

The Mortgage and Financial Crises: The Role of Credit Risk Management and Corporate Governance

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Abstract

This paper discusses the role of risk management and corporate governance as causal factors in the onset of the financial crisis. The downturn in the housing and mortgage markets precipitated the first phase of the financial crisis in August 2007 when the solvency of a number of large financial firms was threatened by huge losses in complex structured financial securities. Why did these firms have such high concentrations in mortgage-related securities? Given the information available to firms at the time, these high concentrations in mortgage-related securities violated basic principles of modern risk management. We argue that this failure was a result of principal-agent problems internal to the firms and to breakdowns of corporate governance systems designed to overcome these principal-agent problems.

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Introduction and Objectives

This paper analyzes the role of risk management and corporate governance in the events leading up to the end of 2007, the “first phase” of the financial crisis. Extremely high rates of mortgage defaults in 2006 and 2007 precipitated a collapse in the asset-backed commercial paper (ABCP) market. This collapse set off a chain of events resulting in the most severe international financial crisis since the Great Depression.¹ The financial crisis that started in 2007, in turn, ignited a deep global recession with enormous consequences for economic and social welfare. This was a direct result of concerns about the solvency of many of the world’s largest financial firms that suffered catastrophic losses as a result of the mortgage crisis. This paper explores the following question: *Given the tremendous advances in financial risk measurement and management, why was the solvency of large and complex financial firms threatened by large losses in the mortgage market?*

We focus on the period through 2007 because the collapse of the ABCP market can be clearly traced to losses in fundamental assets, principally residential mortgage-backed securities (RMBS) and structured financial products backed by those securities. As discussed below, the events leading up to the initial phase of the crisis are precisely the types of events that standard financial risk management methods are designed to mitigate. Later developments in the financial crisis were affected in large part by a general liquidity crisis and contagion, which may be less tied to economic fundamentals and less amenable to standard approaches to risk management. With hindsight, it may seem self-evident that the mortgage crisis would lead to a financial crisis. However, many market analysts at the time doubted that there would be much spillover from the mortgage markets to the rest of the financial system. For example, in a May

¹ See Cecchetti (2008) or Covitz, *et al.* (2009) for a description of the events of August 2007.

2007 speech, when the severity of defaults in the mortgage market was manifest, the Chairman of the Federal Reserve, Ben Bernanke (2007), stated:

“. . . we believe the effect of the troubles in the subprime sector on the broader housing market will likely be limited, and we do not expect significant spillovers from the subprime market to the rest of the economy or to the financial system.”

Chairman Bernanke was not alone in this assessment. Kiff and Mills (2007) wrote:

“Notwithstanding the bankruptcy of numerous mortgage companies, historically high delinquencies and foreclosures, and a significant tightening in subprime lending standards, the impact thus far on core U.S. financial institutions has been limited. . . . The results suggest that new origination and funding technology appear to have made the financial system more stable at the expense of undermining the effectiveness of consumer protection regulation.”

These beliefs were widely held for several reasons. First, the subprime mortgage market was about \$1.3 trillion. Even a very high percentage loss in this market seemed manageable, given the overall size of U.S. and world debt markets. Moreover, the world financial markets had undergone numerous shocks of seemingly similar magnitude, such as September 11, the default of Enron and the subsequent accounting scandal, and the collapse of the tech bubble. In these cases, despite severe financial losses, financial markets remained well functioning and stable. Former Federal Reserve Chairman Alan Greenspan (2002) attributed this stability to financial innovation that enabled institutions to better distribute and hedge their risks.

Commonly cited reasons such as high mortgage defaults in 2006 and 2007 do not provide a sufficient explanation for why this particular shock led to a financial crisis and created doubts over the solvency of a number of major financial institutions. There are numerous explanations in the financial press and academic literature for the mortgage crisis. Some explanations emphasize the role of irrational exuberance in the housing market, which led to a bubble that unexpectedly burst. Others cite the “originate-to-distribute” model as distorting incentives for risk taking, since lenders no longer had “skin in the game.” Other explanations emphasize market participants’ overconfidence in sophisticated but untested statistical models

of risk. This overconfidence led firms to underprice risk and to engage in excessive risk taking. Some studies point to inflated credit ratings of securities issued by the major credit rating agencies as a principal factor in the financial crisis.² Many analysts cite a combination of some or all of these factors in explaining the problems in the mortgage market. However, we argue that taken individually or in combination, these reasons are ultimately unsatisfactory explanations for the failure of these large institutions to mitigate the effects of a large shock to the housing market. We argue that, *based on information available at the time*, the application of fundamental principles of modern risk management would have protected large and complex financial firms from being as vulnerable as they proved to be to shocks in the mortgage market.

Why did large, sophisticated financial firms fail to appropriately apply these risk management principles to avoid the impact of the mortgage crisis? We discuss two potential explanations for this failure of risk management. First, given government policies of too-big-to-fail (TBTF), large financial firms did not have appropriate incentives to worry about “tail risk” — the risk of large losses from low-probability events. Second, issues related to corporate governance and principal-agent conflicts have inhibited the function of a firm’s internal control and risk management system.

The next section describes the economic fundamentals that set the stage for the high rates of mortgage defaults in 2006 and 2007. We then discuss the collapse of securities backed by residential mortgages and its linkage to the “first phase” of the financial crisis. Most of the initial losses in securities markets came from collateralized debt obligations (CDOs) and other structured securities that were tied to the residential mortgage market. Large financial institutions had highly concentrated exposures to this structured securities market relative to their capital position. These structured securities were very complex and difficult to value. Many analysts have focused on the mispricing of the risks of these complex securities in

² Fitch (2006) reports that the number of subprime downgrades during July-October 2006 was the largest in its history. Despite a large number of defaults and downgrades in subprime securities, according to Calomiris (2008), both subprime and Alt-A originations continued to rise in 2006 and early 2007.

explaining the crisis. While this was a necessary condition for the crisis, it was the *combination of mispricing and excessive concentrations* that turned problems in the subprime mortgage market from a large-loss event into a financial crisis. An adequate explanation of the crisis requires an explanation for the high concentration in subprime mortgage-related structured securities.³ We then discuss some of the main explanations commonly given for the financial crisis and discuss why these explanations are ultimately unsatisfying. The remainder of the paper attempts to explain the underlying failures in risk management that led to the financial crisis and the relationship of these failures to problems in corporate governance, the lack of transparency within the firm, and incentive and compensation issues. Finally, we summarize our conclusions and discuss their policy implications.

Economic Fundamentals Leading to the Mortgage Crisis

The proximate cause of the most recent financial crisis was the tremendous growth in the U.S. mortgage market and the meltdown in that market that began in 2006.⁴ This section describes the fundamental factors influencing the tremendous growth in the U.S. mortgage market between 2000 and 2007. Three central, interrelated factors fueled the tremendous growth of the mortgage market beginning in 2000: the high rate of price appreciation in the housing market, the rapid and extensive decline in mortgage underwriting standards, and the tremendous growth of the “private-label” RMBS market.⁵

Figure 1 shows the unprecedented rate of housing price appreciation in the U.S. between 2000 and 2006. Although the housing boom was international in scope, this paper focuses on the U.S. market, since the growth and collapse of the U.S. mortgage market was

³ This concentration in subprime mortgage-related structured securities is the other side of high leverage. While many people speak of high leverage, it is useful to note that assessing the appropriate level of leverage depends on the level of risk being supported by a given level of capital. Prior to the crisis, many analysts argued that large financial institutions were very well capitalized.

⁴ We use the term proximate cause, since developments in the housing market were a result of underlying macroeconomic factors such as low interest rates and large international flows of savings into the developed countries. Discussing the macroeconomic factors underlying the housing boom is not directly relevant to the issues discussed in this paper and goes beyond the scope of the paper.

⁵ Private-label MBS refers to securities that are not insured by the government-sponsored enterprises (e.g., Fannie Mae and Freddie Mac).

central to the ensuing financial collapse. The boom in housing prices fueled the demand of buyers who saw housing as a profitable investment opportunity.⁶ The boom in house prices also helped fuel the supply of mortgage loans, since rising prices increase a borrower's equity, thereby lowering default rates, *ceteris paribus*.

