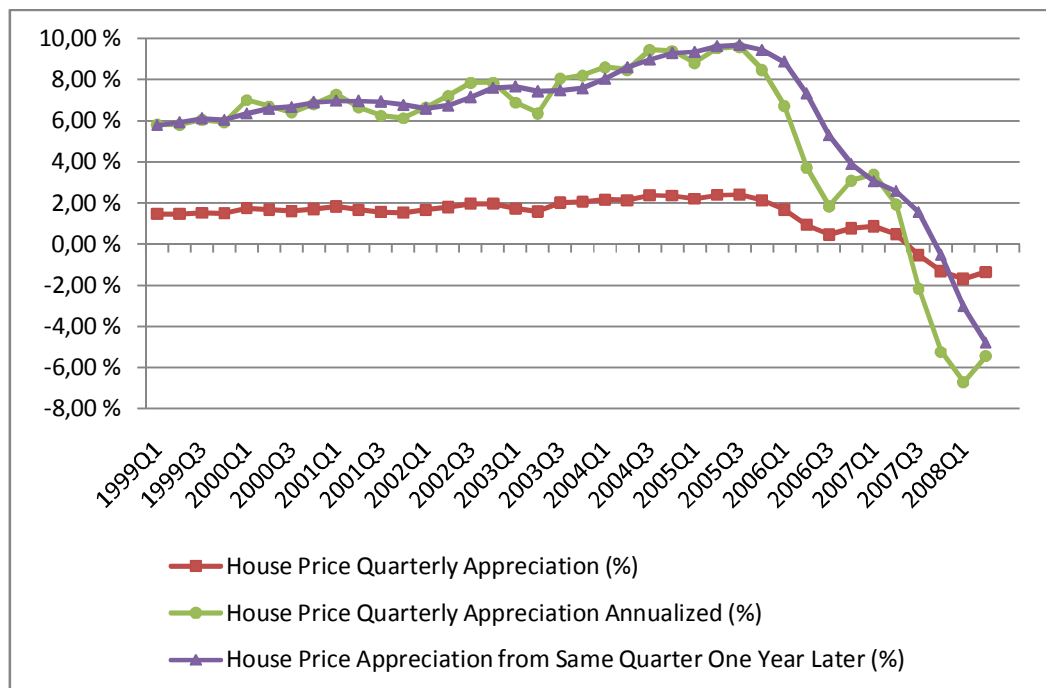
Source: Flow of Funds Account of the United States



The growth rate in household debt had been rising or staying fairly constant until 2005 and a huge decline occurred in years 2007 and the first two quarters in 2008 (see Figure 2). The highest increase in debt was experienced in the home mortgage market with a 14 % growth in 2003.

Housing prices had been rising steadily for years and both borrowers and lenders assumed that this growth would continue. However, the change can be observed in the graph below (Figure 3). According to the OFHEO (Office of Federal Housing Enterprise Oversight) House Price Index the growth in house prices stagnated in the 3<sup>rd</sup> quarter of 2005. Inevitably house price quarterly appreciation has been negative since the 2<sup>nd</sup> quarter of year 2007.

**Figure 3: OFHEO Seasonally-Adjusted House Price Index for USA, Q1/1999-Q2/2008**



Source: Office of Federal Housing Enterprise Oversight

Subprime mortgages are mortgages to individuals with a history of delinquencies or bankruptcy, high default probability (e.g. according to FICO scale<sup>2</sup>) or debt service-to-income ratio of 50 percent or greater (Ashcraft & Schuermann 2008). Lending conditions of these mortgages were

<sup>2</sup> Most credit bureau scores are produced by a software developed by Fair Isaac Corporation giving the name "FICO scale"

various and subprime lenders are sometimes accused of predatory lending practices, that is, benefiting from the financial ignorance of borrowers. The subprime mortgage market had also been growing since 2001 encouraged by the rising values of properties. It reached a peak in 2005 and 2006 with subprime mortgage originations of over 600 billion U.S. dollars (Jaffee 2008). That was over 20% of the total mortgage originations. Between years 2000-2006 the number of subprime mortgage loans increased by 8,5 million in total. As the value of home owners properties started to decline, starting from 2005 delinquency rates of subprime mortgages increased heavily reaching 18 % in 2007 (Mizen 2008).

### ***2.3 Securitization***

Mortgage-backed securities (MBSs) are debt securities which are secured by a pool of mortgages, usually on residential or commercial properties. This means that the value of these instruments depend highly on the mortgage payments. The issuance of MBSs started as an activity of Government Sponsored Agencies (GSEs). The loans were government backed and were mainly constructed by a pool of mortgages to prime borrowers (borrowers with low credit risk). Since 1980's securitization was also performed by commercial and investment banks with non-agency class loans which also include subprime mortgages. In 2006, 75 % of subprime mortgage loans were securitized, in total \$449 billion (Ashcraft & Schuermann 2008).

Securitization was undertaken through Special Purpose Vehicles (SPVs) which are off-balance sheet items and therefore do not incur risk of bankruptcy. SPVs consisted of various debt receivables and tranches of asset-backed securities that could be sold to investors. The pool of mortgages was tranced in different classes according to their quality and risk rating. The loans classes were senior, mezzanine and equity. The senior tranche had the lowest level of risk, equity tranche the highest level and the mezzanine tranche between of these two. In the case of defaults by the mortgage holders, the losses would occur firstly in equity tranche loans, then in mezzanine loans and finally in senior tranche loans. Later it turned out that the ratings of the securitized loans should have not been the same as the loan classes. For example, the high rating of securitized senior loans was not well earned and these instruments were in fact quite risky.

Collateralized debt obligations (CDOs) consisted of asset-backed securities distributed by SPVs. These instruments were packaged with different seniorities and pooled and resold even more than once. CDOs that were resold once or twice were called CDO-squared and CDO-cubed, respectively. After the complex operations the credit risk of a single CDO, CDO-squared or CDO-cubed was hard measure. In addition, sellers of the securities relied on the rising house prices and low interest rates and based their risk pricing on that assumption. Consequently, mistakes were made in operations and risk rating of securitized products which were the origins of the problems in structured markets.

#### ***2.4 Impacts to interbank lending***

As the news of rising delinquency rates of subprime mortgages spread, the market operators became aware that CDOs and MBSs were actually high risk instruments. In June and July 2007, rating agencies downgraded considerably the ratings of subprime related MBSs. Also the procedures regarding the rating of these products were revised which also increased suspicion in the market.

The ownerships of the underlying assets were quite unclear after several rounds of pooling and repackaging loans. Eventually the high complexity of products resulted to unawareness of financial institutions with regard to their exposure to subprime and other low quality loans. Uncertainty about the amount of losses made banks reluctant to lend to each other. Lenders demanded high risk premiums to compensate for the counterparty risk.

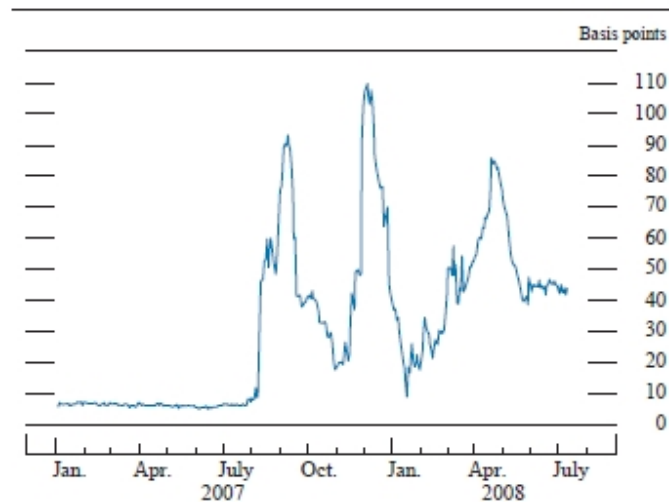
Contributing to the U.S. market credit crunch were conduits and structured investment vehicles (SIVs) created by banks who were among the purchasers of CDOs. SIVs were off-balance sheet entities which held usually illiquid bonds that were funded by issuing short-term asset-backed commercial papers (ABCPs). These institutions were not bound by the Basel I capital adequacy rules so they were not prepared to cover for unexpected liquidity commitments. Due to the uncertainty in the financial market, SIVs were not able to roll over ABCPs periodically. This resulted to a lack of short term funding and liquidity pressures of banks were elevated. Interbank

lending stopped as banks hoarded liquidity in case of losses of SIVs which might be taken back onto their balance sheets.

The increase in credit and liquidity risk can be perceived by looking at the LIBOR-OIS spread (Figure 4 below). It is the most used spread for describing the risk of interbank lending which is defined as the London Interbank Offered Rate reduced by overnight index swap rate. Overnight index swap rate is the periodic floating rate which is equal to the geometric average of an overnight index, in this case the daily Fed Funds rate, over every day of the payment period. The risk premium of OIS rate is usually smaller than the interbank rate, LIBOR. A high LIBOR-OIS spread is a sign of a strained interbank money market.

In August 2007, precisely on Thursday 9<sup>th</sup> of August, the LIBOR-OIS spread jumped 25 basis points above its 11 bps average. The increase was fueled by the announcement of the French bank BNP Paribas on the same day. It would freeze withdrawals from three of its hedge funds which invested into CDOs stating that the illiquidity in the CDO market prevented it from valuing assets.

**Figure 4: One-month USD Libor minus overnight index swap rate, 2007-2008**



Source: Board of Governors of the Federal Reserve System 2008a

Inaccessibility to all sources of money market funding surprised banks and only few of them were prepared for a crisis of this duration and magnitude. Bank failures started with Northern Rock in the UK and continued later in 2008 with Bear Stearns, Freddie Mac and Fannie Mae in US.

## ***2.5 Causes for moves in the LIBOR-OIS spread summarized***

The interbank credit crunch was caused by a combination of multiple factors of which are summed up in this section. According to Taylor and Williams (2008a) there are four explanations for the dry-up of interbank lending and for the jumps in the LIBOR-spread. The first two relate to the lenders' problem of whether to lend money at all and if so, who would be a solid borrower during the period of uncertainty.

The first explanation is *the counterparty risk* which refers to banks' reluctance to lend due to the increased default risk on loans or the market price of taking that risk. The banks were in fact experiencing writedowns because the value of some securities, e.g subprime loan backed, were falling. In addition, the banks were not certain about restructurings of the off-balance sheet operations.

The second explanation is *the liquidity risk*. This means that banks are unwilling to invest their funds for a period of time when they might need those funds to cover for their own shortfalls. Thus, not as much liquidity is available for the bank's traders to invest.

The third explanation for the credit crunch was *the hoarding of liquidity* which occurred during especially the period from November 2007 to January 2008. The reason for the need of liquidity was that banks, after a period of stress and close observation, wanted their balance sheets to look respectable in financial reports of 2007.

The fourth explanation for the high spreads in Libor rate according to Taylor and Williams (2008a) relates to *expectations of future interest rate changes*. Expectations of high overnight interest rates affected also the Libor rates.

### **3 THEORY OF CREDIT CRUNCHES AND INTERBANK LIQUIDITY**

Before turning into numerical data about the credit crunch in the interbank money market and Federal Reserve responses, the theoretical aspect of the topic is described. This section introduces some articles and models about credit crunches or squeezes and interbank liquidity.

#### ***3.1 Previous research on credit crunches***

Some research on credit crunches has been made before the ongoing crisis. Especially the tight lending conditions during the recession in 1990-1991 evoked discussion. The method of the research has depended strongly on the definition of the credit crunch and disagreement on this part has led to different results. Some agreement, however, is found in the factors affecting the credit crunch emergence.

##### **3.1.1 Definitions**

The exact definition of the credit crunch is somewhat obscure when observing the discussion between the researchers. Credit crunch refers to a reduction of credit which is evident. However, the difference in definitions can be found in the background and the timing of the credit reduction. These factors ultimately decide which period deserves the title "credit crunch".

Bernanke and Lown state in their article "The Credit Crunch" (1991) that a credit crunch exists in a situation where the *supply curve for bank loans experiences a significant leftward shift when both the safe real interest rate and the quality of potential borrowers are constant*. They also state that a macroeconomically significant credit crunch does not necessarily involve elements of credit rationing. This view was questioned by Benjamin M. Friedman (Bernanke & Lown, 1991) in his comment. He noted that the credit crunch is not just a shift in the loan supply and that market does not clear in every situation in such a way that all borrowers could obtain credit.

Owens and Schreft (1995, 2) support the view of Friedman in their definition. They say that a credit crunch is *a period of sharply increased nonprice credit rationing* which means that the available supply of credit will be rationed by some other means than pricing. In this situation, a creditworthy borrower is not able to obtain credit at any price.

Some researchers believe that credit crunches are components of the business cycles, preceding or triggering recessions. Owens and Schreft (1995,1) present the definition of Eckstein and Sinai (1986) which is that credit crunches are *periods when financial distress produces sharp discontinuities in flows and spending and when the financial strains include tight monetary policy, much lessened availability of money and credit, sharp rises of interest rates, and deteriorating balance sheets for households, businesses and financial institutions.*

Another definition is from Albert M. Wojnilower (1980), who claims that *cyclically significant retardations or reductions in credit and aggregate demand occur only when there is an interruption in the supply of credit*, referred to as the credit crunch. Interruptions can occur as a result from interest rate ceilings and other regulatory rigidities which reduce the lenders' incentives or default problems in major financial institutions or markets.

In this thesis, the definition of credit crunch is not based on business cycles, rising interest rates or regulatory rigidities. As discussed before, the credit crunch of 2007-2008 stems from the burst of the subprime bubble which cannot be regarded as a part of changes in an economic cycle. Thus, the definition of Owens and Schreft (1995) seems to be the most fitted one for this situation. A creditworthy borrower, in this case a financial institution, is not able to obtain credit at any price due to e.g. counterparty and liquidity risk.

### **3.1.2 Causes of credit crunches**

Owens and Schreft (1995) found several factors that caused credit crunches in different periods. In years, 1966, 1969 and 1980 the causes were issues related to legislation and politics such as credit controls, interest rate ceilings and tight monetary policy. In 1990-1991 they were more in



the deteriorating collateral values, economic uncertainty, higher bank capital requirements and tightening bank and thrift regulators' examination standards on real estate loans.

Overall, the conclusion of Owens and Schreft (1995) was that a political or regulatory interference with the credit allocation process causes credit crunches. In fact, crunches could be avoided if the policymakers did not interfere. However, a tight monetary policy alone is not to blame, so easing monetary policy may not be a best response to a crunch.

Another study focusing only on the credit crunch in years 1990-1991 was the article by Ben Bernanke and Cara Lown (1991). They categorize the reasons for a lending slowdown to be related to the demand side factors and supply side factors.

Bernanke and Lown (1991) identified the demand side factor to be a weakened state of borrowers' balance sheet. This is related to the recession in which prices of real estates and other assets are going down which, in turn, affects borrowers' net worth negatively. In addition, creditworthiness of the borrowers had deteriorated due to the recession which had reduced the willingness to borrow. Bernanke and Lown thought that the demand factors affected the credit crunch in 1990-1991 because the nonbank credit extensions have not grown at that time, on the contrary. If the lending slowdown was affected only by the supply factors of the bank, one would assume that the demand of alternative means of lending would increase.

According to the study the supply side factors of bank lending in 1990-1991 were availability of loanable funds, securitization of bank loans and overzealous regulation. Availability of loanable funds such as capital, deposits and managed liabilities (CDs and other instruments) are affected by the reserve requirements governed by the Federal Reserve. The Fed has reserve ratios for the funds that a depository institution must hold against specific deposit liabilities. However, Bernanke and Lown (1991) did not find that in years 1991-1990 shortage of funds in the form of reserve requirements was a major factor in credit slowdown. The need for funds did not show in the ratios of large time deposits to total bank deposits. Through the period of the research, the ratios experienced a drop.

The second supply-side factor affecting the credit crunch was securitization of bank loans. The reasoning there is that securitization of consumer credits, mortgages, and commercial and industrial loans was growing in 1990-1991. These assets did not show in the bank's balance sheet and are not considered to be bank loans. In fact, the credit slowdown could be the spurious result of increased securitization processes in banking institutions. In their calculations, Bernanke and Lown found that only securitization of mortgages had increased rapidly. Consumer credit securitizations are small compared to the total bank lending and commercial and industrial loans in fact decreased in 1990-1991.

Overzealous regulation is the third supply side factor of credit crunch according to Bernanke and Lown (1991). That refers to the examination practices that have forced banks to make high capital charges against loan losses and to have a more cautious approach to accepting new credit risk. The issue of examination standards was also raised by Owens and Schreft (1995) in their study when talking about the 1990-1991 credit crunch. Bernanke and Lown concluded that the evaluation of the capital charges was difficult to execute and thus did not find it to be an explicit reason for a lending slowdown. The main thought was that the standards were lax for years before the recession in 1990-1991 and now they were on "a fair level". A data on allowances for loan losses and charges to capital proved that neither of these experienced a discontinuous jump. Thus Bernanke and Lown saw no clear connection between overzealous regulation and lending slowdown.

Although the demand factors, especially securitization, had an effect to bank lending, the fundamental factor of lending slowdown, was a fall in the bank capital. According to Bernanke and Lown, as a result of regulatory capital standards, banks had to sell assets and reduce lending. This situation was also called the capital crunch.

### 3.2 *Funding vs. market liquidity*

To understand more about the credit crunch in 2007-2008 it is important to comprehend the concepts of market and funding liquidity. The credit crunch in 2007-2008 is a fine example of an event where market illiquidity turns into funding illiquidity.

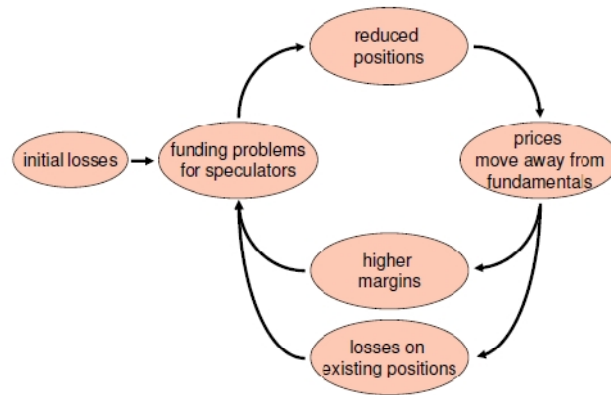
According to Brunnermeier and Pedersen (2008) market liquidity is the ease with which an asset is traded and funding liquidity is the ease with which traders can obtain funding. A trader cannot use the entire value of the security as collateral because she must pay a margin (or a haircut) which is financed with the trader's own capital. A margin is a difference between security's price and collateral.

