

Tumbling Tower of Babel: Subprime Securitization and the Credit Crisis

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Financial products that purport to reduce the risks of investing can end up actually magnifying those risks.¹ In the 1980s, portfolio insurance, which was intended to protect stock portfolios against loss, contributed to the crash of 19 October 1987 (see Jacobs 1998, 1999a). In the 1990s, supposedly low-risk globally diversified arbitrage strategies led to the 1998 meltdown of Long-Term Capital Management and the consequent market turbulence (see Jacobs 1999a, 1999b; Jacobs and Levy 2005). We are now seeing the destructive results of structured finance products that disguised the real risks of subprime mortgage loans as low-risk, high-return investment opportunities.

The current crisis has been characterized by a lack of due diligence on the part of mortgage brokers, lenders, and investors, a lack of oversight by banks and credit-rating agencies, and a lack of regulation and enforcement by government agencies. The low interest rates set by the Fed following the tech stock bubble of the late 1990s and the events of 11 September 2001 prepared the foundation for hundreds of billions of dollars in untenable loans. The overblown edifice itself, however, was built on structured finance products that seemed to be reducing the risks of lending and investing while actually multiplying those risks and spreading them throughout the global financial system.

Risk-Shifting Building Blocks

As discussed in Jacobs (2004), essential differences exist between risk sharing and risk shifting. Risk sharing works by combining risk exposures in such a way that they offset one another to some degree; thus, the risk of the whole is less than the sum of the risks of the individual parts. Risk shifting works by moving risk from one party to another; for example, buying a stock index put option on a stock portfolio shifts the systematic risk of a market decline from the put option buyer to the put option seller. Mortgages are essentially risk shifting with regard to underlying housing prices.

A mortgage loan provides the homebuyer with a put option that allows the risk of a decline in the value of the house to be shifted to the mortgage lender.² If the value of the house declines below the value of the mortgage, the homebuyer can default on the loan. Default, however, can entail costs for the homebuyer. In some jurisdictions, lenders may have recourse to the assets and income of a defaulting borrower in order to make good on any shortfall between the price at which the house is resold and the value of the mortgage

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Highly complex financial instruments and mechanisms were devised to shift risk from one part of the financial system to another. As in a shell game, the risk itself seemed to disappear in the shifting. But the underlying systematic risk remained and, magnified by ... leverage, blew up ... the financial system and, in turn, the economy.
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loan. To the extent that such recourse is available and can be successfully implemented, it reduces the value of the homeowner's put. Recourse may not be pursued, however, because of the costs the lender would incur to recover and the low likelihood of recovery. In such cases, the homebuyer can essentially "put" the house back to the mortgage lender and walk away with a limited loss. This loss is the down payment on the house.³

Down payments relative to the value of the mortgaged house are generally smaller for subprime than for prime borrowers. For subprime mortgages issued in 2006, the average size of the loan as a percentage of the home's value (the loan-to-value [LTV] ratio) was about 15 percentage points higher than the average LTV ratio for prime mortgages (Gorton 2008). Furthermore, with a substantial portion of subprime loans—particularly in the hottest real estate markets—borrowers took out piggyback loans of home equity or second mortgages to cover down payments. These borrowers are highly leveraged and, barring price appreciation, have little or no equity in their homes.

Subprime loan default rates are likely to be more sensitive than prime loan default rates to declines in underlying housing prices because the subprime borrower is more likely than the prime borrower to use the put option. Having made a smaller down payment than the prime borrower, the subprime borrower has less to lose by defaulting. Moreover, in the event of default and recourse, the subprime borrower has fewer assets and less income to attach than the prime borrower. If housing prices decline, subprime borrowers—with high LTV ratios—are more likely than prime borrowers to be "underwater," owing more on their mortgages than their homes are worth. Therefore, they are more likely than prime borrowers to default.

For mortgage lenders, diversifying lending among a number of borrowers can reduce the lenders' exposure to default risk. This type of diversification is what a traditional insurance company does to protect itself against the monetary risk of a particular home burning down; it diversifies geographically among policyholders. The likelihood of all insured houses burning at the same time is minuscule. Even if a few houses burn, the well-diversified insurance company can use the proceeds from other insurance premiums to pay off the losses. Risk is essentially *shared* among policyholders.

Diversification of mortgage loans can reduce a lender's exposure to default by a given homeowner

when that default is the result of a specific, diversifiable event—say, the borrower's loss of a job. Risk of default resulting from housing-price declines, however, is unlikely to be that specific a risk. The value of one house rarely declines in isolation. Usually, a decline in the price of one house signals broader woes that affect the prices of surrounding houses. For instance, after the 1987 stock market crash, housing prices fell broadly throughout the New York City metropolitan area (Jacobs 2004). The risk-reducing benefits of diversification are more limited when the underlying risk is more systematic, and the risk of a decline in housing prices is more systematic than the risk of a house fire.⁴

Mortgage lenders, however, do not have to retain this risk because much of it can be shifted to others. Mortgages can be pooled, repackaged, and sold to various types of investors. This process of securitization has been used since the 1970s to reduce risk and increase the funds available for prime mortgages. Since the late 1990s, it has been increasingly used in the subprime mortgage market, as well as for other types of loans, including credit card debt. The relatively high interest rates on subprime mortgages have made them particularly appealing candidates for securitization and resale.

RMBSs. Mortgages are generally securitized and sold through special purpose vehicles (SPVs) established by mortgage originators or by banks that buy mortgages from the originators. SPVs pool hundreds or even thousands of residential mortgages to create residential mortgage-backed securities (RMBSs). Moving mortgages to an SPV removes them—and their risk exposures—from the lender's balance sheet. With less risk on its balance sheet, the lender is generally subject to lower capital requirements by regulators and internal risk management systems. Capital is thus freed up for making more loans.

The pooling of mortgages for an RMBS has diversification benefits. Rather than taking on the risk of default by one or a few borrowers in a given locality, a single RMBS diversifies risk exposures among numerous individual mortgages spread over a large area. The effects of default by one mortgage holder, or even defaults by several mortgage holders in a locally depressed area, are diluted within a pool of otherwise healthy mortgages. The primary risk-reducing mechanism of mortgage-backed securities, however, is not risk *sharing* but rather risk *shifting*.

