



STOCKHOLM SCHOOL OF ECONOMICS
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Reviewing the financial crisis

A descriptive analysis of the turmoil in financial markets 2007-2009

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Abstract

The global financial crisis that originated in 2007 is commonly claimed to have been caused by subprime mortgages and a real-estate price bubble in the U.S. The aim of this descriptive thesis is to give an overview of the instruments and institutions that were in the centre of the financial turmoil that started in 2007, using previous research on the crisis as starting point. The reader is guided through the developments in the U.S. mortgage market, the securitization process where mortgages and other assets are transformed into financial instruments, and the institutional setting surrounding mortgage-related financial instruments. Following the structural overview of the mortgage-related financial market is a timeline of significant events during the crisis, and a case study on the near default of Bear Stearns, at the time one of the largest investment banks in the United States. The information presented is combined to provide an overview of the market interconnection, and a qualitative analysis of the gathered information is made to identify some of the major factors causing the crisis. The authors argue that the increase in mortgage origination, mortgage securitization, use of leverage by financial institutions and the institutional interconnectivity were some of the main factors behind the crisis.

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Key words: subprime mortgages, financial crisis, leverage, structured finance, securitization, Structured Investment Vehicles

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1. Introduction

The ongoing global financial crisis is commonly claimed to have its origins in an asset price bubble in the United States real-estate market. New complex financial innovations based on real-estate mortgages, excessive leverage, and loose regulatory oversight of financial institutions are factors that, among others, have been said to be part of the cause behind the widespread financial turmoil during 2007-2009.

The lending and mortgage system in the U.S. and rest of the world has gone through significant changes during previous decades – the old system where banks used balance-sheet money to lend has been replaced with a system where mortgages are securitized, i.e. transformed into financial instruments, and sold to investors. The process of securitizing mortgages includes a long chain of intermediaries and the risk of the mortgages thus becomes transferred far away from the actual source. To provide safety, the mortgage instruments were hedged with either credit derivatives or by companies specialized in insuring financial instruments, e.g. monoline insurers, further increasing the distance between the asset (e.g. mortgage) and the investor. Investment banks and other institutions used short-term funding to finance long-term positions in assets and were highly leveraged – a phenomenon that is pro-cyclical, as asset prices boom, leverage is increased. The use of repurchase agreements, repos, was common and could finance up to approximately 25% of investment banks balance sheets. Short-term repos are refunded daily making them highly reliant on functioning money markets. As long as the world experienced a booming economy with low interest rates and liquid funding markets the system functioned smoothly – but as mortgage holders in the U.S. started to default on their mortgages it sent shockwaves through the entire global financial chain.

Structured Investment Vehicles (SIVs) were, up until the crisis, popular conduits set up by banks in order to purchase long-term high-yielding assets funded by issuing short-term commercial paper. The profitable strategy functioned well as long as the assets were highly rated by credit rating agencies and the funding market was liquid – but as the crisis unveiled, SIVs were among the first institutions to be hit, and not a single one of them has survived in their initial form up until today (2009).

In March 2008 Bear Stearns, at the time the fifth largest investment bank in the world, was bought and merged with J.P. Morgan Chase preventing the firm from filing for bankruptcy. A few weeks earlier Bear Stearns had been, what was known at least, a well-functioning company – but as lenders and counterparties started to mistrust their creditworthiness it was a matter of days before Bear Stearns ran out of liquidity and funding possibilities.

The objective of this descriptive thesis is to provide the reader with a better understanding of the financial crisis that started in 2007 with regards to instruments and institutions related to the mortgage market. The research question that will be examined is:

- **What were the main factors behind the turmoil in mortgage-related financial markets that started in 2007?**

1.1 Thesis Structure

The structure of this thesis begins with section 2, “Theoretical Framework”, which aims to describe the opinions regarding the crisis expressed by a few well-renowned researchers; Charles P. Kindleberger, Marcus K. Brunnermeier, Gary B. Gorton, Bengt Holmström and Martin Hellwig. The research described will be used as a framework for the rest of the thesis with regards to which parts of the financial markets to focus on. Section 3, “The Subprime Mortgage Market” provides a description of the U.S. subprime mortgage market and its development during the years prior to the crisis, as well as the general development in the U.S. real-estate market. Section 4, “Mortgage Instruments” aims to give a description of the asset securitization process, providing the reader with an understanding of how mortgages and other assets can be transformed into financial products and end up in the portfolio of an investor anywhere in the world, far from the actual asset. The section focuses on ABSs (asset-backed securities) in general and MBSs (mortgage-backed securities) and CDOs (collateralized debt obligations) in particular. Section 5, “Money Market Instruments”, provides a description of the money market instruments commonly used by financial institutions as tools to fund their operations. Section 6, “Institutional Structure”, aims to provide an overview of the institutional structure in the financial markets, focusing particularly on institutions connected to the originating, securitizing, trading and holding of different types of ABSs. Section 7, “Timeline” provides a timeline of significant events during 2007-2009. Section 8, “Case Study” describes the event where Bear Stearns was acquired and merged with J.P. Morgan Chase and how their loss in counterparty confidence led to their collapse. The case study aims to link previous sections to an actual event, described in detail. In section 9, “Market Interconnection”, we provide an overview of the complexity of the financial market related to mortgages, linking previous sections together. In section 10 “Conclusions” we present our main findings from the reviewed material.

1.2 Method

Given the descriptive nature of this thesis the method used for answering the research question will be mainly qualitative. The material used as base and starting point will be academic literature produced by

economic researchers, and other material used will be, for example, company financial reports, SEC-filings, research reports, news articles and data from Thomson Datastream. The material will be thoroughly examined to find relevant information, and the conclusions will be based on qualitative analyses of the information found. Since we do not use any pre-defined information set the research process will include a large amount of screening, in order to find information related to the subject that comes from trustworthy sources. Much of the information treats separate parts of the market that we intend to investigate and in order to provide a full overview the separate information will be linked together.

2. Theoretical Framework

The problems related to the financial crisis began in 2007, and the turmoil in the global financial systems has since continued. Approaching the second half of 2009, it is still unclear how long the problems will continue and even though many financial markets have stabilized, the crisis still has effects in the real economy affecting for example unemployment rates and GDP growth. Despite the uncertainty about the extent and length of the crisis, many academics have already published their views on the causes of the financial turmoil that started in 2007. As a base for this paper, in this section we present the theoretical framework of the crisis made by a few well-renowned scientists in this field.

Researcher Charles P. Kindleberger (2005) argued that all financial crises follow a certain pattern, or anatomy, first developed by researcher Hyman Minsky. The late Kindleberger did not live to see the extent of the current crisis, but his theories on financial crisis might very well be suitable on the current situation. In short, Kindlebergers' crisis pattern proceeds as follows; it starts with an economic displacement of some kind, a displacement large enough to affect the current investment environment and that alters the profitability opportunities between different business sectors. The displacement could for example be the invention of revolutionizing new technology, or the deregulation of a market (such as the deregulation of the Swedish banking sector in the 1980's). If the new investment opportunities are larger than old ones, investors will switch focus to the new investment and the economy as a whole will experience a boom when investments increase productivity, wages and spending, and decrease unemployment rates. Investments are fuelled by an increase in credit and lending that further drives investments leading to increasing asset prices and profits, attracting more and more investors. Kindleberger denotes this as a phase of euphoria as the spiral of new investments and increasing profits will keep spinning fuelled by speculation (i.e. purchase of assets with the sole intention of making a profit, often financed by credit). Eventually, investors with little or no professional

knowledge enter the market that will now start to show signs of a bubble (or “mania”) as future profits are overestimated. Finally, investors realize that prices have been pushed too high and a rush for liquidity will begin – the bubble bursts.

The common public view is that the recent crisis began in the real-estate mortgage sector in the U.S., and more specifically with the phenomenon of subprime mortgages. But how was it possible that delinquencies in subprime mortgages ended up affecting the entire financial system, causing money markets to dry up and forcing large financial institutions into bankruptcy? Many academics blame the securitization process of mortgages combined with the use of off-balance sheet vehicles as the factors behind the crisis. However, some academics differ slightly in their positions as to what were the most important causes.

The shared view is that the first signs of trouble were seen when the market values of securitized mortgages (e.g. mortgage-backed securities, collateralized debt obligations etc) began to fall in 2007. Many financial institutions had positions in such instruments, purchased by using short-term funding, and as market values started to decline they were forced to take actions further affecting the financial system.

Brunnermeier (2008) argues that most investors prefer assets with short maturities since such assets, for example, allows investors to withdraw funds at short notice should they need to. This led to the creation of off-balance sheet vehicles such as SIVs (Structured Investment Vehicles) by commercial banks. These vehicles shortened the maturity of long-term structured products by purchasing them using short-term commercial paper funding. Investors could thus purchase short-term commercial papers to get exposure to long-term structured products. Even though SIVs were legally separated from the sponsoring commercial banks, the banks still bear some of the liquidity risk by granting credit lines to the SIVs. Since these credit lines did not have the same capital requirements as when holding the assets directly on the balance sheet, SIVs were popular as instruments for regulatory and ratings arbitrage. These off-balance-sheet vehicles were among the first institutions to be affected by falling asset prices, and Brunnermeier identifies four amplifying processes that worsened the outcome. The first amplification process was the downward spiral of assets prices as the funding requirements for financial institutions increased as asset prices dropped. Increasing funding requirements led to further declining assets prices as investors were forced to cut back on leverage. The second amplification process was the general uncertainty about future funding needs among financial institutions combined with potentially limited access to the lending market, leading to rising interest rates in the interbank

money market. The third amplification process was the run on financial institutions as investors that mistrusted the credit worthiness of their counterparties had incentives to withdraw their funding before others did so. The fourth amplification process was that when financial institutions are lenders and borrowers at the same time there might be network and gridlock risk as institutions are unable to meet their obligations just because others are. As an example of network and gridlock risk Brunnermeier illustrates the event where several connected trading parties fail to net offsetting positions because of concerns of counterparty risk and the lack of information on counterparty positions.

Gorton (2008) argues that the lack of information deriving from the securitization process was one of the main factors behind the crisis. He develops the thesis that the interlinked security designs were necessary to make the subprime-mortgage market function, but that it also resulted in a loss of information as the chain of structures – securitized mortgages and off-balance-sheet vehicles – became longer and longer. Since subprime mortgages are uniquely designed, their securitizations are uniquely structured and the mortgage risks are repackaged and sold in many steps, leading to a situation with low transparency as to where the risks finally end up. Gorton argues that the sell side of securitized mortgage products understood the complexity of the securitization chain, but investors did not – they did not have the resources to individually assess the structure and risks of the products.

With regards to the information problem, a significant event according to Gorton during the development of the crisis was when the synthetic indices of mortgage risk (ABX indices) were introduced in 2006. For the first time investors could now view aggregated values of risks of mortgage products, although the locations of the risks were still unknown. When these indices started to plummet during 2007 it, combined with the uncertainty of risk locations, led to a loss of confidence among institutions and counterparties holding securitized mortgage products. As Brunnermeier, Gorton argues that the run started on off-balance sheet vehicles such as SIVs, followed by runs on hedge funds, and it ultimately affected the repo markets as counterparties started to make margin calls or refused to lend through repos. SIVs were not large holders of subprime products but the problem was lack of information, investors could not penetrate the portfolios sufficiently enough. The market for asset-backed securities and mortgage-backed securities soon dried out. Gorton further argues that the mark-to-market accounting practices worsened the effects since it forced institutions to mark their positions in the absence of reliable market prices leading to massive write-downs and further sell offs.

Furthermore, Gorton argues that there is no problem with securitizations in general, but the problem with subprime mortgage securitization during this crisis was the instrument sensitivity to changes in

house prices. The use of off-balance sheet vehicles is also functioning well in general, but combined with these types of instruments they became the ignition that started the crisis.

As a response to Gorton (2008), Holmström (2008) argues that it is partial information transparency that is the problem – complete transparency or complete lack of transparency increases liquidity. Interbank markets, repo markets or other near-money markets function well when they are based on trust rather than a complete assessment of information prior to each trade. The need for information is generally kept low by assuring that there are enough assets and reputation to back up liabilities. When collateral value decreases towards the face value of the debt the creditors becomes more like equity holders since they must assess and analyze the quality of the assets. In a market rolling over billions of dollars of debt each day, a sudden need to perform detailed analyzes of the collateral, or a sudden drop in confidence towards counterparties might be devastating, since there is no time for detailed evaluations. Holmström argues that the money markets functioned well without detailed information, and that the main cause of the problems was the sensitivity of the securitized mortgage products to changes in average house prices.

Hellwig (2009) stresses the importance of mark-to-market valuation which made institutions exposed to systemic risk that has little to do with the intrinsic value or solvency of debtors and instead relies upon the functioning (or malfunctioning) of the financial system. Fair value accounting and maturity transformation made the values of securities held on the balance sheet dependent on the prevailing market prices even if the possessor has the intention to hold the securities until maturity. Lack of information and lack of understanding about systemic risk exposure made market participants unaware of the risks they were facing due to systemic interdependence. The securitized mortgages did not end up in the portfolios of pension funds and insurance companies, instead they went to highly leveraged financial institutions engaged in substantial maturity transformation and who were in constant need of refinancing.

Hellwig introduces the concept of “yield panic”, a situation prior to the crisis where low real and nominal interest rates and small interest margins for financial institutions created a surge for products that could generate high returns. Furthermore, originators of securitized products competed against each other in gaining shares of the market, and even as the risks in subprime mortgages increased, the risk premia of securitized mortgage products decreased due to “blindness to risk in the competition for turf”. The relatively high returns provided by mortgage-backed securities were very attractive to investors, and high ratings from credit rating agencies provided confidence. Hellwig argues that too much depended on

the rating agencies assessments, and that too little attention was paid to the symbiotic relationships between issuers of structured products and credit rating agencies. As other academics, Hellwig argues that the crisis started by runs on highly leveraged SIVs with hardly any equity buffers at all, as ratings for several ABSs were downgraded, creating a chain reaction in the entire financial system.

3. The Subprime Mortgage Market

3.1 What Makes a Loan Subprime

There is no consensus on the exact definition of subprime mortgages. The term subprime is often used to describe certain characteristics of the borrower. For example, a FICO score (a standard industry model to evaluate creditworthiness of a borrower) less than 620 is a common definition of a subprime borrower. Another definition is that a subprime mortgage does not usually need any down-payments and that little documentation is required. However, a broad definition is that a subprime loan entails a high risk of default (Demyanyk et al (2008)).

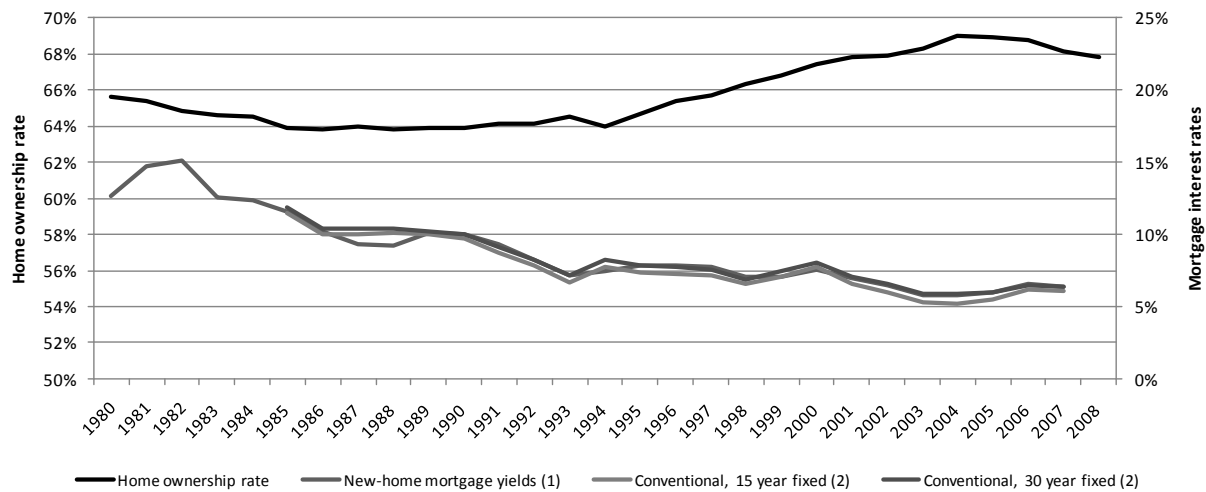
3.2 The Origin of Subprime Lending

In the beginning of the 21th century, interest rates in the United States were low and loans, credits and mortgage money was easily available. With Americans borrowing money at low costs, the real estate market boomed, moving out of line with fundamentals such as house hold income. Between 1996 and 2006, the U.S. national average house prices rose between 93% and 137%, depending on the index employed.¹ At the same time, mortgage interest rates were in a negative trend (see Figure 3.1) and in June 2003, the mortgage interest rates hit 45-year low. As interest rates were going down, the total mortgage origination was going the opposite direction. The mortgage origination volume quintupled between 1996 and 2003, rising from \$800 million to \$3.9 billion (Sanders (2008)).

¹ S&P/Case-Shiller Index or the Office of Federal Housing Enterprise Oversight (OFHEO) House Price Index

² Alt-A is a mortgage where the credit worthiness of the mortgagor is between prime and subprime

³ A company that is bankruptcy remote from its owner will not be legally affected in case of owner default

Figure 3.1 Home ownership and mortgage interests 1980-2008

Source: Bankrate Inc, U.S Census Bureau

To attract the growing pool of customers, lenders started to offer new types of mortgage products that often had low initial costs and were designed to be refinanced after a few years, when the value of the real-estate had increased. An example is the NINJA mortgage, offered to borrowers with “No Income, No Job or Assets”. With cheaper loans, low income families and other customers with poor credit histories were now given the opportunity to enter the real estate market. At the same time, since the home values increased, borrowers felt that the probability of default, in case of financial difficulties, decreased. As long as house prices were up, mortgagors could sell their home and repay the mortgage.

The housing mortgage market in the U.S. has been well functioning over the past two centuries, enabling millions of people to fulfil the dream of home ownership. During this time there has been several periods of disruption in these markets, but none of them as severe as the episode, sometimes referred to as the “subprime mortgage market meltdown” that begun around the summer of 2007, with falling real-estate prices and increasing defaults. Today, economists fear that more than 2 million or more Americans might lose their homes to foreclosure in 2009 (Barth et al (2008)).

Many experts blame the rapid growth of subprime lending and mortgage market excesses in the 2000s for the sharp increase in the U.S. real estate prices as well as the quick downturn in 2007. This phenomenon also appeared in other countries, for example in Germany, UK and Spain. However, in Europe and in many other parts of the world, the subprime loans were originated by regulated, deposit-taking banks rather than, as in the U.S., by specialized mortgage brokers who did not operate under the same regulatory oversight (Mayer et al (2008)).

Before 2000, U.S. subprime lending only existed to some extent (see Figure 3.2), but shortly thereafter it increased significantly. With house prices expected to continue rising and new financial innovations available, subprime borrowers became a prime customer target for mortgage lenders. One popular mortgage product, devised by lenders, was the Adjustable Rate Mortgage (ARMs). ARMs were very beneficial for low income clients – they have low “teaser rates” and no down-payments are required. In short, ARMs are loans where interest rates change periodically. The benefit is that the initial interest rate usually is lower for ARMs than for fixed-rate mortgages, implying that the borrower faces a lower initial monthly payment than for traditional loans, thus more borrowers can afford home ownership and qualify for bigger loans. Lending institutions started to offer interest-only and payment-option loans. An interest-only ARM means that the borrower only pays the interest of the loan, but not the principal balance. A payment-option ARM means that the borrower can choose how much to pay each month; enough to cover the interest, less than the interest, or both the interest and the principal. Some ARMs even allow the borrower to postpone the interest due next period and add it to the principal.

The looser lending practices led up to that the homeownership rate reached a record of 69.2% by the end of 2004 (U.S. Census Bureau (2008)), which pushed housing prices to double digit growth in some areas (Lander et al (2008)). However, due to the subprime phenomenon, a large share of the mortgages that fuelled the home ownership rate and real-estate prices were of bad quality – Chomsisengphet et al (2006) suggest that the probability of default for nonprime loans is six times higher than for prime loans.

Another contributing factor to the increased lending was innovations in the process of securitizing mortgages (discussed in section 4.1). Securitizing mortgages is a way of granting funds for the loans, by selling the cash flow rights to investors. In the 1970s, the two government-sponsored enterprises (GSE), Fannie Mae and Freddie Mac (discussed in section 6.7), invented this method of financing to ease access to lending capital and to promote home ownership. Fannie Mae and Freddie Mac’s operations were originally restricted to prime borrowers who took loans with a principal below a certain limit and with decent credit scores. These were known as conforming loans. However, as time passed, new private actors entered the securitization market and developed products on non-conforming loans, based on less strict credit worthiness criteria. Up until the 1990s, this market stayed small but thereafter became a popular way for investors and mortgage brokers to finance real estate transactions across the country. Financial institutions, banks and brokers had developed a new industry for mortgages where they originated the loans but did not keep them, the way home ownership was traditionally financed.