The rationale of Brunnermeier and Pedersen (2008) is explained as follows. When traders' are having difficulties in acquiring funding, that is, the funding liquidity is tight, the traders' are not willing to invest in high-margin securities which would require a lot of capital. This reduces market liquidity and increases volatility because asset is not traded as smoothly. When the market liquidity is low, it might increase the risk of financing a trade, meaning that higher margins are demanded which worsens traders' funding constraint even more. The phenomenon described above is called *a margin spiral*. *A loss spiral* is formed when speculators have a large initial capital position that is negatively correlated with the customer's demand shock. That increases market illiquidity and induce higher speculator losses on their positions. Speculators are finally forced to sell more of their assets which cause a further drop on the price of an asset.

In short, funding problems of investors force the leveraged investors to reduce their positions, which causes more losses and higher margins, which in turn worsens the funding problems and so on. These reinforcing liquidity spirals are presented in Figure 5.

The reason for this short presentation of these mechanisms of spirals is that it is useful to know that even a small shock in the traders' funding can cause a severe crisis with liquidity drying up.

**Figure 5: Liquidity spirals**



Source: Brunnermeier & Pedersen (2008)

### **3.3 The interbank liquidity models**

A credit crunch can refer to a lending slowdown from banks to individuals, to firms or to other banks. In this section and in this study, the focus is on the latter case, the interbank market. The interbank markets are usually considered liquid and well functioning. Through interbank markets the reallocation of liquidity from the banks with surpluses to banks with deficits is made possible. In addition, the central bank implements its monetary policy by open market operations targeted to the interbank markets.

Starting in August 2007, the malfunctioning of the interbank markets started to occur. The market operators, including the Federal Reserve, were confused about the failure of this usually efficient market place. According to Allen, Carletti and Gale (2008,1), a lack of theoretical framework made central banks unsure about how to react to a credit crunch. However, there are some studies that have been made about the inefficiencies in the interbank market. In this section a few models concerning the causes for problems in the interbank liquidity and the effects of monetary policy are presented.

### **3.3.1 Liquidity freezes**

Allen, Carletti and Gale (2008, 1) conclude in their article that banks' liquidity needs face two uncertainties, idiosyncratic and aggregate. Idiosyncratic uncertainty is present when at a given level of aggregate demand for liquidity it is uncertain which banks will face the demand. Aggregate uncertainty in turn is formed because the aggregate demand for liquidity for banks is stochastic. The problem is that the banks suffer from the lack of hedging opportunities against these uncertainties and they are constrained by deposit contracts which had to be paid regardless of liquidity need in the banking system or within the bank. Banks need to achieve this constrained efficient allocation of funds which might be challenging.

Acharya, Gromb and Yorulmazer (2008, 3-4) have another approach to their study. In their article they suggest that the liquidity transfers to the deficit banks are not efficient due to the market power possessed by the surplus banks. The banks with liquidity surplus are able to charge higher interest rates to the banks in need of liquidity. In addition, the deficit banks are tempted to sell their assets due to the lack of monitoring their reducing claims on assets. Thus, according to this study, there exists a moral hazard problem in the interbank market. The bank with market power benefits from the strategic gains which occur when it buys assets from the deficit bank at fire sale prices, that is, at extremely discounted prices.

### **3.3.2 Monetary policy in liquidity provision**

A great part of the research in the interbank markets also focuses on the role of the central bank. If the interbank market freezes, what are the optimal procedures of the central bank? Or should the central bank intervene at all and let the market do the work for it?

The model of Acharya et al. (2008, 28) is in favor of an active monetary policy. It suggests that the central bank has a major role in providing liquidity to the deficit banks at lower rates and eliminating the market power of the surplus banks and, consequently, improving the efficiency in the interbank market.

The model of Allen et al. (2008) suggests that through open market operations of the central bank, it is made possible for banks to achieve the constrained efficient allocation. However, sometimes the “freezes” of the interbank market are consistent with constrained efficiency. That is the case when the aggregate demand is low and banks have enough liquidity to cope with idiosyncratic uncertainty. In this state of constrained efficiency the central bank intervention is not needed.

Holmström and Tirole conclude in their article “Private and Public Supply of Liquidity” (1998) that in the presence of aggregate uncertainty the private supply of liquidity is not sufficient and the government can improve welfare by issuing Treasury bonds to firms. In the case of liquidity shock, the firms need these liquid securities because they can obtain funding through the sales of the asset. Thus, the public provision of liquid assets can prevent the spillover of crisis from financial market to the real economy when the firms are able to continue with their operations since they have sufficient funding and do not go bankrupt. In addition, Homström and Tirole (1998) argue that a government should have an active liquidity management procedure so that liquidity should be loosened when the aggregate liquidity shock is high and tightened when it is low.

The previous research thus mostly agrees that there exists rationale for the central bank intervention to the interbank markets. Monetary policy can relieve liquidity pressures of the deficit bank by offering an alternative source of liquidity. However, there remain differences in models of the interbank market and the reasons behind the interbank market freezes.

## **4 ISSUES IN THE INTERBANK MONEY MARKET**

In the previous sections, the focus has been on the overview of the credit crunch and the theory of interbank market functioning. This section characterizes the problems in the interbank market in depth, specifically in the money market. The main issue is to find out which money markets were affected by the crisis and to identify reasons behind the possible freezes. Also the perspective of the main interbank market operators is presented by describing the motives of their behaviour and consequences of market freezes.

### **4.1 *Bank funding markets***

In this section, the main issues of bank funding in the money market are addressed. The focus is on the commercial paper, fed funds, interbank and the repo market since these are the major markets where financial institutions acquire their funding but also features in other markets are presented.

#### **4.1.1 Interbank market**

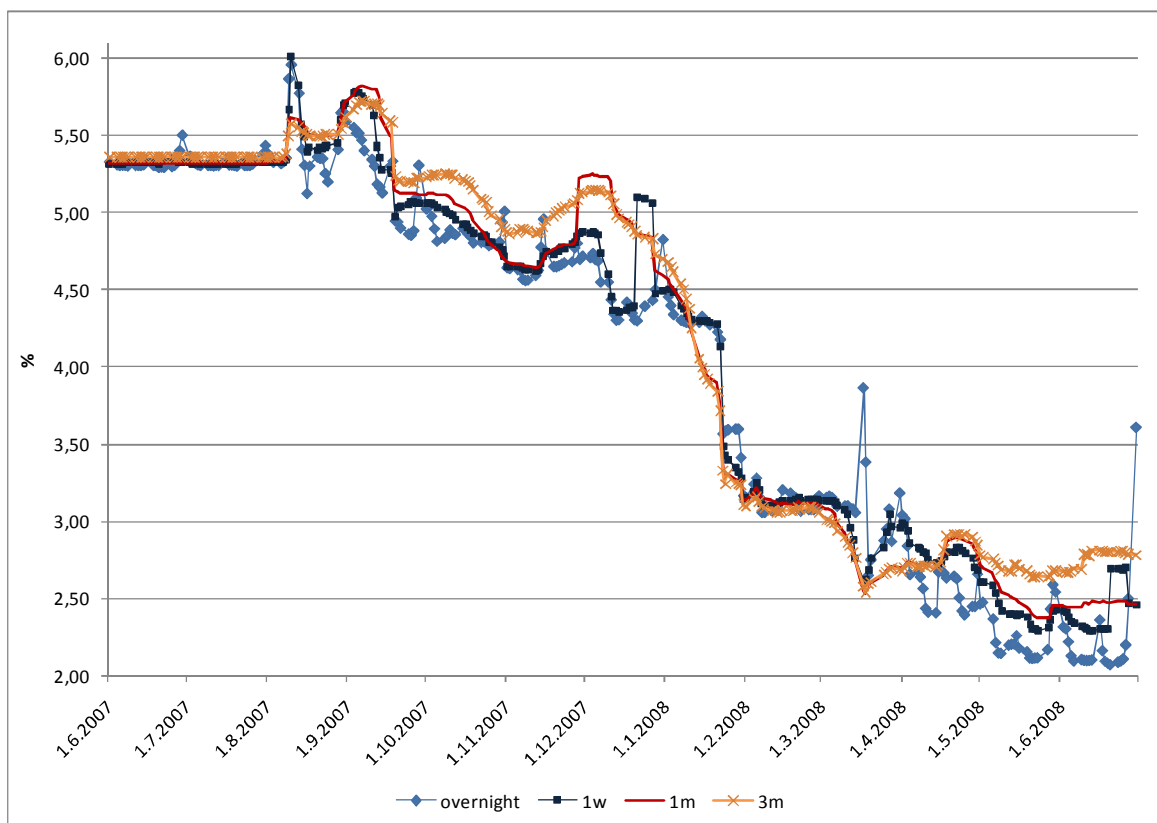
Interbank market forms an important means of funding for banking institutions as well as a measure for a liquidity crisis in the market. The reason for this is that banks generally charge higher rates for unsecured loans in unsteady times so the crisis should show in rising interest rates. Interbank market refers to a market where banks borrow and lend unsecured and typically short-term funds. The interest rate is usually agreed upon between the parties of a loan but the reference rate for the market is LIBOR (London Interbank Offered Rate) that is specific for every currency in which the loan is denominated (BBA 2009). This reference rate is published by British Bankers' Association (BBA) with a reference panel of at least eight contributor banks<sup>3</sup>. LIBOR can be regarded as similar to the Federal Funds rate since it is also targeted to banks and the funding is unsecured. Federal Funds are looked more closely in section 4.1.5.

---

<sup>3</sup> BBA LIBOR Contributor Banks are presented for each panel in BBA's website <http://www.bba.org.uk/bba/jsp/polopoly.jsp?d=226>

As shown before in section 2.4, LIBOR-rate experienced changes due to the uncertain climate in the market. Figure 6 presents the LIBOR rates in different maturities from overnight to three months for loans denominated in US dollars. There were a few major peaks in this time period but overall, the level of LIBOR rates has been falling. As well as for the other money market products, the volatility of the rates began in August 2007. The major peaks after that occurred in the mid-September 2007, beginning of December 2007, in the turn of the year and 17<sup>th</sup> of March 2008 and 30<sup>th</sup> of June for overnight rate. Consequently, major fall in LIBOR rates was in 23<sup>rd</sup> of January 2008. With chronologies describing the events of the crisis (e.g. Gorton 2008, Cecchetti 2008), it is possible to identify the reasons behind the peaks and the falls.

**Figure 6: USD LIBOR rates, 6/2007-6/2008, %**



Source: British Bankers' Association

The reasons for these peaks are in the increased uncertainty surrounding that time. September was an uneasy month in total due to the unveiling subprime exposures. The peak in December, in



turn, resulted from the hoarding of liquidity before the year-end and the compilation of financial reports. The high demand for excess liquidity might also be a reason for the high overnight LIBOR rate at the end of June 2008 when interim reports were closing up. The total jump then was 111 basis points. In addition, at the same day investment management company Legg Mason announced capital contributions of \$240 million to its money market funds against losses of SIVs (Gorton 2008, 81). That might have added to the high rate at that time.

The peak in overnight LIBOR on 17<sup>th</sup> of March 2008 was due to the increased uncertainty when the renowned investment bank Bear Stearns was saved by JP Morgan and the government. The reasons behind these events are discussed later in this section 4.

A fall in the LIBOR rates in all maturities occurred in 22<sup>nd</sup>-23<sup>rd</sup> of January. This can be explained by the announcement of the Federal Reserve to reduce Federal Funds target rate by 75 basis point at an unscheduled meeting of Federal Open Market Committee (Cecchetti 2008, 11). This was quite a significant drop since other cuts were either 25 or 50 basis points in size. As LIBOR and Federal Funds are closely connected this monetary policy act had also an effect on the LIBOR panel.

The volatility was high during the period under examination from summer 2007 to summer 2008 as can be seen in Table 1 in which the standard deviations of rate changes for different maturities are shown. The highest volatility was in USD LIBOR rates for overnight and one week maturities. The least volatile rate was usually for one month maturity, except for the last two quarters of 2007.

**Table 1: Standard deviations for changes in USD LIBOR rates for different maturities, basis points, 6/2006-6/2008**

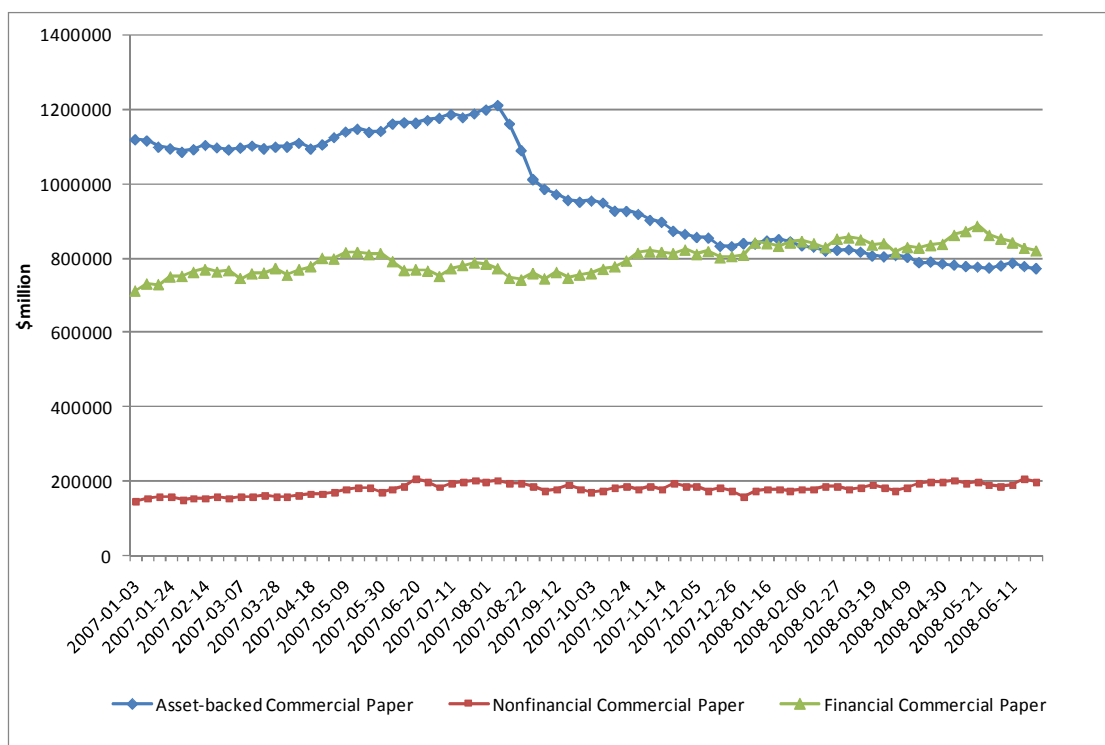
	<b>Overnight</b>	<b>1 week</b>	<b>1 month</b>	<b>3 month</b>
<b>6/2006-12/2006</b>	2,60	1,46	0,90	1,15
<b>1/2007-6/2007</b>	2,66	0,49	0,02	0,26
<b>7/2007-12/2007</b>	11,04	10,64	6,07	3,97
<b>1/2008-6/2008</b>	18,49	8,09	5,14	5,32

One can conclude that the monetary policy actions made at that time did in fact have an effect on LIBOR rates since they were falling throughout the period of June 2007-June 2008. However, the volatility of LIBOR rates for all maturities was still high during the crisis period even though the rates were decreasing. Without the actions of the Fed and other major central banks, the average LIBOR rates would have probably remained at a high level with high volatility.

#### 4.1.2 Commercial paper market

The commercial paper market is a major source of bank and firm funding. It is a relatively cheap form of funding for firms that consists of a secured and an unsecured market. The instruments in the secured market are called asset-backed commercial papers (ABCPs). They are usually backed by a pool of mortgages or other loans as collateral.

**Figure 7: Asset-backed, financial and nonfinancial commercial papers in the U.S., outstanding amount, \$ million, 6/2007-6/2008**



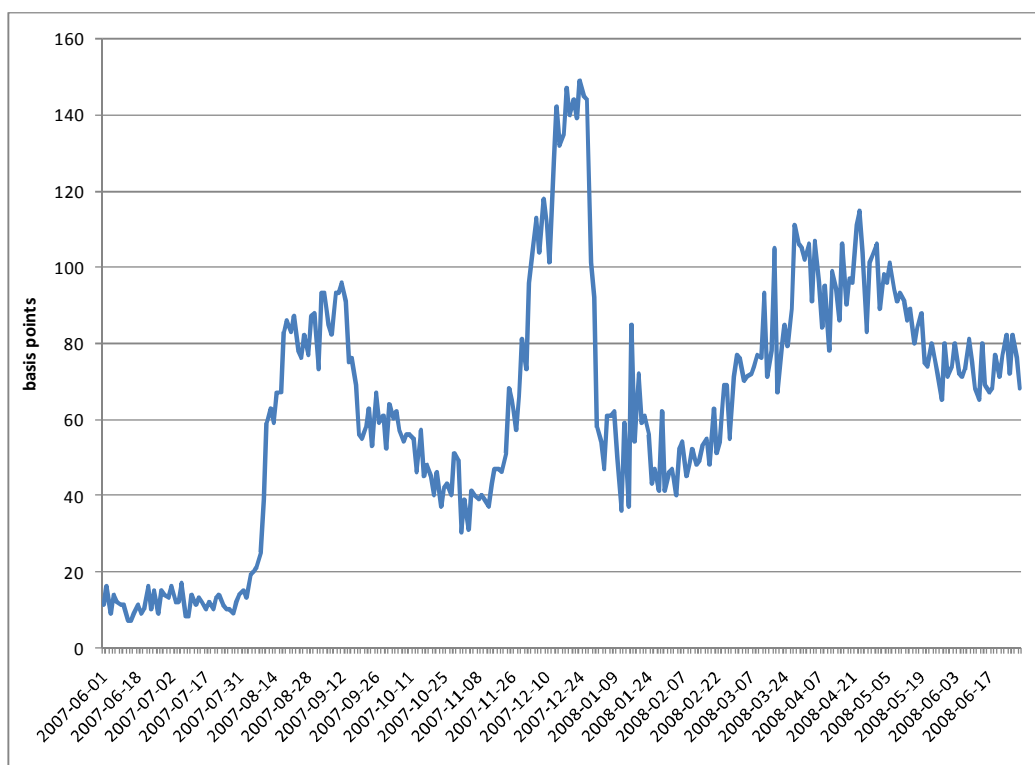
Source: Federal Reserve Statistical Release

According to Calomiris (2008), the increased risk of loss in the money market products occurs rather through quantity than price. This fact and the effects of subprime crisis in the commercial paper market can be seen in the graph above (Figure 7). The change in the loan supply occurred mostly in the secured market, more accurately in asset-backed commercial papers. The outstanding amount of ABCPs declined about 200 billion U.S. dollars in one month after 9<sup>th</sup> of August 2007. The reason for this decline lies in the collateral assets used these in papers. In case of a default the lender has a right to seize and sell the underlying asset. However, as the house prices were falling dramatically, the value of collateral assets was not attractive to lenders. In addition, the subprime connections of the issuers were uncertain which raised suspicions of defaults among the lenders. As the value the underlying assets began to fall and the banks experienced a scramble of cash, they started to deleverage their positions which decreased the price of these structured products even further.

