Unfolding the Subprime Crisis

– A Study on the Origin of a Global Crisis

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Abstract

This study examines the subprime crisis, and more specifically, possible causes behind the misjudgements in the evaluation of downgraded structured-finance products collateralizing subprime mortgages. These subprime CDOs were created in order to meet the demand for high-yield products and customized to fit a broad investor base. The results show that the misjudgements behind the investment decisions were caused by numerous factors from which a self-regulated subprime market, lack of historical data, and the complex structured-finance products were the most prominent elements.

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Preface

We would gratefully like to acknowledge our tutor Professor Kenth Skogsvik for interesting comments and inspiring discussions. Further, immense gratitude is directed at Håkan Thorsell for his helpful guidance on valuation techniques during the summer. The effort made by all the interviewees is also thankfully appreciated, especially due to the complexity and controversy of the subject.

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Equations, Figures and Tables

1. Introduction

In the Introduction the subject of the study is revealed. Arguments supporting the attention to and emphasizing the importance of the matter from a wide perspective are presented.

During the last years the global capital market has experienced dramatic growth while national boundaries have successively diminished. The larger global market has enabled more specific demands to be met in financial transactions. The increased ability to align financial products with the investor's individual risk and return appetite has created a demand for complex structured finance. However, in a world of complex products the ability to assess the underlying risk becomes ever more intricate. Simultaneously, the global economy has gained new welfare peaks due to the high activity within industrial markets. Consumers devour like never before and company revenues have reached all-time high. To a growing extent consumers have engaged in mortgage loans to finance everyday consumption. However, as the economy grows healthy while consumers gradually leverage based on appreciating house prices, an unbalanced situation emerges.

Lately, we have witnessed a dramatic rise in the rate of delinquency and default of subprime-mortgage loans in the United States (U.S.). Borrowers have not been able to make the larger payments required by a higher interest rate. Simultaneously, the value of their underlying assets, their houses, have declined and hence the ability to either refinance the loan or sell their home at a sufficient amount is vanished.[3] The subprime-mortgage loan defaults have initiated a credit crisis that, by contagion, covers many other segments of the credit market. Due to the uncertainty of the extent and allocation of the loans the valuation of many other structured-finance products is now under great pressure.

We have experienced fallacies in the financial market before, and survived. However, what makes the current crisis unique is that it directly strikes the highly leveraged financial system. A consequence of the leveraged structure is that actors that are hit lose largely. Some of the largest subprime lenders have filed for bankruptcy as a result of the credit crisis.[4] Further, several of the most well-renowned global financial institutions have reported huge losses reflecting write-downs in their financial accounts. These write-downs are due to the dramatic reduction in the market value of securities collateralizing mortgage

[3] Turnbull, Crouhy & Jarrow (2008), p.7.
[4] Standard & Poor's RatingsDirect (2007c), p.2.

loans. As a consequence of the financial institutions' poor performance, banks limit their risk by employing a more restrictive lending policy. Thus, interest rates rise and the whole business and private communities are affected.

As international trade has made the markets more integrated, every industrialized country is affected by the current financial turmoil. Signs of recession in the U.S. are beginning to show and economic growth has slowed down in recent year. The financial crisis is hence an issue of utter importance for the whole community.

Both warnings about the crisis' growing effects as well as relieves about the worst peak being over have been heard in the press debate. The contradicting opinions indicate that the underlying causes are not yet completely identified. Thus, we believe that there is no comprehensive understanding of what has actually happened. Understanding the subprime crisis involves comprehending the structures of the financial products and the roles of involved actors. The greatest losses in securities can be derived from CDOs of ABS, a form of collateralized structured-finance products backed by asset-backed securities (ABS).[5]

[5] International Monetary Fund (2008), p.12.

2. Statement of Purpose, Question Formulation, and Delimitations

In this chapter the purpose of the study is presented followed by the question formulation at hand. Delimitations and assumptions are presented pursued by the disposition of the study.

2.1 Purpose and Question Formulation

Main Objective. The main objective of this study is to create a better understanding of the subprime crisis in the credit markets, focusing on its causes derived from mechanisms in the structured-finance market.

Partial Objective.
The partial objective is to present a descriptive illustration of the financial products involved through:

- Following the distribution chain of the CDOs and suggest possible fallacy points along the way.
- Scrutinizing why CDOs collateralizing, among others, subprime-mortgage loans have caused losses to such great extent.
- Analyzing the difference in CDO values derived from diverging assumptions and valuation techniques.
- Implicating the size of the financial losses of the CDO investments and the potential savings that could have been made with the competence as of today.

To achieve the purpose of creating enhanced understanding of the subprime crisis and its potential causes we try to respond to the following question:

What are potential causes of the misjudgements in the evaluation of subprime CDO investments?

2.2 Delimitations

Financial Product Category. In this study we focus on one single type of securities, CDOs of ABS, and thus only a limited fraction of the credit crisis and the underlying causes is

captured. The study further focuses on CDOs collateralizing mortgage loans, primarily subprime. The valuation is conducted on a selection of nine subprime CDOs. Due to data restrictions, only 'AAA'-, 'AA'-, 'A'-, and 'BBB'-rated tranches are valued. The valuation of CDOs is based on the credit ratings made by Standard & Poor's (S&P).

Our focus further lies on what reasoning, derived from the prospective fallacy points in the market, has affected investment decisions.

Excluded Possible Causes. This study focuses on characteristics of the structured-finance market and the products traded. Thus, some possible underlying causes are not further examined.

It could be argued that incentive structures within investment banks may have affected CDO investment decisions. The agent/principal situation that arises from these incentive structures, with variable salaries dependant on investment performance, could be analyzed further in order to establish whether it is a possible fallacy point or not.

We do not examine the role of home appraisers, who assess the market value of the house. Since the market value often represents the collateral of the mortgage loan, home appraiser's actions could affect the quality of the mortgage. We do not believe that home appraisers played an active part in the mortgage origination process and argue that home appraisers provide support to the origination process, but not as an active participant.

The U.S. government provides aid to both banks and individuals struck by liquidity deficiency. This insight may cause financial actors to abuse such governmental supportive actions, creating a moral hazard situation. Financial actors with the insight of being rescued in the event of default may be encouraged to take on higher risk.

2.3 Disposition

Next, the disposition of the remaining chapters is presented.

3. Theoretical Framework

The theoretical framework provides a review of relevant literature regarding the subprime crisis as well as valuation theories. The valuation of CDOs is based on Håkan Thorsell's study on corporate bonds.

4. Methodology

This chapter describes the methodology and methods used in order to address the question. An overview of the choice of methodology and sources, as well as the implications attached is shown. The theoretical approach and the data selection are presented followed by a discussion about the level of validity and reliability, where implications of delimitations and assumptions are discussed.

5. Terminology

The following chapter defines terms used in the Empirical Data and Analysis. Further abbreviations and definitions can be found in the Glossary.

6. Background

The background story describes the effects of the subprime crisis as we have witnessed until today. The purpose of this chapter is to facilitate the comprehension of the forthcoming sections.

7. Empirical Data

The empirical data describes the U.S. mortgage market and the process of securitizing and distributing structured-finance products, focusing on subprime CDOs. The data elucidates on current actions and characters, which may have contributed to the subprime crisis development. Subsequently, a valuation basis for CDO investors is presented followed by a valuation of CDOs. The valuation outcome shows the size in losses and savings potential of CDO investments.

8. Analysis

The Analysis connects the Empirical Data with the Theoretical Framework. The chapter points at potential misjudgements derived from the fallacy points elucidated in the Empirical Data. In addition, the linkage between these misjudgements and the investment decisions is established.

9. Concluding Remarks and Discussion

In the closing chapter the outcome of the Analysis is summarized and criticised in order to point at potential weaknesses of this study. Concluding, suggestions on further research are made.

10. References

In this section the references are presented in alphabetical order followed by the interview material used for gathering information from primary sources.

11. Glossary

The glossary encompasses the most commonly used abbreviations and definitions of essential terms in the study.

3. Theoretical Framework

The theoretical framework provides a review of relevant literature regarding the subprime crisis as well as valuation theories. The valuation of CDOs is based on Håkan Thorsell's study on corporate bonds.

3.1 Review of the Relevant Literature

During the last year the volume of material dealing with the subprime crisis has become massive. However, we deem the information to be fragmented to a high extent and few studies cover the greater part of the crisis. We have found some studies, which we consider as reliable, to state the main underlying sources of the Empirical Data.

As a Professor at Princeton University and an academic consultant to the Federal Reserve Bank of New York, Markus Brunnermeier has produced several publications covering especially financial crises and mispricings. For instance, his work describes why liquidity dries up during crises and the implications on risk management.[6] In May 2008, a study was published examining the amplification mechanisms of the subprime crisis, which accelerate the huge losses in the credit market. Brunnermeier concludes that in many ways the crisis is classic, worsened by the extraordinary extent of securitization. Complex structures attained through securitization complicated the assessment of risk exposure to financial institutions and the value of structured-finance products.[7]

Another wide-spread study, produced by Turnbull, Crouhy, and Jarrow was presented at the Federal Deposit Insurance Corporation Bank Research Conference in the summer of 2008. With combined research or professional experience on derivatives, risk management, economic theory and uncertainty, the three authors scrutinize the causes of the subprime crisis and offer suggestions on how to prevent such scenarios in the future.[8] The authors conclude that the surge for high yield, agency problems, and failure to identify a changing environment are some of the factors contributing to the crisis. Since the focus of this study is directed at the structured-finance market, we do not address the issue of agency problems.

[6] Princeton University, Profile (2008).
[7] Brunnermeier (2008), p.32.
[8] Defaultrisk.com (2008).

Each year the International Monetary Fund publishes the Global Financial Stability Report addressing current issues in the financial market. In this study we refer to the publications of 2007 and 2008. The issues draw on several discussions with, among others, commercial and investment banks, asset management companies, hedge funds, pension funds, credit rating agencies, and academic researchers as well as regulatory authorities. The latter analysis dissects the subprime crisis specifically and concludes that risk management and regulation lagged behind, there were failures in assessing the extent of leverage taken on by institutions, and the transfer of risk to off-balance sheets was overestimated.[9]

Although many studies on the subject have been conducted, there is no study presenting a holistic perspective covering every stage of the securitization of structured-finance products. In this study, a comprehensive picture is presented by following the securitization and distribution chain of CDOs, from the initial U.S. subprime borrower to the final investor, in order to show where miscommunications may have emerged along the way. Furthermore, this study tries to capture the reasoning of investors in order to ascertain possible misinterpretations of CDO investments, implicated by the market fallacies. This study presents a comprehensive explanation of the subprime crisis and its potential causes from an economist's perspective, supported by the CDO valuation results.

3.2 DCF Valuation Model

The valuation model is based on Håkan Thorsell's study on the pricing of corporate bonds. The model constitutes a Discounted Cash Flow Model (DCF), where the bond value is calculated as the sum of discounted expected cash flows adjusted for the recovery rate and default rate for the specific bond. Every discounted cash flow is further adjusted for the cumulative probability of default, i.e. the probability of not defaulting the lapsed years.[10] It is assumed that the principal will be redeemed at maturity. The discount rate is derived from the Capital Asset Pricing Model (CAPM).

[9] International Monetary Fund (2008), p.*ix*.
[10] Thorsell (2008), p.31.

Equation 1. Discounted Cash Flow Valuation Model

$$p_t = \sum_{i=1}^{T} \frac{(1-\mathrm{E}[\bar{\pi}_{t+1}(1-\bar{\gamma})])\mathrm{x}_{t+i}}{(R^f_{t,t+i} + \beta_{t,t+i}\lambda_{t,t+i})} \prod_{j=1}^{i-1} (\mathrm{E}[1-\bar{\pi}_{t+j}])$$

Where:

p_t = *price at time t*

E = *expected*

$\bar{\pi}$ = *probability of default*

$\bar{\gamma}$ = *recovery rate*

R^f = *Gross risk free rate of return*,

β = *beta*

λ = *risk premium*

x_{t+i} = *coupon received at* $t+i$

i = *time period i*

j = *previous time period*

t = *time t*

Hence:

$(1-E[\bar{\pi}_{t+1}(1-\bar{\gamma})])x_{+i}$ = *Expected cash flow adjusted for default and recovery rate received at time* $t+i$

$R^f_{t,t+i} + \beta_{t,t+i}\lambda_{t,t+i}$ = *CAPM interest rate* (*Cumulative expected rate of return* $= (1+CAPM)^i$)

$\prod_{j=1}^{i-1} (\mathrm{E}[1-\bar{\pi}_{t+j}])$ = *Expected cumulative probability of survival*

3.2.1 Capital Asset Pricing Model

The valuation model is based on the CAPM developed by William Sharpe, John Lintner and Jack Treynor. In total, the model is based on six assumptions:[11]

- Investors make mean-variance efficient choices when building a portfolio, i.e. investors aim to maximize their utilities.
- Investors are rational and risk averse, thus focusing only on the mean and variance of the return of their investments.
- Borrowing and lending is available at the risk-free rate of return. Hence, the cost of capital is equal for all actors resulting in one efficient portfolio better than all other portfolios.
- There should be no asymmetric information and investors cannot influence the price of the security. Thus, all investors should hold the same portfolio with the same correlation, expected return and standard deviation.

[11] Brealey, Myers & Allen (2003), p.181-197.

- Securities are highly separable into small parcels.
- There are no transaction costs or taxation costs.

The CAPM states the relationship between risk and return, where a higher risk requires a higher return. Furthermore, CAPM claims that the risk premium is proportional to beta. The beta describes the market risk as the covariance between an individual security and a diversified market portfolio. Thus, beta expresses the market risk of the individual security, i.e. its sensitivity to movements in the reference portfolio. A positive beta implies that the return on the individual security moves in the same direction as the market portfolio. A negative beta implies the opposite movement direction.[12]

The discount rate in our valuation model is derived from the following model:[13]

Equation 2. Capital Asset Pricing Model

$$E(r_i) = r_f + [E(r_M) - r_f]\beta_{i,M}$$

$$\begin{aligned}
&Where: \\
&i = 1,\ldots,N \\
&E(r_i) = Expected\ \ return\ \ on\ \ any\ asset\ \ i \\
&\beta = beta \\
&E(r_M) = Expected\ return\ on\ market\ portfolio \\
&r_f = Risk\ \ free\ rate\ of\ \ return\ \ (annual)
\end{aligned}$$

3.2.2 Mark to Market Valuation

The Financial Accounting Standards Board's statement 157 states that most financial instrument positions should be valued at fair value, i.e. marked-to-market. Fair value refers to the exchange price of the financial instrument, i.e. the asset or liability. The exchange price is the price at which an orderly transaction between market participants is traded in the principal or most advantageous market for the asset or liability.[14]

[12] Brealey, Myers & Allen (2003), p.167.
[13] Ibid, p.192.
[14] FASB: Summary of Statement 157 (2007).

The illiquidity of the CDO market creates obstacles in determining a market price of the CDO respondent to the fair value. In order to use fair value accounting, an index called ABX is used as a proxy for the market value, which CDO positions can be marked against.[15] The ABX index is based on credit default swaps, weighted at equal proportion referencing 20 series of mortgage-backed securities (MBS) collateralized by subprime mortgages.[16] New ABX series are generated every six months on January 19th and July 19th.[17] The narrow structure of the index increases the sensitivity to value changes in the underlying assets.[18]

[15] Alpha, interview May 2008.
[16] International Monetary Fund (2008), p.118.
[17] Citi (2007), p.7.
[18] Alpha, interview May, 2008.

4. Methodology

This chapter describes the methodology and methods used in order to address the question. An overview of the choice of methodology and sources, as well as the implications attached is shown. The theoretical approach and the data selection are presented followed by a discussion about the level of validity and reliability, where implications of delimitations and assumptions are discussed.

4.1 Theoretical Approach

The study is written from a hermeneutic viewpoint, which is closely linked to the field of social science with an interpretive view on understanding of the world. This is contrasted to the positivistic view, which is strictly linked to science with no room for interpretations. We believe that the hermeneutic viewpoint is essential for the data collection and analysis, since the recent development in the credit markets as well as the valuation of structured-finance products incorporate different assumptions, perspectives and interpretations. In line with this perspective the study is conducted through a descriptive approach. The approach involves the examination of a phenomenon to more fully define and comprehend it.[19]

There are two main approaches when conducting an empirical study; inductive and deductive. Adopting an inductive approach implies collecting data and creating new theories from the obtained results. A deductive approach implies collecting data and comparing it to present theories in order to explain the results.[20]

In this study, in order to gain insight from a holistic perspective, the question is approached by using both inductive and deductive methods. The inductive method covers the gathering of secondary data as well as conducting interviews. The aim of this method is to create a comprehensive theory of the subprime crisis, thus enabling a deeper understanding of the crisis and its causes. Furthermore, the valuation analysis is based on a theoretical framework and promotes a deductive approach. The valuation represents a replication of the valuation method a prospective investor is expected to have performed with the available information at the time of issuance.

[19] Bryman (2002), p.34.
[20] Ibid, p.21-23.

The gathering of information for this study is conducted using a qualitative method. A qualitative research is preferred when using an inductive approach and the method incorporates behavioural aspects and attitudes, and considers social interaction between different parties.[21] Since we believe that there are psychological and behavioural aspects affecting the development of the subprime crisis, a qualitative method is employed when gathering primary information. Further, a quantitative research method is adopted when establishing the valuation analysis, which is more in line with the deductive approach.[22]

4.2 Data Selection and Working Process

4.2.1 Primary Sources

Our primary data is gathered from eight interviews conducted with nine people connected to the financial industry. To attain a high validity of this study it is essential to capture the views of people with experience and competence closely related to the subject. Relevant actors are mainly rating agencies, investment banks, and other core participants of the structured-finance industry. The interview objects have been selected due to their insights in the financial sector. Three of the interview objects have wished to remain anonymous. Further, in addition to the eight interviews a short conversation was held with the person referred to as Delta. However, due to its length and informal nature we do not consider this discussion to be an interview.

Before each interview a questionnaire preparing the prospective interviewee for the subject was emailed. During the interviews the discussions emanated from the questionnaire, but also included other issues related to the subject. The duration of each interview was 30-150 minutes with an average of about 60 minutes. After each interview the authors initially summarized the conclusions individually so that each author's perception remained unaffected by the other's opinions and interpretations. The conclusions of each interview were subsequently discussed between the authors and elusive statements were investigated through follow-up discussions via telephone or email with the interviewee. With several of the interviewed a continuous dialogue was held during the writing process.

[21] Silverman (2000), p.8, p.89.
[22] Bryman (2002), p.34.

A description of each interview object as well as the questionnaire is provided in *Interview Material Table 10.2.1, Table 10.2.2, and Table 10.2.3.*

4.2.2 Valuation of CDOs

A valuation analysis of subprime CDOs is conducted at two different junctures, at the issuance date and at current date (August 6th, 2008). The valuation shows the difference between CDO values generated by the available information at the time of issuance and at current date, demonstrating the relative losses and the potential savings with today's competence level on assumptions and valuation techniques. These results enhance the understanding of the subprime crisis so as to it shows the impact of changes in the underlying assumptions and thus enables an understanding of probable expectations from a prospective investor.

The valuation is mainly based on the information provided in a selection of nine CDO prospectuses. CDOs are the most common form of ABS collateralizing bonds and securitized loans.[23] The CDOs mainly contain residential-backed mortgage loans, including subprime-mortgage loans, and are deemed as representative for the wider range of structured-finance products that have been subject to downgrading and illiquidity. The CDOs were selected after a discussion with one of the anonymous interview objects, Beta, whom is based at an investment bank in London. The CDO prospectuses comprise a diverging selection with Deutsche Bank, Lehman Brothers, or Morgan Stanley as bookrunners. Each CDO prospectus is described in *Appendix 1*.

Three valuation rounds are performed on each CDO; two at the issuing date and one representing current values (as of August 6th, 2008). The 'ABX'-prefix is used to denote mark-to-market valuations and the 'CDO'-prefix to denote calculated CDO values. The aim is to benchmark value changes of the ABX against model-based changes of the CDO values. Thus, the DCF valuation model is used to evaluate the values of the ABX index.

Issuing values. The first valuation constitutes CDO values based on the available competence and assumptions at the issuing date.