New innovations in the mortgage market facilitated the run-up in subprime lending in the beginning of 2000. The funds were channelled through institutional investors that supported the origination of the subprime crisis as households, earlier not eligible for mortgage credits, now qualified for larger and larger loans.

3.3 How Subprime Lending Evolved

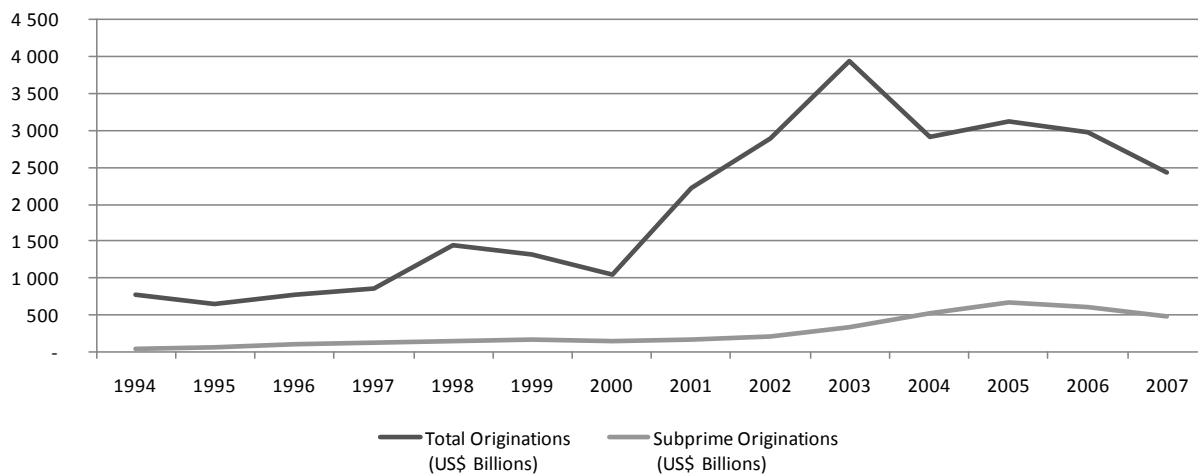
The mid- to late 1990s is often referred to as the origin of the subprime mortgage market. During the past decade, the growth of mortgages in the United States has been dramatic. The total loan origination has grown from \$639 billion in 1995 to \$2,430 billion in 2007, an increase of more than 280%. However in 2004-2007, the total origination dropped from a peak in 2003 where the home mortgages reached \$3,945 billion, an increase of 517% since 1995 (see Figure 3.1). In 2007, in the wake of the turbulence in financial markets, total loan amount fell sharply, primarily during the first half of the year. To put subprime lending into perspective it is important to view the subprime share of total mortgage originations. In 1994, the subprime mortgage share was still small compared to other loans. That particular year, the subprime-total origination ratio was less than 5% (\$35 billion). This ratio increased to 13% in 2000 (\$138 billion) and thereafter grew at a rate of more than 20% both in 2005 (\$665 billion) and 2006 (\$599 billion). During the same period, between 1994 and 2006, the share of subprime originations that was securitized, increased from 32% to 81%. Security issuance was no longer dominated by the leading GSEs Fannie Mae, Freddie Mac and Ginnie Mae (described in section 6.7). Mortgages issued and securitized by other non-agency entities increased almost 500% between 2000 and 2007, from \$386 billion to \$2.2 trillion.

Worth noting is that the subprime market share of total loan origination dropped from 14.5% in 1997 to 8.4% in 2003. Between these years, existing home mortgages were refinanced in surges as interest rates fell. Pennington-Cross (2003) shows that subprime loans tend to be less responsive to interest rate fluctuation and therefore should the market share of subprime mortgages fall during refinancing booms.

As seen in Figure 3.2, the number of loans originated between 2001 and 2006 quadrupled. During this period the average loan size almost doubled, from \$126,000 to \$212,000. There are many reasons why U.S. subprime lending has grown so fast during recent years; one of them is new legislation. In 1980 the Depository Institutions Deregulation and Monetary Control Act (DIDMCA) was adopted. This act enabled financial institutions and mortgage brokers to charge higher interest rates and fees to borrowers since it pre-empted state regulated interest caps. Two years later, another act to deregulate the mortgage market was adopted; The Alternative Mortgage Transaction Parity Act (AMTPA). As the AMTPA was

approved, lenders were permitted to offer mortgage products with variable interest rates and balloon payments to the market. Even though these laws were door openers for the subprime lending, it was not until the Tax Reform Act (TRA) of 1986 that subprime lending would be generally accepted as a lending alternative. The TRA prohibited interest deduction on consumer loans but allowed deduction of interest on primary home mortgages and one additional home. This meant that the demand for mortgage debt increased since it made even high fee mortgage loans cheaper than consumer loans for homeowners across the country. In times conditioned by low interest rates, such as the late 1990s and early 2000s, so called cash-out refinancing became popular for homeowners and bolstered spending on consumer goods. Cash-out refinancing means that the borrower can take a new mortgage which is larger than the old one and thereby receive the difference in cash, i.e. it is a way to access the value of the property. Since mortgagors could use this method to release cash from the equity in the house and use it for consumption it became so popular that more than one half of subprime loan originations have been for cash-out refinancing between 2001 and 2007 (see Table 3.1).

Figure 3.2 Subprime and Securitization of Home Mortgage Originations 1994-2006



Source: The 2007 Mortgage Market Statistical Annual, Inside Mortgage Finance

Table 3.1 Subprime loans statistics

Year	Size		Loan Purpose			Credit Score
	# Loans (x1000)	Avg Loan Size (x\$1000)	Purchase (%)	Refinancing (cash out) (%)	Refinancing (no cash out) (%)	FICO
2001	452	126	29.7	58.4	11.2	601.2
2002	737	145	29.3	57.4	12.9	608.9
2003	1258	164	30.1	57.7	11.8	618.1
2004	1911	180	35.8	56.5	7.7	618.3
2005	2274	200	41.3	52.4	6.3	620.9
2006	1772	212	42.4	51.4	6.2	618.1
2007	316	220	29.6	59,0	11.4	613.2

Source: Understanding the Subprime Mortgage Crisis, Demyanyk et al (2008)

In contradiction of what is generally acknowledged, the majority of the mortgage products introduced in recent years have been around for a long period of time. Negatively amortization loans of different kinds were introduced already during the mid-1980s. In 1982, the Alternative Mortgage Transaction Parity Act allowed loans with variable interest rates, balloon payments, and negative amortization on the market. However, new interpretations of traditional mortgage instruments providing more funds for the lending agencies entered the market in the 2000s.

According to Wachter (2008) it was the increase in the supply of credit that enabled the rapid growth of these aggressive lending instruments. Since 2003, different variations of ARMs has accounted for two-thirds of all loans in the United States. In 2004, non-prime mortgages continued to grow intensively. A particular ramp up in the number of negative amortization loans and ARMs was offered in the subprime market. This loosening in lending standards resulted in mortgages with higher relative probability of defaults. For example, data released by the Mortgage Bankers Association reveals that in the 3rd quarter of 2007, 43% of the adjustable rate mortgages extended to subprime borrowers started the foreclosure process. In early February of 2008, Fitch Ratings predicted that 48% of subprime loans fully securitized by major financial institutions in 2006 will go into default (Wachter (2008)). In 2006, the subprime mortgages reached 20.1% of the total mortgage market in the U.S. from 7.4% four years earlier.

4. Mortgage Instruments

4.1 Securitization

The aim of this section is to provide an understanding of how the securitization process works – an illustration of the chain where an individual's loan or mortgage ends up in the portfolio of a financial investor. Focus will be held on real-estate mortgages that are securitized, given the importance of this phenomenon during the financial crisis, but in general the same process can be applied to securitize any type of asset. Note that this is just an illustration, the process might be different in terms of participants in the chain, or include other or fewer steps, depending on the type of asset that is securitized and the institutions involved. The final product that evolves from the securitization process might be of different types, but in this section we denote the final product as an ABS (asset-backed security) for simplifying reasons. The phenomenon of securitization is often stated to be part of the originate-to-distribute model, where institutions that originate assets (in this example, mortgages) move them away from their balance sheet by distributing them to purchasers of ABSs. The advantages for institutions conducting in securitization is mainly that they are able to free up capital and liquidity by moving the assets away from the balance sheet. Furthermore, securitization is a way of providing liquidity and funding to mortgages – by investing in an ABS, a Japanese asset manager (for example) might finance the real-estate mortgages of U.S. home owners (Criado and Rixtel (2008)).

The securitization process starts with the borrower applying for a mortgage to be used to purchase a property or to refinance an existing mortgage. The application is made either directly to an originator, or through an intermediary such as a mortgage broker. The originator, that might be a commercial bank or another financial institution, underwrites the mortgage and initially funds and services the mortgage. The originator receives fees from the borrower, such as closing costs.

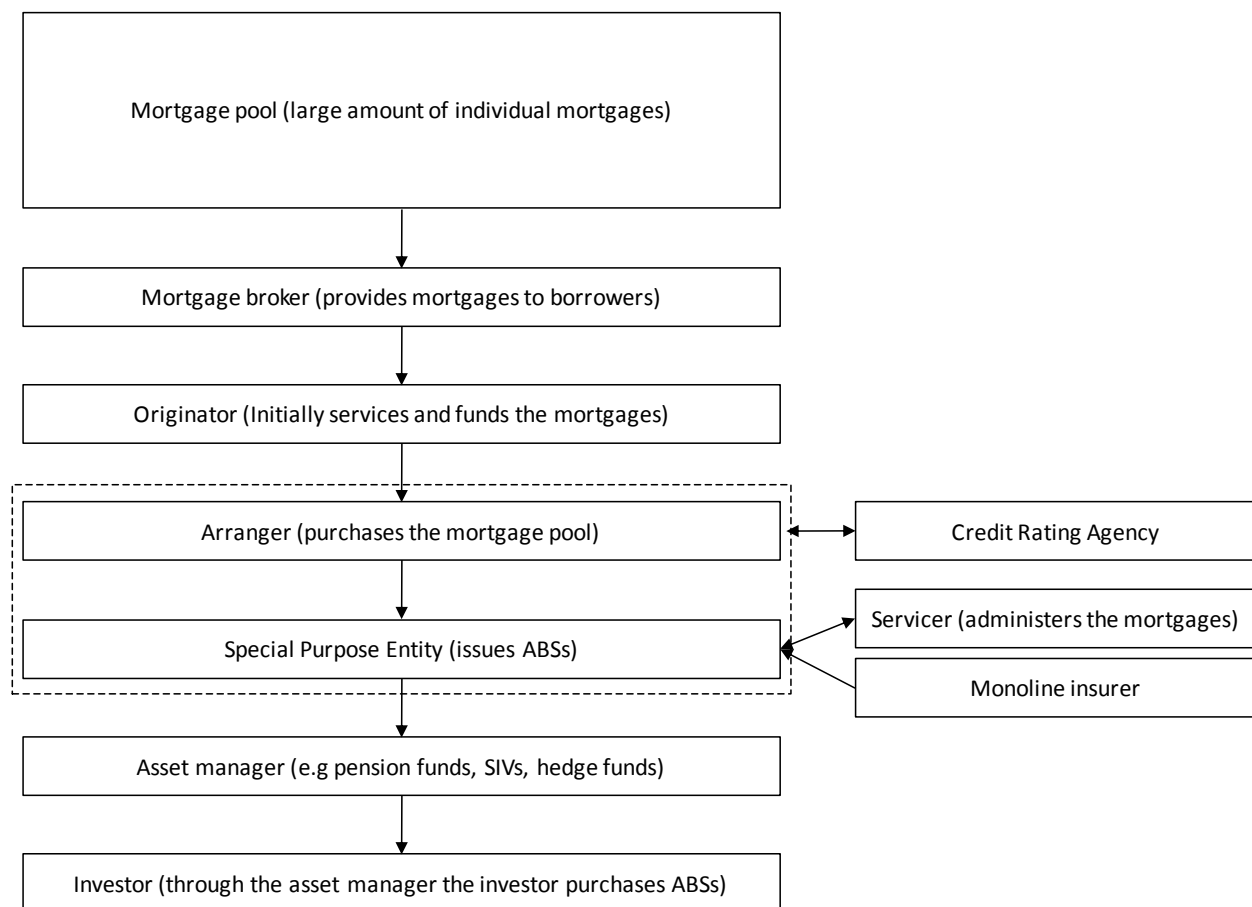
The mortgage is then pooled together with other mortgages and sold further to another institution, known as the arranger (or issuer). The price paid by the arranger is higher than the face value of the mortgage pool, accounting for future interest payments. The arranger sets up a bankruptcy-remote trust (e.g. a special purpose vehicle or a special purpose entity) through which the transaction is finalized. The rationale behind creating a bankruptcy-remote trust is that the assets and liabilities of the ABS must be legally separated from the banks other assets and liabilities and protected in case of default of the arranger.

The arranger can for example be a commercial bank that is both originator and arranger, or the arranger might be an investment bank or another financial institution. The pool of mortgages is then being

securitized and sold as ABSs to third-party asset managers, who are most often agents for the ultimate investors. In this stage the arranger typically consults a credit rating agency to finalize the details about the deal structure. Note that the asset pool that is being securitized might consist of other assets than mortgages, for example corporate bonds, credit card debt or student loans, making the pool more diversified than if the assets were all of the same type.

When the deal is finalized, i.e. the ABSs are sold to asset managers; the arranger receives fees from the asset managers/investors, as well as any premium that is being paid for the ABSs compared to their par value. The trust appoints a servicer who administers the mortgages, i.e. collects loan payments, offers customer service to the mortgagors, contacts delinquent borrowers and supervise foreclosures etc. The servicer might be a commercial bank or another financial institution, and it is being paid by a periodic fee from the trust. The trust has, through the servicer, the function of collecting cash flows from the collateral and passing them on to holders of the ABSs.

Figure 4.1 Overview of the securitization chain

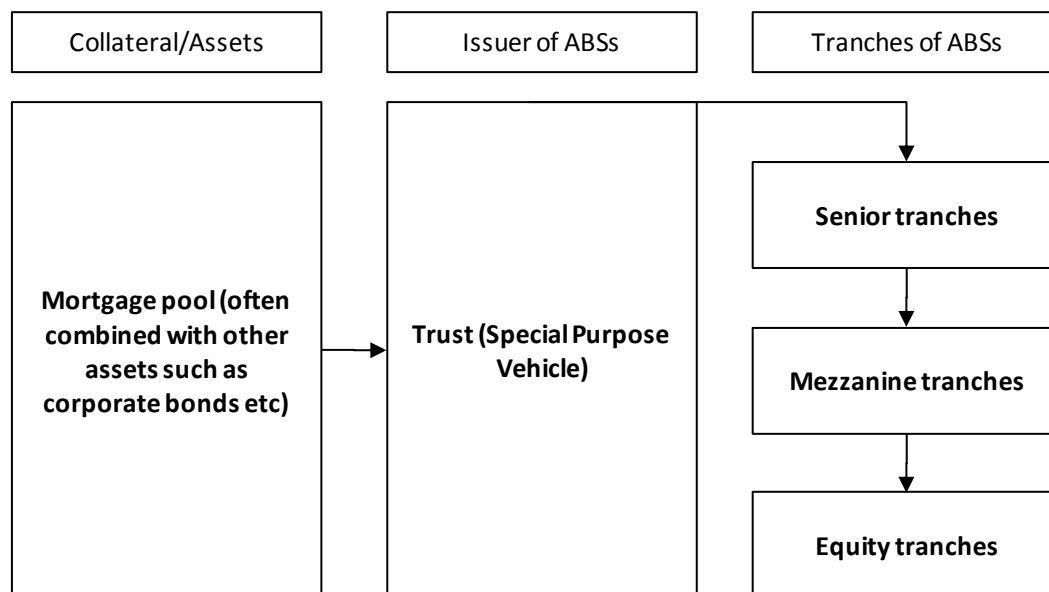


Source: authors' illustration

The process of securitizing assets is mainly based on two motives; 1) to move an asset (or the risk of an asset) away from the balance sheet, and 2) to make an arbitrary profit on the yield of the assets (the returns from the mortgage pool) compared to the yield of financing (i.e. the cash flow paid to the holders of the ABSs).

By securitizing assets and creating ABSs investors are given the opportunity to invest in securities that holds the cash flow rights from the underlying collateral. The ABS is divided into tranches with different levels of rights to the cash flow – when payments from the underlying collateral is collected, the holders of the most senior tranches are the first ones to receive their share of the cash flow and when they are paid in full the holders of the second most senior tranches (e.g. mezzanine tranches) receive their share. Finally, the holders of the least senior tranches (e.g. equity tranches) receive their share, if all other tranches are already paid in full. The cash flow chain of an ABS is illustrated in the simplified Figure 4.2 below:

Figure 4.2 Cash flow chain of an ABS transaction



Source: authors' illustration

By the system with tranches investors are offered instruments with different levels of risk, based on the same underlying collateral. The risks of the tranches vary with their cash flow rights – senior tranches that receive their share of the underlying cash flow first are the instruments with the lowest risk (compared to other tranches of the same collateral). As the cash flow rights decreases, the risk increases. This is for example illustrated by the fact that equity tranches receives their cash flow share

after all other more senior tranches have received their cash flow share. The design of an ABS makes it possible for investors to choose different levels of risks and thus different types of returns (the most senior tranches pay the lowest returns and the most junior tranches pay the highest returns). The tranches receive ratings from credit rating agencies with regards to their risk exposure, and the most senior tranches receive the highest ratings (of all the tranches in the ABS) and the ratings then commonly decreases with seniority. The total risk of the underlying collateral is not reduced by the securitization process, but the risks are rearranged to satisfy investors with different preferences. The securitization process makes it possible to create tranches that receive higher ratings than the weighted ratings of the underlying assets – Benmelech et al (2008) show that many senior tranches rated AAA have underlying assets with ratings less than AAA. This is referred to as a ratings arbitrage (Brunnermeier (2008)) and makes it possible for investors that are required to invest in instruments with certain ratings (e.g. pension funds) to be exposed to assets that they cannot invest in directly. A high rating is also beneficial for the issuer since the yield payable to investors can be set lower the higher the rating of the tranche. Ashcraft and Schuermann (2008) argue that the relationship between the arranger of an ABS and the credit rating agency that is consulted on the design of the ABS creates a potential conflict of interest, as the arranger have the opportunity to contract another credit rating agency should their products not receive the rating the arranger aim for.

The safety of a tranche is mainly dependent on two factors other than the health of the underlying assets, namely the degree of subordination under the tranche and the level of credit enhancement in the ABS. The subordination of a tranche is measured as the total size of the tranches junior to it – e.g. if an ABS consists of 75% senior tranches, then the senior tranches benefit from 25% of subordination. There are many types of credit enhancements; one that is commonly used is when the face value of the pooled assets of the ABS is higher than the face value of the repackaged securities. Such over-collateralization is used to reduce the investor's exposure to the underlying risk of the pool. Another form of credit enhancement is the "excess spread", where the total income from the assets exceeds the total payment made to senior and junior tranche holders (excluding equity tranches), fees to the issuer and other expenses. This is a protection against default since no tranche (except the equity tranche) incurs losses until defaults are high enough to turn the excess spread negative. As long as the excess spread is positive the holders of the equity tranches receives payments.

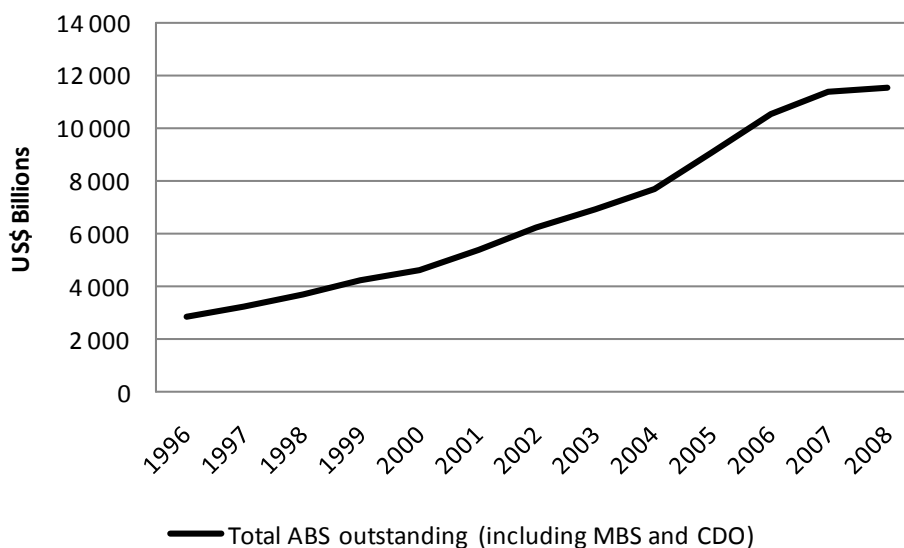
If the ABS consists of only one tranche it is called a "pass-through" security given their functioning as a simple structure conduit through which cash flows pass, from the collateral to the investor. Mason et al

(2007) argue that the complexity of structured finance products has increased over time, and that the number of tranches per securitization has increased accordingly.