The amount of financial commercial papers had a small growing trend towards the end of 2008 whereas the outstanding amount of nonfinancial commercial papers was virtually unaffected. Thus, the non-asset-backed commercial papers, the unsecured market, did not experience huge changes.

Figure 8 illustrates the discount spread of nonfinancial commercial paper in basis points from June 2007 to June 2008. More accurately, the discount spread is A2/P2 nonfinancial commercial paper rate minus AA nonfinancial commercial paper. It indicates the concern for the default of the A2/P2 paper which is a commercial paper released by a lower-rated company or financial institution. As seen in the figure, the spread of the second-tier paper has been fairly stable until August 2007 when stress of the subprime exposures in the financial market started to occur. Another great jump in the discount spread was in December and a corresponding crash in the last banking days of the year and the first days of year 2008. Both of these peaks were mostly due to the rising rates in A2/P2 commercial paper rates rather than declining rates for AA papers. The jump in December can be a result from banks hoarding high-grade securities and moving away from second-tier papers as the the financial year 2007 was closing to an end and balance sheets became under scrutiny.

**Figure 8: Discount rate spread\*, basis points, 6/2007-6/2008**



\*spread between A2/P2 and AA nonfinancial commercial paper in the U.S.  
Source: Federal Reserve Statistical Release

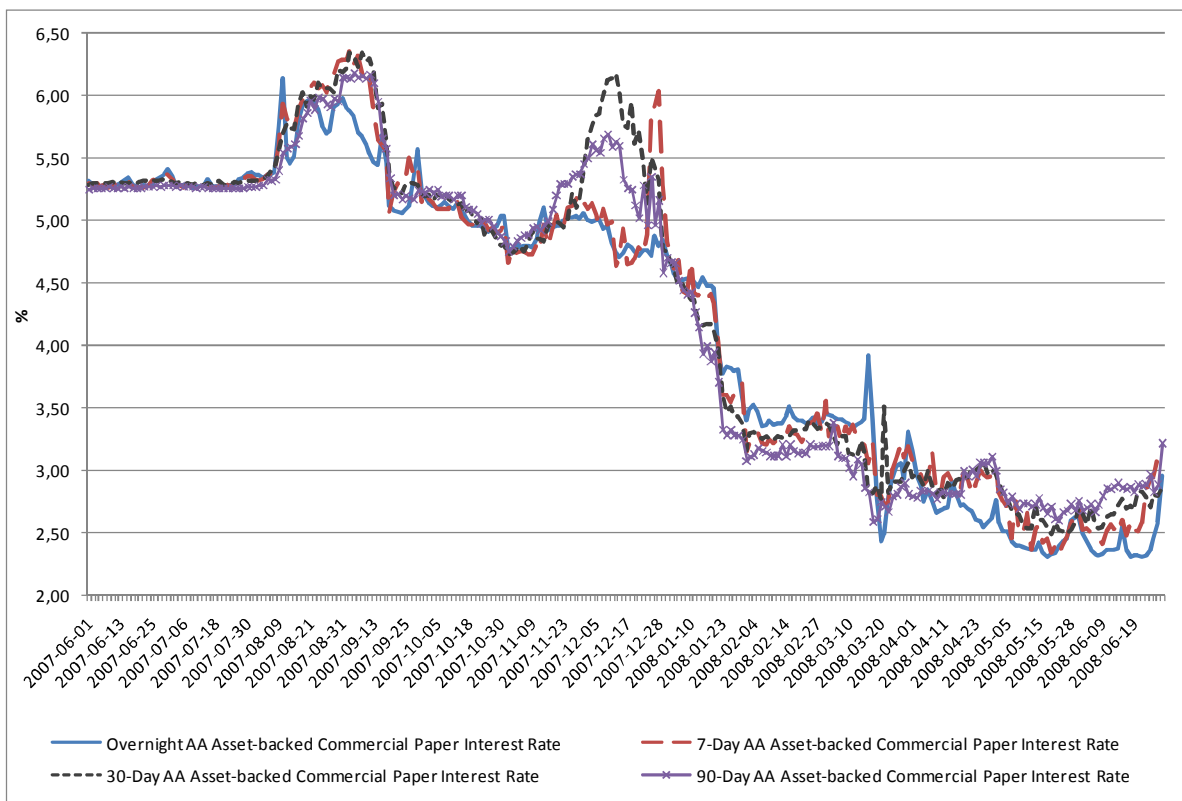
As mentioned before, the banks had created off-balance-sheet items called SIVs which invested in long-term assets and funded them by borrowing in short-term papers. With these operations of maturity mismatching, the banks were exposed to a funding liquidity risk. This risk can present itself as a margin funding risk, rollover risk or redemption risk (Brunnermeier 2008). The margin funding risk and rollover risk became a reality when the ABCP market did freeze. A margin is the difference between the security's price and collateral and a trader must finance it by using its own capital. Inability to rollover debt corresponds to a margin increase of 100 %. The capital for paying the increasing margin or haircut is usually acquired by selling a part of trader's assets, even in firesale prices.

The SIVs of banks protected themselves from funding liquidity risk by having a credit line, a liquidity backstop, in the sponsoring bank. Also the Federal Reserve provided some liquidity backstops when trying to counter the crisis in the ABCP market. However, not all sponsoring

banks could shoulder the credit lines for all of their conduits so the liquidity backstops did not provide help for all financial institutions.

Were there differences in the ABCPs rate changes for different maturities? A graph below (Figure 9) presents the changes in AA asset-backed commercial papers with maturities from overnight to three months. There seems to be no significant changes in the behaviour in different maturities. When calculating the standard deviation of the interest rate changes in these securities, 7- and 15-day AA Asset-backed commercial papers had the highest deviations from the mean in the last two quarters of 2007 and the first two quarters in 2008 (Table 2). The least volatile rate was the 90-day paper. The high volatility during the examination period in AA asset-backed commercial papers in general shows in Table 2 as standard deviations for interest rate changes for AA Asset-backed commercial papers rose. Even though the differences were not great, the papers differed more in their rates than before the crisis.

**Figure 9: AA Asset-backed Commercial Paper Paper Rates for different maturities in the U.S., 6/2007-6/2008, %**



Source: Federal Reserve Statistical Release

**Table 2: Standard deviations for rate changes of AA Asset-backed commercial papers for different maturities in the U.S., basis points, 6/2006-6/2008**

	<b>Overnight</b>	<b>7-day</b>	<b>15-day</b>	<b>30-day</b>	<b>60-day</b>	<b>90-day</b>
<b>6/2006-12/2006</b>	3,12	1,88	1,45	1,32	1,33	1,24
<b>1/2007-6/2007</b>	2,80	1,53	1,02	0,88	0,73	0,72
<b>7/2007-12/2007</b>	2,08	3,07	3,74	2,15	2,32	2,03
<b>1/2008-6/2008</b>	4,39	4,48	2,90	2,73	2,89	2,88

Source: Federal Reserve Statistical Release

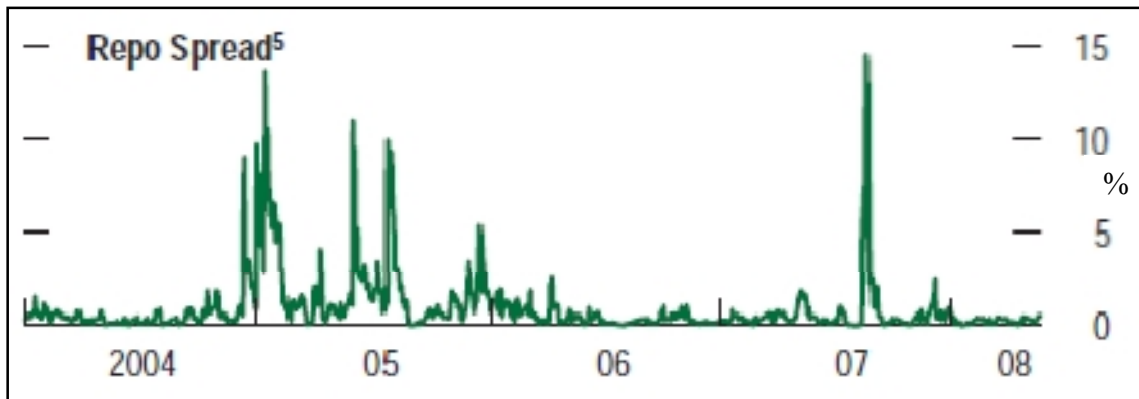
### 4.1.3 Repo market

Collateralized money market, the repo market, is a major component of bank financing and it experienced somewhat unusual freeze in 2007-2008. In this market, banks make repurchase agreements where a bank borrows funds by selling a collateral today with a promise to repurchase it at a later day, however in a less than a year's time. Especially the amount of overnight repo contracts for investment banks has increased during the past few years. According to Brunnermeier (2008) the fraction of total investment bank assets that were financed by overnight repos has roughly doubled from 2000 to 2007. This reliance on overnight financing required created a need for investment banks to roll over a great portion of their funding on a daily basis. Because the repo loans are secured, the counterparty risk should not be a problem. Still the dry-up of the market started occur in 2007 and lasted for several months (Gorton 2008).

A freeze in the repo market can be observed by looking at the spread between 3-month U.S. agency repo rate and U.S. treasury repo rate (Figure 10). In U.S. agency repo agreement, the general collateral repo, the lender is willing to accept a variety of Treasury and other related securities as collateral while in U.S. treasury repo rate, the special (or specific) collateral repo, the lender accepts only Treasury securities. The spread is above zero meaning that the general collateral rate is a bit higher than the specific collateral rate. So when in 2007-2008 there was a high spike in the repo spread, it indicates that the demand for the "specific collateral", the Treasury securities, was high. In effect, the reluctance to accept anything other than the liquid

and safe Treasury securities as collateral resulted to a peak in the repo spread. In the U.S., also the three-month general collateral repo rate, the low-risk repo rate, experienced more volatility than the repo spreads in Euro area and UK as can be observed in Figure 11.

**Figure 10: U.S. 3-month Repo spread\*, 2004-2008, %**



\*repo spread is defined as the U.S. agency repo rate minus the U.S. treasury repo rate

Source: GSFR Report, October 2008

**Figure 11: General Collateral Repo, Libor and OIS\* rates in the US, in the Euro area and in the UK, 3-month maturity, %**



\*General collateral repo = repo where the collateral consists of a basket of non-specific government securities

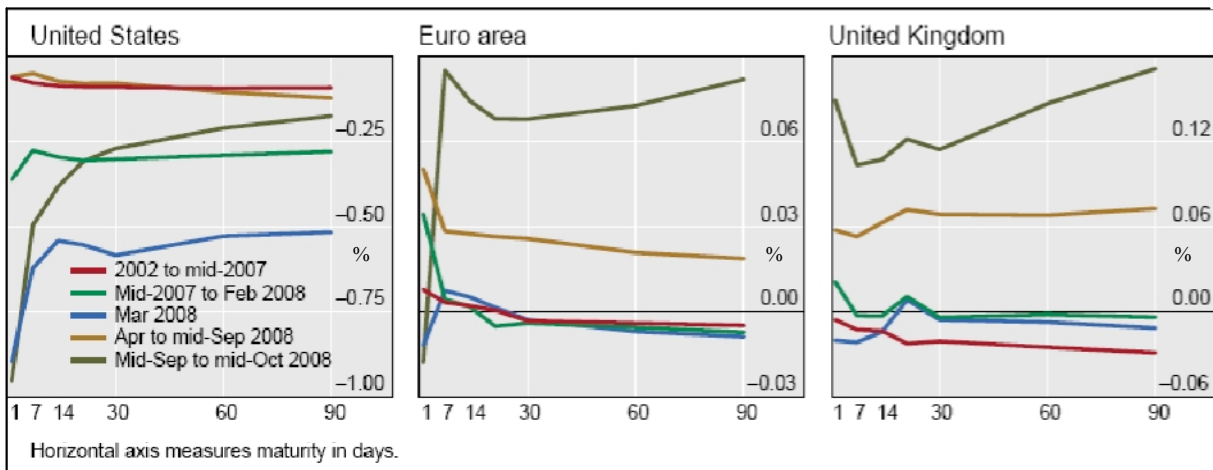
Libor = a reference rate for unsecured interbank lending, in USD, euro and pounds

OIS (overnight index swap rate) = a contract where a fixed short-term interest rate is exchanged for the average overnight interest rate during the maturity of the swap.

Source: Hørdahl & King (2008)

The volatility of repo rates increased and obtaining funds for maturities longer than a month was difficult. The margin requirements rose and the demand for the safe government securities increased. In March, the average US GC repo-OIS curve shifted downwards by 25–30 basis points and even more at the shortest maturity (Figure 12).

**Figure 12: Average general collateral repo-OIS spreads\*, in the US, in the Euro area and in the UK, %**



\*average general collateral repo-OIS spread is a spread between the repo rate where the collateral consists of a basket of non-specific government securities and the overnight index swap rate where a fixed short-term interest rate is exchanged for the average overnight interest rate during the maturity of the swap.

Source: Hördahl & King (2008)

Thus, the reason for the freeze in the repo market was mostly the market risk but also the counterparty risk. The counterparty risk represented itself through the repo failures. That means that the borrowed collateral is not returned when its collateral value was close to zero. According to Mackenzie (2008), the dealers who had borrowed the security needed it as collateral for their clients.

The market risk was associated with the risk of trading the security itself. According to Gorton (2008), the dealer banks suspected that if they would have to obtain the collateral, the market where to sell collateral would not be there due to the absence of prices. Consequently, if the market value of the asset used as collateral could not be determined or the asset would not be saleable, the repo contract is not beneficial to the lender. The question here is why did not the dealer banks accept other assets than the subprime related as collateral? The reason for this is



simply that there existed uncertainty in the ratings of all structured products, so the response was to reject them all from repo agreements.

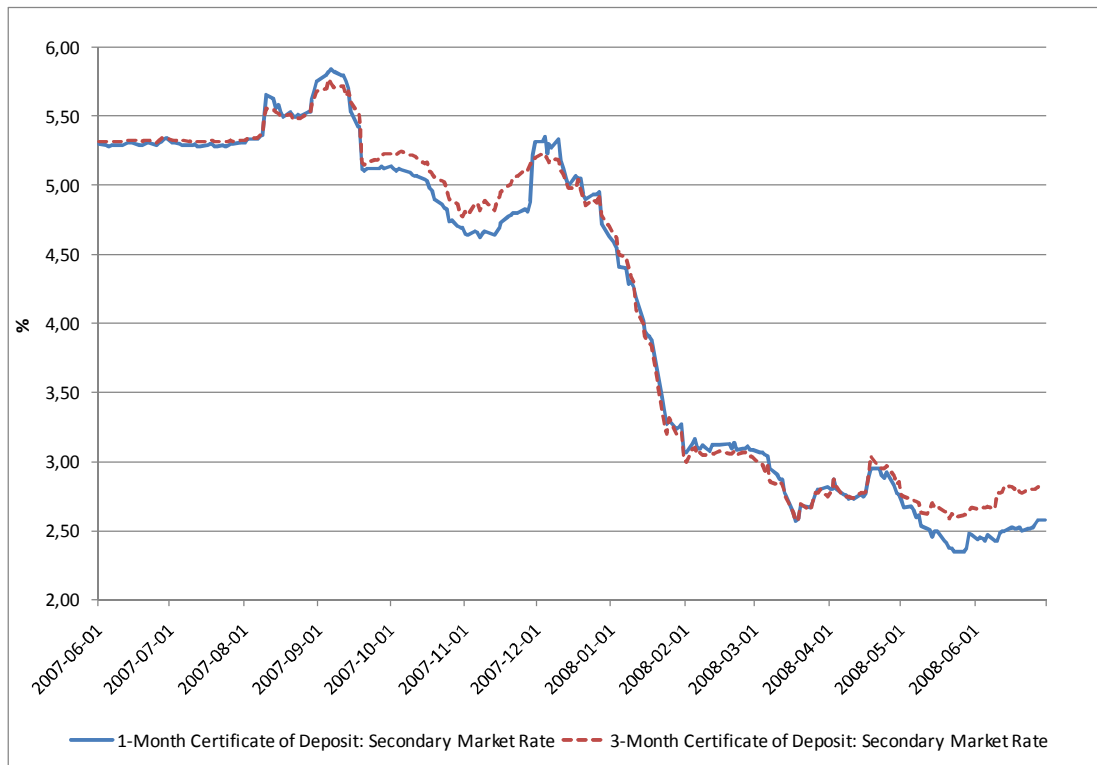
Hördahl and King (2008) suggest that a key factor explaining the disruptions in the US repo market was the dominance of the investment banks. Due to the previous situation where there existed an active repo market for structured securities, the investment banks with large portfolios of structured securities had financed almost a half of their total assets in the repo market. However, in March 2008, the uncertainty in the valuation of riskier products resulted to a total rejection of other than government or agency securities as collateral. Thus, investment banks had huge difficulties in funding since their pool of collateral was no longer accepted as collateral in the repo market. As a result, Bear Stearns was acquired by JP Morgan Chase provided with a loan received from the Federal Reserve.