[23] Brunnermeier (2008), p.3.

Issuing downgraded values. The second valuation constitutes CDO values at the same date, but with new underlying assumptions regarding credit risk (as of August 6th, 2008).
Current values. The third valuation reflects CDO values as of today based on today's assumptions (as of August 6th, 2008).

The underlying assumptions were adjusted between the valuation junctures causing the downgrading of CDO tranches, affecting the value negatively. Thus, it is assumed that the *Issuing values* are too high and that the competence on the underlying assumptions has changed. The general market development is captured in the movements between the *Issuing downgraded values* and *Current values*.

Furthermore, it is assumed that investors have a fixed size investment mandate, independent of the price of the investment. Since the over demand for high-yield investments was met by constructing new structured-finance products, a lower price would have caused an increased volume in the market.

The CDO tranches are valued using a CAPM-based DCF model, generating *CDO Issuing values, CDO Issuing downgraded values* and *CDO Current values*.

Mark-to-market valuation. Due to the structure of the ABX index, the valuation results cannot be directly compared to the index. However, since CDOs are marked to the ABX index, the index movements show the relative financial losses over time. *ABX Issuing values* are index prices as of August 17th, 2006, the median issuance date for the selection of CDOs. We assume that the *CDO Issuing values* correspond to the underlying bonds of the ABX index at the median issuance date of the CDOs. The *ABX Current values* are market prices as of August 6th, 2008. The difference between *ABX Issuing values* and *ABX Current values* represents losses or gains to CDO investors due to market value movements. In order to assess mark-to-market savings potential an estimated market value at the median issuance date is needed. To create this new ABX price level, i.e. *ABX Issuing downgraded values*, we use the *CDO Issuing downgraded values* to *CDO Issuing values* ratio, and relate to *ABX Issuing values*. *ABX Issuing downgraded values* reflect a more accurate ABX price level at the median issuance date. The price level of *ABX Issuing downgraded values* is calculated using the following formula:

$$\frac{CDO\ \ Issuing\ downgraded\ values}{CDO\ Issuing\ values}\ x\ ABX\ \ Issuing\ values = ABX\ \ Issuing\ downgraded\ values$$

The relative losses for each credit rating class derived from the development between *Issuing values* and *Current values* are calculated using the following formula:

$$\frac{Current\ values}{Issuing\ values} - 1 = \mathrm{Re}\,lative\ Loss$$

The relative losses for each credit rating class derived from the development between *Issuing downgraded values* and *Current values* are calculated using the following formula:

$$\frac{Current\ \ values}{Issuing\ downgraded\ values} - 1 = \mathrm{Re}\,lative\ Loss$$

Figure A. Anticipated Development of the ABX Index and Savings Potential

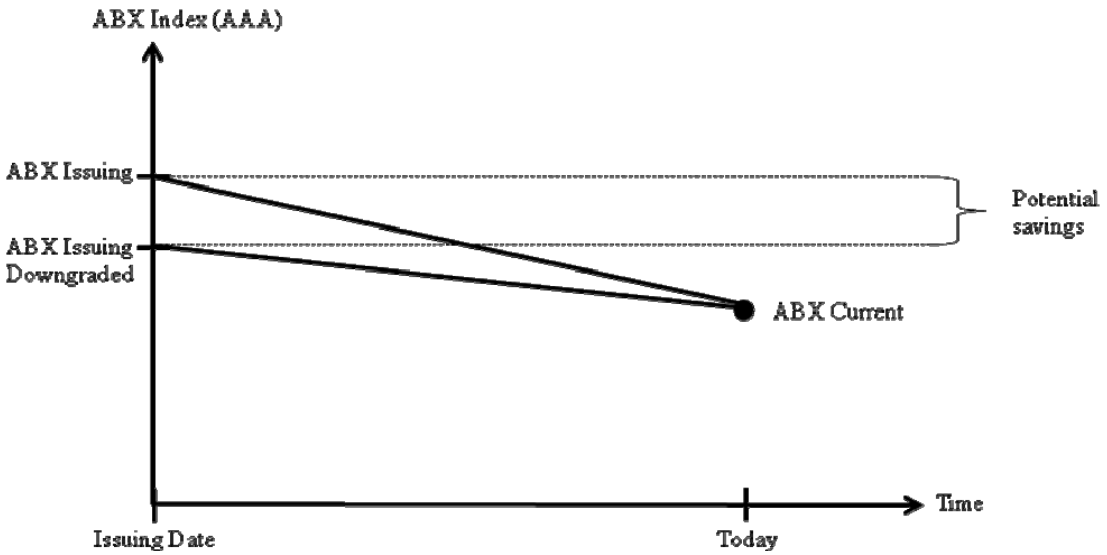

Figure A shows the anticipated development of the ABX index 'AAA'-tranche from issuing date until today. Furthermore, the expected development of the ABX pegged to *Issuing downgraded values* is presented in order to show our presumption of the potential savings. Potential savings are derived from the difference in value change from the Issuing downgraded values compared to the Issuing values, until today. From the figure it is concluded that losses could have been reduced with the current competence and information.

The valuation model is based on the CAPM. The risk premium is derived from Brealey, Myers and Allen's study, suggesting a risk premium for the U.S. between 5-8 percent. The valuation is conducted assuming a 6.5 percent risk premium in the range middle. Each tranche rated 'BBB' or above of the CDOs is valued individually, in total 61 tranches. The

equity tranches are not valued, since the prospectus information is ambiguous whether these have been offered to investors or not. *For a review of a calculation example, see Appendix 4 Table III.*

4.2.2.1 Beta

Due to data restrictions, betas for U.S. corporate bonds are used as proxies for CDO betas. CDO tranches are comparable to corporate bonds since they have similar characteristics and are issued by legal entities similar to corporations. Håkan Thorsell's study on the pricing of corporate bonds is based on U.S. corporate bond returns during 2001-2005 covering 6,045 bonds. Thus, the market portfolio consists of 6,045 corporate bonds from different industries and different rating classes. The rating classes are based on S&P's classification and each class covers the neutral form (e.g. 'AAA') as well as the positive (e.g. 'AAA+') and the negative (e.g. 'AAA–') sub-classes. The result from the study shows that betas for investment-grade bonds are negative, while betas for speculative-grade bonds are positive. Thorsell's study finds that beta increases with lower credit rating. Thus, higher probability of default of a bond implies a higher beta attached.[24] *For a review of Thorsell's results on betas, see Appendix 2 Table I.*

4.2.2.2 Probability of Default and Recovery Rate

The default and recovery rates used in the valuation model are based on S&P's credit ratings, one of the major rating agencies. As the credit rating by any of the major agencies is comparable we do not believe that this will cause any large bias in the outcome of this study.

The default rates are based on S&P's default rates for CDOs advocated in 2006. The default rates take both historical data from the period 1973-2005 as well as S&P's current estimation on future default rates into account. The methodology used in 2006 produces more conservative probabilities of default than previous methodologies. Since the CDOs in this study were issued during 2005-2007, the probabilities of default from 2006 capture the mindset and assumptions from the time of issuance. Another main reason for the choice of default rates is that the competence regarding CDOs has increased over time. The default

[24] Thorsell (2008), p.39-45.

rates from 2006 constitute current updates and capture the expectations before the credit crisis in 2007.[25]

The recovery rates represent the expected proportion of the initial value of the collateral that is recovered in the case of default. A higher recovery rate implies that the default rate has smaller impact on the value of the bond.[26] S&P's recovery rates for different credit rating classes are provided in the prospectuses. The rating of the underlying assets as well as the rating of the CDO tranche is taken into account. The reason for lower recovery rates in highly rated tranches is that they are required to endure a more severe economic scenario, which results in the recovery rates being lower, on average, than subordinate tranches. In this study, a weighted average rating for the underlying assets was calculated. *For a review of S&P's Probabilities of Default and Recovery Rates, see Appendix 2 Table II and Table III.*

4.2.2.3 Sensitivity Analysis

In order to replicate a prospective investor's decision process, we perform a sensitivity analysis with a change in the underlying credit rating of the tranche. Each tranche is additionally valued with a credit rating one level below in order to demonstrate the value change of the CDO derived from a change in the underlying assumptions. Thus, we aim to replicate the potential worst case scenario that an investor could be assumed to expect at the time of issuance.

4.2.2.4 Adjustable Interest Rate

The cash flow, i.e. the coupon, is calculated by the interest rate for the specific tranche multiplied by the face value of that tranche. Cash flows are generated by both fixed and adjustable interest rates in the CDO selection. The maturity time of the selected CDOs differ between 30 and 45 years and adjustable interest rates are based on three-month WSJ LIBOR. This implies that the interest rates are reset each third month indexed at WSJ LIBOR plus margin. Since we deem a forecast on WSJ LIBOR for the coming 45 years to

[25] Standard & Poor's RatingsDirect (2006), p.1-7.
[26] Thorsell (2008) p.31.

generate a more biased result, we assume the adjustable interest rate to be constant over the maturity time of each security.

4.3 Validity and Reliability

4.3.1 Validity

Conducting a qualitative research study imposes several opacities regarding the reliability and validity of the outcome. Since the study includes making subjective judgements the validity may be questioned. The validity of a study describes to which extent an account accurately represents the social phenomena which it refers to.[27] It further explains if the use of certain measures supports results corresponding to the aim of these measures.[28] We believe that our attempt to include several perspectives on the issue, by gathering empirical data from different categories of financial actors, increases the validity.

The primary empirical data has been collected from actors in the financial markets, providing a solid basis for comparison and interpretation, which increases the validity. However, examining causes of a negative impact may impose obstacles to the validity since the interview objects, being to some extent involved in the causal acts, may present biased information. Thus, the rating agencies and investment banks as interview objects may, compared to other independent sources, reduce the validity of this study. Further, since each interview is voluntary, the bias of the empirical data may be amplified. However, all interview objects have been offered anonymity, limiting the degree to which the data may be biased.

The fact that the selection of CDOs is small may be limiting to the ability of generalizing our results on the whole subprime CDO market. Comparing our selection of downgraded CDOs with the ABX index, reflecting market values of a wider selection of CDOs which may not all be downgraded, implies an amplified result in terms of losses and savings potential. However, since we deem our selection to cover the essential characteristics of both cash-flow and synthetic CDOs, the most common forms of CDOs, we believe that the results can be generalized on the whole subprime CDO market.

[27] Silverman (2000), p.175.
[28] Bryman (2002), p.43-44.

Since the decisions regarding the CDO investments already have been made we believe that the collected data covers the causes for misjudgements. This should strengthen the validity of the study.

The choice of basing the valuation on one of the major rating agencies, S&P, should not bias the result significantly, since the CDOs require the same rating from the two foremost rating agencies, Moody's and S&P.[29]

4.3.2 Reliability

The reliability of a study describes to what extent another party can conduct the same investigation by using the same measurements in order to replicate the results of the study.[30]

Since we noticed during the study that the ability to obtain interviews on such a controversial subject was limited, we believe that it may be difficult to replicate the primary data collection process. If the data collection process is replicated, the answers are still dependent on the interviewee's current knowledge and opinions, which probably changes over time as the crisis continues. The dependence on timing lowers the reliability of the study. However, the reliability for the primary data should be relatively high since the interviews have been conducted with some degree of standardization through the use of a questionnaire. Furthermore, the answers obtained are collected from multiple perspectives and should be considered as representative for the industry as a whole. The secondary data collection process can, without difficulty, be replicated and should to a great extent give the same results.

[29] Gemstone CDO Ltd. Prospectus, p.1.
[30] Bryman (2002), p.43.

5. Terminology

The following chapter defines terms used in the Empirical Data and Analysis. Further abbreviations and definitions can be found in the Glossary.

5.1 Definitions

The following definitions clarify the meaning of certain terms used in the study.

Collateralized Debt Obligation (CDO) A security collateralizing a pool of tranched asset-backed securities or corporate bonds, including securitized subprime loans. Usually, an off-balance entity is set up for the sole purpose of issuing tranches (bonds) of a CDO.[31]

Credit Rating A current opinion of the creditworthiness of an obligor/security with respect to a specific financial obligation, a specific class of financial obligations, or a specific financial program. S&P's rating scale ranges from the highest level of 'AAA' to the lowest level of 'D'. The different credit rating levels embody a certain probability of default where higher credit rating embodies lower risk. The scale also encompasses sub-levels modified by plus (+) or minus (–) signatures, e.g. 'AAA–', to show relative standing within the major categories.[32]

Credit Risk The potential for losses on fixed-income investments and derivative contracts, caused by issue and counterparty defaults, and market value losses related to credit-quality deterioration.[33]

Credit Segments In the U.S. borrowers are divided into two main groups depending on their credit worthiness, the prime segment and the subprime segment. Individuals with good credit worthiness are considered prime borrowers whereas individuals with poor credit worthiness are considered subprime borrowers.

Credit Spread The difference in interest rates between corporate bonds and risk-free government bonds.[34] The yield of the bond is usually based on LIBOR plus a spread, given

[31] Standard & Poor's Structured Finance (2002), p.4-6.
[32] Standard & Poor's RatingsDirect Webpage (2008).
[33] International Monetary Fund (2007), p.129.

in number of basis points. The spread adjusts the yield for the probability of default and is dependent on the credit rating of the bond. Accordingly, higher credit risk implies wider spreads and lower prices. The credit spread is sensitive to the business cycle and usually widens during economic downturns.[35]

Federal Funds Rate Interest rate at which depository institutions lend balances at the Federal Reserve lend balances to other depository institutions overnight.[36]

Investment Grade A bond or loan assigned a credit rating in the top four categories ('AAA' to 'BBB–').[37]

Leverage The proportion of debt to equity. Leverage can be constructed by borrowing (on-balance-sheet leverage, commonly measured by debt-to-equity ratios) or by using off balance-sheet transactions. Leverage involves the use of borrowed money in order to invest and gain higher returns. However, both the chances for gain as well as the risk of loss are magnified, since the risk exceeds the equity invested.[38]

Market and Liquidity Risk The potential for instability in pricing risk that could result in broader spillovers and/or mark-to-market losses.[39]

Primary Market The market in which a newly issued security is first offered for sale to investors.[40]

Secondary Market Markets in which securities are traded after they are initially offered/sold in the primary market.[41]

Speculative Grade A bond or loan rated below investment grade ('BB+' and lower).[42]

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[34] Brunnermeier (2008), p.7.
[35] Friberg, interview June 4, 2008.
[36] The Federal Reserve Board – Open Market Operations (2008).
[37] International Monetary Fund (2008), p.120.
[38] Gemstone CDO Ltd. Prospectus, p.11.
[39] International Monetary Fund (2008), p.45.
[40] Ibid, p.121.
[41] Ibid, p.122.
[42] Ibid, p.59, p.123.

WSJ*[43] *LIBOR An index of the interest rates at which banks offer to lend unsecured funds to other banks in the wholesale money market.[44] The WSJ LIBOR is denominated in U.S. dollar (USD).

6. Background

The background story describes the effects of the subprime crisis as we have witnessed until today. The purpose of this chapter is to facilitate the comprehension of the forthcoming sections.

6.1 "The Worst Crisis since the 1930s"[45]

As of today we see a slowdown not only in the U.S., but in the World economy. The weakened economy can be derived from many different factors, the credit crisis being one. The calculated losses of the banking system count to approximately USD 400 billions, of which half relates to American and half to European actors.[46] However, losses may incur other markets as well, reaching a total of USD one trillion.[47]

There are opposing forecasts regarding the expected progress in the financial market due to the high uncertainty of the current situation. What we do know is that several of the world's largest financial institutions have made massive asset write-downs on their balance sheets. We have witnessed a systematic meltdown wave covering several actors within the banking sector all over the world. The write-downs are a consequence of the held investments being downgraded and consequently less tradable in the secondary market. This liquidity crisis initially covered products containing subprime mortgages but has spread to other areas of the credit market.[48] Due to this contagion effect, amplified by high uncertainty, the write-downs concern both subprime-related and non-subprime related assets.[49] Although the size of the total losses is relatively modest, the effects are amplified due to several reasons.

First, the crisis hits the banking system directly, which imposes higher prudence among financial actors. In contrast to industrial companies, the process of bankruptcy is much faster

[43] *Abbreviation for* Wall Street Journal.
[44] International Monetary Fund (2008), p.121.
[45] *Authors' translation of* Värsta krisen sedan 1930-talet (2008).
[46] Lundvik, interview June 17, 2008.
[47] Turnbull, Crouhy & Jarrow (2008), p.1.
[48] European High Yield Association (2007).
[49] Beta, interview May, 2008.

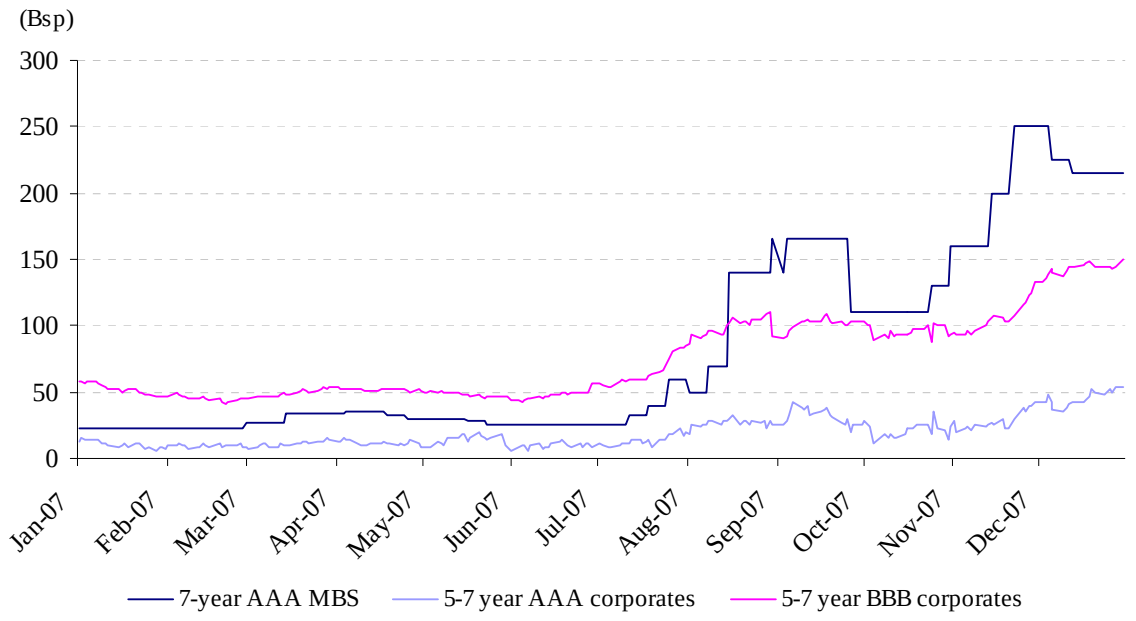
with banks.[50] Due to the implied risk of losing money, lending to a bank that may file for bankruptcy is more restrictive. Further, asset write-downs imply that banks must employ a more restrictive lending policy in general due to capital charge restrictions.[51] These two factors contribute to a reduced activity in the interbank market. With less money circulating fewer deals can be closed. As both business and private activity is dependent on borrowing conditions set by banks, actions in the financial industry have wide-spread effects in other markets as well.

Second, the losses emanate from leveraged positions. In contrast to other crises, the losses of the subprime crisis are less evenly spread within the financial system.[52] Thus, the losses strike fewer actors, which suffer immense losses. The loss structure is reflected in some of the largest U.S. financial actors filing for bankruptcy or being bailed out by the government.

Third, the increase in delinquency and default rates on subprime mortgages has not only translated into spread widening and market value reduction on securities collateralized by them, but many other securities as well.[53] High uncertainty about which securities contain subprime mortgages probable to default prevails and, hence, other credit instruments, *not* encompassing subprime mortgages, have also become illiquid.[54] The higher risk averseness among investors makes the price on risk rise. Due to this contagion effect, the fear is not only reflected in dramatically lower ABS market prices, but other corners of the credit market also show signs of rising spread indicies. The total effect is that price on risk is high which in turn increases the price on return. *(See Figure I.)*

[50] Friberg, interview June 4, 2008.
[51] Lundvik, interview June 17, 2008.
[52] Samuelsson, interview June 4, 2008.
[53] International Monetary Fund (2007), p.6.
[54] Samuelsson, interview June 4, 2008.