During this period there was also a pronounced decline in underwriting standards. Figures 2 and 3 show that market share of subprime mortgages grew rapidly from 2.4 percent in 2000 to 13.5 percent in 2006, and the volume grew from about \$150 billion in 2000 to almost \$700 billion in 2006. However, the growth in the share of subprime loans doesn't tell the whole story. Underwriting standards also declined dramatically within the category of subprime loans. Figure 4 shows that the median combined loan-to-value (CLTV) ratio for subprime loans rose from under 90 percent in 2003 to 100 percent in 2006. Similarly, Figure 5 shows that the share of subprime loans with piggy-back mortgages (simultaneous second mortgages) and low documentation increased substantially over this period. The decline in underwriting standards can also be shown through more formal estimation of mortgage default models. Demyanyk and Van Hemert (2009) estimate the survival time of mortgage loans, controlling for characteristics of the borrowers, characteristics of the individual loans, and macroeconomic factors. They find that the quality of subprime mortgages has been deteriorating monotonically every year since 2001. However, the decline in lending standards did not lead to high rates of default until house prices were no longer appreciating rapidly. Demyanyk and Van Hemert (2009) also show that the deterioration in underwriting standards occurred across all mortgage product types. These results are also supported in Jimenez et al. (2007), Dell'Ariccia et al. (2008), and Mian and Sufi (2009).

A third central factor in the mortgage boom was the growth of the private-label RMBS market. Figure 6 shows the relative market share of private-label RMBS issuance among the

⁶ Taylor (2008) argues that there would have been no housing boom and no subsequent bust if interest rates had been set according to the Taylor rule (rather than too low) during 2002-2005.

GSEs, GNMA, and private-label securities. The growth rate of the private-label market between 2003 and 2007 is staggering. The private-label share of the market had hovered around 20 percent for nearly a decade. Between 2003 and 2006, the share of private-label RMBS soared and peaked at around 56 percent. Mortgage originations of non-conforming loans (i.e., loans not conforming to GSE underwriting standards) were expanding rapidly through companies that were either unwilling or unable to keep these loans in their portfolio. The growth of the private-label securitization market was necessary to provide the funding for the expansion in mortgage credit, particularly to the subprime sector. An important component of the financial crisis in 2007 is the collapse of the private-label RMBS market. Losses in the structured finance market were the main source of initial losses for large financial firms. Figure 7 shows that the volume of CDO issuance rose dramatically during the period leading to the financial crisis. Moreover, residential mortgage-related assets were also making up the overwhelming portion of this rapidly expanding market.⁷

The Collapse of the Mortgage Market and the “First Phase” of the Financial Crisis

This section discusses how the problems in the mortgage market resulted in a severe shock to the financial system in August 2007 with the collapse of the ABS market and the market for private-label RMBS. The boom in the housing market accelerated between 2002 and 2007, and the mortgage market’s performance was tied very closely to continued house price appreciation. Beginning in 2005, housing price appreciation began to slow, with certain regions, such as California, Arizona, and Florida, feeling the worst effects. Figure 8 shows the persistent worsening of mortgage loan performance by loans issued in succeeding years from 2004 to 2007. Unlike the sudden onset of the financial crisis that followed, the rise in mortgage defaults was a gradually worsening process rather than a dramatic and sudden collapse.

⁷ Hu (2007) found that residential mortgage-backed securities (RMBS) accounted for approximately 85 percent of the underlying assets in an asset-backed CDO in 2006 as compared to only 15 percent in 2000. In addition, other CDOs made up about 12 percent of the underlying assets in an asset-backed CDO, and these CDOs were probably also concentrated in residential mortgage-related assets.

While high mortgage defaults and foreclosures were considered a serious social problem and a potential problem for the health of the housing industry, many analysts believed that the mortgage crisis did not represent a significant threat to the overall health of the financial industry. The subprime market still represented a relatively small portion of all mortgages, accounting for approximately 13 percent of all residential mortgages. While some smaller companies were almost exclusively tied to the mortgage origination business, few large diversified financial companies had very high concentrations of subprime mortgages in their portfolios. The often stated position that advances in securities markets were efficiently dispersing risk seemed to be an accurate description of the mortgage market in early 2007.

Throughout late 2006 and the first half of 2007, the performance of mortgages continued to deteriorate, and those firms that were highly concentrated in the mortgage lending business faced severe financial trouble. This was particularly true for the monoline mortgage finance companies such as New Century Financial, a firm that grew into a large mortgage finance company principally through subprime lending and filed for Chapter 11 bankruptcy in April 2007. However, signs began to emerge that the mortgage crisis could have a larger effect on the overall financial system. For example, Bear Stearns revealed in June 2007 that it spent \$3.2 billion to bail out two of its hedge funds exposed to the subprime market – the largest bailout of the fund by a bank in almost a decade. By July, Bear Stearns told investors that they would get little, if any, money back from the two hedge funds. The sharp collapse in financial markets can be dated to August 9, 2007, when short-term credit markets froze up after French bank BNP Paribas suspended three large investment funds, citing problems in the U.S. subprime mortgage sector and stating that it could not value the assets in the fund because the market had disappeared. The European Central Bank pumped €95 billion into the eurozone banking system to ease the subprime credit crunch. The U.S. Federal Reserve and the Bank of Japan took similar steps to ease the crisis.

Figure 9 shows a dramatic decline in the ABX.HE index to about 10 percent of par value in 2008 for BBB rated or lower.⁸ The same index also declined significantly for higher rated ABX -- to about 20 percent for A-rated and 55 percent for AA-rated. In addition, Figure 10 shows that the market for short-term ABCP plummeted and private-label RMBS completely dried up in 2008.⁹ These markets were critical to the continued financing of the highly leveraged positions at many large financial firms. In many cases, the funding of long-term mortgage assets relied on the ability to roll over short-term ABCP. With this market collapsing and because of doubts about counterparties' creditworthiness due to large but unquantified exposure to the mortgage market, many large financial firms faced a severe liquidity squeeze that threatened their survival. The flood of central bank liquidity into these markets probably delayed the day of reckoning for many of these firms. It was a little over a year later when firms such as Bear Sterns, AIG, and Lehman Brothers were unable to survive without direct government assistance.

Common Explanations of the Financial Crisis

The previous two sections described the economic environment in the housing and mortgage markets along with the chronology of events leading up to the "first phase" of the financial crisis in the summer of 2007. This description of events is necessary, since this paper focuses on examining explanations of how this first phase came about. In our view, this is important because the events leading up to the "first phase" of the crisis can be explained by market fundamentals and losses in the value of assets in structured financial securities due to the high rate of mortgage defaults. As the crisis unfolded, market developments were greatly affected by the internal dynamics of crises: contagion and financial panic. This section

⁸ The ABX.HE index was created in response to demand for a tradable instrument that represents the market for subprime RMBS. The ABX.HE index is a series of credit-default swaps based on 20 bonds that consist of subprime mortgages. To help make the index representative of the universe of deals, the index includes no more than four deals from the same loan originator and no more than six deals from the same master servicer.

⁹ Covitz et al. (2009) demonstrate that ABCP programs are subject to a bank-like "panic." In addition, they find that the ABCP market may be a source of systemic risk, since the runs were relatively indiscriminate at least in the early part of the panic, which started in August 2007.

discusses various common explanations for the crisis, which can be found in the financial press and in the academic literature on the crisis. The central contention of this paper is that any explanation of the crisis is incomplete if it fails to explain why firms took extremely concentrated positions in the mortgage market despite basic tenets of modern financial risk management.

Modern financial risk management has concentrated on introducing three main concepts: (1) Risk management must account for unexpected losses as well as accurately measure expected losses; (2) Risk management must view risk from a portfolio perspective, taking into account correlations among assets, implying concerns for concentrated exposures to common risk factors; and (3) Risk management must develop measures of tail risk for assessing capital needs. When examining the various common explanations for the financial crisis, this paper suggests that these explanations are not sufficient in that they do not explain why firms could not avoid disaster in August 2007 by applying basic principles of financial risk management. The remainder of this section will discuss four common explanations for the crisis with this in mind: (a) irrational exuberance, (b) the originate-to-distribute business model, (c) overreliance on statistical risk models, and (d) overreliance on agency ratings.

Irrational Exuberance

Irrational exuberance led to a housing bubble that eventually burst and created the financial crisis. Many analysts argued that housing markets were displaying standard signs of a price bubble in the 2000-2006 period. The subsequent collapse of the housing market certainly supports this view. The bursting of the bubble causes a major decline in asset wealth for those who are long in the asset, which causes serious financial dislocation through a “financial accelerator”; see Bernanke et al. (1996). While an asset-price bubble could potentially explain why large financial firms were so vulnerable to defaults in the mortgage market, it requires that “irrational exuberance” be so great that firms’ risk management function discounted the potential for a substantial change in market price dynamics. It is not sufficient to claim that firms were too optimistic about house prices. Modern financial risk management assumes that some asset

values will perform worse than expected. To explain why firms were so vulnerable to a fall in house prices, firms' risk management had to be managing to tail events that were too optimistic relative to *ex post* realizations.