RMBSs rely on structured securitization, which takes the payments on the underlying mortgages and redirects them—and any associated losses on them—to three basic levels, or tranches, each of which offers a different risk–return profile.⁵ At the top, the senior tranche offers the lowest interest rates and is the least risky because it is protected from loss by the tranches below it; it is the last to incur losses and the first to be paid down. Any losses are absorbed first by the bottom, or equity, tranche (commonly called “toxic waste”); if losses totally erode that tranche, further losses are directed to the next-lowest tranche, and so on. The equity tranche is the riskiest, but if the underlying assets perform well, this tranche can offer very high returns. The mezzanine tranche falls between the equity and senior tranches in terms of both risk and return.

With subprime RMBSs, the protection afforded the senior tranche by the subordinate tranches is usually supplemented by overcollateralization and excess spread. Overcollateralization means that the security’s assets exceed its liabilities; excess spread means that the interest payments on the underlying mortgages are expected to exceed the payments offered to the purchasers of RMBS tranches, as well as any anticipated expenses. Thus, subordination shifts risk within the RMBS structure and allows the transformation of subprime underlying mortgages into AAA rated senior tranches and BBB rated mezzanine tranches, with a generally small, unrated equity tranche supposedly bearing the brunt of the risk.

These various risk–return trade-offs are designed to appeal to a range of potential investors, including commercial and investment banks, hedge funds, insurance companies, mutual funds, pension funds, foreign central banks, and individuals. The sale of RMBS tranches shifts the risks and the returns of the underlying mortgages from the lender to the investors. In particular, it shifts the risk of default—and the largely nondiversifiable, systematic risk of a decline in housing prices—to these investors (especially the investors in the equity and, to a lesser extent, mezzanine tranches). The sale also provides the lender with funds for the purchase of more mortgages for more RMBS issuances.

ABCP, SIVs, and CDOs. Potential buyers of RMBSs include asset-backed commercial paper (ABCP) conduits and structured investment vehicles (SIVs). SIVs issue short-term commercial paper and medium-term notes for purchase by

money market funds and other risk-averse investors. The receipts of the commercial paper and note sales serve to fund the purchase of the collateral, including structured finance products. The long-term nature of the underlying mortgages and other assets is thus transmuted into supposedly less risky, shorter-term instruments. In 2007, SIVs had a hefty exposure to residential and commercial mortgage-backed securities, including an 8.3 percent exposure to subprime mortgages (International Monetary Fund 2008).

SIVs also hold large amounts of collateralized debt obligations (CDOs) that are heavily invested in such asset-backed securities (ABSs) as RMBSs (Gorton 2008). These ABS CDOs (hereafter CDOs), like RMBSs, represent a pool of underlying assets carved into tranches of differing risk–return profiles.⁶ Hedge funds and banks, largely through SPVs, pool several hundred individual RMBS tranches to create one CDO. As with RMBSs, the risk of a CDO is shifted from the upper to the lower tranches. And the sale of CDOs provides CDO issuers with funds to buy more RMBSs, or to underwrite more mortgages to be securitized.

CDSs. RMBSs, CDOs, and SIV commercial paper and notes can be protected by sellers or buyers through the purchase of credit default swaps (CDSs). Monoline insurers like Ambac Financial Group and MBIA sell CDSs that “wrap” individual RMBS or CDO tranches or SIV issuances and thus confer on the products the insurer’s own credit rating. CDSs are also sold by such financial entities as banks and hedge funds. In exchange for a negotiated premium, the CDS seller agrees to “make whole” the buyer of the contract if the latter suffers because a default or other specified credit event (e.g., a credit-rating downgrade) causes a loss on a specified underlying asset. The underlying asset may be a particular debt issue, a tranche, or (since 2006) an index referencing one of a number of RMBS tranches.

The insurance provided by monolines is subject to capital requirements designed to ensure that the funds required to cover commitments are available. CDSs not sold by monolines do not have to meet the same collateral requirements; they are largely unregulated derivatives, not regulated insurance.

Multiple CDSs can be sold on a given underlying asset. (In contrast, an insurance company cannot market a life insurance policy that allows multiple buyers to speculate on the health of a

particular individual.) Thus, a market for CDSs exists, with prices that reflect the perceived financial health of the underlying asset. As surrogates for the underlying assets, CDSs can be used to create “synthetic” CDOs, which serve in place of actual RMBS tranches. The volume of subprime mortgage exposures in CDOs can thus exceed (and did come to exceed) the amount of subprime mortgages actually securitized.

CDSs may seem to be the ultimate bearer of the risk of loss resulting from defaults stemming from housing-price declines. One point that seems to have been forgotten in this long chain of structured products and structuring mechanisms, however, is that shifting risk does not eliminate or even reduce it. Diversification among mortgage loans may reduce exposures to specific geographic areas, and combining mortgage loans with securitizations of other types of debt may reduce the exposure to subprime loans alone. For the most part, however, the underlying systematic risk represented by housing-price declines is merely shifted from borrower to lender, from tranche to tranche, from lender to investor, from investor to guarantor. Although hidden, the risk remains, and it eventually brought down the entire financial edifice.

What Goes Up . . .

In mid-2003, subprime mortgages started to gain ground quickly, with the level of subprime originations rising from about \$200 billion to more than \$500 billion by mid-2004 (Federal Reserve Bank of San Francisco 2008). At their height (2005–2006), subprime originations totaled roughly \$600 billion a year. During that period, they accounted for about 20 percent of all new residential mortgages, a significant increase from their historical 8 percent share (Gorton 2008; Krinsman 2007). All residential investment represented 6.3 percent of U.S. GDP by the end of 2005; thus, the portion underwritten by subprime mortgages made up a rather small part of the economy. Yet that small part created huge problems for the whole.