4.1.1 Asset-Backed Securities – ABS

As described in the previous section, securitization is a process in which collateral (assets such as mortgages, credit card debt, student loans etc) are pooled together to form instruments known by the general umbrella term ABSs (asset-backed securities). The amount of ABSs outstanding has increased rapidly during previous years, implying that the phenomenon of securitization has grown in popularity. At the end of the first quarter in 2008, there were a total of \$11,569 billion worth of ABSs and mortgage-related debt outstanding in the U.S. bond market. The size of this market has shown substantial growth during the last decade – since 1996 the outstanding amount has increased by approximately 300% as shown in Figure 4.3.

Figure 4.3. ABS and mortgage-related debt outstanding in the U.S. 1996-2008 in \$billion



Source: Securities Industry and Financial Markets Association (SIFMA).

Note: the total amount includes agency and non-agency MBSs and CDOs.

As other fixed income instruments ABSs are valued as the present value of the discounted cash flows, adjusted for the risks associated with the instrument. Thus, an issuer of ABSs benefits from high ratings of the tranches, since this implies a higher selling price (or alternatively, lower yields paid to investors). The credit rating agencies rate not only the tranches of an ABS, but also the originating bank and the trust through which the transaction is finalized. Besides ratings from credit rating agencies, issuers might also turn to so called monoline-insurance companies (further discussed in section 6.6) to insure their

issued ABSs against default. This type of protection also implies less risk, and thus higher selling prices (or lower yields).

When issued, the tranches are given a coupon rate (also known as spread), typically LIBOR (London Interbank Offered Rate) plus X basis points, depending on the rating of the tranche (the coupon is increasing with decreasing rating). The coupon rate at launch is expressed as a percentage of the initial par value (value of the collateral pool in the tranche). If the market value of the tranche changes, the coupon is expressed as the percentage of the new market value – if the market value decreases, the coupon as a percentage thus increases.

There are many different types of ABSs – their names are dependent on the collateral on which they are based, for example, CLOs (collateralized loan obligations) hold loans as underlying collateral. In this paper CDOs (collateralized debt obligations) and MBSs (mortgage-backed securities) are given further attention since these types of ABSs are by many (e.g. Criado and Rixtel (2008)) stated as crucial factors behind the recent financial turmoil.

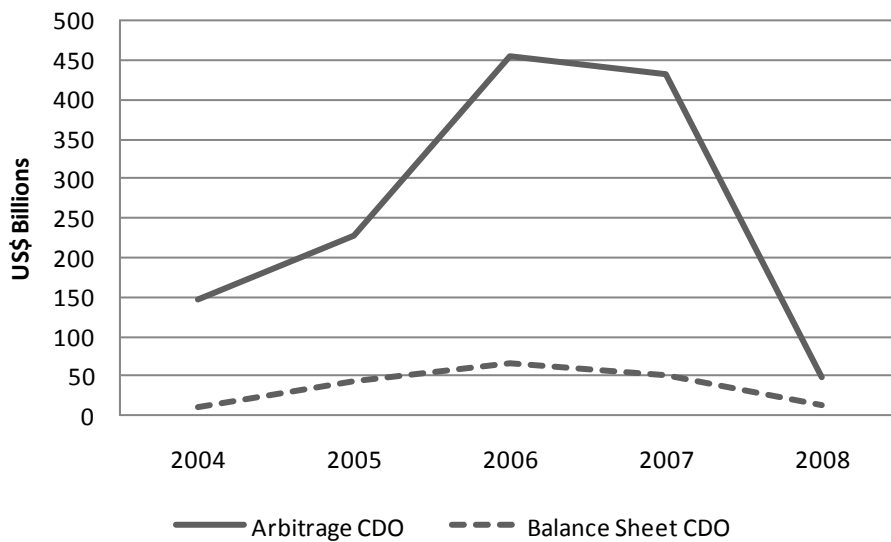
4.1.2 Collateralized Debt Obligations – CDO

CDOs are ABSs that are constructed by pooling and securitizing in particular higher risk assets such as risky loans or tranches of other ABSs (Criado and Rixtel (2008)). There are different types of classifications for CDOs and one of the most common is *cash flow CDOs*, a term relating to the scenario where the trust (special purpose vehicle or special purpose entity) involved in the securitization owns the underlying debt posted as collateral in the CDO. A *synthetic CDO* refers to the scenario where the trust does not own the underlying debt, and instead invests in CDSs (credit default swaps) to synthetically track their performance. The *hybrid CDO* combines cash flow CDOs and synthetic CDOs. The *ABS CDO*, also known as a *structured CDO*, refers to a securitization of another securitization, e.g. a CDO that holds tranches of another ABS as underlying collateral. There is also the *CDO squared* (CDO^2) which is a CDO that has securitized the tranches of another CDO. ABS CDOs and CDOs squared thus consist of a “double layered securitization” (Criado and Rixtel (2008)). Some tranches in an ABS CDO or CDO squared might have higher ratings than the average rating of the underlying tranches because of the securitized structure with different seniorities holding different cash flow rights – a phenomenon by some described as “ratings arbitrage” or “financial alchemy” (e.g. Benmelech et al (2008)).

Besides classifying the CDO upon its credit risk or upon the assets it holds as collateral, CDOs are also classified in terms of why they are created. As mentioned in section 4.1, ABSs are created for two main reasons, namely; 1) to move an asset away from the balance sheet, or 2) to make an arbitrary profit on

the difference between the returns from the collateral and the yield paid to investors in the ABS. At the issuance peak in 2006, the total global CDO issuance was approximately \$521 billion, and 87% of this amount was issued as arbitrage CDOs, and the rest as balance sheet CDOs. In 2008 the total amount issued had decreased to \$61 billion, of which 79% was issued as arbitrage CDOs. As seen in Figure 4.4 below, the CDO issuance during 2006 and 2007 was significantly higher than during the other years in the previous five-year period.

Figure 4.4 Global CDO issuance 2004-2008 in \$billion



Source: Securities Industry and Financial Markets Association (SIFMA)

An important difference between most CDOs and other ABSs is that CDOs are often created by securitizing pools of heterogeneous assets such as tranches of MBSs, while many other ABSs are created by securitizing pools of homogenous assets, such as mortgages. Criado and Rixtel (2008) argue that this collateral diversity makes the risk of CDOs harder to assess.

The U.S. organization SIFMA (Securities Industry and Financial Markets Association) has defined seven collateral classes that are securitized into CDOs; High Yield Loans, Investment Grade Bonds, High Yield Bonds, Structured Finance (includes assets such as MBSs, CDOs, CDSs among others), Mixed Collateral, Other Swaps and Other. Of the total global CDO issuance in 2005-2008 these collateral classes were represented in the following way:

Table 4.1 CDO issuance overview

CDO issuance by collateral	2005	2006	2007	2008
High Yield Loans	26.2%	33.0%	28.8%	42.9%
Investment Grade Bonds	1.5%	4.8%	16.3%	25.4%
High Yield Bonds	1.1%	0.2%	0.4%	0.0%
Structured Finance	65.0%	59.1%	53.8%	30.2%
Mixed Collateral	0.0%	0.0%	0.0%	0.0%
Other Swaps	0.9%	0.1%	0.2%	0.0%
Other	5.3%	2.8%	0.4%	1.6%
Total (USDbn)	272	521	482	61

Source: Securities Industry and Financial Markets Association (SIFMA)

As seen in Table 4.1 above, Structured Finance (i.e. collateral such as RMBSs, CMBSs, CMOs, ABSs, CDOs, CDSs and other securitized/structured products) constituted the majority collateral of CDOs issued in 2005-2007. This implies that a significant share of the CDOs issued were securitizations of other securitized products, further distancing the investor from the original assets.

4.1.3 Mortgage Backed Securities – MBS

As mentioned, ABSs that have securitized a pool of mortgages are denoted MBSs. A RMBS (residential mortgage-backed security) has securitized residential mortgages, and a CMBS (commercial mortgage-backed security) has securitized commercial mortgages. The securitized mortgages in a MBS are often dispersed geographically in an attempt to create diversification (based on the theory that real-estate prices are less correlated as the geographical distance between the real-estates grows). Given their collateral, the values of MBSs are sensitive to fluctuating prices of real-estate and as the U.S. real-estate prices started to decline in 2007, the MBSs were affected. When real-estate prices decline, the probability of default on mortgages increase as borrowers might not be able to sell their estate at or above the mortgage value, thus increasing the risks and lowering the value of MBSs holding the mortgages as collateral.

The collateral mortgages in a MBS might be of different qualities, i.e. prime, Alt-A² or subprime. As with all securitizations, the portfolio of mortgages is separated into tranches with different risk profiles and the tranches are sold to investors with different risk and yield preferences. For example, a MBS might consist of 75% of senior tranches that are AAA rated, and 25% of tranches below AAA.

² Alt-A is a mortgage where the credit worthiness of the mortgagor is between prime and subprime

The risks associated with MBSs are mainly twofold and consists of default risk and pre-payment risk. The default risk of a MBS is of the same sort as the default risk associated with most fixed-income instruments; namely the risk that the borrower will not repay, on time and in full, the principal and interest required by the security. By definition, the default risk of the MBS increases with the default risk of the mortgages in the underlying portfolio meaning that MBSs that holds subprime mortgages as underlying assets are riskier than MBSs holding prime mortgages as underlying assets. The other primary risk associated with MBSs is the pre-payment risk, which is the risk that the borrower will unexpectedly pay off the mortgage before the maturity ends (Mason et al (2007)).

The default risk is measured and calculated using FICO scores as the lender approves a mortgage to the borrower. This method is accepted by financial firms and their regulators as valid when determining default risk. The pre-payment risk on the other hand is hard to measure since it is a function of market risk such as interest rates and the level of competition among lenders, and there is no industry standard as to how the pre-payment risk should be measured. One could (falsely) argue that the pre-payment risk is less important since the investors receive full principal and interest payments upon pre payment – but, since pre payment normally occurs when interest rates are low the investor faces low interest rates on competing investments (re-investment risk). The complexity of measuring the pre-payment risk makes it difficult to project the future cash flow of the mortgage pool, and thus hard to value the MBS itself (Mason et al (2007)).

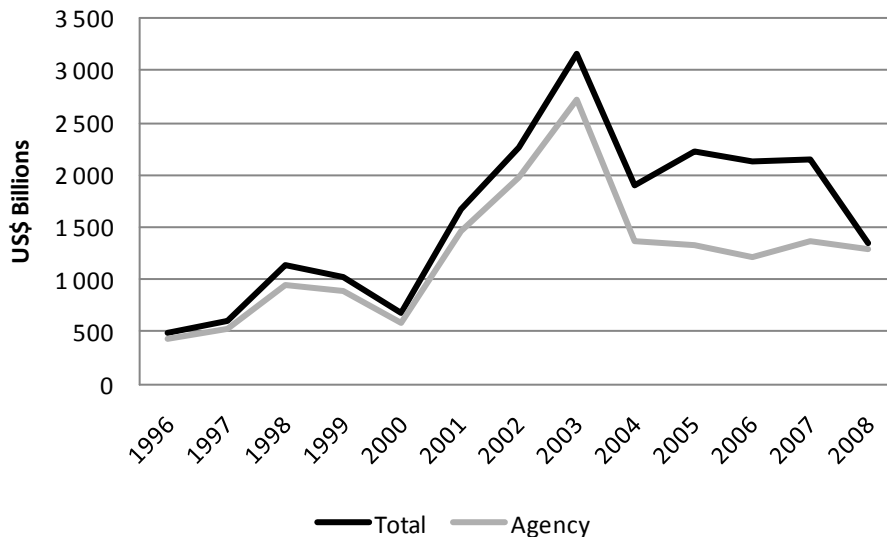
Furthermore, the mortgages used as collateral in MBSs seem to be of less quality than mortgages in general. Keys et al (2008) shows that mortgages originated with the intention to be securitized have larger probability to default, implying that securitized mortgages had laxer lending standards when approved.

Mason et al (2007) argue that MBSs are among the most mature and complex of structured finance products in the market since they often contain many tranches of securities, all of which include sophisticated features to deal with default, pre-payment and other inherent risks. The tranches might also include complex and difficult-to-value assets such as interest-only and principal-only strips, sequential pay securities and planned amortization class bonds.

MBSs (and other products based on securitized mortgages, such as CLOs) are either issued by agencies, i.e. GSEs (discussed in section 6.7), or by private institutions such as commercial banks. The total amount of mortgage-related issuance in the U.S bond market in 1996-2008 is shown in Figure 4.5,

together with the share issued by agencies (GSEs). As can be seen in the graph, the total amount issued peaked in 2003 at \$3,166 billion, and the non-agency amount issued was historically high in 2003-2007.

Figure 4.5 Mortgage-related issuance in the U.S bond market 2004-2008 (includes MBS and CMO)



Source: Securities Industry and Financial Markets Association (2008)

4.1.4 Credit Default Swaps – CDS

A bank that has issued a loan or has a position in a corporate bond or an ABS can insure it against default by buying a CDS (Credit Default Swap). The structure of a CDS is such that the buyer pays the seller a periodic fixed insurance fee, and in case of default on the underlying product, the notional amount (i.e. the original value of the underlying defaulted asset) is paid from the CDS seller to the buyer (less the recovery rate, i.e. the amount that can be recovered at default). CDS instruments are traded over-the-counter (OTC) in the open market, either directly or in the form of indices that consist of portfolios of CDSs, such as CDX in the U.S. or iTraxx in Europe (Brunnermeier (2008)).

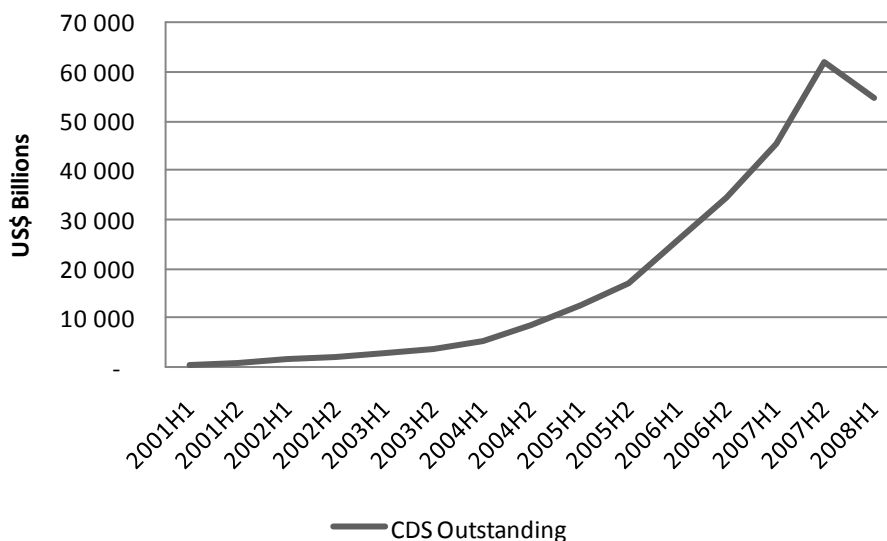
There are some important differences between a CDS and a traditional insurance; the seller of a CDS must not be a regulated entity (there are no capital requirements for the seller), and the buyer must not actually own or have a position in the underlying asset on which the CDS is written – a CDS can be bought for speculative reasons, a strategy that is far off from the CDSs original purpose, namely to transfer credit exposure of commercial loans from commercial banks to a third party (Zabel (2008)).

The spread of a CDS is the annual fee that the buyer pays the seller over the length of the contract, expressed as a percentage fraction of the notional amount. In theory the spread of the CDS is a measure

of probability that the protected asset will default – the higher the spread, the higher probability of default (determined by the CDS market). However, other factors such as market liquidity and estimated loss at default also affect the size of the spread.

The OTC trading of CDSs makes insight and transparency low, and many argue that the market should be subject to stricter regulations (Cox (2008a)). The CDS market has shown significant growth during the last decade – the International Swaps and Derivatives Association reports that in 2001, the value of all CDSs outstanding was \$632 billion and in 2007 the value was \$62 trillion; an increase of almost 10,000%. The development of the CDS market is shown in figure 4.6 below. The sharp growth in CDS contracts implies that the demand for protection against default on financial products has increased dramatically which reflects the increase in securitization during the same years. The figure also shows that during 2007, the amount outstanding decreased rapidly, which coincides with the downturn in the general capital markets.

Figure 4.6 CDS outstanding in the U.S. 2001-2008



Source: International Swaps and Derivatives Association

Duffie (2008) shows that the three largest buyer groups of CDSs are Trading Portfolios of Banks and Dealers (33%), Hedge Funds (31%) and Insurers (33%). The three largest groups of sellers of CDSs are Trading Portfolios of Banks and Dealers (39%), Hedge Funds (28%) and Loan Portfolios (20%).

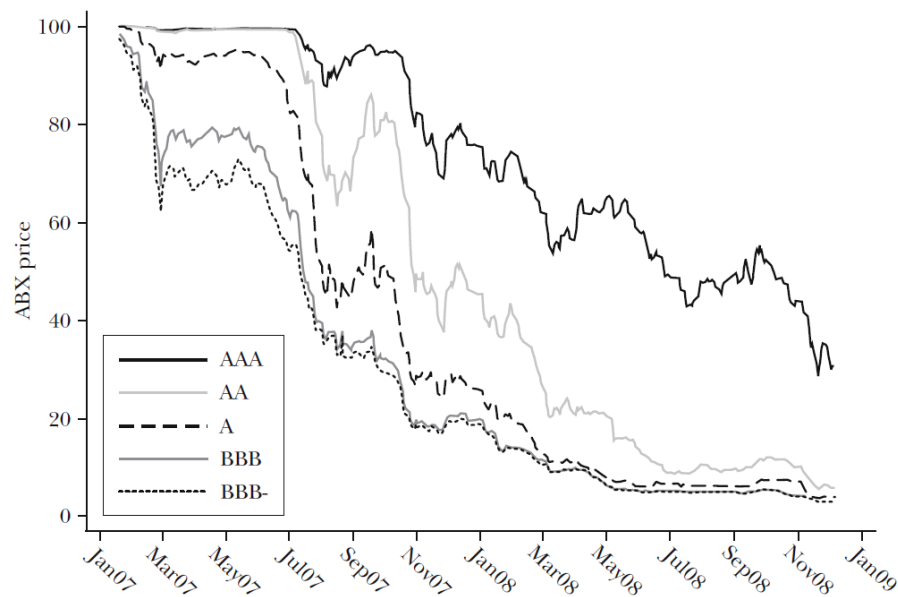
4.1.5 ABX Index

In 2006 the ABX indices were launched, for the first time providing a market aggregated view on the risks of ABSs related to mortgages. The indices are synthetically based on ABSs, meaning that they track

the price of credit default insurance on standardized baskets of home equity ABSs. There are several ABX indices, tracking credit default insurance on ABSs with different ratings and issuance period. For example, the index named ABX.HE.AAA.07-1 tracks the price of credit default insurance on home equity (denoted HE in the index name) ABSs rated AAA (denoted AAA) issued during the first half of 2007 (denoted 07-1).

At the semi-annual launch of new index series market participants collectively decides the coupon rate of the underlying ABS basket, i.e. the annual coupon that the credit default insurance buyer pays the seller to insure an ABS position. The index then expresses the extra up-front cost that the credit default insurance buyer must pay the seller, once market conditions has changed, calculated as 100 (par) minus the current index quote, divided by 100. Thus, if the index quote is 90, the credit default insurance buyer must pay the seller 10% of the value to be insured in addition to the fixed coupon rate. This implies that the lower the index is quoted, the higher is the cost to insure positions in the underlying asset basket. As the risk of ABSs as perceived by market participants increase, the index decreases.

Figure 4.7. ABX Indices – 07-1 series



Source: Brunnermeier (2009)

As seen in figure 4.7 above, the 07-1 series of the ABX index has decreased significantly since its launch in the beginning of 2007, showing heavy falls primarily during the second half of 2007. The decreasing indices implies that investors believe the risk of ABSs to be much higher than when the index was

launched, and logically, it is the indices tracking ABSs with lower ratings that has shown the largest declines.