By the summer of 2007, housing prices had fallen by about 3.5 percent from their peak, using the Case-Shiller house price index. Was this event outside the stress scenarios used by risk managers? The evidence suggests not. For example, the stress test used by the GSEs for regulatory capital purposes had an immediate 5 percent national house price decline, followed by continued depreciation. A later section of the paper provides an example of a large financial firm's views of potential house price scenarios published in 2006. The firm estimated a 5 percent probability that there would be an annual national house price decline of 5 percent for three consecutive years. While this is a relatively low probability, it is well within the typical probability tail that modern financial firms use for measuring capital adequacy. To give some perspective, the Basel II rules for capital adequacy use a 0.1 percent solvency standard for establishing minimum capital standards for banking organizations. The evidence suggests that firms analyzing tail risk would incorporate events at least as bad as the house price declines as of August 2007. While firms may have been overly optimistic in their views on house prices, they still appreciated the potential for downside risk of the magnitude that occurred in 2007.¹⁰ Of course, it is possible that irrational exuberance or poor risk models led firms to underestimate the relationship between house price declines and mortgage defaults and, therefore, to underestimate the tail risk from a 3.5 percent house price decline. This issue is addressed in a later section.

The 'Originate-to-Distribute' Model

Mortgage securitization or the originate-to-distribute model meant that lenders did not have "skin in the game." This distorted incentives and led to a decline in underwriting standards

¹⁰ This is less likely to be true when talking about the continued slide in house prices. It is not clear that house price depreciation scenarios used for tail analysis would have included the kinds of price declines that had occurred by the fall of 2009.

along with predatory lending practices that created the financial crisis, and it has come under close scrutiny during the financial crisis. A well-known issue in finance is that the securitization process of converting illiquid loans into liquid securities can reduce the incentives of mortgage originators to carefully screen borrowers.

Over the years, entities that securitize loans have developed various mitigating factors to protect investors from moral hazard or adverse selection behavior by originators. However, it is possible that those mitigating factors did not function as expected and that loan originators used their informational advantage to sell investors loans of relatively low quality relative to the observable characteristics provided to investors.¹¹ In other words, investors were buying worse mortgages than they understood given the portfolio characteristics provided to them. Traditional methods of insuring against moral hazard or adverse selection by loan originators somehow failed to work properly. Keys et al. (2009) find evidence supporting this proposition. They find that portfolios that were more likely to be securitized had higher default rates than portfolios with similar risk profiles (e.g., FICO scores) but with a smaller probability of being securitized. Similarly, Dell’Ariccia et al. (2008) find that increasing recourse to loan sales and asset securitization appears to have affected lender behavior, with lending standards (in terms of loan-to-income ratio and denial rate) deteriorating more in areas where lenders sold a larger proportion of originated loans.

Perhaps more important, many of the largest originators of mortgages held very large investments in senior tranches of RMBS. In the words of John Mack of Morgan Stanley, “We did eat our own cooking, and we choked on it.”¹² While Morgan Stanley was not a major mortgage originator, firms like Bank of America, Citigroup, JP Morgan Chase, and Wells Fargo were major mortgage originators that also suffered substantial write-downs in their RMBS-

¹¹ That investors were buying more subprime mortgage loans is not by itself evidence of moral hazard or adverse selection problems. Investors typically had information indicating that they were buying subprime mortgage pools as well as information about risk characteristics of those pools, such as average loan-to-value ratios.

¹² Quote from John Mack’s testimony before the Financial Crisis Inquiry Commission on January 13, 2010.

related securities. In addition to plain vanilla securitization, large financial organizations engaged in other types of securitization, such as ABCP programs and structured investment vehicles (SIVs). Acharya and Schnabl (2009) suggest that these types of securitizations did not transfer credit risk to outside investors but were often used as a sophisticated form of performing “carry trades” – a form of regulatory capital arbitrage that allowed financial firms to take on exposure to tail risks that were systemic in nature with low regulatory capital requirements.¹³ This lack of risk transfer was mainly prevalent in some ABCP programs and structured investment vehicles (SIVs). In addition, Arteta et al. (2009) examine the characteristics of ABCP vehicles and their sponsors and find that the vehicle growth patterns and returns are consistent with excessive risk-taking, probably to take advantage of government-induced distortions (e.g., accounting and/or capital requirement rules, regulatory forbearance, deposit insurance) or due to corporate governance issues.

To summarize, securitization of mortgage loans was an important factor in the expansion of mortgage credit and the decline in underwriting standards, since loan originators did not carry the loans they made in portfolio and there was a growing investor market for subprime mortgage loans. However, it is clear that investor's appetite for loans with observably high risk factors grew rapidly between 2004 and 2007 and that many of the large originators retained exposure to risky mortgage loans through their securities holdings.

Firms' Overreliance on Untested Risk Models

Financial firm's overreliance and overconfidence on untested risk models led to an underestimation of risk, which led to excessive positions in the mortgage market and ultimately to the financial crisis. Market participants greatly underestimated the potential downside risk in the mortgage market. Insofar as large financial firms now rely on advanced quantitative models to measure this risk, a natural explanation for the crisis is that firms relied on unproven and

¹³ Acharya and Schnabl (2009) also find that banks that were more exposed to these conduits had lower stock returns and greater widening of credit default swap spreads around the August 2007 crisis – consistent with the risk-taking motive in securitization.

untested credit risk models.¹⁴ This overreliance on statistical analysis led firms to ignore more qualitative judgments on the nature of the housing boom, irrational exuberance, and the increasing problems associated with moral hazard and adverse selection. Financial and credit risk models are used widely at large financial institutions. In particular, participants in the mortgage market on the origination side and on the investment side relied heavily on advanced quantitative models of prepayment and default. However, these models may have performed poorly in the recent mortgage crisis for a number of reasons.

First, mortgage credit risk models at most firms relied on a relatively short history of data that did not contain periods of severe economic stress. Modelers typically had to choose between building models covering longer time periods but with fewer data elements and lower data quality versus building models with more data elements of higher quality covering a shorter time period. Typically, firms chose to use more sophisticated models with higher quality data covering a shorter time period. In part, many firms believed older data were not that relevant, given the changes in the mortgage market over the last two decades. Second, mortgage credit risk models are essentially “reduced-form” models rather than “structural models.” A true structural model would account for underlying changes in supply and demand behavior, including possible changes in adverse selection or moral hazard behavior. Given the unprecedented changes in market conditions, the rapid growth in new products, the unprecedented changes in underwriting, and the changes in the securitization market, it is reasonable to assume that reduced-form estimates from data of a relatively short horizon would contain substantial errors.¹⁵ However, the relative performance of the reduced-form model is an empirical question to be answered, and there has been research on this question.

¹⁴ A large number of research articles have been written on predicting default risk. See Demyanyk and Hasan (2009), Kumar and Ravi (2007), Fethi and Pasiouras (2009), and Altman and Saunders (1998) for comprehensive reviews of studies on the predictions of default risk models.

¹⁵ Capuano et al. (2009) summarize some of the recent advances in an effort to improve credit risk modeling: modifications of structural models and reduced-form models, reassessment of default correlations using copulas, pricing of credit index options, etc.

Before discussing this evidence, it is worthwhile to engage in a brief description of the structure of hazard models, which are the main credit risk modeling tool used in the mortgage industry. A mortgage hazard model estimates the probability that a mortgage holder will either default or prepay over some time period. Thus, after estimating a hazard function over a set of mortgages, the model can produce a probability distribution for the cumulative defaults and prepayments by the end of some specified time interval. Mortgage hazard models assume that mortgage defaults are a function of loan-specific characteristics, such as year of origination, credit score, or loan-to-value. They also assume that mortgage defaults depend on some exogenous environmental factors that are not loan specific, although they can depend on the geographic location of the house. Thus, a mortgage hazard model used for credit risk can be thought of as containing two separate sub-models: one that estimates model parameters relating mortgage default/prepayment to loan-specific characteristics and exogenous state variables, and another that estimates the stochastic evolution of the exogenous state variables.

This first sub-model is what we mean when discussing the accuracy of the reduced-form parameters from a credit risk model. The second sub-model would be directly affected by over-optimism or irrational exuberance concerning the path of house prices and thus potentially understate expected defaults. Thus, we can decompose model errors into errors resulting from a mis-forecast of the exogenous state variables and errors due to inaccurate reduced-form parameters. Gerardi *et al.* (2008) specifically address the issue of the accuracy of reduced-form parameter estimates of mortgage models. They review a number of studies produced by firms prior to the mortgage meltdown and ask how well the models performed. They find that the reduced-form parameters were reasonably accurate in that models produced relatively accurate forecasts *conditional on the true path of house prices*. In other words, modelers were reasonably accurate in understanding the relationship between house prices and defaults. On the other hand, they show that firms had an optimistic view of the future path for house prices.

An example of one large firm's analysis, as reported by Gerardi *et al.* (2008), is instructive.¹⁶

The firm provided the following house price appreciation (HPA) scenarios it used for its forecasts along with the associated probabilities for these forecasts.

