

ANATOMY OF A MODERN CREDIT CRISIS

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The credit crisis of 2007 has been caused by multiple risk management failures by supervisors, individuals and financial institutions. It has been driven by a rapid increase in leverage at both the household and financial intermediary level, amplified by the development of credit derivatives. The dynamics of Value at Risk have been critical for both the upswing and downswing. Excess demand for high quality assets weakened market discipline in a lightly regulated environment. This paper discusses these mechanisms, the policy responses so far, and the likely implications for future policy and regulation.

1 Introduction

Credit crises are all similar. A long period of credit expansion, typically triggered by a financial liberalization or innovation, eventually leads to the buildup of imbalances that break at the weakest link. The events of the last few years played out according to this scenario: after a few years of rapid credit and asset price inflation were imbalances accumulated in several areas, global interest rates finally rose as a result of an increase in inflationary pressures and a shift in the asset allocation strategies of the saving countries, mainly Asian emerging markets (once their desired level of reserves had been achieved and started creating Sovereign Wealth Funds). This triggered the unfolding of the global imbalances. Unfortunately, the expansion in credit had not been done under safe and sound criteria and, once it became clear that the quality of credit growth had been dismal, the global credit bubble burst at its weakest link, the credit derivative architecture.

What makes this crisis different is the speed and violence of the correction, fostered by the prominence of credit derivatives. Prior credit crises unfolded in slow motion, as banks slowly recognized the deterioration of the quality of their portfolios and slowly took remedial measures. Prior credit crises were typically measured in years. This credit crisis, however, is happening at very fast speed, for three reasons. First, the weak assets, mortgages, are not in the balance sheet of the banks but rather in the hands of market participants in the form of asset backed securities. These asset backed securities have market prices, and thus the repricing has happened in an almost instantaneous form. Second, this crisis has been caused by a very sharp increase in leverage at both the household and financial institution level, amplified by the development of structured credit. The ensuing deleveraging process has been as sharp as the buildup. Third, structured credit has been both at the heart of the leverage buildup and at the core of the process of insuring this leverage buildup, generating dynamics similar to those of portfolio insurance. The combination of these three factors has been a very fast process of marking down of asset values, reduction of leverage, and asset sales.

The importance of the portfolio insurance dynamics (gamma selling in technical terms), triggered as the institutions who had sold credit default swaps as insurance devices had to hedge their positions once the credit bubble burst, cannot be underestimated. Because financial institutions had kept these positions unhedged, their "true" leverage was much higher than understood and the ensuing firesale of assets turned out to be very violent.

The implications for policy of this episode are important. It is clear that monetary policy, by itself, is not able to contain asset bubbles or its aftermath. In other words, leaning against the wind does not work. And it shouldn't, because that would imply using one instrument, interest rates, for two tasks. Overall, policy makers should aim at stabilizing risk over the cycle, and this should be achieved by a combination of monetary policy and activist macroprudential policy. As this episode is showing, macroprudential and liquidity policies try to introduce risk in

the system when market participants become extremely risk averse. Symmetry requires that these same policies, not interest rates, remove some risk from the system at times of extreme risk seeking behavior.

In the rest of this paper we discuss in detail the building blocks of this credit bubble, the diverging responses by the authorities, and the policy implications.

2 The building blocks of the credit bubble: a double leverage shock

The credit bubble was underpinned by an (ex-post) excessive increase in leverage in two critical sectors: at the household level – fueled by strong house price increases and the rapid development of subprime mortgages – and at the banking sector level – fueled by rising asset prices and very low volatility levels. This leverage boost was amplified by the development of credit derivatives. At the heart of this process is the central role of Value at Risk as a risk management technique. As these elements started to play in reverse a double process of liquidation (foreclosures and asset sales) increased counterparty risk and sparked a vicious financial accelerator circle. We discuss all of these dynamics in turn.

2.1 THE INCREASE IN HOUSEHOLD LEVERAGE: THE EVOLUTION OF THE US HOUSING MARKET AND THE EMERGENCE OF THE SUBPRIME PHENOMENON

The expansion of the US housing market followed the standard stages of a bubble. The initial surge was based on some fundamental factors, such as low interest rates, immigration and an increased desire to invest in housing as a store of value. Technological improvements in mortgage markets, such as better assessment and management of risks due to massive computing improvements, facilitated this expansion. After a few years, the expansion matured, speculation increased (recall the famous “pockets of froth” described by Alan Greenspan in 2005 and the multiples anecdotes of day trading with apartments and condos in Florida) and both activity and prices deviated from fundamentals. The last stages become a bubble, with the phenomenon of subprime mortgages and the weakening of underwriting standards at the heart of the final acceleration.

In fact, the US housing market experienced a period of buoyancy that accelerated after 2004. Real house prices grew by almost 35% in 2000-05 – a rate of growth more than double any five year period in the last decades. This very rapid pace of house price appreciation quickly generated an incentive for borrowers to very rapidly refinance their mortgages, in order to extract some equity and/or to improve the terms of their borrowing. Thus products designed to match this demand were developed, such as 2/28s ARMs, “interest only” ARMs, ARMs with teaser rates and option ARMs. Mortgage brokers, outside the supervisory control of the federal authorities, became leaders in this area – in 2005-06 they accounted for over 50 percent of new mortgage issuance – and underwriting standards quickly deteriorated. These products became increasingly popular with subprime and Alt-A (lower quality) borrowers because they required less documentation (or, in some case, no documentation at all, the now infamous “liar loans” and NINJA – no income, jobs or assets – loans), thus allowing for bigger purchases¹. The result was an increase in the leverage of the household sector as debt/income and loan to value ratios rose, on the heels of an already highly leveraged consumer with a barely positive savings rate².

For as long as house prices continued to raise the refinancing dynamic could continue and, despite their higher risk, mortgage delinquency rates stayed low (since about 2/3 of subprime

¹. Alt-A loans are loans issued to borrowers with good credit but which do not meet the definition of prime or conforming. Often they are issued to borrowers with limited or no income or asset verification and have high loan to value ratios. ². The increase in leverage was stark. A few statistics to illustrate: the combined loan to value rose from 80 percent in 2001 to 90 percent in 2006; 100 percent financing rose from 3 percent in 2001 to over 30 percent in 2006; limited documentation loans rose from 25 percent in 2001 to 45 percent in 2006; 100 percent financing and limited doc rose from 1 to 15 percent.