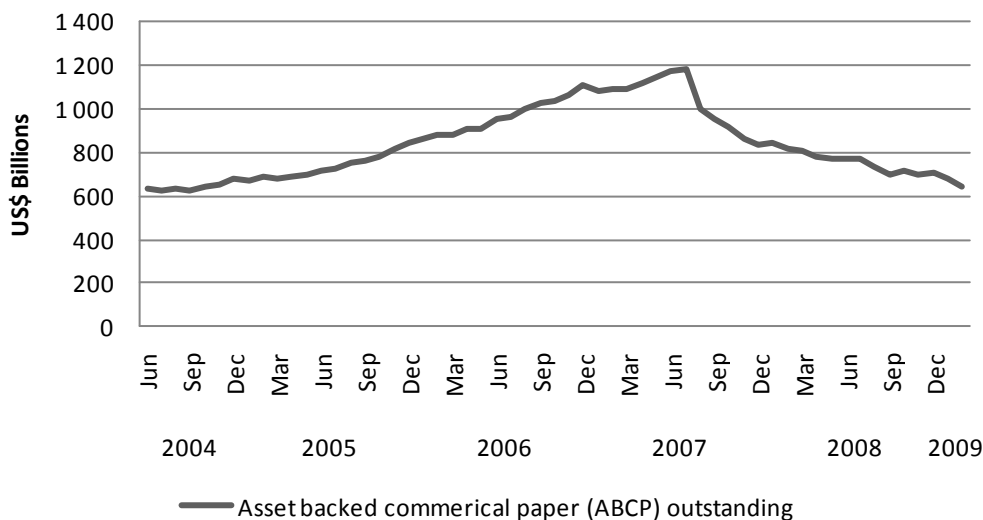
5. Money Market Instruments

5.1 Asset Backed Commercial Paper

An instrument that has gained in popularity during recent years is the ABCP (Asset Backed Commercial Paper). An ordinary CP (Commercial Paper) is a money market instrument with a fixed maturity of 1 to 270 days, and the instrument is not backed by any collateral, just the issuers promise to repay. An ABCP is a short-maturity paper with an average maturity of 90 days, and unlike the ordinary commercial paper, the ABCP can be issued by an institution that holds other assets as collateral, such as illiquid long-maturity assets, which are used as security. In case of default, the owner of the ABCP has the right to seize and sell the collateral. The strategy to invest in long-term assets using short-term funding exposes the investor to funding liquidity risk since the issued short-term papers must be rolled over (renewed) frequently.

Until 2007 funding through ABCPs increased dramatically – when the amount of outstanding ABCP peaked in July 2007 (at \$1,187bn) it had increased by 89% in three years (since July 2004). ABCPs then accounted for 55% of the total commercial paper market (totaling \$2,161bn in July 2007).

Figure 5.1 ABCP outstanding in the U.S. 2004-2009 in \$billion



Source: Securities Industry and Financial Markets Association

The sharp decrease of the ABCPs outstanding during the summer months of 2007 is related to the fact that investors started to fear that the underlying collateral of the commercial paper had larger probability of default than previously believed. This followed the sharp decrease in the ABX indices and the downgrading of several ABS during the same period. In August, Reuters (Shan (2007)) reported that the spreads on ABCPs increased significantly as investors lost confidence in the assets pledged as collateral, and even ABCPs with the highest rating were unattractive to investors such as money market funds, who instead turned to Treasury Bills. As seen in figure 5.1, the amount of ABCP outstanding in the beginning of 2009 has fallen back to approximately the same levels as in 2004.

Criado and Rixtel (2008) show that at the end of March 2007, the outstanding ABCP in the U.S. were as follows:

Table 5.1 ABCP exposure per mortgage type

Collateral	ABCP exposure
Mortgages	26%
CDOs	13%
Credit card loans	10%
Car loans	10%
Commercial loans	7%
Other	34%

Source: Criado and Rixtel (2008)

According to SIFMA, the total amount of ABCPs outstanding at the same time (end March 2007) was \$1,094 billion, implying that the ABCP total mortgage exposure was \$284 billion.

To buy highly rated medium and long-term assets by using funding from issuing cheaper (in terms of yield) highly rated short-term paper (e.g. ABCPs) became popular during the years leading up to 2007, and the strategy is successful as long as the commercial paper market is liquid (Brunnermeier (2008)). The liquidity requirement stems from the maturity transformation of the assets, i.e. the fact that the issued papers have shorter maturity than the bought assets – this means that the funding must be rolled over as the maturity expires, which requires functioning money markets. In case of default the held assets becomes property of the owner of the ABCP and the strategy fails. During the years before the crisis this strategy was executed by many so called off-balance-sheet vehicles such as SIVs.

ABCPs are issued through conduits, and Criado and Rixtel (2008) show that in March 2007, the different types of ABCP conduits held the following shares of the total U.S. ABCP market; Single-seller conduits (16%), Multi-seller conduits (54%), Securities arbitrage conduits (15%), Structured Investment Vehicles

including SIV-lites (10%). Single-seller conduits are based on a single collateral provider which sells collateral to the conduit – the seller can for example be a finance subsidiary of a large company. Multi-seller conduits are based on multiple collateral providers – they can for example be set up by a bank to provide financing for multiple clients. Securities arbitrage conduits exploit arbitrage opportunities, often by investing in long-term assets by issuing short-term ABCP. Structured Investment Vehicles also exploit arbitrage opportunities by investing in long-term assets by issuing short-term ABCP, and specifically invests in structured finance products such as ABSs (SIVs are further discussed in section 6.4).

5.2 Repurchase Agreements – Repos

A repurchase agreement, or a *repo*, is a short-term funding transaction where securities are used as collateral. The seller (borrower) commits to buy the same security back at a specified future date and price. The repurchase price includes the *repo rate*, i.e. the premium (funding cost) that the seller (borrower) pays the buyer (lender). The design of a repo is much like a traditional collateralized loan where the collateral is the securities used in the transaction. If the length of the repo is one (1) day the agreement is referred to as an *overnight repo*, and if it is longer than one day it is referred to as a *term repo*. For the buyer (lender), the transaction is referred to as a *reverse repo*.

The securities used as collateral in repos are, for example, federal agency securities, MBSs and other balance-sheet assets. Both parties in a repo transaction are subject to credit risk; if the seller (borrower) is unable to repurchase the securities the buyer (lender) keeps the collateral which might increase/decrease in market value, or if the market value of the collateral decreases during the length of the repo the seller (borrower) might be subject to a margin call and will have to post more collateral or cash. To limit risk repos are designed with a repo margin, a feature called the “haircut”, which is the difference between the original market value of the collateral and the amount borrowed, intended to serve as a cushion should the market value of the collateral decrease. The haircut is generally 1-3%, but might be much higher for borrowers of lower credit worthiness or for less liquid collateral. Another feature designed to limit risk in repos is the use of mark-to-market valuation where the value of collateral is updated regularly and the repo agreements change accordingly (Fabozzi (2007)).

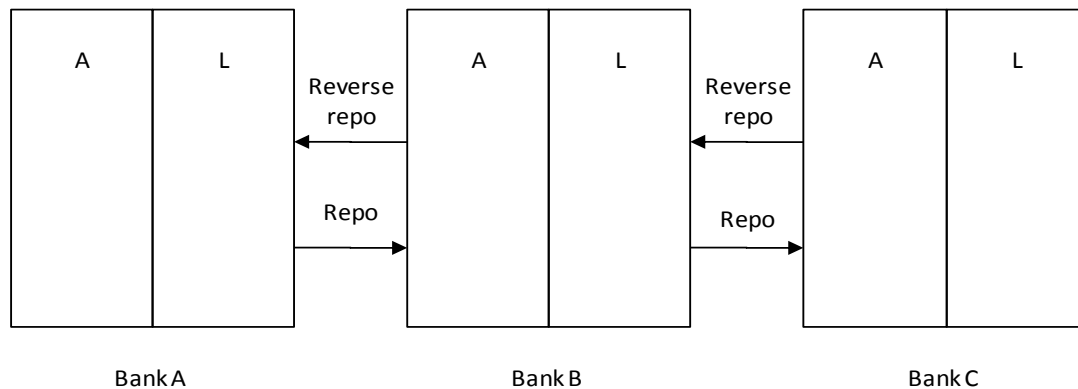
The haircut stipulates the possible leverage that an institution might have on its assets (through the use of repos); if, for example, the haircut is 2% the institution can borrow \$98 for every \$100 worth of securities pledged implying that it must provide \$2 of equity to hold securities worth \$100. The maximum leverage ratio (ratio of assets to equity) thus is 50. If the haircut would be doubled to 4%, the maximum leverage ratio would be 25 which then must be reached either by doubling the equity to 4, or

by selling half of the collateral (and changing the size of the repo). Morris and Shin (2008) argue that increases in haircuts are especially prevalent in times of financial stress and that the potential outcome of such events, raise of new equity or selling off collateral, is notoriously difficult in the same market conditions. Furthermore, the authors argue that if the financial system as a whole holds long-term, illiquid assets financed by short-term liabilities, the effects of sharp increases in haircuts will inevitably show up somewhere in the system. The possible leverage ratio is also affected if the market value of the collateral changes. If the value of the collateral decreases the borrower must provide the difference between the old market value (less the haircut) and the new market value (less the haircut). This is referred to as a margin call.

Overnight repos are commonly rolled over daily, meaning that the agreement is renewed as it expires each day. A repo transaction often interconnects many institutions since the holder of a reverse repo can net his holding by designing the equivalent repo agreement with a third institution. The third institution might in turn perform the same strategy with a fourth institution, and so on. This is illustrated in the following example:

Bank A holds MBSs and funds their position by pledging them as collateral in overnight repos. Bank A sells these securities to Bank B, at the same time agreeing to repurchase them the next day at a slightly higher pre-specified price. This procedure is repeated at the end of each day. For Bank A, the repo is entered as a liability on the bank's balance sheet. For Bank B, the reverse repo enters as an asset. To fund the lending to Bank A, Bank B will enter the same agreement, pledging the same securities, to Bank C. Now, Bank B has the overnight reverse repo to A on the asset side and the overnight repo to C on the liabilities side of the balance sheet. From a credit point of view, Bank B's position is safe since the loan is fully collateralized and protected if Bank A defaults. Since both are overnight transactions, B's balance sheet has a matching maturity profile, on the asset and liability side.

Since the financial institutions in this chain are closely linked to each other, the whole chain will be affected if one gets into trouble. To put it in the context of the example above; if Bank A's assets are illiquid, then the impact on Bank A's solvency of a run on its liabilities would be severe. If Bank B refuses to roll over the overnight reverse repos to Bank A, this will force Bank A to sell its assets.

Figure 5.2 Repurchase agreement interaction

The overnight repos became so important for the funding of investment banks that the repo share of total investment bank assets grew from 12% to over 25% between 2001 and 2007. In other words, in 2007, investment banks could roll over liabilities equivalent to one quarter of their balance sheet every day (Brunnermeier (2008)).

In the case of Bear Stearns, the frequent repo usage was one of the factors behind their near default in 2008. With a total balance sheet of approximately \$399 billion, and a leverage ratio of 33.5, they were highly dependent on the ability to roll over their debt. Furthermore, \$98.3 billion, or approximately 25% of their balance sheet was funded by collateralized borrowing, of which approximately \$75 billion was settled daily. Of Bear Stearns total long positions (that could be pledged as collateral), \$38.2 billion consisted of mortgages and MBS, which implies that a large share of the repos used by the company had these kinds of instruments as collateral and thus were sensitive to factors related to the mortgage market. The events surrounding Bear Stearns are further discussed in section 8.1.

6. Institutional Structure

6.1 Banks Capital Requirements

Banks are subject to restrictions in terms of capital requirements, meaning that regulations stipulate how much equity capital the banks have to have in relation to their total balance sheet. The regulations in each country are influenced by the Basel Committee on Banking Supervision at the Bank for International Settlements, and the system used to measure capital levels is referred to as the Basel Accord, or Basel I (which is being replaced by the Basel II). The primary capital ratio used is the Tier 1 capital ratio, which, simplified, is calculated as follows:

$$\textit{Tier 1 capital ratio} = \frac{\textit{Tier 1 capital}}{\textit{Risk weighted assets}}$$

where

$$\textit{Tier 1 capital} = \textit{Equity capital}$$

and

$$\textit{Risk weighted assets} = \textit{Value of outstanding debt} \times \textit{Risk weight}$$

The risk weight is dependent on several factors such as expected loss, probability of default, loss given default and exposure at default – for every asset (outstanding debt). Logically, riskier debt has higher risk weight and thus lowers the Tier 1 capital ratio.

When calculating the risk weights the bank might either use a standardized approach where all assets of a certain type are given the same risk weights or the internal models approach where all risk weights are calculated individually.

In the U.S., banks need to have a Tier 1 capital ratio of 6% in order to be considered well capitalized under federal bank regulatory agency definitions. The exact levels might differ across nations depending on national regulations. In section 6.4 the use of off-balance sheet vehicles in order to circumvent capital requirements is discussed.

6.2 How Investment Banks and Commercial Banks Differ

Investment banks and commercial banks are different from each other in some ways that have had implications during the crisis. Commercial banks are more regulated than investment banks. The main reason for this is that they accept insured deposits from the public. Since they are deposit takers they need significant capital requirement and they are required to back their loans with a larger share of equity than do investment banks. Investment banks, on the other hand, are not subject to the same

regulatory oversight. For this reason, these institutions may hold lower capital ratios than commercial banks, enabling them to take on more leverage.

If banks are caught in financial distress where they lack liquidity to meet withdrawals and contractual obligations they can borrow from the central bank. In the U.S., this lender of last resort facility is known as the *Federal Reserve Discount Window* and could, prior to 2008, be used by commercial banks only. It enables banks to borrow against collateral that the market will not finance.

Because of lacking regulations, investment banks, up until 2008, were not eligible for traditional discount loans in the U.S. But on March 16, 2008 the Federal Reserve decided to open the discount window for investment banks and brokers and created the Primary Dealer Credit Facility. The PDCF allows borrowers to pledge a relatively broad set of collateral including “investment-grade corporate securities, municipal securities, mortgage-backed securities and asset-backed securities for which a price is available” (Federal Reserve Bank of New York (2008)).

According to Cecchetti (2008) there are two main objectives for lending directly to primary dealers. The first objective is to enable short-term funding for investment banks. The experience with Bear Stearns, which sustained a sudden loss of short term funding but looks to have remained solvent, made Fed officials realize that lender of last resort operations needed to be extended beyond commercial banks. Secondly, the PDCF seeks to reduce interest-rate spreads between the asset-backed securities that can be used for collateral in these loans and U.S. Treasury securities, thereby improving the ability of investors to buy and sell asset-backed securities in financial markets.

6.3 Leverage of Banks

Leverage is defined as the ratio of total assets to equity, denoted as follows:

$$Leverage = \frac{Assets}{Assets - Debt}$$

The leverage formula implies that a passive investor who does not adjust his leverage at fluctuating values of his assets experiences declining leverage when asset values increase and vice versa (under the simplified assumption that the debt level can be held constant at fluctuating asset values). An intuitive approach to this phenomenon is that when someone’s total assets increase in value, his net worth increases and his leverage decreases, and vice versa.

Adrian and Shin (2007) show that the level of leverage for non-financial firms does not show a clear negative relationship between asset values and leverage suggesting that non-financial firms shifts their stance on leverage as asset values changes. For commercial banks, evidence implies that leverage is held fairly constant as asset values changes. Investment banks on the other hand show a strong positive relationship between changes in asset values and leverage, suggesting that as the economy booms and asset values rises, leverage of investment banks increases. The leverage relationship for investment banks thus is pro-cyclical.

If a firm is actively managing its balance sheet to maintain a constant leverage ratio, its actions is explained by the following example. The initial simplified balance sheet looks as follows:

Table 6.1

Assets	Liabilities
Securities 100	Equity 10
	Debt 90

The securities held on the asset side of the balance sheet are funded by 10 in equity and 90 in debt. The value (price) of debt is assumed to be approximately constant for small changes in total assets. If the value of the securities on the asset side increases by 1% the balance sheet now looks as follows:

Table 6.2

Assets	Liabilities
Securities 101	Equity 11
	Debt 90

The initial leverage ratio was 10 (100/10) and the new leverage ratio is 9.18 (101/11). In order to hold the leverage ratio constant, the firm must take on new debt of 9 and purchase securities for the same amount. The balance sheet then looks as follows:

Table 6.3

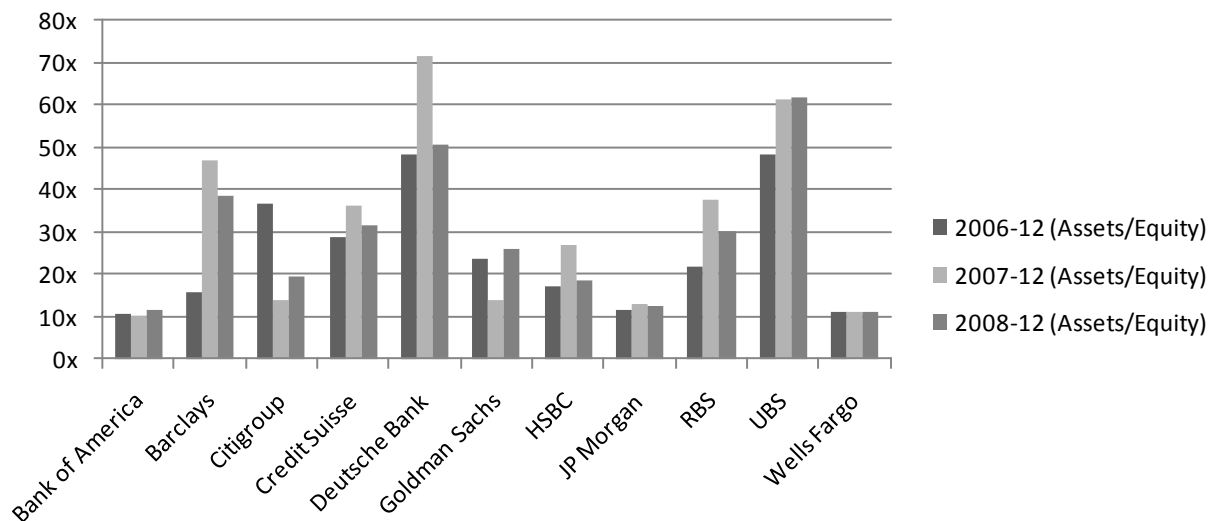
Assets	Liabilities
Securities 110	Equity 11
	Debt 99

The leverage thus becomes 10 again (110/11). As shown in the example an increase in asset values leads to the purchase of new assets. If the value of the securities had decreased instead of increased it had worked in reverse; securities would have been sold and debt would have been repaid to maintain the same leverage ratio. For a firm that entails a pro-cyclical leverage strategy (increases leverage with asset values) the effect is even greater; when asset values are increasing more new assets will be bought

(than in the example), and when asset values are decreasing more assets will be sold (than in the example). Adrian and Shin (2007) argue that the adjustment of leverage and fluctuating asset prices tends to reinforce each other.

As described in the previous section, 6.2, commercial banks are subject to restraints in terms of their leverage ratio since they are able to borrow funds from the Federal Reserve Discount Window. Up until 2004, the U.S. Securities and Exchange Commission (SEC) limited investment banks to a maximum leverage ratio of 12 for the top five U.S. investment banks, but during this year the restraint was abolished (Harish et al (2009)). The leverage ratios of 11 banks (both commercial banks and investment banks prior to the crisis) during the years 2006-2008 are shown in figure 6.1 below:

Figure 6.1 Leverage ratios of selected banks



Source: Annual Reports

6.4 Structured Investment Vehicles – SIVs

Due to capital requirements it might not be preferred by a bank to hold debt assets on its balance sheet and a method that (prior to the crisis) indirectly circumvented these regulations was the use of structured investment vehicles (SIVs). The operation of an SIV was, simplified, as follows:

1. The SIV was set up as a limited-purpose operating company separated from the bank initiating/sponsoring it
2. The SIV purchased long-term, illiquid, high-yielding assets (e.g. MBSs) from the sponsoring bank (or another financial institution)

3. The portfolio was funded by issuing short-term, liquid, commercial paper backed by the assets and a credit line from the sponsoring bank
4. The excess yield between the assets and the funding was either paid to the SIV investors or used to lower the amount of needed funding

SIVs tried to undertake arbitrage opportunities in capital requirements, market liquidity and/or credit ratings and were popular among banks and investors during the years prior to the crisis, but as a result of the financial turmoil they all ceased to exist as of October 2008, when all SIVs had either collapsed or been absorbed back to the sponsoring banks balance sheets (Euroweek (2008)).

Instead of holding mortgages on the balance sheet, banks could securitize them and transfer them to SIVs, supporting the vehicles with credit lines. The capital requirement recommended in Basel I for a contractual credit line is much lower than the capital requirement for holding a mortgage on the balance sheet, and the capital requirement for a reputational credit line was none. Basel II has more strict regulations but SIVs were still favorable for a long time since credit rating agencies did not fully adjust the banks ratings due to their credit lines to sponsored SIVs (Brunnermeier (2008)).

The assets in an SIV often had a weighted average life of approximately 3-4 years while the funding liabilities were short-term. SIVs could use funding (e.g. commercial paper, medium-term notes, and ABCP) that had higher ratings than the asset portfolio, making the funding costs lower than the asset yields, thus providing a profit to investors of the SIV. In order to preserve the initial ratings on their senior debt, SIVs must manage its asset and liability portfolio within pre-agreed limits, maintain enough liquidity to meet projected cash outflows, and mark-to-market the asset portfolio frequently (often daily). These procedures were carried out by an investment manager appointed by the SIV, and the manager typically was the sponsoring institution/bank (Moody's Investor Service (2002)).