Figure I. Credit Spreads on 'AAA' Mortgage Backed Securities, 'AAA' and 'BBB' U.S. Corporate Bonds 2007



Source: International Monetary Fund (2008).

Higher rated securities normally imply lower spreads, reflecting the lower risk attached. Widening spreads, like the development since August 2007, implies that investors generally demand higher interest payments for the same level of credit risk. Further, *Figure I* shows that the spread for 'AAA'-rated MBS exceed the spread for 'BBB' corporate bonds, implying investor sentiment that higher rated MBS are riskier than lower rated corporate bonds.

Another effect of the financial turmoil to witness today is the sudden absence of the U.S. subprime market. People with low credit rating are unable to borrow money on their houses anymore.[55]

So how did we come to this depressive scenario? The chain of causes transpiring the current situation can be derived back until the early years of 2000 and embraces the development in the U.S. mortgage market and the structured-finance market.

[55] Allen, interview June 9, 2008.

7. Empirical Data

The empirical data describes the U.S. mortgage market and the process of securitizing and distributing structured-finance products, focusing on subprime CDOs. The data elucidates on current actions and characters, which may have contributed to the subprime crisis development. Subsequently, a valuation basis for CDO investors is presented followed by a valuation of CDOs. The valuation outcome shows the size in losses and savings potential of CDO investments.

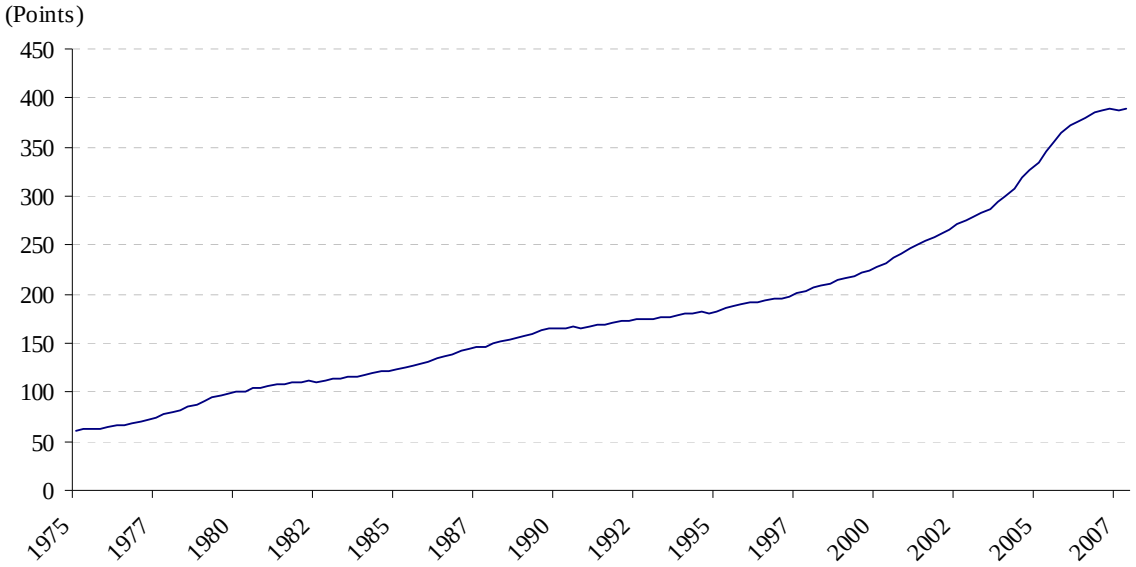
7.1 The U.S. Mortgage Market

Worldwide, the total borrowing volume has grown and the greatest increase can be derived from mortgage loans.[56] In the U.S., mortgage loans as percentage of GDP have grown steadily since 2001.[57] Consequently, the mortgage market drives the U.S. economy to an increasing extent.

The ability to engage in mortgage loans is dependent on the value of the underlying collateral, i.e. the house. In general, U.S. house prices have experienced a stable price appreciation since the 1970s. *(See Figure II.)* The lenders of the primary mortgage market include mortgage banking companies, saving banks and housing finance agencies. Mortgage banking companies often rely on secondary market funding in order to originate more mortgage loans. In the secondary market there are several key actors that facilitate funding in order to keep interest rates low on house purchases. Fannie Mae, Freddie Mac and Ginnie Mae are government-sponsored enterprises (GSEs) that operate in the secondary market, providing primary lenders with liquidity. The GSEs purchase mortgage loans from primary lenders, repackage them into securities and sell them to institutional investors. This allows mortgage lenders to remove loans from their balance sheets.[58]

[56] Nyberg (2007), p.4.
[57] Borg, interview May 26, 2008.
[58] Fannie Mae (2007), p.4.

Figure II. OFHEO House Price Index 1975-2007



Indexed based on prices of 1980.

Source: Office of Federal Housing Enterprise Oversight (2008).

One distinguishing feature of the U.S. mortgage market, compared to the Swedish market, is that the underlying asset is so called ring-fenced, i.e. the house is the only collateral backing the mortgage.[59] In the Swedish market, when a borrower defaults on the payments, the individual is personally responsible for the whole debt even though the value of the house does not cover it. If the borrower cannot commit to the obligations the house will be foreclosed. However, if the foreclosed value does not correspond to the outstanding debt to the lender, other assets of the borrower may be confiscated.[60] Thus, the borrower's whole economic capital is put at stake in loan engagements. In contrast, in the U.S. mortgage market, a borrower who defaults on the payments can offer the underlying house to the lender. The foreclosure of the property cancels the borrower's debt, even if it is a short sale.[61] Accordingly, in the U.S. mortgage market borrowers can make sound deals by turning in houses of less value than their loans. The system supports speculative house ownership, since the borrower may transfer the ownership to the bank and move if the value of one property is reduced.[62] However, as transferring the collateral to the bank is considered to be a mortgage default, such action lowers the borrower's credit score.[63]

[59] Friberg, interview June 4, 2008.
[60] Utsökningsbalken (1981:774), ch.4, §4.
[61] Friberg, interview June 4, 2008.
[62] Nyberg, interview June 9, 2008.
[63] Allen, interview June 9, 2008.

Another feature of the U.S. mortgage market is the high loan-to-value (LTV) ratio that banks can offer to borrowers. There is no regulation regarding LTV ratios for 1-4 family residential properties, i.e. common residential houses.[64] Accordingly, loans may exceed the value of the underlying collateral. There are loans allowing a LTV of 125 percent.[65]

House owners and potential house owners are usually approached by mortgage brokers when engaging in mortgage loans. However, since mortgage brokers only intermediate between the borrower and the lender they do not bear any risk. The risk is solely borne by the financial institution originating the loan. The requirements for being a licensed mortgage broker are generally low, but vary between different states. In the Tri-State region, for instance, the requirements are basically a good credit history and no previous convictions.[66]

Another distinguishing characteristic of the U.S. mortgage market is that the subprime segment represents a significant amount of the total borrowing volume.[67] The subprime segment, however, has no government-supported surveillance and operates through self-regulating mechanisms.[68]

The U.S. mortgage market is divided into to two main segments according to their credit quality; prime and subprime. These segments can further be divided into sub-segments; while prime represents A-quality, subprime embodies A–, B, C, and D-quality.[69] The level of mortgage credit quality implies, within a range, a certain level of risk and return.

FICO scores, created by Fair Isaac Corporation, are the most commonly used credit scores in the U.S. The scores provide guidance for lenders to evaluate a person's credit risk. The credit quality of mortgages measures the borrower's probability of delinquency and default, where a higher score implies a lower credit risk.[70] Estimating default and delinquency rates is mainly based on historical performance, both relating to behaviour of the loan and of the

[64] Federal Deposit Insurance Corporation Laws, Regulations related Acts (2008).
[65] Is the 125 Percent Home Equity Loan Right for You? (2006).
[66] Allen, interview June 9, 2008.
[67] Nyberg (2007), p.4.
[68] Allen, interview June 9, 2008.
[69] Deutsche Bank Global Markets Research (2007), p.3.
[70] NERA Economic Consulting (2007), p.2.

borrower.[71] The main aspects considered when determining credit quality are the characteristics of the borrower, of the collateral, and of the loan. FICO scores can range from 300 to 850 with a majority of scores between 600 and 700.[72]

The GSEs decide on the credit rating criteria for an individual to borrow within the Prime segment.[73] Generally, these individuals have good credit quality and complete documentation.[74] If the borrower does not meet the required prime criteria the borrower is classified as subprime. The extra risk entailed by the lower credit rating results in a higher interest on subprime mortgages. Many of subprime borrowers are low educated, have low income and live in poor residential areas.[75] Subprime borrowers usually use their loans to finance consumption. Mostly, the GSEs deal with prime mortgages, while mortgages outside this segment are usually issued and securitized by private-label companies.[76,77] The three major segments of the private-label industry are subprime, alternative-A (alt-A), and jumbo, all of which have experienced remarkable growth throughout the last decade.[78] *For a review of the FICO scale, see Appendix 6 Illustration I.*

In general, people with FICO scores ranging from 300 to 620 are considered subprime borrowers.[79] However, since there are no GSEs deciding on certain credit-quality guidelines, these criteria tend to differ among mortgage lenders. *For a review of the application of underwriting guidelines, see Appendix 3 Table I and Table II.*

7.1.1 The U.S. Subprime Mortgage Market

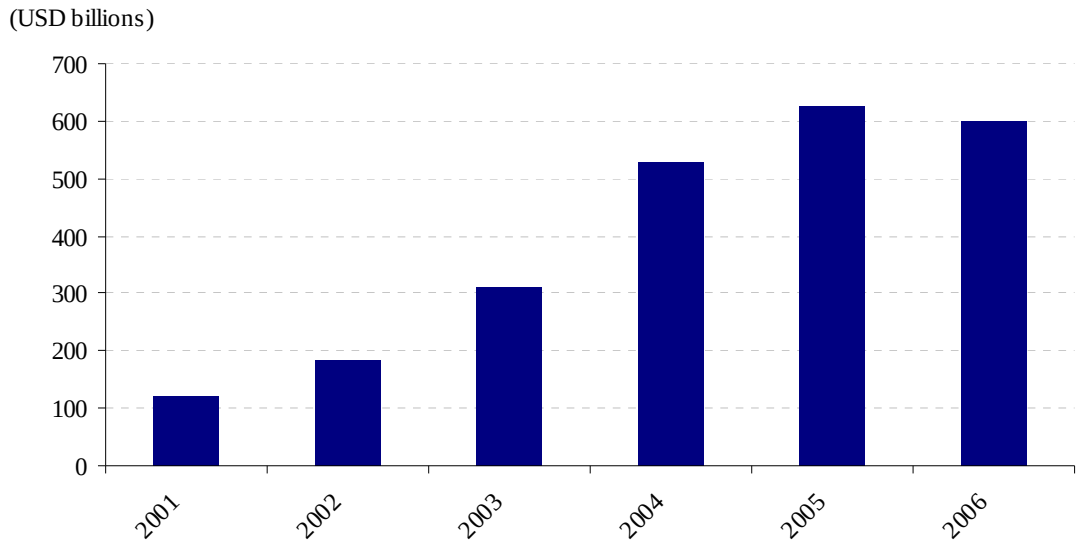
The birth of the U.S. subprime-mortgage market dates back to the early 1980s, but it was not until the mid-1990s that growth started to accelerate. Ten years ago the subprime market accounted for about five percent of the total U.S. mortgage market, during 2005-2006 the

[71] Friberg, interview June 4, 2008.
[72] Fair Isaac Corporation (2007), p.1, p.7-12.
[73] Fannie Mae (2007), p.4.
[74] Deutsche Bank Global Markets Research (2007), p.3.
[75] Allen, interview June 9, 2008.
[76] NERA Economic Consulting (2007), p.2, p.4-5.
[77] Allen, interview June 9, 2008.
[78] NERA Economic Consulting (2007), p.5.
[79] *The upper attachment point may vary between 660 and 620.*

fraction had grown to about 20 percent, but declined subsequently to about 12-13 percent in 2007.[80,81,82] In 2007, the subprime market size was approximately USD 1.5 trillion.[83]

During 2001-2006, the subprime market experienced an immense growth. (*See Figure* III.) The market explosion was mainly driven by investor demand for high-yield securities, causing a growing proportion of securitized subprime mortgages. The growing investor demand can be derived from the economic conditions during the early years of 2000. As a countermeasure to the decreased national consumption in the U.S. the Federal Funds Rate was kept at a low level for several years.[84,85] With relatively low market risk premium investors especially sought high-risk investments to obtain profitable return.[86]

Figure III. Total U.S. Subprime Origination 2001-2006



Source: NERA Economic Consulting (2007).

In turn, securitization enables an even larger investor base, which contributes to higher liquidity in the mortgage market. More mortgages are repackaged into MBS and sold to investors. The market provides a wide range of products customized for each individual's risk appetite and return demands.

[80] NERA Economic Consulting (2007), p.1.
[81] Standard & Poor's RatingsDirect (2007a), p.2.
[82] Deutsche Bank Global Markets Research (2007), p.4.
[83] LBBW Credit Research (2007), p.4.
[84] Borg, interview May 26, 2008.
[85] Federal Funds Overnight Effective Rate (2008).
[86] Borg interview May 26, 2008.

Regarding the supply side of the subprime-mortgage market, growth was driven by several factors. Credit innovations allowed subprime borrowers to engage in a wider range of mortgage products.[87] As the prime segment had become saturated mortgage lenders looked for alternative customers in new markets. Instead of entering new geographic markets, lenders detected a great opportunity by approaching the subprime segment.[88]

Over the last years, in order to attract the new customer base in the subprime segment, mortgage lenders loosened credit standards.[89] Weaker credit controls, for instance by accepting high LTV ratios and reduced documentation, were employed in order to adjust to subprime borrowers' financial situation.[90] Loans that usually only were offered to prime borrowers now became available even to subprime borrowers.[91]

Not only did the mortgage lenders loosen their credit controls, but all subprime borrowers did not fully understand their commitments. Such weaker credit controls allowed for subprime borrowers to state their income without any documentation. Since higher income renders better loan conditions, some borrowers overstated their income. Hence, mortgage lenders allowed for loans that borrowers could not afford. In addition, all borrowers were not familiar with the expenses involved in mortgage loan engagements. Income was deemed sufficient when it covered the expected interest expense. Expenses that were not considered were for instance mortgage insurance, closing fees, instalments, and tax. Thus, the total expenses could be up to three times as high as the interest expenses, committing the borrower to loans he or she does not afford.[92]

Subprime MBS are sometimes referred to as HELs to denote home-equity loans as underlying collateral.[93] Some properties have multiple liens where first-lien mortgage loans are the initial mortgages offered to borrowers. Home-equity loans allow home owners to borrow against the non-mortgaged value of their homes, i.e. use the equity element as

[87] NERA Economic Consulting (2007), p.1.
[88] Lundvik, interview June 17, 2008.
[89] Financial Stability Forum (2008), p.5.
[90] International Monetary Fund (2008), p.5.
[91] Deutsche Bank Global Markets Research (2007), p.5-6.
[92] Allen, interview June 9, 2008.
[93] Deutsche Bank Global Markets Research (2007), p.3.

collateral.[94] Thus, loans exceeding the value of the underlying collateral always encompass home-equity loans.[95] Normally, a home-equity loan is second lien, subordinated to the first-lien mortgage loan. However, during last years first-lien loans constituted home-equity loans to an increasing extent.[96, 97]

During 2005 and 2006 "80/20" products were offered to subprime borrowers, which allowed for such multiple-lien mortgage loans to finance their homes. The first mortgage allowed borrowers to loan 80 percent of the purchase price, while the second mortgage allowed for another 20 percent of the underlying value. During recent years, within the subprime segment such mortgage loans covering up to 100 percent of the market value of the underlying house, or above, were not unusual. Most subprime mortgages were high LTV loans corresponding to more than 80 percent of the underlying value.[98] A high LTV implies that the borrower makes a smaller down-payment, which increases the risk for the lender to be unable to recover the capital in a credit event or default.[99]

There are two types of mortgages, fixed-rate mortgage (FRM) and adjustable-rate mortgage (ARM), where the latter became more common in the mortgage market over the last years.[100] In FRM arrangements a fixed interest payment based on the principal is due on a regular basis. In ARM arrangements interest is set to LIBOR index plus a certain margin in basis points.

The growing demand for ARMs during recent years was especially referred to the subprime segment.[101] In 2007, roughly 80-85 percent of subprime loans were ARMs.[102] Many of the ARM subprime loans were hybrids, with fixed interest rate during the first 2-3 years, known as a teaser, which then reverts into adjustable rate.[103] The deterioration in the subprime-mortgage market is primarily associated with defaults on ARMs, including hybrids.[104] Since teaser hybrids are relatively new there is no historical performance data in a housing

[94] International Monetary Fund (2008), p.120.
[95] The Bond Market Association (2004), p.4.
[96] Allen, interview June 9, 2008.
[97] Turnbull, Crouhy & Jarrow (2008), p.7.
[98] Ibid.
[99] NERA Economic Consulting (2007), p.2.
[100] International Monetary Fund (2008), p.5.
[101] Ibid, p.5.
[102] International Monetary Fund (2007), p.6.
[103] NERA Economic Consulting (2007), p.3.
[104] International Monetary Fund (2008), p.5.

downturn.[105] The result of the increased popularity of these loans is a massive proportion of outstanding mortgage loans with lack of performance record prevalent in the U.S. mortgage market during last years.

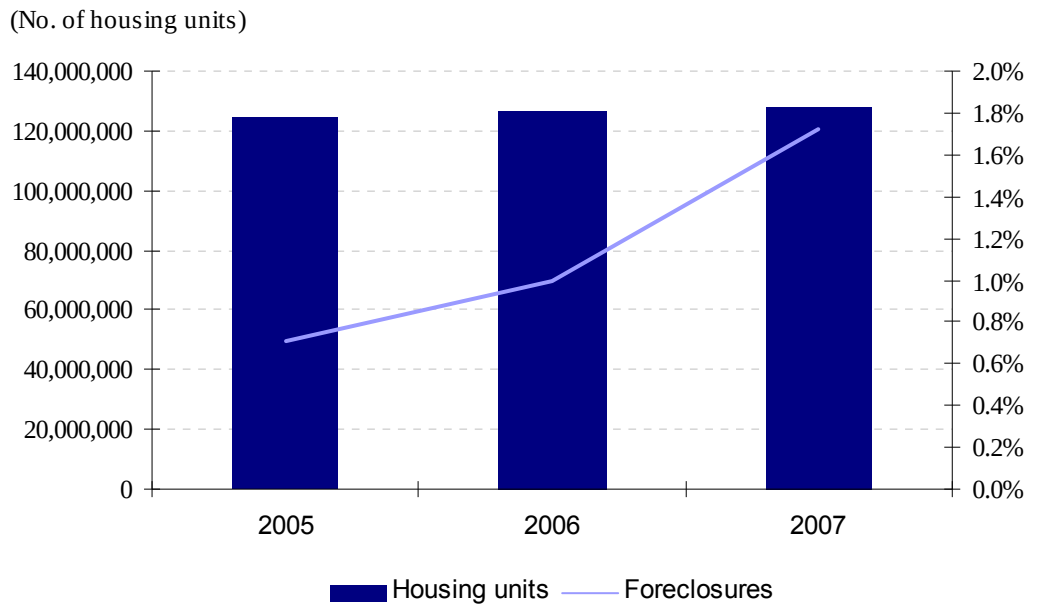
One of the most common hybrids during last years was the 2/28 hybrid, with a fixed interest rate the first two years and then adjustable rate for 28 years. The introductory fixed teaser rate is set below the margin of the loan plus index. While the mortgage owner makes interest payments below margin during the first years, the mortgage lender adds the interest gap to the loan. Since the construction generates negative amortizations, these loans are also referred to as Neg-am loans. After two years the adjustable rate takes off, which further compensates for the previous advantageous fixed rate.[106] The rate is then reset and linked to an index, usually six-month LIBOR,[107] which makes the monthly payments dependent on the short-term interest rate upon reset.[108] The compensation policy implies higher interest payments for the borrower. The combination of shortreset-loan engagements and rising interest rates, transformed seemingly bearable loans to unaffordable economic conditions for subprime borrowers. As these mortgages started to reset borrowers could no longer bear the higher interest payments. In 2004, short-term interest rates started to rise, which further amplified the interest cost increase for the borrowers.[109]

The sale pitch of the teaser hybrid ARMs promoted the low initial monthly cost and suggested borrowers to refinance before the adjustable rate would take off. However, since the initial negative amortizations accelerate the growth of the loan, the borrower may eventually face refinancing difficulties. The growing LTV ratio may deter any refinancing through new mortgage loans. With ever appreciating housing prices, new mortgage loans would be made in the future to finance the higher interest costs.[110] Thus, subprime borrowers counted on this possibility to refinance based on an appreciated market value of the underlying asset. However, difficulties started to show as the rate of U.S. house price appreciation started to decline in 2005. Instead, many borrowers incurred higher mortgage costs than expected.[111]

[105] Deutsche Bank Global Markets Research (2007), p.7.
[106] Allen, interview June 9, 2008.
[107] International Monetary Fund (2008), p.5.
[108] NERA Economic Consulting (2007), p.9.
[109] Turnbull, Crouhy & Jarrow (2008), p.7.
[110] Allen, interview June 9, 2008.
[111] Turnbull, Crouhy & Jarrow (2008), p.7.