	YEAR 1	YEAR 3
Interest Rate	7.95%	10.44%
Payment	\$1,480	\$1,841
Mortgage Payment as share of gross income	48%	56%

SOURCE: International Strategy and Investment.

loans were refinanced in the first two years, the reset shock did not apply). This process accelerated in 2004-05, when the subprime phenomenon evolved rapidly – subprime and Alt-A represented about 40 percent of total mortgage origination in 2005 – and became the key factor for final leg up in US house prices as lenders reached lower in the credit distribution, leading to a sharp increase in homeownership, especially among the young – homeownership rose from about 64 percent in 1990-94 to almost 70 percent in 2004.

The critical issue is that this process was sustainable only as long as home prices continue to increase because the financial burden that these loans imposed on borrowers was very high. Table 1 shows a typical subprime loan, a 2/28 ARM, and demonstrates that if the loan cannot be refinanced after two years because home prices have stop increasing, then the payment increases by 30 percent and represents over 50 percent of income. In other words, households were leveraging their balance sheet hoping that future payments would be lower than expected, de facto basing their borrowing decisions on the conditions of the first two years of the loan – thus increasing, knowingly or not, their leverage. No wonder that housing valuations rose well above historical averages: the percentage of average disposable income required to service the mortgage on an averaged price home rose from about 15 percent in the 1990s to well above 20 percent in 2004. With so much leverage, it is not surprising that delinquencies of the 2006 subprime vintage have already exceeded the levels of the 2000 mortgage vintage, the worst performing of recent years.

2.2 THE INCREASE IN BANKS LEVERAGE, SECURITIZATION, CREDIT RISK TRANSFER, AND THE PROCYCLICALITY OF LEVERAGE

Securitization improved the risk management of the financial sector, but it also allowed to leverage up and spread the US housing boom. Securitization (repackage assets to sell to liberate capital for further intermediation) and credit risk transfer techniques (separate and repackage the different risk characteristics of assets to improve and diversify risk exposures) changed the way the banking sector operates, moving from a traditional model of “originate and hold” (loans were originated by banks and kept in the balance sheets) to “originate to distribute” (loans are originated by banks and quickly sold to market participants). Very quickly an important portion of the lending business became a volume business, where proper valuation of risk became secondary to rapid volume, and thus fee income, generation.

Highly profitable fees from the securitization business boosted the supply of credit derivatives, which was met by an increased global appetite for credit risk exposure, thus leading to the rapid expansion of the global credit derivatives markets. Asset backed securities slowly moved from mortgages into credit cards, commercial paper and corporate loans, and the process of credit risks transfer exploded³. Being standardized products, credit derivatives were considered as easy-to-understand, high yielding products [see Duffie (2007)].

3. According to the BIS, the notional value of OTC derivatives doubled between 2000-03 (100 to 200 trillion usd) and then again between 2004-07 (200-400 trillion).

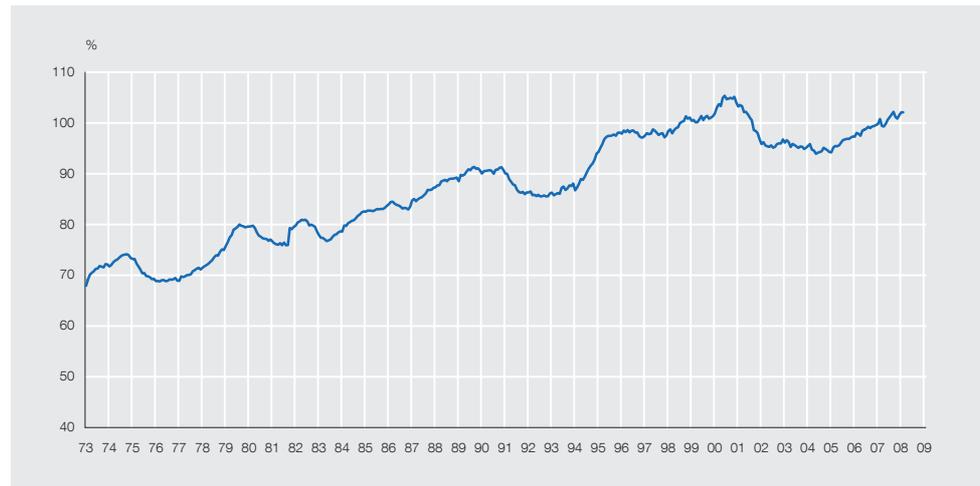
The model of originate to distribute allowed originators to separate the fee income from the risk of the mortgage; in a standard principal-agent problem, this resulted in, at the margin, lower underwriting standards⁴. As it happens in almost every banking crisis, the source of the problem was lending based on collateral values, not on expected capacity to repay. The final result was an increase in system-wide risk. Focusing on volume, loan officers reached lower in the credit quality scale in order to generate more loans, while transferring the assessment of risks mostly to investors⁵. Anecdotal evidence suggests that banks issuing collateralized loan obligations (CLO) increased target loans by a significant amount – thus there was an important volume of loans that were made to sell. Securitization allowed for (ex-ante) lower cost of credit for individual banks and, in fact, banks who bought and sold loans had lower capital ratios. In addition, some of this risk was transferred outside the banking system to institutional investors, pension funds and finance companies. Thus, intermediation declined at bank level and increased at the investor level – who, however, is less willing to be a shock absorber in case of systemic stress. In addition, banks typically retained the equity tranche of structured products – which is illiquid and more vulnerable to macro performance and systemic events⁶. Thus, the end result was lower ex-ante risk at the individual institution level because of diversification, but similar or even higher systemic risk as the exposure to macro events that increased correlations increased and the capacity of the system to absorb systemic shocks declined.

As with any financial innovation, increased complexity and opacity were the byproduct of securitization and risk transfer, and investors became more reliant on rating agencies to assess risks. Through the repackaging process, as we explain below, a large share of subprime and risky assets were converted into leveraged AAA assets. Thus, the inherent risk of the financial system is expanded twice, first through the declining underwriting standards and then through the increase in leverage facilitated by complex securitization. The ultimate consequence of opacity and complexity is an increase in the total risk of the financial system.

In addition, the model of originate to distribute model is highly dependent on the existence of continuous liquidity – no demand for securitized loans, no loan growth – and thus banks had made themselves less liquid (see Chart 1). In the old model, banks were risk absorbers, during bad times they would hold the loans to maturity, having provisioned accordingly during good times. In the “originate to distribute” models the final holders of the loans are not risk absorbers, but risk managers – and if the risk increases they may just dispose of it. In the event of a negative shock demand for these products may just disappear, breaking down the system. In some sense, the new model is more resilient to small shocks where liquidity remains abundant but more fragile in the event of a large shock where liquidity vanishes – as a large part of intermediation is now performed by entities that are not shock absorbers but rather leveraged players.

