

The Subprime Credit Crisis of 2007

MICHEL G. CROUHY, ROBERT A. JARROW,
AND STUART M. TURNBULL

MICHEL G. CROUHY is head of Research and Development at Natixis in Paris, France and New York. michel.crouhy@natixis.com

ROBERT A. JARROW is a professor in the Johnson Graduate School of Management at Cornell University in Ithaca, NY, and a managing director of Kamakura Corporation in Honolulu, Hawaii. raj15@cornell.edu

STUART M. TURNBULL is a professor in the Bauer College of Business at the University of Houston in Houston, TX. sturnbull@uh.edu

This article examines the different factors that have contributed to the subprime mortgage credit crisis—search for yield enhancement, investment management, agency problems, lax underwriting standards, rating agency incentive problems, poor risk management by financial institutions, lack of market transparency, limitation of extant valuation models, complexity of financial instruments, and failure of regulators to understand the implications of the changing environment for the financial system. The article sorts through these different issues and offers recommendations to help avoid future crises.

The credit crisis of 2007 started in the subprime mortgage market in the U.S.¹ It has affected investors in North America, Europe, Australia, and Asia, and it is feared that write-offs of losses on securities linked to U.S. subprime mortgages and, by contagion, other segments of the credit markets, could reach US\$1 trillion.² It brought the asset-backed commercial paper market to a halt, hedge funds have halted redemptions or failed, CDOs have defaulted, and special investment vehicles have been liquidated. Banks have suffered liquidity problems, with losses since the start of 2007 at leading banks and brokerage houses topping US\$300 billion, as of June 2008.^{3,4} Credit-related problems have forced some banks in Germany to fail or to be taken over, and Britain had its first bank run in 140 years, resulting in the effective nationalization of Northern Rock, a troubled

mortgage lender. The U.S. Treasury and the U.S. Federal Reserve Bank (Fed) helped to broker the rescue of Bear Stearns, the fifth largest U.S. Wall Street investment bank, by JP Morgan Chase during the weekend of March 17, 2008.⁵ Banks, concerned about the magnitude of future write-downs and counterparty risk, have been trying to keep as much cash as possible as a cushion against potential losses. They have been wary of lending to one another and, consequently, have been charging each other much higher interest rates than normal in the interbank loan markets.⁶

The severity of the crisis on bank capital has been such that U.S. banks have had to cut dividends and call global investors, such as sovereign funds, for capital infusions of more than US\$230 billion, as of May 2008, based on data compiled by Bloomberg.⁷ The credit crisis has caused the risk premium for some financial institutions to increase eight-fold since last summer. It has now become more expensive for financial than for nonfinancial firms, with the same credit rating, to raise cash.⁸

The crisis has affected the general economy. Credit conditions have tightened for all types of loans since the subprime crisis started nearly a year ago. The biggest danger to the economy is that, to preserve their regulatory capital ratios, banks will cut off the flow of credit, causing a decline in lending to companies and consumers. According to some

economists, tighter credit conditions could knock 1¼ percentage points from U.S. first-quarter 2008 growth and 2½ points from second-quarter 2008 growth. The Fed lowered its benchmark interest rate 3.25 percentage points to 2% between August 2007 and May 2008 in order to address the risk of a deep recession. The Fed has also been offering ready sources of liquidity for financial institutions, including investment banks, primary dealers, as well as the two government-sponsored mortgage enterprises (Fannie Mae and Freddie Mac) that are finding it progressively harder to obtain funding, and has taken on mortgage debt as collateral for cash loans.

The deepening crisis in the subprime mortgage market has affected investor confidence in multiple segments of the credit market, with problems for commercial mortgages unrelated to subprime, corporate credit markets,⁹ leveraged buy-out loans (LBOs),¹⁰ auction-rate securities, and parts of consumer credit, such as credit cards, and student and car loans. In January 2008, the cost of insuring European speculative bonds against default rose by almost 1½ percentage points over the previous month, from 340 bps to 490 bps,¹¹ while the U.S. high-

yield bond spread has reached 700 bps over Treasuries, from 600 bps at the start of the year.¹²

This article examines the different factors that have contributed to this crisis and offers recommendations for avoiding a repeat. In the next section, we briefly analyze the chain of events and major structural changes that affected both capital markets and financial institutions that contributed to this crisis. The players and issues at the heart of the current subprime crisis are analyzed in the third section. In the fourth section, we outline a number of solutions that would reduce the possibility of a repeat, and a summary is given in the last section.

HOW IT ALL STARTED

Interest rates were relatively low in the first part of the decade.¹³ This low interest rate environment spurred increases in mortgage financing and substantial increases in house prices.¹⁴ It encouraged investors (financial institutions, such as pension funds, hedge funds, investment banks) to seek instruments that offer yield enhancement. Subprime mortgages offer higher yields than standard mortgages and consequently have been in demand for securitization. Securitization offers the opportunity to transform below-investment-grade assets (the investment or collateral pool) into triple-A and investment-grade liabilities. The demand for increasingly complex structured products such as collateralized debt obligations (CDOs), which embed leverage within their structure, exposed investors to greater risk of default, although with relatively low interest rates, rising house prices, and the investment-grade credit ratings (usually triple-A) given by the rating agencies, this risk was not viewed as excessive.

Prior to 2005, subprime mortgage loans accounted for approximately 10% of outstanding mortgage loans. By 2006, subprime mortgages represented 13% of all outstanding mortgage loans with origination of subprime mortgages representing 20% of new residential mortgages compared to the historical average of approximately 8%.¹⁵ Subprime borrowers typically pay 200 to 300 basis points above prevailing prime mortgage rates. Borrowers who have better credit scores than subprime borrowers but fail to provide sufficient documentation with respect to all sources of income and/or assets are eligible for Alt-A loans. In terms of credit risk, Alt-A borrowers fall between prime and subprime borrowers.¹⁶

During the same period, financial markets had been exceptionally liquid, which fostered higher leverage and

EXHIBIT 1

Biggest Losses/Write-Downs from January 1, 2007, as of April 2008 (US\$ billions)

Citigroup	\$40.9
UBS	\$38.0
Merrill Lynch	\$31.7
Bank of America	\$14.9
Morgan Stanley	\$12.6
HSBC	\$12.4
JP Morgan Chase	\$9.7
IKB Deutsche	\$9.1
Washington Mutual	\$8.3
Deutsche Bank	\$7.5
Wachovia	\$7.3
Crédit Agricole	\$6.6
Credit Suisse	\$6.3
RBS	\$5.6
Mizuho Financial Group	\$5.5
Canadian Imperial Bank of Commerce	\$4.1
Société Générale	\$3.9

Source: Bloomberg.

greater risk-taking. Spurred by improved risk management techniques and a shift by global banks toward the so-called originate-to-distribute business model, where banks extend loans and then distribute much of the underlying credit risk to end-investors, financial innovation led to a dramatic growth in the market for credit-risk transfer (CRT) instruments.¹⁷ Over the past four years, the global amount outstanding of credit default swaps has multiplied more than tenfold,¹⁸ and investors now have a much wider range of instruments at their disposal to price, repackage, and disperse credit risk throughout the financial system.

There were a number of reasons for this growth in the origination of subprime loans. Borrowers paid low teaser rates over the first few years, often paid no principal, and could refinance with rising housing prices. There were typically two types of borrowers: 1) those who lived in the house and got a good deal, and 2) those that speculated and did not live in the house. When the teaser-rate period ended, as long as housing prices had risen, the mortgage could be refinanced into another teaser-rate-period loan, but if refinancing proved impossible, the speculator could default on the mortgage and walk away. The losses arising from delinquent loans were not borne by the originators, who had sold the loans to arrangers. The arrangers securitized the loans and sold them to investors. The eventual owners of these loans, the ABS trusts, generated enough net present value from the repackaging of the cash flows that they could absorb these losses. In summary, the originators did not care about issuing below-fair-value loans, because they passed the loan losses to the ABS trusts and the originators held none of the default risk on their own books.

CDOs of subprime mortgages are the CRT instruments at the heart of the current credit crisis, as a massive amount of senior tranches of these securitization products have been downgraded from a triple-A rating to non-investment grade. The reason for such an unprecedented drop in the rating of investment-grade structured products was the significant increase in delinquency rates on subprime mortgages after mid-2005, especially on loans that were originated in 2005 and 2006. In retrospect, it is very unlikely that the initial credit ratings on bonds were correct. If they had been rated correctly, there would have been downgrades, but not on such a massive scale.

According to the Mortgage Bankers Association [2007a], the delinquency rate for conventional prime adjustable rate mortgages (ARMs) peaked in 2001 to about 4% and then slowly decreased until the end of 2004, when

it started to increase again. It was still below 4% at the end of 2006. For conventional subprime ARMs, the peak delinquencies rate occurred during the middle of 2002 reaching about 15%. It decreased until the middle of 2004 and then started to increase again to approximately 14% by the end of 2006.¹⁹ During 2006, 4.9% of current home owners (2.45 million) had subprime adjustable-rate mortgages. For this group, 10.13% were classified as delinquent,²⁰ which translates to a quarter of a million homeowners. At the end of 2006, the delinquency rate for prime fixed-rate mortgages was 2.27% and 10.09% for subprime.

There are four reasons why delinquencies on subprime loans rose significantly after mid-2005. First, subprime borrowers are typically not very creditworthy, often highly levered with high debt-to-income ratios, and the mortgages extended to them have relatively large loan-to-value ratios. Until recently, most borrowers were expected to make at least a 20% down payment on the purchase price of their home. During 2005 and 2006, subprime borrowers were offered 80/20 mortgage products to finance 100% of their homes. This option allowed borrowers to take out two mortgages on their homes. In addition to a first mortgage for 80% of the total purchase price, a simultaneous second mortgage, or *piggyback* loan for the remaining 20% would be made to the borrower.

Second, in 2005 and 2006, the most common subprime loans were of the *short-reset* type. They were the 2/28 or 3/27 hybrid subprime ARMs. These loans had a relatively low fixed teaser-rate for the first two or three years, and then reset semiannually to a much higher rate (i.e., an index plus a margin for the remaining period with a typical margin in the order of 400 to 600 bps). Short-term interest rates began to increase in the U.S. from mid-2004 onwards. However, resets did not begin to translate into higher mortgage rates until sometime later. Debt service burdens for loans eventually increased, which led to financial distress for some of this group of borrowers. The distress will continue, as US\$500 billion in mortgages will reset in 2008.

Third, many subprime borrowers had counted on being able to refinance or repay mortgages early through home sales and at the same time produce some equity cushion in a market where home prices kept rising. As the rate of U.S. house price appreciation began to decline after April 2005, it became more difficult for subprime borrowers to refinance and many ended up incurring higher mortgage costs than they expected to bear at the time of taking their mortgage.²¹

Fourth, a decline in credit standards by mortgage originators in underwriting over the last three years was a major factor behind the sharp increase in delinquency rates for mortgages originated during 2005 and 2006.²² The pressure to increase the supply of subprime mortgages arose because of the demand by investors for higher-yielding assets. A major contributor to the crisis was the huge demand by CDOs for BBB mortgage-backed bonds that stimulated a substantial growth in home equity loans. This CDO demand for BBB ABS bonds was due to the fact that the bonds had high yields, and the CDO trust could finance their purchase by issuing triple-A rated CDO bonds paying lower yields. This was because the rating agencies assigned triple-A ratings to the CDO senior bond tranches that did not reflect the CDO bond's true credit risk.²³ Because these tranches were mispriced, the CDO equity holders generated a positive net present value investment from just repackaging cash flows. This process boosted the demand by CDOs for residential mortgage-backed securities (RMBS). Furthermore, this repackaging was so lucrative, that it was repeated a second time for CDO-squared trusts. A CDO-squared trust purchased high-yield (low-rated) bonds and equity issued by other CDOs. To finance the purchase of this collateral, they issued triple-A rated CDO-squared bonds with lower yields. This, in turn, created demand for CDOs containing mortgage-backed securities (MBS) and CDO tranches.

This environment encouraged questionable practices by some lenders (Morgenson [2007]). Some mortgage borrowers have ended up with subprime mortgages, even though their creditworthiness qualifies them for lower-risk types of mortgages, and others with mortgages that they were not qualified to have.²⁴ Some borrowers and mortgage brokers took advantage of the situation and fraud increased.²⁵

PLAYERS AND ISSUES AT THE HEART OF THE CRISIS

The process of securitization takes a portfolio of illiquid assets with high yields and places them into a trust. This is called the trust's collateral pool. To finance the purchase of the collateral pool, the trust hopes to issue high-rated bonds paying lower yields. The trust issues bonds that are partitioned into tranches with covenants structured to generate a desired credit rating in order to meet investor demand for high-rated assets. The usual trust structure results in a majority of the bond tranches being rated investment grade. This is facilitated by running the collateral's

cash flows through a *waterfall* payment structure. The cash flows are allocated to the bond tranches from the top, down: the senior bonds are paid first, then the junior bonds, and then the equity. To ensure that a majority of the bonds are rated triple-A, the waterfall specifies that the senior bonds receive accelerated payments (and the junior bonds get none), if the collateral pool appears stressed in certain ways.²⁶ Stress is usually measured by (collateral/liability) and (cash-flow/bond-payment) ratios remaining above certain trigger levels. A surety wrap (insurance purchased from a monoline) may also be used to ensure super senior triple-A credit-rating status. In addition, the super senior tranches are often unfunded, making them more attractive to banks.

There are costs associated with securitization, such as managerial time, legal fees, and rating agency fees. The equity holders of an asset-backed trust (ABS) would only perform securitization if the process generated a positive net present value. This could occur if the other tranches were mispriced. For example, if a triple-A rated tranche added a new security with unique characteristics, this could generate demand and attract new sources of funds. However, asset securitization started in the mid-1980s, so it is difficult to attribute the demand that we have witnessed over the last few years for triple-A rated tranches to new sources of funds. After this length of time, investors should have learned to price tranches in a way that reflects the inherent risks. If ABS bond mispricing occurred, the question is, why? The triple-A rated liabilities could be mispriced either because of the mispricing of liquidity or because the rating of the trust's bonds was inaccurate.