The main issue in the repo market was the absence of prices for the subprime related structured products. This fear of losing a market for the collateral if seized spread to the other structured product classes causing a freeze and a huge increase for the demand of government securities referred to as “flight to quality” by Allen (2008b). The Federal Reserve introduced new facilities to help the stressed repo market, such as TSLF (Term Securities Lending Facility), and conducted a series of single-tranche repurchase agreements where a wider range of collateral was accepted. These operations are discussed in section 5 of this thesis.

#### **4.1.4 Certificates of deposit market**

A lot of the discussion during the crisis has been focused on the commercial paper and repo markets. However, banks use also certificates of deposits (CDs) as a form of funding. They are securities issued by a bank that document a deposit, the interest rate and the maturity date. It is a term security which can be sold and bought at any time until maturity which usually is from one to four months. The denomination of a CD is generally over \$ 1 million. The certificate of deposits are considered fairly low-risk instruments and they usually move at the same pace with other low-risk money market products, such as Treasury bills. (Mishkin & Eakins 2009, 224)

**Figure 13: 1-month and 3-month Certificates of Deposit Rates, 6/2007-6/2008, secondary market rate, %**



Source: FRED® (Federal Reserve Economic Data)

Secondary market rates of CDs tell that a subprime crisis hit that funding market also. According to Figure 13, there were two peaks, one in August 2007 and one in the beginning of December 2007. After that, the rates of certificates of deposit experienced a drop of 220 basis points in two months reaching a rate of 3 % in February 2008. One can conclude that the certificate of deposit market has followed the declining rate trend but there have been fewer and less dramatic peaks and falls in the interest rates.

#### 4.1.5 Federal Funds market

Federal funds are funds that are loaned or borrowed between financial institutions. The Fed has minimum requirements for banks to keep a certain fraction of their deposits in the Fed. On a daily basis, the banks have either excess or deficit reserves. Depending on that, they would like to lend

or borrow funds to correspondent banks. No interest on the required or excess balances was paid until 1<sup>st</sup> of October 2008. The investments are usually overnight investments. (Federal Reserve Bank of New York 2007a)

The federal funds have same features as the interbank market. The operations in both markets involve intermediating unsecured short-term funds between banks. Federal funds rate has an impact for other money market interest rates and it is thus the most important monetary policy tool for the Federal Reserve.

By setting a *federal funds target rate*, the Federal Open Market Committee (FOMC) signals changes in the monetary policy of the Federal Reserve. Federal funds target rate is set by FOMC in its regular or unscheduled meetings. The *effective federal funds rate* is determined as the weighted average of rates on trades through New York brokers. The rate is therefore actually set by the market participants with their agreements with each other. However, the Federal Reserve affects the effective federal funds rate through the supply of the reserve balances in the banking system. It has three monetary policy tools for that purpose: open market operations, discount policy and reserve requirements. (Mishkin & Eakins 2009, 170-222)

Open market operations (OMOs) are conducted by repurchase agreements (both regular and reverse) and buying and selling of U.S. Treasury and Federal Agency securities. These transactions concerning U.S. Treasury instruments are made through the Fed's SOMA<sup>4</sup> portfolio (Federal Reserve Bank of New York 2007b). The bottom line is that an open market purchase decreases the effective federal funds rate and a sale causes it to rise.

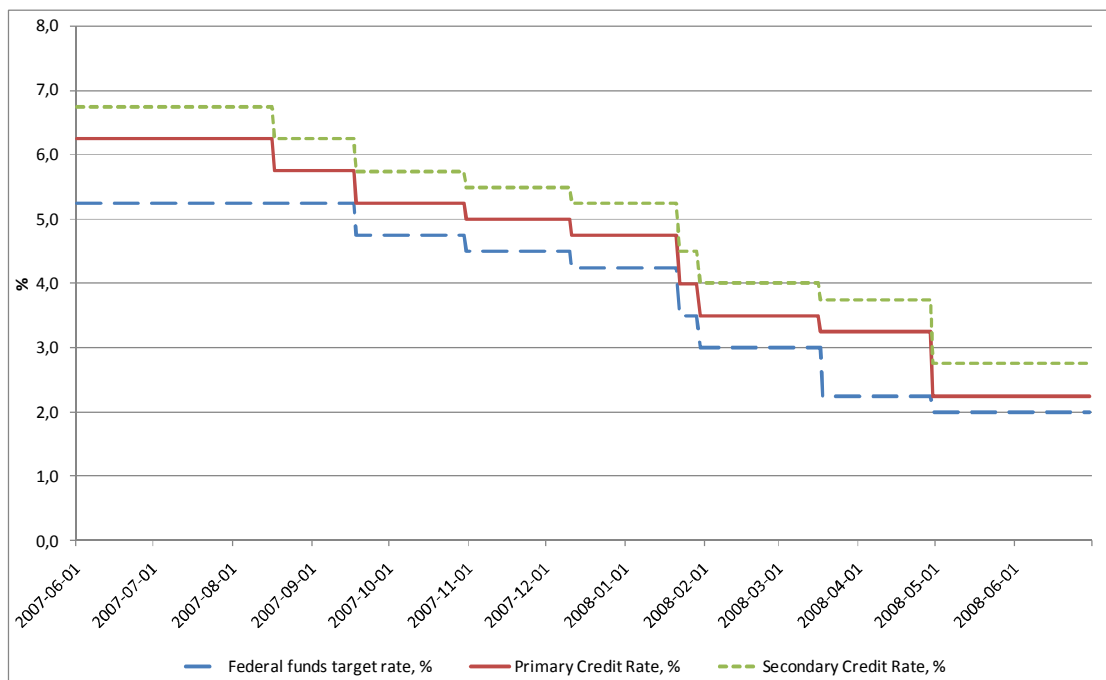
Discount policy refers to the lending of the Federal Reserve to banks with a discount rate. This facility is called the discount window and there are three types of discount loans, primary credit secondary credit and seasonal credit. The features of these credit programs are described in section 4.1.7. Changes in the discount rate rarely have an effect for the effective federal funds rate because the discount rate is usually higher than the target for the federal funds rate (Mishkin

---

<sup>4</sup> System Open Market Account (SOMA) holds the investments of the open market transactions. It consists of domestic portfolio (U.S. Treasury securities) and foreign portfolio (investments dominated in euros and yen). (More information: Reserve Bank of New York, 2/25/2009)

& Eakins 2009, 173-176). As the Figure 14 shows, this is the case throughout the examination period of June 2007-June 2008.

**Figure 14: Federal Funds Target Rate, Primary Credit Rate, Secondary Credit Rate, 6/2007-6/2008, %**



Source: Federal Reserve Discount Window & Payment System Risk Website 2008a, Federal Reserve Statistical Release

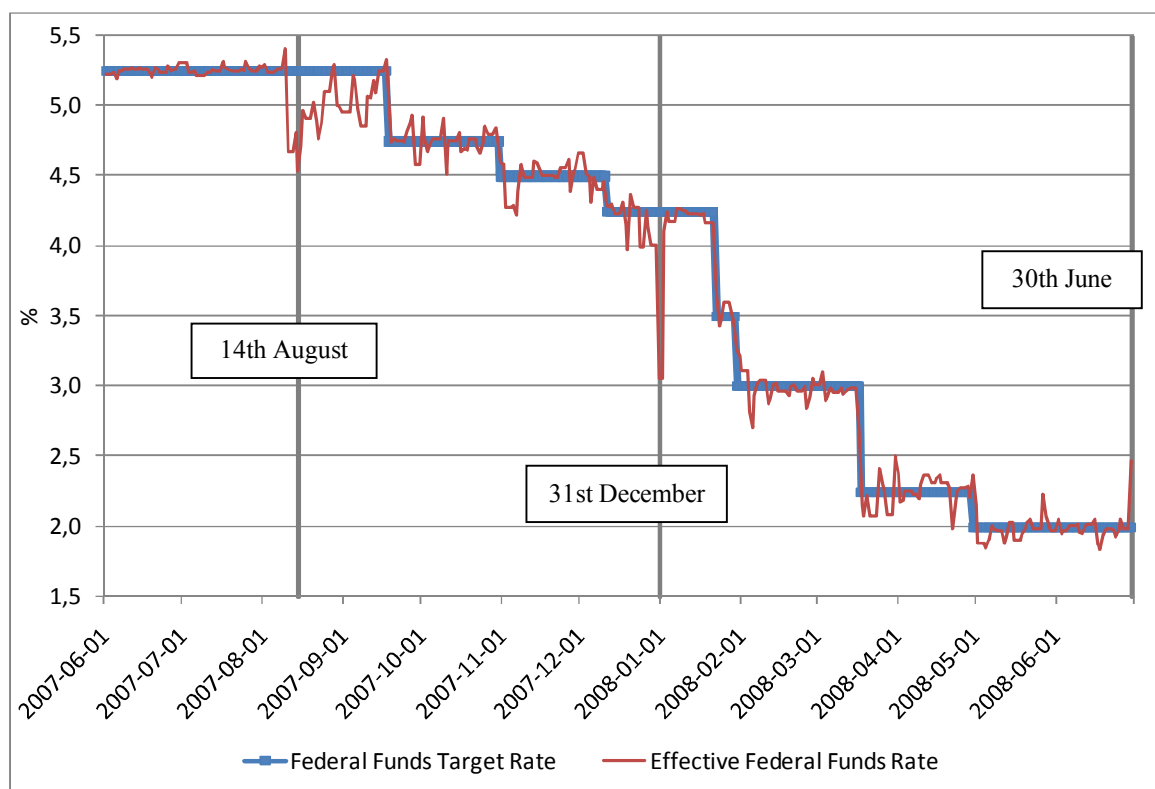
Reserve requirements, as mentioned before, are a fraction of checkable deposits of the banking institution which must be kept with the Fed. The effect of reserve requirements for the federal funds rate is that when a reserve requirement ratio increases, the federal funds rate rises and vice versa. (Mishkin & Eakins 2009, 173-176)

One can conclude that the monetary policy tools of the Federal Reserve that had an effect on the effective federal funds rate between June 2007 and June 2008 were the actions concerning the federal funds target rate, open market operations and reserve requirements.

In Figure 15, the developments in the federal funds market are presented. Table 3 describes the decisions of FOMC concerning the federal funds target rate. From June 2007 to June 2008 the total decrease of the target rate was 325 basis points to 2 % which is much lower than the

investors expected before the crisis. The declining trend is a result from the monetary policy actions of the Fed when it attempted to alleviate the credit crunch by lowering short-term interest rates and therefore providing funding to financial institutions.

**Figure 15: Federal Funds Rates, 6/2007-6/2008, %**



Source: FRED® (Federal Reserve Economic Data)

**Table 3: Changes in Federal Funds target rate, 6/2007-6/2008**

Date	A cut at FOMC meeting
18 <sup>th</sup> of August 2007	-50 basis points
31 <sup>st</sup> of October 2007	-25 basis points
11 <sup>th</sup> of December 2007	-25 basis points
21 <sup>st</sup> of January 2008 (unscheduled meeting)	-75 basis points
30 <sup>th</sup> of January 2008	-50 basis points
18 <sup>th</sup> of March 2008	-75 basis points
30 <sup>th</sup> of April 2008	-25 basis points

Source: Cecchetti (2008)

The effective federal funds rate was very volatile during the period as the third column of Table 4 describes. The volatility (the standard deviation calculated from effective rate changes) was at its highest in the last two quarters in 2007 reaching a standard deviation of 14,25 basis points. The effective federal funds rate follows usually the target rate quite closely. In the first and the second quarter of 2007, before the financial market strains started to occur, the average deviation of federal funds rate from its target was only 0,35 basis points whereas in the latter half of the year it was -6,69 basis points. During the first and the second quarter of 2008 average deviation from the target rate was not as large, perhaps due to the major drops in the target rate at that time.

**Table 4: Effective federal funds rate, deviations, 6/2006-6/2008**

	<b>Average deviation from the federal funds target rate, basis points</b>	<b>Standard deviation of the effective federal funds rate changes, basis points</b>
<b>6/2006-12/2006</b>	-0,86	3,25
<b>1/2007-6/2007</b>	0,35	3,16
<b>7/2007-12/2007</b>	-6,69	14,25
<b>1/2008-6/2008</b>	-1,53	13,79

Source: FRED® (Federal Reserve Economic Data)

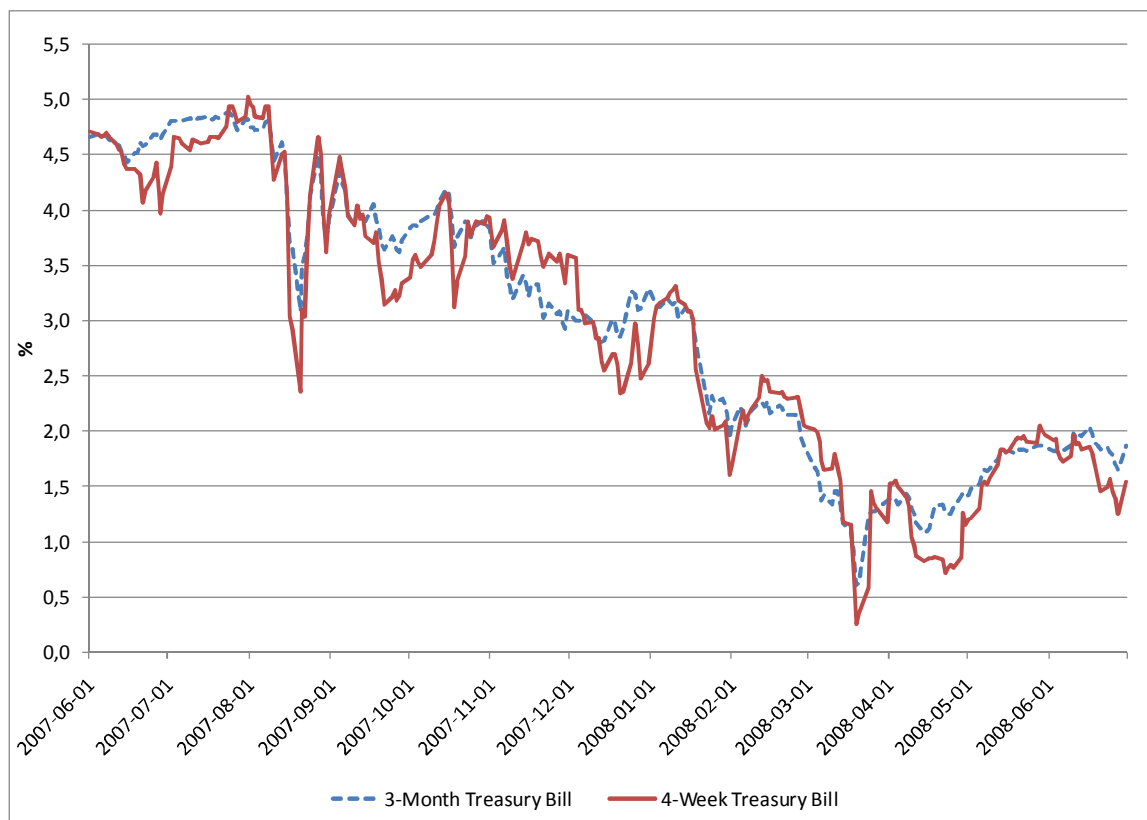
Major deviations from the target rate took place between 31<sup>st</sup> December 2007 (effective rate minus target rate was -119 basis points), 14<sup>th</sup> of August 2007 (-71 basis points) and 30<sup>th</sup> of June 2008 (+47 basis points). Why has the deviation from the target rate been negative in August and in the turn of the year? As opposed to other money market instruments, the fed funds effective rate experienced a drop at those times. That refers increased demand for fed funds at that time. For example, in the turn of the year, the banks were in strong need of liquidity. This implies that the open market operations of the Federal Reserve were not enough to respond to strong demand peaks so the deviation from the target rate was increased.

#### **4.1.6 Treasury bill market**

Treasury bills are government debt securities issued by the U.S. Department of the Treasury that have the maturity of 28, 91 and 182 days. No interest is paid on T-bills because they are issued at

a discount from par value. They are considered to be almost risk-free and the most liquid instruments of the money market since they are backed by the solvency of the government. Usually the T-bill rate is very close to inflation rate so the investors use these instruments only to storage their excess funds temporarily (Mishkin & Eakins 2009, 221). This is the case in normal times but not at times of financial stress as we can see next.

**Figure 16: Treasury Bills, 6/2007-6/2008, secondary market rates, %**



Source: FRED® (Federal Reserve Economic Data)

In Figure 16 the secondary market rates of three-month and 4-week Treasury bills are presented. The overall trend in rates was declining with some significant peaks and falls. Major drops in both of the rates took place in 16th and 20th of August 2007. In 20th of August the secondary market rate of 4-week Treasury bill fell 107 basis points in one day. The drops were a result of flight to quality as investors moved to the safe haven of government instruments. The bid-ask spreads were high in mid-August. Bid rate refers to the highest rate in which the investor is willing buy the bill and ask rate is the lowest rate in which the seller is willing to sell the

instrument. The high bid-ask spreads of T-bills demonstrates the huge demand of government instruments. In September the seasonal reduction in the supply of Treasury bills worsened the situation (Board of Governors in the Federal Reserve System 2008d).

So while all the structured instruments were rejected by investors, the government securities were a safe choice. Other banking institutions needed the funds and other who had excess liquidity would not lend showing signs of extreme risk aversion. Instead they moved to Treasury instruments because it was the safest option at that time.