<i>Very Optimistic Scenario:</i>	<i>11% HPA over the life of the pool:</i>	<i>prob. 15%</i>
<i>Optimistic Scenario:</i>	<i>8% HPA over the life of the pool:</i>	<i>prob. 15%</i>
<i>Base Scenario:</i>	<i>HPA slows to 5%</i>	<i>prob. 50%</i>
<i>Pessimistic Scenario:</i>	<i>0% HPA for the next 3 years</i>	<i>prob. 15%</i>
<i>Very Pessimistic Scenario:</i>	<i>-5% for the next 3 years</i>	<i>prob. 5%</i>

Over the relevant period of the analysis through August 2007, the *Very Pessimistic Scenario* was closest to the actual path of HPA, with HPA declining somewhat less than 5 percent. As with most of the studies reviewed by Gerardi *et al.* (2008), the modelers were roughly accurate in predicting defaults given the scenario. That is, this firm's *Very Pessimistic Scenario* produced defaults in line with what actually occurred. One way to look at this example is to see it as more evidence of irrational exuberance, since the analysts assigned a low probability to what actually occurred. But note that they do give a 5 percent probability to this outcome. That is a much higher probability than that used by large financial firms in estimating tail risk for capital purposes. In other words, it is well within the range of tail risk that firms are supposedly protecting themselves against. Thus, the puzzle remains: Why would firms leave themselves vulnerable to a large, knowable risk that was within the range of tail risk that they were supposedly guarding against?

The Role of Credit Rating Agency

The market relied on the accuracy of ratings by the major rating agencies, which were greatly overstated, perhaps because of conflicts of interest in the rating process and the reliability of complex structured financial securities backed by low-quality mortgage loans and low-quality RMBS. Reliance on agency ratings of CDOs was a direct outcome of the difficulty in evaluating such complex financial products such as CDOs. Ratings of securities by the major

¹⁶ See Lehman Brothers (2005).

rating agencies play a major role in this market. In many cases, even sophisticated financial firms will do little independent analysis of the credit risk of a security if it has an AAA rating. Firms may believe that it is an inefficient use of resources to independently analyze these AAA-rated securities.¹⁷ Agency ratings of CDOs were viewed as an efficient form of informational intermediation (at least until the beginning of the financial crisis). It is now evident that the default and downgrade performance of asset-backed CDOs performed much worse than could have been expected, given the history of corporate bonds with similar ratings. Moody's Investors Service (2007) reports that as of 2005, the Baa-rated CDO securities had much higher 5-year default probability (20 percent) than other corporate bonds with the same Baa rating (only 2 percent).¹⁸

While it is clear that inflated ratings played a major role in promoting mortgage-related structured financial products, there are several problems with relying on this as an explanation for why large firms were so vulnerable to severe negative shocks to the mortgage market. First, pricing of many of these securities indicated that market participants knew that they were riskier than typical AAA securities. Much of the attraction of holding these securities in portfolio was the higher yield. It is difficult to maintain that market participants simply accepted the AAA rating without question. More important, even if large financial firms were convinced of the rating's accuracy, it does not explain a decision to have excessive concentrations of mortgage-related assets in a portfolio. As discussed above, a central tenet of modern financial risk management is the need to analyze portfolio risk and to guard against the unexpected. Just as we would not expect a large sophisticated firm to have all of its securities investments in AAA-rated firms within a small group of firms or within a specific industry, we would not expect such a

¹⁷ There is some evidence that many large firms did independent modeling of complex structured financial products backed by mortgage-related assets. Nevertheless, it is probably the case that some did very little.

¹⁸ Calomiris (2008) argues that rating agencies intentionally understated the risk of CDOs and inflated the ratings for securitized products so that institutional investors would be able to invest in these products without being bound by the constraints of regulation.

firm to be so concentrated in a sector that a severe tail event in that sector threatens the solvency of the firm.

Failures of Risk Management: Conscious Choices vs. Lack of Transparency

The central focus of this paper has been on explaining how large and complex financial firms could leave themselves so vulnerable to the severe negative shocks to the mortgage market that led to questions about their solvency by the summer of 2007. We've argued that the kinds of shocks that occurred during that period were well within the range of stress events that would have been considered by risk managers of these firms. Moreover, the evidence suggests that mortgage models would have indicated very high levels of default under those stress scenarios. Then why did firms not protect themselves from this type of tail event? Our preferred answer — failures in risk management and corporate governance — will be explored below. However, an alternative theory needs to be considered.

Given the implicit government subsidy produced by a too-big-to-fail (TBTF) policy, large financial firms may not have the incentives to protect themselves from tail risks at the expense of higher expected returns. In this view, there was no failure of risk management but simply large firms willing to take very risky bets as long as those bets had sufficiently high expected returns. While this paper will not fully explore this hypothesis, and the TBTF policy clearly does create incentives for moral hazard behavior, there are reasons to be skeptical of this view for some of the firms that played a major role in the crisis. Many firms whose solvency was threatened by this crisis, such as AIG and many of the large investment banks, were not banks or bank holding companies that were historically the candidates for TBTF treatment. It may be a leap to assume that these firms were making conscious decisions under the belief that the safety net would be extended to their firms. In addition, as discussed below, the evidence suggests that many large firms were unable to accurately calculate their exposure to the mortgage market. While TBTF can explain why a firm will make very risky choices, it doesn't explain why a firm doesn't understand the risk-return choices it is making. While incentives due

to TBTF undoubtedly contributed to the failures in risk management, there is considerable evidence that many firms did not understand the quantity and nature of much of their exposure to the mortgage market. The complexity of many of the asset-backed CDO markets made valuation of these instruments very difficult and uncertain. Perhaps more important, the complexity of these instruments meant that firms were not able to accurately measure their exposure to a particular asset and therefore were unable to analyze the correlation structure of their portfolio. For example, the Senior Supervisors Group Survey (2009) found that many firms were unable to accurately aggregate their exposures to mortgage-related assets *after the events of August 2007*. Obviously, if firms were not able to judge the size of their exposure after the crisis, they clearly did not understand their exposures before the crisis.

Some evidence suggests that the mortgage crisis generated a financial crisis because of the highly concentrated exposure that large financial firms had through complex structured financial products, since the majority of losses that occurred in 2007-2008 were mainly from highly rated (AAA) structured products (rather than on-balance-sheet mortgage lending), particularly CDOs with high concentrations of subprime real estate exposures.¹⁹ Figure 11 shows large losses from available-for-sale securities that were realized by banking institutions right after the “first phase” of the financial crisis. Figure 12 shows that during the “first phase” of the crisis, the overwhelming losses to large financial firms came from investment security write-downs with a relatively small portion coming from defaults of loans in portfolio. Much of the investment security write-downs came from complex structured products such as CDOs, which were most vulnerable because the underlying assets were lower rated RMBS. As noted in Kirkpatrick (2009), many financial institutions decided to retain large exposures to super senior tranches of CDOs that far exceeded the firms’ understanding of the risk inherent in these instruments. The concentration of mortgage-related securities at Bear Stearns, for example, represented a significant concentration of mortgage risk beyond its internal limits.

¹⁹ See Senior Supervisors Group Survey (2008).

Gorton (2008) discusses in detail the complexity of many of these structured products. CDOs are far from homogeneous securities, in terms of the underlying residential RMBS and the contractual structure. Gorton points out that it is virtually impossible for an investor in a CDO tranche to determine its subprime exposure in the CDO portfolio without looking through each of the bonds in the CDO portfolio and other CDO tranches within the portfolio. The heterogeneity of CDOs effectively led to opacity in security valuation. As explained in Dwyer and Tkac (2009), a model to evaluate CDOs would require knowledge of the implications of the entire CDO structure as well as knowledge about the characteristics of the underlying RMBS and their underlying mortgages. This is an extremely complex process, since a CDO could have purchased a large number of tranches of different securitizations, including a large number of subprime tranches, from many different dealers. The degree of complexity of these products was widely underestimated, and their impacts were widely misunderstood prior to the financial crisis. For many years, credit derivatives were viewed as an efficient means to transfer risk and promote financial stability.²⁰ As noted by former Federal Reserve Chairman Alan Greenspan (2002):

“Financial derivatives, more generally, have grown at a phenomenal pace... These increasingly complex financial instruments have especially contributed, particularly over the past couple of stressful years, to the development of a far more flexible, efficient, and resilient financial system than existed just a quarter-century ago... More recently, instruments that are more complex and less transparent – such as credit default swaps, CDOs, and credit-linked notes – have been developed and their use has grown very rapidly in recent years. The results? Improved credit risk management together with more and better risk management tools appear to have significantly reduced loan concentrations... and the associated stress on banks and other financial institutions.”