The economy experienced some changes in 2004 as the Federal Funds Rate rose, which in turn made rates on ARMs increase. Simultaneously, the earlier decade-long continuous appreciation in house prices started to decelerate. The delinquency rate for subprime ARMs increased steadily from mid 2004 until the peak by the end of 2006, when it reached about 14 percent. During 2006, 2.5 million mortgage borrowers had subprime ARMs.[112] All together, delinquency rates on subprime mortgages originated in 2005-2006 reached all-time high.[113] Consequently, the number of foreclosures grew dramatically as reflected by the end of 2007 when foreclosures corresponded to about half of all home sales.[114] *(See Figure IV.)*

Figure IV. U.S. Foreclosure Activity Relative to Housing Units 2005-2007



Source: RealtyTrac (2008a), U.S. Census Bureau State Housing Estimates: 2000 to 2007 (2008).

In July 2007, the total number of households in the U.S. was 127.9 million, whereas the number of foreclosed households totalled 2.2 million, representing about 1.7 percent of the total number of households. The increase in foreclosures during 2005-2007 was almost 150 percent.

Since the subprime mortgages only make up a small proportion of the U.S. mortgage market, it could be expected that defaults incurring the subprime market would not make great impact on housing prices. However, as marginal house buyers the subprime borrowers influence market prices to a high extent. In 2006, subprime and alt-A borrowers together

[112] Turnbull, Crouhy & Jarrow (2008). p.7-8.
[113] International Monetary Fund (2008), p.5.
[114] Borg, interview May 26, 2008.

constituted almost 40 percent of home purchases.[115] Consequently, when the marginal home buyers cannot afford to purchase anymore, demand is heavily reduced together with market prices. A vicious circle is initiated as lower housing prices further complicate the refinancing of homes to handle higher mortgage costs.

[115] Deutsche Bank Global Markets Research (2007), p.7.

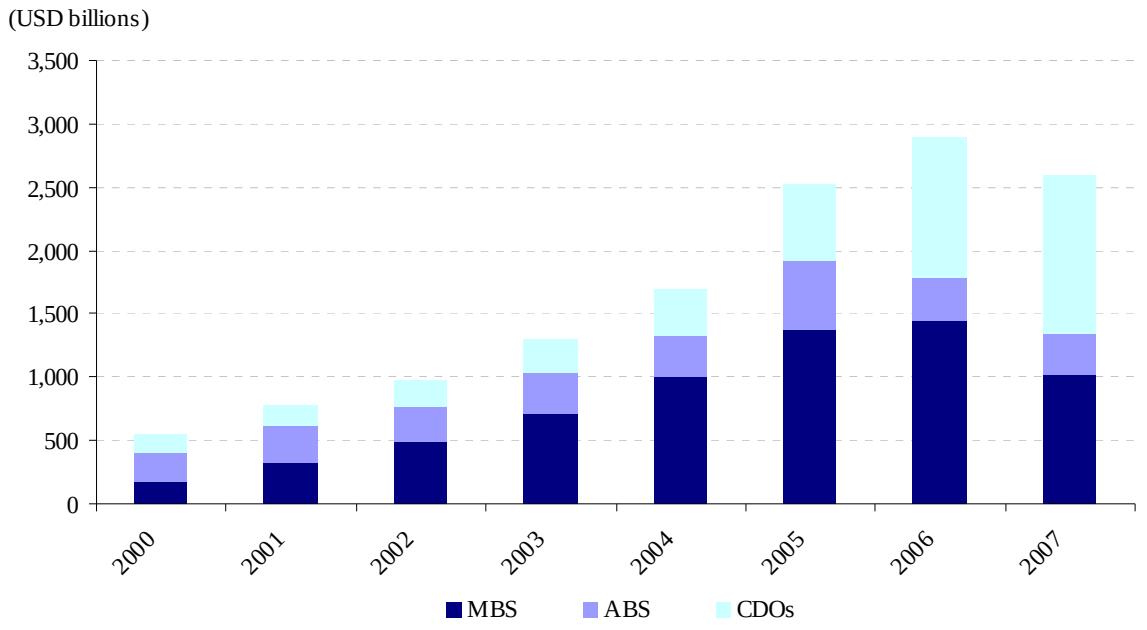
7.2 The Structured Finance Evolution

7.2.1 The History of Securitization

The history of securitization originates in 1970 with structured financing of mortgage pools in the U.S. More sophisticated investor preferences combined with better available technology has made the asset securitization business one of the fastest growing trends in the capital markets.[116,117] Securitization refers to the creation and issuance of debt securities, whose payments derive from cash flows generated by pools of assets, comprising the collateral.[118] Concerning mortgages, securitization refers to the procedure of turning pools of mortgage loans into tradable bonds. The securitized loans are generally referred to as mortgage-backed securities (MBS).[119] The securitization process allows originators to diversify their funding base since the holder has exposure to the credit risk of a number of borrowers instead of one single loan. The securitization further allows the creation of a wide range of financial products with the customization of risk and return structures. Investors can choose from credit products with risk/return patterns in almost any form satisfying various levels of trade-offs.[120] Structured finance is characterized by the resulting cash flows being divided into tranches paid to different holders in a sequential order.[121] *(See Figure V.)*

[116] Structured Investment Vehicles (SIV) (2006), p.1.
[117] Borg, interview May 26, 2008.
[118] Structured Investment Vehicles (SIV) (2006), p.1.
[119] NERA Economic Consulting (2007), p.4.
[120] Deutsche Bank Global Markets Research (2007), p.9.
[121] International Monetary Fund (2008), p.56.

Figure V. European and U.S. Structured Credit Issuance 2000-2007



Source: International Monetary Fund (2008).

Note: MBS excludes U.S. agency MBS. ABS includes securities backed by auto, credit card etc. and excludes MBS. Structured credit refers to credit based structured-finance products.

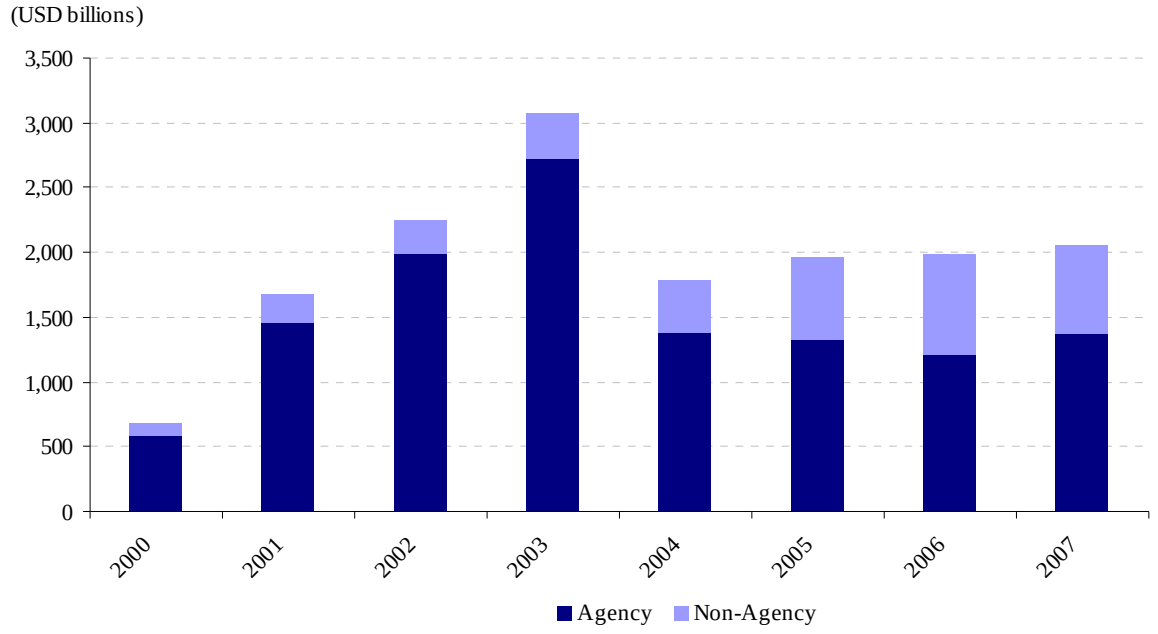
Not only has the securitization business experienced dramatic growth during the last 30 years, but the securitization landscape has also altered. About 20 years ago, speculative-grade issues represented about one third of all S&P ratings, whereas by the end of 2006 the volume had ascended to more than half of all S&P ratings. The risk appetite of investors has increased while the low-risk investment-grade market has become saturated. Investors seek riskier investments with higher yield. Due to the growing popularity in speculative-grade investments, the required yield of such investments has decreased. In the second quarter of 2007 speculative-grad spreads hit record low.[122]

The low cost of capital during the early years of 2000 generated a high level of liquidity in the global markets. A low price on risk caused a surge for leveraged structured-finance products generating high yield.[123] Low interest rates implied low cost of borrowing, which in turn generated rapidly appreciating house prices. Increasing house prices, facilitating mortgage engagements, in combination with a growing demand for high-yield investments

[122] Standard & Poor's RatingsDirect (2007c), p.4-6.
[123] Financial Stability Forum (2008), p.5.

were two main factors driving the recent evolution of securitization and the structuring of subprime CDOs.[124] *(See Figure VI and Figure VII.)*

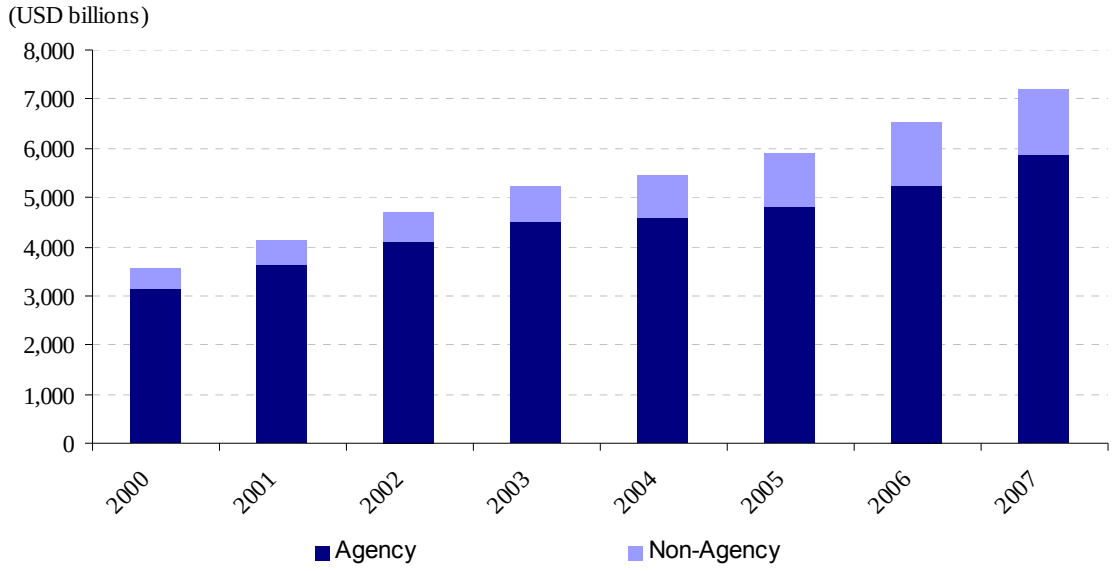
Figure VI. U.S. Mortgage Related Issuance 2000-2007



Source: Securities Industry and Financial Markets Association (2008a).

Note: Includes agency and non-agency MBS and collateralized mortgage obligations (CMOs).

Figure VII. U.S. Mortgage Related Outstanding 2000-2007



Source: Securities Industry and Financial Markets Association (2008b).

Note: Includes agency and non-agency MBS and collateralized mortgage obligations (CMOs).

[124] Beta, interview May, 2008.

However, as a steadily growing volume of mortgages are securitized, the effects of any market fallacy become increasingly evident. Lately, consequences from the explosive increase in delinquency rates on subprime mortgages have started to show.[125] High levels of delinquencies have generated an exceptional drop in the rating of investment-grade structured products. The worst downgrade hit loans that were issued in 2005-2006. Essentially, the downgrading struck CDOs of subprime mortgages, of which many senior tranches were downgraded from 'AAA' to speculative grade.[126] *For a review of the downgrading on our selection of CDOs, see Appendix 5.*

7.2.2 The Elements of Structured Finance Products

7.2.2.1 Asset Backed Securities

An asset-backed security (ABS) is created by the sale of assets to a legal entity, which becomes the legal issuer of the ABS.[127] The ABS comprises bonds or notes backed by underlying financial assets, which may include loans, leases or credit card debt. The loans are packaged, or pooled, into the ABS. Since ABS are secured by, and the risk is diversified through, a pool of underlying assets, the ABS are considered to be safe and predictable investments. One distinguishing feature of ABS compared to other corporate bonds, is the underlying pooled collateral and the inherent credit enhancement, allowing investors with different risk appetite to choose from appropriate structures.[128] ABS are structured to reallocate the risks entailed in the underlying collateral into security tranches. Under this structure at least two classes of ABS are issued, senior and subordinated. The senior classes have priority claim on cash flows from the underlying collateral.[129]

While some consider MBS as a separate investment category,[130] we use the label ABS as an umbrella term to include all securities backed by financial assets, including MBS.

[125] International Monetary Fund (2008), p.5.
[126] Turnbull, Crouhy & Jarrow (2008), p.6.
[127] Gemstone CDO Ltd. Prospectus, p.56.
[128] The Bond Market Association (2004), p.2-4.
[129] Gemstone CDO Ltd. Prospectus, p.56.
[130] The Bond Market Association (2004), p.2.

A MBS signifies an ownership right in mortgage loans, often pooled. These loans are issued by financial institutions, to finance the borrower's purchase of a home or other real estate.[131] There are both residential mortgage-backed securities (RMBS) that focus on residential debt and non-residential securities that focus on commercial debt (CMBS). Subprime mortgages are residential mortgages, thus collateralized in RMBS. These entire ABS contain loans or mortgages pooled and subsequently tranched into tradable securities.[132]

The mortgage securities may be pooled again into collateral of new securities. These more complex forms of mortgage securities are so called collateralized mortgage obligations (CMOs).[133] CMOs constitute one among many varieties of collateralized debt obligations, CDOs.

7.2.2.2 Collateralized Debt Obligations

The most common form of ABS are CDOs, which encompass a complex structure of collateral comprised by bonds and securitized loans.[134] A CDO encompasses a collection of tranched securities and is managed by a collateral manager.[135] Because the CDO invests in securitized assets, the distance between the ultimate investor and the underlying asset is at least two layers of securitization. Accordingly, a first-layer CDO signifies a second-layer ABS.[136]

Cash-flow CDOs consist of a pool of tranched securities based on a reference portfolio of debt. The underlying instruments are mostly debt, loans, credits, bonds or default swaps, which are characterized by different risk levels, ranging from very safe to highly speculative.[137]

Synthetic CDOs are backed by credit default swaps (CDS) contracts and treasury bonds.[138] A CDS contract merely transfers the credit risk, and not the cash flow, of a reference portfolio in return for a fee. Hence, the underlying instruments are replaced by the CDS,

[131] The Bond Market Association (2002), p.1.
[132] Citi (2007), p.4.
[133] The Bond Market Association (2002), p.1.
[134] Brunnermeier (2008), p.3.
[135] Friberg, interview June 4, 2008.
[136] Beta, interview May, 2008.
[137] Hull & White (2004), p.8.
[138] Brunnermeier (2008), p.3.

whose credit risk is passed on to the investors of the CDO tranches.[139,140] The CDS counterparty, i.e. the investor, must accordingly pay the issuer if the underlying borrower defaults on the payments and the underlying collateral does not correspond to the security's value. Thus, an unfunded CDO, both cash-flow and synthetic, gives rise to counterparty risk since the ultimate seller of the CDO must rely on the investor's ability to cover the losses in case of a credit event.[141]

The swap fee in a synthetic transaction may not create enough cash flow in order to pay interest to the ultimate investors of the CDO. Hence, the synthetic CDO is backed by both a CDS and a low risk security, like treasury bonds. The treasury bonds create a low-risk cash flow securing the interest payments to the ultimate investors.[142]

If the CDO is backed by other structured-credit securities, it is referred to as a structured-finance CDO.[143] A CDO backed by a portfolio of loans is also referred to as collateralized loan obligation (CLO). The same logic applies to a CDO backed by bonds, a collateralized bond obligation (CBO). A CDO can further derive from other CDOs and is then referred to as CDO-squared.[144]

The securities of a CDO are sold in tranches according to their credit risk, i.e. the probability of default, of the underlying reference portfolio.[145] The tranched characteristic of a CDO offers a way to trade protection from a certain fraction of the losses incurred if the obligor defaults. Each tranche represents a type of securities with certain yield and risk characteristics. The most senior tranche (referred to as super-senior or senior) is considered to be as close to risk-free as a financial security can be and constitutes the largest fraction of the CDO. Securities of lower tranches generate higher yield due to their higher credit risk.[146]

CDO tranches are usually issued by a special purpose vehicle, i.e. an off-balance entity.

[139] Glasserman & Suchintabandid (2007), p.3.
[140] Elizalde (2006), p.11.
[141] Gibson (2004), p.3.
[142] Ibid, p.3.
[143] International Monetary Fund (2008), p.118.
[144] Brunnermeier (2008), p.3.
[145] Elizalde (2006), p.11.
[146] Incisive Financial Publishing (2007), p.6.

7.2.2.3 The Role of Special Purpose Vehicles

A special purpose vehicle (SPV) is a legal entity that has neither physical location, nor employees, and separated control rights for the business and financing decisions. The entity is initiated by a firm, the so-called sponsor or originator, which is often an investment company or a bank. Furthermore, the SPV is designed so that it cannot go legally bankrupt. Typically, SPVs are highly leveraged.[147] The SPV acquires liquid assets, such as loans, in exchange for interest on those assets. The acquisition is financed by investors purchasing tranched securities issued by the SPV. The tranching of securities satisfies different investor risk and return profiles.[148] The cash flow generated by the interest on the liquid assets is transferred to the investors holding the securities. The true sale of loans by an originator to the SPV implies that the originator no longer has ownership rights to the loans. The SPV may be consolidated with the sponsoring firm, as a subsidiary.

Typically, the SPV is highly insulated from many types of risks due to hedging and swap agreements.[149] However, the operation structure exposes the SPV to liquidity risk, since the funding relies on the structured-finance market not desiccating. The sponsoring bank partly guarantees funding liquidity by issuing a contractual credit line, also referred to as liquidity backstop.[150] The formal credit line may only be partial and does not cover all the losses in a credit event or default. However, the sponsoring bank may still bail out the SPV in order to protect the bank's reputation, through an implicit contract.[151] These reputational credit lines are non-contractual default warranties provided by the bank to protect its reputation.[152] All together, the contractual and reputational credit lines insulate the SPV from credit risk. This implies that, in reality, the bank bears the liquidity and credit risk.[153]

Motivation of Special Purpose Vehicle

Mostly, investment banks utilize the SPV technique in order to remove assets from their balance sheets. There are benefits for the bank to reap from moving debt into off-balance sheet vehicles.