In this section, we identify the different players in the crisis and their economic motivation, and we briefly describe the events that have unfolded since 2005 and 2006. We start with the role of the rating agencies, as the issues of timely and accurate credit ratings have been central to the crisis. Then, we turn to the role of the mortgage brokers and lenders. We then describe some of the institutions that have been at the center of the storm. We also discuss how central banks reacted to the current crisis. We then address the issues of valuation and transparency that have been catalysts for the crisis. We end this section with an explanation of why systemic risk occurred.

Rating Agencies

In the summer of 2006, it became clear that the subprime mortgage market was in stress.²⁷ At this time, the

rating agencies issued warnings about the deteriorating state of the subprime market. Moody's first took rating action on 2006 vintage subprime loans in November 2006. In February 2007, Standard and Poor's (S&P) took the unprecedented step of placing transactions that had been closed, as recently as the last year, on its *Credit Watch*. From the first quarter of 2005 to the third quarter of 2007, S&P [2008] reported that for CDOs of asset-backed securities, 66% were downgraded with 44% downgraded from investment grade to speculative grade, including default. For residential subprime mortgage-backed securities, 17% were downgraded, and 9.8% were downgraded from investment grade to speculative grade, including default.²⁸ These changes are large and naturally raise questions about the rating methodologies employed by the different agencies.

Rating agencies are at the center of the current crisis as many investors relied on their ratings for many diverse products: mortgage bonds, asset-backed commercial paper (ABCP) issued by the structured investment vehicles (SIVs), derivative product companies (DPCs), and monolines which insure municipal bonds and structured credit products such as tranches of CDOs. Many investors are restricted to investing in assets with certain ratings. For example, money market funds are restricted to investing only in triple-A assets, and pension funds and municipalities are restricted to investing in investment-grade assets; all of these investors base their investment decision on the rating attributed by the rating agencies.²⁹ Many of these investors invested in assets that were both complex and had exposure to subprime assets. Investors in complex credit products had considerably less information at their disposal to assess the underlying credit quality of the assets they held in their portfolios than the originators. As a result, these end-investors often came to rely heavily on the risk assessments of rating agencies. Implicitly in the investment decision is the assumption that ratings are timely and relatively stable. No one was expecting, until recently, a triple-A asset to be downgraded to junk status within a few weeks or even a few days. The argument could be made that as the yields on these instruments exceeded those on equivalently rated corporations, the market knew they were not of the same credit and/or liquidity risk. But investors still misjudged the risk.

The CDO rating process worked as follows. The CDO trust partners, the equity holders, would work with a credit rating agency to get the CDO liabilities rated. They paid the rating agency for this service. The rating agency explained to the CDO trust the procedure it would

use to rate the bonds—the methods, historical default rates, prepayment rates, and recovery rates. The CDO trust structured the liabilities and waterfall so a significant percentage of the issue would be triple-A rated bonds (with the assistance of the rating agency). The rating process was a fixed target. The CDO equity holders designed the liability structure to reflect the fixed target. Note that given the use of historic data, the ratings did not reflect current asset characteristics, such as the growing number of undocumented mortgages and large loan-to-value ratios for subprime mortgages.

From the CDO equity holders' perspective, if not enough of the CDO bonds are rated triple-A, it is not economically profitable to proceed with the CDO. Creation of the CDO is also in the interest of the rating agencies, because the CDO trust requires continual monitoring by the rating agency, with appropriate fees paid.³⁰ This ongoing fee-payment structure created a second incentive problem for the credit rating agency.

Rating agencies, such as Moody's, S&P, and Fitch, are Nationally Recognized Statistical Rating Organizations, which provides a regulatory barrier to entry. The reputation of rating agencies depends in part on their performance. However, there are institutional and regulatory features that imply there is always demand for their services. Basel II uses credit ratings to determine the amount of regulatory capital a regulated financial institution must hold. Reputation is of course important. However, there is no guarantee that the incentive structures offered to management, which are essentially short term in nature, will align management to act in the best long-run interests of the firm.³¹ The European Commission and Barney Frank, the chair of the House Financial Services Committee, have held separate hearings on the agencies' response to the subprime mortgage crisis and possible conflicts of interest arising from rating agencies being paid by issuers and rating agencies offering advisory services to issuers.

Originators make loans and supposedly verify information provided by the borrowers. Issuers and arrangers of mortgage-backed securities bundle the mortgages and should perform due diligence. The rating agencies receive data from the issuers and arrangers and assume that appropriate due diligence has been performed. Rating agencies clearly state that they do not crosscheck the quality of borrowers' information provided by the originators.³² Normally mortgages tend to have high recovery rates, but with the declining underwriting standards in the subprime

market and high debt to value ratios, this was no longer the case. Failure to check the data meant that estimates of the probability of default and the loss given default did not reflect reality. This meant that the probability of default and the loss given default were probably under estimated. It also affected the ability to model default dependence amount the assets in the collateral pool.

The rating process proceeds in two phases. First, the estimation of the loss distribution over a specified horizon and, second, the simulation of the cash flows. The simulations incorporated the CDO waterfall triggers, designed to provide protection to the senior bond tranches in case of bad events, and were used to investigate extreme scenarios. The loss distribution allows the determination of the credit enhancement (CE), that is, the amount of loss on the underlying collateral that can be absorbed before the tranche absorbs any loss. If the credit rating is associated with a probability of default, the amount of CE is simply the level of loss such that the probability that the loss is higher than CE is equal to the probability of default. CE is thus equivalent to a Value-at-Risk type of risk measure. In a typical CDO, credit enhancement comes from two sources: "subordination," that is, the par value of the tranches with junior claims to the tranche being rated, and "excess spread," which is the difference between the income and expenses of the credit structure. Over time, the CE, in percentage of the principal outstanding, will increase as prepayments occur and senior securities are paid out. The lower the credit quality of the underlying subprime mortgages in the ABS CDOs, the greater the credit enhancement, for a given credit rating. Deterioration of credit quality, will lead to a downgrade of the ABS structured credits.

Rating agencies seek to make the rating of subprime related structured credit stable through the housing cycle, as with the rating of corporate bonds. Therefore, rating agencies must respond to anticipated shifts in the loss distribution during the housing cycle by increasing the amount of CE needed to keep the ratings constant as economic conditions deteriorate, or by downgrading the structured credit. The contrary happens when the housing market improves.³³ Unanticipated changes may result in a rating agency changing a rating for a product. What was not anticipated by some investors was the volatility of the rating changes that followed as the housing market started to deteriorate.³⁴

For example, during the second week of July 2007, S&P downgraded US\$7.3 billion of securities sold in 2005

and 2006. A few weeks later, Moody's slashed ratings on 691 securities from 2006, originally worth US\$19.4 billion. Some 78 of the bonds had Moody's top rating of Aaa. The securities were backed by second-lien mortgages that included piggyback mortgages. Moody's stated that the cause for the downgrades was the dramatically poor overall performance of such loans and rising default rates. Fitch also downgraded subprime bonds sold by Barclays, Merrill Lynch, and Credit Suisse. In October, S&P lowered the ratings on residential mortgage-backed securities with a par value of US\$22 billion. In November, Moody's downgraded 16 special investment vehicles with approximately US\$33 billion in debt, and in December another US\$14 billion was downgraded with US\$105 billion under review.

Mortgage Brokers and Lenders

Originating brokers had little incentive to perform due diligence and monitor borrowers' creditworthiness, as most of the subprime loans originated by brokers were subsequently securitized. This phenomenon was aggravated by the incentive compensation system for brokers, based on the volume of loans originated, with few negative consequences for the brokers if the loan defaulted within a short period.³⁵

Distress among subprime mortgage lenders was visible during 2006. Problems started to appear when the Fed started to raise interest rates. This raised the cost of borrowing and made it more expensive for people to meet the floating-rate interest payments on their loans. At the end of the year, Ownit Mortgage Solutions, Inc., ranked as the 11th largest issuer of subprime mortgages, closed its doors. This was perhaps surprising, given that Merrill Lynch had purchased a minority stake in Ownit the previous year. In the first quarter of 2007, New Century, ranked as the second largest lender in the subprime market, also closed its doors. Others also failed or left the business.

Problems with mortgage lenders spread from subprime to other parts of the mortgage market, as concerns about collateral values increased. The share price of Thornburg Mortgage, Inc., which specializes in large (jumbo) prime home loans, dropped 47% after it stated that it was delaying its second-quarter dividend and was receiving margin calls from creditors due to the declining value of mortgages used as collateral. National City Home Equity Corporation, the wholesale broker equity lending unit of National City Corporation, announced that in response

to market conditions, it has suspended approvals of new home equity loans and lines of credit. Aegis Mortgage Corporation in Houston, TX, has announced it is unable to meet current loan commitments and has stopped taking mortgage applications. Other institutions have also withdrawn from the subprime and Alt-A markets. Alt-A originators, such as American Home Mortgage, filed for bankruptcy.

Small mortgage brokers were being hurt in a number of different ways. GMAC, LLC, announced that it was tightening its lending terms. It would not provide warehouse funding for subprime loans and mortgages for borrowers who did not verify their income or assets. Many small lenders use short-term warehouse loans that allow them to fund mortgages until they can be sold to investors. The inability to warehouse reduces the availability of credit.

Originators also spent funds persuading legislators to reduce tough new laws restricting lending to borrowers with spotty credit. Simpson [2007] reported that Ameriquest Mortgage Company, which was one of the nation's largest subprime lenders, spent over US\$20 million in political donations. Citigroup, Wells Fargo Countrywide Financial Corporation, and the Mortgage Bankers Association also spent heavily on lobbying and political giving. These donations played a major role in persuading legislators in New Jersey and Georgia to relax tough predatory lending laws passed earlier that might have contained some of the damage.³⁶

Special Investment Vehicles

A special, or structured, investment vehicle (SIV) is a limited-purpose, bankrupt-remote company that purchases mainly high-rated medium- and long-term assets and funds these purchases with short-term asset-backed commercial paper (ABCP), medium-term notes (MTNs), and capital.³⁷ Capital is usually in the form of subordinated debt, sometimes tranching, and often rated. Some SIVs are sponsored by financial institutions that have an incentive to create off-balance-sheet structures that facilitate the off-balance-sheet transfer of assets and generate products that can be sold to investors. The aim is to generate a spread between the yield on the asset portfolio and the cost of funding by managing the credit, market, and liquidity risks. Trading the slope of the yield curve would not have been profitable enough to justify the capital allocated to support most SIVs if they had to pay a credit spread on their borrowing. Hence, for almost all SIVs, the triple-A rating for their debt was essential.

This is also partly due to the commercial paper (CP) market and how it operates. CP is held by money market funds, and most want only triple-A rated paper.

General descriptions of the methodologies employed for SIVs by the agencies are publicly available on their websites. The basic approach is to determine whether the senior debt of the vehicle will retain the highest level of creditworthiness (e.g., AAA/A-1+ rating), until the vehicle is wound down for any reason. The level of capital is set to achieve this triple-A type of rating, with capital being used to make up possible short falls. The vehicle is designed with the intent to repay senior liabilities, with at least a triple-A level of certainty, before the vehicle ceases to exist. If a trigger event occurs and the SIV is wound down by its manager (defeasance) or the trustee (enforcement), the portfolio is gradually liquidated. Wind-down occurs if the resources are becoming insufficient to repay senior debt. No debt will be further rolled over or issued and the cash generated by the sale of assets is used to payoff senior liabilities.

The risks that a SIV has to manage to retain its triple-A rating include credit, market, liquidity, interest rate, foreign currency, and managerial and operational risks. Credit risk addresses the creditworthiness of each obligor and the risk during the wind-down period when the SIV assets have suffered credit deterioration. For market risk, the manager is required on a regular basis to mark-to-market the liquid assets of the portfolio and mark-to-model the illiquid assets. When a SIV is forced to sell assets under unfavorable conditions, this will, in general, affect the value of all its assets. The manager's ability to address this type of situation is assessed. Liquidity risk arises because of the need to refinance due to the maturity mismatch between assets and liabilities and because some of the portfolio's assets will require due diligence by potential investors, which will increase the length of the sale period. The SIV must demonstrate that apart from the vehicle's cash flows that provide liquidity, it has backstop lines of credit from different institutions and highly liquid assets that can be quickly sold, so that it is able to deal with market disruptions. In a SIV, the liabilities are rolled over, provided that defeasance has not occurred.³⁸ In theory, a SIV could continue indefinitely.³⁹

According to Moody's [2007], there were some 30 SIVs and the total volume under management of SIVs and SIV-Lites⁴⁰ had nominal values of approximately US\$400 billion and US\$12 billion, respectively, at the end of

August 2007. The weighted-average life of the asset portfolios in these vehicles is in the 3–4 year range.

The SIVs relied on being able to continuously rollover their short-term funding and, even though they were *bankruptcy remote* from their sponsors, those that were unable to achieve this were able to turn to their sponsoring banks, which had undertaken to provide them with backstop liquidity via credit lines in such situations. In fact these SIVs, akin to an “unregulated” bank, funding long-term assets with short-term funding resources, have been contributors to the current credit crisis.

As the credit crisis intensified and the mortgage-backed securities held by the SIVs suddenly started to decline in value, some of the ABCP was downgraded, sometimes all the way to default within a few days. An increasing number of SIVs became unable to roll their ABCP, due to concerns about the value of collateral, and turned to their sponsor banks for rescue. HSBC was the first bank, on November 28, 2007, to transfer US\$45 billion of assets to its balance sheet. Other banks soon followed: Standard Chartered took US\$1.7 billion on December 5, 2007; Rabobank took US\$7.6 billion on December 6, 2007; and Citigroup US\$49 billion on December 14, 2007. This is not a complete listing. Société Générale bailed out its investment vehicle with a US\$4.3 billion line of credit on December 11, 2007.