The development of “originate to distribute” also enabled banks to stabilize their profitability – the focus shifted from interest rate spread and credit risks into more stable fee income, lead to less cyclical earnings and higher share prices, facilitating the leveraging of the balance sheet. Rising asset prices and historically low volatility allowed banks to increase their leverage while maintaining roughly stable levels of Value at Risk (VaR), thus resulting in procyclical increases in leverage (Chart 2). This allowed banks to profit from what essentially were “selling volatility”

4. An interesting fact is that loans at the 620-625 FICO score, which is the cut-off for securitization, have higher delinquency rates than the loans at the 615-620 FICO score, which could not be securitized. 5. Ashcraft and Schuermann (2008) discuss the problems of predatory lending, moral hazard and adverse selection associated with the securitization of subprime loans. 6. Banks keep the worst quality loans because there are expensive and less cost effective to sell [see Duffie (2007)].



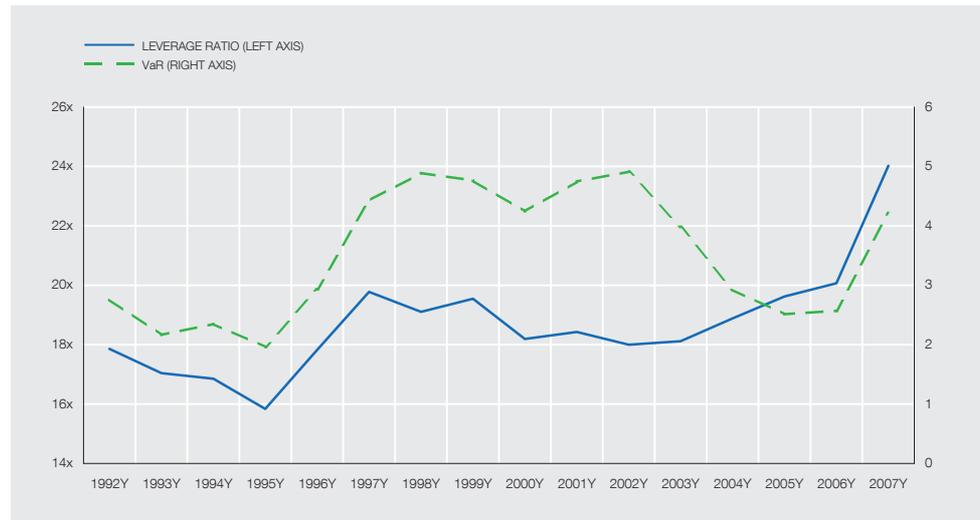
SOURCE: Federal Reserve.

strategies: origination and sale of complex credit derivatives products that generated high fees but that, when banks kept a portion of it, generated a covert high exposure to tail risks. This exposure to tail risk was not easily captured by standard VaR models because of the novelty of these products and the lack of time series to stress test portfolios, and thus leverage increased⁷.

Another development that contributed to the increase in leverage in the financial sector was the LBO boom. This was highly profitable, but involved two risks. On the one hand, credit quality deteriorated rapidly in the LBO market as demand rose. Higher leverage and weaker underwriting – with covenant lite and payment in kind toggles – pushed deals towards riskier companies and increased the riskiness of the loans. On the other hand, the LBO boom was financed mostly by leveraged loans, rather than by high yield bonds, sold through a syndication process and driven in part by the expansion of the CLO market. This increase in syndication contributed to the distribution of risks across market participants, but raised an important risk for the banking sector: the multi month process of syndication implies that banks have to provide bridge financing and/or underwrite the provision of the leverage loan. If market events make the deal unattractive during this “processing” period, the banks will then have to carry in their balance sheets highly leveraged loans that they were not counting on.

In any event, why did market discipline fail to price assets properly? The critical failure was that when market discipline is to be exerted by a new market where there is excess demand, market based discipline is bound to be suboptimal. In fact, there was abundant excess demand for structured credit products, as market participants were searching for yield in a low interest rate environment. Further, there was plenty of excess demand from emerging markets suffering from asset shortages to invest their excess reserves and oil proceeds and from private pension funds in need of higher yield to solve their demographic problems. In addition, declining deficits led to a decline in the stock of AAA sovereign bonds and CDOs were considered a better investment than corporate bonds because corporate bonds lose about 50% in case of default while CDOs were less exposed to the default of any of their component. Finally, a “need

7. The role of Value at Risk is critical. With rising asset values the value of capital increased and with lower volatility the VaR of a given position size declined. This double effect led to an increase in balance sheet sizes, as the chart shows.



SOURCE: SNL.

- a. Tangible Assets/Tangible Equity.
- b. Tangible Assets*Volatility/Tangible Equity.

to be in that market” mentality was created for reputational reasons, which may explain why banks were both principal and agents and manage to suffer large losses⁸.

2.3 CREDIT DERIVATIVES AND THE CURSE OF AAA RATINGS

The role of rating agencies was critical for this credit expansion. At the heart of the credit expansion was the increasing ability of financial markets to handle and manipulate risks – to slice and dice risk and then redistribute it in a more efficient manner. The necessary element of this process is an increase in the complexity of the credit products, thus the development of the so called structured finance. The increased complexity created value by allowing for a more efficient evaluation and distribution of risks but, at the same time, reduced the ability of investors to properly evaluate their investments, and increases the role played by the rating agencies as delegated monitors. Thus, rating agencies became critical for the process of transformation of risk - anecdotal evidence shows that downgrades of structured finance products have a larger impact on prices than downgrades of bonds, suggesting that investors rely more on ratings for the monitoring and price discovery of these products.

Securitization implies that the loan originator will likely sell the loan to a third party. The third party will package the loan with others and sell the payment rights to investors in the form of Asset Backed Securities (ABS). For example, MBS are bonds whose payments are based on payments of a collection of individual mortgages. As payments are collected on the mortgages, these are passed through to the bond holders. Principal payments on the mortgages are used to pay down the principal on the bonds.

Securitization also involves the allocation of risk of the underlying loans to the investors. There are three major risks with any loan: interest rate risks, prepayment risk and default risk. These risks are allocated and distributed using overcollateralization, excess spread, and subordination. Overcollateralization is the difference between the principal balance on the loans and the principal balance on the outstanding bonds. Excess spread is the difference between the interest payments coming in and the payments to the bondholders.