[147] Nyberg (2007), p.3.
[148] Gorton & Souleles (2005), p.7-8.
[149] CNBS MarketCast - Revenge of the SIV (2008), p.1.
[150] Brunnermeier (2008), p.4, p.36.
[151] Gorton & Souleles (2005), p.3.
[152] Brunnermeier (2008), p.4.
[153] Nyberg (2007), p.3.

The capital charges for holding loans on and off balance differ. On balance loans are imposed an eight percent capital charge, which implies that the bank must deposit eight percent of the total lending, limiting the lending of the bank. The capital charge for contractual credit lines is much lower than for assets on balance. On reputational credit lines there is no capital charge at all.[154] Buying a loan effectively results in the buyer becoming a lender, thus increasing the capital charge. Accordingly, in order to reduce the capital charge, as well as being able to invest in more loans, investment banks remove them off balance.

Further, some financial institutions believed that selling securities to a SPV insulated them from credit risk, since the vehicle was off balance.[155] A motivation for establishing off-balance vehicles at distant locations is to avoid authority surveillance and reap tax benefits.[156] A common residence for SPVs is the Cayman Islands.[157]

7.2.3 The Securitization Process

7.2.3.1 Credit Enhancement

The rating agencies determine the amount of credit enhancement required for CDOs to attain credit quality equivalent to that of a same-rated corporate bond. These requirements are based on the characteristics of the collateral and its performance under severe stress.[158]

Credit enhancement is either achieved through internal or external processes. The risk conversion process leans on internal credit enhancement, including overcollateralization and subordination. Overcollateralization implies that the face amount of the underlying loan pool is larger than the security it backs. During recent years, the most risky and unrated tranche, equity, was typically created by overcollateralization mechanisms.[159] This enables the

[154] Brunnermeier (2008), p.4.
[155] Lundvik, interview June 17, 2008.
[156] Special Purpose Vehicles (2001).
[157] Lundvik, interview June 17, 2008.
[158] The Bond Market Association (2004), p.9.
[159] International Monetary Fund (2008), p.59.

security to withstand losses up to the amount of the surplus, i.e. the difference in value between the collateral and the liability.[160]

The most common internal mechanism used in subprime mortgages is subordination, i.e. tranching. The mechanism involves the parcelling of securities into different classes, so called tranches, in a senior/subordinated structure.[161] The losses are applied sequentially to each tranche starting with the equity tranche and moving up towards more senior tranches.[162] Senior tranches get paid preferentially while subordinated tranches only get paid to the extent the underlying security permits. In event of default, the most junior tranche covers the first losses. The senior tranche is not affected as long as losses do not exceed the amount of subordinated tranches.[163, 164] Consequently, an investment in a junior tranche is riskier than an investment in a senior tranche and, thus, junior tranche investors require higher yield. Top tranches consist of the 'AAA'-rated securities and the most junior level comprises equity, which is usually not rated.[165] In general, the equity tranche is not defined by any interest rate, but receives the residual after the payment allocation to all the other tranches. The tranching technique allows investors with different risk appetites to purchase customized products containing appropriate risk and return structures.[166]

For CDO-issuing entities, there were two reasons to keep the equity element in the SPV. First, keeping the equity tranche aligned the collateral manager's interest with investors', since it related the investment's performance to the manager's earnings. Second, demand for such high-risk investments was low. However, in some cases equity tranches were resecuritized into new CDOs or sold to risk keen investors.[167]

There is typically a senior tranche, a mezzanine tranche, and an equity tranche. The tranches are defined by a lower and an upper attachment point.[168] Next, an example is presented with attachment points of the equity tranche at 0-5 percent, the mezzanine tranche at 5-20 percent, and the senior tranche at 20-100 percent. Thus, the equity fraction absorbs the first

[160] NERA Economic Consulting (2007), p.6.
[161] The Bond Market Association (2004), p.10.
[162] International Monetary Fund (2008), p.59.
[163] NERA Economic Consulting (2007), p.6
[164] The Bond Market Association (2004), p.10.
[165] Nyberg (2007), p.2.
[166] Standard & Poor's RatingsDirect (2007b), p.4.
[167] Lundvik, interview June 17, 2008.
[168] Elizalde (2006), p.11.

five percent of the credit losses in the reference portfolio. In return, the equity holders initially receive the highest yield or a residual subordinated to all other tranches. Accordingly, in the absence of defaults the equity holder receives the highest yield. However, the yield paid is based on the outstanding face value on the tranche, which implies that holders are paid less if any losses incur. Accordingly, a default loss of 2.5 percent of the reference portfolio implies a 50 percent loss of the equity tranche's principal. Following, the mezzanine tranche covers the subsequent losses from 7-20 percent of total face value. These losses reduce the yield paid to investors of the mezzanine tranche. All losses in excess of the absorbed 20 percent are endured on the senior tranche.[169,170]

7.2.3.2 Credit Rating

Introduction to Credit Rating

Credit rating describes the probability of default for a company or an issued security. Credit rating does not demonstrate the security's future performance, but estimates the probability of the investor receiving interest and principal as stated in the purchase agreement. S&P uses the following methods to assess credit rating.

In order to obtain a certain credit rating, the company's or the security's probability of default must correspond to a certain level, calculated by S&P. The model used by S&P to assess credit rating of a CDO is referred to as CDO Evaluator.

A downside of the explosive development in the subprime market is that the projection of default and delinquency rates, i.e. the assessment of mortgage credit quality, gets more difficult. A sudden growth implies a lack of historical data on loan and borrower behaviour. Since default and delinquency rate forecasts are based on historical data, rating agencies thus used prime borrowers' data and stressed it to create a proxy for subprime loans.[171] Normally, attachment point levels are based on the probability of a certain amount of the borrowers defaulting on their payments.[172] However, during the last years the attachment points were set inaccurately, resulting in 'AAA'-tranches not meeting the requirements for 'AAA'-

[169] Hull & White (2004), p.8-9.
[170] Elizalde (2006), p.11.
[171] Gamma, interview June, 2008.
[172] Friberg, interview June 4, 2008.

securities.[173] Investment banks, which provide financing for the rating, cooperated with rating agencies in order to structure the CDOs to maximize the size of the most senior tranches.

Rating Model – The CDO Evaluator

The CDO Evaluator is used to rate both cash-flow and synthetic CDOs. The model relies on the rating of the underlying ABS.[174] Since there is no given rating theory for CDOs, S&P uses simulations to create a probability of default distribution. The results from the CDO Evaluator are used as a benchmark for different tranches in order to assess what stress level the tranches should survive. CDOs are built up by ABS, which in turn contain different types of loans and mortgages. S&P's model takes the correlation of the underlying assets into consideration. Based on historical data, a correlation of 0.3 is applied within a certain ABS sector and 0.1 is applied between ABS sectors. A higher correlation implies a higher probability of default.[175]

According to S&P, manager quality is the most important factor used to estimate CDO performance. However, there are difficulties to quantify and evaluate manager quality. The main factors that are taken into account when evaluating the manager are the track record, quality of the sponsoring entity and investment strategy.[176]

7.2.3.3 The Originate and Distribute Model

Traditionally, bank loans involve two counterparts, the lender and the borrower. The bank decides whether to grant and finance the mortgage loan after evaluating the underlying collateral and verifying borrower income. After the loan is granted, the borrower pays interest and principal to the bank until the loan matures. The bank is responsible for collecting payments, restructuring the loan, and foreclosing in case of default.[177] Traditional mortgage lending is financed through the bank's own deposit received from customers. This procedure limits the bank's lending, since it cannot lend more than it collects.

[173] Beta, interview May, 2008.
[174] Gamma, interview June, 2008.
[175] Standard & Poor's Structured Finance (2002), p.44.
[176] Ibid, p.55-59.
[177] NERA Economic Consulting (2007), p.4.

In the Originate-and-Distribute (O&D) model, which is broadly used today,[178] the secondary mortgage market has become a vital component in addition to the primary market. The O&D model facilitates securitization by the insulation of each actor along the securitization process. Through the insulation each actor becomes less dependent of decisions made further up or down the chain.[179] With the O&D model, financial institutions can increase their lending by originating mortgages and selling them on to investors. The O&D model allows for business expansion through the facilitation of additional borrowing and lending.[180]

See Appendix 6 Illustration II. Loans are originally issued by financial institution, with or without the help of mortgage brokers. Among subprime-mortgage loans about 2/3 use the intermediation of mortgage brokers.[181] Both the mortgage broker and the lender conduct credit controls to assess borrower credit worthiness. The mortgage brokers earn a fee based on the size of the mortgage loan. The lender, also referred to as originator, then sells the loan to an investor, usually an investment bank, where the loans are pooled. The investor uses an underwriter to assess to eligibility of the borrower and the collateral.[182] The investment bank establishes a SPV in order to keep the loans off balance. After the true sale of the loans the SPV becomes the ultimate holder of the loans.[183] The SPV issues securities of different tranches collateralizing the pool of loans, which is thereby securitized into a MBS.[184] Each tranche encompasses a certain credit rating with the most senior tranche representing the highest rating. Interests in the tranches, signifying the right to certain cash flows generated by the underlying collateral, are sold in the form of securities to investors. The cash flows of the MBS are collected by the servicer. The servicer, usually representing the originator of the collateral, administers payments and evaluates the underlying borrower's accounts.[185]

All tranches of the MBS are not always directly sold to investors. Additional, second-layer, SPVs are established to invest in the tranches of the initial SPV (i.e. the MBS). Since the

[178] Lundvik, interview June 17, 2008.
[179] Samuelsson, interview June 4, 2008.
[180] The U.S. Subprime Crisis in Graphics (2007).
[181] NERA Economic Consulting (2007), p.5.
[182] Allen, interview June 9, 2008.
[183] NERA Economic Consulting (2007), p.6.
[184] Gemstone CDO Ltd. Prospectus, p.56.
[185] Ibid, p.56.

second-layer SPVs invest in structured-credit securitizes, they comprise structured-finance CDOs.[186]

There are two main categories of CDOs; high-grade and mezzanine. Tranches rated 'A–' or above are resecuritized by high-grade CDOs, while 'BBB'-rated tranches and below are predominantly resecuritized by mezzanine CDOs. Typically, more than 90 percent of a high-grade CDO is collateralized by 'AAA'-rated senior, or super-senior, tranches. Likewise, the senior tranche of the mezzanine CDO represents about 75 percent of the structure. Many of the 'A'- and 'BBB'-rated mezzanine CDO tranches are further transformed into CDO-squared.[187] The proportion of underlying speculative-grade securities increases with the number of resecuritizing stages. The process of resecuritizing can proceed up until sixth layer.[188] On average, the collateral of mezzanine CDOs consists of 75 percent 'BBB'-rated ABS.[189] Through the aggregation of a large amount of MBS gathered in the new CDO, the collateral may be re-rated into higher tranches.

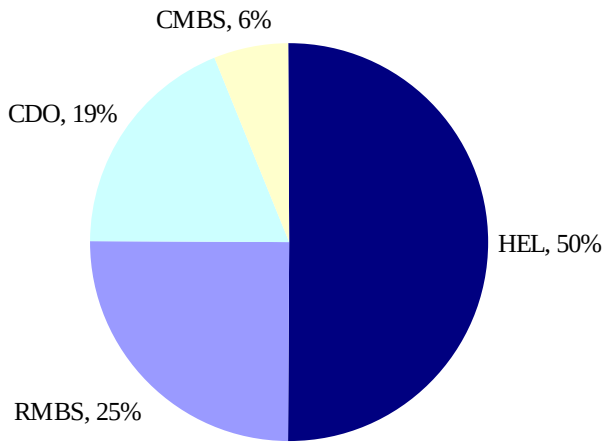
The process of converting tranches of a MBS or CDO into even more primarily investment-grade securities implies a transfer of credit risk into new securities as the tranches are resecuritized. By aggregating a large number of securities the credit risk of each individual instrument is reduced. For instance, if you have 100 papers in the CDO and 30 of them must default before losses to incur the senior tranche, the probability of all of them defaulting is very low. Accordingly, you can attain an 'AAA'-rating on speculative-grade papers.[190] The CDOs offered during recent years were considered low-risk investments with unusually high yield.

Many of the high-liquid investors, like pension funds and banks, may only invest in 'AAA'-rated, or at least 'AA'-rated, products.[191] Thus, the demand for MBS and CDO mezzanine tranches is low. To satisfy investor demand and generate more highly rated investment opportunities, certain CDOs were formed exclusively for the purpose of resecuritizing mezzanine tranches into third-layer products.

[186] International Monetary Fund (2008), p.118.
[187] Ibid, p.59-60.
[188] Friberg, interview June 4, 2008.
[189] Citi (2007), p.12.
[190] Friberg, interview June 4, 2008.
[191] Ibid.

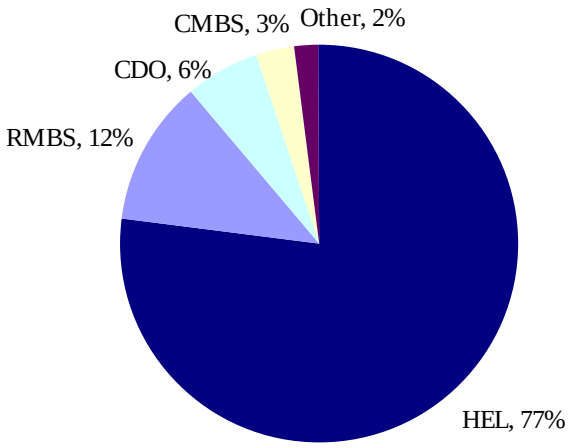
Both high-grade and mezzanine CDOs encompass HEL as their major collateral. In high-grade CDOs the proportion of HEL is, on average, 50 percent while corresponding proportion for mezzanine CDOs is 77 percent. Other common asset types comprising the collateral are RMBS, CDOs, and CMBS. *(See Figure VIII and Figure IX.)*

Figure VIII. Average Collateral Composition High Grade CDO of ABS



Source: Citi (2007).

Figure IX. Average Collateral Composition Mezzanine CDO of ABS



Source: Citi (2007).

7.3 Valuation Basis for CDO Investors

7.3.1 Offering Information

When securities are offered to the public or admitted to trading a prospectus is compiled.[192] The prospectus states a legal document including the conditions of the transaction. However, the prospectus denies the role of investment advisor and encourages each prospective investor to conduct an own valuation. The presented conditions include the interest rate, principal and maturity of every tranche as well as the subordination of payments. The interest rate may be adjustable, set by three-months LIBOR, or fixed, and the type of interest rate may differ between tranches. Each prospectus provides information regarding the collateral securing the notes, the credit rating, and the recovery rates.

Further, the prospectus provides information about the issuers, the collateral manager and the book runner. The issuer of the CDO is the SPV, an exempted company with limited liability.[193] A co-issuer with U.S. domicile is required if the SPV targets the U.S. market.[194] The collateral manager manages the collateral securing the offered notes. In our selection, all CDOs except one have collateral managers.

The view whether the marketing of CDOs is transparent or not differs. One view is that the marketing is transparent and since it only targets institutional investors, higher risk awareness should be expected.[195] However, some approached actors, who declined CDO investment offers, claim that the reason for the denial was the lack of transparency both regarding the construction, contents and pricing procedures.[196]

The prospectuses provide a discussion about the inherent risks a prospective investor should consider. The risk factors relate either to the notes or the collateral. Next, some of the risk factors presented are described.

[192] Gemstone CDO IV Ltd. Prospectus, p.*i*.
[193] Gemstone CDO Ltd. Prospectus, p.2.
[194] Beta, interview May, 2008.
[195] Ibid.
[196] Delta, conversation May 2008.

7.3.1.1 Liquidity Risk

Since CDOs are over-the-counter (OTC) derivatives, there is no official market place. Hence, there is no assurance that the initial purchaser will be able to trade the instruments in a secondary market. Furthermore, there is no clearing-and-settlement structure, which makes it difficult for parties to assess who bears the risk.[197] In addition, the notes are subject to transfer restrictions. The transfer restrictions limit the investor base of the notes as it only allows institutional investors with knowledge regarding the evaluation of the product. Furthermore, liquidity risk arises from increased perceived credit risk, derived from the perception of the probability of default and delinquency. If investors perceive the instruments to be riskier than expected, the products may become illiquid as demand for them is reduced. However, the securitization transaction may include a liquidity backstop, which entitles the SPV to funds in the case of liquidity deficiency.

7.3.1.2 Investment Company Act

The issuer has not registered with the regulatory laws of the U.S. and is thus not pursuant to the Investment Company Act. This is in accordance with the exemption applicable on any investment company organized under the laws of a jurisdiction other than the U.S. and whose investors resident in the U.S. are qualified or knowledgeable purchasers.[198]

7.3.1.3 Mandatory Redemption

Interest coverage tests are performed regularly and show if interest proceeds from the underlying assets can cover interest payments to the investors. If a test is not satisfied, interest proceeds will be used to repay principal in order to restore the interest coverage to a satisfactory level. The repayment will be made with regards to seniority. The repayment process could cause an elimination, deferral or reduction in the interest payments or principal repayments to the noteholders.[199]

[197] Nyberg, interview June 9, 2008.
[198] Gemstone CDO Ltd. Prospectus, p.11.
[199] Ibid, p.12, p.24.

7.3.1.4 Asset Backed Securities

Some of the risk factors relating to the underlying collateral are the following.

Operations risk arises from the possibility "for misrepresentation of the loan quality or terms" by the originating institution or the servicer.[200]

Credit risk may arise from losses incurred by the borrower defaulting on the underlying collateral. Another factor generating credit risk is the issuer's or servicer's failure to perform. Credit risk may further be derived from fraud.[201]

Market risk arises from the, often predictable, cash flows of the ABS. Market risk describes the risk of a decrease in the market value of the ABS due to movements in the market.[202]

7.3.1.5 Credit Ratings

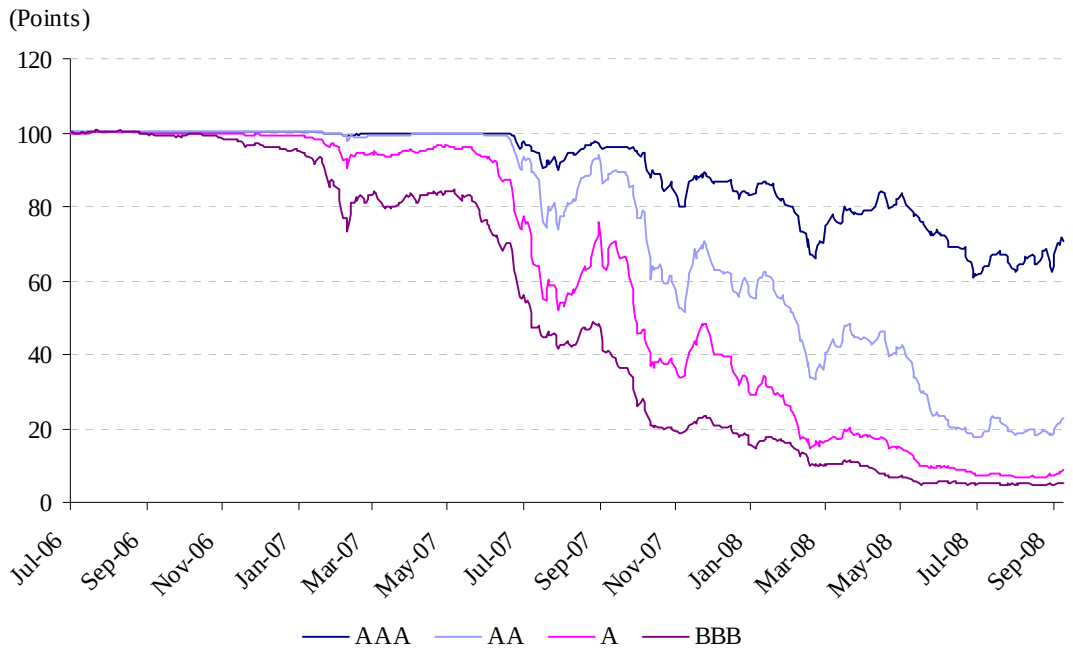
The credit ratings of securities represent the rating agencies' opinion regarding their credit quality. However, this is not a quality guarantee but an opinion and merely includes the credit risk of such security. The rating agencies evaluate the safety of principal and interest payments from one perspective but do not take all risk factors into consideration.[203]

7.4 Valuation of Subprime CDOs

Although CDOs should be marked to the ABX index, the pricing process differs between the primary and the secondary markets. When CDOs are issued and offered in the primary market, the sellers gather the investor base and lets demand determine a market price. If subprime CDOs are sold in the secondary market, the market value is provided by the ABX index. The high volatility of the index, producing unreliable market prices, has amplified the size of write-downs of subprime CDOs.[204] *(See Figure X.)*

[200] Ibid, p.58.
[201] Ibid, p.58.
[202] Brealey, Myers & Allen (2003), p.162.
[203] Gemstone CDO Ltd. Prospectus, p.15.
[204] Beta, interview May, 2008.