The plight of SIVs continues. In February 2008, Citigroup announced that it plans to provide a US\$3.5 billion facility to support six of the seven SIVs it took onto its balance sheet to shore up their debt rating and protect creditors. Also in February, Standard Chartered faced the prospect of a fire sale for its US\$7.1 billion Whistlejacket SIV. The value of its assets had fallen to less than half of the amount of startup capital, which is a trigger for calling in receivers. More recently, on February 21, 2008, Dresdner Bank announced that it is providing a backstop facility of at least US\$17 billion on senior debt for its US\$19 billion K2 SIV to avoid a forced sale of its assets.⁴¹

Monolines

Monoline insurers provide insurance to investors that they will receive payment when investing in different types of assets. Given the low risk of the bonds and the perceived low risk of the structured transactions insured by monolines, they have very high leverage, with outstanding guarantees amounting to close to 150 times capital.⁴²

Monolines carry enough capital to earn a triple-A rating and this removes the need for them to post collateral.⁴³ (This triple-A rating is essential to stay profitable, because capital is costly and the spreads earned on insurance are small.) The two largest monolines, MBIA and AMBAC, both started out in the 1970s as insurers of municipal bonds and debt issued by hospitals and nonprofit groups. The size of the market is approximately US\$2.6 trillion, with more than half of municipal bonds being insured by monolines. This insurance wrap guarantees a triple-A rating to the bonds issued by U.S. municipalities.

In recent years, much of their growth has come in structured products such as asset-backed bonds and CDOs. The total outstanding amount of bonds and structured financing insured by monolines is around US\$2.5 trillion. According to S&P, monolines insured US\$127 billion of CDOs that relied, at least partly, on repayments on subprime home loans and face potential losses of US\$19 billion.

Since the end of 2007, monolines have been struggling to keep their triple-A rating. Only Financial Security Assurance (FSA) has been able to inject enough new capital to keep its sterling credit rating.⁴⁴ The issue, from a systemic point of view, is that when a monoline is downgraded, all of the paper it has insured must be downgraded too, including the bonds issued by municipalities. And holders of downgraded bonds under *fair value* accounting have to mark them down as well, impairing their capital. Some institutional investors, such as pension funds and so-called dynamic or enhanced money market funds, may hold only triple-A securities, raising the prospect of forced sales. In addition, some issuers such as municipalities might lose their access to bond markets, which may result in an increase in the cost of borrowing money to fund public projects. Some municipalities and local agencies have issued tender option bonds, which are auctioned weekly or monthly. The underlying collateral—municipal bonds—is insured by monolines. Concern about the creditworthiness of the monolines has caused disruptions to this market. The loss of the triple-A rating could cost investors up to US\$200 billion, according to Bloomberg. Already, banks have had to write off around US\$10 billion of the paper they insured with ACA.⁴⁵

In response to this crisis, a group of banks explored a bailout plan of the largest monolines with New York’s insurance regulator, who asked the banks to contribute as much as US\$15 billion to help MBIA and AMBAC preserve their ratings. The main consideration was whether

the cost of participating in a bailout was greater than any loss of value in their holdings.⁴⁶ On February 14, 2008, Eliot Spitzer, the former governor of New York, gave bond insurers three to five business days to find fresh capital, or face a potential break-up by state regulators who wanted to safeguard the municipal bond markets.⁴⁷ Under the division of bond insurers into a “good bank/bad bank” structure, the insurers’ municipal bond business would be separated from their riskier activities, such as guaranteeing complex structured credit products. Warren Buffet’s Berkshire Hathaway Assurance Corporation has already offered to take over the municipal bond portfolios of AMBAC, MBIA, and FGIC.⁴⁸ While these plans would help to restore faith in the municipal bond market, they would do little to help the structured products insured by the monolines.⁴⁹ Monolines are counterparties to credit derivatives held by financial institutions and have sold surety wraps to financial institutions. A breakup of the bond insurers would have grave implications for financial institutions that face massive write-downs on these instruments.

ABS Trust, CDO, and CDO-Squared Equity Holders

These equity holders made profits by repackaging the cash flows of a pool of mortgages and selling these new cash flows in the form of bond tranches. The repackaging of a mortgage’s cash flows only has a positive net present value if the repackaged cash flows (the ABS bonds issued to finance the purchase of the mortgages) are overvalued by the market.

Unsophisticated investors were less informed than sophisticated investors (defined as those investors involved in the origination process in some manner). This asymmetric information was generated by two facts. First, the complexity of the ABS trust waterfall. The waterfalls were complex with various triggers (to divert cash flows to the more senior bonds in the case of financial stress in the collateral pool). The complexity of the waterfall made the ABS hard to value. In addition, the waterfalls were unique to a particular trust, so each new ABS needed to be programmed and modeled. Second, the scarcity of generally available and timely data on the collateral pool of specific ABS trusts made the modeling (and simulation for scenario analysis) of the cash flows nearly impossible. Although data could have been purchased from Loan Pricing Corporation, it was incomplete with respect to the current

state of the underlying mortgage loans. Furthermore, alternative historical databases with histories of mortgage loans were not representative of new risk trends because the new mortgage loans had teaser rates, no principal payments in the beginning, and different loan standards (high loan-to-value ratios and no documentation).

The information asymmetry in markets was even greater for CDOs than for ABS trusts, because a typical CDO collateral pool depends on the ABS bonds of many different ABS trusts (approximately 100). Thus, to model the CDO collateral pool, one needs to model the different ABS bonds; hence, the ABS collateral pool. This multiplier in terms of modeling complexity and the absence of readily available data on the collateral pools, made the accurate modeling of CDO cash flows nearly impossible (even for sophisticated investors).

Also crucial in the creation of CDOs was the existence of credit default swaps (CDS) on ABS bonds, or ABS CDS. This was essential for two reasons. First, there were not enough ABS bonds trading to construct the underlying CDO collateral pools. CDOs were being constructed and issued in great quantities in 2006 and 2007. Consequently, a majority of CDO collateral pools were synthetic ABS bonds (ABS CDS). This leveraging of the real ABS bonds multiplied the effect of defaulting mortgage holders significantly beyond the original notional values and thus increased systemic risk. Second, the use of ABS CDS meant that less capital was needed to construct the collateral pool. This facilitated the rapid growth of CDO issuance. In fact, one reason for the creation of CDO-squared trusts was the desire to finance the equity capital of CDOs by including CDO equity in a CDO-squared collateral pool.

Financial Institutions

The change in the bank regulatory framework to Basel II has perhaps had unanticipated consequences. The required regulatory capital requirement for holding triple-A rated assets is 56 bps (a 7% risk weighting and an 8% capital requirement). This provided banks with an incentive to hold highly rated triple-A assets. Thus, banks were willing customers for super senior triple-A rated tranches. Being this highly rated, it was thought that there was an insignificant chance of the assets being impaired due to defaults in the collateral pool. With the tranches being held in the trading book and marked-to-market, this did expose banks to the risk of write-downs,

especially if a surety wrap had been provided by a monoline insurance company. Banks and regulators never anticipated these risks.

The credit rating of triple-A reduced, if not removed, incentives for investors (pension funds, insurance companies, mutual funds, hedge funds, and regional banks) to perform their own due diligence about the collateral pool. The short-term horizon of management's payment structure (bonus) further reduced their incentives to perform due diligence. If their investments soured, managers might lose their jobs, but labor markets are imperfect. Failed money managers seem to get new jobs even after horrific losses. CDO bonds offered higher yields than corporate bonds with the same credit rating. The managers working in these financial institutions wanted triple-A bonds (or investment-grade bonds) with higher yields (and rewards) for "equivalent risk." Although the risks were not really equivalent, the incentives were against doing due diligence.

The Economy and Central Banks

At the end of the spring of 2007, Ben Bernanke, the chairman of the Federal Reserve, stated on May 17, 2007: "We do not expect significant spillovers from the subprime market to the rest of the economy or the financial system." It was vain hope, since at the start of August the European Central Bank injected 95 billion (US\$131 billion) and informed banks that they could borrow as much money as they wanted at the bank's current 4% base rate without limit. The Bank of Canada issued a

statement that it pledged to "provide liquidity to support the Canadian financial system and the continued functioning of financial markets." Exhibit 2 summarizes the actions of central banks.

In the second week of August, the Fed reported that total commercial paper (CP) outstanding fell more than US\$90 billion to US\$2.13 trillion over the previous week. Traditionally, prime corporate names used the CP market to finance short-term cash needs. However, the low levels of interest rates during the past few years has meant that many of these issuers moved away from the CP market and issued low-cost debt with maturities ranging from 5 to 10 years. The current lack of demand for CP has made it very difficult for borrowers to rollover debt. William Poole, the president of the St. Louis Federal Reserve, publicly argued on August 16, 2007, against a rate cut. The Fed took the unusual step of issuing a public statement that Mr. Poole's comments did not reflect Fed policy.

During the same week, a flight to quality occurred, with investors buying Treasuries. The yield on the three month T-bill fell from approximately 4% to as low as 3.4%. The FTSE 100 Index declined by 4.1%, with financial companies being the hardest hit. Man Group fell 8.3% and Standard Chartered fell 7.6%. The Chicago Board Options Exchange Vix index, an indicator of market volatility, jumped above 37, its highest level in five years, and then eased back to 31. Unwinding carry trades caused a sudden 2% increase in the ¥/US\$ exchange rate. Further unwinding occurred two days later, with hedge funds and institutional investors reversing carry trades, causing the yen to increase 4% against the

EXHIBIT 2

Central Bank Interventions in August 2007

European Central Bank	August 9, €95 billion (US\$130 billion) August 10, €61 billion (US\$84 billion)
U.S. Federal Reserve	August 9, US\$24 billion August 10, US\$38 billion
Bank of Canada	August 10, C\$1.64 billion (US\$1.55 billion)
Bank of Japan	August 10, ¥100 billion (US\$8.39 billion)
Swiss National Bank	August 10, SFR 2–3 billion (US\$1.68–2.51 billion)
Reserve Bank of Australia	August 10, A\$4.95 billion (US\$4.18 billion)
Monetary Authority of Singapore	August 10, S\$1.5 billion (US\$ 0.98 billion)

U.S. dollar, 5.3% against the euro, 5.8% against the pound, 10.3% against the New Zealand dollar, and 11.5% against the Australian dollar.

Also during this period, the Fed injected US\$5 billion into the money market through 14-day repurchase agreements and another US\$12 billion through one-day repurchase agreements.⁵⁰ The Russian Central Bank injected Rb\$43.1 billion (US\$1.7 billion) into the banking system. Foreign investors had started to flee the ruble debt market, causing a liquidity squeeze. The European Central Bank pumped money into Europe's overnight money markets. The Fed took similar actions in the U.S.

Four banks, Citigroup, JP Morgan, Bank of America, and Wachovia, each borrowed US\$500 million from the Fed. In a statement, JP Morgan, Bank of America, and Wachovia stated that they had substantial liquidity and had the capacity to borrow money elsewhere on more favorable terms. They were trying to encourage other banks to take advantage of the lower discount rate at the Fed window.

During the third week of August, the flight to quality continued. At the start of trading in New York, the yield on the three-month T-bill was 3.90%, but during the day it fell to 2.51%, and by the end of day, closed at 3.04%. However, other parts of the fixed-income markets continued to function, with investment-grade companies issuing debt: Comcast Corporation sold US\$3 billion in notes; Bank of America sold US\$1.5 billion in notes, and Citigroup US\$1 billion in notes. There was a rare high-yield issue by SABIC Innovative Plastics, which sold US\$1.5 billion in senior unsecured notes.

The volatility in the foreign exchange market caused some hedge funds to close their yen carry trade positions. Between August 16 and 22, 2007, investors poured US\$42 billion into money market funds. Institutional investors switched from commercial paper to Treasuries.

In April 2008, the Fed took the unprecedented measure of introducing a new lending facility, called the Primary Dealer Credit Facility (PDCF), for investment banks and securities dealers, which allows them to use a wide range of securities as collateral for cash loans from the Fed. Among other things, the securities pledged by dealers must have market prices and investment-grade credit ratings.⁵¹

Valuation Uncertainty

One of the critical issues driving the crisis has been the difficulty of valuing structured credit products.⁵² In a

fair value accounting framework⁵³ and with liquid markets, it is straightforward to value standardized instruments, though there are issues with nonstandard instruments. In this framework, there are three levels used for classifying the type of fair valuation employed: Level 1—clear market prices; Level 2—valuation using prices of related instruments; and Level 3—prices cannot be observed and model prices need to be used.⁵⁴ For example, valuation under Level 1 can be achieved for standard instruments, such as credit default swaps for well-known obligors. For a CDS with a nonstandard maturity, direct market prices cannot be observed. Prices of credit swaps for the same obligor with standard maturities can be used to calibrate a valuation model to price the nonstandard maturity. This would fall under the Level 2 classification. There are many instruments that are nonstandard and are illiquid, making valuation difficult. For such instruments, model valuation must be employed. This situation would fall under the Level 3 classification. Faith in the reliability of these values is highest for Level 1 and lowest for Level 3, which is more subjective. There are numerous difficulties associated with implementing fair value accounting, even in liquid markets.⁵⁵ In the first quarter of 2008, Level 3 assets had increased in U.S. banks. Goldman Sachs reported an increase of 40% of these assets for a total of US\$96.4 billion, of which US\$25 billion are ABS. Level 3 assets are US\$78.2 billion and US\$42.5 billion for Morgan Stanley and Lehman Brothers, respectively.

Model prices are used for marking-to-model illiquid assets. For model estimation, prices of other assets and time-series data may be used. Inferring the parameters necessary to use the model becomes problematic in turbulent markets. This increases the uncertainty associated with the model prices. If markets are in turmoil, the number of instruments that can be valued under Level 1 decreases and the difficulties associated with implementation greatly increase. This increases the uncertainty associated with the valuation of instruments held in portfolios and this uncertainty feeds back into the market turmoil. Lenders want collateral for their loans, but turbulence in the markets increases the potential for disagreement between borrowers and lenders over the valuation of collateral. This can place borrowers in the position of being forced to sell assets, and in some cases cause funds to close, adding to the market turmoil.