⁸. See the discussion in Ferguson et al. (2007).

The key innovation in structured credit is subordination, or tranching, which involves issuing different classes of bonds that differ in their bankruptcy priority. Senior bonds have bankruptcy priority, so that if the underlying loans default the first losses are taken by the subordinated classes – some structures have as many as 6 layers of subordination, facilitating the AAA rating for the most senior layer. These ABSs cover a wide range of loans, including mortgages, home equity loans, car and personal loans or corporate loans, and are typically monoline – that is, they include only one type of loan. In addition, they are typically pass-through instruments: the underlying assets are the flow of interest rate and principal payments.

The next step in the securitization process is re-securitization. Different types of ABSs are pooled and securitized in what is typically known as Collateralized Debt Obligations (CDOs). CDOs are like ABSs, with the only difference that the underlying assets are not flows, but bonds. Conduits and Structured Investment Vehicles are similar to CDOs, with the only difference that Conduits and SIVs finance themselves in short term markets (commercial paper markets) issuing Asset Backed Commercial Paper (ABCP) while CDOs issue longer term bonds. CDOs are typically high grade (average rating A) or mezzanine (average rating BBB), and purchase collateral diversified by issuer, collateral type and rating. CDOs allowed for a highly leveraged investment: through the purchase of equity in the transaction, the equity investor can gain leveraged exposure to 100 percent of the assets while dedicating only 3-5 percent of capital. At the same time, the AAA tranches were considered safe investments, with the only hidden downside that the value of a senior CDO tranche is a negative function of the correlation of the package of assets – it is the most exposed to systemic risk.

Pooling and tranching are the devices that allow for the process of transformation of risk. Pooling implies that the evaluation of the risk of a security depended on the whole loss distribution of the underlying asset pool which, because it included a menu of diversified assets assumed to have low cross-correlations of default, was lower than that of the individual underlying securities. Tranching allowed the creation of classes of securities whose rating is higher than the average rating of the underlying collateral. As we have indicated, the priority ordering of payments across tranches provided a critical source of credit enhancement: the most senior tranches are insulated from the average default risk of the asset pool through the absorption of losses of the lower (equity and mezzanine) tranches.

Thus, rating collateralized debt obligations (CDOs) requires attributing a probability of default to each obligor within the portfolio and involves assumptions concerning recoveries and correlated defaults of a pool of assets, thus combining credit risk assessments of individual collateral assets with estimates about default correlations and other modeling assumptions. Rating agencies use complex models to size the credit enhancement for a given CDO tranche and rating. The higher the complexity, the higher the model risk – therefore, an important part of the higher yield of these securities relative to equally rates single obligor securities is related to model risk. And model risk is highly vulnerable to time-variation in correlations and recovery rates, with correlations very likely to converge towards unity at times of stress. The real problem was the lack of good models for default correlation [(Duffie 2007) argues that the standard practice was to calibrate them to CDS tranches].

Due to the pooled nature of structured finance, and their inherent diversification, they were expected to have higher average ratings stability – in other words, the volatility of structured finance ratings is lower than for comparable corporate bonds, although the average number of notches per rating change is higher, reflecting the higher leverage. Therefore, ratings are changed less often but by more. And, even in their short history prior to August 2007, CDOs had an empirical ratio of downgrades to upgrades much higher than corporate bonds.

The key conclusion is that, despite the apparently similar rating, an AAA CDO tranche did not have similar risk characteristics as a AAA corporate bond: average probabilities of default were similar, but the tails of the distribution were fatter for the CDO. In other words, their ratings were more stable but had a greater likelihood of tail events. Their stable rating history and higher yield made them a very attractive proposition for investors, but their higher leverage (note that a CDO security is, de facto, leveraged several times, with an equity tranche of only 5 percent) and exposure to tail risk made them a potentially very risky investment in times of market stress, especially when hit by a systemic shock. This apparent stability led investors to apply high levels of leverage to the AAA and super senior tranches – to extract a good return from a security that pays a small spread one has to apply a very large size – which turned out to be fatal when this stability broke down.

The case of the super senior ABS CDO tranches deserves special attention. Losses in Super Senior ABS CDO tranches, which were supposed to be even safer than the AAA tranches, have represented the lion share of the losses of the crisis, as the key assumption that the junior tranches were large enough to absorb the losses proved to be wrong – and they were accumulated in size by the investment banks who created the CDOs as there was less demand for them and, in any case, were considered a “safe” investment.

3 *The burst of the bubble*

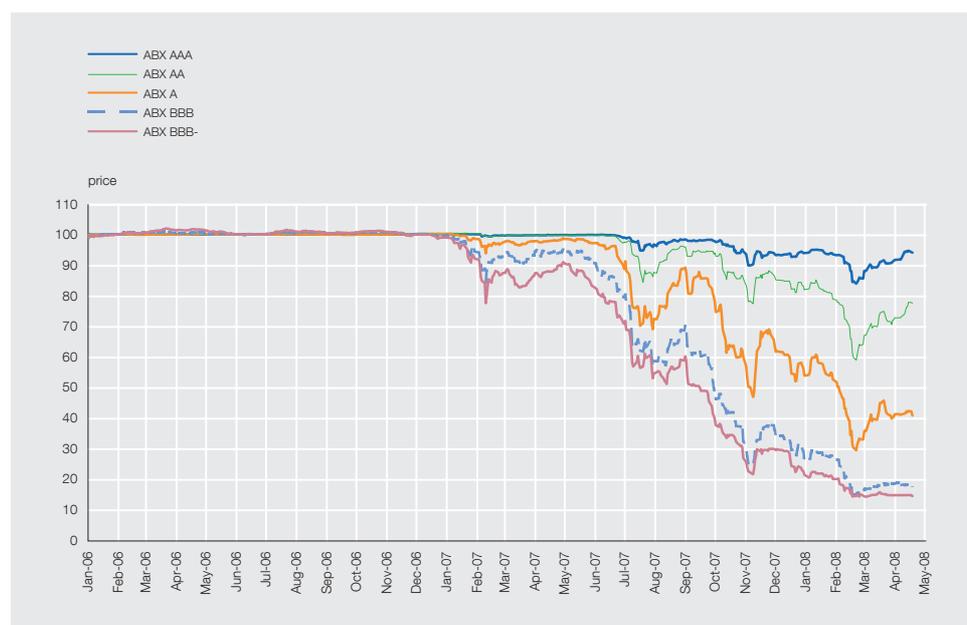
The chronology of events is by now well known. Following several weeks of dismal news on US housing, negative news on the financial sector and a slow widening of risk spreads, on August 8 BNP Paribas announced that it would not be able to meet redemptions on two of its investment funds. This was the final straw that broke the camels' back: markets seized up and the ECB had to inject emergency funds into the market, with the Fed and other central banks following suit⁹. The first reaction back then was to characterize this as a liquidity crisis – some banks were having undue difficulties in securing funds in the interbank market, and thus central banks reacted by providing extra liquidity through open market operations. Many central bankers and academics started smiling with an “I told you so, there was so much excess liquidity, this was bound to happen”, and adopted a tough anti-moral hazard stance. A few months later and many billions of dollars of extra liquidity injections, however, the situation in money and credit markets has not improved much. Central banks have added liquidity to a situation of already “excess liquidity” to tackle an apparent liquidity crunch, and yet nothing has got better. Perhaps it was not about liquidity, after all. In fact, events have demonstrated that the solvency of the global financial system was under severe threat.