In the middle of 2006, as housing prices began to decline, foreclosure rates on subprime mortgages started to increase significantly (OFHEO 2008a). Subprime mortgage originations subsequently dropped off by more than half between mid-2006 and mid-2007 (Federal Reserve Bank of San Francisco 2008). Major subprime-related problems became apparent in a number of markets in mid-2007, but these proved to be merely the preface to the autumn of 2008.

The construction of the great tower of RMBSs, CDOs, SIVs, and CDSs and its subsequent collapse are inextricably linked to the underlying subprime market and integral elements of the subprime crisis. Much like portfolio insurance’s required sale of stocks in 1987 and the forced unwinding of arbitrage positions undertaken by Long-Term Capital Management in 1998, the structured finance instruments and mechanisms that manipulated the cash flows to and from mortgage loans formed a positive feedback system that magnified underlying trends and their effects. The disconnect between the relatively high returns offered by subprime-mortgage-based products and their perceived low risk fueled demand for the products, thereby increasing funding for mortgages, facilitating home purchases, and raising housing prices. The complexity and opacity of the instruments and mechanisms and the web of interrelationships they constructed between firms and between markets magnified the effects.

The Rise of Subprime. Subprime mortgages offered higher interest rates than did prime mortgages. Initial fixed rates on subprime mortgages were roughly 200 bps higher than rates on fixed prime mortgages (Federal Reserve Bank of San Francisco 2008).⁷ The rate differential, especially meaningful in a low-interest-rate environment, allowed RMBS and CDO packagers to retain or improve their profit margins while offering competitive returns on both senior and mezzanine tranches of their securitizations. Subprime loans thus proved extremely attractive both as candidates for securitization and as investments.

Securitization became a major profit source for financial intermediaries and came to be viewed as an indispensable source of yield enhancement for most asset managers (Ashcraft and Schuermann 2008). Citigroup—with fees of 0.4–2.5 percent on securitizations of more than \$20 billion in 2005 (up from \$6.3 billion in 2003)—reportedly made hundreds of millions of dollars in fees alone that year (Dash and Creswell 2008). UBS’s postmortem of its 2007 write-downs on subprime investments noted that the consultant that was brought in to hone the firm’s broad business plan had recommended

that UBS selectively invest in developing certain areas of its business to close key product gaps, including in Credit, Rates, MBS Subprime and Adjustable Rate Mortgage products . . . , Commodities and Emerging Markets. ABS, MBS, and ARMs . . . were specifically identified. (UBS 2008)

Securitization of subprime mortgages became an ever-larger portion of the ABS market. In 2001, subprime mortgages accounted for less than 9 percent of mortgages issued and about 6.5 percent of mortgage-backed securities; by 2005, subprime made up more than 22 percent of mortgages and almost 23 percent of mortgage-backed securities (Ashcraft and Schuermann 2008). Subprime mortgages proved particularly popular CDO ingredients. According to one credit-rating agency, as a share of the collateral pools of CDOs, subprime RMBSs grew from 43.3 percent in 2003 to 71.3 percent in 2006 (SEC 2008).

The popularity of subprime products was epitomized by the mushrooming growth of new entrants into the mortgage origination field. Many of these entrants, including more than 50,000 independent brokers, were not subject to federal supervision (Gramlich 2007). Most were dependent for their financing on the capital markets (i.e., securitization or selling mortgages for securitization) rather than deposits (Gorton 2008). Commercial and investment banks bought up these new originators to secure their own supplies of subprime mortgages; in 2006, for example, Merrill Lynch purchased First Franklin, a domestic subprime lender, reportedly “to generate in-house mortgages that it could package into CDOs” (Morgenson 2008).

Between 2004 and 2006, the issuance of CDOs more than tripled globally, to nearly \$552 billion; more than half of these CDOs incorporated structured finance securities, such as subprime RMBSs (Gorton 2008). The mezzanine tranches of RMBSs were particular favorites of CDO packagers because they offered relatively high returns and could be transformed via subordination into AAA rated products. The popularity of these instruments was so great that the demand outstripped the supply of raw material. CDO exposure to mezzanine RMBS issuance—65 percent in 2004—grew to 160 percent in 2005 and 193 percent in 2006 (Bank for International Settlements 2008a). The excess exposure was created synthetically by the use of CDSs, which, as noted, can be used as surrogates for underlying CDO exposures.

Robert Shiller (2008) has argued that the subprime crisis is a product of the housing bubble itself and that it was created from a faddish belief in never-ending housing-price appreciation. Price appreciation was a necessary foundation, and without it, the whole edifice came tumbling down. But the bubble itself was prolonged and enlarged by the mortgage market’s expansion into subprime

lending. Much of this expansion was driven by the demand for product—particularly subprime RMBSs—on the part of CDO packagers and others.

The question is, Would lending to the subprime market have grown, and grown so substantially, had lenders *not* been able to off-load their risky loans via structured securitization? And would they have marketed those loans so aggressively if investors had not been so eager for the high-return, supposedly low-risk securitized products? Was not the expansion itself, in large measure, instigated by financial intermediaries’ desire for the underlying high-yield products, which they could transform into even more profitable structured products?

This dynamic created a trend-reinforcing, positive-feedback loop. Just as portfolio insurance, with its trend-following purchases of stock as stock prices rose, buttressed the equity market’s run-up before the 1987 crash (Jacobs 1999a), so did the interaction between structured finance products and subprime lending help inflate the housing-price bubble of recent years.

Low Risk for Sellers and Buyers. The relatively high yields on underlying subprime mortgages—and on structured finance products that included subprime mortgages—were accompanied by irresistibly low perceived risk, which widened the scope of subprime’s popularity. For lenders and many financial intermediaries, this perception was built on their ability to shift some or all of the credit risk of the mortgages to RMBS and CDO buyers. For those buyers, risk perception was distorted by several factors.