One of the major issues in an illiquid market and one that has been repeatedly raised in the current crisis is that,

due to the high degree of uncertainty, current prices for certain instruments are well below their “true” values. Pricing assumptions that were reasonable a few weeks ago must be reevaluated. In fair value accounting, the price of an instrument is what you would receive if you sold it. This implies that many institutions and funds have been forced to mark down their portfolios. For some funds, this has triggered automatic shut-down clauses. In the case of the asset-backed commercial paper market, it has brought the market to a close. Hedge funds borrow in the commercial paper market, pledging assets as collateral. Lenders look at the value of the pledged assets, which in many cases were related to the subprime market. Given the increasing levels of uncertainty associated with the valuation of assets, lenders refused to extend credit. This caused a major disruption to the asset-backed commercial paper market and was one of the critical events in the crisis.

When financial institutions report their quarterly earnings, their valuation methodologies and associated inputs for Level 3 assets will generally differ. This is unavoidable given the use of models. Institutions know this and have incentives to pick their inputs to ensure that their results are “reasonable.” Investors know that this game is going on, so even when quarterly results are published, uncertainty remains about the value of Level 3 assets.

The problems arising from the valuation of collateralized mortgage obligations which contain subprime mortgages and the rolling over of asset-backed commercial paper came to a head during the summer of 2007. At the beginning of the summer, two of Bear Stearns’ hedge funds—High Grade Structured Credit Strategies Master Fund and High Grade Structured Credit Strategies Enhanced Leverage Master Fund—ran into collateral trouble after substantial losses in April. Merrill Lynch seized US\$800 million in collateral assets and planned to sell these assets on June 18, 2007. Bear Stearns had negotiations with JP Morgan, Chase, Merrill Lynch, Citigroup, and other investors over the state of the two hedge funds. However, these negotiations did not stop Merrill Lynch from selling the assets. Bear Stearns disclosed that the hedge funds were facing a sudden wave of withdrawals by investors and by July, it closed the two hedge funds, wiping out virtually all invested capital.

The widespread gravity of the valuation problems were highlighted when at the beginning of August, BNP Paribas froze three hedge funds, stating that it was impossible to value the assets due to a lack of liquidity in

certain parts of the securitization market. The asset values were reported to have fallen from US\$3.47 billion to US\$1.6 billion. Paribas stated that the funds were invested in triple-A and double-A rated structures.⁵⁶ In the third week of August, BNP Paribas announced that it had found a way to value the assets of three of its funds and it allowed investors to buy and sell assets. In the same week, the Carlyle Group put up US\$100 million to meet margin calls on a European mortgage investment affiliate that had US\$22.7 billion in assets. The group issued a statement, explaining that while 95% of the affiliates’ assets were triple-A mortgage-backed securities with implicit U.S. government guarantees, the value of the assets had declined due to diminished demand for the securities.

During this period, money market funds that normally purchased asset-backed commercial paper (ABCP) adopted a policy of buying only Treasuries. The yields on Treasury bills fell as a result of this flight to quality. This action by money market funds and other investors helped to trigger a corporate funding crisis, with many special investment vehicles unable to roll over their ABCP. This forced vehicles to seek funding from other sources and to sell assets. The problems were not restricted to the U.S. ABCP market.⁵⁷

The difficulty that underlies the valuation of collateral and resulting liquidity and funding problems affected many special investment vehicles and hedge funds. In the middle of August, the Goldman Sachs fund, Global Equities Opportunities, lost over 30% of its value over several days. Investors injected US\$1 billion and Goldman injected US\$2 billion of its own money into the fund.⁵⁸ Funds in the U.S., Canada, Europe, and Australia also experienced funding difficulties, some being forced into bankruptcy. The need to generate cash forced the sale of assets. This affected many quantitative hedge funds, such as Renaissance Technologies, which fell 8.7%. Exchange rates were affected, as funds reduced their leverage. Selling by hedge funds and nervous investors also forced municipal bond prices down.

Other players were affected. Real estate funds were hard hit due to both falling real estate prices and the tumult in the credit markets. The Dow Jones U.S. Real Estate Index fund lost 12.8% over the first three months of the summer 2007 and was down 18.1% on the year (see www.ishares.com). Fund redemptions have forced managers to sell assets in falling markets. KKR Financial Holdings, LLC, a real estate firm, that is 12%-owned by

Kohlberg, Kravis, Roberts, and Company, reported in the middle of August that losses threatened its ability to repay US\$5 billion in short-term debt. It announced plans to raise US\$500 million by selling shares to Morgan Stanley and Farallon Capital.

Merger arbitragers were also hit, with many being forced to unwind positions to offset losses. Sowood Capital Management liquidated positions in a number of pending mergers and went into default.⁵⁹ In the fight to gain deals, banks waived such provisions as the “market out clause,” which allows banks to renegotiate an underwriting deal if market conditions have deteriorated. Banks are now forced to renegotiate deals without this weapon in their arsenal. Home Depot delayed and renegotiated a US\$10.3 billion deal to sell its construction supply business to private equity firms.

Asset-backed structured products are difficult to value for many reasons. First is the general complexity of the liability structure, with cash-flow waterfalls and the different types of collateral/interest-rate triggers. Each structure is unique and computer programs used to simulate the cash flows to the different bonds must be tailored to each trust. Second is the valuation of the assets in the collateral pool. For subprime ABS trusts, this typically implies valuing a pool of several thousand subprime mortgages with different terms and a wide diversity in the characteristics of the borrowers. For CDOs, this implies valuation of the bonds issued by ABS trusts, and for CDO-squared structures, this implies the valuation of bonds issued by CDOs. Compounding these difficulties, many of the asset pools are synthetic credit default swaps on ABS, which need to be valued. Third, cash flows to trusts often depend on future values of the collateral or the future ratings of the collateral by the credit rating agencies. This creates an additional layer of complexity, because to estimate the value today, it is necessary to estimate values in the future or predict future credit ratings of the collateral. Fourth is the scarcity of data about the nature of the different asset pools. Data on the asset pools is usually not readily available and not updated on a regular basis.

Transparency

There are a number of different dimensions associated with the general issue of transparency in credit markets. First is the complex nature of the products and how this affects both pricing and risk assessment. Many unsophisticated investors have used credit ratings as a

sufficient metric for risk assessment. Buyers of these products, such as pension funds, university endowment funds, local counties, and small regional banks, do not have the in-house technical sophistication to understand the true nature of these products, the frailty of the underlying assumptions used in their pricing and credit rating, and how these products might behave in difficult economic conditions. For risk measurement, the buyers relied on the rating agencies and took comfort in the protection a rating apparently gave.⁶⁰ The rating agencies have been unclear as to the precise meaning of a rating for structured product bonds and the robustness of their methodologies for such products.

Second is the lack of transparency with respect to the valuation of illiquid assets. This lack of transparency has generated investor concerns about the robustness of posted prices in assessing the creditworthiness of counterparties. For some funds, this is a substantial issue. For example, in the Bear Stearns High Grade Structured Credit Strategies Enhanced Leveraged fund over 63% of its assets were illiquid and valued using models (see Goldstein and Henry [2007]). This was one of the causes of the collapse of Bear Stearns.

Third is the type of assets within a vehicle, such as the percentage of CDOs, CDO-squareds, prime, Alt-A, and subprime mortgages. This basic type of information is rarely available and has produced a market for lemons; that is, unsophisticated investors who are unable to observe or unwilling to believe that funds have no exposure to the subprime market. Synapse closed one of its high-grade funds on September 3, 2007, citing “severe illiquidity in the market.” The company stated that the fund had no exposure to the U.S. subprime market.⁶¹

Fourth is not knowing the total magnitude of the commitments a financial institution has given in terms of backstop lines of credit or loan commitments to private equity buyouts. A vehicle that relies upon funding from, say, the commercial paper market, will buy a commitment from a financial institution to provide funding in the event of a market disruption. Financial institutions also offer lines of credit to firms, which can be drawn down and repaid at the firm’s discretion. Fulfilling all such commitments could have a serious impact on an institution’s liquidity. The level of such commitments is not known to outside investors.⁶² To avoid holding all the committed capital, the institution will purchase a contract from another institution to provide additional capital, if needed. This type of contract is of questionable value if there is a major

market disruption, as the institution selling the contract will also have its own liquidity problems.

Fifth, money market funds provide a safe haven for investors to park their money.⁶³ In order to retain their triple-A level rating, they are generally restricted from investing in low-grade securities. If any of their holdings are downgraded, the fund is under pressure to sell these holdings, incurring losses. Unless the fund has sufficient liquidity, it risks its net asset value per share falling below one dollar, resulting in “breaking the buck,” which could trigger investors to exit the fund due to concerns about the safety of their investments. It would also harm the reputation of the fund manager. Some of the money market funds have invested in SIVs. A few of these SIVs have been downgraded and others are facing downgrading. Many banks have very profitable money market franchises and have implicit commitments to these funds. It is in a bank’s own interests to buy the fallen assets and to take the loss, rather than risk a run on their money market funds.⁶⁴ This is another form of commitment that is not reported.

Finally, many banks hold assets similar to those held by SIVs. In the arrangement process, a bank may hold or warehouse assets until they can be securitized and sold. The extent of these holdings is often unknown to investors, although the amount of Level 3 assets might be a guide. If SIVs are forced to sell assets, this will drive the prices down and banks will be forced to mark-to-market similar assets at the lower prices. Investors are uncertain about the magnitude of potential losses banks might be facing, which is one factor that is contributing to the increased volatility in the share prices of banks. This could cause a credit crunch and affect the whole economy. In an attempt to avoid such a scenario, Bank of America, Citigroup, and JP Morgan Chase held talks with the U.S. Treasury to establish a new super-conduit to buy up to US\$100 billion in assets from SIVs.⁶⁵ Because the conduit would be backed by a group of banks, it was hoped that investors would have confidence in buying the fund’s commercial paper, which would then restart the ABCP market.

Systemic Risk

Systemic risk arises if events in one market affect other markets. Many money market managers that normally purchase ABCP abandoned the market and fled to the Treasury bill market, causing a major increase in prices

and decrease in yields. The ABCP market relies on the quality of the collateral to minimize the risk of nonperformance by borrowers. Lenders need assurance as to the nature of the assets *and* their values. In the breakdown of the ABCP market, there have been reservations about both dimensions. Some lenders have been concerned that the collateral contains subprime mortgages. This lack of transparency has meant that some borrowers were unable to rollover their debt, even though they had no exposure to the subprime market. There has also been uncertainty with respect to the value of collateral. The lack of transparency with respect to the holdings of structured products by monolines and the associated valuation concerns, has adversely affected many markets, such as bond auction markets and tender-option bonds, which use monolines to provide an insurance wrap.

Even under normal market conditions, many instruments are illiquid making it difficult to estimate their price. In the turmoil of the summer of 2007, these problems became insurmountable. These problems were illustrated by BNP Paribas’ decision to freeze withdrawals from three hedge funds at the beginning of August, stating that it was impossible to value the assets due to a lack of liquidity in certain parts of the securitization market.⁶⁶

The effective closure of the ABCP market had many repercussions. For many hedge funds, the inability to rollover debt, forced them to sell assets, which affected many diverse markets. First, the collateralized debt obligation market came under a lot of pressure from this selling to the extent that many funds found prices to be artificially low and some resorted to selling other assets. Some funds closed trading positions by selling “good” assets and buying “bad” assets that were shorted. This caused prices of good assets to decrease and prices of bad assets to increase. This type of price reversal adversely affected some “quant” hedge funds that trade based on price patterns. Hedge funds and institutional investors reduced their leverage by unwinding carry trades.

Many SIVs have backstop lines of credit from banks. The uncertainty of the magnitude of these possible demands has forced banks to hoard cash, making them reluctant to lend to other banks. Three-month LIBOR increased by over 30 bps during the first part of August 2007. Compounding the banks’ funding concerns are the commitments to underwrite levered buyouts. The reluctance to lend and the tightening of credit standards has affected hedge funds, the availability of residential and

commercial mortgages, bond auction markets, and lending to businesses.

Summary

The following factors contributed to the credit crisis:

1. A low interest-rate environment that generated a search for yield enhancement;
2. Demand for high-yielding assets to put into collateral pools in order to increase the profitability of securitization, and subprime mortgages were an ideal choice, along with auto loans and credit cards;
3. Mortgage originators not assuming default risk of risky mortgage loans so they had little incentive to perform due diligence, and there was fraud and lax regulatory oversight;
4. Banks employing an originate-to-distribute mode of operation to reduce capital requirements, resulting in little incentive to perform due diligence;
5. Equity holders of CDOs, CDO-squareds, SIVs, and DPCs selling many derivative claims, often resulting in the underlying collateral being CDS written on asset-backed bonds, thus implying that CDS written on the same asset could appear in many different structures, which increased systemic risk;
6. Rating agencies not monitoring the raw data, even though it was common knowledge that lending standards were declining and fraud increasing, which implied that assumptions used to estimate the probability of default, recovery rates, and default dependence did not reflect current conditions;
7. Rating agencies being tardy in recognizing the implications of the declining state of the subprime market for the ratings of monolines;⁶⁷
8. Rating agency incentive problem arising because rating agencies are paid by clients and regulation limits competition, resulting in the rating of structured products being a very profitable business for the agencies;
9. Monolines accepting at face value the ratings for senior tranches from the agencies and sold insurance wraps;
10. Agency-shareholder problem of financial institutions giving bonuses based on short-run performance, resulting in little incentive to care about the long-run consequences of actions, and because labor markets are not perfect, failure, even spectacular failure, is rarely a barrier to getting another job;
11. New Basle II capital requirements that make it attractive for banks to invest in super senior tranches, and by requiring money market funds to invest only in triple-A rated assets and other financial institutions to invest only in investment-grade assets, provides a receptive market for triple-A rated asset-backed bonds;
12. Absence of complete data on the collateral pools for many structures that made valuation impossible even for sophisticated investors and made independent analysis of credit ratings impossible, resulting in a ratings process that was not transparent and which forced unsophisticated investors to rely on the rating agencies, while regulators ignored the problem;
13. Absence of complete and timely data and concern about valuation methodologies which made investors uncertain about valuations posted by banks in their trading books;
14. Lack of reporting to investors about the implicit commitments of banks to their SIVs and money market funds.