Figure X. ABX Prices 2006-2008



Indexed based on prices of July 19th, 2006. Figure X shows the development until August 6th, 2008.

Source: Markit (2008).

Before investment decisions are made, especially with regards to the narrow structure of the ABX index, it could be expected that prospective investors conduct a valuation analysis in order to ensure the accuracy of the market price. However, in many cases, no valuation analysis has been made, which implies that the offer price is solely based on investors' willingness to pay.[205]

7.4.1 Valuation Results

The valuation results and savings potential, both relative and absolute for our portfolio, are presented in two sets for each credit rating class. The first set, *ABX values*, describes the calculated levels of the ABX index and the potential savings derived from a mark-to-market valuation policy. The second set, *CDO values*, describes our CDO sample values deemed to be representative as underlying bonds to the ABX index. The *CDO values* are used to calculate the *ABX Issuing downgraded values*. *For a review of the weights for each valued credit rating class, see Appendix 4.*

[205] Friberg, interview June 4, 2008.

Table 1. ABX Values

Credit Rating[1]	ABX Issuing,[2] (pts)	ABX Issuing Downgraded,[1] (pts)	ABX Current, (pts)	Δ ABX Issuing, (%)	Δ ABX Issuing Downgraded, (%)	Potential Savings, (%)	Potential Savings, (USDm)
AAA	100.1	49.8	68.0	-32.1	36.4	68.5	2,887
AA	100.1	22.1	22.8	-77.2	3.2	80.4	495
A	100.1	14.9	7.7	-92.3	-48.6	43.8	140
BBB	100.3	19.4	5.0	-95.0	-74.3	20.7	98
Weighted Total				**-45.7**	**18.6**	**64.4**	**3,621**

1) The rating class describes the initial credit rating of the tranches before the downgrading. For current credit ratings of 'AAA'-tranches, see Appendix 5.

2) The ABX prices are provided as of August 17th, 2006, the median issuance date of the CDO sample in this study.

The results in Table 1 show that, on a weighted average, the relative change between *ABX Issuing values* and *ABX Current values* is negative, representing a reduction of 45.7 percent. In contrast, the relative change between *ABX Issuing downgraded values* and *ABX Current values* is positive, representing an increase of 18.6 percent. Thus, the implied total savings potential is high, 64.4 percent, representing an absolute savings potential for our portfolio of CDOs is USD 3.6 billions.

The results also show the effect of the downgrading of CDOs, e.g. the difference between 'AAA'-tranches of *ABX Issuing values* and *ABX Issuing downgraded values*, from 100.1 to 49.8, implies a 50.2 percent value reduction due to the downgrading.

Table 2. CDO Values

Credit Rating[1]	CDO Issuing, (% of FV)	CDO Issuing Downgraded,[1] (% of FV)	CDO Current, (% of FV)	Δ CDO Issuing, (%)	Δ CDO Issuing Downgraded, (%)	Potential Savings, (%)	Potential Savings, (USDm)
AAA	117.1	58.3	64.8	-44.7	11.1	55.8	2,352
AA	124.5	27.5	26.5	-78.7	-3.8	74.9	462
A	162.8	24.3	21.8	-86.6	-9.9	76.7	245
BBB	126.1	24.4	22.7	-82.0	-6.8	75.2	357
Weighted Total				**-53.9**	**6.8**	**60.7**	**3,415**

1) The rating class describes the initial credit rating of the tranches before the downgrading. For current credit ratings of 'AAA'-tranches, see Appendix 5.

Table 2 shows, on a weighted average, the relative change between the values of the CDOs of our portfolio as of the issuing date and today. The *CDO values* follow a similar pattern to

the *ABX* values in Table 1. The relative change between *CDO Issuing values* and *CDO Current values* is negative, a reduction of 53.9 percent, whereas the change between *CDO Issuing downgraded values* and *CDO Current values* is positive, an increase of 6.8 percent. In relative terms, the potential savings for the highly rated tranches are modest, whereas the potential savings for the lower rated tranches are higher. The total savings potential constitutes 60.7 percent, implying an absolute value of USD 3.4 billions, slightly lower than the results of the mark-to-market valuations.

Figure B. Actual Development of the ABX Index and Savings Potential

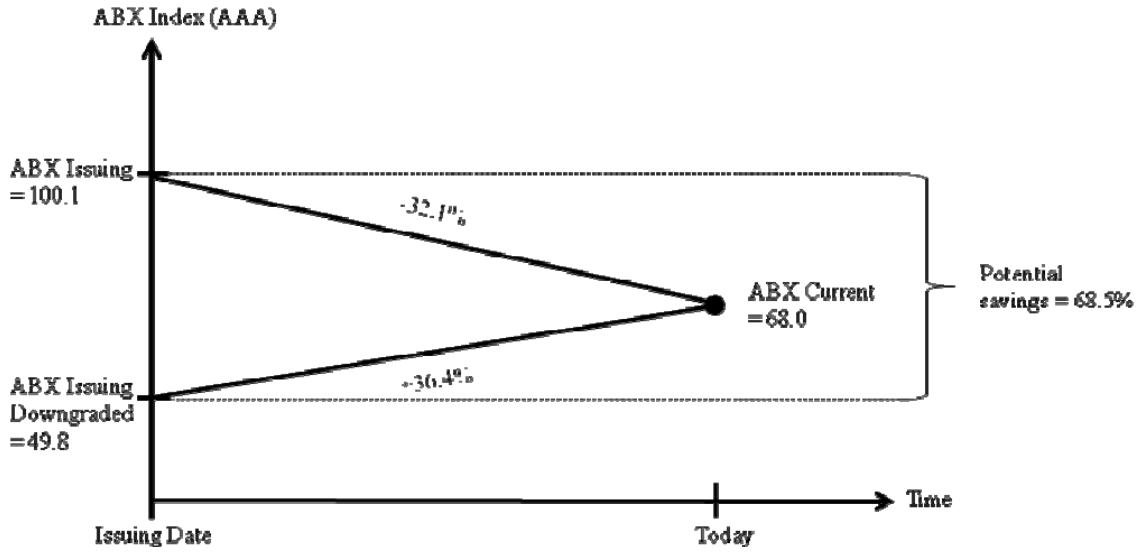


Figure B shows the actual development of the ABX index 'AAA'-tranche, i.e. *ABX Issuing values* to *ABX Current values*, corresponds to the expectation presented in section 4.2.2. However, the development of *ABX Issuing downgraded values* to *ABX Current values* differs from the anticipation. Instead of a small decline, the outcome shows a substantial increase, of 36.4 percent, implying higher savings potential than expected. The potential savings constitute 68.5 percent, i.e. USD 2,887 million for 'AAA'-tranches.

The initially high credit ratings imply that rating agencies considered CDOs to be safe investments regarding default risk, whereas the downgrading suggests the contrary.

A downgrading effectively means a higher probability of default due to lower credit rating. In turn, a higher probability of default implicitly causes a higher beta and a higher recovery rate. Due to the high credit ratings of the CDOs, a sensitivity analysis, reflecting the effects of changes in the underlying probability of default, is performed.

7.4.1.1 Sensitivity Analysis

If a CDO has a high credit rating and simultaneously generates high returns, it could be expected that the credit rating may be questionable. Thus, creating worst case scenarios by downgrading CDOs is a reasonable approach to stressing the product. The sensitivity analysis shows value changes due to such difference in underlying assumptions on the probability of default. *CDO Issuing Worst Case* describes CDO values that have been downgraded one level.

Table 3. Worst Case Scenario

Credit Rating[1]	**CDO Issuing, (% of FV)**	**CDO Issuing Worst Case,[1] (% of FV)**	**CDO Current, (% of FV)**	**Δ CDO Issuing, (%)**	**Δ CDO Issuing Worst Case, (%)**	**Potential Savings, (%)**	**Potential Savings, (USDm)**
AAA	117.1	118.6	64.8	-44.7	-45.4	-0.7	-30
AA	124.5	116.5	26.5	-78.7	-77.3	1.5	9
A	162.8	118.8	21.8	-86.6	-81.6	5.0	16
BBB	126.1	64.6	22.7	-82.0	-64.9	17.1	81
Weighted Total				**-53.9**	**-52.6**	**1.4**	**76**

1) The rating class describes the initial credit rating of the tranches before the downgrading. For current credit ratings of 'AAA'-tranches, see Appendix 5.

Generally, Table 3 shows that, on a weighted average, the change in the credit rating only cause insignificant potential savings of 1.4 percent in total. The value of 'AAA'-rated tranches even increased as they were hypothetically downgraded one level, in turn causing greater value losses from the development until today. The value increase is derived from the lower, negative beta of 'AA'-tranches compared to 'AAA'-tranches. The greatest savings potential from the downgrading is derived from the 'BBB'-rated tranches, with potential of 17.1 percent.

8. Analysis

The Analysis connects the Empirical Data with the Theoretical Framework. The chapter points at potential misjudgements derived from the fallacy points elucidated in the Empirical Data. In addition, the linkage between these misjudgements and the investment decisions is established.

In the analysis our effort is to elaborate on the following question:
What are potential causes of the misjudgements in the evaluation of subprime CDO investments?
The main purpose of this study is to enhance the understanding of the subprime crisis in the structured-finance market, and its causes.

8.1 The U.S. Subprime Mortgage Market

Complicating factors causing difficulties in assessing values of the securitized mortgage loans may refer to several stages of the securitization chain. The presumable reasoning made by involved actors is derived from either the subprime-mortgage market or the following securitization process. The complicating factors related to the subprime-mortgage market are lack of regulations, lack of historical data on borrowers and loan structures, and the ring-fencing of houses. These factors together added complexity to the subprime investments and, thus, caused misjudgements when investments decisions were made.

8.1.1 Lack of Regulations

Low levels of governmental surveillance and regulation in the subprime market may induce several complicating factors in the initial approach stage of the subprime-mortgage market.

Since there were no GSEs determining borrower or loan conditions, the subprime-mortgage market was expected to self regulate. As the mortgage market is the initiator in a longer chain of securitization distribution, a malfunctioning mortgage market may have augmenting consequences. Normally, the O&D model, which insulates every actor of the securitization process, facilitates securitization. However, the lack of regulation in the subprime market

combined with the personal insulation effect of the O&D model may have caused mortgage brokers, who approach and select the subprime borrower, to misuse the O&D model. The mortgage brokers earn their fee by intermediating between borrowers and lenders and, accordingly, they have no commitments to the loan. The fact that the mortgage brokers were exempted from any consequences of the borrower's performance reduced incentives for the brokers to provide mortgage lenders with accurate information on the borrower and the collateral. Thus, the operations risk at this early stage of securitization was augmented. In addition, the misrepresentation induced higher credit risk due to less reliable borrower quality. Since borrowing requisites were relaxed, brokers could conduct weaker credit controls and still sell the loan to the bank. In an unregulated market such incentive deficiency increases the risk of fraudulent behaviour. Financial institutions loosened credit controls and allowed the novel subprime borrowers to engage in loans that they had never experienced before. The outcome was a high volume of subprime loans based on the payment ability of borrowers, who could not afford such mortgages in the long run.

Further, lack of regulation may have allowed for inconsistent standards in the subprime-mortgage market. Diverging and insufficient criteria for mortgage-broker establishment may have lowered the credibility in the private-label mortgage market. The inconsistent criteria for mortgage brokers allowed non-serious actors to establish in the market, which in turn further encouraged fraudulent behaviour among brokers.

Due to the inconsistent market structure, facilitated by regulation deficiency, borrowers may have had difficulties to completely understand what loan engagements they committed to. Fraud and inconsequent regulations combined may have complicated the process of gaining insight of mortgage engagements. Hence, it is questionable how much the subprime borrowers understood of their loan engagements. Since many of the subprime borrowers are low educated people, the need for comprehensive information to understand complex loan engagements may be prevalent. Such kind of information was insufficiently provided by mortgage brokers, either due to negligence or fraudulent behaviour. For instance, as weaker credit controls allowed subprime borrowers to overstate their income, borrowers were able to engage in mortgage loans that they could not afford. Low awareness of the costs attached made borrowers engage in too expensive loans. In the short run the compensation policy of hybrid ARMs may sound like a good deal, whereas in the long run the deal may be devastating. With negative amortization the loans grew during the initial teaser years, which

may not have been not thoroughly communicated to borrowers. Hence, complex deal structures combined with information deficiency on loan requirements may have caused borrowers low awareness of their commitments.

With appreciating house prices, expensive loan engagements must not have large impact on a borrower's payment ability. Through the appreciated market value the borrower can refinance later on by taking new loans. However, subprime borrowers may not have foreseen the consequences of depreciating house prices. Loans with high LTVs are especially sensitive to depreciating house prices. Already when the loan is granted, the borrower takes on loans covering more than the underlying collateral. Thus, a down-turn in the housing market may have devastating effects. Mortgage brokers based their marketing on appreciating house prices and subprime borrowers believed them.

Estimating appreciating house prices is not an unwarranted assumption. However, the insulation from further consequences of defaults and delinquencies for mortgage brokers may indicate that brokers marketed loans with the only intention to earn their fee by engaging the borrower and then selling the loan as quickly as possible. A consequence may be lower borrower quality due to insufficient broker engagement.

All together, the lack of regulations may have caused an inconsistent subprime-mortgage market with an increased risk for fraudulent behaviour. Inconsistency, caused by fraud or negligence, may have imposed difficulties for borrowers to comprehend the conditions of mortgage loans. The downside effects were amplified by the depreciation in house prices.

8.1.2 Lack of Historical Data

From the investor's perspective there are further aspects that imposed obstacles on judgement decisions. The fact that mortgage lenders approached a relatively new borrowing segment with lack of historical performance data raised the intricacy of making projections on probability of default. The only record on default and delinquency behaviour was based on the prime segment and, hence, parameters used for estimating default and delinquency rates may have been misleading. The implied difficulty of evaluating securities based on a novel and untried borrowing segment may have caused investors to misjudge investment performance, when relating to prime borrowers.

8.1.3 Ring Fenced Houses

Since the collateral of mortgage loans is ring-fenced, the bank bears all the market risk of the mortgage loan. If the value of the underlying asset depreciates the losses incur the bank.

The ring-fencing of houses implied that in the event of default, lower recovery rates should be expected. In addition, with loans exceeding the value of the underlying collateral, the bank already lent more than it could recover based on the current market price. Thus, with absence of movements in the underlying house value the lender should make a loss. In contrast, a mortgage loan default in the Swedish market puts the entire borrower's economic capital at stake, which should induce a higher expected recovery rate. In the U.S. mortgage market it may be questionable whether the lending institutions made accurate pricing of their mortgage loans, covering the inherent market risk borne by the lender. In turn, the mispricing of mortgage interest rates may have caused investors to engage in subprime loans without charging enough for the inherent risk. Thus, the investors may not have realized the accurate risk level of subprime-mortgage loans. High yield and low credit risk on CDOs attracted a wide range of investors. It could be speculated that such good conditions on a product should imply hidden detriments not obvious to the investor.

Further, if a mortgage loan is used for measures that increase the value of the house, the probability of default decreases and the expected recovery rate increases. The probability of default decreases since the borrower can re-finance based on the appreciated value of the house. With an increase in the underlying collateral, the expected value to recover also rises.

Since many subprime borrowers used mortgage loans for financing consumption, the recovery rates should be negatively affected, thus enlarging any losses in the event of default. With ring-fenced houses the choice of investments financed by the mortgage loan becomes increasingly crucial. If the mortgage loan is collateralized by the borrower's economic capital, practically like in the Swedish market, consumption in other areas also contributes to a higher value of the underlying collateral. For the lender it matters less if the borrower buys a television or renovates the house, since both alternatives increases the value of the economic capital. However, in the U.S. non-residential related consumption does not affect the underlying value at all. The negative effects on the probability of default and

expected recovery rate caused by the choice of consumption may not have been incorporated in the evaluation of subprime investments.

The ring-fencing of houses may further have reduced the incentives for the borrower to commit to loan payments. The possibility of transferring house ownership to the bank can be compared to the borrower holding a put option, where the borrower has no economic downside. With several properties the borrower can act based on the market situation. If the house price appreciates the borrower earns profit by selling the house. To the contrary, if the price declines the borrower can transfer the house to the bank. Thus, ring-fencing of houses should increase the credit risk and market risk borne by the lender, while there is low risk borne by the borrower. However, since the number of defaults affects the credit score, the borrower is still subject to a possible downgrading due to the house transfer.

The lack of incentives for making mortgage payments may have caused borrowers to give up on their loans earlier and thus amplify the magnitude of mortgage defaults. However, the argument is undermined by the expectation that subprime borrowers with low credit rating did not afford speculative house ownership. Thus, their homes may have been of great sentimental and financial value and every possibility to keep the houses may have been desirable.

In total, the ring-fencing of houses may have lowered expected recovery rates, especially with regards to the high consumption financing, and increased the credit risk of subprime loans through the misalignment of payment incentives.

8.2 Securitization

Further, complication factors contributing to misjudgements of subprime CDO investments may derive from the securitization process. These factors include the rapid growth in securitization, the complexity of off-balance entities, characteristics of the O&D model, as well as the credit rating.

8.2.1 A Rapid Evolution of Complex Products

A rapid growth in securitization products can remain healthy provided that the required competence keeps up at the same pace. One essential area required for managing the emergence of new securitization structures is risk management. The widening of the investor base, enabled by structured-finance products meeting customized demands, combined with a rapid securitization technique evolution may have caused a knowledge gap on desired investments. As demand increased, investors became less price-sensitive and thus the required return for a given risk level on the structured product decreased. This is particularly evident in the pricing on risk for speculative-grade instruments, which decreased dramatically. During recent years the risk appetite may have grown faster than the risk-management expertise in structured finance. However, the low price on risk was not only due to high demand. A low Federal Funds Rate made the price on risk decrease all the more. These two factors, the increased risk appetite among investors and the lowered interest rate, contributed to a surge for high-yield investments, which may have encouraged unhealthy investment strategies as well as negligence of risk management. Furthermore, the high demand for these products may have accelerated the process from offer to closure, thus limiting the possibility for proper evaluation. A rapid process may further have resulted in greed taking the upper hand. Greed may have amplified negligent analyses by overlooking important factors, since return attracts too much the attention of a greedy investor.

8.2.2 The Complexity of Special Purpose Vehicles

Because SPVs are not regulated by the Investment Company Act, they are barely supervised, which lowers transparency. The lack of regulation and transparency may encourage SPVs to take on more leverage, implying higher risk. The issuing entity, the SPV, being exposed to an increased risk, implies a higher risk for the CDO investors. CDO

investors may not have been able to foresee such structures caused by the liberties allowed for these exempted entities.

The utilization of SPVs for securitizing assets has many advantages. According to the legal structure, the investment bank that securitizes assets through a SPV should remain unaffected by any events afflicting the SPV. However, to preserve the reputation of the bank and to retain the investor base, there is usually an implicit support to the SPV in the event of default. This support makes the bank concerned with any defaults in the SPV.