3.1 DIAGNOSIS OF THE CRISIS – A VaR CRISIS

This crisis represents the unraveling of the leverage build up described above. It can be described as a combination of reduction in the value of global collateral, deleveraging, reintermediation, and increase in risk aversion. And in order to fully understand that process, it is critical to understand the dynamics of Value at Risk (VaR). Financial intermediaries use VaR as a risk management technique. Essentially, the VaR measures the expected loss of a portfolio under normal circumstances. It is defined as the position size (S) times a measure of volatility (V) and divided by capital (K), thus $VaR = (S \cdot V) / K$. The hypothesis is that financial institutions would want to stabilize the VaR – as we argued above, the decline in V and the increase in K during the upswing allowed financial intermediaries to increase S, increase their leverage. As the bubble burst, all the forces started to play in the opposite direction, in a self-reinforcing vicious cycle.

When the US housing market started to slow down and delinquencies started to rise, the value of many of the mortgage derivatives, especially those packaging the later vintages of

9. See Ubide (2007) for a discussion, from the view point of late September 2007, of the events.



SOURCE: Bank of America.

subprime mortgages, had to be revised down. A local shock, the US housing crash, became global through the worldwide sales of mortgage derivatives. As a result, the wealth of US households declined and the holdings of assets of many financial market participants were marked down in value. Thus the value of both household and financial sector collateral declined.

Note that, for the financial intermediaries, this mark down happened in an abrupt way. Despite a steady deterioration of the fundamentals of the US housing market since 2005, most of the mortgage derivatives had been kept in the books at face value – most of these derivatives were illiquid and rarely traded, and thus there were no available prices to mark them to market. As Chart 3 shows, the ABX index was very slow to react and was trading at par until mid 2007. Thus, what should have been a gradual downward revision of values that should have inhibited further leverage buildup took place in a drastic manner in the few months following the summer of 2007. In fact, it is telling that, when the two Bear Stearns hedge funds were going to be liquidated in July 2007, an auction was organized to sell the assets. This auction was suspended because, had it gone through, prices would have been created for many of these assets hitherto kept at par and thus banks and funds would have been forced to mark down to value their assets as a result. Price discovery was being avoided. But, in late 2007, the rating agencies engaged in sudden, massive downgrades of historically unprecedented proportions, and very drastic mark downs ensued¹⁰.

At the household level, the shock has been equally strong. By late 2007/early 2008, house prices have declined by 10 percent, according to the Case-Shiller index; foreclosures and repossessions had increased almost 100 percent with respect to the previous year; almost 9 million homeowners are estimated to have mortgage balances equal or greater than the value of their homes; almost 6 percent of all mortgages were delinquent, the highest in 23 years;

¹⁰ For example, Moody's downgraded 198 triple A-rated ABS CDO tranches. More than half of the downgrades exceeded 7 notches (Aaa to Baa1); 30 were downgraded 10 or more notches to below-investment grade; and one was downgraded 16 notches from Aaa to Caa1. To provide some reference, since 1970 Moody's has never downgraded a triple A-rated corporate bond more than six notches in a single step.

and, for the first time since the records started in 1945, Americans' percentage of equity in their homes has fallen below 50 percent.

As discussed above, banks had been following strategies of holding AAA rated assets that yielded more than government bonds and could be financed at low rates in money markets. The crisis unveiled that, in order to free space in the balance sheets and further enhance profitability, many of these assets were held by banks off balance sheet – so as to lower the capital cost of holding these riskier assets – in the now well-known conduits and SIVs, funded by commercial paper issuance. As the CP market dried up and conduits and SIVs had to be brought into the balance sheet, the result was a realization that banks had too much leverage: the size of their balance sheet was higher than previously thought (thus increasing S in the VaR) and losses dented the banks' capital (thus reducing K in the VaR). Further complicating matters, many positions had been hedged using credit default swaps. As counterparty risk increases, the value of these CDSs declined and the hedge became less than perfect, thus further increasing the leverage¹¹. Therefore, to stabilize the VaR, S had to be reduced: some assets had to be sold in order to reduce the leverage, which implies granting fewer loans and sometimes selling assets at any price – potentially creating firesales of assets and downward price spirals.

The role played by the insurance role of CDSs cannot be underestimated. Investment banks had been very active in the business of selling protection (CDS) for a fee, mostly to holders of ABS. It was a very profitable business, with the hope that the event they were insuring against, namely a sharp negative economic shock, probably associated with a hard landing in the US housing market, was a very low probability event. However, when the probabilities of loss started to rise, the insurers had to hedge their positions to cap losses, generating very strong selling pressures that can result – as it did - in non-linear asset price moves. In other words, the CDSs operate like put options, and they generate downside gamma selling pressures – with dynamics very similar to those of portfolio insurance that generated the 1987 stock market sell-off¹².

The unexpected increase in delinquencies induced many market participants to think that, all of a sudden, the ratings supporting many of these credit derivatives were suspect and that all banks were potentially at risk, thus leading to a sharp increase in counterparty risk (see Chart 4). This created important dislocations in interbank markets and *libor* spreads have since remained very wide (see Chart 5)¹³. From that point onwards, the appetite for complex derivatives plunged and a flight to simplicity ensued (see Chart 6). As a result, risk aversion and volatility increased and the demand for risky assets declined – thus increasing V in the VaR, and inducing a corresponding decline in S .