STEPS TO PREVENT A REPEAT

We have identified the major issues that have contributed to the credit crisis. In this section we make recommendations about the steps necessary to avoid a repeat. The rating agencies have received considerable attention, although they are only one part of the story. Other issues have played an important role in the crisis—incentive structures, difficulties in valuing illiquid assets, lack of transparency, lack of data, the underlying design of SIVs and structured credit products, inadequate risk management, and the failures of state and Federal regulators.

Rating Agencies

In the current crisis, we have witnessed relatively newly rated facilities having their credit ratings changed from triple-A to junk, and the tardy response of agencies in recognizing the risk arising from the holding of subprime mortgages by monolines. These observations raise the question of the effectiveness of the methodologies used by the agencies to model loss distributions for portfolios of assets and the failure of the agencies to recognize the limitations of their models in a timely manner.

Rating agencies have a long history of estimating the probability of default and the loss given default for

individual obligations. This is not the case for structured products, for which there are many additional difficult issues. As discussed by Aschcraft and Schermann [2007] subprime ABS ratings differ from corporate debt ratings on a number of different dimensions. Corporate bond ratings are largely based on firm-specific risk, while CDO tranches represent claims on cash flows from a portfolio of correlated assets. Thus, the rating of CDO tranches relies heavily on quantitative models, while corporate debt ratings rely essentially on the analyst's judgment. Although the rating of a CDO tranche should have the same expected loss as a corporate bond for a given rating, the volatility of loss—that is, the unexpected loss—is quite different and strongly depends on the correlation structure of the underlying assets in the pool of the CDO.

For structured products, such as ABS CDOs, it is necessary to model the cash flows and the loss distribution generated by the asset portfolio over the life of the CDO, implying that it is necessary to model prepayments⁶⁸ and default dependence (correlation) among the assets in the CDO and to estimate the parameters describing the dependence.⁶⁹ Over the life of a CDO, individual defaults may occur at any time, implying that it is necessary to model the loss distribution over time. This necessitates modeling the evolution of the different factors that affect the default process and how these factors evolve together.⁷⁰ This requires assumptions about the stochastic processes that describe the evolution of the different factors, such as interest rates and prepayment behavior, and the estimation of the parameters describing these processes, which usually requires the use of time-series data. If there are major changes in the economy, then these parameters may change, implying that it is necessary to examine the sensitivity of a rating methodology to parameter changes.

It is critical to assess the sensitivity of tranche ratings to a significant deterioration in credit conditions affecting creditworthiness and default-clustering. As shown in Fender, Tarashev, and Zhu [2008], the impact of shocks affecting creditworthiness on CDO tranche ratings is very different than for a corporate bond. It depends critically on the magnitude and the clustering of the shocks and it tends to be nonlinear.

If default occurs, it is necessary to estimate the resulting loss. We know from the work of Acharya, Bharath, and Srinivasan [2003] and Altman, Brady, Resti, and Sironi [2005] that recovery rates depend on the state

of the economy, the condition of the obligor, and the value of its assets. Loss rates and the frequency of defaults are dependent (correlated); that is, if the economy goes into recession, the frequency of defaults and loss rates increase. It is necessary to model the factors that affect the loss and the joint dependence between the frequency of default and loss. The level of dependence will vary, in general, with the state of the economy.

To have confidence in a model, it is necessary to have a clear definition of what a rating means for a particular type of instrument, the factors that an agency considers when assigning a rating, and how well a rating model performs in different economic environments. A lack of clarity surrounds what a rating actually measures.⁷¹ Is it a measure of the probability of default or the expected loss over some specified horizon? What is the length of the horizon? Does a rating, say triple-B, have the same meaning for asset-backed securities as for corporate bonds?

To test model predictions against actual outcomes requires data.⁷² Unfortunately, for many types of collateralized products, data availability is limited across instruments and does not extend over long periods. Consequently, there is little information about the accuracy and robustness of models over different parts of the credit cycle. To assess the credit risk of structures such as SIVs, it is necessary to consider other risk dimensions, such as market liquidity and valuation of collateral. These factors have been overlooked, though they affect creditworthiness.

The rating agencies clearly state that they do not perform due diligence on the raw data. The current situation is analogous to accountants accepting at face value the figures given to them by firms. There is no auditing function. The current situation is problematic. In moving forward, if data auditing is required, then the issue of compensation both for rating and for auditing needs to be addressed. It is not clear that regulating the originators will solve the problem of faulty data unless there is adequate enforcement. Continuing the analogy, firms are required to follow generally accepted accounting principles (GAAP), although accounting fraud still occurs.

For the last few years, the characteristics of subprime mortgage borrowers were undergoing major changes due to declining underwriting standards and fraud. The failure to explicitly recognize the changing nature of the underlying data used in model estimation implied that the probabilities of default, recovery rates,

default dependence, and dependence between default and recovery rates were poorly estimated. Models need to capture default contagion that exists in local housing markets. Statistical techniques—such as data sampling and the introduction of unobservable heterogeneity and different prior distributions—exist and have the potential to ameliorate some of these problems.⁷³ For collateralized structures, there is the need for more transparency about 1) the types of models used by the agencies, 2) the assumptions about the data used to rate a particular structure, and 3) the accuracy and robustness of the rating methodologies to the underlying assumptions. Current methodologies failed due to the use of inappropriate assumptions derived from historic data for corporate CDOs with tranches much wider than for ABS CDOs. They also failed to appropriately model both default and recovery dependences.

To rate the commercial paper of a SIV, there are additional factors to consider. First is an assessment of the backstop lines of support and other contingent funding in the case of market disruptions. The rating agencies rate the contingent sources of funding available to a vehicle. Second, for an investor to buy asset-backed commercial paper (ABCP), they need to know the *nature* of the assets supporting the paper and the *value* of the collateral. The agencies are clear that they make no statement about valuation. Yet if the value of the collateral deteriorates, this adversely affects the creditworthiness of the commercial paper. Thus, valuation of the collateral must be addressed in order to assess the creditworthiness of the vehicle.

There is the need to be more transparent with respect to the meaning of a rating for commercial paper or medium-term notes for structured products and investment vehicles.⁷⁴ What does a rating actually consider and what assumptions are made in reaching a rating decision? At present the onus is on the investor in an ABCP to understand exactly what a rating means, the underlying assumptions and data used to derive such a rating, and the limitations of the rating methodology. This is demanding a lot from investors, given the lack of transparency. Again, there is also the need for more transparency about the methodologies used to assess the different factors and how these considerations are incorporated to reach a final decision. There is a long list of uninformed investors who naively interpreted an ABCP credit rating as a measure of its underlying creditworthiness, being unaware of the limitations of the methodologies.

Recommendations

1. The meaning of a rating needs to be clearly stated. For example, is a rating a measure of the probability of timely payment? Is it a measure of the expected loss averaged over the life of the instrument or some other horizon? If a rating is through-the-cycle, what is the length of the cycle? How do the agencies actually calculate their numbers? To avoid confusion, the agencies need to be explicit and attach *actual numbers* to their forecasts.
2. For any type of instrument that is being rated, the need exists for a clear statement about the methodology used to derive a given rating and the underlying assumptions. These have to be generally available, so that in principle the rating could be reproduced by an independent party. At present, the information agencies make available to non-clients is quite limited. Rating agencies often state that a rating depends both on quantitative and qualitative factors. The quantitative part of the rating should be reproducible by an independent party. The ability to independently validate a rating would go a long way toward reducing the effects of conflicts of interest. Independent validation requires that data be available. We address this issue in the next recommendation.
3. For asset-backed securities, the government should sponsor an agency that collects information on a timely basis about the collateral pools and make it available to market participants. This will facilitate an independent party's ability to reproduce the credit ratings.
4. Clarity is required about the data sources used to reach a rating. Is the agency accepting data from a third party and has the agency checked for structural changes in the data sources? Has it checked the data to justify the validity of its distributional assumptions?

Valuation

In the current crisis, one of the fundamental problems is the valuation of the securitized tranches for mortgage assets. To value a simple credit default swap requires specification of the probability of default of the obligor over the life of the swap and the loss if default occurs. These probabilities and loss rates are not those estimated by rating agencies. For pricing purposes, we need the *price of risk* for

each factor that affects the loss distribution. The price of risk for a factor relates the risk-of-loss to value. Market prices for swaps with standardized maturities of 1, 3, 5, 7, and 10 years now exist for a large number of obligors, although the market for nonstandardized maturities is still illiquid. The existence of market prices means that models can be calibrated to match current prices. Once the price of risk can be inferred for a particular obligor, we can price nonstandard swaps written on the same obligor.

For synthetic CDOs, valuation becomes more complicated, because it is necessary to model default and recovery dependences among the obligors in the CDO.⁷⁵ For each credit default swap within the structure, the probabilities of default over the life of the CDO are inferred using the current market prices for all the swaps on the particular obligor. It is necessary to patch together the individual credit swaps to produce a price for the whole structure. The typical types of models used by financial institutions are relatively simple and static in nature, and they do a relatively poor job of pricing all of the different tranches.⁷⁶ Transparency in pricing and the liquidity of the market has greatly increased following the introduction of credit indices and the trading of tranches written on the indices. This has also facilitated the calibration of models to the prices of the individual tranches of an index. However, for synthetic CDOs that do not contain the same obligors as an index, additional assumptions are required for pricing.

For pricing assets such as mortgages, auto loans, or credit cards, the difficulties associated with valuation greatly increase, as there are few prices that can be used for calibration. Even under normal conditions, markets are illiquid. The types of models used to estimate the credit ratings of CMOs could be extended to pricing. This can be achieved by estimating the price of risk associated with each factor that affects default and the resulting loss. However, this requires market prices. Mortgage-related credit indices now exist that allow the price of risk to be estimated. Unfortunately, mortgage portfolios may differ substantially from the characteristics of the index, because of the wide heterogeneity across different types of mortgages. Standardization of structures will help to improve liquidity and pricing, as recently suggested by the French minister of economy, finance, and employment, Lagarde [2007], although many practical difficulties with this type of suggestion remain. If the price of risk cannot be estimated, another approach is to use the credit rating for the mortgage structure and make some heroic assumptions

about what yield an asset with a given rating commands. The use of this type of model has meant that in the current crisis, as rating agencies have downgraded assets, automatic write-downs have occurred. There are two difficulties with this approach. First, it assumes that ratings are both accurate and timely. Second is the nature of the required heroic assumptions. Apart from pragmatism, there is little justification for their use.

Recommendations

1. Simplification and standardization of instruments is needed, because many instruments have become too complicated, making reliable pricing or risk management problematic.
2. For many different asset classes, the industry needs to develop markets for indices written on standardized assets. This will help in price discovery and for pricing related assets.

Transparency

The lack of transparency has affected financial institutions in a number of ways. First, banks hold or warehouse mortgages before securitization, as well as tranches of structural products that they are in the process of selling to investors. In the credit crisis, as the value of credit-sensitive instruments has declined, financial institutions have been forced to write down the value of these assets. In many cases, investors have been surprised by the magnitude of the write-downs.

Second is the level and diversity of commitments, both explicit and implicit, given by banks. The first explicit type of commitment is to underwrite levered buyouts. For the first part of 2007, the competition was such that many banks offered to provide financing, without the protection of an “adverse market” clause that gives them an escape route. The total magnitude of these commitments was often not disclosed on a timely basis. The second type of explicit commitment occurred when banks gave backstop lines of credit to their sponsored SIVs. A bank will often provide a backstop line of credit, usually for a fraction of the total amount the vehicle needs. There is a lack of clarity as to the total level of these commitments and a bank’s ability to honor such commitments.

The first type of implicit commitment arose because of reputation concerns. Bank-sponsored SIVs are off-balance-sheet vehicles, created and managed by banks, who

earn revenue from the generous management fees. To qualify for off-balance-sheet treatment, a bank should not be exposed to risk. This test is usually satisfied, given the typical SIV structure. Yet in a number of cases, banks have brought vehicle assets onto their balance sheets to protect their reputation. The second type of implicit commitment arose because a number of banks run enhanced money market funds that invested in subprime assets. The banks have stepped in to support the funds in order to avoid “breaking the buck,” as the value of the subprime assets declined. During 2007, bank shareholders have had a series of negative surprises due to the lack of information about the different types and magnitude of implicit commitments.

Banks’ 10-K statements offer little information about actual holdings of assets being warehoused and little clarity with respect to the total level of bank commitments. Regulators could request that this information be reported on a regular basis. This would provide investors with information about a bank’s exposure and the effects on valuation if downgrades occur. A similar requirement is also needed for monolines. The recent report of the Senior Supervisors Group [2008b] surveyed 20 financial firms and found that, in some cases, the level of disclosure was extensive. However, even in these cases, the level of disclosure was at such an aggregated level, that many important details were hidden about the true nature of an institution’s exposure.

The lack of transparency in the pricing of subprime structures has been a major issue. Illiquid assets are difficult to value even in normal markets. One way to improve pricing transparency and liquidity is to encourage the trading of indices based on standardized baskets of assets. Trading in these indices would improve transparency and provide guidance for calibrating models used for non-standard baskets of assets. The last few years have seen the development of such indices, although in some cases, the asset structures used to define the underlying assets in the index lack transparency.⁷⁷ There is a need for more simplicity and transparency in design.