#### **4.1.7 The discount window**

The discount window is one of the funding sources for depository institutions provided by the Federal Reserve. There are three different programs for discount window lending: primary credit, secondary credit and seasonal credit. Depository institutions that are qualified for primary credit have strong financial position and a large capital base. The primary credit rate is above the federal funds rate but below the secondary credit rate. Secondary credit facility is offered to institutions which are not eligible for primary credit. The loans of primary credit program are usually overnight but can be extended in to maturities of few weeks. The secondary credit loans are also short-term but can be extended for institutions with funding problems. Seasonal credit is targeted to small or medium size depository institutions that have intra-year fluctuations in their funding. (Federal Reserve Bank of New York 2007c)

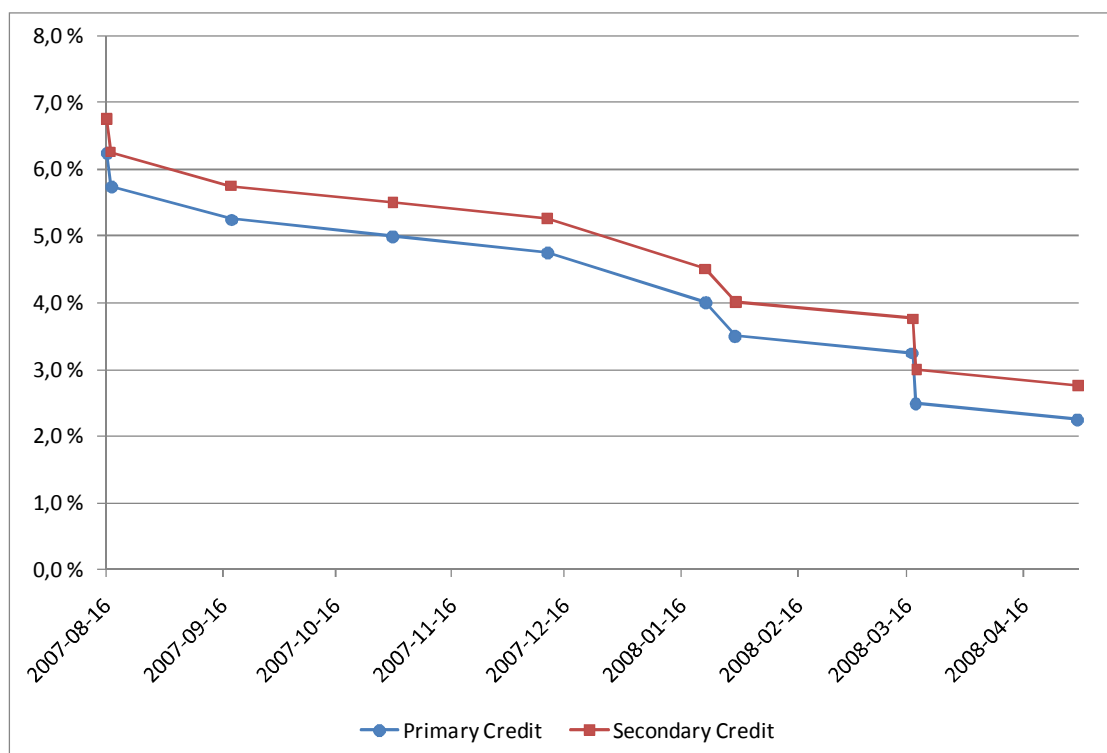
The discount window loans are fully secured. The acceptable assets include investment grade and performing assets held by depository institution such as commercial, industrial or agricultural loans, customer loans, corporate bonds and money market instruments, asset-backed securities and collateralized mortgage obligations (Federal Reserve Discount Window & Payment System Risk Website 2008b).

Primary and secondary credit rates are set by each Reserve Bank's board of directors with a review by the Board of Governors of the Federal Reserve System. The rates are the same for all reserve banks, except during the change period. Figure 17 presents the primary and secondary



credit rates established by the Federal Reserve Bank of New York. The trend has been declining since June 2007 with the largest cut in 18th of March 2008 of 75 basis points. However, this cut was not as major as markets had expected and showed, for example, that the Fed was interested also in controlling the inflation rate regardless of its fight against the credit crisis (Guha 2008).

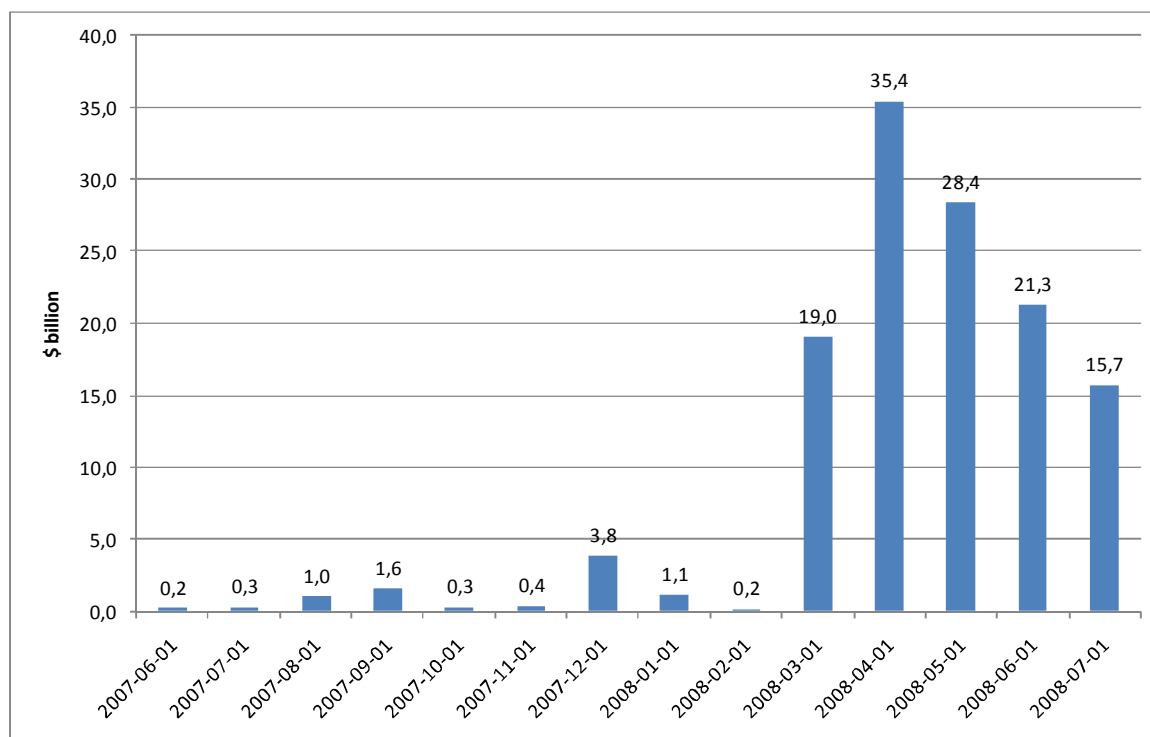
**Figure 17: Discount rates of Federal Reserve Bank of New York, %, 6/2007-6/2008**



Source: Federal Reserve Discount Window & Payment System Risk Website

For a long time, using the discount window has had a stigma of reputational risk. Depository institutions were reluctant of using the facility in fear that the public would assume that the institution was suffering from liquidity problems. From the beginning of the crisis, the officials tried to remove the stigma and convince the depository institutions to exploit the facility. To increase the attractiveness of discount loans, it changed the lending conditions of the discount window facility by prolonging the term lending to 30 days in August 2007 and 90 days in March 2008 (Board of Governors in the Federal Reserve System 2008b, 2008c).

**Figure 18: Discount window borrowings of depository institutions and primary dealers\*, 6/2007-7/2008, \$ billion**



Source: FRED® (Federal Reserve Economic Data)  
 \*primary dealer lending included since March 2008

However, no huge changes in discount borrowing occurred in 2007 but the massive growth in the spring 2008 can be observed in Figure 18. The total borrowings here include primary, secondary and seasonal credit, primary dealer credit facility and other credit extensions except for the term auction facility (TAF). In March 2008, the total borrowing of depository institutions reached 19 billion U.S. dollars. The amount was over twelve times the figure from the previous month. This was due to introduction of Primary Dealer Credit Facility (PDCF) in 17<sup>th</sup> of March, which provides overnight discount loans to primary dealers against a broad range of investment-grade securities (Board of Governors in the Federal Reserve System 2008c). Thus, the discount loans for primary credit rate were also available for participants in the securitization markets, investment banks. These liquidity troubled institutions took advantage of the offer and the discount lending increased. The PDCF and other unconventional lending facilities of the Federal Reserve during the crisis are discussed more closely in the last section of the thesis.

#### **4.1.8 Issues in money market securities summarized**

After this analysis of different money markets of bank funding separately, it is useful to summarize what has been written above. There are four major aspects to discover when examining the money market developments in June 2007- June 2008. To grasp these concepts, the Figures 19 and 20 show the developments in some money market rates.

Firstly, the trend for all the money market rates was declining partly due to the monetary policy actions of the Federal Reserve. The one-month Treasury bill rate was close to zero in March 2008.

Secondly, the strains in the money market were at its worst in four periods between June 2007 and June 2008: mid-August 2007, December 2007, mid-March 2008 and end of June 2008 which are observed in Figures 19 and 20.

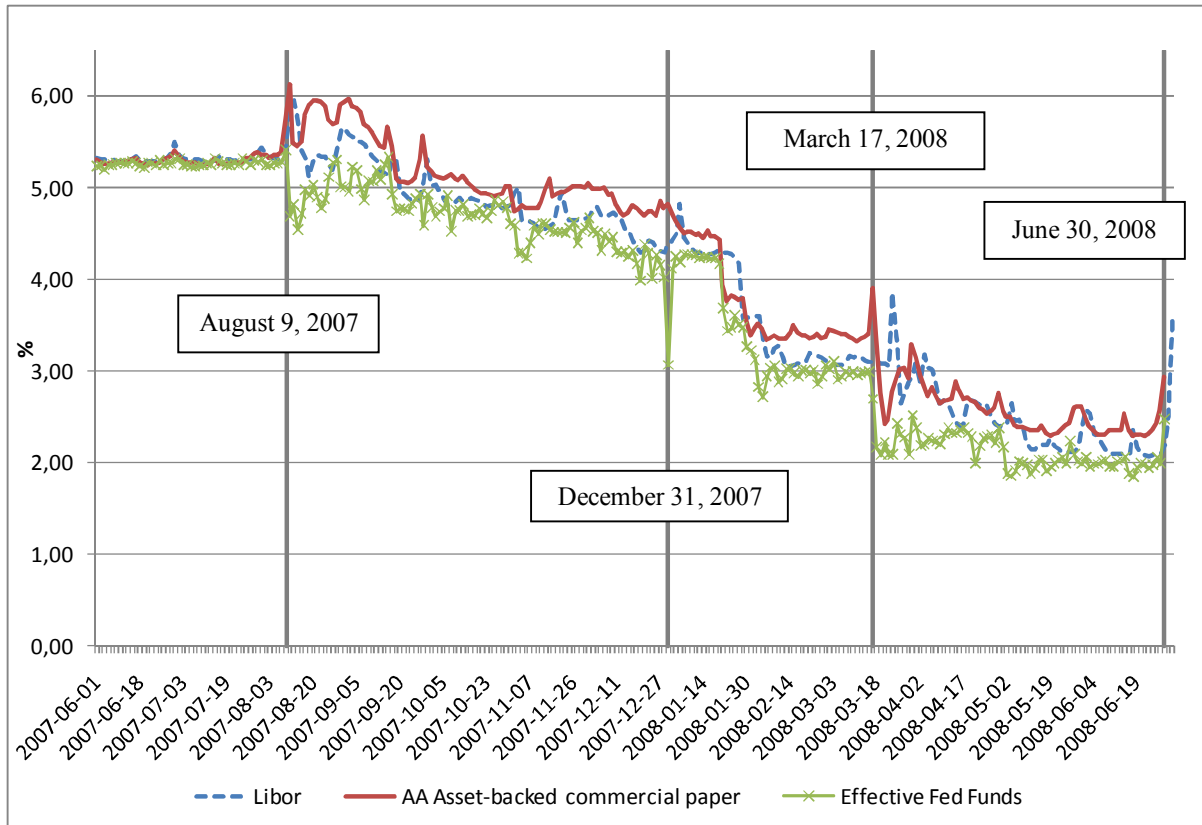
Thirdly, the most severe problems were in collateralized funding markets. The asset-backed commercial paper market and repo market experienced a total freeze whereas non-collateralized products were less affected (although the interest rates were dropping for all securities as a result of the Federal Reserve's monetary policy rate). This was a result from the absence of prices and uncertainty of the rating related to structured products. With regard to an instrument with different maturities, one can conclude that the highest rate volatility was usually experienced in securities of overnight and 1-week maturity.

Fourthly, in the period of the crisis, the money market experienced a "flight to quality" - phenomenon which means that some central bank lending facilities became increasingly popular which did not have the stigma problem. Consequently, investing in the Treasury bills was considered the best storage for excess liquidity at that time.

Figure 19 and Figure 20 present the money market rates for maturities of overnight and one month and the dates of severe stress in the market are marked with poles. It can be seen that the rates of T-bills and effective federal funds move on the opposite directions when comparing to

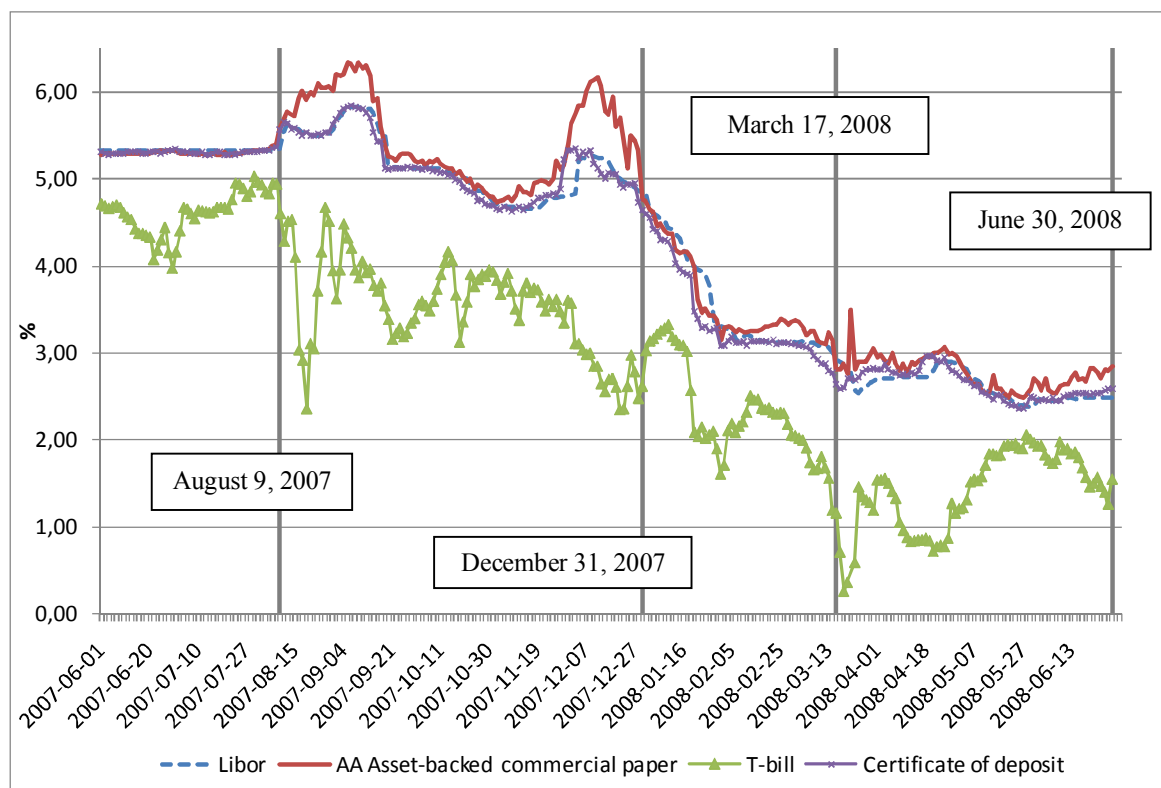
other money market products during the time periods with the worst liquidity freezes. This demonstrates the move to safe government securities.

**Figure 19: The Development of Overnight Money Market Rates and periods of severe liquidity strains 6/2007-6/2008, %**



Sources: Federal Reserve Statistical Release, FRED® (Federal Reserve Economic Data), British Bankers' Association

**Figure 20: The Development of 1-month Money Market Rates and periods of severe liquidity strains, 6/2007-6/2008, %**



Sources: Federal Reserve Statistical Release, FRED® (Federal Reserve Economic Data), British Bankers' Association

In the next section, the reasons behind the behaviour of operators of the bank funding market are analyzed more closely.

#### ***4.2 Market operators: motives and consequences***

In this section, for the basis of the section above, the goal is to summarize the U.S. interbank money market operators and the motives they had for their behavior in the crisis. Also the consequences of the credit crunch for specific institutions are shortly presented.

#### **4.2.1 The interbank money market operators and motives**

The interbank money market has mainly two operator groups: depository institutions and investment and securities firms. Depository institutions consist of commercial banks and thrift institutions<sup>5</sup> and investment and securities firms are investment companies, finance companies, insurance companies and pension funds (Mishkin & Eakins 2009, 216). The focus here is on commercial and investment banks since these were at the center of the crunch. In addition to corporate institutions, the government is a huge operator in the interbank money market via the monetary policy of the central bank. The credit crunch in the interbank money market was formed in part due the behaviour of its operators. Their actions during the crisis were motivated by a number of reasons which are summed up here.

The regulation of the depository institutions has been high in the U.S. during recent decades. The investment banks, however, were not so regulated and in retrospect, one could say, were free to take even excessive risks.

Lack of trust was the defining factor of the credit crunch. The banks were not confident about the financial condition of their counterparties or even about their own performance. Not even the high risk spreads increased the willingness to lend for those who had extra liquidity. Instead they chose the government which seemed like the safest option at that time.

Hoarding of liquidity presented a lot of the problem especially during December 2007 and June 2008. The need for the banking institutions to look proper at the time of financial statements was huge due to the writedowns from subprime-connections (Figure 21), both occurred and possible future losses. Not only investors but clients are interested in the performing of the bank.

One aspect to notice about the bank funding markets is the reputational factors when using central bank lending facilities. The fact that borrowing from the Fed was considered a sign of weakening liquidity, few institutions were willing to use that facility. That was the case at least in

---

<sup>5</sup> Thrift institutions are savings and loan associations, mutual saving banks and credit unions.