The reduced demand for risky assets implies that banks are less able to sell their loans and mortgages – and thus have to keep them in their balance sheets. There is therefore a substantial reintermediation of credit, with three consequences: first, banks may run into regulatory limits as their balance sheet suddenly expands; second, banks need more cash to service all these new commitments and become reluctant to lend just in case further surprises appear;

11. This is the key reason why the soundness of the monoline insurers became so critical at some point, they were key providers of CDS protection for many banks. **12.** Gamma is the rate of change of the delta of an option with respect to the change of the price of the underlying asset. The delta of an option is the rate of change of the price of the option with respect to the change of the price of the underlying asset. Thus, gamma refers to the second derivative, and generates accelerated price changes. **13.** As securitization dried up banks had to resort to corporate bond issuance for funding, but they refused to issue debt at higher spreads for cost and reputational reasons. Therefore banks increased their interbank lending as a transitory solution, shortening the maturity of their funding. This created tension in the interbank markets and led to the sharp widening of *libor* spreads.



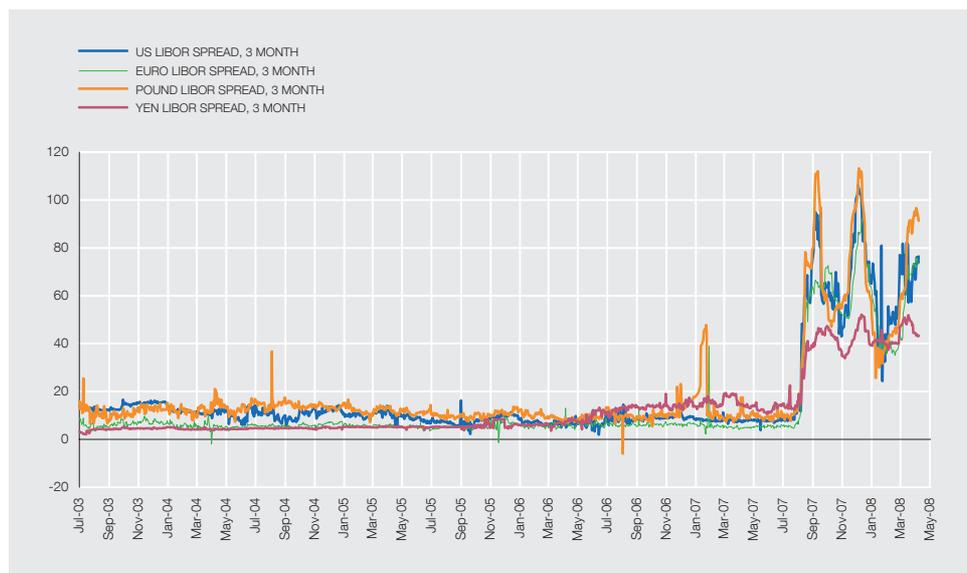
SOURCE: Bloomberg.

third, banks realize that everybody has increased its leverage and become reluctant to lend because counterparty risk has increased. In VaR terms, S increases more than desired. For these reasons, banks hoard cash and further reduce leverage, sharply increasing the procyclicality of the financial system. As central banks inject liquidity, banks just accumulate more and more. The system is in a liquidity trap.

What is the right response from a risk management standpoint to a sudden decline in capital and increase in leverage, volatility and uncertainty? As the VaR increases (measured VaR at financial institutions has increased by 50-80 percent using recent volatility estimates, and up to 200 percent in the worst cases), risk managers have to reduce S – reduce positions dramatically – and, if possible, increase K , but this is difficult and costly at times of financial stress. Thus, financial intermediaries reacted to the crisis by engaging in capital preservation strategies and become extremely cautious. Instead of multiplying credit, banks are restricting credit, creating a strongly contractionary force in the economy. The negative financial accelerator is at play.

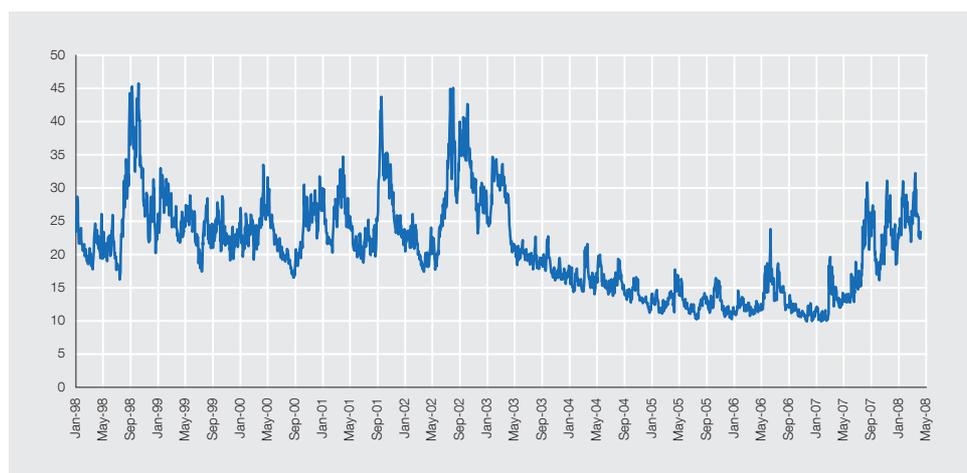
In addition to losses that have led to capital preservation strategies, banks have been hit with funding shortages. Three main sources of funding stress have been clogging the balance sheets: warehoused portfolio of mortgages and HY bonds; leveraged loans that had not been able to syndicate; and backstop liquidity lines to SIVs/conduits that had to be executed, in many cases for reputational reasons. The increase in counterparty risk amplified the funding crunch, which materialized in several forms, including margin calls, higher haircuts on securities (even on Treasuries), inability to roll over short term paper, or redemptions at investment funds. In general, banks were facing a standard maturity mismatch problem, funding increasing portions of long term assets with short term funds. As the funding crunch intensified, banks increased their precautionary levels of funding, thus compounding the problem. This increasing reliance in short term funds and wholesale funding made the system very vulnerable to a “market run”, as it happened – with Northern Rock in the UK and Bear Stearns in the US being extreme cases.

The process of loss recognition is likely to be long lasting because the “true” value of the underlying assets, subprime loans, is not going to be known for a long time. As the US housing market continues to deteriorate and house prices decline, the estimates of the potential total



SOURCE: Bloomberg.