Diversification offered some protection. Structured finance products were more diversified than their underlying mortgages. After all, RMBSs might hold thousands of mortgages, and CDOs might hold hundreds of RMBSs. The structured instruments seemed to offer smoother payouts because the effects of refinancings and defaults were more diversified (Gerardi, Lehnert, Sherlund, and Willen 2008). Furthermore, CDOs with subprime RMBSs were often perceived as more diversified than the underlying RMBSs because the CDO tranches were backed by more geographically diverse mortgage pools (Criado and Van Rixtel 2008). The pooling of the mortgages also afforded RMBS and CDO buyers some protection against adverse selection, whereby sellers with superior information could cherry-pick mortgages, securitizing the least attractive ones for sale and retaining the best.⁸

The structured securitization process offered another layer of protection. The extent of overcollateralization and excess spread and the relative sizes of the tranches were designed to allow for an anticipated level of losses on cash flows from borrowers. Losses exceeding this level were absorbed by sequential tranches from the bottom up. The AAA tranche (or in some cases, a supersenior AAA tranche above it) appeared to be very well protected from loss caused by default. Through the magic of subordination, underlying subprime loans were transformed into AAA rated RMBS tranches and underlying BBB rated RMBS tranches were transformed into AAA rated CDO tranches.

Credit-rating agencies played a crucial role in the success of subprime mortgage securitization inasmuch as their ratings came to be viewed as virtual guarantees of investment quality. Many potential investors—including insurance companies, mutual funds, pension funds, and third-party banks—desired the highest ratings on their investments. Money market funds required AAA ratings on any ABCP and SIV paper they purchased.

Ratings are assigned by third-party credit-rating agencies (e.g., Moody's Investors Service, Standard & Poor's, and Fitch) on the basis of the subordination schedules (including overcollateralization and excess spread) submitted by the structured product packagers. According to post-crisis reports from the U.S. SEC (SEC 2008), these agencies perform stress tests to determine default rates and apply predicted recovery rates in the event of default. They look at the individual mortgages underlying an RMBS, including each loan's principal amount, its geographic location, the borrower's credit history, the loan amount in relation to the value of the property, and the type of loan. For CDOs, however, the agencies routinely analyze the underlying RMBS tranches but not the original mortgages. Unlike the agencies' analyses of corporate bonds, which rely heavily on fundamental factors and company histories, analyses of structured products are dependent on financial modeling (Bank for International Settlements 2008b). None of the credit-rating agencies examined by the SEC (2008) had specific written procedures for rating subprime instruments, as opposed to other MBSs and CDOs.

Structured product providers used CDSs to solidify or bolster credit ratings; structured product purchasers used CDSs to hedge their investments. Monolines insured about \$125 billion of super-

senior tranches of CDOs containing subprime RMBSs (Bank for International Settlements 2008a). Monoline insurance of structured products carried a AAA rating, in line with the insurers' credit ratings. Collateral requirements for CDO insurance products, however, were set in line with monolines' other basic product, municipal bond insurance, which meant that the value of the insurance could be up to 150 times the value of the underlying collateral (Crouhy, Jarrow, and Turnbull 2008).

A final fallback for structured products was the ability to sell them if worse came to worst. By the end of 2006, for example, many institutions purchasing subprime mortgages or mortgage pools were starting to recognize the increased risk of the underlying loans and requiring sellers to contract to buy back loans that defaulted within three months of purchase (Krinsman 2007). But most arrangements were much less formal. Securitization appeared to transform illiquid assets—individual loans—into more liquid, transferable assets—mortgage-backed securities (Criado and Van Rixtel 2008)—and investors seemed to rely on their ability to tap this liquidity as needed. SIV commercial paper purchasers perceived their investments as very liquid, even though the underlying collateral had much longer maturities.

The belief that one can get out before everyone else is what helps sustain bubbles, including the tech stock bubble (Jacobs 2000). Thus, investors may have thought themselves well positioned; by early 2007, thanks to such instruments as RMBSs, CDOs, and CDSs, markets for mortgages appeared to be more liquid than ever.

High Risk for the System. Although RMBSs, SIVs, CDOs, and CDSs may have appeared to reduce risks for such individual market participants as the lenders that made the mortgage loans, the banks that structured them into RMBSs and SIVs, the investment banks that held CDOs, and the investors that purchased ABCP, these instruments ended up increasing the risk of the entire financial sector and the economy. They did so by facilitating an increase in leverage—underwritten by the expansion of balance sheets and perceived reduction in risk that structured finance instruments and vehicles enabled—and an extension of the funding sources beyond the leveraged financial sector and well beyond U.S. borders.

In 2007, about 40 percent of subprime mortgage exposure—50 percent if government-sponsored Fannie Mae (Federal National Mortgage Association) and Freddie Mac (Federal Home Loan Mortgage Association) are included—was held by U.S. leveraged financial institutions, mostly commercial and investment banks and hedge funds (Greenlaw, Hatzius, Kashyap, and Shin 2008). These institutions tend to increase their leverage levels as their measured risk levels fall (Adrian and Shin 2008). For banks, leverage and risk are limited by capital requirements set by such authorities as the Bank for International Settlements (BIS) and/or by such internal risk management systems as value at risk (VaR). In general, however, the lower the measured risk of an entity's assets, the higher the level of leverage it can support. Thus, low risk leads to high leverage (total asset-to-equity ratios).

Securitization enabled financial institutions to free up capital for lending, to pass the riskier portions of their mortgage loans on to investors, to earn profits on the sales, and to retain low-risk products for their own portfolios. The imprimatur of agencies' credit ratings and the protection offered by monoline insurers and other CDS sellers enhanced the perception that subprime mortgage loans and structured finance products based on subprime mortgages were low risk. In fact, the spread between subprime and prime mortgage rates declined by almost 250 bps between 2001 and mid-2004; per unit of risk, the spread declined even more and for longer (into 2006) as the riskiness of subprime loans increased over the period (Demyanyk and Van Hemert 2008). Not surprisingly, Greenlaw et al. (2008) documented a sharply positive relationship between total asset growth and leverage growth for both commercial and investment banks over the 1998–2007 period.