Recommendations

1. For banks, more transparency is needed regarding the magnitude of explicit commitments arising from lines of credit, backstop supports, and funding for levered buyouts.
2. For banks, more transparency is needed regarding the magnitude of implicit commitments that arise from reputational concerns. Examples are the

implicit commitments to off-balance-sheet vehicles and enhanced money market funds. In its annual report, a bank should state the consequences of bringing its off-balance-sheet vehicles back onto its balance sheet. This would help reduce information asymmetry.

3. Greater transparency is needed with respect to the nature of assets held by financial institutions, especially assets that are difficult to value (Level 3 assets).

Instrument Design

The lack of transparency and liquidity for many asset-backed securities, such as subprime mortgages, auto loans, and more exotic CDO-squared securities, has been a major issue in the current crisis. In the near future, we can expect investors to focus on relatively simple and liquid products that can be easily standardized and valued.

The introduction of credit default swap indices in late 2002 enhanced the development of the credit swap market by improving transparency. Investors could observe bid-ask spreads for the different tranches of the index. Indices, such as the ABX, have been introduced for the mortgage market. However, the heterogeneity of the mortgage market means the prices of the subindices are of limited help for calibrating particular mortgage structures. To improve pricing transparency, more subindices are required. For more exotic instruments, such as CDO-squareds, there are two issues with indices. First is the identification of obligors in each of the underlying CDOs and, second, the modeling of default dependence. Given the limited success of models for simple CDOs, modeling a CDO-squared is problematic.⁷⁸ The data for all structured products should be collected by a regulator and made available for analysis. This would be a first step in improving the pricing transparency of such complex instruments.

New products exposed to “gap” risk, such as Constant Proportion Portfolio Insurance (CPPI) and Constant Proportion Debt Obligations (CPDO), have been introduced. Both products are leveraged investments whose return depends on the performance of an underlying trading strategy. Quite often positions are taken in the available credit indices, such as iTraxx and CDX. Typically, the performance of these trading strategies is exposed to gap risk that is not captured with traditional option pricing models, because of the continuous paths of Brownian

motion assumed by these models. The rating of these products was initially based on flawed models, with most of the CPDOs being subsequently downgraded with huge losses. For example, on November 26, 2007, Moody's announced that Tyger Notes, a CPDO based on financial credits from UBS, lost 90% of its value after its net asset value fell below the level that triggered its unwind. Moody's later cut the rating of the other CPDOs.⁷⁹

SIVs were funding medium-term and hard-to-value assets with short-term money market securities exposing the vehicle to the risk of a market disruption.⁸⁰ When banks were unable to roll the ABCP funding these SIVs, and market liquidity had totally evaporated for subprime-related assets, in order to preserve their reputation, banks had no other alternative but to take back the assets on their balance sheet. The design of the SIVs can be altered to make them less sensitive to market disruptions. A number of ways are possible to achieve this. Currently, some of the extant short-term commercial paper gives the vehicle the option to extend the maturity of the debt. Usage of this option could be expanded. Another type of option would be to allow the vehicle to convert the paper into one- or two-year floating-rate debt. The option could be contingent on the event of a market disruption. The cost of the option would be relatively small, given that the probability of a market disruption is small. The cost of these modifications would decrease expected profits.

Recommendations

1. Demonstrate that valuation methodologies can be validated with respect to external prices and that risk management is feasible, especially for complex instruments.
2. Design instruments that allow for market disruptions.

Regulatory Issues

The Basel-based Financial Stability Forum (FSF), whose membership consists of central bankers, regulators, and finance ministers from many countries, presented to the G-7 Ministers and Central Bank Governors at their April 2008 meeting in Washington a set of 67 recommendations for increasing the resilience of markets and institutions going forward. Many of these recommendations aim at improving transparency in financial markets and regulatory oversight and coordination across regulatory bodies at the national and international levels.

The proposals include increased capital requirements for structured credit products, the trading book to explicitly capture default and event-risk of credit exposures held in the trading book, faster disclosure of losses by banks, and increased cross-border monitoring of banks by regulators.

A number of issues at the heart of the current credit crisis need an urgent regulatory response. First, the lax lending standards over the last few years have been a major contributor to the current crisis. Both regulators and risk managers ignored the implications. A decline in underwriting standards for subprime mortgages (and also auto loans and credit cards) implied that the probability of default for subprime borrowers and default-dependence increased, while recovery rates decreased. This, in turn, lowered the value of structures that contained subprime mortgages. There needs to be regulatory requirements for the random sampling of the raw mortgage data, and the methodologies used to generate the multiperiod loss distributions need to be flexible enough to incorporate the changing-regime nature of the data.

In response to the credit crisis, there has been a rush to introduce new laws regulating lending standards. However, without effective enforcement mechanisms such efforts will be of little value. The responsibility for enforcement needs to be clearly defined, especially given state and fragmented federal divisions. To motivate financial institutions that sell structured products to undertake the appropriate due diligence, requirements could be instituted mandating that they must hold a specified percentage of the equity portion of the structures they sell to investors. This way they bear the direct costs from mispricing due to inappropriate assumptions about the nature of the loss distribution. For example, if a bank set up a special purpose vehicle, it would be required to purchase and hold a specified percentage of the equity.

Second, the issue of counterparty risk has arisen at two levels. Many banks had put options that allowed them to put mortgages back to originators in the case of delinquency. In a number of cases when banks attempted to exercise this option, the originators did not have the assets to reimburse the banks. The credit derivatives market is an over-the-counter (OTC) market, implying that there is always counterparty risk. In the current credit crisis, the ability of some counterparties to honor their commitments has been called into question.

While banks keep track of their counterparty exposure, the determination of the value of the total exposure

to a counterparty (after netting), and the posting of collateral, has been based on relatively simple rules. The reliance on credit ratings both as a measure of the risk of a counterparty, as well as the valuation of illiquid assets, has been a contributing factor to the crisis. The rating agencies have done a poor job of assessing, on a timely basis, the creditworthiness of many of the counterparties, and the valuation of illiquid assets is difficult even in normal times. Both banks and regulators have failed to recognize that a credit event which adversely affects a bank may also adversely affect both the creditworthiness of a counterparty and the value of the bank's collateral. Moving forward, there is a need to understand and model the relation between the valuation of the cash flows of a counterparty and its ability to pay, known as *wrong-way* counterparty credit exposure. Regulators should ensure that methodologies adequately account for this type of dependence.

Centralized clearing houses (CCHs) offer a potential way to localize counterparty risk. All OTC trades would be cleared through a CCH. The CCH must have sufficient capital, monitor its exposure to each customer, and request the posting of collateral. If a party fails, such as Bear Stearns, the CCH bears the counterparty risk for all the OTC contracts.

Third, banks have many implicit commitments that do not appear on their balance sheets. For example, some banks receive managerial fees from hedge funds and SIVs, and provide lines of credit. Some banks have used their name to market enhanced money funds. In these cases, it was known that the bank had implicit commitments. It is not surprising, and should have been expected, that many banks brought assets onto their balance sheets to protect their reputations, adversely affecting their capital and forcing some to raise additional capital. Regulators should request that these implicit commitments be recognized for capital calculations and that these contingencies given explicit recognition in value-at-risk (VaR) measurements. For practical implementation, regulators should be ready to specify some minimum probability of occurrence. Whether it is desirable to hold capital against these commitments is another issue. There are two types of contingencies. The first type is the case of a vehicle having refinancing problems that are isolated to the particular vehicle and the bank transferring assets onto its balance sheet. The second type is the case of a general market disruption. To hold capital against this type of event could be prohibitive. Explicit and implicit

commitments should also be reported in the bank's accounts so investors know of potential future liabilities.

Fourth, the requirement that assets in the trading book be marked to market (or marked to model), has come under attack from some bankers.⁸¹ The central issue is the belief that in the current crisis, market or model prices do not reflect the true value of an asset and consequently companies are being forced to recognize losses on assets they had no intention of selling. In the current crisis, companies have recognized huge write-downs, causing investors to become increasingly concerned about the credit worthiness of financial institutions, which have been forced to raise capital at unfavorable prices.⁸²

The valuation of illiquid assets is difficult under normal market conditions and problematic when markets are in turmoil. In the current crisis, there was a failure to adjust distributional assumptions due to misrepresentation of the underlying risk associated with subprime borrowers. For assets recorded in the banking book, a loss reserve is required. The magnitude of the reserve is usually based on the expected loss over the next year. In general, in the current crisis this has been underestimated, given the inappropriate distributional assumptions. If markets are mispricing assets in the current crisis, it is probably due to the lack of transparency with respect to the nature of the assets. Investors need to assess the value of an institution's assets. The focus of the debate should be on the issues of transparency of the assets held by institutions and the valuation of these assets.

Fifth, the systemic nature of the crisis has arisen because of widespread ownership of structures containing subprime mortgages and the circular dependence between refinancing and collateral valuation. Regulators failed to recognize the existence of positive feedback mechanisms and to understand their implications for the financial system.⁸³ If asset values decline, ability to refinance declines, valuation of counterparty collateral declines, value of monoline assets declines, and value of the guarantees given by monolines declines. Regulators were blind to the impending crisis. To avoid a repeat, there needs to be more transparency as to the nature of assets held by different institutions. To achieve this will require increased cooperation of regulators across national boundaries. There is also the need to explicitly recognize feedback mechanisms and understand their implications for the financial system.

Many financial institutions failed to anticipate the liquidity risks associated with some of their businesses.

Regulators need to understand the risks that can be caused by liquidity and require that these risks be formally recognized in measuring the risk of an institution.

Rating agencies failed to understand the risks arising from structured products. Given the regulatory importance attached to ratings, the onus is on regulators to monitor the rating agencies with respect to data quality, methodologies, and rating designations.

Recommendations

1. Minimal Federal lending standards should be required across all states in order to avoid the problems arising from lobbyists pressuring state lawmakers to have state laws relaxed.
2. Compulsory random sampling of mortgage lending practices and mortgage delinquency rates is needed, especially in major states. The responsibility for such duties must fall to an independent body.
3. Originators should be required to hold a randomly selected number of mortgages from each mortgage class. Arrangers should be required to hold a specified percentage of the equity tranche of any structure that they sell.
4. In the case of a counterparty posting collateral, regulators need to consider the effects of *wrong-way* counterparty credit exposure in determining capital requirements. They also need to recognize the effects of procyclicality in stress testing and scenario analysis.
5. Fair value accounting has come in for criticism due to its procyclical nature. A possible solution is to allow investment banks to place an asset either in the trading book or the bank book at the time of purchase. Rules to avoid cherry-picking are needed, so banks cannot switch an asset back and forth as market conditions change.
6. Consistent regulation and oversight is needed for financial institutions of a size or importance that their failure would threaten the stability of the financial system.⁸⁴
7. The fragmented regulator system at the federal and state levels needs to be improved.⁸⁵
8. Regulators need to monitor the rating agencies with respect to data quality, methodologies, and efficacy of their prediction. The inherent conflicts of interest between the rating agencies and their clients need to be addressed.⁸⁶ The ability to perform independent validation of ratings would go a long way

toward reducing the effects of possible conflicts of interest, which are impossible to eliminate.

9. Centralized clearing houses (CCHs) should be used to reduce and localize counterparty risk.

Risk Management Issues

The Senior Supervisors Group issued a report in March 2008 that identified the risk management practices of financial institutions which have weathered relatively well the recent financial market turmoil, and compared them to institutions that did not perform well and are thus exposed to large credit write-offs.

Firms that performed relatively well:

- adopted a comprehensive view of their exposures. They shared quantitative and qualitative information more effectively across the organization and were thus able to identify very early sources of significant risk and had more time to evaluate the appropriate actions to be taken. These firms have risk management committees that meet on a weekly basis to discuss all significant risk exposures across the firm. The risk management committee members are treated as equals and include senior management (CEO, CFO, CRO, COO, and so on), heads of business lines, and legal and compliance officers.
- had in place rigorous internal processes to value complex and potentially illiquid securities. They had independent in-house expertise to assess the credit quality of structured credit assets and did not rely only on the assessment of credit rating agencies.
- enforced active controls over the consolidated organization's balance sheet, liquidity, and capital positions. They aligned the treasury functions more closely with risk management processes, incorporating information from all businesses in global liquidity planning, including actual and contingent liquidity risk. These firms had in place internal pricing mechanisms that provided incentives for the business units to better control balance sheet growth and ensure that contingent liquidity risk does not outweigh expected returns.
- relied on a wide range of risk measures. They had adaptive risk measurement processes and systems that could rapidly alter underlying assumptions in risk measures to reflect current circumstances.

In particular, they complemented VaR measures with forward-looking stress testing, stress tests specially designed to allow firms to estimate the economic benefits of diversification and the impact of correlation risk in stressed markets.⁸⁷ The appendix discusses “cliff” effects, or strong nonlinearities, that characterize the risk of subprime CDO tranches and limit the usefulness of VaR measures under some circumstances.

The report also emphasizes the role of senior management in articulating the firm’s strategy to increase its franchise value. Imbedded within this responsibility is the task of finding the right balance between the desire to develop new businesses and the risk appetite of the firm. In particular, senior management plays a critical role in identifying and understanding material risks and acting on that understanding to mitigate excessive risks. Internal communication across the firm is also critical to performance in stressed market conditions. The existence of organizational silos in the structure of some firms appears to be detrimental to firm performance during the turmoil. Firms that avoided significant losses cited a degree of integration among the liquidity, credit, market, and finance control structures. Firm-wide risk management has become a necessity to keep pace with the growth of risk-taking.

Finally, compensation has been cited as a major issue in the current credit crisis. In particular, the incentive structure tied loan originator revenues to loan volume, rather than to the quality of the loans being securitized. There is a need to better align compensation and other incentives with the interests of investors and shareholders of the firm, and to find the appropriate balance between short-run and long-run performance, and between individual business-unit goals and firm-wide objectives. The originate-to-distribute business model has created incentives for both firms and individuals that have conflicted with sound underwriting practices, risk management best practices, and the interest of investors and shareholders.