The SPV is structured so that it cannot go legally bankrupt. However, some SPVs conduct interest coverage tests in order to assess whether expected interest income of the underlying MBS covers interest expenses or not. If the SPV cannot go legally bankrupt, there should be no need for an interest coverage test. Accordingly, being unable to go legally bankrupt does not effectively mean that there are no defaults on interest payments from the SPV. If the interest income does neither cover the interest payments nor the principal payments, the SPV becomes insolvent.

The insulation of risk and the bankruptcy remoteness may have cradled the investor in a gratuitous feeling of security. Even if investors did not believe in or understand the bankruptcy remoteness feature, the assurance was still sustained by the implicit support from the sponsor. Investors relying on the bankruptcy remoteness or the implicit support may have assumed that the off-balance sheet entity was insulated from credit risk. Simultaneously, the sponsors may have relied on the insulation from any credit risk incurring the SPV.

All together, the bankruptcy remoteness and the implicit support may have caused actors at both ends, sellers and investors, to neglect the practice of risk management. The investors did not exercise risk management because of the perceived insulation of risk created by the implicit bank support or the bankruptcy remoteness feature. Likewise, the sponsor did not exercise risk management due to the perceived insulation of risk encouraged by bankruptcy remoteness and the true sale of assets.

8.2.2.1 Too Strong Reliance on Third Parties

Financial institutions spend significant amounts of money to receive rating for CDO tranches, suggesting that they trust rating agencies. The fact that investors make investment decisions based on the credit rating implies that investors also trust the rating agencies. This confidence in the accuracy of credit rating, from both sellers and investors, probably had relaxing effects on the respective risk management departments. The lack of performance data on both subprime borrowers and complex securities may have further encouraged an increased lean on the rating agencies. However, the difficulty of scrutinizing complex structured-finance products applies to the rating agencies as well.

Like with any security, the credit rating only addresses the credit risk of a security. Risks not considered are for instance market or liquidity risk. Since CDOs are OTC-traded securities the liquidity risk of the instruments is significant. Investors may not have recognized that credit rating does not incorporate value depreciation due to liquidity risk. The fact that the interest rates on CDO tranches were unusually high should have made investors question the underlying characters of the security.

8.2.2.2 Lack of Transparency

By using SPVs and advanced securitization techniques, financial institutions created highly rated financial products backed by subprime mortgages. Poorly rated assets were transformed into highly rated bonds. In order to assess risk and return of a security accurately the investor must be familiar with the underlying assets. In general, a MBS is relatively transparent since it is securitized through only one layer, thus building only a short distance between the ultimate investor and the borrower. However, simultaneously a MBS contains numerous mortgage loans and home-equity loans, which complicates the examination of the security structure.

The new and complex structures of securitized and resecuritized assets may have caused investors to misjudge their investments. A subprime CDO is the outcome of resecuritized tranched ABS in varying number of layers. In the CDO, ABS are resecuritized and re-tranched, which impedes the analyzing of the original loans. Accordingly, the ability for the investor to gain comprehensive knowledge and understanding of the investment is intricate.

With every new resecuritization layer the gap between the final investor and the initial collateral increases and, hence, the ability to control underlying assets is reduced. In addition, the combination of difficulties in analyzing the underlying assets and the relatively high level of embedded leverage of CDO tranches may cause understatements of risk.

Another aspect adding complexity to the transactions was the equity element of the CDOs being further resecuritized, due to the over demand for highly rated tranches in the market. By resecuritizing equity elements into new CDOs, the non-rated securities obtained 'AAA'-ratings. These resecuritized multiple-layer CDOs, thus, contained a larger proportion of non-rated assets and should intuitively have a higher default rate. If losses incurring the first-layer CDO exceed the corresponding size of the equity element, the new next-layer CDO, containing prevalently equity elements, is highly affected. Further, it could be expected that a high proportion of similar tranches, in this case equity tranches, would increase the total correlation level and, thus the inherent credit risk. A default in one tranche then implies higher probability of defaults in the other similar tranches. It may be questionable what value was added by transforming low-demand speculative-grade securities into investment-grade securities.

8.2.2.3 Lack of Long Term Incentives for Collateral Managers

Keeping the equity element in the SPV creates an incentive to maintain collateral management of high quality. Without the equity investment, the incentive is removed since the collateral manager's individual financial performance is detached from the performance of the CDO. The reasoning may be illustrated by the example of CEO share ownership in the managed company. Then, the performance of the company affects the CEO's private economy, thus aligning the CEO's incentives with the company's. Likewise, the ownership of the equity tranche, who covers any initial losses, in a CDO creates an incentive for the SPV manager to attain good performance. Over the last years the sale of equity elements, or other low-rated tranches, in CDOs may have reduced the quality of the collateral management.

8.2.3 The Originate and Distribute Model

Earlier, the traditional loan model contained two parties of a transaction whereas today the transaction involves at least six parties. A plausible effect is a reduced awareness of the transaction from both the borrower's and the lender's point of view. The re-sale of loans may have lowered borrowers' willingness to pay, since the emotional attachment between the borrower and the bank is reduced. From the lender's point of view, the sale of the loan removes the credit risk and the bank can lend the same amount to another borrower. This stimulation of business expansion may have increased competition to the extent at which risk management suffered. Thus, the negligence of risk management may have contributed to misjudgements of credit risk even at this early stage of securitization. However, since rating agencies are expected to assess the credit risk of every securitized asset, the effects of these misjudgements should be mitigated.

The securities created through the use of the O&D model contained a large fraction of home-equity loans, often subordinated to first-lien mortgage loans. These subordinate multiple-lien home-equity loans comprising the collateral should increase the credit risk of the security. The fact that the mortgage loans were of subprime quality further implied increased overall risk. The confidence in removal of risk through diversification accomplished by the securitization process may have been exaggerated, which in turn motivated mistakes in the evaluation of securities.

8.2.4 Credit Rating

Rating agencies are expected to give their view on the default and recovery rates of a specific asset. Effectively, the assigned rating should correspond to their view of a certain probability of default for the asset. However, it seems as if investors and sellers confided too much in the 'AAA'-rating of CDO tranches. Not fully comprehending what credit rating actually represented may have caused inaccurate value assessments. However, the downgrading of CDOs implies that rating agencies realized that they had stated inaccurate assumptions when estimating the probability of default. These assumptions may derive from the use of historical prime data when estimating default rates for subprime-mortgage loans. One could argue that stressing the prime-based data enough would create a decent proxy for subprime. However, stressed prime-based data may not have corresponded to these

expectations. Bias may be derived from the fact that borrower's willingness and ability to make payments are not only dependent on disposable income. One problematic issue that arises when estimating subprime default rates is the determination of stress level on prime-based data.

Another complicating issue of estimating default rates is the correlation between underlying assets. The fact that the same correlation was used for the subprime MBS as for any other ABS may be a source of misjudgement. Subprime borrowers being a quite homogenous group implies a higher correlation between underlying loans compared to well-diversified ABS. A higher correlation generates higher default rates.

Further, high LTV ratios reduced the ability for borrowers to re-finance the mortgage. Thus, with high LTV ratios, the probability of default should, to a greater extent, be influenced by the risk of a decline in the housing market. During years of steady house price appreciations the probability of house prices depreciating may have been underrated. These circumstances may have caused an underestimation of default rates, generating unreasonably high credit ratings.

The collateral manager is claimed to be the main determinant for the rating of a CDO, but also the most difficult factor to evaluate. This combination suggests a high complexity in the evaluation of CDOs. The fact that investment banks and rating agencies co-operated to determine attachment points implies that default rates were the main determinants in estimating the tranche structure of the CDO. This partly contradicts the importance of the manager quality, since this factor is not considered at all in the CDO evaluation. The procedure indicates that models and theories for defining credit rating were deviated from, further complicating any analysis of fundamental components of the CDO.

All together, the credit rating may not have matched the characters of CDOs. The new structured-finance products evolved quickly and grew more complex than rating agencies could handle and, hence, proxies were used for determining the probability of default. However, these proxies turned out to be inaccurate for estimating the credit quality of subprime CDOs.

8.3 Valuation Results

The valuation results show that the savings potential based on the ABX index is larger than the savings potential for the calculated values of the CDOs. This could be an effect of the index's narrow structure, facilitating manipulation and causing volatile index prices. However, within credit rating classes the potential saving is not always greater for the ABX index. With ABX prices, the higher savings potential of the lower rated tranches may be derived from human psychology generating underpriced tranches. Anxiety and uncertainty among investors trading with the ABX index may push down prices on lower rated tranches more than the underlying value suggests. Similar to the over reliance on highly rated tranches, investors may exaggerate the uncertainty of lower rated tranches.

The positive development from *Issuing downgraded values* until today shows that, with the knowledge about underlying assumptions as of today, investors may not only have avoided losses, but also received a positive return on their investments. However, it is not reasonable to believe that investors could have had access to all information available today at the time of issuance. Nevertheless, assuming that investors know what they are buying, a valuation analysis of the CDOs and the credit rating model should generate values below *ABX Issuing values*. However, if investors are not aware of the contents, structures and mechanisms of the investment, there is clearly an argument for not investing at all.

A downgrading implies a change in the underlying assumptions of the credit rating. One parameter that has a significant impact on the probability of default, i.e. the credit rating, is the correlation between the borrowers, and thus the underlying collateral. The lack of historical data on subprime mortgages may have caused an underestimation of the correlation between mortgage owners across the U.S. The lack of data forced rating agencies to estimate the correlation based on data for the prime segment. However, the correlation between borrowers may differ depending on their credit worthiness. The prime segment includes people from several social classes implying a high diversity and, thus a lower correlation. The subprime segment seems more homogenous with people mainly from the same social class and similar professions, implying a higher correlation. This is also evident from the FICO scale, with a prime segment wider than the subprime segment. Subprime borrowers usually have low income and high leverage, and are therefore more severely affected by interest rate changes and economic downturns than prime borrowers. The

subprime borrower's low stress level reduces the ability to make payments when interest rates increase, which implies a high correlation among subprime borrowers' ability to pay. Prime borrowers on the other hand, with a generally higher surplus to allocate on savings and consumption, afford greater interest rate increases. Since prime borrowers' priorities, to a higher extent than subprime borrowers' priorities, control the ability to manage higher interest payments, the correlation between the probabilities of default on prime borrowers should be further reduced. In accordance, relating subprime borrowers to prime borrowers causes overestimated performance due to, among others, misjudgements in borrower correlation.

Since the greatest losses are derived from 'AAA'-rated tranches, from the sensitivity analysis it is concluded that worst case scenarios would not have contributed to substantial loss avoidance in the subprime crisis.

9. Concluding Remarks and Discussion

In the closing chapter the outcome of the Analysis is summarized and criticised in order to point at potential weaknesses of this study. Concluding, suggestions on further research are made.

9.1 Conclusion

All together, it can be concluded that the causes of the subprime crisis derive from two dimensions of the structured-finance market: poor investment analyses and the quality of subprime mortgage loans. Poor investment analyses made investors unaware of all the risk factors of CDOs.

With new and complex high-yield structures sellers could satisfy investor demand, however unaware of the behaviours of such products. In accordance with Brunnermeier, this study concludes that the complex structures of CDOs made the assessment of risk intricate for both sellers, investors, and rating agencies. In turn, the lack of understanding the complex structures of CDOs made investors rely on inaccurate credit ratings and assumptions on the CDO performance. Like Turnbull, Crouhy and Jarrow it is concluded that the surge for high-yield products combined with the failure to adjust to changing conditions caused complications in assessing CDO values. The lack of historical data on subprime borrowers complicated investment judgements and forecasts. Relating to prime borrowers made subprime loans seem less risky. Hence, unanticipated risks generated unexpected losses to investors.

Rating agencies did not have enough historical data to correctly estimate the probability of default for subprime mortgages, thus creating a poor basis for CDO ratings. Wrongful assumptions about probability of default resulted in inaccurate credit ratings on which investors and sellers based substantial parts of their analysis on. All together, investors relied on the rating agencies whereas the rating agencies based the credit rating on wrongful assumptions.

The high yields of subprime CDOs show that sellers were willing to pay a high price for low risk, which implies that they were aware of the inherent risks of the CDOs. However, an

investor buying the product with these conditions should have scented trouble due to the inconsistencies of the product. Furthermore, the increased demand for yield motivated investors to act faster, which in turn led to the negligence of proper risk management. Not conducting a valuation analysis and stressing the investment by performing a sensitivity analysis caused investors to only acknowledge one case scenarios and thus making unsound investment decisions.

The failure to identify changing conditions in the structured-finance market further made risk management practise lag behind. In accordance with the International Monetary Fund, this study finds that the lack in the appliance of risk management contributed to misjudgements of risks. The lack of risk management can be derived from the over estimation of risk transfer to off-balance entities and an over confidence in credit ratings.

Poor investment analyses must not be detrimental as long as the underlying bond is of high quality. The second aspect of causes of the subprime crisis concerns the quality of subprime-mortgage loans derived from market conditions of the mortgage market.

A market only operates efficiently if there are either comprehensible regulations and surveillance or strong incentives for market actors. Thus, a prerequisite for a market to self regulate is strong incentives to align private market actors' interests with customers' interests. The climate of the U.S. subprime-mortgage market during recent years has indicated neither of these features. Since the O&D sentiment requires short liability lead-times, the regulatory level of the subprime market was insufficient. Lack of regulations and surveillance enabled non-serious actor to establish in the market and reduced the level of standardization in market transactions. Low levels of standardization created inconsistent conditions on loans, borrowers and mortgage brokers, which increased the potential for misunderstandings and fraud.

The fact that investment banks are expected to regulate the subprime market may be unfortunate. The profitability of investment banks is, in accordance with many actors within the financial industry, dependent on the return on investments. This may misalign incentives for banks to create a fair and effective market situation. Focus was directed at meeting demand for high yield through the development of complex credit products instead of increasing transparency through regulative actions. Thus, the ability to properly analyze and

evaluate the new structured-finance products did not develop quickly enough. In addition, the transparency of the new products was reduced through several steps of securitization, which restrained the ability to unbundle the underlying collateral.

The lack of regulations in the subprime market further contributed to lower awareness among borrowers, due to difficulty of comprehending inconsistent conditions. Low-income borrowers were attracted to complex loan deals with appreciating interest costs, which eventually became too expensive. The low awareness of loan conditions among borrowers was further amplified by the poor communications between actors.

A higher inherent risk is partly derived from the ring-fencing of houses comprising collateral of high LTV loans exceeding the underlying collateral value. The lender can only recover the loan if the value of the house increases. In order for the house value to increase, there is either a general price appreciation in the market or the borrower uses the loan to finance measures that increases the house value. However, in the U.S. subprime-mortgage market a scenario with the absence of both these prerequisites eventually emerged. Hence, the risks of not retaining the lent money in subprime-mortgage securities were higher than anticipated. Speculative house ownership generating lower payment incentives for borrowers amplified the downside effects of a depreciated housing market.

Overall, the misjudgements causing the subprime crisis can mainly be derived from lack of regulation in the subprime market, combined with lack of historical data on subprime mortgage loans and complex financial engineering. These underlying conditions generated securities backed by low-quality mortgage loans not recognized by investors.

9.2 Discussion

Since the study and its explorative reasoning mainly do not follow any theoretical framework, the authors' views are to an amplified extent critical to the content and interpretations presented may be questioned. Thus, in this study the difficulty to sustain objective on the matter is high. The authors have had the liberty to select what information is presented and how the information should be interpreted. Further, personalities and perceptions on certain sources' reliability may have caused a biased outcome. However, our

effort was to present a comprehensive picture of the subprime crisis in an objective manner in order for the reader to make own judgements.

The addressed causes of misjudgements should be mitigated by the fact that the CDOs were solely available for professional investors. The underlying assets and the market conditions affecting them may have been feasible to examine for professional investors contend with such security structures.

The choice of contrasting the U.S. mortgage market to the Swedish market may have caused the outcome a biased emphasis on the effects of features contrasting the Swedish market. Other causes of misjudgements, in conformity with the Swedish market, may have been disregarded, since they are more difficult to discern. The bias may have been amplified due to the geographical spread of the interview objects. Accordingly, the ring-fencing of houses in the U.S. mortgage market may have attracted too much attention due to its disparity to the Swedish market.

The fact that we did not capture the borrowers' perspective may reduce the validity of the conclusions addressing borrowers' awareness and behaviour. These conclusions should attain higher validity and could be further examined if a direct connection with a subprime borrower would have been established.

Since we did not get in contact with any loan originator, the conclusions regarding originators' actions and views on ring-fenced houses and risk management may be undermined.

The assumptions that betas for corporate bonds represent proxies for CDOs may reduce the validity of the conclusions based on the valuation. However, the fact that CDOs are issued by corporate-like entities, strengthens the support for the use of proxies. Furthermore, choosing recovery rates based on a weighted average rating instead of the exact rating of the underlying assets could also generate an underestimated present value. However, the impact on the tranche value derived from adjustments in recovery rates is insignificant, which limits the effect from biased recovery rates.

Furthermore, the risk premium in the valuation is based on a study from 2003. It could be expected that the risk premium during recent years, while the CDOs were issued, decreased. Thus, our result may be based on a too high risk premium causing upward biased values of the investment-grade CDO tranches and downward biased values of speculative-grade tranches. In total, this would imply that our calculated CDO values are too high. However, because of the low betas, changes in the risk premium have insignificant impact on present values, which limits that bias. Hence, the approximate size of the present values should be reasonably supported and the general conclusions relevant.

The difference between potential savings for *ABX values* and *CDO values* suggests that our selection of CDOs is not representative as underlying for market prices. A larger and randomly selected sample may support the movements of the ABX index to a greater extent, thus reflecting prices closer to market value.

9.3 Suggestions on Further Research

In this study our effort was to enhance the understanding of the subprime crisis in 2007 and its underlying causes.

This study builds a potential foundation for further research on how to prevent such scenarios, or alike, to emerge. Further research on whether the causal factors are specific for the U.S. market or encompassed in other markets as well may develop the ability to foresee where the risk for a subprime crisis emergence is evident. One possibility is that the U.S. market precedes the global conjuncture and shows forecasts on what scenarios are to be expected in other markets.

Another subject to examine based on the conclusions of this study is the mechanisms required by a well-functioning subprime-mortgage market. Some of the conclusions of this study are probably applicable to other mortgage segments as well, which is why a further examination of the prerequisites for a properly functioning subprime-mortgage market is desirable. Since it is our view that the self regulation contributed to the misjudgements, a more specific study on the formation of self-regulating mechanisms could provide a basis for preventive actions.

Further research on the relationship between rating agencies and financiers of rating business could provide better insights on how to produce more accurate credit ratings. The incentives of the current relationship, where the issuing entity finances the rating service, may be questioned and thus, a study could elucidate potential flaws and enhancement areas.

Studying the correlation between and within different social classes regarding willingness and ability to make interest payments and instalments on mortgages would provide a deeper understanding of the effects on credit rating and its underlying assumptions.

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In this section the references are presented in alphabetical order followed by the interview material used for gathering information from primary sources.

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10.2 Interview material

The interview objects are presented in chronological order according to the time of interview. Stefan Friberg and Kimmy Samuelsson were interviewed together, although presented separately.

Table 10.2.1 Description of Public Interview Objects

Interview object	*Organization*	*Title/position*	*Location*	*Time and Date*
Borg, Tor	Sveriges Bostadsfinansierings-bolag AB	Interest Rate Analyst	Löjtnantsgatan 21, Stockholm	14^{00}-15^{00} May 26, 2008
Friberg, Stefan	Skandinaviska Enskilda Banken AB	Head of Portfolio Management, Group Treasury	Kungsträdgårdsgatan 8, Stockholm	14^{00}-16^{30} June 4, 2008
Samuelsson, Kimmy	Skandinaviska Enskilda Banken AB	Credit Portfolio Manager, Group Credit Portfolio Management	Kungsträdgårdsgatan 8, Stockholm	14^{00}-16^{30} June 4, 2008
Allen, Linda	Skandinaviska Enskilda Banken AB	Global Head of Product Management for Payments, GTS Product Management & Development[a)]	Rissneleden 110, Sundbyberg	10^{00}-11^{00} June 9, 2008
Nyberg, Lars	Sveriges Riksbank	Deputy Governor	Brunkebergstorg 11, Stockholm	13^{00}-13^{45} June 9, 2008
Lundvik, Petter	Svenska Handelsbanken AB	Senior Economist	Telephone interview	14^{30}-15^{30} June 17, 2008

a) Linda Allen has been interviewed due to her earlier position as mortgage underwriter at an investment bank in New York during 1992-2002.