VIX INDEX



SOURCE: Bloomberg.

decline in house prices are revised upwards and the potential total losses for the global financial sector are thus being revised upwards. Estimates started around 100 billion USD and are now approaching a trillion USD, of which over 200 billion have been recognized as of April 2008¹⁴. In addition, valuation is very difficult, as many of these credit derivatives are highly illiquid and demand has dried up, and therefore there are no market prices (thus the proliferation of 20/90 situations, assets for which there is a 20 bid and 90 offer), or prices have overshoot to the point of implying truly disastrous scenarios. In this environment, the question of what the “right” price is to mark to market a portfolio of such assets becomes critical, and auditors, supervisors, bankers and market participants may have very different views, leading to calls for a suspension of mark to market accounting. Until the US housing market finds a bottom and estimates of losses can be made with more confidence, uncertainty about the soundness of the banking sector is likely to persist.

14. See IMF (2008).

4 Policy responses and implications

In a nutshell, this crisis is the result of a risk management failure at multiple levels. At the supervisory and regulatory level for allowing the deterioration of underwriting standards and the excessive buildup of leverage, at the banking level for failing to perform due diligence on the structured credits that they were intermediating and for failing to engage in a comprehensive approach to risk management that contained the short volatility strategies, no matter how profitable they may have been. Clearly, some risk managers did not understand how costly, in terms of potential risks, these profits were (see Chart 6). And, needless to say, the rating agencies failed to perform their role of evaluators of assets.

There are several policy implications of this episode. First, this crisis was not primarily the result of interest rates being too low. For any given risk free rate, banks can always choose which level of leverage to run, and it is now clear that banks chose, in some countries, to run highly leveraged portfolios. The way to stop this leverage buildup would have been tighter supervisory control, not higher interest rates. It has been the quality, not the quantity of credit, what has created this crisis. In fact this leverage problem has occurred in countries with very different monetary policy approaches to asset prices and different monetary policy stances. The phenomenon of subprime mortgages was a function of weak underwriting standards and excess demand for the asset class, not of low interest rates¹⁵. Whether these exposures were on or off balance sheet is a critical determinant of where the surprises are, and that is a supervisory failure, not a monetary policy failure. The debate of monetary policy and asset prices suggests that monetary policy should deal with two objectives, price stability and financial stability, but we know that tackling two objectives with one instrument is not an efficient arrangement. Monetary policy should ensure price stability, macro prudential supervision should ensure that risk management at the financial institutions' level is appropriate, and both should work together. The debate of whether monetary policy should take asset prices into account and lean against the wind was thus focusing on the wrong problem and demanding too much from one instrument. An extra 50 bp increase in interest rates here or there would have not precluded the deterioration of underwriting standards. It looks as if policy makers have been looking under the wrong lamppost.

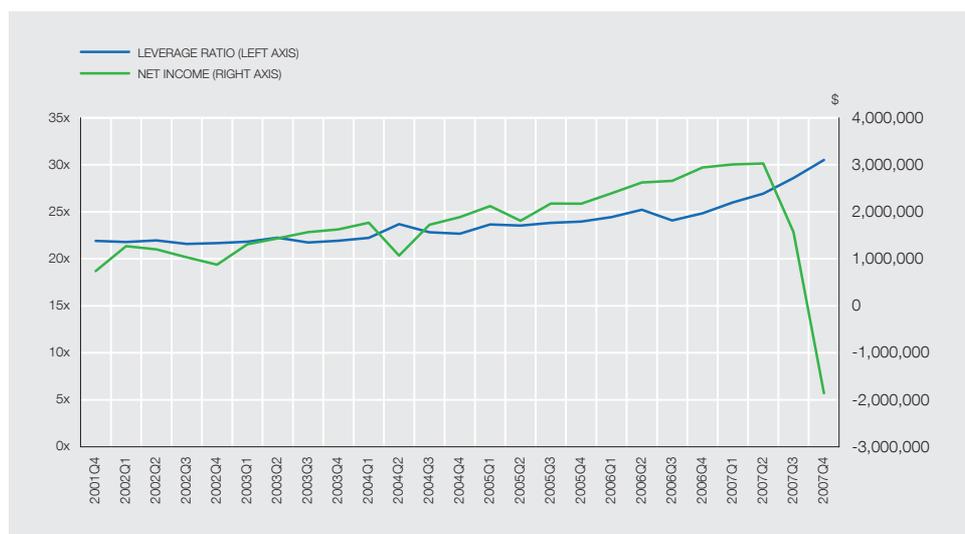
In this respect, the case of Spain, a country with one of the most overvalued house markets by some metrics and one of the loosest monetary policy stances (it has enjoyed negative real interest rates for many years now), is illuminating. It has little or no subprime problems and its financial sector has not engaged, as far as it is known, in the leverage buildup that is at the heart of the current crisis. The Bank of Spain simply did not allow a deterioration of underwriting standards in the mortgage market – despite heavy use of securitization¹⁶ – and forced banks to keep the SIV on balance sheet, and thus remain properly capitalized. In addition, it implemented a system of statistical provisioning to lower the procyclicality of capital ratios that implies that, now that the crunch is taking place, Spanish banks have provisions worth about 200 percent of risks, compared to barely above 50 percent in the rest of the G7. It shows that the right macro prudential settings can offset a given stance of monetary policy.

Second, monetary policy must adopt a multi-pronged approach with a risk targeting strategy. The different responses of the different central banks to the crisis have been telling. In one extreme, the Bank of England adopted a very tough approach to liquidity provisions, relying on its standing facilities until December 2007, when it expanded the menu of collateral accepted at the money market operations. In the other extreme, the ECB already had a very wide menu

¹⁵. See Mian and Amir (2008) for a very detailed microeconomic analysis of the mortgage markets in different US States which supports this point. ¹⁶. An important reason why underwriting standards help up may be that Spanish banks used securitization as a funding technique not as a risk management technique, keeping the equity tranche in their balance sheets.

BANK PROFITS vs. TANGIBLE LEVERAGE RATIO OF LARGE U.S. COMMERCIAL AND INVESTMENT BANKS

CHART 7



SOURCE: SNL.

of collateral and actively managed the provision of liquidity by extending the maturity of the funding. The Fed stayed somewhere in between, cutting rates drastically, including at the discount window, but only reluctantly expanding its liquidity operations to accept a wider set of collateral, extend maturities and include the investment banks¹⁷. In some sense, the Fed has converged towards the ECB model, expanding the range of counterparties in its liquidity operations – the primary dealer system has proved to be very rigid at times of extreme funding pressures – extending the terms and increasing the amount of risk it takes on the balance sheet. Critically, that is what is needed in periods of sudden and extreme risk aversion and rapid deleveraging, central banks have to inject risk in the system by taking risk into their balance sheets. In other words, central banks have to stabilize risk aversion as the means towards price stability. The Fed’s opening of the discount window to primary dealers appears to have been effective in this regard, putting a bottom on the probability of default of banks. The next step, if secondary mortgage markets remain closed and the overhang of MBS continues to clog balance sheets, should be a long term swap – say one or two years – that removes MBSs from the banks’ balance sheets and allows them to return to their business of lending¹⁸.