Recommendations

1. Firms should adopt a comprehensive, firm-wide risk management plan and share quantitative and qualitative information in risk management committees that meet frequently and include, as equal partners,

senior management, heads of business lines, and legal and compliance officers.

2. Rigorous internal processes should be put in place to value complex and illiquid securities, and internal credit quality assessment should complement external ratings.
3. The treasury functions should be closely aligned with risk management to plan and control balance sheet, liquidity, and capital positions.
4. Traditional VaR measures should be complemented by forward-looking stress-testing to capture the impact of severe market shocks.
5. The incentive and compensation system should be reviewed to better align the interests of all the participants in the securitization chain with the interests of the investors and shareholders of the firm. The incentive compensation scheme should be closely related to long-term, firm-wide profitability.

SUMMARY

Securitization allows banks to move assets off their balance sheets, freeing up capital and spreading the risk among many different players. These are real benefits. Federal Reserve Chairman Ben Bernanke said at the April 2008 opening meeting of the G-7 in Washington, DC, that failures in the so-called originate-to-distribute model of credit extension were the root of the current crisis. It broke down at a number of key points, including at the stages of underwriting, credit rating, and investor due-diligence. Financial institutions that had bought structured credit products coming from the securitization of subprime loans did not have adequate risk management or liquidity plans in place. Chairman Bernanke also said “these problems notwithstanding, the originate-to-distribute model has proven effective in the past and with adequate repairs could be so again in the future.”

In this article, we have identified many of the factors that have contributed to the crisis, from the search for yield, fraud, agency problems resulting in lax underwriting standards, incentive issues, failure to identify a changing environment, poor risk management by financial institutions, lack of transparency, the limitation of extant valuation models, and the failure of regulators to understand the financial system implications of the changing environment. The article addresses the different issues and offers suggestions on how to move forward.

APPENDIX

“CLIFF” EFFECTS OR NONLINEARITIES IN THE RISK OF SUBPRIME CDO TRANCHES

Banks and rating agencies have based their risk assessments on market assumptions which did not reflect the severity of the current environment after the housing market started to deteriorate and market liquidity evaporated. It has long been suggested that standard risk analyses based on normal market conditions should be complemented by stress-testing methods and scenario analyses, which take into account liquidity risk and other complexities to ensure that banks are aware of the potential losses they might incur in highly unlikely, but plausible, scenarios (see, for example, Crouhy, Galai, and Mark [2006]). It is well known that value-at-risk (VaR) models do not accurately capture gap risk (i.e., extreme market events). It is clear that if the term structures of default probabilities, losses given default, and default correlations of the mortgage bonds in the pool of subprime CDOs had been reasonably stressed, we would have known the extent of the potential losses. Traditional VaR risk measurement models are static in nature and do not capture the impact of limited liquidity and complex nonlinearities embedded in structured credit products on the potential for loss.

In particular, the nature of the risks involved in holding a triple-A rated super senior tranche of a subprime CDO was completely missed by all the players—rating agencies, regulators, financial institutions, and investors. Subprime CDOs are, in fact, CDO-squareds, because the underlying pool of assets of the CDO is composed of subprime MBS bonds that are themselves tranches of individual subprime mortgages. A typical subprime trust is composed of several thousand individual mortgages, typically around 3,000 to 5,000 mortgages for a total amount of approximately a billion dollars. The distribution of losses of the mortgage pool is tranching into different classes of MBS bonds from the equity tranche, typically created through overcollateralization, to the most senior tranche rated triple-A. A typical subprime CDO has a pool of assets composed of MBS bonds rated double-B to double-A, with an average rating of triple-B. The problem is that the initial level of subordination for a triple-B bond is relatively small, between 3% and 5%, and the width of the tranche is very thin, 2.5% to 4% maximum.

As prepayments occur the level of subordination of the lower tranches increases, in relative terms, and can reach 10% over time. Assuming a recovery of 50% on the foreclosed homes, a default rate of 20% on subprime mortgages, which is realistic in the current environment, will most likely hit most of the triple-B tranches. Moreover, it is also quite likely that in the current housing market downturn and recessionary economic environment, the loss correlations across all the triple-B tranches will be close to one. As a consequence, if one triple-B tranche is hit, it is quite likely that most of the

triple-B tranches will be hit as well during the same period. And, given the thin width of the tranches, it is quite likely that if one MBS bond is wiped out, they all will be wiped out at the same time, decimating the super senior tranche of the subprime CDO. In other words, a binary situation exists in which either the cumulative default rate of the subprime mortgages remains below the threshold that keeps the underlying MBS bonds untouched so that super senior tranches of subprime CDOs do not incur any loss, or the cumulative default rate breaches this threshold and super senior tranches of subprime CDOs could all be wiped out.

ENDNOTES

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¹The term *subprime* refers to mortgagees who are unable to qualify for prime mortgage rates. Reasons for this include poor credit histories, payment delinquencies, charge-offs, bankruptcies, low credit scores, large existing liabilities, and high-loan-to-value ratios.

²In April 2008, the International Monetary Fund (IMF) said that total financial losses stemming from the housing turmoil and the global credit crunch, including the securities tied to commercial real estate and loans to consumers and corporates, may reach US\$945 billion over the next two years, with US\$565 billion directly related to the subprime crisis. And losses at financial institutions are likely to be saddled with half the potential losses, or about US\$440–US\$510 billion.

³The US\$300 billion in losses related to the subprime crisis compares to about US\$170 billion in losses from the U.S. savings-and-loan crisis in the 1980s and early 1990s.

⁴Exhibit 1 shows the credit losses and subprime related write-downs since the beginning of 2007 as of April 2008 at major banks worldwide, based on data compiled by Bloomberg. We expect these numbers to keep increasing substantially during 2008. Early 2008, AIG's auditors forced the insurer to lower the value of credit default swaps it holds by an estimated amount of US\$4.88 billion. Credit Suisse also announced in February that it had to write down US\$2.85 billion of previously mis-marked structured credit products.

⁵To smooth the deal, the Fed has taken the unprecedented step of providing US\$30 billion in financing for Bear Stearns' less liquid assets. The Fed is assuming responsibility for managing the assets and takes the risk of those assets declining in value—except for the first US\$1 billion which will have to be absorbed by JP Morgan Chase—as well as earning the profit if the assets rise in value.

⁶These rates form the foundation for monthly payments on millions of credit cards and mortgages in Europe and the U.S. The dollar-LIBOR fixings represent the cost for banks to borrow dollars from each other. There has been concern over the last few months that LIBOR was underestimated as some banks were reporting to the BBA (British Bankers Association) quotes lower than their actual cost of borrowing in order to hide their funding difficulties.

⁷As an alternative to raising more capital, banks are trying to shrink their balance sheet by selling loans at a discount. On April 18, 2008, Citigroup negotiated with a group of leading private equity firms (Apollo, Blackstone and TPG) the sale of US\$12 billion in leveraged loans at a discount of about 90 cents on the dollar.

Anxiety is such that even some dedicated free-market spirits, such as Nobel laureate Myron Scholes, declared to the French newspaper *La Tribune*, on January 24, 2008, that a concerted political effort has become necessary. In addition to sovereign funds, the U.S. government may have to step in to recapitalize some of the large financial institutions subject to large losses to ensure that they can keep financing the economy.

⁸For example, funding for Citigroup, one of the hardest hit by the credit crisis, has risen from 12 bps to 1 percentage point over LIBOR, while the cost of borrowing for Merrill Lynch has climbed from 20 bps to 1.50 percentage points over LIBOR. Investors believe there is an increasing probability of default for banks. The iTraxx Senior Financial Index that tracks the cost of insuring the senior debt of a portfolio of 25 European banks and insurers has increased from 8 bps to 57 bps.

⁹The credit crisis has caused credit spreads to increase, especially for junk bonds. Some highly levered companies have been forced to postpone new debt issues.

¹⁰The leveraged loan market in February 2008 is starting to show signs of weakness as UBS and Credit Suisse announced the write-down of a combined US\$400 million in the value of leveraged loans as part of their fourth-quarter 2007 earnings report. Some analysts expect as much as US\$15 billion in leveraged loan-related write-downs at commercial and investment banks in the first quarter of 2008.

¹¹The iTraxx Europe Crossover Index closed at 510 bps on February 6, 2008, which means that the annual cost of insuring €10 million worth of high-yield debt against default over five years is €510,000. In the U.S., the HiVol index of the 30 riskier investment-grade credits of the 125 names composing the CDX index reached almost to its peak on February 6, 2008, at 271 bps.

¹²According to a recent report by Altman and Karlin [2008] default rates were at near-record lows and recovery rates were at near-record highs in 2007 for high-yield bonds. Default rates fell to just 51 bps, the lowest since 1981. According to S&P, the default rate on leveraged loans decreased again in 2007 to just 26 bps, down from 1.1% in 2006 and 3% in 2005. Default

losses on high-yield bonds were just 20 bps in 2007, based on an average recovery rate of 67%. One measure of the potential increase in defaults going forward is the distress ratio (i.e., bonds yielding more than 10% above Treasuries). This ratio increased dramatically to 10.4% as of year-end 2007 from record low levels just six months earlier, and from 1.7% at the end of 2006. Altman forecast a default rate for high-yield bonds of 4.6% in 2008 and 5% in 2009, a significant increase from the current default rate of 51 bps.

¹³The fed funds rate was 1% in June 2003. It started to slowly increase in June 2004 and was 5.25% by June 2006. It was reduced to 4.75% on September 18, 2007.

¹⁴In the U.S., 50 million, or two-thirds, of homeowners currently have mortgages, with 75.2% financed with fixed-rate mortgages and the remaining 24.8% with adjustable-rate mortgages (ARMs). These figures come from the Mortgage Bankers Association, August 15, 2007.

¹⁵Subprime loans grew from US\$160 billion in 2001 (or 7.2% of new mortgages) to US\$600 billion in 2006 (or 20.6% of new mortgages).

¹⁶For a comparison of prime and subprime mortgages, see Agarwal and Ho [2007].

¹⁷See Duffie [2007] for a discussion of credit risk transfer innovations.

¹⁸According to the Bank for International Settlements (BIS), the notional amount outstanding of credit default swaps (CDS) was US\$58 trillion at the end of December 2007, while it was only US\$14 trillion at the end of 2005. However, according to ISDA, the net exposure to the banking system is “only” US\$1 trillion after netting.

¹⁹Doms, Furlong, and Krainer [2007] found a negative correlation between house price appreciation and subprime delinquency rate. They also show that the rate of change in the price appreciation affects the delinquency rate.

²⁰The Mortgage Bankers Association defines *delinquent* as having one or more payments overdue.

²¹The economy started to change during 2004. First, mortgage rates started to increase, as the Fed increased the fed funds rate and, second, house price appreciation decelerated. There are many factors that cause delinquency in the mortgage markets with the major candidates being job loss, unanticipated medical expenses, divorce, and rising mortgage expenses. House prices can also affect the default decision. If house prices are falling, this can affect this decision in two ways. First, it limits the ability to refinance, and second, it can cause the homeowner's equity to become negative if the initial equity stake was small, as is often the case for subprime mortgages. Since the middle of 2005, the rate of house price appreciation has been continuously decreasing. There has been wide variation across the country with California, Florida, Michigan, Massachusetts, and Rhode Island having price depreciation. Consequently, there has been wide variation in subprime delinquency

rates across different metropolitan areas (see the report from the Office of Federal Housing Enterprise Oversight, August 30, 2007).

²²This phenomenon was exacerbated by the decline in subprime mortgage rates starting in 2004 due to increased price competition. This, along with the Fed increasing interest rates, reduced the profitability of lending. To offset this decrease, some originators reduced standards (see Coy [2007]). Evidence of loosening underwriting standards was first noted in 2005 in the Office of the Comptroller of the Currency's annual survey of underwriting practices at nationally chartered banks.

²³We will subsequently discuss why the CDO bonds were misrated. Briefly, the rating methodology did not reflect current market conditions, and there was an incentive problem in the way rating agencies were compensated for rating assignments.

²⁴Lenders were far too willing to lend as evidenced by the creation of new types of mortgages, known as *affordability products* that required little or no down payment, as well as little or no documentation of a borrower's income; the last ones being known as *liar loans*. Liar loans accounted for 40% of the subprime mortgage issuance in 2006, up from 25% in 2001. The Fed issued three cease-and-desist orders due to mortgage-related issues in the last four years: Citigroup and CitiFinancial Credit Company (May 27, 2004); Doral Financial Corporation (June 16, 2006); and R&G Financial Corporation (June 16, 2006). Ameriquest Mortgage Company (Aegis Mortgage Corporate and associated companies) set up a US\$295 million settlement fund to compensate borrowers for unlawful mortgage lending practices.

The state of the subprime market also attracted attention to industry practices in mortgage origination. The declining underlying standards and fraud is noted by Cole [2007] and Bernanke [2007a]. Morgenson [2007] identified some of the techniques used by lenders to increase subprime mortgages originations. These were often not in the best interest of the borrower.

²⁵In 2007, the Federal Bureau of Investigation was looking at over 1,200 fraud cases compared to 818 cases in 2006. In 2006, they obtained over 204 mortgage fraud convictions, generating US\$388 million in restitution and US\$231 million in fines (see Davies [2007]).

²⁶Consequently, these waterfall payment structures are often complex and difficult to model for risk management purposes.

²⁷Some of the material in this section draws from the publicly available information supplied by Moody's, S&P, and testimony given by Michael Kanef, Managing Director, Moody's Investors Services [2007], and Vickie Tillman, Executive Vice President, Standard & Poor's [2007].

²⁸Fitch [2008] reported numbers for the year 2007. Transitions from investment to speculative grade, including default, for U.S. structured finance show a dramatic increase.