Securitization also allowed the expansion of funding for subprime mortgages to move beyond the leveraged financial sector to such traditionally unleveraged investors as insurance companies, pension funds, and mutual funds. These incremental sources of credit increased the supply of funding for subprime loans. At the same time, an expansion in the loan supply was perceived as an increase in funding liquidity, which reduced the perception of risk and the probability of default. This situation, in turn, resulted in further expansion of the credit supply, more lending, lower perceived risk and default probabilities, and so on (Shin 2008). So, the positive feedback initiated by the demand for sub-

prime mortgages and structured finance products was reinforced by the enlargement of funding.

Of course, the entire leveraged system rested on a shaky foundation: loans to high-risk borrowers. Furthermore, subprime loans had themselves become increasingly leveraged, with loan-to-value ratios rising more than 6 percentage points between 2001 and 2006 (Demyanyk and Van Hemert 2008).

... Must Come Down

The S&P/Case-Shiller U.S. National Home Price Index shows that the average price of U.S. homes (seasonally adjusted) rose by 10.6 percent, 10.7 percent, 14.6 percent, and 14.7 percent annually from 2002 through 2005. In 2006, prices were essentially flat (–0.2 percent) for the year but actually began declining from the second quarter on. The LTV ratio of the average subprime mortgage issued that year was nearly 86 percent (Demyanyk and Van Hemert 2008).

Delinquency rates on subprime loans, which had picked up in mid-2005, continued to build in 2006 (Federal Reserve Bank of San Francisco 2008). Mortgage lenders that had agreed to repurchase any loans that defaulted early found themselves increasingly called upon to make repurchases in the fourth quarter of 2006 (Krinsman 2007), just as investment banks started shutting down credit lines to independent mortgage lenders (Tavakoli 2008). Highly dependent on funding from securitization flows, these lenders started running out of capital to repurchase the bad mortgages.

For 2007, the S&P/Case-Shiller U.S. National Home Price Index shows that home prices ended the year off 8.7 percent. They dropped even more steeply in 2008, falling 12.3 percent through the third quarter and finishing that quarter down 21.2 percent from their peak in the second quarter of 2006.⁹ Subprime mortgage originations declined with housing prices, falling from \$93 billion in the first quarter of 2007 to \$14 billion in the fourth quarter (all but disappearing by 2008), and delinquencies and foreclosures rose (Greenlaw et al. 2008).

Positive Feedback's Negative Consequences. Many of the positive-feedback dynamics that had buttressed the tower of structured finance products underlying the housing bubble now helped to undermine its foundations. As default rates on subprime mortgages increased, credit ratings of subprime-based RMBSs and CDOs

were downgraded and VaR estimates increased. The feedback between risk and leverage that had helped inflate the subprime bubble when risk was low now acted to deflate it by shutting down the flow of funds. A given dollar contraction in the balance sheet of a typical firm in the U.S. leveraged financial sector can produce a cutback in lending of many times that size (see, e.g., Greenlaw et al. 2008).¹⁰

The rating agencies began issuing warnings about subprime RMBSs and CDOs in the spring of 2007. In April, New Century Financial Corporation, the second-largest subprime lender in 2006, succumbed to borrower defaults—one of many such lenders to disappear. In June, two Bear Stearns hedge funds failed, brought down by their investments in subprime CDOs—especially toxic waste tranches; one of the funds was leveraged by more than 21-to-1 (Kelly and Ng 2007). In July, the credit-rating agencies downgraded hundreds of subprime tranches. The German bank IKB took a substantial hit on U.S. subprime mortgage investments and required an emergency infusion of funds from shareholders and the German government. In August, the French bank BNP Paribas was forced to halt redemptions from three funds that could not be valued because their subprime holdings had become so illiquid.

As liquidity dried up in the summer of 2007, ABCP conduits began to have increasing difficulty in locating buyers for their paper. Mortgages represented the single largest category of collateral, and buyers of short-term paper did not know how much of this exposure represented subprime mortgages (Criado and Van Rixtel 2008).

Hedge funds were major buyers of equity tranches of subprime structured products and were major players in CDO and CDS markets. They were also heavily leveraged. With so many subprime tranches receiving rating downgrades, some hedge funds faced large margin calls. To delever and reduce risks, they sold their most liquid assets, including common stocks (if they held any). On 9 August 2007, the stock market declined substantially, causing large losses for equity investors, particularly quantitative equity investors, which held many of the same names as the liquidating hedge funds.

After the tremors of August, problems continued in the form of heightened volatility in equity markets and contracting liquidity in credit markets. Subprime RMBSs and CDOs started piling up on banks' balance sheets (Sender 2007). Citi-

group, Bank of America, and JPMorgan Chase & Co. began to unwind sponsored SIVs, taking the assets and liabilities onto their own balance sheets, with resultant balance sheet stress and further tightening of lending.

At year-end 2007, UBS announced a \$10 billion write-down, largely the result of losses on subprime AAA rated tranches of CDOs held as investments or warehoused for future packaging. Many of these positions were unhedged or underhedged because UBS had planned to sell them, purchase guarantees on them, or short credit indices against them, but the firm discovered that the potential counterparties for these strategies disappeared after the market disruption in August 2007 (UBS 2008). (UBS had to be bailed out by the Swiss government in October 2008.)

In January 2008, Bank of America bought Countrywide Financial, the largest subprime lender, which faced mounting delinquencies and imminent bankruptcy. Monoline insurers were struggling to retain their AAA credit ratings in the face of losses on their subprime-related guarantees. As subprime troubles began to undermine the monolines' reputations, the yields on their primary insured securities—municipal bonds—rose to historic levels.

In March 2008, Bear Stearns—one of the major suppliers of subprime credit and still reeling from the demise of its two hedge funds almost a year earlier—was brought down by its \$46 billion in mortgages, RMBSs, and CDOs. The prices of CDSs that paid off in case of a Bear Stearns credit event soared. As Bear Stearns hovered on the brink of bankruptcy with its customers fleeing, JPMorgan, aided by a \$29 billion guarantee from the U.S. government, took over the firm for \$10 a share (up from the \$2 originally offered and accepted).