Third, moral hazard has to be dealt with during the upside rather than during the downside. It is clear that, from a political standpoint and especially if the asset is housing, it is very difficult to adopt anti-moral hazard policies when asset prices are spiraling downwards – and even more if the poorer classes of the population are affected, as it is the case with the sub-prime problem in the US. It is also clear that in today’s integrated capital markets, with bank’s business model heavily exposed to liquidity runs, the system is more resilient to small shocks but more fragile to big shocks, and thus considerations of “too big or too many to fail or to unwind in an orderly fashion” have become more prominent – in other words, the distinction between liquidity and solvency is becoming thinner, for this episode has shown that banks

¹⁷. See Federal Reserve Bank of New York (2008) for a discussion of all actions undertaken so far on the liquidity front. ¹⁸. There are three steps in the resolution of any banking crisis: close the bad banks, recapitalize the good banks, and remove the non performing loans from the balance sheets of the banks so that they can devote their time and energy to new lending. The first two steps are happening, the third one is not. Removing the MBS for the balance sheets would be akin to temporarily “suspending” mark to market until the US housing market finally finds a bottom and MBSs can be valued accordingly.

currently can't easily stand liquidity crunches. Past historical examples¹⁹ and the rescue of Bear Stearns show that, in general, moral hazard becomes secondary when the stakes are high. In the Bear Stearns case, equity holders did suffer but creditors were made whole by the rescue.

The corollary of these conclusions is that all systemically important banks should be under tighter control by central banks. The principle, included in Treasury Secretary's Paulson proposal, that only banks enjoying an ex-ante explicit government guarantee should be tightly regulated is clearly inadequate, for the rescue of Bear Stearns and the opening of the discount window to investment banks makes clear that investment banks did enjoy an ex-post government guarantee – and, as the evolution of the banks' CDS shows, markets interpreted those moves as reducing sharply the default risk of investment banks. In other words, despite multiple denials, markets understand that all investment banks bigger than Bear Stearns are too big to fail. The concept of “constructive clarity”, introduced last year by the Swiss National Bank – whereby systemically important banks discuss, ex ante, contingency plans with the authorities for the event of episodes of financial stress – should become the rule rather than the exception. With it should come a tighter supervisory control that prevents a repetition of the excessive leverage buildup and thus includes bigger capital cushions, tighter controls on risk management structures, stricter stress testing that incorporates recent events (when so many 10 and 20 sigma events happen, perhaps they are not 20 sigma events, perhaps the underlying distribution is wrong), and the elimination of incentives to manufacture “loans for sale” (by providing incentives for the issuance of covered bonds instead of MBSs)²⁰ All of this should be possible within the framework of Basle II, it is up to supervisors to be determined and demand it. In addition, serious consideration should be given to statistical provisioning methodologies that reduce the procyclicality of the system.

An important issue to consider is the symmetry of these actions. At the moment forbearance with capital standards, suspension of mark to market accounting, and increased risk taking by central banks are all considered “creative” ways to support monetary policy. However, during previous upswings there has always been heavy criticism against similar measures, for example increases in margins on futures trading, on the basis that this is a rough instrument and would interfere with market pricing. The buildup of this crisis and its aftermath strongly suggest that, as we argue above, macroprudential policy has to be active also during the upswing with an objective of, together with monetary policy, stabilize risk aversion. Moving from mark to market to “over the cycle” marking opens another set of problems, but policy makers need to be symmetrical in order to create the right set of incentives.

Finally, this experience has shown that supervision of systemically important institutions should be inside the central bank, as the state of the balance sheets provides critical information for timely decision making at times of stress – and the important failures have happened in countries where supervision is outside the central bank. In fact, the old argument that central banks should not be supervisors because they would, at times, prioritize financial stability over inflation has been turned over its head in this crisis. Thus, in the euro area the supervision of the large, systemically important banks, should be transferred to the ECB.

19. The events during the 1997 Asian crisis are illuminating. At the time, the theory was that bank deposit guarantees should always be limited to avoid moral hazard. The IMF went to Indonesia and announced the closure of several banks – and a bank run ensued. From that moment, the orthodoxy changed: first declare a blanket deposit guarantee, then announce a bank restructuring process – one wonders why this lesson was not applied in the Northern Rock case in the United Kingdom. **20.** Mortgages backing covered bonds remain in the balance sheet of the banks, while in the case of MBS the mortgages are transferred to SIVs. Thus banks has to allocate capital for the mortgages even if they issue covered bonds, ensuring higher underwriting.

5 Conclusion

This crisis was the result of a sharp deterioration in underwriting standards in the US subprime mortgage market – and the array of remedial actions already undertaken by the US authorities in this area, for example banning “liar loans”, are an implicit admission of failure – a procyclical increase in leverage in the financial sector – and the very large markdowns suggest that, indeed, leverage was too high – amplified by the explosion of a highly leveraged and poorly understood structured credit market – as the massive and sharp downgrades of CDOs suggest. All of this was compounded by the portfolio insurance dynamics of CDS insurance. Excess demand for high quality assets – the famous conundrum – weakened market discipline in an environment of light regulation, and this excess demand is likely to persist as it was fostered by longer term structural, demographic and regulatory changes. Future policy changes must be directed at fixing these failures. It is clear that monetary policy by itself can’t – and shouldn’t – solve these problems, and thus macroprudential policies will have to become more active in preventing future boom bust dynamics by, inter alia, introducing statistical provisioning measures that increase the capitalization of the financial sector and reduce its procyclicality.

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LIST OF ABBREVIATIONS

ABCP:	Asset backed commercial paper.
ABS:	Asset backed securities.
ARM:	Adjustable rate mortgages.
BIS:	Bank for International Settlements.
CDO:	Collateralized debt obligation.
CDS:	Credit default swap.
CLO:	Collateralized loan obligation.
CP:	Commercial paper.
FICO score:	Credit score developed by Fair Isaac Corporation.
HY:	High yield.
LBO:	Leveraged buy-out.
MBS:	Mortgage backed securities.
OTC:	Over the counter.
SIV:	Special investment vehicle.
VaR:	Value at Risk.