Despite the difficulties in measuring risk associated with these complex products, firms did bring substantial resources to the analysis of individual deals. However, large financial institutions generally held a very large number of CDOs and other complex structured financial products. Moreover, these financial firms did not have data systems that would allow risk

²⁰ Kiff et al. (2009) discuss the role of credit derivative markets in increasing systemic risks (due to the lack of transparency) and the increasing inter-connectedness of large financial institutions.

analysts to drill down to the underlying components of each of these structured products to understand how risks in these products were correlated. This is analogous to deciding to buy a portfolio of AAA-rated securities without knowing whether your entire investment was in one company or one sector. This violates a basic principle of advanced financial risk management: analyzing portfolio risk rather than merely the risk of individual securities. It is obviously impossible to analyze portfolio risk when your portfolio includes complex securities backed by multiple types of assets, but you are unable to incorporate those underlying risks into a portfolio analysis. Some firms abstained from the mortgage-related CDO market precisely because it was impossible to reach back to the underlying assets.

This lack of transparency suggests a basic failure of risk management and corporate oversight of the risk management function. Financial firms lacked effective internal controls, accurate and timely financial and risk reporting to the right management level, and a corporate-wide view of risk or an enterprise-wide risk management program. Federal Reserve Chairman Ben Bernanke (2009a) has pointed out that “although the sources of the crisis were extraordinarily complex and numerous, a fundamental cause was that many financial firms simply did not appreciate the risks they were taking.” One of the causes of the financial crisis was that large financial firms were willing to engage in these complex mortgage-related products when they had not built the capability to analyze the portfolio risk of these activities. Further, no oversight function within the company demanded that kind of information and that kind of analysis. Ultimately, it is the responsibility of senior management and the board of directors to see that appropriate systems are in place so that a firm can adequately understand its risk exposures. The inability to do so represents a fundamental failure of risk management and corporate controls among many of our largest financial firms.

Incentives, Corporate Governance, and the Failures of Risk Management

While lack of transparency explains how senior managers may have unknowingly put their firms at risk, it doesn't explain why firms gravitated to large exposures in these non-

transparent securities. Was it purely an accident that firms were so exposed to these securities? Typically, large firms did apply sophisticated analytical resources to evaluating individual complex structured financial products. Managers at the business line level must have understood that they were booking very large numbers of securities whose underlying assets were tied to the health of the subprime mortgage market. At the business line level, managers' incentives were to increase the profitability of the business line rather than consider the firm's overall risk position. This is a basic internal principal-agent problem that risk management controls and corporate oversight are meant to address. Complex structured financial products were a close-to-perfect vehicle for business line managers to produce large profits by promoting individual positions that seemed safe and profitable without revealing excessive concentrations of risk. There are generally two types of approaches to mitigating the principal-agent problem described above. The first is to better align the agent's incentives with the principal through how the agent is compensated. The second approach to mitigating the principal-agent problem is through effective internal controls, monitoring, and oversight.

Risk management systems at many large financial companies failed on both counts. With regard to compensation systems, rather than mitigate the principal-agent problem, compensation plans often encourage excessive risk taking through incentive plans that reward business line managers for producing high short-run returns for the business line. Banking regulators have enunciated three principles for reforming incentive compensation plans in banking organizations. The first principle is that compensation should not encourage excess risk-taking beyond the organization's ability to effectively identify and manage risk. Second, compensation should be compatible with effective controls and risk management. Third, compensation should be supported by strong corporate governance, including active and effective oversight by the organization's board of directors. Whether such changes in compensation can successfully improve the incentives of business line managers, it will still

remain the function of the board and senior management to see that proper risk controls are in place.

Improving managers' incentives by improving the compensation system is an important component of reform. However, there is a limit to the effectiveness of aligning incentives through compensation. Building more effective internal controls and oversight systems, including more effective regulatory oversight, is a necessary component of reform. This requires creating a powerful independent risk management function with appropriate resources and skills. It also requires a clear commitment from senior management and the board of directors to ensure that controlling risk is rewarded and valued.

Conclusions and Policy Implications

The events leading up to the financial crisis of August 2007 were the types of events that modern financial risk management systems were designed to avoid. Risk management systems are designed to avoid excessive harm from unexpected but knowable events. The risk of large scale defaults generated by house price depreciation was precisely that type of event.

This suggests a fundamental failure of the risk control systems at large financial firms. These controls failed to pierce through the lack of transparency in these complex structured financial instruments that generated excessive concentration of risk in the mortgage market. Business line managers making huge bonuses from increasing their firm's investment in structured financial products gained from these instruments' lack of transparency. It allowed them to increase these exposures unchecked. As noted by Federal Reserve Chairman Bernanke (2009b), "One of the lessons learned from the current financial crisis has been the need for timely and effective internal communication about risks."

Why did risk management, internal controls, and corporate governance fail? Undoubtedly, government policies of too-big-to-fail may encourage lax risk controls at large financial firms. Establishing a credible ability to resolve a failed large financial firm is a necessary policy reform for promoting better risk oversight and risk controls. Kashyap et al.

(2008) propose a “capital insurance,” aiming to reduce the adverse consequences of the crisis while making the private sector (rather than the public sector) pick up the costs. Blinder (2009) outlines several important potential regulatory reforms to deal with issues of excessive risk taking at large financial institutions.

In addition, firms need to generate better incentive compensation structures to encourage business line managers to consider risk in their decisions and to ensure greater firm-wide transparency. Finally, senior managers and boards must be held to greater accountability when they fail to carry out their responsibilities. In part, this can be accomplished by changes in incentive packages, but it will also require improved regulatory oversight of risk control functions. Fischer (2008) points out that internal risk management in banks and financial institutions should be the first line of defense for the financial system — before looking for control from outside, such as the board of directors or from regulators. Incentives and compensation packages, with a mix of cash, equity, and other forms of compensation, should be consistent with risk alignment.

References

- Acharya, V. & Schnabl, P. (2009). Securitization without risk transfer. Working Paper, NYU Stern School of Business, April.
- Arteta, C., Carey, M., Correa, R., & Kotter, J. (2009). Revenge of the steamroller: ABCP as a window on risk choices. Unpublished Working Paper, Federal Reserve Board, Division of International Finance, May.
- Altman, E., & Saunders, A. (1998). Credit risk measurement: developments over the last 20 years. *Journal of Banking and Finance* 21, 1721-42.
- Bernanke, B. (2009a). Frequently asked questions: how can we avoid a similar crisis in the future?" Speech at the Economic Club of Washington D.C., December 7.
- Bernanke, B. (2009b). Lessons of the financial crisis for banking supervision. Speech at the Federal Reserve Bank of Chicago's Conference on Bank Structure and Competition, May 7.
- Bernanke, B. (2007). The subprime mortgage market. Speech at the Federal Reserve Bank of Chicago's 43rd Annual Conference on Bank Structure and Competition, May 17.
- Bernanke, B., Gertler, M., & Gilchrist, S. (1996). The financial accelerator and the flight to quality. *Review of Economics and Statistics*, 78(1), 1-15.
- Blinder, A. (2009). It's broke, let's fix it: rethinking financial regulation. Working Paper, Princeton University, presented at the Federal Reserve Bank of Boston Conference, October 23.
- Calomiris, C. (2008). The subprime turmoil: What's old, what's new, and what's next. Working Paper, Columbia University, presented at Jackson Hole Conference, August.
- Capuano, C., Chan-Lau, J., Gasha, G., Medeiros, C., Santos, A. & Souto, M. (2009). Recent advances in credit risk modeling. IMF Working Paper 09-162.
- Cecchetti, S. (2008). Monetary policy and the financial crisis of 2007-2008: Advances in credit risk modeling. IMF Working Paper.