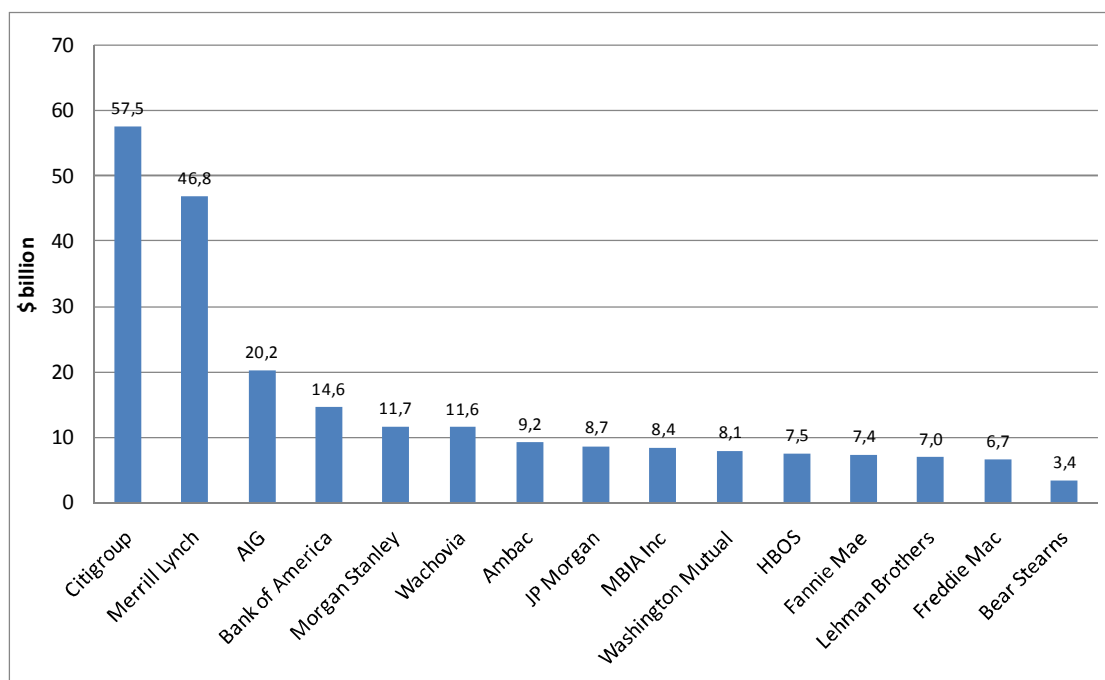
the beginning of the crisis, in fall 2007, when discount borrowing of the depository institutions experienced no huge changes (see Figure 18) and this put more pressure on other money markets.

#### 4.2.2 Consequences of market freezes

The credit crunch in the interbank market had serious effects on the action and operations of the banks involved in the market. In 2007-2008 some of them proved out to be the losers in the turmoil.

The following graph (Figure 21) shows the largest write-downs according to the estimates of Reuters (2008) based on write-downs, loss provisions and trading losses from subprime securities, mortgages, CDOs, derivatives, and SIVs. Among them are major interbank money market operators.

Figure 21: Writedowns of major U.S. Financial Institutions, 6/2007-6/2008



Source: Reuters (2008)

The investment bank Bear Stearns was the first U.S. bank to fall into the hands of its competitor and the central bank. The events resulting to the failure of Bear Stearns are described next

because the incident of Bear Stearns is a fine example of how the credit crunch can prove out to be detrimental for a financial institution. The structured finance products were once again a source for the concerns in the market: the hedge funds of Bear Stearns had been investing heavily into mortgage-backed securities and there were wide concerns on the leverage-ratio of the company and the quality of MBSs (Mizen 2008).

Brunnermeier (2008) describes the events following the bailout of the renowned investment bank. The events started in March 2008 when the hedge fund Carlyle Capital could not meet its margin calls and its collateral asset was partly liquidated due to the widening credit spreads of agency bonds in which it had invested in. The price of these bonds (especially Fannie Mae and Freddie Mac) decreased even more after the Carlyle liquidations. Bear Stearns both held great amounts of agency bonds and was a creditor of Carlyle which added to the difficulties of the bank. Also the second event that had more effect was the announcement of the Fed's TSLF, through which it was possible for investment banks to swap agency and other mortgage-backed securities for Treasury bonds. Although the banks that used the facility were kept secret, somehow the market interpreted the creation of the facility as a sign that some investment bank was in trouble, and the guess was Bear Stearns. In addition, the rumour (either correct or incorrect) that Goldman Sachs indicated to a hedge fund that it did not want to take direct exposure on Bear Stearns resulted to a run of its hedge fund clients and other counterparties. In 13<sup>th</sup> of March, Bear Stearns was unable to acquire funding on repo market. Also the funding of Bear Stearns was largely based on selling the ABCPs and it soon became to public knowledge that it was not able to rollover the papers and it would not meet payments due on 17<sup>th</sup> of March (Mizen 2008).

As a result, JP Morgan Chase acquired the failed investment bank and was granted a loan of \$30 billion from the New York Federal Reserve to assist in the bailout. With these actions, the Federal Reserve tried to prevent a situation where the collapse could result to failure of other financial institutions. According to Brunnermeier (2008) Bear Stearns had 150 million trades with different counterparties so it was effectively "too big to fail". The actions of the Fed in this bailout situation are discussed further in section 5.



However, as we can see from Figure 21 Bear Stearns was not a bank with the highest writedowns. Although Citigroup's balance sheet was almost 6 times larger than that of Bear Stearns, the writedowns that Citigroup experienced were almost 17 times higher (Bear Stearns Company, Inc. 2008, Citigroup, Inc. 2008). Thus, with this numerical data, Bear Stearns would not be the first institution that would fall in the turmoil although it's an undeniable fact that the writedowns of Bear Stearns were substantial. The essential reason for the failure was, once again, the lack of trust that spread across the market, which was not necessarily based on facts about the financial condition of the bank.

In this section, specific issues in the interbank money market were addressed and analyzed. The focus was on different financial products and the motives and action of market operators. Now it is time to examine the actions of an important player in the interbank money market, the Federal Reserve.

## 5 THE FEDERAL RESERVE RESPONSES IN THE INTERBANK MONEY MARKET

The severity of the credit crunch forced the Federal Reserve to take serious, and somewhat broadminded, actions in addressing the issues in the interbank money market. In the beginning, it tried to improve the situation by traditional means such as cuts on the main policy interest rate and changes in the terms of the discount window facility. These procedures proved out to be quite inefficient and outdated and totally new monetary policy tools were created. The timeline of the monetary policy responses by the Federal Reserve is shown in Table 5.

**Table 5: Timeline of the Federal Reserve responses 6/2007-6/2008**

<b>Date</b>	<b>The Federal Reserve Response</b>
August 9, 2007	Increase in the level of temporary open market operations
August 16, 2007	Announcement of adjustments to the Discount Window Facility: -50 basis points cut to the discount rate, term financing up to 30 days
September 18, 2007	-50 basis points cut of Federal Funds Target Rate
October 31, 2007	-25 basis points cut of Federal Funds Target Rate
December 11, 2007	-25 basis points cut of Federal Funds Target Rate
December 12, 2007	Announcement of the creation of Term Auction Facility and Central Bank Liquidity Swap Lines
January 21, 2008	-75 basis points cut of Federal Funds Target Rate
January 30, 2008	-50 basis points cut of Federal Funds Target Rate
March 2, 2008	Announcement of the creation of Single-Tranche Open market Operations Program
March 11, 2008	Announcement of the creation of Term Securities Lending Facility. Announcement of the increase in swap lines with the ECB and SNB to \$30 and \$6 billion, respectively.
March 16, 2008	Announcement of the creation of Primary Dealer Credit Facility. Adjustments to the Discount Window facility: -25 basis points cut to the discount rate, term financing up to 90 days. Announcement of granting a \$30 billion loan to JP Morgan Chase in Bear Stearns acquisition.
March 18, 2008	-75 basis points cut of Federal Funds Target Rate
April 30, 2008	-25 basis points cut of Federal Funds Target Rate

Sources: Cecchetti (2008), Gorton (2008)

The next sections will contain descriptions and of major procedures of the Federal Reserve that were implemented to address the crisis in the interbank money market. Although some new monetary policy tools were presented only during the “second phase” of the crisis, this examination limits itself to period between June 2007 and June 2008. In addition to the monetary policy action itself, the evaluation of the effectiveness and accuracy judged by the academic community is included in the review. The emphasis in the efficiency review is on facilities and actions concerning the interbank money market.

The purpose of this section is to answer the question of whether or not the monetary policy responses of the Federal Reserve in the interbank money market were effective and justified during the crisis according to the opinions and evaluations of the academic community and other related organisations. Efficiency in this context means that the responses relieved the strains in the section of the money market they were targeted to. Firstly, the traditional monetary policy tools and their effectiveness and justification are examined. Secondly, the functioning of the new innovations of the Federal Reserve is described based on studies on the econometric evaluations of the facilities’ efficiency in addressing the problems in the interbank market. Thirdly, the summarization of the Federal Reserve responses during the credit crunch is made.

## ***5.1 Traditional monetary policy tools and responses***

The Federal Reserve tried to improve the functioning of the money markets through its standing monetary policy tools. These included policy interest rate cuts, discount window facility and possible bailouts of financial institutions that were in trouble.

### **5.1.1 Federal Funds rate cuts**

As discussed before in section 4.1.5 the Fed made significant interest rate cuts between June 2007 and June 2008. The total reduction of the federal funds target rate was 325 basis points, which was thought to ease the situation in the financial markets.

There are critical opinions regarding the effectiveness of the interest rate reductions. According to Buiter (2008), the interest rate cuts of the Fed were mostly related to the atmosphere in Wall Street which, in his opinion, should not be the case. Buiter argued that, for example, the largest cut at an unscheduled meeting in 21st of January 2008 was prompted only by the previous days' uneasiness in the European stock market and by the fear that it would spill over to U.S. market the next day. Buiter says that the interest rate cuts were exaggerated by the Fed since the causal effects of stock prices on household spending and on private investment were not so large that such reductions would have required. Not even the policy makers of the Federal Reserve thought that the policy interest rate cuts would help in solving the crisis. This showed as a sign of voting disagreements in the Federal Open Market Committee meeting on 18<sup>th</sup> of March 2008 (Guha 2008).

Inflationary reasons behind the interest rate cuts also provoke discussion. Martin Feldstein (2008), the former CEO of National Bureau of Economic Research, argued in April 2008 that the Fed should stop the interest rate cuts to avoid the increase in prices of food and oil. His point of view is that the interest rate cuts do not induce higher demand for individuals and businesses and therefore has a relatively small gain in improving the market functionality compared to the possible loss experienced via inflation. On the other hand in his earlier article in December 2007 (Feldstein 2007) he was content with the interest rate reductions that would especially boost the economy and would also encourage borrowing of households and businesses. Consequently, the opinions on the subject of interest rate policy were changing as the crisis developed.

According to the opinions mentioned above, the interest rate cuts of the Federal Reserve were considered quite outdated and inefficient in solving the crisis. However, positive views were found in the reduction of interest rates considering them as a means to boost the economy. Still there remained a doubt of whether or not the price of rising inflation rate was too high when comparing to the minor effect it had on the money market.

### **5.1.2 Adjustments to Discount Window Program**

On August 17, 2007 when the interbank market showed first signs of severe stress, the Federal Reserve decided to make changes to its discount window program. The discount rate was brought closer to the federal funds target rate by reducing the spread from 100 to 50 basis points. As mentioned before, there were other means used to make discount loans more desirable for banks. The term of the discount loans was changed so that the depository institutions could acquire loans for a 30-day period (Board of Governors in the Federal Reserve System 2008b, 2008d). On 16<sup>th</sup> of March, it prolonged the term again to 90 days (Board of Governors in the Federal Reserve System 2008c).

Consequently, the goal was to stabilize the term funding due to the fact that interbank lending in other terms than overnight was difficult. It seems like the procedures of changing the terms and primary rate were not efficient since they did not reduce the stigma associated with the discount lending. In effect, Armantier et al. (2008) pointed out that the unsuccessfulness of the discount lending facility to ease the term funding due to the stigma-effect was the reason of creating the new lending facilities like the Term Auction Facility for depository institutions.

### **5.1.3 Bear Stearns bailout**

As mentioned in section 4.2.2 the central bank had to resort to a rescue operation of a major player in the financial market. Usually the Federal Reserve lets the market do the work for it and does not interfere in troubles of single institutions but due to the interconnectedness of financial institutions, the Federal Reserve decided that it was best to stabilize the situation and The New York Federal Reserve granted \$30 billion loan to JP Morgan Chase, who acquired Bear Stearns. According to a testimony of the Fed's chairman Bernanke (2008) on 2<sup>nd</sup> of April 2008, the failure of Bear Stearns would have led to "a chaotic unwinding of positions in (critical) markets and could have severely shaken confidence".

The opinions regarding the bailout of Bear Stearns were quite positive. Paul Krugman (2008a) argued in his column “The B Word” that the rescue operation was necessary even though due to the reckless behaviour with regards to subprime loans, Bear Stearns did not deserve to be rescued. Moreover, he emphasised the fact that it was important to bailout the financial system, not the people who caused the trouble. This is also an issue concerning the bailout of Bear Stearns also. Joseph Stiglitz, Nobel-awarded professor at Columbia University, found that it would be fair to offer bailouts to the homeowners in trouble rather than to the investment banks. Moreover, some economists were concerned that the bailout would add to the moral hazard problem. Professor Roberts (2008) mentioned that the bailout of Bear Stearns was dangerous because it would increase the reckless behaviour of financial institutions since they would not be accountable for the bad choices they make.

It is difficult to predict what would have happened if the Federal Reserve would have let Bear Stearns to fall although there exists a consensus that the failure of Bear Stearns might have damaged the financial system severely. The action was therefore justified but not necessarily morally correct because it, in fact, was also a rescue for the people of the bank who were responsible for the reckless risk taking.

## 5.2 *New monetary policy tools and responses*

In this section, the unconventional and new monetary policy tools are described that were established to aid the banks to obtain funding in specific interbank money markets. The following Table 6 serves as a summarization of the new liquidity facilities' features. In the following chapters the tools are discussed in detail.

**Table 6: New liquidity facilities**

<b>Liquidity Facility</b>	<b>Date of announcement</b>	<b>Borrowers</b>	<b>Facility type</b>	<b>Type of borrowing</b>	<b>Eligible collateral</b>	<b>Lending term</b>
Central Bank Liquidity Swap Lines	12 <sup>th</sup> of December, 2007	Central Banks	Auction	U.S. dollars	Foreign currency.	From overnight to three months
Term Auction Facility (TAF)	12 <sup>th</sup> of December, 2007	Depository institutions	Auction	Funds	Investment grade and performing assets such as commercial, industrial or agricultural loans, customer loans, corporate bonds and money market instruments, asset-backed securities and collateralized mortgage obligations. (Discount window collateral)	28 days
Single-Tranche Open Market Operations Program	7 <sup>th</sup> of March, 2008	Primary dealers	Auction	Funds	U.S. Treasury securities, agency debt securities and agency mortgage-backed securities. (Regular open market operation collateral)	28 days
Term Securities Lending Facility (TSLF)	11 <sup>th</sup> of March, 2008	Primary dealers	Auction	U.S. Treasury securities	Other U.S. Treasury securities, agency debt securities, agency mortgage-backed securities and investment-grade debt securities.	28 days
Primary Dealer Credit Facility (PDCF)	16 <sup>th</sup> of March, 2008	Primary dealers	Standing	Funds	U.S. Treasury securities, agency debt securities, agency mortgage-backed securities (Regular open market operation collateral). Investment grade corporate securities, municipal securities, mortgage-backed securities and asset-backed securities.	Overnight

Sources: Armantier et al. (2008), Federal Reserve Discount Window & Payment System Risk Website (2008b), Fleming et al. (2009)

### **5.2.1 Central Bank Liquidity Swap Lines**

The Federal Reserve announced on 12<sup>th</sup> of December, 2007 that it would establish temporary reciprocal currency arrangements, the so-called swap lines, with the European Central Bank and the Swiss National Bank (later expanded also to other banks). The aim was to provide dollar liquidity also for the banks outside the U.S. market.

In a central bank swap agreement, the foreign central bank first sells a specific amount of its currency to the Federal Reserve and gets dollars for exchange. At the specified date of the agreement (maturities were from overnight to three months) the foreign central bank buys back its own currency at the same exchange rate and also pays a market-based interest on the loan for the dollars. The swap lines were initially \$20 and \$4 billion for ECB and SNB, respectively. (Board of Governors in the Federal Reserve System 2008d, 2009a)

This facility was the first major coordinated response of the central banks to the credit crunch. The duration and the number of banks involved has expanded greatly showing that it has brought some relieve to the international U.S. dollar market.

### **5.2.2 Term Auction Facility**

One of the issues that required a solution from the Federal Reserve was how to provide liquidity for financial institution for periods longer than overnight. The changes that had been made to Discount Window program did not appear to have the desired effect on the interbank markets so the Federal Reserve had to come up with an alternative choice. The introduction of Term Auction Facility (TAF) was announced by the Federal Reserve on December 12, 2007. The worsening situation in the term funding markets at the end of the year encouraged the Fed to establish this auction-based lending facility: acquiring funding for periods longer than overnight was extremely difficult due to uncertainty regarding the counterparty risk and future liquidity situation of the bank (Armantier et al. 2008).

Term Auction Facility makes it possible for depository institutions that are eligible for primary credit through discount window to acquire collateralized term funding for the period of 28 days



via an auction organized in every two weeks by the Federal Reserve. The rate is determined by the auction process and is constrained by the minimum bid-rate. The maximum auction award to an institution was 10 % of the announced auction quantity. The initial bid-size was \$10 million but was reduced to \$5 million to allow the smaller banks to participate. The collateral pledged and the haircuts were the same as in the discount window facility. (Armantier et al. 2008, Board of Governors in the Federal Reserve System 2009b)

The TAF has the features of both open market operations and discount window facility because the lending is collateralized and auction-based. According to Armantier et al. (2008) the TAF and the auction-feature has several advantages compared to these facilities. Firstly, lending through fixed-amount auctions makes it possible for the Federal Reserve to plan more effectively the total supply of reserves. It can control how much is the auctioned amount of liquidity and is less concerned about the volatility of liquidity demand compared to the discount window facility where funding is provided according to the requests of depository institutions. Secondly, by providing a lending facility with an interest rate based on the market demand rather than a premium set by the Fed, it can avoid the stigma related to discount window facility. The lenders would be less concerned about the reputational factors when they can approach the Federal Reserve collectively rather than separately. Thirdly, with an auction format it is possible to lend funds directly to a greater number of depository institutions. In open market operations, only a small number of primary dealers are involved.