²⁹Most of the US\$2.5 trillion sitting in money market funds is invested in such assets as U.S. Treasury bills, certificates of deposit, and short-term commercial debt. In the recent low interest rate environment these funds have also invested in triple-A super senior tranches of CDOs and triple-A rated ABCP, in order to increase the yield generated by these funds.

³⁰Rating agencies earn hefty fees for rating structured credit securities. In 2006, Moody's reported that 43% of total revenues came from rating structured notes.

³¹See Partnoy [2006]. The conflict between incentives and reputation is illustrated by the recent disclosure by Moody's on July 2, 2008, that management failed to inform investors on a timely basis that a computer program used to rate constant proportional debt obligations contained an error. Consequently, a number of credit ratings were overestimated by several notches.

³²In testimony to the Committee on Banking and Urban Affairs, both agencies stated that they accepted the raw data without any form of checking—for Moody's see Kanef [2007, Footnote 3] and for S&P see Tillman [2007, p. 7].

³³This pro-cyclicality in CE has the potential to amplify the housing cycle. See Ashcraft and Schermann [2007]. A rating that is *through the cycle* means that it underestimates the true probability of default in a recession and overestimates it in an expansion.

³⁴Some hedge funds aware of the problems in the subprime markets (these were public knowledge) and the failure of rating agencies to incorporate such information into their ratings, anticipated significant downgrades and declining prices.

³⁵To some extent this should have been mitigated by originators having to repurchase delinquent loans within a few months of origination (*early payment default clause*). However, as some of the brokers were experiencing financial difficulties and, in some cases, filed for bankruptcy, this did not occur which led to even greater losses on the underlying asset pools. For example, Merrill Lynch demanded in December 2006 that ResMae Mortgage Corporation, which sold it US\$3.5 billion in subprime mortgages, buy back US\$308 million of loans on which the borrowers had defaulted. ResMae said that those demands "crippled" its operations, in its filing for bankruptcy protection in February 2007. Accredited Home Lenders Holding reported a loss of US\$37.8 million due to repurchase of bad loans in February, 2007.

³⁶In June 2004, the New Jersey Assembly and Senate passed bills that rolled back parts of the earlier law, including the *tangible net benefit rule* that required lenders to prove that a refinancing of any home loan less than five years old would provide a *tangible net benefit* to the borrower. Thousands of New Jersey homeowners subsequently refinanced existing mortgages or took new loans with Ameriquest before the subprime market tanked. Many of these loans are now in foreclosure.

³⁷This section draws on material given in Polizu [2006].

³⁸The defeasance mode is the orderly wind-down by the manager of the portfolio. The enforcement mode occurs if the trustee undertakes the wind-down.

³⁹Capital notes are subordinated to senior creditors and rank *pari passu* with all other capital notes outstanding. Capital notes typically have a fixed maturity date. Each year the maturity is automatically extended for another year, unless the investor stops the automatic extension. This mechanism is termed “rolling capital notes.” Capital notes usually receive some minimum rate, payable at prespecified dates. The intention of the manager is to create excess spread above this minimum rate. Profits are shared between the manager (performance fees) and the investor (additional interest amount). Leverage for a SIV is defined as the ratio of senior debt (ABCP plus MTNs) to capital notes. Typical leverage varies in the 12–14 range.

⁴⁰A variant of a SIV is the SIV-Lite structure. In these types of vehicles, capital has a finite maturity. The vehicles typically hold residential mortgage-backed securities and home equity-backed securities. The fixed maturity implies that, at launch, the maximum permitted leverage is fixed through the life of the vehicle. This is not the case with a SIV.

⁴¹In the case of K2, Dresdner does not anticipate taking substantial losses as its assets are entirely investment grade and do not contain any exposure to subprime mortgages and related structured credit products.

⁴²In the event of a bond defaulting, the monoline agrees to make whole interest and principal payments on their respective due dates.

⁴³The only exception was ACA which was rated single-A and which guaranteed US\$26.6 billion of CDOs backed by subprime mortgages. As long as the monoline maintains its single-A rating, the counterparties don't require the monoline to post collateral even if the value of the securities it insured fell in value.

⁴⁴As mortgage delinquencies rose, so did paper losses. In November, the monoline CFIG, which had exposure of approximately US\$6 billion to the U.S. subprime market, received a US\$1.5 billion injection from two French banks. After the injection, Fitch reaffirmed CFIG's AAA ratings. MBIA and AMBAC wrote assets down by a combined US\$8.5 billion in the third quarter of 2007. There is now a general market concern that monolines have insufficient resources to honor their commitments. Recently MBIA added US\$3.5 billion in write-downs on its credit derivatives portfolio for the fourth quarter of 2007 and a US\$2.3 billion fourth quarter loss. MBIA has raised about US\$2.5 billion in capital since November and has plans for more, possibly involving obtaining reinsurance on portions of its portfolio. Fitch recently cut its triple-A rating to double-A on AMBAC, Security Capital Assurance, and FGIC, citing their failure to raise capital. Fitch also put the triple-A rating of CFIG on a negative watch, just weeks after

affirming its rating. In March, Moody's, then S&P and Fitch, downgraded CFIG from triple-A to single-A plus and rating agencies are now questioning the long-term viability of CFIG as a guarantor, as shareholders have declared they may not be prepared to recapitalize the monoline a second time. AMBAC benefited from a capital infusion of US\$1.5 billion, which allowed it to maintain its triple-A rating.

ACA might be the first monoline to file for bankruptcy. S&P slashed ACA's rating to CCC, a low junk level, from A in December 2007. The stock of ACA was de-listed from the New York Stock Exchange last December, and ACA is now on a runoff mode.

MBIA and AMBAC were downgraded to a AA rating in June 2008. FSA is the last monoline to be rated triple-A although it was put on negative watch by Moody's on July 21, 2008.

⁴⁵There is concern that banks might have to write down an additional US\$40–70 billion following the downgrade or bankruptcy of monolines.

⁴⁶A potential bailout of FGIC, the third-biggest municipal bond insurer in the U.S. with about US\$315 billion of insured bonds outstanding, is being led by Calyon, the investment banking unit of France's Credit Agricole. Other banks in the consortium include UBS, Soc Gen, Citigroup, Barclays, and BNP Paribas.

⁴⁷According to Eliot Spitzer, speed in resolving the monoline recapitalization issue is critical as the diminishing confidence in the monoline to meet their obligations has already hurt markets, such as auction-rate securities. Just before Eliot Spitzer's injunction, the auction-rate securities market, a US\$330 billion slice of the municipal bond market shut down. (These securities are also issued by student loan authorities, museums, and many others.) Investors stopped buying securities at regular municipal auctions because they were concerned about the fate of the bond insurers who guarantee around 80% of the entire market. The Port Authority of New York and New Jersey found itself paying a rate of 20% on US\$100 million of its debt, almost quadruple its cost a week before. Auction-rate bonds are initially sold as long-term securities, but are effectively turned into short-term securities through auctions where interest rates are determined by bidding that typically occurs every 7, 28, or 35 days. When there are not enough buyers, the auction fails and bondholders who wanted to sell are left holding the securities. Rates at failed auctions are set at a level spelled out in official statements issued at the initial bond sale.

⁴⁸It is not clear that this will help monolines keep their current credit ratings.

⁴⁹The plan advanced by William Ackman did directly address this issue.

⁵⁰In the U.S., banks are required to have a minimum level of reserves on average for a two-week period, known as a maintenance period. If a bank has excess reserves, it can lend

them in the fed funds market, and if it has insufficient reserves, it can borrow in the fed funds market. The Fed adds and drains credit from the market so as to keep the effective fed funds rate (the actual rate that banks borrow or lend) near the target official fed funds rate.

⁵¹This facility was used the first time by Lehman in April 2008. Lehman shifted around US\$2.8 billion in loans, including some risky LBOs it had been unable to sell, into a new investment vehicle it named Freedom, which issued debt with 20% subordination that was assigned a single-A rating by rating agencies and therefore was eligible as collateral at the PDCF of the Fed.

⁵²The decision to close one of the Synapse funds apparently arose due to the failure to reach agreement with its prime broker, Barclays Capital, about the valuation of assets held by the fund. The fund did not hold subprime mortgages (see Davies, Hughes, and Tett [2007]).

⁵³See the Statement of Financial Accounting Standards, rules SFAS 157 and SFAS 159.

⁵⁴Price is defined as the amount that would be received to sell an asset or paid to transfer a liability.

⁵⁵For a recent discussion and references to extant literature, see O'Brien [2005].

⁵⁶It was not clear what assets these structures held.

⁵⁷In the second week of August, Coventree, a Canadian investment firm, could not sell US\$229 million of commercial paper. Its shares fell by 80% before trading was stopped. Three days later, in the asset-backed commercial paper market, 17 Canadian issuers failed to sell short-term debt and sought financing from banks and the market closed down. The funds had backstop lines of credit. However, the criterion for usage is more restrictive in Canada than in the U.S. Canada requires a *general* market disruption. As some funds could still rollover their ABCP, some banks took this as evidence that there was no *general* market disruption and refused to honor their commitments, triggering the funding crisis in Canada. In Europe and Australia, many SIVs reported problems. For example, in Europe, Mainsail II, an affiliate of Solent Capital Partners (London), and Synapse Investment Management and, in Australia, Ram Home Loans, all reported problems in rolling over asset-backed commercial paper.

⁵⁸The fund agreed to waive its annual management fees.

⁵⁹Sowood played credit spread versus equity prices and was crushed when the spread widened, while equity markets did not fall.

⁶⁰King County, Washington, officials bought US\$53 million in Mainsail commercial paper, once rated AAA by S&P. It is now rated B. An official from the county is quoted as stating "we rely heavily on that [the rating]." (see Henry [2007]).

⁶¹SachsenLB had asked for the return of its investment in the fund. Synapse was unable to find alternative funding.

⁶²Some institutions do disclose the aggregate amount of such commitments. However, at this level of aggregation, the

investor does not know the types of firms or individual levels of support provided by the bank.

⁶³The size of U.S. money market funds is approximately US\$2.70 trillion, according to the Institute of Money Market Funds Association.

⁶⁴Credit Suisse recorded a third quarter loss of US\$128 million after removing assets from one of its money market funds. At the beginning of summer, it had money market assets of US\$25.5 billion and six months later these had sunk to approximately a quarter of that size. In November 2007, it transferred approximately US\$6 billion of the remaining assets onto its balance sheet to meet redemption claims. In December 2007, Columbia Management, a unit of Bank of America, closed its Strategic Cash Portfolio after withdrawals reduced the fund from US\$40 billion to US\$12 billion. Prior to the shut down, the bank had provided US\$300 million in support.

⁶⁵It is unclear how the fund would have avoided this issue if assets were purchased at market prices. At the end of the year, the three major banks abandoned the idea of the fund. It had met with a lukewarm response from other investors.

⁶⁶The asset values were reported to have fallen from US\$3.47 billion to US\$1.6 billion. Paribas stated the funds were invested in triple-A and double-A rated structures.

⁶⁷The problems of rating credit-related structures are currently illustrated by the ratings assigned to the monoline CIFG. As of June 8, 2008, S&P gives it investment grade A+ (negative), Moody's a Ba1, and Fitch a near-default rating of CCC.

⁶⁸Prepayments of principal include both voluntary and involuntary (default) prepayments. Voluntary prepayments depend strongly on the path followed by interest rates. Interest rate risk is a key source of uncertainty in the analysis of cash flows.

⁶⁹There are many different types of factors that influence default dependence. For example, if the local economy deteriorates, then defaults might increase, or if a particular sector of the economy deteriorates, this may adversely affect obligors within the sector.

⁷⁰The recent work of Chava, Stefanescu, and Turnbull [2007] examines the multiperiod loss distribution for single corporate assets.

⁷¹See Nomura [2006] for a discussion about bond rating confusion. The issues also extend to municipal bond ratings.

⁷²See Deventer [2007].

⁷³See the recent papers by Duffie, Eckner, Horel, and Saita [2006] and Chava, Stefanescu, and Turnbull [2007].

⁷⁴The same issue has been raised about the rating for municipal bonds compared to corporate bonds, as both default and recovery rates are quite different for the same rating.

⁷⁵Synthetic CDOs are structures that contain credit default swaps.

⁷⁶Schonbucher [2003, Chapter 10] provides a clear introduction to the topic of these pricing models.

⁷⁷Examples of such indices are the CDX and iTraxx for synthetic CDO structures, LCDX for loans, ABS for asset-backed securities, and CMBX for commercial mortgage-backed securities.

⁷⁸See Jarrow, Mesler, and van Deventer [2007].

⁷⁹The size of the CPDO market is only approximately US\$3.5 billion.

⁸⁰This was also the root of the problems for the British bank Northern Rock that caused the first bank run in 140 years in Britain.

⁸¹Adrian and Shin [2008] argued that mark-to-market accounting can cause procyclicality.

⁸²One recent proposal is for auditors to estimate the maximum losses for a financial institution and recognize these losses in the profits (see Guerrero and Hughes [2008]). Given that auditors have generally even less expertise than credit rating agencies at making such estimates and rating agencies have done a poor job in the current crisis, investors will be forced to rely on their own estimates without the benefit of market opinion. The outcome may be a “market for lemons” with even greater declines in asset values than under the mark-to-market framework.

⁸³The recent U.K. House of Commons Treasury Committee Report on the failure of the Northern Rock Bank notes the failure of the regulators to recognize the implications of positive feedback mechanisms.

⁸⁴On June 9, 2008, the head of the New York Federal Reserve suggested such a plan.

⁸⁵The recent announcement on March 31, 2008, by the Treasury Department of such a framework represents a start in this difficult process.

⁸⁶As of June 4, 2008, a start was made by the New York Attorney General; the agreement requires rating agencies to be paid for any preliminary work they do, irrespective of whether they are selected to give a final rating. This will help, provided that at least two agencies are employed and the details are made public.

⁸⁷VaR measures perform well under normal conditions, but are unable to capture severe market shocks.

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