- Covitz, D., Liang, N., & Suarez, G. (2009). The evolution of a financial crisis: Panic in the asset-backed commercial paper market. Federal Reserve Board, Finance and Economic Discussion Series #2009-36.
- Dell’Ariccia, G., Igan, D. & Laeven, L. (2008). Credit booms and lending standards: evidence from the subprime mortgage market. IMF Working Paper 08-106.
- Demyanyk, Y., & Hasan, I. (2009). Financial crisis and bank failures: A review of prediction methods. Working Paper 09-04R, Federal Reserve Bank of Cleveland.
- Demyanyk, Y., & Van Hemert, O. (2009). Understanding the subprime mortgage crisis. *Review of Financial Studies*, May 4 (RFS Advance Access), forthcoming.
- Dwyer, G. & Tkac, P. (2009). The financial crisis of 2008 in fixed income markets. Federal Reserve Bank of Atlanta, Working Paper 2009-20.
- Fethi, M.D., & Pasiouras, F. (2009). Assessing bank performance with operational research and artificial intelligence techniques: A survey. Working Paper, University of Bath School of Management.
- Fischer, S. (2008). Preparing for future crisis. Presented at Jackson Hole Conference, August.
- Fitch Ratings (2006). 2007 Global structured finance outlook – Economic and sector-by-sector analysis. December.
- Gerardi, K., Lehnert, A., Sherland, S.M., & Willen, P. (2008). Making sense of the subprime crisis. Federal Reserve Bank of Boston, Public Policy Discussion Paper, December.
- Gorton, G. (2008). The panic of 2007. Working Paper, Yale School of Management and NBER, presented at the Jackson Hole Conference, August.
- Greenspan, A. (2002). International financial risk management. Speech before the Council on Foreign Relations, Washington, D.C. November 19.
- Hu, J. (2007). Assessing the credit risk of CDOs backed by structured finance securities. *Journal of Structured Finance* 13 (3), 43-59.
- Jimenez, G., Ongena, S., Peydro, J.L., & Saurina, J. (2007). Hazardous times for monetary

- policy: What do twenty-three million bank loans say about the effects of monetary policy on credit risk? Bank of Spain and CEPR Discussion Paper DP6514.
- Kashyap, A., Rajan, R.G., & Stein, J. (2008). Rethinking capital regulation. Working Paper, University of Chicago and NBER, presentation at the Jackson Hole Conference, August.
- Keys, B.J., Mukherjee, T., Seru, A., & Vig, V. (2009). Did securitization lead to lax screening? Evidence from subprime loans. *Journal of Monetary Economics* 56, 700-20.
- Kiff, J., Elliott, J., Kazarian, E., Scarlata, J., & Spackman, C. (2009). Credit derivatives: Systemic risks and policy options. IMF Working Paper 09-254.
- Kiff, J.J. & Mills, P. (2007). Money for nothing and checks for free: Recent developments in U.S. subprime mortgage markets. IMF Working Paper 07-188.
- Kirkpatrick, G. (2009). The corporate governance lessons from the financial crisis. *Financial Market Trends*, OECD Publication.
- Kumar, R.P. & Ravi, V. (2007). Bankruptcy prediction in banks and firms via statistical and intelligent techniques - A review. *European Journal of Operational Research* 180,1-28.
- Lehman Brothers (2005). U.S. ABS weekly outlook. Fixed-Income Research, April 15.
- Mayer, C.J., Pence, K.M., & Sherlund, S. (2009). The rise in mortgage defaults. *Journal of Economic Perspectives* 23(Winter), 27-50.
- Mian, R.A. & Sufi, A. (2009). The consequences of mortgage credit expansion: Evidence from the U.S. mortgage default crisis. *Quarterly Journal of Economics* 124(4) 1449-1496.
- Moody's Investors Service (2007). U.S. subprime: Overview of recent refinements to Moody's methodology: July 2007. July 24.
- Senior Supervisors Group Survey (2009). Risk management lessons from the global banking crisis of 2008. October 21.
- Senior Supervisors Group Survey (2008). Observations on Risk Management Practices During the Recent Market Turbulence. March 6.
- Taylor, J.B. (2008). The financial crisis and the policy responses: An empirical analysis of what

went wrong. Working Paper, Hoover Institute and Stanford University.

Figure 1: Historical Record of Housing Market Boom (1968-2006)

Note: US National Index – Solid Line for Level (left axis); Dotted Line for Change (right axis)