SIVs mainly invested in assets of highest credit quality and followed portfolio diversification guidelines to reduce the credit risk of the portfolio to a minimum. The SIVs followed credit and investment policies predefined at the launch of the vehicle (Fitch Rating (2008)). The assets of an SIV might be CDOs, MBSs or other long-term institutional debt, but regulations stipulate that, aside from credit card debt, no single class of asset-backed bonds held by an SIV can constitute more than 20% of its portfolio, and assets must hold specific credit ratings to be approved (O'Leary et al (2008)). According to Standard & Poor (2007), in August 2007, the aggregated weighted average of the SIV portfolio assets rating were 61% in AAA, 27% in AA, 12% in A and less than 1% in lower rated assets.

A variant of the SIV was the so-called SIV-lite which differed from the traditional SIVs since their expected lifespan was defined at launch, in contrast to SIVs that theoretically could have an infinite expected lifespan. Compared to SIVs, SIV-lites held smaller and less diversified portfolios, and tended to invest exclusively in U.S. RMBSs and home-equity backed securities, making their exposure to the U.S. housing market larger than regular SIVs (Moody's Investor Service (2007a)).

The first SIV ever created (named Alpha Finance Corporation) was launched by Citibank in 1988, and up until 2007 a total of 30 SIVs and 6 SIV-lites were launched. The size of the assets under management of SIVs and SIV-lites peaked in the summer of 2007 at approximately \$400 billion and \$12 billion respectively, having doubled in three years (Khakee (2007)). The largest SIV held over \$55 billion worth of assets, and several of the more established SIVs held assets worth approximately \$20 billion each (Moody's Investor Service (2007a)).

Table 6.4 SIV market overview

SIV	Sponsor/Manager	Launch Date	Senior Notes ¹ (\$m)	Capital Notes ¹ (\$m)	Original Capital Rating	Capital Rating ²	Liquidity ¹ (\$m)
Asscher Finance Ltd.	HSBC Bank plc	2007	6 523	534	A2	Caa2	750
Axon Financial Funding Ltd.	Axon Asset Management Inc	2007	7 746	1 100	A1	Ca	125
Beta Finance Corp.	Citibank International Plc	1989	14 634	1 080	Baa1	Caa3	1 320
Carrera Capital Finance Ltd.	HSH Nordbank Securities S.A	2006	4 336	398	Baa2	Baa2	4 870
Centauri Corp.	Citibank International Plc	1996	15 227	1 208	Baa1	Caa3	1 417
Cheyne Finance Plc.	Cheyne Capital Management Ltd	2005	6 614	n/a	n/a	n/a	n/a
Cullinan Finance	HSBC Bank plc	2005	25 460	2 194	Baa2	Ca	1 711
Dorada Corp.	Citibank International Plc	1998	7 695	628	Baa1	Caa3	1 171
Five Finance Corp.	Citibank International Plc	1999	9 752	736	n/a	n/a	1 080
Harrier Finance Funding Ltd.	WestLB, New York	2002	10 092	988	Baa2	Caa2	1 090
Hudson-Thames Capital Ltd.	MBIA Asset Management	2005	460	35	Baa3	C	140
K2 Corp.	Dresdner Kleinwort	1999	18 271	2 125	n/a	n/a	1 705
Kestrel Funding	WestLB, New York	2006	3 152	315	Baa2	Caa3	300
Links Finance Corp.	Bank of Montreal	1999	17 456	1 866	Aa2 / A3	A1 / Caa2	800
Nightingale Finance Ltd	AIG-FP Capital Management Ltd	2007	2 375	301	Baa2	B3	482
Orion Finance Corp.	Eiger Capital Ltd.	1995	738	178	n/a	n/a	165
Parkland Finance Corp.	Bank of Montreal	2001	3 172	357	n/a	n/a	293
Premier Asset Collateralized Entity Ltd.	Société Générale, New York	2002	4 009	315	Baa2	Caa3	410
Rhinebridge Plc	IKB Credit Asset Management GmbH	2007	866	390	Aaa / A3 / Baa2	Caa3 / Ca / Withdrawn	250
Sedna Finance Corp.	Citibank International Plc	2004	9 728	973	n/a	n/a	1 317
Sigma Finance Corp.	Gordian Knot Ltd.	1994	36 307	3 703	n/a	n/a	4 387
Victoria Finance Ltd.	Ceres Capital	2002	6 329	777	Baa2	Ca	525
Tango Finance Corp.	Rabobank International	2002	6 900	567	Baa1	Caa3	1 050
Vetra Finance Corp.	Citibank International Plc	2006	824	155	n/a	n/a	383
Whistlejacket Capital Ltd.	Standard Chartered Bank	2002	8 717	929	Baa2	Ca2	1 508
Zela Finance Corp.	Citibank International Plc	2006	2 463	220	n/a	n/a	383
TOTAL			230 272	22 993			29 141

¹ As of November 30, 2007

² As of December 20, 2007

Source: Moody's Investor Service (2008)

ABCPs often comprised approximately 20% of the total funding of the biggest SIVs, although SIV-lites often used approximately 80-90% in ABCP funding (Gorton (2008)). Moody's Investor Service (2008) report that in July 2007 the senior debt of SIVs totaled \$352 billion of which 31.5% were commercial paper (including ABCP) and 68.1% medium-term notes (and 0.5% in repos).

As mentioned, the SIVs had a credit line (also called liquidity facility/back-stop facility) from the sponsoring bank, providing security to creditors, thus lowering the credit risk and thereby contributing to higher credit ratings of the funding products. The advantage of providing a credit line was that it did not have to cover 100% of the SIV liabilities – the typical credit line from a sponsoring bank covered between approximately 5 and 10% of the outstanding senior debt of an SIV, relying on the inherent liquidity of the asset portfolio for the remaining share (Moody's Investor Service (2002)). By providing credit lines the banks' still bear some of the liquidity risk if the commercial paper market would suddenly dry out and the SIVs cannot roll over their capital market securities and ABCP positions. This liquidity risk is much like the traditional banking system where commercial banks take on short-term deposits and invest in long-term projects (Brunnermeier (2008)).

By being separated from the bank, SIVs held the legal title "bankruptcy remote"³ which meant that they could obtain cheaper funding than the banks themselves. Technically, SIVs were separate from the banks, creating a "clean break" from the banks' balance sheets as defined by the Basel II Accord and did not add to the banks' capital requirements. But, although SIVs were bankruptcy remote from their owners, the owners (i.e. banks) could step in if the SIVs ran into financial trouble. This was possible through a footnote called "implicit recourse" outlined in the Basel II Accord that says a sponsoring bank might provide support to an SIV that exceeds the banks' contractual obligations to preserve its reputation and morale standing. This meant that if an SIV had financial troubles, its assets could be absorbed back to the balance sheet of the sponsoring bank (Gorton (2008)). O'Leary et al (2008) argue that this was done by the sponsoring banks mainly because many SIV counterparts were large clients to many areas of the banks, and letting them take the losses would constitute a reputational risk. Bank sponsors were also often investors in capital notes issued by the SIV and thus had economic incentives to maintain funding, apart from their desire to protect their reputation and client relations. To support an SIV, besides from granting the credit line, the sponsoring institution/bank could purchase commercial paper issued by the SIV, or purchase its assets at par rather than market value under standard repurchase documentation (Moody's Investor Service (2007a)).

³ A company that is bankruptcy remote from its owner will not be legally affected in case of owner default

O'Leary et al (2008) states that SIVs and other forms of conduits prior to the crisis were buying approximately 50% of all highly rated structured finance assets in the market, thus accounting for a significant part of the liquidity in this market. The aggregate SIV exposure to different asset classes in August 2007 were as follows; Financial debt 41.5%, RMBS prime 21.5%, CDO 13.2%, CMBS 7.6%, ABS 7.2%, Student loans 4.6%, Home equity loans/subprime 2.0%, CDO of ABS 0.3%, Corporate 0.2% and Other 2.0%. The direct exposure to the subprime market thus was small, and Standard & Poor's described the aggregated SIV portfolios as "highly diversified" at this time (Standard & Poor (2007)).

When credit markets started to experience troubles during the summer/fall of 2007, SIVs were badly hit as they began to have difficulties funding their operations. Moody's Investor Service (2007a) stated that SIVs issuing commercial paper found it impossible to finance their operations, or had to issue debt at yields up to 7.5 times above the average portfolio yield – clearly, this became a failure of the strategy to profit on the difference between asset and funding yields. Moody's Investor Service (2007a) reports that the majority of SIVs continued to issue debt either to an affiliate of the manager, or through ABCPs with maturities as short as overnight. Furthermore, the rating agency reported that the average NAV (NAV is the market value exceeding the senior debt, divided by paid-in equity capital) across the traditional SIV sector was 102% in the beginning of June, and approximately 71% at the beginning of November, following the decline in asset values (which, as mentioned above, are marked-to-market frequently). Regarding SIV-lites and those SIVs with significant subprime RMBS and CDO RMBS exposure the decline was even more rapid – from approximately 96% in the beginning of July to approximately 72% at the beginning of September. The development in the SIV sector made the ability to use alternative funding such as liquidity facilities and repurchase agreements crucial. In November 2007 there was a total of \$23 billion in SIV capital notes (the most junior securities) outstanding, securities that were widely held by banks (Moody's Investor Service (2007a/b)).

The severe impact on SIVs can be demonstrated by the fact that in November 2007, the assets under SIV management had decreased to approximately \$300 billion, from \$400 billion in July (Moody's Investor Service (2008)), and in April 2008 the assets under SIV management had further decreased to approximately \$190 billion (Fitch Ratings (2008)). Furthermore, one of the major SIV-sponsoring banks, Citigroup, announced in December 2007 that it would provide a support facility to its seven sponsored SIVs, absorbing their assets and liabilities to the banks balance sheet. The Citigroup-sponsored SIVs had a total asset value (net of cash and cash equivalents) of \$49 billion, down from \$87 billion in August the same year (Fitch (2007)).

In September 2008, the longest surviving SIV, Sigma (using repo funding, managed by financial institution Gordian Knot), received a notice of default from JP Morgan, one of its repo-counterparties meaning that the repo-agreements between them were closed out, triggering a close-out from all other 17 repo-counterparties. Sigma could not meet the counterparty's demands and thus defaulted. Sigma was the last SIV that had not yet collapsed, and its default marked the end of the SIV as a tool to move leverage off the balance sheet (Euroweek (2008)).

6.5 Credit Rating Agencies

Due to the lack of transparency in the CDO and MBS markets actors are dependent on the ratings from credit rating agencies when determining the risk of instruments such as CDOs and MBSs. The complexity of the instruments also makes it difficult for single buyers to assess their risks. The credit rating agencies acts as proxies for regulators, who are not present in the market.

When determining the probability of default of the underlying mortgages of CDOs and MBSs the principal rating agencies Standard & Poor's, Moody's and Fitch uses statistical models based on Monte Carlo simulations. When rating instruments prior to the crisis, the input data in the models consisted of information on the characteristics of the mortgage pool, in terms of credit scores of the borrowers, the cumulative loan-to-value ratio, documentation of income, whether the mortgages were the borrowers' primary residence or not, and historical default rates on similar mortgages. The historic default rates used were largely collected during the years 1992 until the early 2000s which implies that the input data might have been corrupt in terms of reliability, given the fact that home prices were increasing during this period, and default rates were low (Ashcraft et al (2008)).

Credit rating agencies receives fees from the issuers in return for providing advice and assessments on the credit quality of CDOs, MBSs and other instruments, and to provide specific ratings on different tranches. This relationship gives rise to conflict of interest – if issuers do not receive the rating they want, they can turn to another credit rating agency for the advice service, an act sometimes referred to as “ratings shopping”. Given the lack of transparency in the market and the reliance upon ratings, the credit rating agencies became the only actors judging risk in the entire market.

Gerardi et al. (2008) shows that the probability of a S&P ratings downgrade of an RMBS during the years 1978-2004 was much lower than the possibility of a ratings upgrade which reflects the low default rates prevailing during the period leading up to the current crisis. Between the first quarter of 2005 and the third quarter of 2007, 66% of all CDO ABSs were downgraded – 44% from investment grade to

speculative grade, including default. Of all RMBSs, 17% were downgraded – 10% from investment grade to speculative grade, including default (Crouhy et al (2008)).

6.6 Monoline Insurers

Monoline insurance companies guarantee the repayment of principal and interest in case of default of a bond issuer. The service is used by issuers in order to pay lower yields on the bonds issued, since the monoline insurance company lowers the risk of the bond and hence lowers the yield – monoline insurance thus can be seen as a way of hedging risk. The instruments insured ranges from municipal bonds to ABSs. Prior to the crisis, the bonds and structured products insured by monolines were perceived as entailing low risk, allowing the insurers to be highly leveraged. Some of the largest monolines had outstanding guarantees equivalent to 100-150 times equity capital (see Figure 6.4).

In order for a monoline insurance company to provide guarantee to an investor the company must hold a certain level of credit rating such that the investor is confident that the guarantee will be paid in full in case of issuer default. Thus, monoline insurers are monitored by credit rating agencies and are highly dependent on ratings high enough to support their outstanding insurances. Since a guarantee from a monoline insurance company adds financial strength to the issuers products, credit rating agencies can reevaluate the rating of, for example, a MBS if the issuer gets monoline insurance. Given a high rating of the monoline insurer, insurance can be bought by issuers that want to raise their rating to get funding at a lower cost which is profitable as long as the guarantee premium paid is less than the gain in cheaper funding. The implication is that the rating of the MBS is dependent not only on its underlying assets, but also the financial strength and rating of the monoline insurance company guaranteeing it.

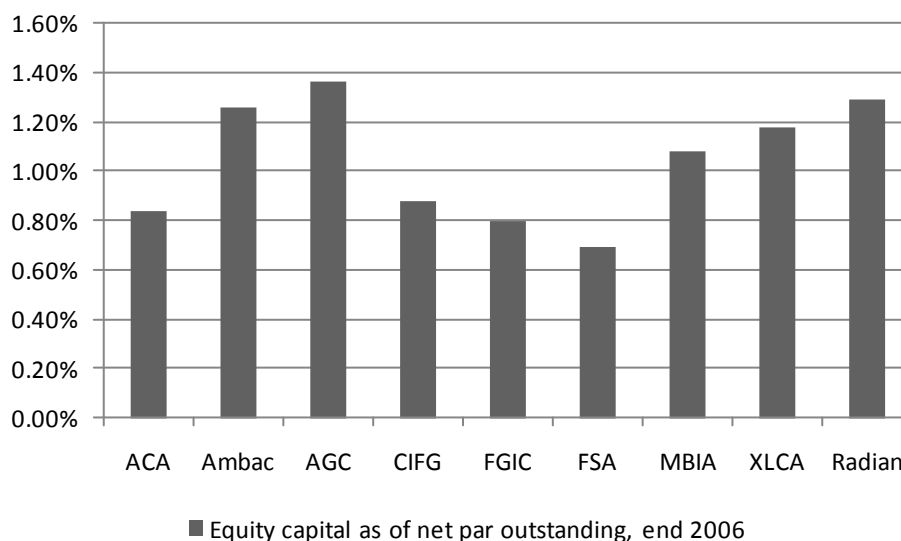
To provide an accurate and correctly priced guarantee to issuers, monoline companies must conduct running analysis of the issuers and the collateral used in their products and can therefore be seen as a market regulator. Examples of monoline insurers are Ambac Financial Group Inc. and MBIA Inc., both American companies listed at the New York Stock Exchange. In the financial guarantee sector there are nine main firms. Even though the industry is largely based in the U.S., 20% of the business reported on the balance sheets of these firms is regarded as international, and the assets guaranteed by insurers are held in portfolios worldwide (Schich (2008)).

Financial guarantors, such as monoline insurers, have played a key role in many securities markets, including the large U.S. municipal bond market as well as those for structured financial instruments such as CDOs. In January 2008, the seven largest monoline insurers had outstanding insurance on debt

instruments totaling \$2.4 trillion, of which \$100 billion was different types of CDOs with subprime mortgages as underlying assets (Richard (2008)).

Since 2007 monoline insurers have struggled to keep their AAA-ratings but no one has been able to inject enough equity capital in order to keep their ratings. From a systemic point of view, having high ratings are essential for monolines since a downgrading means that all the assets that they have insured automatically will be downgraded too. Due to the fact that many institutional investors only have mandate to invest in triple-A securities, a downgraded monoline may cause forced sales of those assets. Another problem for bondholders is that if the assets are downgraded under their fair value they must be marked down causing capital losses. Downgrading may cause issuers to lose their access to bond markets, a situation that will severely increase the cost of borrowing (Crouhy et al (2008)).

Figure 6.4 Equity capital of monoline insurers in relation to insured amount



Source: Schich (2008)

6.7 Government Sponsored Entities (GSE)

The GSEs (Government Sponsored Entities) in the U.S. are a group of financial services corporations initiated by the United States Congress with the function to enhance credit flows to targeted sectors of the economy. The GSEs are constructed to enhance the availability of credit and to reduce the cost of credit in specific sectors such as agriculture, home finance and education in the U.S. They are called GSEs because of the looser tax regulations they face, and the credit lines provided to them from the U.S. treasury.

The two most well known GSEs are Fannie Mae (Federal National Mortgage Association) and Freddie Mac (Federal Home Loan Mortgage Corporation), who operates in the secondary mortgage market. The primary mortgage market is where residential mortgage loans are originated in transactions between lenders and borrowers, and the secondary mortgage market is where mortgages are sold (often pooled and securitized as described in section 4.1) to investors in order to secure funding.

Fannie Mae was created in 1938 and Freddie Mac was created in 1970. They both have the public mission to expand affordable housing and the secondary mortgage market, and to bring global investments throughout the nation in order to serve the housing market. This is done by raising capital from investors through issuing debt securities and MBSs and using the proceeds to buy mortgages and thus financing housing. The MBSs issued by the GSEs are guaranteed, i.e. they guarantee the collateral payments to the MBS holders. Fannie Mae began issuing MBSs in 1981 and has been the largest agency issuer of MBSs since 1990 (Fannie Mae (2008)).

By providing liquidity in the secondary mortgage market the GSEs contributes to a functioning primary mortgage market, and given their role as provider of mortgage financing through issues of debt and MBSs, they are highly dependent on their credit ratings. Until 2008, Fannie Mae and Freddie Mac were public companies traded on the New York Stock Exchange and thus not directly backed by the U.S. government, but the role as a GSEs seemed to provide confidence to investors that the company could not default; Nobel Laureate in economics 2002, Smith (2007), called Fannie Mae and Freddie Mac “implicitly taxpayer-backed agencies /.../ housing lenders of last resort”. Smith highlighted the fact that the GSEs are seen as governmental agencies that will provide mortgage liquidity at any cost, and McDonald and Thornton (2008) argues that the fact that GSE debt were traded at interest rates often just a few basis points higher than equivalent government debt was a consequence of GSEs being seen as backed by the U.S. government.

During the financial turmoil in 2007-2008, Fannie Mae and Freddie Mac began to have troubles as the MBS market was affected by falling house prices and increasing delinquencies (in total, the two GSEs had \$5.4 trillion of guaranteed MBSs outstanding in 2008). On September 7, 2008, it was announced that Fannie Mae and Freddie Mac had been placed under conservatorship⁴ by the U.S. FHFA (Federal Housing Finance Agency). James B. Lockhart, director of FHFA, stated that the ability of the two GSEs to

⁴ Conservatorship is a statutory process intended to stabilize a troubled institution, by for example taking management control, with the objective of turning the institution into normal business operations

fulfill their mission had deteriorated and that the goal of the conservatorship was to “help restore confidence in Fannie Mae and Freddie Mac, enhance their capacity to fulfill their mission, and mitigate the systemic risk that has contributed directly to the instability in the current market” (FHFA (2008)). In addition to the conservatorship action, FHFA decided to issue preferred stock to the U.S. treasury, amounting to 79.9% of the share capital in each GSE.

GSEs are not the only institutions issuing mortgages; this can be done by private financial institutions as well, such as commercial banks. Figure 4.5 in section 4.1.3 shows the total and agency mortgage issuance during 1996-2008, and as can be seen from the graph the non-agency share was historically high during 2003-2007. This implies that the mortgage-related issuance grew in popularity among non-agency firms during the same period. At the issuance peak in 2003, the GSEs made mortgage-related issues of \$2,726 billion in the U.S. bond market, and the largest yearly amount issued by non-agencies was \$917 billion in 2006 (compared to the GSE amount of \$1,215 billion in the same year). In 2008 the non-agency issues totaled \$40 billion, a decrease of 96% compared to 2006 (SIFMA (2009)).

6.8 Mortgage Brokers

When lending money to the public, banks and lending institutions traditionally have sold their own products, i.e. sold their own loans. But as competition within the lending industry has increased the number of intermediaries marketing loans between the lender and the consumer have increased as well.

The role of a mortgage broker is to act as an intermediary between the industry and the market, matching borrowers and lenders. The role of a mortgage broker might differ depending on which state or country it is acting in because of different regulations of their responsibilities. Depending on jurisdiction the mortgage broker might act as a full adviser and have full financial responsibility if the advice is shown to be incorrect, or he might have a simple sales function where the borrower is pointed in a direction without advice or financial responsibility. The activities undertaken by a mortgage broker might include actions such as marketing, assessment of borrowers' circumstances such as credit history, finding a product that fits the client, gathering the needed documents, completing a lender application form, submitting material to the lender.