In the first of a series of unprecedented moves, the Fed opened its discount window to investment banks and offered to lend them up to \$200 billion in U.S. Treasury securities, to be collateralized by mortgage-backed securities. Between August 2007 and the early spring of 2008, the U.S. government provided nearly \$1 trillion in direct and indirect support to financial institutions. Nevertheless, the banks' ability and willingness to lend became tighter and tighter. As spring ended, estimated write-downs and losses on subprime-related investments ranged from \$400 billion to \$1 trillion. (By year-end 2008, the estimate was more than double the upper bound of that range.)

By June 2008, the three major credit-rating agencies had downgraded the AAA ratings of the monoline insurers MBIA and Ambac. This action meant downgrades on the municipal bonds they insured, which raised municipalities' borrowing costs, as well as increased collateral requirements for the monolines. In July, IndyMac Bank, once a major independent mortgage lender, was seized by the U.S. government after a run by depositors. Subprime troubles were becoming systemic.

Government-sponsored Fannie Mae and Freddie Mac, the largest purchasers of U.S. mortgages, had to be taken fully under the wing of the federal government in early September. On 10 September 2008, declines in the values of its mortgage-related holdings led to a large loss at Lehman Brothers, which faced huge margin calls from creditors and threats of a downgrade from credit-rating agencies. Wary of creating moral hazard and public outrage, the government declined to shore up the storied Wall Street firm. Lehman Brothers filed for Chapter 11 bankruptcy on 15 September, becoming the largest bankruptcy in U.S. history. On the same day, Bank of America bought Merrill Lynch, another fabled investment bank, which had suffered many billions of dollars in write-downs on mortgage-related products.

Barclays, based in the United Kingdom, eventually bought most of Lehman's U.S. business, but the firm's failure wiped out the investments of thousands of German and Asian holders of structured notes that Lehman itself had guaranteed. Most significantly, Lehman's collapse set off an implosion at American International Group (AIG), whose London-based subsidiary had sold CDSs "insuring" Lehman's debtholders. The prices of CDSs written on AIG spiked, and its equity shares sold off sharply. On 16 September 2008, the U.S. government acquired most of AIG for \$85 billion. (AIG eventually needed additional funds.)

September 2008 ended with the government's seizure of Washington Mutual and the sale of its branches and assets to JPMorgan. A \$700 billion government rescue package for the U.S. financial sector was voted down by the U.S. House of Representatives, which caused the largest one-day percentage decline in the stock market since the crash of 1987. Despite the passage of the Troubled Asset Relief Program (TARP) on 3 October 2008, the stock market continued its slide, ending down 17 percent for the month of October—its worst monthly loss since October 1987.

As 2008 came to a close, central banks in Europe, the United States, Japan, and other countries pumped several trillions of dollars into the global banking system. The U.S. government rescued Citigroup, once the country's largest financial institution, which faced up to \$65 billion in losses—half of which was on mortgage-related assets. More money—up to \$600 billion—was pledged in support of Fannie Mae and Freddie Mac debt, and TARP was expanded to absorb losses on small-business and consumer loans, as well as to bail out two of the Big Three automakers (an initial \$13.4 billion, with \$4 billion and possibly more to follow).¹¹

But the recession that began in the United States in December 2007 threatens to become the worst since the Great Depression. Credit markets are still distressed, with high-yield bonds at astronomically high spreads over Treasuries. The S&P 500 Index reached an 11-year low in mid-November 2008—more than 50 percent below its October 2007 peak. Equity volatility has reached and remains at levels well above historical averages. International stock markets have experienced similar volatility and declines. Even commodities—widely thought to be the next speculative bubble—have deflated, with oil prices down from a record \$145 a barrel in July 2008 to below \$40 a barrel by late December.

Risk-shifting structured finance instruments seemed like risk-reducing mechanisms in 2003, when the subprime run-up began. CDSs seemed to solve the problem of who would ultimately bear that shifted risk. But what happens if the risk bearers fail?

Who . . . becomes the risk bearer of last resort? It may be the taxpayer, if the government decides that the firms that offered these products are "too big to fail." Often, it's investors in general, who must bear the risk in the form of the substantial declines in price that are required to entice risk bearers back into the market.¹² (Jacobs 2004, p. 28)

Fault Lines. In hindsight, the risk of mortgage-backed securities was obviously underestimated. Some of the blame for this misperception may be laid at the feet of the credit-rating agencies. A BIS review of the performance of these agencies during the subprime cycle noted that they underestimated the severity of the decline in housing prices, in large measure because such a decline, on a nationwide scale, had not occurred since the 1930s (Bank for International Settlements 2008b). Although the agencies looked at diversification among borrowers

within mortgage pools, they did not pay attention to diversification among mortgage originators and securitizers. The downgrades of subprime RMBSs in July 2007 turned out to be concentrated in the hands of only four issuers (New Century, WMC Mortgage Corporation, Long Beach Savings, and Fremont General Corporation) (Ashcraft and Schuermann 2008).

An SEC review of the three largest U.S. rating agencies found that they were unprepared to service the huge volume of subprime business they were asked to rate in the years following 2003 (SEC 2008). According to an e-mail from one rating-agency analyst cited in the study, “It could be structured by cows and we would rate it” (SEC 2008, p. 12). Furthermore, although the agencies supposedly looked at data on individual loans, they were not required to verify any of the information given to them for rating purposes.

The SEC (2008) study mentioned the familiar conflict-of-interest problem that can arise with the “issuer pays” model, whereby the entity seeking the rating pays for it. Some observers told the SEC that they believed the conflict was exacerbated by structured finance products because of the flexibility to adjust the structures in order to obtain desired ratings. Those who structure RMBSs and CDOs may also have a large say in choosing the agency that rates the instruments. To date, no solid data have emerged indicating that conflicts of interest led to distorted ratings by rating agencies, but the agencies face subpoenas from several state attorneys general, as well as hundreds of civil lawsuits.