Table 7 shows the main results of the fifteen auctions held between December 2007 and June 2008. The amounts allocated in auction varied from \$20 billion to \$75 billion during that time. The number of bidders has been fairly high because in each auction the number of bidding banks was above 50. That could indicate that the interest in the facility has been quite strong. The participation declined first during the first 4 auctions but increased again and was above 70 in the last 10 auctions. In addition, the bid-to-cover ratio (the total bid amount compared to the amount allocated to auction) was well above one in every auction. Only the auctions held in May and in the beginning of June had lower bid-to-cover-rates but that was probably due to the higher amounts allocated to auction, \$75 billion. The stop-out rates, meaning the interest rate on the loans, were quite steadily declining.

**Table 7: TAF Auctions 12/2007-6/2008**

<b>DATE</b>	<b>Bid-to-cover ratio</b>	<b>Stop-out rate (%)</b>	<b>Number of bidders</b>	<b>Amount allocated (\$ billion)</b>
Dec 17 2007	3,08	4,65	93	20
Dec 20	2,88	4,67	73	20
Jan 14 2008	1,85	3,95	56	30
Jan 28	1,25	3,123	52	30
Feb 11	1,95	3,01	66	30
Feb 25	2,27	3,08	72	30
Mar 10	1,85	2,8	82	50
Mar 24	1,78	2,615	88	50
Apr 7	1,83	2,82	79	50
Apr 21	1,77	2,87	83	50
May 5	1,29	2,22	71	75
May 19	1,13	2,1	75	75
Jun 2	1,28	2,26	73	75
Jun 16	1,19	2,36	76	75
Jun 30	2,34	1,21	77	75

Source: FRB Monetary Policy Press Releases 2007-2008

According to calculations of Armantier et al. (2008), in auctions 3-7 the spread between stop-out rate and the expected discount rate<sup>6</sup> was below zero meaning that the depository institutions were willing to borrow more costly from the TAF than from the discount window. This can be interpreted as a sign of the banks avoiding the stigma related to the traditional window facility.

The active participation in TAF auctions made the Federal Reserve to announce some positive comments. It commented that although the isolation of the TAF effect on the financial market was difficult, the declining term spreads may indicate that the TAF was beneficial component in providing liquidity in the banking system. Also Mishkin (2008) had the similar comments plus that the stigma of the discount window facility was successfully avoided and the Fed was able to predetermine the auctioned amounts, it did not face uncertainties regarding the bank reserves and thus effective federal funds rate.

---

<sup>6</sup> defined by Armantier et al. (2008) as the OIS rate plus 50 basis points before March 16 and the OIS rate plus 25 basis points after March 16

Although the Federal Reserve and some other researchers saw the TAF popularity in first auctions a sign of success of the facility, there are some other opinions and econometrical models that show controversial results. Taylor and Williams (2008a) evaluated the effectiveness of the TAF with regards to LIBOR-OIS spread to grasp the effect that it had in the strained interbank money markets. The econometric tests they performed showed that the TAF does not have an effect on the LIBOR-OIS spread, the impact is caused by counterparty risk. In addition, they argued that the TAF does not affect total liquidity (due to the Fed's reserve-neutralizing open market operations), expectations of future interest rates or counterparty risk so it does not even have an indirect effect to the spread. In their further studies (2008b) this result strengthened. However, it is useful to point out that the reviews of Taylor and Williams (2008a, 2008b) focus only on the effect on LIBOR-OIS spread and do not evaluate the effectiveness in addressing the stigma-problem. Wu (2008) and McAndrews et al. (2008) have different results in similar studies. McAndrews et al. (2008) argue that announcements and operations of TAF had an effect on LIBOR-OIS spread and therefore alleviated the strains in the interbank market. Wu (2008) had a same conclusion that the TAF reduced financial strain in the interbank money market, mainly through reducing liquidity concerns of financial institutions. Also Christensen, Lopez and Rudebusch (2009) had such a result that the TAF did lower LIBOR rates from December 2007 to July 2008.

One can draw a conclusion that there remains differences of a opinion on whether or not the TAF has been effective or not. Nonetheless, the proof and the overall evaluations of the Term Auction Facility have been fairly positive. According to some studies the facility did lower the interbank spread temporarily but unfortunately it was not enough to solve the problem because other monetary policy tools were still presented by the Federal Reserve.

### **5.2.3 Single-Tranche Open Market Operations Program**

The Single-Tranche Open Market Operations Program was launched in the beginning of March. The name of the program is new but basically it refers to modified open market operations it launched. That meant that the Federal Reserve would conduct a series of 28-day term repo transactions where primary dealers could offer any kind of collateral that is eligible in

conventional open market operations: Treasury securities, agency debt or agency mortgage-backed securities. The operations were expected to accumulate \$100 billion. This was again a measure that aimed to mitigate the problems in the term funding market for banks, especially in repo financing with Agency MBSs. The outstanding amount of single-tranche repos reached \$80 billion and it remained approximately at that level the rest of the year 2008. (Federal Reserve Bank of New York: Markets Group 2009)

The evaluation of the effectiveness of these repo operations is not extensive due to the fact that other lending facilities (TSLF, PDCD) were launched around the same time. In addition, these operations were not extremely different from the traditional open market operations of the Federal Reserve since the collateral accepted was still the same. Only the term of the funding was different. The fact that the outstanding single-tranche repos has remained at almost the same level ever since, conveys that the objective of the Fed to accumulate \$100 billion was a bit overrated. Funding in this form was not necessarily essential but may have relieved the strains in the repo market with other lending facilities created in March 2008.

#### **5.2.4 Term Securities Lending Facility**

The creation of Term Securities Lending Facility (TSLF) was announced at the time of turmoil surrounding the investment bank Bear Stearns, 11<sup>th</sup> of March 2008. The first auction was organized on 27<sup>th</sup> of March. Such as Single-Tranche Open Market Operations and PDCF the facility was targeted to primary dealers instead of depository institutions. The TSLF attempted to respond to the strains in the secured funding market, thus, the repo market.

With Term Securities Lending Facility primary dealers are able to borrow up to \$200 billion in Treasury securities for 28 days with collateral that can contain other Treasury securities, agency debt securities, agency MBSs and investment-grade debt securities. At the time of distress, Treasury securities were more easily accepted as collateral in repo contracts which were representing a considerable amount of the primary dealers' funding. Consequently, the TSLF was hoped to help obtaining financing via repo markets and also to improve the situation in other markets. This results from the increased supply of treasury securities and reduced supply of less

liquid collateral. Also the TSLF could increase the willingness of primary dealers to make markets for these less liquid securities since they were able to finance them. (Fleming, Hrung, Keane 2009)

The Term Securities Lending Facility is auction-based and the auctions are held weekly. In each auction the Fed defines the auctioned amount, the Treasury securities it will lend and the acceptable collateral that can be pledged. For one dealer, the minimum bid size is \$10 million and the maximum award from the auction can be 20 % of the offering amount.

Fleming et al. (2009) distinguish some key differences between TSLF and other facilities offered to primary dealers. The Primary Dealer Credit Facility has the same feature as TSLF but it is offered at a standing facility and accepts a wider range of collateral. The auction-based system, as mentioned in section presenting the TAF, is more attractive to dealers since it does not have the stigma related to discount window facility. Also the Single-Tranche Program is close to TSLF since it is also an auction-based facility. The differences are that in the TSLF accepts a broader range of collateral securities and it imposes a minimum fee which is higher than the corresponding lending agreement when markets are operating normally. Thus, the TSLF is targeted to situations of financial distress. The main difference, however, according to Fleming et al. (2009) is that the TSLF does not affect the dealer bank's reserves. Due to the fact that securities are exchanged for other securities there is no need for the dealer bank to withdraw or add funds in its clearing bank account. Moreover, the reserve-neutrality implies that the Federal Reserve does not have to make adjustments to the interest rate policy because the bank reserves remain at the same level.

In Table 8 the main results of the fifteen auctions held between March 2008 and June 2008 are presented. As can be seen, there were only four auctions where the bid-to-cover ratio was above one. In all the other auctions, the demand of funds was less than the offered amount. These undersubscriptions can indicate that the TSLF was not a desirable funding source for primary dealers. However, according to Fleming et al. (2009) this might be a result of ameliorating situation in the secured financial market because the facility was designed to attract a high

number of dealers when the market is strained (the effect caused by the minimum fee se high enough).

**Table 8: TSLF Auctions, 3/2008-6/2008**

<b>Date</b>	<b>Offering amount (\$ billion)</b>	<b>Bid-to-cover ratio</b>	<b>Stop-out rate (%)</b>
Mar 27	75	1,15	0,33
Apr 3	25	1,88	0,16
Apr 10	50	0,68	0,25
Apr 17	25	1,40	0,10
Apr 24	75	0,79	0,25
May 1	25	0,96	0,10
May 8	50	0,58	0,25
May 15	25	0,29	0,10
May 22	75	0,62	0,25
May 29	25	0,66	0,10
Jun 5	50	0,54	0,25
Jun 12	25	1,09	0,10
Jun 19	75	0,49	0,25
Jun 26	25	0,62	0,11

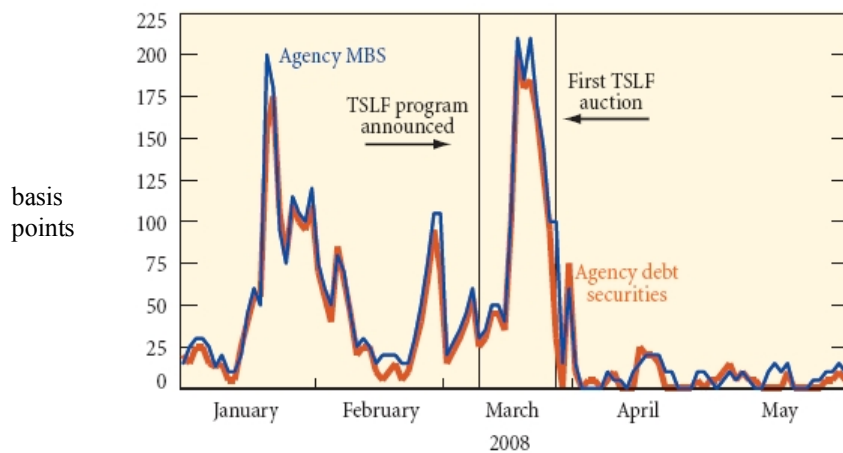
Source: Federal Reserve Bank of New York 2009

In addition to the TAF and PDCF, Wu (2008) studied the effectiveness of the TSLF through its effects on the LIBOR-OIS spread. He found that the TSLF facility did not alleviate financial strains in the LIBOR market significantly. Somehow this result is not surprising since this policy tool was targeted in the secured term funding market rather than in the unsecured interbank market. However, the effect of the facility on the counterparty and liquidity risk in the interbank market can be observed through the examination of LIBOR-OIS spread (discussed in section 2.5). Wu (2008) suspected that this result is consistent with the low participation rate in some auctions but, on the other hand, could result also from the small number of observations regarding the TSLF auctions. So according to Wu (2008), the TSLF was not effective in relieving strains in the interbank money market.

Fleming et al. (2009) discussed the effectiveness of the TSLF and distinguished two methods of evaluation: the dealer willingness to use the facility in strained market conditions and the financing spreads between Treasury collateral and non-Treasury collateral. An effective liquidity

facility should narrow the spreads either by increasing the supply of liquidity or by reducing the financial uncertainty. Figure 22 indicates that the TSLF announcement did not reduce the spreads of overnight agency repo rate and agency mortgage-backed security repo rate compared to the overnight Treasury general collateral repo rate, quite the opposite. However, after the first auction the spreads decreased significantly but that was caused by the rising Treasury repo rates rather than the declining agency debt or agency MBS repo rates. Still Fleming et al. (2009) considered that the development of repo spreads was positive and the conclusion was drawn that the narrowing of spreads resulted from the implementation of the TSLF, specifically the first auction. Thus, in this view the TSLF was effective tool for the Federal Reserve. Also Chailloux et al (2008) claim that the creation of the TSLF calmed down the repo market and eased the funding gridlocks of the banks.

**Figure 22: Financing Spreads and the TSLF**



Source: Authors' calculations, based on data from Bloomberg L.P.

Note: The chart plots spreads between overnight agency and agency mortgage-backed security (MBS) repo rates and the overnight Treasury general collateral repo rate.

Source: Fleming et al. (2009)

Buiter (2008) had a negative view on accepting a wider range of collateral. He argued that the TSLF increases the risk of adverse selection and eventually moral hazard. The reasoning for this is that the primary dealer is able to price the collateral with its clearing bank and therefore overpricing would become possible which would lead to adverse selection. The Federal Reserve would end up with overpriced and poor-quality assets. In the end, that would induce the problem

of moral hazard when primary dealers engage in reckless lending and investment procedures in hope that the Federal Reserve will accept the subgrade assets as collateral.

In conclusion, one can say that the econometrical research on the efficiency of TSLF is not extensive just yet. The existing studies show that the TSLF did help to reduce the repo spreads but not the LIBOR-OIS spreads. The TSLF was targeted to help the secured term market, so, in my opinion, the effect on repo spreads is quite promising. The problem of adverse selection and moral hazard was also mentioned, implying that accepting a wide range of collateral does not necessarily lead to good things, even though it would improve the situation in the repo market. One additional proof of the efficiency could be that in February 2009 the Federal Reserve did extend the TSLF program to continue through the end of October 2009. Somehow it is hard to believe that a totally inefficient tool would be kept working unless the Federal Reserve is experiencing of problem of finding an exit strategy for this lending facility when too many dealers are depending on it.

### **5.2.5 Primary Dealer Credit Facility**

Primary Dealer Credit Facility (PDCF) was launched on March 16, 2008, just during the turmoil concerning Bear Stearns. PDCF is a lending facility to primary dealers where they can take overnight loans against collateral that is acceptable in open market operations plus investment grade corporate securities, municipal securities, mortgage-backed securities and asset-backed securities. The rate at which these loans are given is the normal primary credit rate of discount window facility. In effect, comparing to the discount window facility, the PDCF is the corresponding lending facility for primary dealers except for on a widely collateralized basis.

The PDCF was meant to alleviate the daily liquidity situation of the primary dealers when the assets that they hold would not be accepted as collateral in the repo market. That would prevent the dealers from the forced selling of these instruments and reducing the already low value. The goal for the Federal Reserve was thus to improve market liquidity and encourage the dealers to make markets and to provide credit for their clients (Federal Reserve Bank of New York 2008).



Wu (2008) drew conclusions on the TSLF's effect on LIBOR-OIS spreads and expanded the idea to the Primary Dealer Credit Facility since it is targeted also to primary dealers and was announced almost at the same time as the TSLF. According to him, the effects of the TSLF and the PDCF on financial markets were difficult to separate due to these similarities. The article of Wu (2008) thus shows in his article that also the effect of PDCF on LIBOR market was not discernible.

According to Buiter (2008), the PDCF has a same flaw as the TSLF when it is accepting a wider range of collateral. That might increase the risk of adverse selection and moral hazard.

The research on the effectiveness of the Primary Dealer Credit Facility lacks proper proof. At this point, only subjective assessments are made on the pros and cons of this facility. Since the PDCF has the same features as the TSLF and it was launched around the same time, the effects of these facilities are not easy to separate. The defining difference between these facilities is that the PDCF is a standing facility and therefore does not possess the advantages of an auction-based facility.

### ***5.3 Tools and responses of the Federal Reserve summarized***

After assessing the traditional and the new tools and responses, summarization can be made of the arguments made about these procedures.

The general opinion seems to be that the Federal Funds rate cuts and the modifications made in the discount window program did relieve the strains in the money markets. The policy interest rate cuts did not and will not be effective in the crisis of this magnitude and the fear of inflation was also a concern for some economists. On the other hand, the cuts needed to be made to boost the economy and preventing the crisis from spreading to the real economy but the direct impact to the bank lending was not significant. Moreover, the discount window program even with modifications turned out to be unsuccessful since the stigma problem related to the facility still remained.

The rescue operation of Bear Stearns induced controversial opinions. According to most arguments, the bailout needed to happen due to the interconnectedness of the investment bank. However, the criticism concerned the problem of moral hazard. Banks would be encouraged to act recklessly in the hope that the central bank would come to their rescue in the end if the things got worse.

The single-tranche operations and the central bank liquidity swap lines attracted mainly positive arguments. The announcement of central bank liquidity swap lines were in December was noted because it was the first joint action of the central banks in responding to the credit crunch. According to a report by Committee on the Global Financial System (2008), the operations of swap lines should be continued. The recommendation made by the committee suggested that central banks should ease the international distribution of liquidity for example through the swap lines and that the program should be a standing facility or to be established at short notice. The single-tranche operations, on the other hand, were shadowed by the creation of other lending facilities at the same time in March which were aimed to help the strained repo market. The discussion of the Federal Reserve responses at that time concentrated mostly on the TSLF and PDCF.

What conclusions can be drawn on the effectiveness of the new lending facilities for primary dealers and depository institutions, the TAF, the TSLF and the PDCF? The econometric analysis made on these programs is definitely not extensive yet. The reason for this is that the research and separating the effects of each facility can be difficult or even impossible. The calculations of some studies have different results concerning the effect of the TAF on the LIBOR-OIS spread. However, the TSLF and PDCF was said not to have an effect on LIBOR-OIS but launching these programs did lower the repo spread which actually indicates that it affected the market it was targeted to. In conclusion, one can say that the new facilities all had positive features. In effect, they were not enough to bring the crisis to a halt, but there exists proof that the facilities provided some relief to specific money markets and their operators.

The biggest concerns regarding the Federal Reserve's actions relate to the scale of the responses, to the riskiness of the measures for the Federal Reserve itself and to moral hazard. The Federal

Reserve faces a problem where it tries to balance between steady risk taking and sufficient scale of actions against an extraordinarily large crisis. According to the view of Krugman (2008b), the size of the Federal Reserve actions in March 2008 regarding the TAF, single-tranche operations and TSLF was not large enough. Although the Federal Reserve gathered a lot of risk onto its balance sheet by obtaining a wide range of collateral, Krugman still thought the procedures amounting to \$400 billion were small compared to the problem. In addition, by allowing the banks to pledge a wide range of collateral, the central bank exposes itself on large amounts of market risk and at the same time might induce a wrong kind of behaviour in its counterparties.

The report of Committee of the Global Financial System (2008) conveys that the actions of the central banks, including the Federal Reserve, did help to reduce strains in the money market but did not remove them altogether. Although the procedures reduced the excess demand of liquidity they did not prevent it from coming back. That is a result of counterparty risk associated with the crisis which cannot be totally solved with the means of the central bank. In retrospect, the previously mentioned is true since the problems in the interbank money markets returned in the autumn 2008 and were even more severe than before.