Brunnermeier (2008) argues that the phenomenon of loan securitization and the easy access to capital led to a scenario that allowed almost anyone to become a mortgage broker, often offering teaser rates,

no-documentation mortgages, piggyback mortgages⁵ and NINJA⁶ loans. According to the National Mortgage News (2007), the share of loans originated by mortgage brokers was at a record high of 68% in 2005, and two years later the share had fell to 60%.⁷

6.9 Federal Reserve

The Board of Governors of the Federal Reserve System (Federal Reserve) is a U.S. government agency. The Board consists of seven members appointed by the President of the U.S., and they are supported by a staff of approximately 2,000 persons. The Federal Reserve is responsible for the U.S. monetary policy and has its goal set by the Federal Reserve Act; “to promote effectively the goals of maximum employment, stable prices, and moderate long-term interest rates.” The agency is also responsible for the supervision and regulation of the twelve Federal Banks who in turn are each responsible for the supervision and regulation of the commercial banking system of a specific geographical area.

The goals of the monetary policy are pursued by the Federal Open Market Committee (FOMC) which consists of the seven members from the Board of Governors and five of the twelve Reserve Banks presidents. They set a target rate that their money market operations should follow. The money market operations are conducted almost daily and refer to the system where the FOMC trade money, i.e. borrow and lends according to the needs of their member banks. The money market operations in practice consists of buying and selling U.S. Treasury securities, often referred to as T-Bonds or T-Bills, with commercial banks as counterparts. By buying and selling these instruments the federal funds rate is adjusted towards the target rate by controlling the money supply, and the actions indirectly affects inflation, currency, savings, stock prices, household income etc which affects companies and individuals.

The system with a national central bank is implemented throughout the world; examples from Europe are the European Central Bank (ECB) and the Bank of England (BoE). A central bank plays an important role as the lender of last resort meaning that investors rely on the institution to provide credit when no one else will.

⁵ Two mortgages combined in such a way that the need for down payment is eliminated

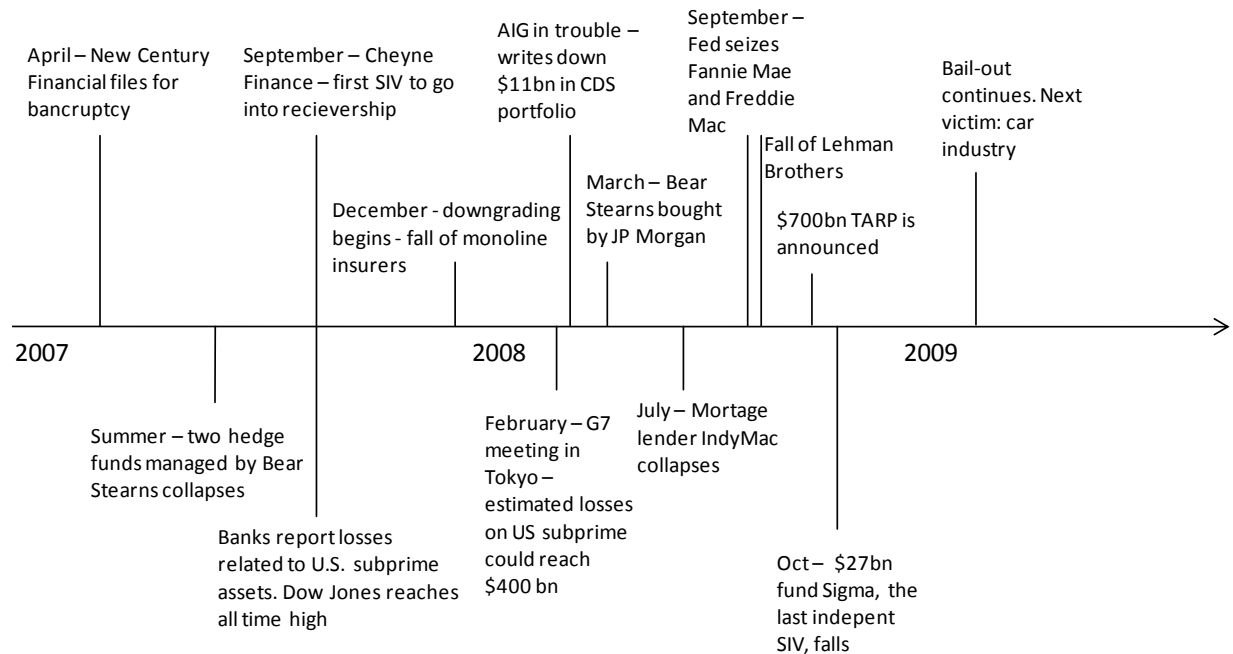
⁶ NINJA is an abbreviation of “No Income, No Job or Assets” referring to the borrower

⁷ National Mortgage News – June 2005, and May 2007

7. Timeline: Important Events During the Turmoil of 2007-2009⁸

As a base for this section, a simplified illustration of the timeline is presented, with selected major events during 2007-2009.

Figure 7.1 Timeline overview



Source: authors' illustration

Events during 2007

Warning signs

One of the early warning signs came in April 2007 when New Century Financial, at the time being one of the largest subprime lenders in the U.S., filed for chapter 11 bankruptcy. The event followed a sharp rise in customers defaulting on their loans, and the company creditors included investment banks Goldman Sachs, Morgan Stanley and Barclays Bank, creditors that were said to have claims of \$8.4 billion that New Century Financial was not able to repay.

In the summer of 2007, the global economy started to experience a striking deterioration in credit markets. Two hedge funds managed by Bear Stearns faced collapse as their mortgage related assets quickly decreased in value (these events are further described in section 8.1). In August, investment bank BNP Paribas told investors that they would not be able to take money out of two of their funds,

⁸ The timeline is sourced from news flows from various online sources such as Bloomberg.com, Wallstreetjournal.com, Reuters.com and company press releases

following troubles to value underlying assets due to a “complete evaporation of liquidity” in markets. In an attempt to stabilize the turmoil, central banks across the world started to take actions. The European Central Bank quickly decided to provide more than €200 billion into the funding markets to improve liquidity. The U.S. Fed cuts its primary discount rate by 50 basis points to 5.75%.

The troubles intensified in September as the German bank IKB announced losses of approximately €700mn related to subprime exposure through an ABCP conduit, turning their 2007 earnings negative. The CEO commented that the bank had total balance sheet credit investments of €6.2 billion of which €1.3 billion was subprime exposure. At this point, LIBOR reached 6.90% (3m GBP), compared to the Bank of England base rate (5.75%) and the punitive emergency lending rate (6.75%). The high level of LIBOR signaled that banks had become reluctant to lend to each other because of the uncertainty about exposure to subprime products. In the same month the U.S. Fed lowered its target for the federal funds rate by 50 basis points to 4.75%. Due to the “strains in longer-maturity money markets” Bank of England on the 19th of September announced an auction of initially £10bn, and stated that three more auctions would be held the coming weeks. The auctions would provide funds against a wider range of collateral, including mortgage collateral, than in the Bank’s weekly open market operations.

In September, the SIV Cheyne Finance went into receivership (i.e. its sponsor absorbed the responsibilities of the SIV’s assets and liabilities), the first SIV to do so. Two months later, in November, HSBC takes \$41 billion in SIV assets onto its balance sheet, and in December, West LB and HSH Nordbank bails out \$15 billion of their SIVs, while Citigroup absorbs its seven SIVs holding assets totaling \$49 billion.

During the autumn, international banks began to report losses. UBS, one of the world’s largest investment banks, announced in October that they would have to make write downs of \$3.4 billion mainly related to the US subprime RMBS market resulting in an overall loss of the third quarter. The CEO commented that the remaining positions in direct subprime RMBS had a current net value of \$19 billion. Citigroup announced subprime related losses of \$3.9 billion while Merrill Lynch announced write-downs of \$4.5 billion related to CDO’s and subprime investments.

In October, the Dow Jones Industrial Average Index reached its all time high at 14,164 index points. Sixteen months later, in February 2009, the index traded at approximately 8,000 index points, a decrease of more than 40%.

By the end of 2007, the US government reacted to the downturn in the housing market and announced plans to freeze rates on certain subprime mortgages in order to help people affected by the decreasing house prices. President George W Bush commented that US were facing a “serious challenge”, but that the economy remained resilient.

In December, Bank of England cut its official bank rate by 25 basis points to 5.5%. A few days later, US Fed co-ordinates an unprecedented action together with the European Central Bank, Bank of England, Bank of Canada and the Swiss National Bank to provide liquidity to the banking system through money-market auctions. The actions followed the current pressures in the short-term funding markets and were designed to decrease the relatively high inter-bank lending rates. The central banks said they will auction approximately \$100bn in this specific action.

By the end of 2007, rating agency Standard & Poor's had unveiled new dimensions of the crisis when they started to downgrade the rating on monoline insurers. As the monoline insurers were downgraded, so were the third-party bonds and companies that they had insured, spreading the effect through the financial system. Moreover, Standard & Poor's assigned negative outlooks to 18 SIVs, saying it doubted that the investment vehicles would survive as an asset class. S&P's actions came one week after Moody's Investors Service said it had or will cut ratings for over \$100 billion of debt issued by SIVs.

Events during 2008

January – March 2008

Big name casualties

On January 19th, the second-largest bond insurer in the world, Ambac Financial Group Inc. had its rating downgraded two levels from AAA to AA. At the time of the downgrade, Ambac had guaranteed bonds worth \$556 billion – guarantees that lost their significance since they were dependent on the top rating. Bloomberg reported that the seven AAA rated bonds insurers on the market at the time had outstanding guarantees on a total of \$2.4 trillion worth of bonds, of which \$100 billion was CDOs linked to subprime mortgages. If the ratings of the AAA insurers were all downgraded it could cost investors \$200 billion.

A rush to withdraw money from their commercial property funds forced Scottish Equitable to introduce delays of up to 12 months for investors wanting to withdraw money, they announced in January.

Citigroup announced subprime-related write downs in the fourth quarter of 2007 of \$18.1 billion, and said that they will raise \$12.5 billion from investors to shore up the balance sheet. Meanwhile, JP Morgan announced subprime-related write-downs of \$1.3 billion. U.S. Fed described the economic

outlook as grim and cut interest rates 75 basis points to 3.5% on January 22nd – their largest cut in 25 years.

On February 11th, The Group of Seven Finance Ministers met in Tokyo and projected that the write off losses on U.S. subprime mortgages could reach \$400 billion. The Japanese Financial Services Agency showed that losses from the Japanese exposure to the subprime crisis reached \$5.6 billion in 2007, where half came in the last three months of the year.

The same day as the G7 meeting in Tokyo, several banks reported troubles with their SIVs. Standard Chartered announced that it will appoint a receiver to run its \$7.2 billion Whistlejacket Capital SIV after the investment vehicle had lost more than half its NAV. Whistlejacket would become the sixth SIV to fail on its debt obligations after defaults by funds including Axon Financial Funding, Victoria Finance, Cheyne Finance and Rhinebridge. According to S&P, SIVs now had defaulted on more than \$27 billion of senior debt since October. Also HSBC stepped in to support their SIVs after the total SIV market assets had been reduced by more than \$100 billion from a peak of \$400 billion in the previous year. To avoid fire sales of SIVs, the U.S. Treasury Secretary Henry Paulson proposed to set up an \$80 billion SIV bailout fund. Citigroup, Bank of America and JPMorgan Chase abandoned the so-called Super SIV after banks began rescuing their own funds, led by HSBC.

Two weeks later, AIG announced a fourth quarter loss of \$5.2 billion, the second consecutive quarter of losses. The loss followed write-downs of \$11.12 billion on their large credit default swap portfolio. At the moment, AIG had written \$78 billion in CDSs that could be at trouble if the housing market downturn would continue.

The largest bank in the UK, HSBC, reports a write-down loss of \$17.2bn, related to their U.S. mortgage portfolio (March 3rd). A few days later, the largest retail bank in France, Credit Agricole, announced subprime-related write downs of €3.3 billion. On the 11th of March, U.S. Fed makes \$200 billion of funds available to banks and other institutions to try to improve liquidity in the markets.

In the beginning of March, rumors saying that Bear Stearns had liquidity problems hit investors, and the share plummets. The management initially denies the rumors saying that the volatility in the share is created by speculators. A few days later the bank reports that their liquidity has decreased as investors have reacted to the illiquidity rumors. On March 16th it is announced that Bear Stearns will be bought and merged with J.P. Morgan Chase at \$2 per share (compared to a market share price of \$30 two days

earlier), implying a total market cap of \$240 million (the offer was later raised and followed through at \$10 per share). The Bear Stearns event is further discussed in section 8.1.

April – June 2008

Mortgages consigned to history

On April 1st, UBS announces first quarter write downs of \$19 billion on its U.S. holdings. Deutsche Bank announces first quarter write downs of \$3.9 billion. At the same time, Moneyfacts, a U.K. financial information group, showed that the number of mortgages available in the U.K. had dropped 40% in the last month. The last bank offering 100% loans now disappeared from the U.K. market, saying that changed conditions regarding subprime defaults caused the withdrawal of the product.

IMF release new projections regarding global losses from the financial crisis, estimating losses of up to \$945 billion. Bank of England cuts its official bank rate by 25 basis points to 5.0% and offers to acquire U.K. banks' mortgage-backed securities for up to three years in return for Treasury bills, a plan worth £50 billion (April 22nd). One of the more troubled banks, The Royal Bank of Scotland, announced a deeply discounted £12 billion rights issue in an attempt to raise capital to cover £5.9 billion in write downs on its April-June investments. The issue was the largest in U.K. corporate history.

In May 2008, Fitch Ratings estimated losses by banks on subprime RMBS and CDO ABS exposures to \$165 billion. Given the size of the subprime market, which was estimated to have originated \$1.4 trillion of loans between 2005 and 2007, Fitch estimates total losses for the market to be in the region of \$400 billion. Approximately \$200 billion, equivalent to 50% of these losses were estimated to reside with banks, while the remaining 50% was estimated to be distributed between insurers, monolines, asset-managers and hedge funds. Up to date, banks had reported losses of approximately \$165.3 billion. Four banks accounted for approximately 60% of the losses. The remaining 40% is accounted for by more than 50 banks.

Table 7.1 Estimated Bank Losses per Region

Institution	Total Losses (\$bn)	Region	Total Losses (\$bn)
Citigroup	21	Europe	77
Merrill Lynch	28	Asia	10
UBS	38	USA	78
IKB	12		
TOTAL	98	TOTAL	165

Source: Fitch Ratings (2008)

On June 6th, Standard & Poor's downgraded the world's two largest bond insurers, MBIA and Ambac, from AAA to AA. It is feared that banks might face further write downs of \$10 billion because of the downgrade. Citigroup, Merrill Lynch and UBS are said to have the most exposure to the insurance companies. Lehman Brothers reports a \$2.8 billion second quarter loss – the first loss in the company's 14 year history as a public company. The insurance company AIG reports a first quarter loss of \$7.8 billion, mainly due to write downs on their CDS portfolio.

July – September 2008

The eye of the storm

In the summer of 2008, banks continue to suffer. On July 12th, U.S. mortgage lender IndyMac collapses - the second-biggest bank in U.S. history to fail. The collapse was due to troubles meeting demand for withdrawals by customers. In Spain, one of the country's largest property companies, Martinsa-Fadesa, files for bankruptcy. The action came after the company failed to raise equity needed to complete a €4 billion debt refinancing with banks. Merrill Lynch reported write downs of \$9.4 billion from mortgage-related assets and hedges with bond insurers. The company still had \$50 billion in CDOs, subprime mortgages and real-estate assets that could lead to further losses and announced an \$8.5 billion share offering.

Problems on the real estate market worsened. On July 23rd, The U.S. House of Representatives passed a housing bill which contained a rescue plan for Freddie Mac and Fannie Mae along with giving the government power to guarantee up to \$300 billion in mortgages refinanced through the Federal Housing Administration. Standard & Poor showed that U.S. home prices dropped 15.8% in May – the largest drop since the measuring started and slightly larger than the 15.3% drop in April. In the U.K., home prices had fallen 11% from January to July 2008.

In September 2008 the crisis moved beyond its origin in subprime mortgages and began to accelerate in ways few could have predicted. The global economy was in shock and experienced what is said to be the most dramatic weeks in the history of modern times – some of the most hallowed names on Wall Street, such as Merrill Lynch, AIG, Wachovia, Fannie Mae, Freddie Mac, Washington Mutual and Lehman Brothers were soon to be casualties of the crisis.

On September 7th, The U.S. Fed had to seize the nation's two largest mortgages companies, Fannie Mae and Freddie Mac. In an extraordinary intervention, FED provided financial aid of \$100 billion to each company, to backstop capital shortfalls. The two institutions owned or guaranteed \$5.4 trillion in loan products, or about half of the U.S. mortgage market. Because of their size and importance for the

economy as a whole, the U.S. Federal Reserve was forced to bailout these institutions, to avert a total collapse of the financial system. Investors feared that the take-over could lead to a default of up to \$500 billion in CDSs.

At the same time as the bailout of Fannie Mae and Freddie Mac, the investment banks Lehman Brothers, Merrill Lynch and the insurance company AIG struggled after losing more than half of their market values. As Lehman was approaching bankruptcy, speculation arose that the government would not intervene this time and come to Lehman's rescue, as they previously had done with Bear Stearns six months earlier (through the merger with J.P. Morgan).

September 14th became an historical day in modern financial markets. Lehman Brothers filed for bankruptcy and liquidation after all attempts to find a buyer had failed. On the same day it was announced that Merrill Lynch agreed to be bought by Bank of America for \$50 billion. In the financial turmoil, the Dow Jones Industrial average fell 504 index points, the largest drop since the 9/11 terrorist attacks, while the implied volatility of the S&P100 skyrocketed. Within days, this index, commonly known as the index of "financial fear", had doubled since the subprime crisis first emerged during the summer of 2007. This increase in market uncertainty quickly jumped to levels that were seen during the Cuban missile crisis and the Gulf War.

Two days after the collapse of Lehman, the U.S. Federal Reserve decides to take over AIG after an \$85 billion loan. As one of the world's largest insurance companies, AIG, faced billions of dollars in losses due to high exposure to CDSs that was no longer considered safe. The Dow Jones index fell another 500 points and the yields on treasury bills were pushed close to zero. Safer investments, such as treasury bills and commodities, were among the winners. For example, the gold had its biggest one-day gain in nearly 10 years.

As a consequence of the turbulence and falling asset values, the Bush Administration in September proposed a rescue plan. In their bailout package, the Treasury Department was requested to buy \$700 billion worth of distressed mortgage related assets from financial institutions in a program called Troubled Assets Relief Program (TARP).

Bloomberg report that Sigma Finance Corp., the \$28 billion SIV run by Gordian Knot in London had ratings on its debt placed under review for new downgrades by S&P. Sigma had \$27.5 billion of assets. It had \$6.3 billion of medium-term debt and \$3.9 billion of lower-ranking capital notes outstanding and \$17.3 billion of repurchase financing from banks. The company had sold more than \$25 billion of assets

since the start of the credit crisis, including swapping assets with creditors, according to S&P. Rumours that Sigma faced significant losses made Moody's cut Sigma's senior debt 13 steps to Ca, its second-lowest rating, from A3. S&P cut the fund's rating 13 levels to CCC- from A.

By the end of the month, Wachovia, the fourth largest retail bank in U.S., was in the hands of Citibank and Wells Fargo and the two last big independent investment banks, Goldman Sachs and Morgan Stanley, had announced that they would transform into banking holding companies subject to greater regulation to be able to participate in the bailout packages. The sixth largest bank in the U.S., Washington Mutual, had its assets seized by the government, after facing large problems with exposure to subprime-related investments, and the event was the largest bank failure in U.S. history.

The wave of consolidation and restructuring in the financial sector had now come to Europe. The Dutch bank Fortis was in financial distress and was acquired by BNP Paribas in France.

October – December 2008

Crisis spreads

Sigma Finance Corp, the \$27 billion fund run by Gordian Knot Ltd and known as the last independent SIV, announced in the beginning of October that it would cease trading and expected a receiver to be appointed, blaming recent volatility in financial markets.

Iceland, one of the world's richest countries in terms of GDP/capita and with an explosive financial sector sized 8 times GDP, showed signs of overheating and was granted a multibillion dollar loan from Russia and Sweden to stay out of national bankruptcy. The German, Spanish, French, British as well as the Swedish government raised the guarantee level in all private savings accounts. The leading central banks all over the world coordinated simultaneous interest rate cuts to halt the collapse on global stock markets and freeze in credit markets. On October 8th, a group of 7 nations, including The Federal Reserve, The European Central Bank (ECB), the central banks of Canada and Sweden reduced lending rates by 50 basis points. The efforts led to a brief rally on European and American stock markets with high volatility. However, on October 10th, stocks were down for seven consecutive days, with the Dow Jones Index posting its worst week on record, down 15.1%.

With record low levels of consumer confidence, October 2008, was the most volatile month in Wall Street history. S&P500 posted its worst month since the 1987 crash and consumer spending fell for the first time in 17 years.