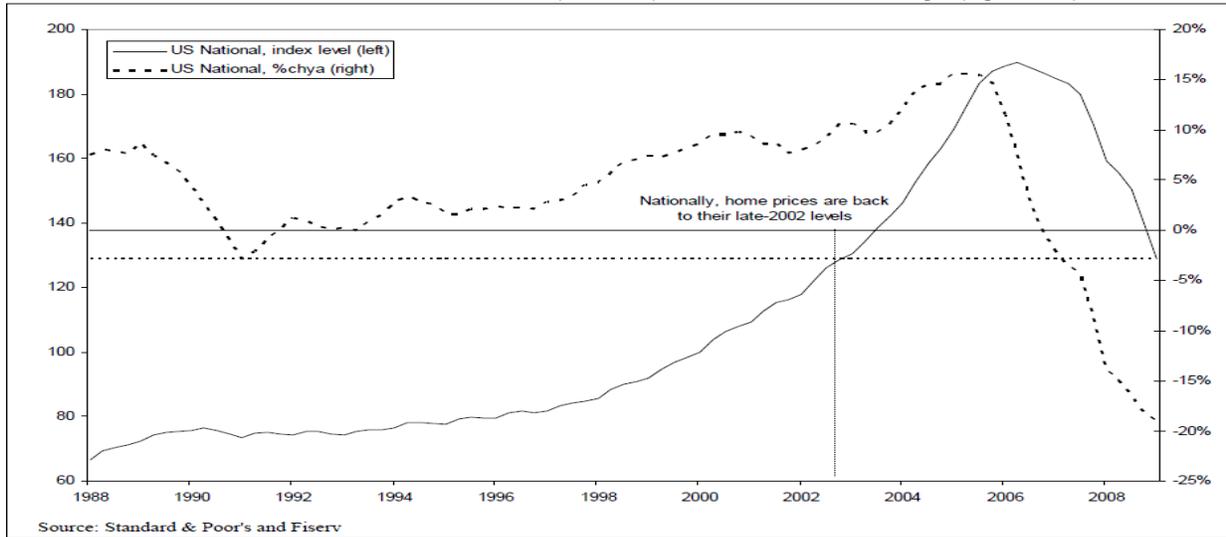


Figure 2: Subprime Share of Mortgage Market

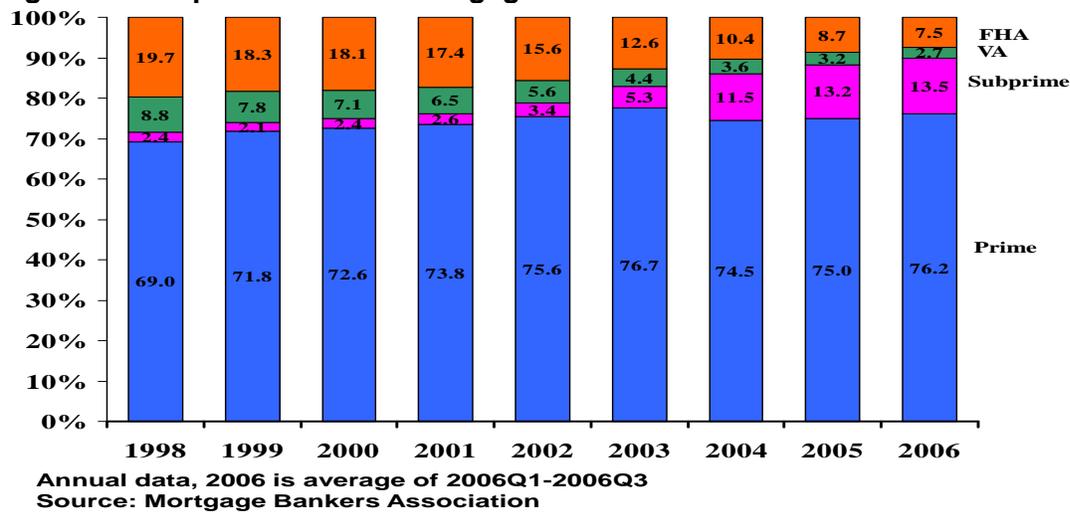


Figure 3: Volume of Subprime Mortgage

Source: www.mortgagecalculator.org/images/us-subprime

**Growth of Subprime Mortgages
1994 - 2006**

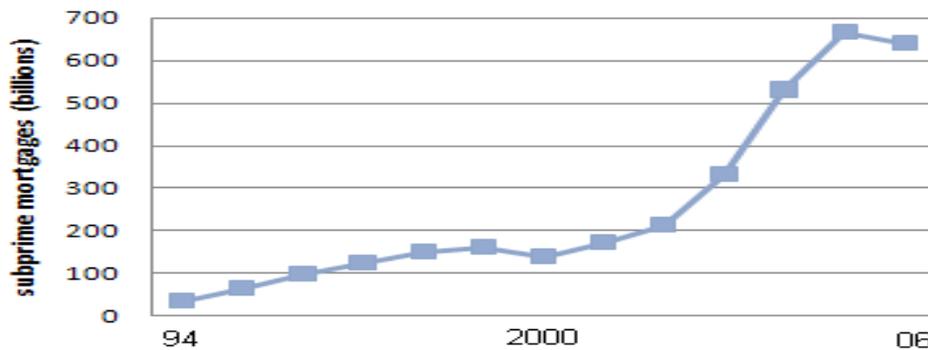


Figure 4: Median Combined LTV for Mortgages in Subprime and Alt-A Pools

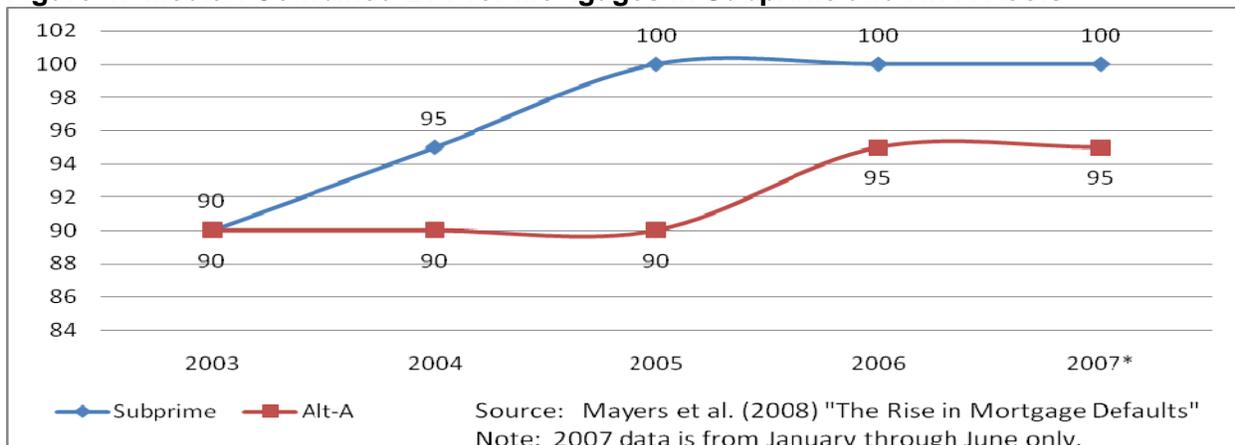


Figure 5: Percentage of Piggy Back Loans in Subprime and Alt-A Pools

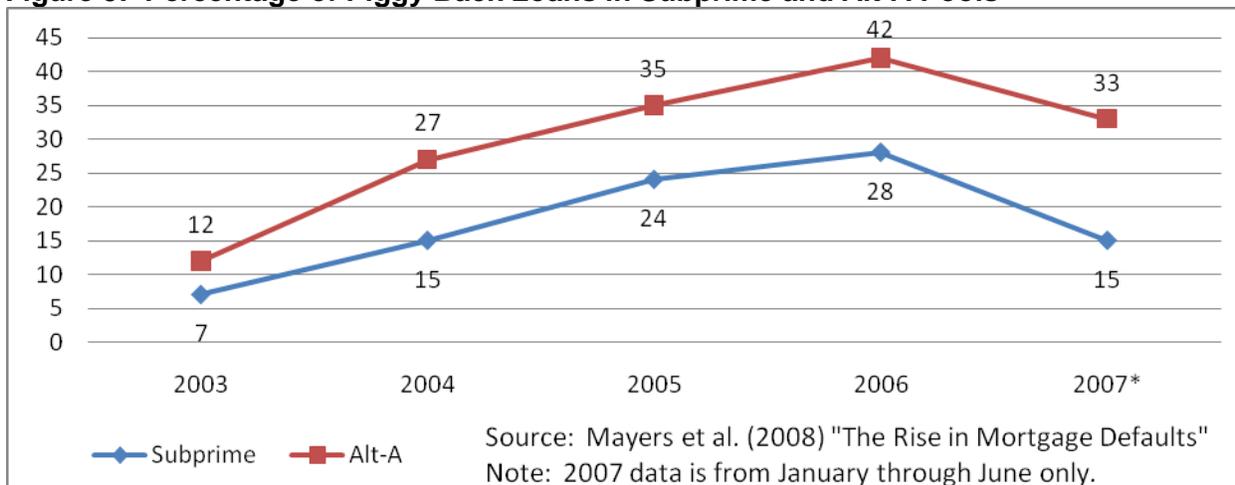


Figure 6: Non-Agency MBS Issuance (as Share of Total MBS Issuance): 1995-2008

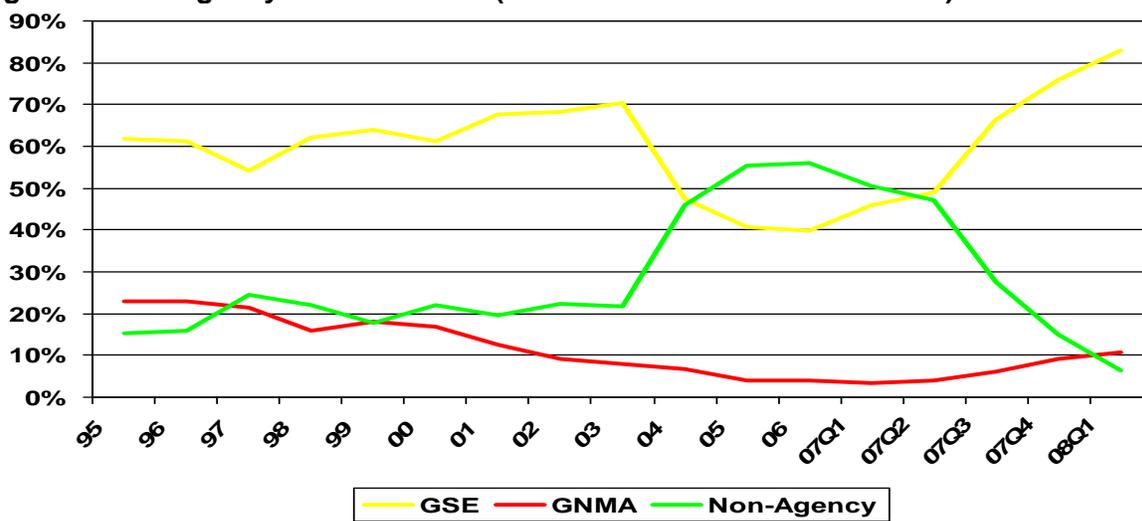


Figure 7: Mortgage-Backed CDO Issuance Prior to the Financial Crisis

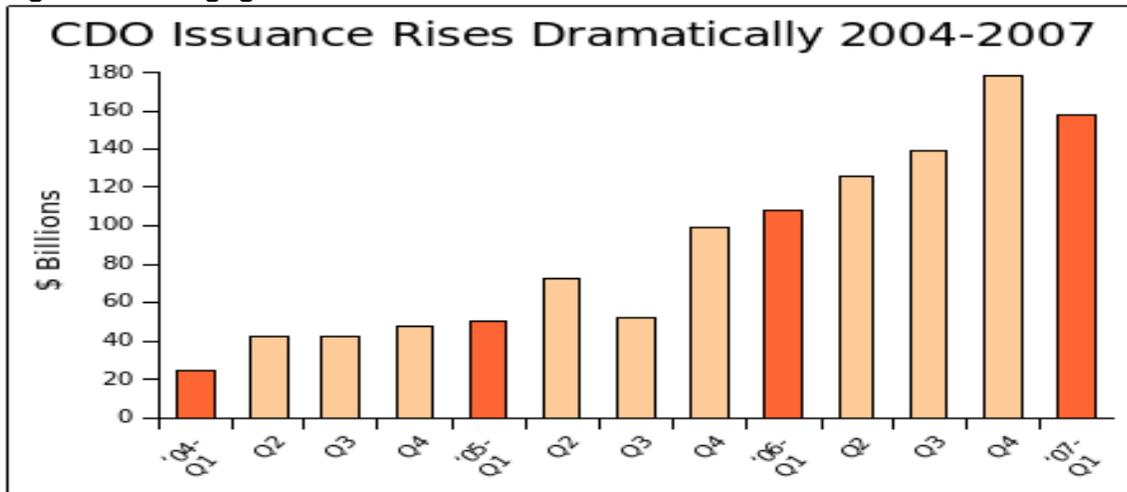


Figure 8: Delinquency Rates by Loan Age & Vintage

Source: Mayer, Pence, and Sherlund (2009)