The actions of mortgage originators have also been called into question. Securitization represents an “originate-to-distribute” model that has long been blamed for introducing baleful incentives into the lending process. The argument is that because securitization allows lenders to sell the loans and thereby rid themselves of the risks of the loans, the lenders have little incentive to ensure the robustness of those loans. In fact, they have some disincentive because the more loans they make, the more fees they collect. With a short-term profit motive, they may lend as fast as they can and limit the time they spend on verifying borrowers’ claims.

One study (reported in Fitch Ratings 2007) found that some 70 percent of default losses were associated with fraudulent misrepresentations on loan applications. But many studies have concluded that foreclosures on subprime loans over the period are most strongly correlated with declines in hous-

ing prices—not with any measure of lending standards (see, e.g., Demyanyk and Van Hemert 2008; Bhardwaj and Sengupta 2008a, 2008b).

The LTV ratio of the underlying property also appears to be an important factor in subprime loan risk. The magnitude of the increase in LTV ratios as the subprime bubble grew was probably unknown to most investors in RMBSs and CDOs, given the coincident rise in the percentage of loans with incomplete documentation (Gerardi et al. 2008). Whether or not adequate information was both available and disclosed, the investors in RMBSs and CDOs seem to have relied largely on credit ratings rather than in-depth analyses. UBS (2008) admitted that its analyses did not “look through” the CDO structure to assess the risks of the underlying mortgage collateral. Instead, it relied on AAA ratings as the measure of safety. Furthermore, UBS’s assessment of its risk control mechanisms found that its VaR and stress tests relied on only five years of data—too short a period to capture the last large decline in U.S. housing prices. And the risk models that AIG applied to its CDSs failed to take into account the effects of increased collateral needs following declines in the values of assets covered by the CDSs; AIG was thus inadequately hedged and incurred large losses (Mollenkamp, Ng, Plevin, and Smith 2008).

Conclusion: Building from the Ruins

Structured finance products, including RMBSs and CDOs, helped inflate the housing-price bubble by providing a ready market for subprime loans. That market was enlarged through securitization, leverage, and extension to unleveraged economic sectors. Moreover, expansion of the subprime market was probably assisted by a relaxation of lending standards on the part of mortgage originators, at least after 2005 (Zimmerman 2007).

The enlargement of credit enabled by structured finance products—and the interconnectedness these products created between institutions and between markets—magnified the effects of the deterioration of the underlying subprime loans. As housing-price appreciation slowed and then reversed, delinquencies and defaults in the subprime sector increased beyond the expectations reflected in mortgage rates, RMBS yields, and CDS premiums. The real underlying risk of subprime mortgages, hidden for so long by the instruments used to shift that risk, became apparent.

At the same time, the extent of the problem remained opaque. The complexity of CDOs, in particular, made it difficult for market participants to discern which instruments and which entities were going to disintegrate next. The solvency of some critical institutions began to be questioned, counterparty risk came to the forefront of decision making, and liquidity dried up as banks hoarded their capital and declined to lend. The effects on both the U.S. economy and the international economy have been severe.

Setting aside discussion of appropriate solutions to the immediate crisis, let us consider what can be done in the coming months or years to reduce the possibility, or at least the malign effects, of the next "tumbling tower."

The crisis itself has ameliorated some of the underlying problems. The independent subprime lenders that supplied the risk-shifting building blocks are greatly reduced in number.¹³ Many of these lenders, such as New Century, are now defunct. Others have been taken over—for example, Countrywide (by Bank of America) and IndyMac (by a group of private equity investors).

The big investment banks are also gone—bankrupt, bought out, or, in the cases of the Goldman Sachs Group and Morgan Stanley, transformed into bank holding companies and receiving transfusions from TARP. Investment banks had basically been allowed to set their own leverage levels since 2004 (SEC 2004). These new bank holding companies will have to abide by the constraints set by bank regulators. Of course, constraints and regulations can create their own problems. For example, BIS has been criticized for the capital requirements set by Basel II, which was just coming into use as the current crisis broke. In particular, Basel II allows the largest banks to use internal risk management procedures to determine capital adequacy—a choice that seems to have contributed to the current crisis—and fails to provide adequate protections for dealing with bouts of severe illiquidity.

The President's Working Group on Financial Markets (2008) and the SEC (2008) have encouraged credit-rating agencies to consider some method of differentiating between their ratings for ordinary corporate debt and for the much more complex structured finance products. The SEC has also recommended that rating agencies disclose the characteristics of the assets underlying such structured products as RMBSs and CDOs so that competing agencies can provide their own ratings.

Lack of transparency in the CDS market is of particular concern. Under pressure from regulators, the dealers behind the Depository Trust & Clearing Corporation (DTCC) have begun to release more information on CDS trading to assuage the fears of a public dumbfounded by the seemingly insane magnitude of the notional value of these swaps. DTCC, which reportedly settles 90 percent of the electronic trades of the biggest dealers, announced that the notional value of outstanding CDSs globally totaled \$35 trillion as of mid-November 2008.¹⁴ The International Swaps and Derivatives Association, however, asserted that the figure was closer to \$47 trillion.¹⁵ So, opacity remains in the system.

This over-the-counter market is huge, highly leveraged, and unregulated. Given the critical financial roles played by the counterparties in this market, credit failures have the potential to be highly disruptive not only to the credit market but also to other asset markets and the real economy. Currently, several organizations, including the CME Group, IntercontinentalExchange, Eurex, and NYSE Euronext, are struggling to get CDS clearinghouses off the ground. Traders appear to be willing, even eager, to move business to exchanges, which can provide protection against counterparty credit risk. Such a move will go some way toward providing regulators and investors with more transparency about the extent of credit risk exposures.

As we have seen, the sale of structured finance products helped fuel mortgage lending and expand the housing bubble, which, in turn, provided incentive for more homebuyer demand for mortgages. As the pool of possible homebuyers began to be exhausted at the elevated housing prices, prices eventually declined. With declines, many subprime borrowers with high LTV ratios (small down payments) found themselves underwater. Some of these borrowers exercised the put options in their mortgages, passing the downside risk of housing-price volatility back to lenders and, via structured finance vehicles, on to investors in CDOs and sellers of CDSs.