Table 10.2.2 Description of Anonymous Interview Objects

Interview object	*Organization*	*Interview type*	*Location*	*Time and Date*
Alpha	Investment bank	Direct	Stockholm	May, 2008
Beta	Investment bank	Telephone	London	May, 2008
Gamma	Rating agency	Telephone	London	June, 2008
Delta	Pension Fund	Telephone	Stockholm	May, 2008

Table 10.2.3 Questionnaire

The questionnaire was used as a foundation for conversation during the interviews. The questions were adjusted according to the role of the organization represented by the interviewee. Other subject-related issues were also discussed. Questions were skipped if we had already received a satisfactory response and added when needed.

What is your opinion about what has happened on the financial market with regards to the volatility that we have witnessed over the past two years?
What are the underlying causes of the financial crisis?

What financial instruments are or have been subject to write-downs?
How are these (CDOs) designed with regards content and structure?

How are the risk, return, and price of CDOs assessed?
Do you use mark-to-model in the valuation of CDOs?

What does the marketing of CDOs look like?

How big are the relative losses for your institution?
How big are the relative losses on average in the industry?

What have you learned from the recent development?

In addition, interviewees representing rating agencies were asked the following questions:

How transparent is the information about the underlying assets of CDOs when the credit rating is determined?

What criteria must a CDO fulfill for the different rating levels (both cash-flow and synthetic CDOs)?
What are the main determinants of CDO credit rating?
Does the rating process differ between CDOs and other ABS?

11. Glossary

The glossary encompasses the most commonly used abbreviations and definitions of essential terms in the study.

ABCP	Asset-Backed Commercial Paper
ABS	Asset-Backed Security
ABX	Five indicies, developed by Markit, for market valuation of different categories of ABS and representative to each category's current market.[206] One index, ABX.HE Home Equity (in this study referred to as ABX), provides the market price for subprime CDOs based on CDS of 20 bonds containing subprime-mortgage loans. New ABX series are generated every six months on January 19th, and July 19th [207]
Alt-A	Alternative-A: Private-label mortgage segment included in the lower Prime segment covering borrowers with clean credit histories, but may have inadequate income documentation or high debt-to-income ratio
CBO	Collateralized Bond Obligation
CDO	Collateralized Debt Obligation
CDS	Credit Default Swap
CLO	Collateralized Loan Obligation
CMBS	Commercial Mortgage-Backed Security
CMO	Collateralized Mortgage Obligation
Counterparty Risk	The risk that a counterparty might default on a contract by failing to pay amounts due or failing to fulfill the delivery conditions of the contract[208]
Funded CDO	A CDO which obliges investors to make immediate payment[209]
GSE	Government-Sponsored Enterprise
HEL	Mortgage-backed security collateralizing home-equity loans[210]
Home-Equity Loan	Loans or lines of credit drawn against the equity in a home, calculated as the current market value less the value of the mortgages on the house
Jumbo	Private-label mortgage segment included in the upper Prime segment covering borrowers with excellent credit quality, but requiring mortgages

[206] Markit (2006), p.7.
[207] Citi (2007), p.7.
[208] Markets International Glossary (2008).
[209] Recent Developments in Collateralised Debt Obligations in Australia (2007).
[210] International Monetary Fund (2008), p.120.

	above the agency loan size guidelines
LTV	Loan-To-Value
Mark-to-Market	The valuation of a position or portfolio by reference to the most recent price at which a financial instrument can be traded in normal volumes. The mark-to-market value might equal the current market value – as opposed to historical accounting or book value – or the present value of expected future cash flows[211]
Mark-to-Model	The valuation of a position or a portfolio by reference to a theoretical valuation model that use various relevant fundamental parameters as input[212]
MTN	Medium-Term Note
MBS	Mortgage-Backed Security
Mezzanine Capital	The subordinated debt between the senior tranches and the equity element (rated from 'AA+' and below)[213]
Neg-Am	Negative-Amortization: Loans where negative amortization is made during the initial years
Notice-of-Default	The initial document filed by a trustee that starts the foreclosure process, usually after the occurrence of a default of a mortgage[214]
Risk Appetite	The willingness of investors to take on additional risk by increasing exposure to riskier asset classes, and the consequent potential for increased losses[215]
RMBS	Residential Mortgage-Backed Security
SPV	Special Purpose Vehicle, an off-balance entity created to securitize assets
Senior Capital	Least risky capital, as close to risk-free as possible, which represents a claim on a company's assets that is senior to all other tranches. Often, a tranche senior to an 'AAA'-rated tranche is defined as super-senior[216]
True Sale	An actual sale, as distinct from a secured borrowing, which means that assets transferred to an SPV are not expected to be consolidated with those of the sponsor in the event of the sponsor's bankruptcy. Rating agencies

[211] International Monetary Fund (2007), p.132.
[212] International Monetary Fund (2008), p.83.
[213] Brunnermeier (2008), p.3.
[214] Realtytrac (2008b).
[215] International Monetary Fund (2008), p.42.
[216] Gibson (2004), p.1.

usually require what is called a true-sale opinion from a law firm before the securities can receive a rating higher than that of the sponsor[217]

Unfunded CDO A CDO where the initial payment is made at the issuance date and full payment is made in the event of default[218]

[217] The Bond Market Association (2004), p.25.
[218] Recent Developments in Collateralised Debt Obligations in Australia (2007).

Appendix 1 – Prospectuses

Prospectus	*Sole Bookrunner*	*Face Value (USD millions)*	*Date*
Gemstone CDO Ltd.	Lehman Brothers Inc.	424.0	December 15, 2004
Gemstone CDO IV Ltd.	Deutsche Bank Securities Inc.	566.4	January 20, 2006
Gemstone CDO V Ltd.	Deutsche Bank Securities Inc.	643.7	May 18, 2006
Gemstone CDO VI Ltd.	Lehman Brothers Inc.	700.0	August 17, 2006
Gemstone CDO VII Ltd.	Deutsche Bank Securities Inc.	1101.5	March 15, 2007
Tourmaline CDO I Ltd.	Morgan Stanley & Co. Inc	322.8	September 29, 2005
Tourmaline CDO III Ltd.	Deutsche Bank Securities Inc.	1511.0	April 5, 2007
MKP Vela CBO Ltd.	Lehman Brothers Inc.	456.4	November 16, 2006
Arca Funding 2006-II Ltd.	Morgan Stanley & Co. Inc	245.2	December 19, 2006

Acknowledgement: FactSet Global Filings (2008).

Appendix 2 – Beta, Probability of Default, Recovery Rate

Table I. Beta

Rating	Beta
AAA	-0.0879
AA	-0.1302
A	-0.1052
BBB	-0.0128
BB	0.1227
B	0.1366
CCC	0.1099
CC	0.1637
C	1.4823
D	-0.4892
Not Rated	-0.4956
Not Available	0.0192

Source: Thorsell (2008).

Table II. Probability of Default

Credit Rating	Probability of Default, (%)
AAA	0.12
AA+	0.17
AA	0.32
AA–	0.41
A+	0.47
A	0.58
A–	0.80
BBB+	1.36
BBB	2.20
BBB–	3.00
BB+	6.35
BB	8.30
BB–	11.34
B+	14.45
B	18.60
B–	24.89
CCC+	36.51
CCC	43.80
CCC–	52.14

Source: Standard & Poor's RatingsDirect (2006).

Table III. Recovery Rate

If the Collateral Debt Security is an Asset-Backed Security and is the senior-most tranche of securities issued by the issuer of such Collateral Debt Security:

S&P's Rating of the Collateral Debt Security	Liability Rating assigned by Standard & Poor's						
	AAA	AA+ AA AA–	A+ A A–	BBB+ BBB BBB–	BB+ BB BB-	B+ B B–	CCC+ CCC CCC–
AAA	80.0%	85.0%	90.0%	90.0%	90.0%	90.0%	90.0%
AA+, AA, AA–	70.0%	75.0%	85.0%	90.0%	90.0%	90.0%	90.0%
A+, A, A–	60.0%	65.0%	75.0%	85.0%	90.0%	90.0%	90.0%
BBB+, BBB, BBB–	50.0%	55.0%	65.0%	75.0%	85.0%	85.0%	85.0%

If the Collateral Debt Security is an Asset-Backed Security and is not the senior-most tranche of securities issued by the issuer of such Collateral Debt Security:

S&P's Rating of the Collateral Debt Security	Liability Rating assigned by Standard & Poor's						
	AAA	AA+ AA AA–	A+ A A–	BBB+ BBB BBB–	BB+ BB BB–	B+ B B–	CCC+ CCC CCC–
AAA	80.0%	85.0%	90.0%	90.0%	90.0%	90.0%	90.0%
AA+, AA, AA–	55.0%	65.0%	75.0%	80.0%	80.0%	80.0%	80.0%
A+, A, A–	40.0%	45.0%	55.0%	65.0%	80.0%	80.0%	80.0%
BBB+, BBB, BBB–	30.0%	35.0%	40.0%	45.0%	50.0%	60.0%	70.0%
BB+, BB, BB–	15.0%	15.0%	15.0%	25.0%	35.0%	40.0%	50.0%
B+, B, B–	2.5%	5.0%	5.0%	10.0%	10.0%	20.0%	25.0%
CCC+, CCC, CCC–	0.0%	0.0%	0.0%	0.0%	2.5%	5.0%	5.0%

Source: Gemstone CDO Ltd. Prospectus.

Appendix 3 – Application of Underwriting Guidelines

Table I. Standard & Poor's Subprime Underwriting Guidelines

Characteristics	**A–**	**B**	**C**	**D**
Mortgage credit	2x30	3x30	4x30 or 1x60	5x30 or 2x60 or 1x90
Consumer credit	2x30 or 1x60	3x30 or 2x60	4x30 or 3x60 or 1x90	4x30 or 3x60 or 2x90
Debt/income ratio, (%)	45	50	55	60
NOD[1]/bankruptcy	None in past 5 years	None in past 3 years	None in past 2 years	None in past years

[1]NOD: Notice-of-Default

[2]LTV: Loan-to-Value

Source: Standard & Poor's Structured Finance (2004).

Mortgage credit and *Consumer credit* show the maximal number and length of late payments for an individual within the different Subprime segments. Thus, 3x30 implies that a borrower may have a maximum of three payments that are each 30 days late. The debt to income ratio describes the percentage of monthly gross income used to pay debt. Furthermore, notice-of-default or bankruptcy sets the time frame since the mortgage loan applicant applied for the most recent personal bankruptcy or had a notice-of-default.[219]

[219] Standard & Poor's Structured Finance (2004), p.11-13.

Table II. Comparison between Three Originators' Subprime Guidelines

	Characteristics	A–	B	C	D
Company A	Consumer Credit	Minor derogatory in past 24 months	< 35% of trade lines reported	<50% of trade lines reported	Total disregard for credit
	Debt/Income	45	50	55	55
	NOD[1]/ Bankruptcy	None in past 3 years	None in past 2 years	None in past 1,5 years	Recent bankruptcy/ foreclosure
Company B	Mortgage Credit	2x30	2x30	4x30 or 3x30 and 1x60	5x30 or 2x60 or 1x90
	Consumer Credit	3x30 revolving 3x30 instalment	4x30 or 2x60	8x30 or 2x60 and 1x90	12x30 or 6x60 or 4x90
	Loan-to-Value	LTV[2] <75+/45 LTV[2] <75/55	LTV[2] <80+/45 LTV[2] < 75/50	LTV[2] < 80+/45 LTV[2] < 75/50	LTV[2] < 75+/55 LTV[2] < 75/60
	NOD[1]/ bankruptcy	None in past 2 years	None in past 2 years	None in past 1,5 years	None in past year
Company C	Mortgage credit	2x30	4x30	6x30 or 1x60 and 1x90	12x30 or 6x60 or 2x90
	Consumer Credit	Not stated	Not stated	Not stated	Not stated
	Debt/Income	42	Not stated	Not stated	55
	NOD[1]/ Bankruptcy	Not stated	Not stated	Not stated	None in past year

[1]NOD: Notice-of-Default

[2]LTV: Loan-to-Value

Source: Standard & Poor's Structured Finance (2004).

Appendix 4 – Valuation Results

Table I. Original Average Tranche Size of Face Value

Average Tranche Size, (% of Face Value)	
AAA	64.6
AA	12.6
A	8.2
BBB	10.4
BB	1.8
N/R	5.2

The decomposition of the CDO structure shows, on average, the relative size of each tranche. It demonstrates the effect of inaccurate valuations, due to the different sizes of each tranche. Since 'AAA'-tranches constitute the largest fraction of face value, misjudgements of 'AAA'-tranches have the largest impact on CDO values. On average, the 'AAA'-tranche constitutes 64.6 percent of the total capital invested in the CDO, implying influence on more than half the capital invested.

Table II. Average Size of Valued Tranches

Rating Class	Tranche Size, (USDm)	Weight, (%)
AAA	4,216	74.9
AA	617	10.9
A	320	5.7
BBB	475	8.4
Total	**5,627**	**100.0**

Since we do not value all tranches, a weighted average size of each tranche used in the valuation is calculated. Table II shows the size of the 'AAA'-, 'AA'-, 'A'-, and 'BBB'-tranches relative to the total face value of valued tranches.

Table III. Calculation Example for Gemstone CDO Ltd.

Tranche	Principal, (USDm)	Interest Rate, (%)	Credit Rating	Beta		
A-1	143	2.82	AAA	-0.0879		
Year	**Cash Flow, (USDm)**	**Default Risk, (%)**	**Recovery Rate, (%)**	**Risk Free Rate of Return, (%)**	**Risk Premium, (%)**	**Discounted Cash Flow, (USDm)**
1	4.03	0.12	50.0	2.21	-0.57	3.97
2	4.03	0.12	50.0	2.21	-0.57	3.90
3	4.03	0.12	50.0	2.21	-0.57	3.83
4	4.03	0.12	50.0	2.21	-0.57	3.76
5	4.03	0.12	50.0	2.21	-0.57	3.70
6	4.03	0.12	50.0	2.21	-0.57	3.64
7	4.03	0.12	50.0	2.21	-0.57	3.57
8	4.03	0.12	50.0	2.21	-0.57	3.51
9	4.03	0.12	50.0	2.21	-0.57	3.45
10	4.03	0.12	50.0	2.21	-0.57	3.39
11	4.03	0.12	50.0	2.21	-0.57	3.33
12	4.03	0.12	50.0	2.21	-0.57	3.27
13	4.03	0.12	50.0	2.21	-0.57	3.22
14	4.03	0.12	50.0	2.21	-0.57	3.16
15	4.03	0.12	50.0	2.21	-0.57	3.11
16	4.03	0.12	50.0	2.21	-0.57	3.05
17	4.03	0.12	50.0	2.21	-0.57	3.00
18	4.03	0.12	50.0	2.21	-0.57	2.95
19	4.03	0.12	50.0	2.21	-0.57	2.90
20	4.03	0.12	50.0	2.21	-0.57	2.85
21	4.03	0.12	50.0	2.21	-0.57	2.80
22	4.03	0.12	50.0	2.21	-0.57	2.75
23	4.03	0.12	50.0	2.21	-0.57	2.70
24	4.03	0.12	50.0	2.21	-0.57	2.66
25	4.03	0.12	50.0	2.21	-0.57	2.61
26	4.03	0.12	50.0	2.21	-0.57	2.56
27	4.03	0.12	50.0	2.21	-0.57	2.52
28	4.03	0.12	50.0	2.21	-0.57	2.48
29	4.03	0.12	50.0	2.21	-0.57	2.43
30	147.03	0.12	50.0	2.21	-0.57	87.15
				Present Value (USDm)		178.22
				Present Value as % of FV		124.63

Calculation example, cash flow year 1:

$$CF_1 = \sum_{i=1}^{T} \frac{(1 - 0.0012 * (1 - 0.5) * 4.03}{(1 + 0.0221 + (-0.0057))^1} * (1 - 0.0012)^1 = 3.97$$

Appendix 5 – Downgrading of CDOs

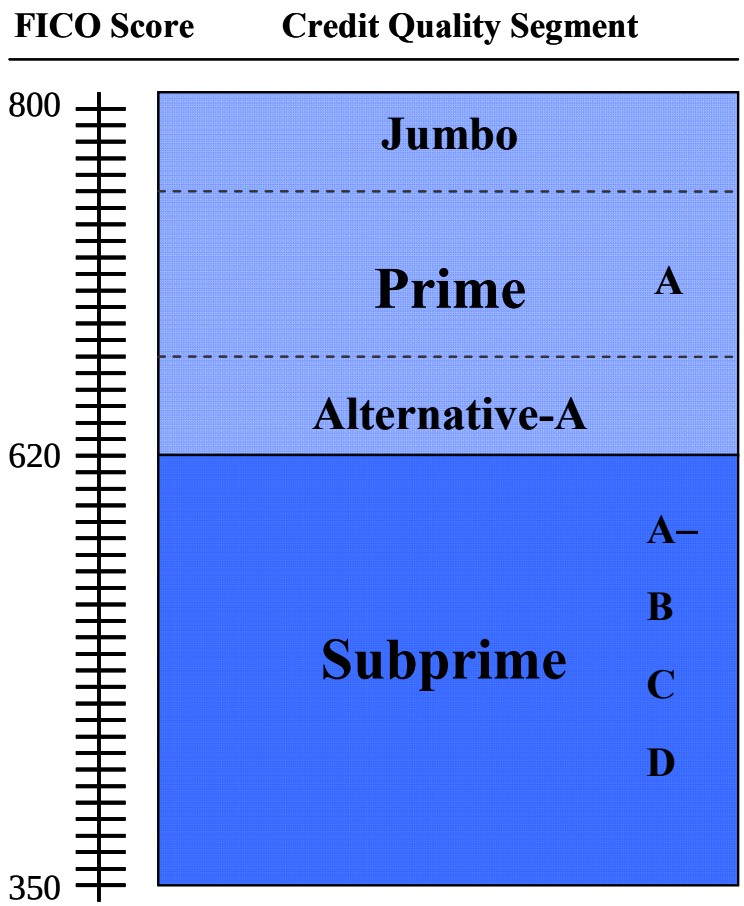
CDO	Initial Rating	Current Rating
Gemstone CDO		
A-1	AAA	AAA
A-2	AAA	AAA
A-3	AAA	AAA
Gemstone CDO IV		
A-1	AAA	AAA
A-2	AAA	AA
A-3	AAA	AA
Gemstone CDO V		
A-1	AAA	AAA
A-2	AAA	A–
A-3	AAA	BB+
A-4	AAA	BB+
Gemstone CDO VI		
A-1	AAA	BBB
A-2	AAA	BB–
Gemstone CDO VII		
A-1a	AAA	BB+
A-1b	AAA	CC
A-2	AAA	CC
Tourmaline CDO I		
I	AAA	AAA
II	AAA	AA
Tourmaline CDO III		
A-1a	AAA	B–
A-1b	AAA	B–
A-2 FLT	AAA	CCC+
A-2 FXD	AAA	CCC+
MKP Vela CBO		
Super Senior	AAA	CC
A	AAA	CC
Arca Funding CDO		
II	AAA	D

Source: Standard & Poor's RatingsDirect Webpage (2008).

The table above shows the downgrading of 'AAA'-tranches in our selection of subprime CDOs. The current rating represents the credit rating by S&P on August 6th, 2008. The 'AAA'-tranches of Gemstone CDO Ltd. have not been downgraded.

Appendix 6 – Illustrations

Illustration I. Mortgage Credit Quality Segments



The alt-A segment, within the lower prime segment, typically covers borrowers with clean credit histories, but may have inadequate income documentation or high debt-to-income ratio.[220] The jumbo segment serves prime borrowers with excellent credit quality, but requiring mortgages above the agency loan size guidelines.[221]

[220] Borg, interview May 26, 2008.
[221] NERA Economic Consulting (2007), p.5.

Illustration II. The Originate and Distribute Model.

This example is conducted with MBS as underlying collateral of the CDO, but the procedure is applicable to all ABS.