In November, European central banks continued to cut interest rates. Bank of England lowered their interest rate by 150 basis points to 3.0%, the lowest level since 1955. To further boost the consumption and to save the country from deep recession, the U.K. government announced a temporary 2.5 percentage points VAT cut. The European Central Bank followed shortly thereafter and dropped the euro zone rates 50 basis points point to 3.25%. On November 14th, the euro zone slipped into recession after revealing the Q3 GDP figures showing a 0.2% decline. By the end of November, the European Commission presented a €200 billion recovery plan with the objective to save millions of European jobs, to stimulate spending and to bring back confidence among consumers. At the same time in the U.S., the National Bureau of Economic research declared that the nation now officially had entered recession.

The turmoil in the banking sector proceeded. Goldman Sachs reported a Q4 loss of \$2 billion, the first quarterly loss since the company's IPO in 1999. Worsening outlook in the sector led up to that S&P downgraded eleven of the largest banks in the world in both US and Europe, including J.P. Morgan Chase, Bank of America, Wells Fargo, Citigroup, Morgan Stanley, Goldman Sachs, Barclays, Credit Suisse, Deutsche Bank, Royal Bank of Scotland and UBS. With a frozen credit market, M&A activity plunged. Global mergers and acquisitions reached \$3,280 billion, down 29% y-o-y. Due to financing difficulties, unpredicted volatility and risk aversion an estimated 1,300 M&A deals were abandoned worldwide.

January – March 2009

Gloom deepens

In the first week of 2009, the German government takes a 25% equity stake in Commerzbank through a €10 billion capital injection in an effort to help Commerzbank take over Dresdner Bank that has been hit badly by the global financial crisis.

The U.S. government continued to carry out their bail-out programmes for troubled financial institutions, and they extended a \$138 billion bailout to Bank of America (BoFA). The bailout included \$20 billion in capital injection and a guarantee on \$118 billion of potential losses on remaining hard-to-value assets. BoFA issued preferred stock to the government for the capital injection, and took responsibility for the first \$10 billion of losses associated with the pool of risky assets. The Treasury and FDIC will pick up the next \$10 billion in losses, with the remainder to be absorbed through a Federal Reserve loan. BoFA was in the process of acquiring Merrill Lynch, which had reported a record loss of \$15.3 billion in the fourth quarter of 2008.

On January 22nd, Bond insurer CIFG cancels \$12 billion worth of CDSs in an attempt to boost its capital.

Reports show the global crisis continues to deepen in Asia. China announces the slowest growth in seven years, the Bank of Japan reduces economic forecasts for the next two years, and South Korea reports the first decline in quarterly economic growth since the Asian financial crisis.

Citigroup announce to issue \$12 billion of government-guaranteed bonds in an attempt to strengthen its capital. This is the largest bond issue guaranteed by the Federal Deposit Insurance Corporation (FDIC) since the beginning of the financial crisis. Since the beginning of the financial crisis, Citigroup has taken more than \$50 billion in credit-related losses.

By the end of January IMF announced that it will significantly adjust its forecasts for global economic growth downward. Up to date, the IMF has contributed \$50 billion to member countries in response to the global financial crisis but managing director Dominique Strauss-Kahn expects many more member countries to apply for loans.

On February 6th, regulators close three US banks, bringing the total number of failed U.S. banks to nine in 2009, adding to the 25 failed banks in 2008. This was a significant increase up from the three that failed in 2007.

On February 17th, 2009, the new U.S. President Barack Obama signs a \$787 billion economic stimulus package into law. The stimulus is aimed to kick start the economy and create more jobs through government spending and tax cuts. The following day, the Boston Consulting Group reveals a study showing that the global financial crisis has decreased the market value of the world's banks by \$5.5 trillion – an amount equivalent to 10% of the world's GDP. Fears of further negative development and nationalization cause U.S. bank shares to fall to their lowest level since 1992. The sell-off of financial shares pushed the Dow Jones Industrial Average to its lowest level in six years.

The U.K. government reveals plans to inject £25.5 billion into the Royal Bank of Scotland (RBS). This announcement came after RBS posted a loss of £24.1 billion for 2008 – the largest corporate loss in Britain's history.

In February, credit card defaults in the U.S. rose to the highest level in the past 20 years. Two of the largest issuers, Citigroup and American Express, reported default rates of around 9%.

In March, AIG announces a fourth quarter loss of \$61.7 billion and receive an extended lifeline amounting to \$30 billion by the U.S. government. The following days the U.S. Treasury announces the

details on the TALF (Term Asset-Backed Loan Facility). TALF will accept AAA rated ABSs as collateral for loans in an attempt to generate lending by unfreezing the ABS market.

In Europe, Iceland's economy is suffering and The Icelandic Financial Supervisory Authority (IFSA) nationalizes investment bank Straumur Burdaras, the last major Icelandic bank. Straumur's losses for the fourth quarter amounted to \$779 million on loan losses and asset write downs.

A few financial institutions start to see positive signs. At Citigroup, CEO Vikram Pundit, announces that Citi has achieved \$19 billion in revenue over the first two months of 2009. After suffering five consecutive quarters of multi-billion dollar losses, Citigroup is expected to have its best profit performance since the third quarter of 2007. At the rival institution BofA, CEO Kenneth Lewis reports that the company was profitable in January and February. The fourth quarter of 2008 was the bank's first quarterly loss in 17 years but Lewis expects BofA to be profitable in 2009 without governmental help.

During in the end of March, Financial Times reported that that the U.S. economy fell at its fastest rate since 1982 in the fourth quarter of 2008. GDP in the U.S. shrank by 6.3%, which was slightly better than the 6.6% that was expected.

8. Case Study

8.1 The collapse of Bear Stearns

Bear Stearns Companies Inc (Bear Stearns) was until 2008 the world's fifth largest investment bank (by market value), and during the fiscal year of 2006, prior to many of the events related to the crisis, the company reported a net income of just over \$2 billion (Bear Stearns AR (2008)). In March 2008 Bear Stearns entered into an agreement to merge with the American commercial bank J.P. Morgan Chase (JPM) in order to avoid bankruptcy following a short period of distressed liquidity. Up until then Bear Stearns had been one of the major underwriters of mortgage-backed securities.

In a letter to the Basel Committee on March 20, 2008, Christopher Cox, Chairman of the U.S. Securities and Exchange Commission, stated that "...the fate of Bear Stearns was the result of a lack of confidence, not a lack of capital" implying that market rumours regarding the financial situation of Bear Stearns led to a dry out of the company's liquidity pool as counterparties started to withdraw their funding.

Many argue that a sudden collapse of Bear Stearns would have been catastrophic to the financial system (e.g. Cecchetti (2008)) because the company was part of a large interconnected network with derivative

contracts such as futures, options and swaps, as well as being both lender and borrower in the funding markets. Furthermore, a default of Bear Stearns would have forced a sale of their assets in a market that lacked the liquidity to handle it. To avoid a situation that could potentially have triggered a domino effect of bank failures across the world, the Federal Reserve created a discount window system for investment banks allowing JPM to secure \$30 billion in funds to back the assets of Bear Stearns in the merger deal.

As described earlier in this paper, during the year of 2007 several events occurred that were troubling for the financial system, and in the Bear Stearns 2007 annual report the company described the turmoil as follows:

“The widespread dispersion of credit risk related to mortgage delinquencies and defaults through the securitization of mortgage-backed securities, sales of collateralized debt obligations ("CDOs") and the creation of structured investment vehicles ("SIVs") and the unclear impact on large banks of mortgage-backed securities, CDOs and SIVs caused banks to reduce their loans to each other or make them at higher interest rates. /.../ As prices declined and delinquencies increased, investors lost confidence in the rating system for structured products as rating agencies moved to downgrade CDOs and other structured products. In addition, investors lost confidence in commercial paper conduits and SIVs causing concerns over large potential liquidations of AAA collateral. The lack of liquidity and transparency regarding the underlying assets in securitizations, CDOs and SIVs resulted in significant price declines across all mortgage-related products in fiscal 2007. Price declines were further driven by forced sales of assets in order to meet demands by investors for the return of their collateral and collateral calls by lenders.”

Bear Stearns had been involved in the mortgage industry since 1990. That year the bank established a subsidiary named EMC Mortgage Corporation (EMC) with the purpose of servicing and securitizing residential mortgages. With an economy in bloom, EMC became an important supplier for mortgage loans to Bear Stearns and a financing source for MBS underwriting operations. The investment bank was also deeply involved in the process of securitization where they pooled mortgages into bonds and sold them to investors, mainly hedge funds and pension funds, in the form of CDOs. To further capitalize on the booming real estate market, Bear Stearns set up a hedge fund called High Grade Structured Credit Strategies Fund (SF). SF invested heavily in CDOs and was financed with a high level of leverage. With a capital base of \$925 million the fund invested \$9.7 billion of long positions in CDOs and short positions worth of \$4 billion in CDSs in the subprime-mortgage market (Harish et al (2009)). This implies a

leverage ratio of approximately 14. SF's investment was thus skewed towards a bullish market, a strategy that at the time was successful – the fund reported positive returns for 40 consecutive months.

As signs of trouble started to show in the beginning of 2007 and households began to default on mortgages, SF responded to changing market conditions. But instead of reducing the fund's risk exposure to mortgage-related assets, the managers at SF decided to launch a new fund called High Grade Structured Credit Enhanced Leverage Fund (SELF) investing in CDOs, backed by mortgage loans. SELF raised \$638 million in equity from investors, and the new fund was even higher leveraged than was SF. SELF borrowed an additional \$6billion and leveraged the assets further to invest \$11.5 billion on bullish CDO bets and \$4 billion on bearish CDS bets, implying a leverage ratio of 24 (Harish et al (2009)).

In total, Bear Stearns' two hedge funds borrowed \$9 billion from several lenders, among them Merrill Lynch, JPM, Citigroup, Deutsche Bank, Barclays and Lehman Brothers. By leveraging these assets they invested \$29.7 billion in CDOs with mortgage loans as underlying assets. According to Harish et al (2009) a widely followed norm is that hedge funds have minimum of 10% of their capital in cash holdings. SF and SELF had 1% in cash holdings; and hence they were almost bound to fail to repay if lenders started demanding their funds back at the same time. As the CDOs that the funds had been investing in were being downgraded by rating agencies the demand for them were decreasing and prices started to fall. The development forced SELF to fire-sell CDOs of higher quality worth \$4 billion to raise cash in a fruitless attempt to salvage the fund from liquidation.

During the summer of 2007, the two hedge funds managed by the company faced bankruptcy. In an administrative complaint filed on November 14, 2007, the Securities Division of the Commonwealth of Massachusetts ("Securities Division") stated that the collapses of the two hedge funds were caused by "the combination of illiquid structured debt securities, national mortgage market turmoil, exotic credit derivative contracts, fair value pricing, aggressive and even 'enhanced' leverage /.../". According to the Securities Division the two funds had invested in ABSs, synthetic ABSs, MBSs and various derivatives such as CDSs, interest rate swaps, options, futures, currencies and forward contracts, and at least one of the two funds relied primarily on repo transactions to finance its security purchases. Bloomberg (Pittman (2008)) reported that the collapses sent shudders across Wall Street as fear spread that the sale of the funds positions in CDOs and other ABSs would incur large write downs due to mark-to-market accounting rules. In the 2007 annual report Bear Stearns states that the failure of the two funds resulted in significant losses included in the earnings of 2007. The net income of 2007 was \$233 million, down almost 90% compared to 2006, due to the "extremely challenging market environment".

At the end of the fiscal year of 2007 (November 30th) Bear Stearns had assets totalling \$395.4 billion and equity totalling \$11.8 billion and thus a leverage ratio of 33.5. For the last quarter in 2008, the company posted a loss of \$854 million whereas it had reported a net profit of \$563 million the corresponding period one year earlier. Bear announced that it had to write down \$1.9 billion of their mortgage assets during the fourth quarter. At the end of the first quarter of fiscal year 2008 (February 29th) the company had assets totalling \$399.0 billion and equity totalling \$11.9 billion and thus the same leverage ratio of 33.5 (the first quarter earnings were not official at the time of the announcement of the merger agreement with JPM). At February 29th, 2008 the asset side of Bear Stearns' balance sheet were as follows:

Table 8.1 Bear Stearns balance sheet Q1 2008

Bear Stearns assets end Q1 2008	Value	Share
Long positions	163 102	41%
Collateralized lending	129 402	32%
Receivables	53 332	13%
Cash	20 786	5%
Other	32 373	8%
Total	398 995	59%

Source: Bear Stearns Q1 2008 report

As can be seen in Table 8.1 the largest part of the asset side of Bear Stearns was their long positions (i.e. financial instruments owned by the company) and collateralized lending (including reverse repos of 7% of total assets). Of the total financial instruments owned (including assets owned and pledged as collateral) mortgages and MBSs constituted the lion share of \$38.2 billion followed by financial derivatives of \$28.7 billion. Of the mortgages and MBSs held, 42% were so called level 2 and 58% were level 3. The classification of assets in level 1-3 defines the certainty of their valuations – level 1 assets are valued using observable market prices (e.g. exchange traded securities), level 2 assets are valued using industry standard models with input from observable market data and level 3 assets are valued using internally developed models with significant input from generally less readily observable market data. This implies that more than half of the mortgages and MBSs held by Bear Stearns were (in accounting terms) valued with the least exact valuation methods (level 3).

On February 29th, 2008 the liabilities side of Bear Stearns' balance sheet were as follows:

Table 8.2 Bear Stearns balance sheet Q1 2008

Bear Stearns liabilities end Q1 2008	Value	Share
Collateralized borrowing	126 295	32%
Payables	98 127	25%
Long term debt	71 753	18%
Short positions	51 544	13%
Short term debt	35 277	9%
Equity	11 896	3%
Other	4 103	1%
Total	398 995	44%

Source: Bear Stearns Q1 2008 report

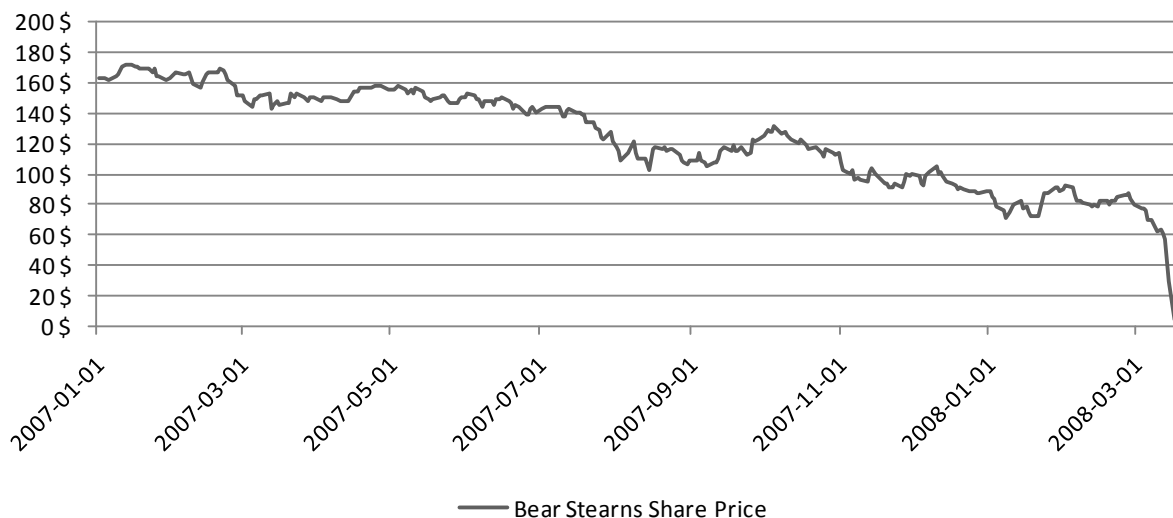
As can be seen in Table 8.2 the largest component in the liabilities of Bear Stearns was collateralized borrowing which includes repo agreements amounting to \$98.3 billion, or 25% of total assets. This implies that Bear Stearns funded 25% of its balance sheet through repo agreements and thus relied upon the ability to roll over these positions at maturity. Since Bear Stearns was not a commercial bank they could not use their collateral to obtain funding from the Federal Reserve, thus the entire item of collateralized borrowing had other financial institutions as counterparts. Cohan (2009) cites a Bear Stearns executive who states that approximately \$75 billion in collateralized borrowing were settled daily. As mentioned, the largest constituent of the long positions held by Bear Stearns was \$38.2 billion in mortgages and MBSs, which implies that the repos used had a significant share of mortgages and MBSs as collateral. It is also worth noting that 25% of the total balance sheet was constituted by payables of which the bulk comes from hedge fund customer deposits reflecting the large prime brokerage business of Bear Stearns (Morris (2008)). As customer deposits are payable on demand this liability item is sensitive to aggregated concurrent cash withdrawals by customers.

In the beginning of March (in 2008) market rumours started to spread about the financial situation at Bear Stearns. The rumours were fuelled by certain specific events, e.g. a Moody's downgrade of a number of MBSs issued by a Bear Stearns affiliate, the news that Rabobank Group would not renew a \$500 million loan to Bear Stearns that was soon due, and the rising contract cost of protecting against default on debt issued by Bear Stearns (Kelly (2008)). After the market close of March 10th, Bear Stearns CEO Alan Schwartz made a statement saying that "there is absolutely no truth" to the rumours, and that "Bear Stearns' balance sheet, liquidity and capital remain strong" (Gianonne (2008)). The statement from the CEO did not seem to calm the rumours as on March 11th, a Goldman Sachs representative sent an e-mail to one of its hedge funds clients that was widely interpreted as Goldman Sachs would no

longer take over derivative deals that their clients had with Bear Stearns (Brunnermeier (2008)). Market speculation of a default increased heavily showed by the unusual large amount of Bear Stearns put options held during the period – the number of put options with strike price \$30, approximately 50% below the share price at the time, increased by more than 10,000% between March 10th and March 11th (Matsumoto (2008)).

The lost confidence in Bear Stearns is illustrated by their share price development during the spring of 2008. At the previous year end the share had been traded at \$88.25, when entering March the share price had dropped 12% to \$57. Until March 13 the share price dropped another 26% to \$57, and the day after the merger offer from JPM the share price closed at \$4.81, down 95% compared to the previous year end two and a half months earlier.

Figure 8.1 Bear Stearns share price performance 2007-01 – 2008-03

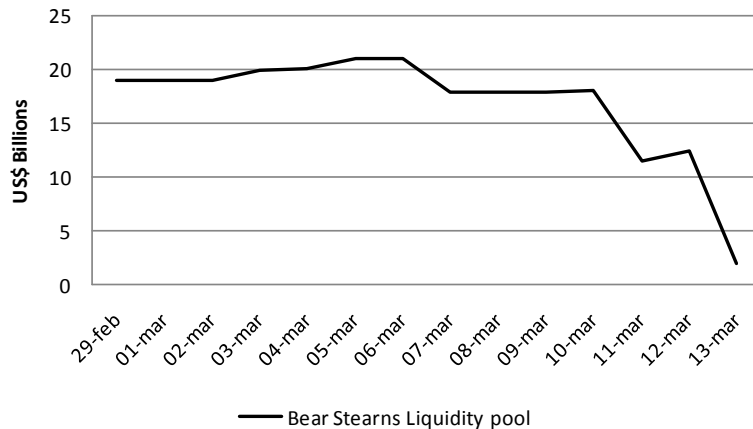


Source: Thomson Datastream (2009)

The week during 10-16 of March 2008 was devastating for the company in terms of lost confidence. In the Bear Stearns 2008 first quarter report the company states that during the 12th of March, large amounts of customers started to withdraw their funds from the company, and counterparties expressed concerns over maintaining their ordinary exposure to Bear Stearns. These actions were enforced during the 13th of March, when "...an unusually high number of customers withdrew funds and a significant number of counterparties and lenders were unwilling to make secured financing available on customary terms...".

At this point, market confidence of Bear Stearns seems to have evaporated which is illustrated by the development of the company liquidity pool during the period. The liquidity pool was used in the daily operations, to meet such actions as deposit withdrawals, margin calls and other actions that demanded an instant outflow of cash. At February 29th Bear Stearns had a liquidity pool of approximately \$19 billion, and at March 13th it had decreased to \$2 billion illustrated in Figure 8.2 below:

Figure 8.2 Bear Stearns Liquidity Pool (2008)



Source: Cox (2008b)

During the period between March 10 and March 13, the market rumours that had been prevailing about Bear Stearns liquidity problems became self-fulfilling and dried out the available liquidity of the company. The expected funding requirements on March 14th significantly exceeded the liquidity pool, and in the morning the same day Bear Stearns announced that it had obtained a secured lending facility from JPM, but despite this action, customers continued to withdraw funds, and counterparties continued to reduce their Bear Stearns exposure throughout the day (Bear Stearns 2008 Q1 report). On March 16, the merger offer from JPM was announced and in the 2008 first quarter report Bear Stearns conclude that the possible “failure to consummate the merger could seriously jeopardize the Company’s financial viability”. Cohan (2009) reports that during the week after the merger offer, JPM had become Bear Stearns sole overnight repo lender as all other counterparties refused to engage in direct funding transactions with the company. Bear Stearns therefore was dependent on the backing from JPM who received backing from the U.S. Fed.