## 6 CONCLUSIONS

The objective of this study was to examine the U.S. interbank money markets during the credit crunch in 2007-2008. It discovered the major issues in the bank funding in money markets and the motives that guided the behaviour of market operators. The Federal Reserve responses to the credit crunch were presented and the attempt was to find an answer to the research question of whether or not the actions of the central bank were effective and accurate according to the opinions stated about the subject.

There are a few main conclusions to be made about the developments of bank funding markets. All the markets were affected as the overall trend of the market rates was declining. The worst dry-ups of interbank lending occurred in the collateralized funding markets. The trouble in the repo market was a result from the concerns related to the securities used as collateral. The demand for the structured products such as asset-backed commercial papers dropped due to the absence of prices and uncertainty of the credit ratings for these products. The demand for the central bank lending facilities and government securities, Treasury bills, experienced a huge growth. This “flight to quality” phenomenon reflected the fact that these products were the safest storage for the excess liquidity at that time although the return of the investment was low, for a Treasury bill it was close to zero in March 2008. What can be said about the maturities of money market products is that most volatile rates were for instruments of overnight and one-week maturities.

The banks’ motives and their behaviour played a significant role in determining the specific features of interbank lending during the credit crunch. The lack of trust, thus the perceived high counterparty risk, caused the dry-up of some markets. Banks were not willing to give funding to practically anyone, not even with a high risk premium. The operators were also uncertain about their possibly upcoming losses from subprime connections of their SIVs so the back-up liquidity was kept in safe. The high demand peaks of Treasury bills and Federal Funds in December 2007 and 2008 resulted from the hoarding of liquidity associated with the closing of financial statement. The need for banks to look proper in the end of the financial year was great because of the stressed situation in the markets. In addition to loss of confidence and hoarding of liquidity,

one feature of behaviour of money market operators was the reluctance to use the standing central bank lending facility, the discount window. The reason for avoiding this means of funding is the stigma related to the facility. The banks were concerned that the usage of the facility might indicate to counterparties in the market that the institution obtaining primary credit was having severe liquidity problems. That was the image that the banks did not want to give as obtaining funding was already difficult.

The Federal Reserve attempted to respond to the above mentioned problems in the interbank money market. It started the procedures with the Federal Funds rate cuts and with changes to the discount window facility. The major bailout the central bank was the one of investment bank Bear Stearns in March 2008. Also the Federal Reserve conducted extended repo operations and a coordinated action with the European Central Bank and Swiss National Bank in the form of swap lines to improve dollar liquidity. The Federal Reserve instituted also new lending facilities for depository institutions and primary dealers: Term Auction Facility, Term Securities Lending Facility and Primary Dealer Credit Facility. These facilities were targeted to help in obtaining term funding especially in the strained repo market.

The efficiency of these procedures was analyzed in this study. According to many opinions, the cuts of Federal Funds Target Rate were not enough and could even turn out to be inflationary. The views on the bailout of Bear Stearns, repo operations and central bank swap lines were mainly positive. The threat of one major financial institution falling created a realization of the huge interconnectedness in the market. The evaluation of TAF, TSLF and PDCF is not extensive yet. However, the results of Wu (2008) and Taylor and Williams (2008) on the effect of TAF to LIBOR-OIS spread, thus the risk of interbank lending, were contradictory. The TSLF and PDCF did not seem to have an effect on the LIBOR-OIS spread but relieved the pressures in the repo market as a result from the lowering of repo spread. The other arguments of the new lending facilities were related to the accepting of wider range of securities as collateral. According to some opinions, allowing the “subgrade” assets onto its balance sheet, the Federal Reserve exposes itself to a high risk and also invites the problem of moral hazard in depository institutions and primary dealers.

In retrospect, one can conclude that the Federal Reserve operations during the first year of credit crunch were varied and in some cases even efficient. Although it is difficult to guess what would have been the consequences if the central bank had decided not to embark on these operations, it is safe to say that they did provide some relief to the strained market. Still the “putting-out-fires” monetary policy is not the best way to act as a central bank when the emphasis should be on the prevention of crises. Nevertheless, the operations of the Federal Reserve were perhaps the best it could do in the face of a crisis with an extraordinary scale.

Currently, in April 2009, the crisis is far from over yet. The turmoil in the market strengthened in September 2008 when first the government-sponsored enterprises Fannie Mae and Freddie Mac were placed under conservatorship of the government and one of the largest investment banks in the U.S., Lehman Brothers Holdings filed for a bankruptcy as a result of loss of confidence in the market. That event was followed by the trouble of a huge insurance company American International Group and collapses and acquisitions of other institutions. This realization of systemic risk showed the vulnerability of financial system. The events led to all-time worse situation in the financial markets with record wide spreads in the interbank money market (Board of Governors in the Federal Reserve System 2008e).

The TAF, the TSLF and the PDCF are still operative. In addition of extending these outstanding lending facilities, the Federal Reserve created a new range of liquidity tools such as Asset-backed Commercial Paper Money Market Mutual Fund Liquidity Facility, Commercial Paper Funding Facility, Money Market Investor Funding Facility and Term Asset-Backed Securities Loan Facility. Also the Federal Funds target rate was set to a very low level, to 0-0,25 percent.

The credit crunch has evidently developed into a global economic crisis that has spread also to the real economy. In this study, one period and one market of the crisis were examined. It leaves behind a massive amount of questions to be answered about the efficiency of the Federal Reserve actions and the operation of interbank money markets. Further studies about the subject could relate to the main issues in financial markets and the monetary policy of the Federal Reserve at times of severe stress. After the turmoil in the economy is over, whenever that may be, the

research can provide information for the challenge of designing the monetary policy in the future. It is safe to say that at that stage the financial markets and banking industry will be changed.

## REFERENCES

### Articles:

Acharya, V., Gromb, D. & Yorulmazer, T. 2008. *Imperfect Competition in the Interbank Market for Liquidity as a Rationale for Central Banking*. IFA Working Paper.

Armantier, O., Krieger, S., McAndrews, J. 2008. The Federal Reserve's Term Auction Facility. *Current Issues in Economics and Finance* 2008 14:5. Federal Reserve Bank of New York.

Ashcraft, A. B. & Schuermann, T. Understanding the Securitization of Subprime Mortgage Credit. *Federal Reserve Bank of New York Staff Reports* 2008: 318.

Allen, F., Carletti, E. & Gale, D. 2008a. Interbank Market Liquidity and Central Bank Intervention. Working paper, University of Pennsylvania.

Allen, F. & Carletti, E. 2008b. The Role of Liquidity in Financial Crises. Working Paper 08-33, *Wharton Financial Institutions Center, University of Pennsylvania*.

Bernanke, B.S. & Lown, C.S. 1991. The Credit Crunch. *Brookings Papers on Economic Activity* 1991:2. 205-247.

Brunnermeier, M. K. 2009. Deciphering the Liquidity and Credit Crunch 2007-08. *Journal of Economic Perspectives* 2009 23:1 (forthcoming).

Brunnermeier, M. K. & Pedersen, L.H. 2008. Market Liquidity and Funding Liquidity. *The Review of Financial Studies* (forthcoming).

Buiter, W.H. 2008. Central Banks and Financial Crises. *Maintaining Stability in a Changing Financial System. Federal Reserve Bank of Kansas City Symposium Proceedings* 2008.

Calomiris, C.W. 2008. The Subprime Turmoil: What's Old, What's New, and What's Next. *Maintaining Stability in a Changing Financial System. Federal Reserve Bank of Kansas City Symposium Proceedings* 2008.

Cecchetti, S.G. 2008. *Monetary Policy and the Financial Crisis of 2007-2008*. CEPR Policy Insight. No. 21, April 2008.

Chailloux, A., Gray, S., Klüh, U., Shimizu, S., Stella, P. 2008. *Central Bank Response to the 2007-08 Financial Market Turbulence: Experiences and Lessons Drawn*. IMF Working Paper WP/08/210. International Monetary Fund.

Christensen, J., Lopez, J. & Rudebusch, G. 2009. *Do Central Bank Liquidity Operations Affect Interbank Lending Rates?*. Preliminary draft. Federal Reserve Bank of San Francisco.



- Committee on the Global Financial System 2008. Central bank operations in response to the financial turmoil. *CGFS Papers no 31*. Bank for International Settlements.
- Fleming, M., Hrungr, W., Keane, F. 2009. The Term Securities Lending Facility: Origin, Design, and Effects. *Current Issues in Economics and Finance* 2009 15:2. Federal Reserve Bank of New York.
- Freixas X. and Jorge J. 2007. *The Role of Interbank Markets in Monetary Policy: A Model with Rationing*. Working paper, Universitat Pompeu Fabra.
- Gorton, G. 2008. The Panic of 2007. *NBER Working Paper Series* 2008:14358.
- Holmström, B. & Tirole, J. 1998. Private and Public Supply of Liquidity. *Journal of Political Economy* 106:1. 1-40.
- Hördahl, P. & King, M. 2008. Developments in repo markets during the financial turmoil. *BIS Quarterly Review, December 2008*.
- International Monetary Fund. 2008. *Global Financial Stability Report*. April.
- International Monetary Fund. 2008. *Global Financial Stability Report*. October.
- Jaffee, D.M. 2008. *The U.S. Subprime Mortgage Crisis: Issues Raised and Lessons Learned*. Working paper no. 28, The World Bank, Commission on Growth and Development.
- McAndrews, J., Sarkar, A., Wang, Z. 2008. *The Effects of the Term Auction Facility on the London Inter-Bank Offered Rate*. Staff Report no. 335. July 2008. Federal Reserve Bank of New York.
- Mishkin, F. 2009. Is Monetary Policy Effective during Financial Crises? *NBER Working Paper Series* 2009:14678
- Mizen, P. 2008: The Credit Crunch of 2007-2008: A Discussion of the Background, Market Reactions, and Policy Responses. *Federal Reserve Bank of St. Louis Review*, September/October 2008, 90:5. 531-567.
- Owens, R. & Schreft S. 1995. Identifying Credit Crunches. *Contemporary Economic Policy* 13:2. 63-76.
- Taylor, J.B. & Williams, J.C. 2008a. A Black Swan in the Money Market. *NBER Working Paper Series* 2008:13943.
- Taylor, J.B. & Williams, J.C. 2008b. Further Results on a Black Swan in the Money Market. *Stanford University Working Paper*. May 2008.

Wojnilower, A. 1980. The Central Role of Credit Crunches in Recent Financial History. *Brookings Papers on Economic Activity* 1980:2. 277-399.

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

### **Books:**

Mishkin, F. & Eakins, S. 2009. *Financial Markets and Institutions*. Pearson International Edition, Boston.

### **Internet:**

Bear Stearns Companies, Inc. 2008: Presentation at Credit Suisse Financial Services Forum. [http://www.bearstearns.com/includes/pdfs/investor\\_relations/presentations/credit\\_suisse.pdf](http://www.bearstearns.com/includes/pdfs/investor_relations/presentations/credit_suisse.pdf), accessed 4/8/2009.

Bernanke, B.S. 2008. The Economic Outlook. Testimony before the Joint Economic Committee, U.S. Congress. <http://www.federalreserve.gov/newsevents/testimony/bernanke20080402a.htm>, 4/11/2009

British Bankers' Association 2009. Historic BBA LIBOR rates. <http://www.bba.org.uk/bba/jsp/polopoly.jsp?d=141&a=627>, 2/24/2009.

Board of Governors in the Federal Reserve System 2008a. Monetary Policy Report to the Congress. July 2008. [http://www.federalreserve.gov/monetarypolicy/files/20080715\\_mprfullreport.pdf](http://www.federalreserve.gov/monetarypolicy/files/20080715_mprfullreport.pdf), 10/29/2008.

Board of Governors in the Federal Reserve System 2008b. Press Release 8/17/2007. <http://www.federalreserve.gov/newsevents/press/monetary/20070817c.htm>, 3/25/2009.

Board of Governors in the Federal Reserve System 2008c. Press Release 3/16/2008. <http://www.federalreserve.gov/newsevents/press/monetary/20080316a.htm>, 3/25/2009.

Board of Governors in the Federal Reserve System 2008d. Monetary Policy Report to the Congress. February 2008. [http://www.federalreserve.gov/monetarypolicy/files/20080227\\_mprfullreport.pdf](http://www.federalreserve.gov/monetarypolicy/files/20080227_mprfullreport.pdf), 1/29/2009.

Board of Governors in the Federal Reserve System 2008e. Monetary Policy Report to the Congress. February 2009. [http://www.federalreserve.gov/monetarypolicy/files/20090224\\_mprfullreport.pdf](http://www.federalreserve.gov/monetarypolicy/files/20090224_mprfullreport.pdf), 4/24/2009

Board of Governors in the Federal Reserve System 2009a. Credit and Liquidity Programs and the Balance Sheet: Central bank liquidity swaps.

[http://www.federalreserve.gov/monetarypolicy/bst\\_liquidityswaps.htm](http://www.federalreserve.gov/monetarypolicy/bst_liquidityswaps.htm), 4/13/2009.

Board of Governors in the Federal Reserve System 2009b. Monetary Policy: Term Auction Facility. <http://www.federalreserve.gov/monetarypolicy/taf.htm>, 4/8/2009.

Mishkin, F.S. 2008. The Federal Reserve's Tools for Responding to Financial Disruptions. A Speech delivered at the Tuck Global Capital Markets Conference 2/15/2008.

<http://www.federalreserve.gov/newsevents/speech/mishkin20080215a.htm>, 4/11/2009.

Citigroup Inc. 2008: 2007 Annual Report on form 10-K.

<http://www.citigroup.com/citi/fin/data/k07cu.pdf>, 4/5/2009.

Federal Reserve Bank of New York 2007a. Federal Funds.

<http://www.newyorkfed.org/aboutthefed/fedpoint/fed15.html>, 2/25/2009.

Federal Reserve Bank of New York 2007b. Open Market Operations.

<http://www.newyorkfed.org/aboutthefed/fedpoint/fed32.html>, 2/25/2009.

Federal Reserve Bank of New York 2007c. The Discount Window.

<http://www.newyorkfed.org/aboutthefed/fedpoint/fed18.html>, 2/25/2009.

Federal Reserve Bank of New York 2008. Understanding the Recent Changes to Federal Reserve Liquidity Provision.

[http://www.newyorkfed.org/markets/Understanding\\_Fed\\_Lending.html](http://www.newyorkfed.org/markets/Understanding_Fed_Lending.html), 4/21/2009.

Federal Reserve Bank of New York 2009. Term Securities Lending Facility.

[http://www.ny.frb.org/markets/tslf/termseclending\\_Historical.cfm](http://www.ny.frb.org/markets/tslf/termseclending_Historical.cfm), 4/9/2009.

FRB Monetary Policy Press Releases 2008-2009.

<http://www.federalreserve.gov/newsevents/press/monetary/2009monetary.htm>, 4/16/2009.

Federal Reserve Bank of New York: Markets Group 2009. Domestic Open Market Operations During 2008. A Report Prepared for the Federal Open Market Committee.

<http://www.newyorkfed.org/markets/omo/omo2008.pdf>, 4/10/2009

Federal Reserve Discount Window & Payment System Risk Website 2008a. Historical Discount Rates.

<http://www.frbdiscountwindow.org/historicalrates.cfm?hdrID=20&dtlID=52>, 3/2/2009.

Federal Reserve Discount Window & Payment System Risk Website 2008b. General Information.

<http://www.frbdiscountwindow.org/generalinfo.cfm?hdrID=14&dtlID=>. 3/24/2009

Federal Reserve Statistical Release.

<http://www.federalreserve.gov/econresdata/releases/statisticsdata.htm>, 2/5/2009.

Feldstein, M. 2008. Enough With the Interest Rate Cuts. *The Wall Street Journal* 4/15/2008.  
<http://online.wsj.com/article/SB120822025943314699.html>, 4/10/2009.

Flow of Funds Account of the United States. September 2008. Debt Growth and Sector.  
<http://www.federalreserve.gov/releases/z1/20060919/z1r-2.pdf>, 4/23/2009

FRED® (Federal Reserve Economic Data) 2009.  
<http://research.stlouisfed.org/fred2/> , 2/5/2009.

Guha, K. 2008. Fed signals rate cuts alone will not solve crisis. *Financial Times* 3/19/2008.  
<http://www.ft.com/cms/s/0/cd1c919a-f557-11dc-a21b-000077b07658.html>, 3/25/2009.

Krugman P. 2008a. Betting the Bank. *The New York Times* 3/14/2008.  
[http://www.nytimes.com/2008/03/14/opinion/14krugman.html?\\_r=4](http://www.nytimes.com/2008/03/14/opinion/14krugman.html?_r=4), 4/22/2009.

Krugman P. 2008b. The B Word. *The New York Times* 3/17/2008.  
[http://www.nytimes.com/2008/03/17/opinion/17krugman.html?\\_r=1](http://www.nytimes.com/2008/03/17/opinion/17krugman.html?_r=1) , 4/12/2009.

Mackenzie, M. 2008. Traders pin hopes on Fed's new liquidity programme. *Financial Times* 3/26/2008.  
<http://www.ft.com/cms/s/0/a4bd851e-fb6b-11dc-8c3e-000077b07658.html>, 4/19/2009.

Office of Federal Housing Enterprise Oversight 2008. Rate of House Price Declines Slows in Second Quarter. <http://www.ofheo.gov/media/pdf/2q08hpi.pdf>, 10/1/2009.

Organisation for Economic Co-operation and Development 2008. OECD Stat.  
<http://stats.oecd.org/wbos/index.aspx?r=461248>. 10/20/2008.

Reuters 2008. FACTBOX: Global writedowns and credit losses.  
<http://www.reuters.com/article/innovationNews/idUSN0750533720080807?pageNumber=2&virtualBrandChannel=0&sp=true>, 8/7/2008.

Roberts, R. 2008. Does Bear Stearns Bailout Set a Bad Precedent? Commentary on NPR 3/25/2008. <http://www.npr.org/templates/story/story.php?storyId=89064840>, 4/13/2009.

Stiglitz, J. Ways We Can Fix This Giant Mess. *Newsweek* 30/3/2008.  
<http://www.newsweek.com/id/128539/page/3>, 4/15/2009.