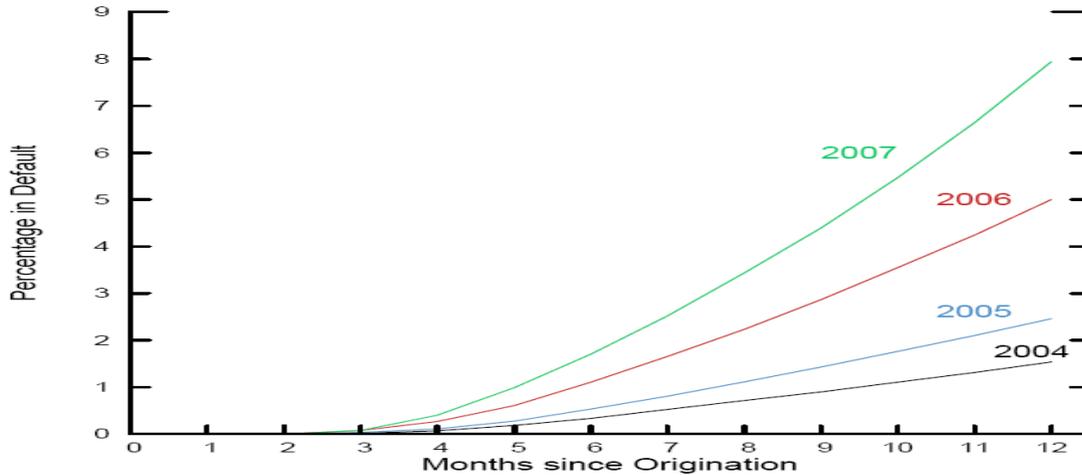


Figure 9: ABX.HE Index, Series 06-1

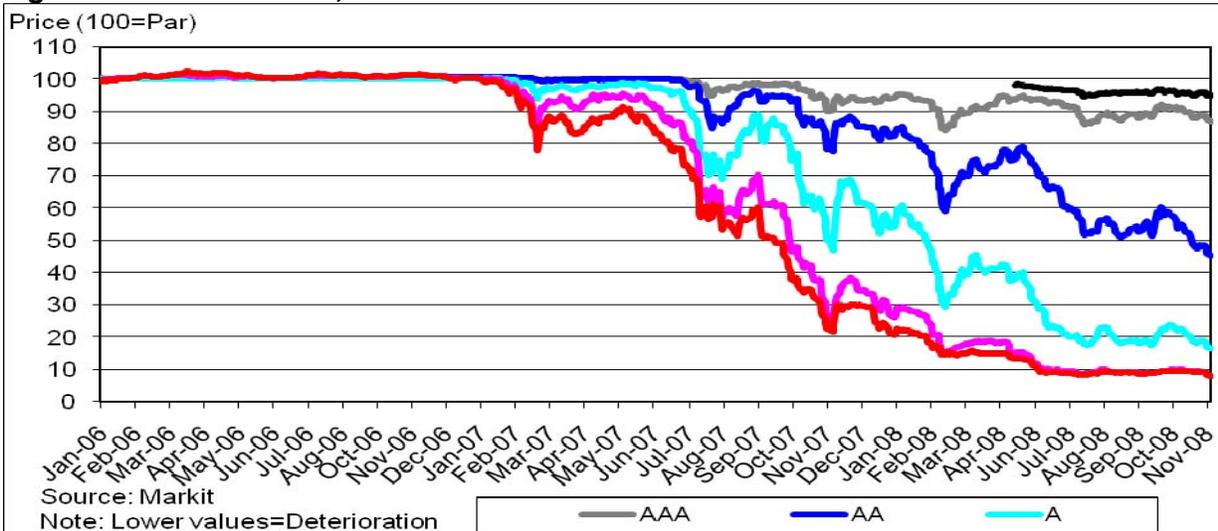
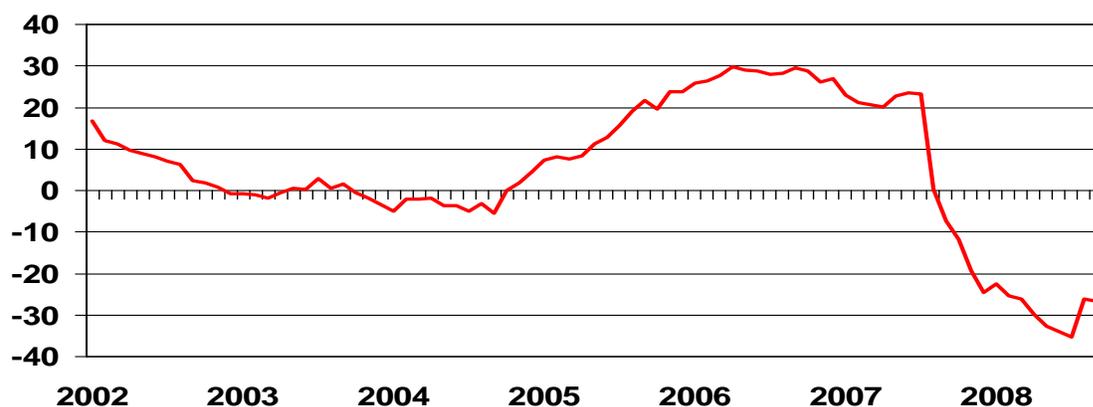


Figure 10: % Change in Asset-Backed Commercial Paper Outstanding: 2002-2008



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Figure 11: Realized Gains (Losses) on Available-for-Sale Securities

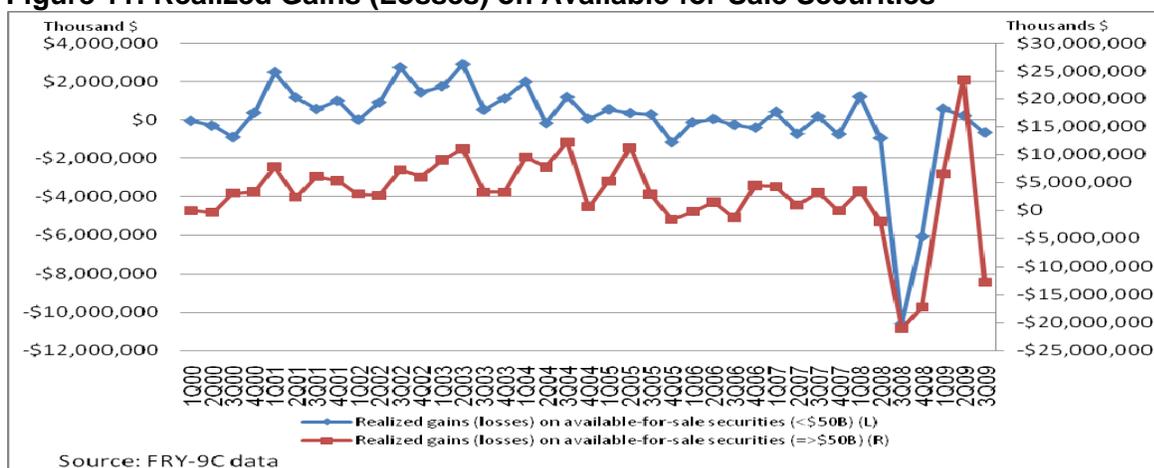


Figure 12: Subprime Related Writedowns at Financial Firms

Subprime Related Writedowns and Credit Losses at Commercial Banks, Investment Banks and Thrifts 2007-2008								
Firm	Writedown	Credit Loss	Total	Firm	Writedown	Credit Loss	Total	
Citigroup	35.3	5.6	40.9	Barclays	3.3		3.3	
UBS	38		38	WestLB	3.2		3.2	
Merrill Lynch	31.7		31.7	Bear Stearns	3.2		3.2	
Royal Bank of Scotland	14.9		14.9	National City	0.5	2.6	3.1	
Bank of America	9.2	5.7	14.9	Goldman Sachs	3		3	
Morgan Stanley	12.6		12.6	Dresdner	2.7		2.7	
HSBC	3	9.4	12.4	Nomura Holdings	2.5		2.5	
JPMorgan Chase	5.5	4.2	9.7	ABN Amro	2.4		2.4	
Credit Suisse	9.6		9.6	Fortis	2.3		2.3	
IKB Deutsche	9		9	HSH Nordbank	2.3		2.3	
Washington Mutual	0.3	8	8.3	Bank of China	2		2	
Deutsche Bank	7.4		7.4	LB Baden-Wuerttemberg	2		2	
Wachovia	4.9	2.4	7.3	Natixis	1.9		1.9	
Credit Agricole	6.5		6.5	BNP Paribas	1.3	0.3	1.6	
Mizuho Financial Group	5.4		5.4	UniCredit	1.6		1.6	
Canadian Imperial (CIBC)	4.1		4.1	DZ Bank	1.5		1.5	
Societe Generale	3.8		3.8	Caisse d'Epargne	1.3		1.3	
Bayerische Landesbank	3.6		3.6	Gulf International	1		1	
Wells Fargo	0.9	2.7	3.6	Other European banks	9.4		9.4	
E*Trade	2.5	0.9	3.4	Other Asian banks	6.9	0.4	7.3	
Lehman Brothers	3.3		3.3	Other North Amer. Banks	2.8	0.9	3.7	
				TOTALS*	268.6	43.1	311.7	

Source: Bloomberg: Subprime Bank Losses Reach \$312 Billion with RBS, Nomura."
Note: Writedowns are mark-to-market losses while Credit Losses are charge-offs and increases in reserves.