Put exercise led to losses on mortgage-related products, and the solvency of some participating institutions became questionable. Lenders were reluctant to extend credit, and liquidity began to dry up. This chain of events led to further declines in housing prices, more defaults and foreclosures, and more losses for mortgage holders and investors in mortgage-related products. As with portfolio

insurance in 1987, a mechanism that could reduce risk for some—equity investors in the case of portfolio insurance, homebuyers in the case of mortgage puts, and mortgage lenders in the case of structured finance products—ended up increasing risk for the system.

The effects of the expansion and decline in the residential housing market were magnified by the massive amounts of leverage used by banks and hedge funds, in particular, in underwriting mortgages and purchasing mortgage-related products. And underlying everything were the highly leveraged home purchases by mortgage borrowers with very high LTV ratios. Requiring a meaningful down payment with all mortgages would reduce the leverage and the value of the put and thus reduce borrowers' incentives to default when housing prices decline.¹⁶ Although requiring substantial down payments will have social costs in the form of reduced rates of home ownership, there are economic costs to making uneconomic loans, as the current crisis has demonstrated.

Establishing stricter criteria for borrower creditworthiness would further decrease the likelihood of default and its deleterious effects. The President's Working Group on Financial Markets (2008) has recommended the imposition of stricter licensing standards for mortgage lenders, as well as strengthened federal oversight. Higher lending standards and better enforcement could reduce the volume of high-risk loans and thus the volume of defaults. Reducing lenders' costs of pursuing

recourse would facilitate more complete recovery of assets in the event of default and could reduce the impact of mortgage-related losses on the solvency of financial institutions.

The current crisis has revealed that our patchwork of regulations is incapable of overseeing a world of increasingly large and integrated asset markets. Problems that arise in one market (the U.S. mortgage market) are all too readily transmitted well beyond that market to become systemic economic problems. A regulatory system that is consistent across markets and instruments is needed. Ideally, such a system would be capable of regulating financial products with a focus on their potential for destabilizing financial markets, taking into account the connections between markets and bringing under the regulatory umbrella previously unregulated instruments.

Once again, as in previous crises, sophisticated, highly complex financial instruments and mechanisms were devised to shift risk from one part of the financial system to another. As in a shell game, the risk itself seemed to disappear in the shifting. But the underlying systematic risk remained and, magnified by huge amounts of leverage, blew up the very foundations of the financial system and, in turn, the economy.

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This article qualifies for 0.5 CE credit.

Notes

1. The current crisis reverberates with some of the concerns expressed in Jacobs (1983).
2. Mortgage borrowers can also exercise a call: They can realize an increase in the value of the house on resale, or they can refinance to take advantage of lower interest rates. This call may be less valuable for subprime borrowers, however, because, unlike the vast majority of prime mortgages, subprime mortgages generally impose prepayment penalties.
3. The loss would also include any principal payments made on the mortgage loan.
4. As indicated in Jacobs (2004), the systematic nature of this risk presents a problem for the insurance of home values, as proposed by Shiller (2008), as well as for the suggestion that financial institutions sell such insurance via options (Merton 2003).
5. The actual number of tranches is greater than three because senior and mezzanine tranches can be subdivided into ever-finer specifications of risk and return. The basic formula calls for six tranches (the so-called six-pack), but one RMBS was alleged to have had 125 tranches.
6. CDO tranches are also sliced and diced to produce other CDOs (known as CDO²s), and CDO² tranches are sometimes used to make CDO³s.
7. Subprime rates were generally fixed for the first two or three years and were then floated at some spread (usually about 6 percentage points) over LIBOR.
8. Keys, Mukherjee, Seru, and Vig (2008) modeled securitization of mortgage loans and found that investors were not well protected in this regard: Mortgages likely to be chosen for securitization defaulted at a rate about 10–25 percent higher than that of mortgages with similar characteristics but with a lower probability of being securitized.

9. The Case-Shiller index shows stronger price rises and declines than the national home price index compiled by the Office of Federal Housing Enterprise Oversight (OFHEO, now the Federal Housing Finance Agency). OFHEO prices, for example, show a decline of only 7.9 percent between their April 2007 peak and the end of the third quarter of 2008 (see OFHEO 2008a; Federal Housing Finance Agency 2008). One of the notable differences between the two series is the Case-Shiller index's inclusion of more homes purchased with subprime lending. For an explanation of the differences, see OFHEO (2008b).
10. As many commentators have noted, the contraction of balance sheets was exacerbated by the need to mark mortgage-related assets to market. Like VaR, marking to market is procyclical in encouraging more lending when times improve and less lending when times deteriorate.
11. In February 2009, the U.S. Treasury proposed a Public-Private Investment Fund, which would provide up to \$1 trillion for private investors to buy distressed securities, and a Consumer Business Lending Initiative for up to \$1 trillion in new consumer and business loans. Congress passed a fiscal stimulus bill with \$787 billion in spending and tax cuts, and President Obama announced plans for spending up to \$275 billion to aid homeowners in refinancing and modifying existing mortgages.
12. This article ("Risk Avoidance and Market Fragility") and its findings were mentioned in the Informer column of *Forbes* ("Weapons of Mass Panic" 2004).
13. Terhune and Berner (2008) have reported that some former subprime lenders have reemerged as specialists in Ginnie Mae (Government National Mortgage Association) mortgages (fully guaranteed by the U.S. government) and are using some shady gimmicks to attract new subprime borrowers.
14. See <http://dtcc.com>.
15. See <http://isda.org>.
16. Ellis (2008a, 2008b) found that U.S. homebuyers were much more sensitive than those in other developed countries to housing-price declines. This sensitivity reflected a rise in initial LTV ratios in the United States, the ready availability of interest-only and negative-amortization mortgage loans in the United States, and the relatively young age of most mortgages (a by-product of the ease of refinancing in the United States and historically low mortgage rates in 2002 and 2003). All these factors made U.S. homebuyers more likely than those in other developed countries to find themselves with negative equity in their homes, given a decline in housing prices, and thus more likely to default.

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