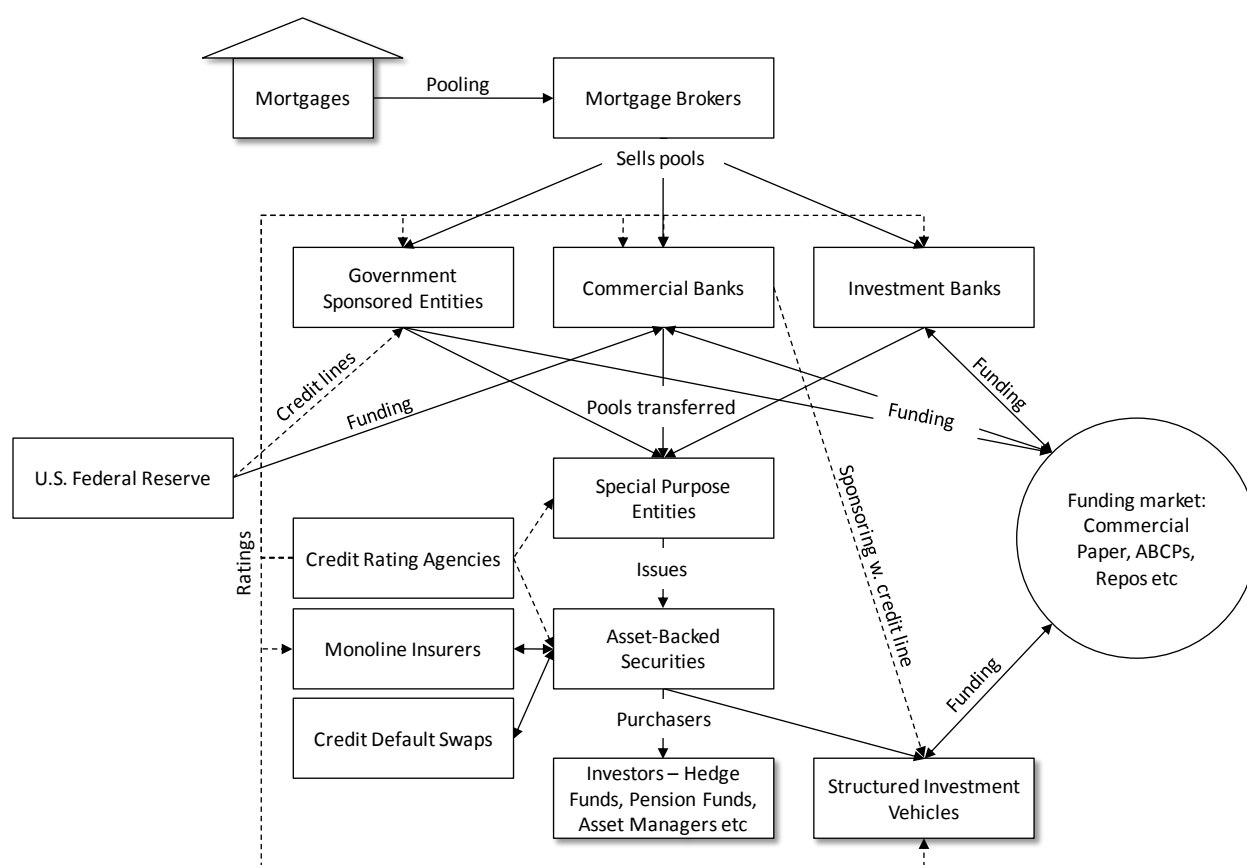
However, as stated by Cox (2008b), the capital structure of the company was at all times prior to the merger announcement with JPM well in line with the regulations set forth by the Basel II standard. The problems stemmed from a lack of market confidence leading to liquidity problems – Bear Stearns faced

a classic bank run as their former counterparties suddenly refused to do business with them. The structure of Bear Stearns' balance sheet, as displayed in the beginning of this section, made the company vulnerable to deposit withdrawals and repo agreements that were not rolled over, leading to that the bank run put the company on the verge of bankruptcy.

9. Market Interconnection

Previous sections of this thesis provides descriptions and explanations of the mortgage market, instruments derived from mortgages and other assets (asset-backed securities), money market instruments used for funding, and the institutional setting surrounding these products and markets. The global financial system is enormous in size and complexity, and to describe the system in its entirety is an effort too large for the context of this thesis. Instead we have focused on providing a description and understanding of the parts of the system related to mortgage products, which are said to have played a major role in the current crisis. The illustration below aims to provide a simplified overview of how the instruments and institutions described in this paper were related to each other prior to the crisis.

Figure 9.1 Interconnection between actors in the mortgage-related financial markets



Source: authors' illustration

The above illustration shows the interconnection of mortgages, mortgage instruments, funding instruments and market institutions. The illustration is simplified; however, it still provides a view on the complexity of the market. Individual mortgages administered by mortgage brokers were pooled together with other mortgages, who sold the pools to GSEs, commercial banks and investment banks. These institutions fund their daily operations through transactions with the U.S. Federal Reserve (apart from investment banks) and the general funding market (issuing commercial paper, asset-backed commercial paper, repos etc). The use of short-term funding, such as overnight repos, made the institutions exposed to liquidity risk; if the short-term funding market suddenly dried out, they would have to find alternative sources of funding, such as using their liquidity pool.

After purchasing the mortgage pools (could also be other assets such as credit-card loans etc) the GSEs, commercial banks and investment banks securitized them by setting up Special Purpose Entities which tranced the pools into ABSs (in Figure 9.1 these instruments are illustrated by the box “Asset-Backed Securities” which represent all such instruments). By selling the ABSs further, the institution transferred the risk of the assets off their balance sheet. Research shows that mortgages that were intended to be securitized had larger probability of default, implying that these mortgages had laxer lending standards when they were approved.

ABSs were also created to make an arbitrary profit on the difference between the yield received from the collateral and the yield paid to investors, as well as to circumvent the capital requirements of banks. To provide safety the ABSs were insured against default by monoline-insurers, as well as by hedging with credit default swaps. The ABSs were purchased by investors such as commercial and investment banks, pension funds, hedge funds, asset managers etc, and by structured investment vehicles (SIVs) that were set up by commercial banks. SIVs invested in long-term structured products using short-term funding – this has been described as a way of shortening the maturity of the long-term products. The SIVs relied on the assets they held as security for the debt issued, and gained extra security from credit lines granted from the sponsoring banks. The use of short-term funding made SIVs dependent on the values of their assets (collateral) and the short-term funding market since the debt had to be constantly renewed on a short-term basis. However, this short-term funding phenomenon was not limited to SIVs, many other financial institutions (e.g. banks, hedge funds etc) used leverage extensively, purchasing assets with borrowed funds (e.g. overnight repos) making them highly exposed to the values of the collateral, and the functioning of short-term funding markets.

Credit rating agencies rated the instruments, as well as the institutions involved in the transactions. They were consulted when designing the instruments, and heavily relied upon when valuing instruments and the credit worthiness of counterparties. Through this chain of instruments and institutions, assets were securitized, rated, sold, insured, hedged and funded by numerous market participants – the risk of the original assets thus became transferred between actors in such a way that the risk locations were hard to identify. The original idea of distributing risk to those who choose to bear it (by securitizing and tranching assets) created a system where risks became hidden somewhere in the market – risk bearers could be the ABS issuers, investors, monoline-insurers, CDS issuers, SIVs, commercial paper holders etc. ABSs were widely popular among investors in the period leading up to the crisis, but their complex nature and the lack of market transparency contributed to the risk uncertainty.

This complex interwoven system was fragile in mainly two contexts; namely the dependency on the values of the mortgage instruments and the dependency on functioning funding markets. As mortgagors started to default on their mortgages, the values of the mortgage-related instruments started to decline. The declining values of assets held as collateral put strain on the funding market as funding transactions became hard to value, leading to mistrust among counterparties. Furthermore, the declining asset values forced institutions to cut back on leverage by selling assets (which were often illiquid), which enhanced the downward spiral of asset values.

As described in this paper, the U.S. house prices increased dramatically during the late 1990's and the beginning of the 2000's, and along with this phenomenon the amount of mortgages originated increased heavily – the amount of mortgages originated reached \$3,945 billion in the peak year of 2003, an increase by approximately 400% in 9 years. The subprime share of the total origination increased as well – in 1994 the subprime share of all mortgage originations was 4.5%, during the years 2004-2006 the subprime share was between 18.2% and 21.3%. The increase in subprime mortgage originations might very well have been a contributing factor to the rising house prices (as new borrowers entered the housing market), and the relatively high risk of subprime mortgages implies that the overall risk of the mortgage market increased with the subprime share. The U.S. home-ownership rate reached all-time-high in 2004, at 69.2% (see Figure 3.1).

The mortgage-related issuance in U.S. bond markets followed the increase in total mortgage origination – during the peak year of 2003 the mortgage-related issuance reached \$3,166 billion, thus accounting for 80% of total origination. During the years 2004-2007 the share of total mortgage-related issuance made by non-agency firms (i.e. other than GSEs) were at historically high levels of between 28% and

43% – i.e. private actors constituted a larger part of the market than usual (see Figure 4.5). The CDO issuance reached its peak in 2006 at \$521 billion (an increase of 92% compared to the previous year), a number that two years later (in 2008) had decreased to \$61 billion (see Figure 4.4). These numbers imply that there was a surge for CDOs prior to the crisis. The implied surge is enhanced by the fact that the total amount of ABSs and mortgage-related debt outstanding in the U.S. reached \$11,569 billion in 2008 (see Figure 4.3), an increase of 300% since 1996 (these numbers should not be confused with the peak in mortgage-related *issuance* that occurred in 2003).

The figures from the two previous paragraphs shows that the housing market and the market for securitized financial products experienced a boom in the years leading up to the crisis. It can perhaps be argued that the two markets showed a symbiotic relationship – without a booming housing market the amount of securitized products might not have increased at the rate it did, and vice versa. Historically, financial institutions originated loans that were kept on their balance sheet, but prior to the crisis the originate-to-distribute model became common as financial institutions originated loans that were distributed to other investors – thus the risk of the assets were distributed as well. To minimize risks, holders of ABSs purchased CDSs that guaranteed the value of the ABSs in case of default (except for MBSs issued by the GSEs who themselves guaranteed the MBS payments). The amount of CDSs outstanding increased by 10,000% during the period between 2001 and 2007, reaching \$62 trillion. This dramatic increase implies that the demand for default protection followed the booming market for ABSs. The CDS hedging provided safety as long as the CDS issuer did not default, but as the crisis evolved the significance of holding CDS protection decreased when investors feared that issuers could not meet their obligations – which is what happened when AIG, who had been very active in issuing CDSs, experienced a liquidity shortage during the fall of 2008 following collateral claims on their CDS positions and received a bailout package of \$85 billion from the Federal Reserve.

In connection with the booming market for securitized products the use of SIVs became popular as tools for shortening the maturity of long-term structured products, or to move an asset off the balance sheet. The first SIV ever created was launched in 1988 by Citibank and in 2007 the number of SIVs had grown to 36, including 6 SIV lites. The assets under SIV management amounted to just over \$400 billion at its peak in July 2007. At the same time the senior debt of SIVs totaled \$352 billion, of which approximately \$111 billion was in commercial paper (including ABCP). The SIVs held many different asset classes, and the ones that in some form could be connected to the mortgage market amounted to approximately \$207 billion (RMBS prime, CDO, CMBS, ABS, Home equity loans/subprime, CDO of ABS). Considering that the amount of ABS and mortgage related debt outstanding in 2007 was \$11,404 billion, the assets

related to the ABS and mortgage market held by SIVs were fairly small – approximately a 1.8% share. Furthermore, given that the total amount of commercial paper (including ABCP) outstanding was \$2,161 billion at the same time, the SIV share of the commercial paper market was approximately 5.1%. The institutions sponsoring SIVs granted credit lines to the vehicles, normally amounting to approximately 5-10% of the SIV value, i.e. \$20-40 billion in July 2007.

As the housing market started to show signs of trouble in 2007 with falling house prices and increasing defaults, the financial markets were soon affected. As shown in section 4.1.5, the cost of insuring ABSs against default increased rapidly towards the mid-year, implying that investors heavily revalued the default risk of ABSs. This followed several credit rating downgrades on ABSs made by credit rating agencies during the summer of 2007. These new conditions soon spread to the funding market affecting ABCPs, instruments that became illiquid during the summer/autumn of 2007. In August 2007 the spreads on ABCPs increased significantly as investors lost confidence in the assets pledged as collateral following the turbulence in the ABS market. Even ABCPs with the highest rating were unattractive to investors such as money market funds, who instead turned to Treasury Bills. During this period, the two Bear Stearns hedge funds collapsed as they had trouble meeting margin calls, following the decreasing values of their structured product positions.

Since the institutions in the market were widely interconnected the troubles spread in a fast pace. As shown in Figure 9.1, the network of actors issuing, investing, insuring, funding and rating ABSs was complex, and events in one end of this intricate system thus could affect actors in the other end. As the values of ABSs started to be uncertain following the troubled housing market it affected practically all participants in Figure 9.1; GSEs, commercial banks and investment banks that issued and invested in ABSs, hedge funds and other holders of ABSs, SIVs that held ABSs as collateral, monoline insurers that insured ABSs, issuers of CDSs, and the funding market accepting ABSs as collateral.

SIVs might have been among the first institutions to be affected by the declining ABS values, although in context of the total market, their share was quite small and the importance of the SIV collapse for the crisis in general might therefore be questioned. For example, the seven SIVs that were absorbed by its sponsor Citigroup in 2007 and added to their balance sheet had assets totaling \$49 billion, which represented approximately 2.6% of the banks' total assets (\$1,884 billion) at the previous year-end.⁹ Furthermore, the *direct* exposure of SIVs to subprime mortgages (Home equity loans/subprime) was as

⁹ Compared to the equity of Citigroup (\$119.6 billion at the previous year-end), the seven SIVs represented 41%. However, this comparison is only relevant if the absorbed SIVs were worth less than the stated figures, a scenario that is unlikely given the very frequent mark-to-market valuation of SIV assets.

small as approximately \$8 billion in the summer of 2007, yet still the vehicles became unattractive to investors as transparency was low. It can be argued that one of the main causes behind the SIV collapse was their reliance on short-term funding combined with their positions in instruments that became hard to value once the crisis enrolled. This proved to be a risky combination when the short-term funding markets experienced problems at the same time as values and risks of ABSs were uncertain. However, the relatively small total size of the SIV sector (\$400 billion at its peak), and the relatively small share of their subprime mortgage exposure makes it difficult to blame the vehicles as the cause of the crisis, although the SIV trouble might have fuelled the beginning of the turmoil.

One factor contributing to the crisis, at least in theory, was the extensive leverage used by financial institutions. As shown in section 6.3, the effect of falling asset values for a leveraged institution is severe in terms of how much assets they must sell to maintain the same leverage ratio. For example, an institution with a leverage ratio of 10 whose assets decline by 5% must adjust its assets down to 50% of their original value in order to maintain the same leverage ratio (the institution *must not* maintain its leverage ratio, but in any case it loses half of its equity). If this phenomenon hits several institutions at the same time it gives rise to further declining asset values as their asset sell-offs pushes market values down. It might also affect other assets than the ones originally affected by the decline depending on which assets the institutions chooses to sell – thus the declining values might spread to other asset classes. The leverage ratios of the commercial and investment banks investigated in section 6.3 were all above 10, some of them as high as 60-70. As the leverage ratio increases, the potential losses from falling asset values increases as well. In the U.S., the institutions with the highest relative leverage ratios were investment banks as they were not regulated by the U.S. Federal Reserve and thus could not borrow from the Federal Reserve Discount Window. In theory, the institutions with the highest leverage ratios should be the ones most affected by falling asset values and thus the ones in most need of funding – however, the institutions with the highest leverage ratios (investment banks) were unable to secure funding from the Fed.

Besides being leveraged, many financial institutions funded large shares of their balance sheets with short-term instruments such as repos, making them dependent on the functioning of these markets. This phenomenon strongly contributed to the crisis and became the fall of several institutions, e.g. Bear Stearns and Lehman Brothers.

The several actions undertaken by the U.S. Federal Reserve that allowed banks and other institutions to borrow funds at broader ranges of collateral than usual highlighted the severity of the troubles in the

ABS market, and the subsequent troubles that institutions faced when they could not use the assets as collateral in the ordinary funding market. Since investment banks initially could not borrow from the U.S. Fed, several funding programs were launched targeted towards these institutions, such as the \$200 billion Term Securities Lending Facility in the spring of 2008, allowing investment banks to swap certain mortgage-related assets against Treasury Bonds for up to 28 days. The largest intervention initiated by the U.S. government was the Troubled Assets Relief Program (TARP), launched during the autumn of 2008. The program has the intention of purchasing troubled assets with a total value of \$700 billion from financial institutions, in order to strengthen the financial sector.

10. Conclusions

The objective of this thesis is to provide a clearer understanding of the financial turmoil that hit financial markets during 2007-2009, the factors causing it, and the factors causing the near-default of Bear Stearns. Through a review of earlier papers on this subject, combined with thorough investigations of numerous other sources such as research reports, news articles and annual reports, we have provided a view of the most important instruments, institutions and events related to the crisis. They have been put in relation to each other to determine their interconnection and relative importance. By analyzing the compiled information we have identified four factors that can be said to have played important parts in the turmoil in general, as well as in the Bear Stearns case. These four factors are the following (without any relative intergroup importance):

- 1) The growth in U.S. mortgage origination in general and the growth in U.S. subprime mortgage origination in particular have played central roles during the turmoil. During the years leading up to the crisis, mortgage interest rates were low, and financial institutions offered mortgages that were very beneficial for the borrower on a short-term basis. The amount of subprime mortgages increased, as well as the share of subprime mortgages compared to total origination. New mortgages such as the NINJA loan (No Income, No Job or Assets) were launched targeted towards borrowers with poor credit histories. The increase in mortgages followed the increase in U.S. real-estate prices, and many mortgages were designed with the assumption that real-estate prices would continue to increase. The booming mortgage market enabled the next phenomenon identified as a factor behind the crisis;
- 2) Mortgage securitization, the process where an individuals' mortgage can end up in the hands of a financial investor anywhere in the world, is the second factor identified as a cause behind the

crisis. By securitizing mortgage pools, financial institutions could offer a wide range of products with different risk classes and yields; products that were considered fairly safe and became very attractive to investors as they searched for investment opportunities. The chain of institutions involved in the securitization process was very long and opaque, a phenomenon leading to the risks becoming hard to locate. The products created through securitization were sometimes securitized once again, thus further increasing the distance between the underlying collateral and the investor. The securitization process and the products that were designed lacked in transparency with regards to the quality of the collateral – some securitized products had a very large number of underlying asset classes making the risk and thus the value of the products hard to determine. Furthermore, securitized products are different from each other and traded over the counter implying that it was hard to observe market prices and to make significant comparisons between products. As the ABX indices were launched in 2006, the market could for the first time observe aggregated views on the risks of securitized products. The market for ABSs experienced a boom during the years prior to the crisis, with the amount issued and outstanding reaching record high levels.

- 3) The third factor identified as a factor behind the crisis is the high levels of leverage used by many financial institutions. As credit was cheap and markets boomed, investment banks and other institutions used leverage to fund the vast majority of their balance sheets. The funding used was to a large extent short-term, making the institutions dependent on functioning funding markets and the ability to roll over their liabilities at maturity. When being leveraged, small changes in asset values can have large effects in terms of losses/gains and equity. Large parts of the leveraged balance sheets consisted of securitized mortgages, and as the values of these products became uncertain their quality as borrowing collateral became evaporated. The funding instruments backed by collateral, such as ABCPs or repos, were widely used and relied upon and as the functioning of these instruments became impaired following declining ABS values, it triggered fire-sales of assets, pushing asset prices further down.
- 4) The fourth factor identified as a factor behind the crisis is the interconnection of the market participants and their transactions. The products and institutions related to the mortgage market were many and they were widely connected to each other. For example, a mortgage-backed security could be related to institutions such as mortgage brokers, issuers, investors, monoline insurers, credit rating agencies, credit default swaps issuers and holders, funding

issuers, etc. This complex web of market participants made the system vulnerable as events affecting one participant could soon spread to affect many others. It can be argued that the high level of interconnection was the reason behind the fact that declining real-estate values in the U.S. soon affected the entire global financial system.

When combined, the fourth factors presented above became the trigger that caused the global financial system to experience the troubles it faced during the years of 2007-2009. To determine what was the most important cause of the crisis is impossible in the context of this paper – perhaps it is impossible in any context given the complexity of financial markets – but we as authors believe that the crisis, or at least the severity of the crisis, would not have been as large if any of these factors had not been present.

The theories presented in section 2, Theoretical Framework, are all in some ways related to the findings presented in this thesis – for example the excessive lending, complex financial instruments, use of leverage, lack of transparency etc are all factors that have been discussed throughout in this thesis. It is not possible and perhaps not relevant to determine which of the academics presented that has had the most plausible explanations of the crisis; however, it is clear that they all focus on important factors.

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