The Panic of 2007

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I. Introduction

> *With a full year elapsed since the panic of 1907 reached its crisis among this country's financial markets, its banking institutions, and its productive industries, it ought to be possible to obtain an insight into the nature of that economic event such as could not easily have been obtained when the phenomena of the crisis itself surrounded us.*
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> —Alexander Noyes, "A Year after the Panic of 1907," *Quarterly Journal of Economics*, February 1909.

We are now about one year since the onset of the Panic of 2007. The forces that hit financial markets in the U.S. in the summer of 2007 seemed like a force of nature, something akin to a hurricane, or an earthquake, something beyond human control. In August of that year, credit markets ceased to function completely, like the sudden arrival of a kind of "no trade theorem" in which no one would trade with you simply because you wanted to trade with them.[1] True, thousands of people did not die, as in the recent natural disasters in Asia, so I do not mean to exaggerate. Still, thousands of borrowers are losing their homes, and thousands are losing their jobs, mostly bankers and others in the financial sector. Many blame the latter group for the plight of the former group; ironic, as not long ago the latter group was blamed

for not lending to the former group ("redlining" it was called). The deadweight losses from bankruptcies, foreclosures, and job search are no doubt significant.

Indeed, the feeling of the Panic of 2007 seems similar to that described by A. Piatt Andrew (1908A) a century ago, in commenting on the Panic of 1907: "The closing months of 1907 … were marked by an outburst of fright as wide-spread and unreasoning as that of fifty or seventy years before" (p. 290). Andrew (1908B) wrote that: "The autumn of 1907 witnessed what was probably the most extensive and prolonged breakdown of the country's credit mechanism which has occurred since the establishment of the national banking system" (p. 497). The actions taken during that panic were extraordinary. They included legal holidays declared by governors and the extensive issuance of emergency currency through clearinghouses.[2]

It is true that today's panic is not a banking panic in the sense that the traditional banking system was not initially at the forefront of the "bank" run as in 1907, but we have known for a long time that the banking system was metamorphosing into an off-balance sheet and derivatives world—the shadow banking system.[3] Still, I would say that the current credit crisis is essentially a banking panic. Like the classic panics of the 19th and early 20th centuries in the U.S., holders of short-term liabilities (mostly commercial paper, but also repo) refused to fund "banks" due to rational fears of loss—in the current case, due to expected losses on subprime and subprime-related securities and subprime-linked derivatives. In the current case, the run started on off-balance sheet vehicles and led to a general sudden drying up of liquidity in the repo market, and a scramble for cash, as counterparties called collateral and refused to lend. As with the earlier panics, the problem at root is a lack of information.[4]

What is the information problem? The answer is in the details. Indeed, the details of the institutional setting and the security design are important for understanding banking panics generally. This should come as no surprise. Panics do not occur under all institutional settings or under all security designs. Contrary to most of the theoretical literature, historically it does not appear that panics are an

inherent feature of banking generally. This point has been made by Bordo (1985, 1986), Calomiris and Gorton (1991), and Calomiris (1993), among others. Bordo (1985), for example, concludes that: "the United States experienced panics in a period when they were a historical curiosity in other countries" (p. 73). Indeed, the same observation was made a century ago by Andrew (1908A): "In England no such general suspension of bank payments and no such premium upon money have occurred since the period of the Napoleonic wars; in France not since the war with Prussia…" (p. 290-91). Why is this point important? If one shares the viewpoint that panics are inherent to banking, then the details of panics perhaps do not matter. My viewpoint is that understanding panics requires a detailed knowledge of the setting.[5] That is what I will try to provide here in the case of the Panic of 2007.

How could a bursting of the house price bubble result in a systemic crisis?[6] In this paper, I try to answer this last question. There are, of course, a myriad of other questions (many of them important, and some distractions from the real issues), but I focus on this one as the central issue for policy. I do not test any hypotheses in this paper, nor do I expound on any new economic theory. I include some anecdotal evidence, as well as observations from my own, and my colleagues', experiences. I focus on describing the details of the financial instruments and structures involved and supply some very simple, stylized examples to illustrate their workings. Although I recognize that these details are probably rather boring for most people, I will argue that understanding the details of how the actual securities and structures involved are designed and intertwined is essential for addressing the most important questions.[7] I develop the thesis that the interlinked or nested unique security designs that were necessary to make the subprime market function resulted in a loss of information to investors as the chain of structures—securities and special-purpose vehicles (SPVs)—stretched longer and longer. The chain of securities and the information problems that arose are unique to subprime mortgages—and that is an important message of this paper.

Subprime mortgages are a financial innovation intended to allow poorer (and disproportionately minority) people and riskier borrowers access to mortgage finance in order to own homes. Indeed, these

mortgages were popular. Subprime mortgage origination in 2005 and 2006 was about $1.2 trillion, of which 80 percent was securitized.[8] The key security design feature of subprime mortgages was the ability of borrowers to finance and refinance their homes based on the capital gains due to house price appreciation over short horizons and then turning this into collateral for a new mortgage (or extracting the equity for consumption). The unique design of subprime mortgages resulted in unique structures for their securitization, reflecting the underlying mortgage design. Further, the subprime residential mortgage-backed securities (RMBS) bonds resulting from the securitization often populated the underlying portfolios of collateralized debt obligations (CDOs), which in turn were often designed for managed, amortizing portfolios of asset-backed securities (ABS), RMBS, and commercial mortgage-backed securities (CMBS). CDO tranches were then often sold to (market value) off-balance sheet vehicles or their risk was swapped in negative basis trades (defined and discussed below). Moreover, additional subprime securitization risk was created (though not on net) synthetically via credit default swaps (CDS) as inputs into (hybrid or synthetic) CDOs. This nesting or interlinking of securities, structures, and derivatives resulted in a loss of information and ultimately in a loss of confidence since, as a practical matter, looking through to the underlying mortgages and modeling the different levels of structure was not possible. And while this interlinking enabled the risk to be spread among many capital market participants, it resulted in a loss of transparency as to where these risks ultimately ended up.

When house prices began to slow their growth and ultimately fall, the bubble bursting, the value of the chain of securities began to decrease. But, exactly which securities were affected? And, where were these securities? What was the expected loss? Even today we do not know the answers to these questions. In 2007, there was a run on off-balance sheet vehicles, such as structured investment vehicles (SIVs) and asset-backed commercial paper conduits (ABCP conduits), which were, to some extent, buyers of these bonds. Creditors holding the short-term debt, i.e., commercial paper, of these vehicles did not roll their positions, which was tantamount to a withdrawal

of funds. A number of hedge funds collapsed. As of this writing, the crisis is not over.

An important part of the information story is the introduction, in 2006, of new synthetic indices of subprime risk, the ABX.HE ("ABX") indices. These indices trade over-the-counter. For the first time information about subprime values and risks was aggregated and revealed. While the location of the risks was unknown, market participants could, for the first time, express views about the value of subprime bonds, by buying or selling protection. In 2007 the ABX prices plummeted. The common knowledge created, in a volatile way, ended up with the demand for protection pushing ABX prices down.

The ABX information, together with the lack of information about location of the risks, led to a loss of confidence on the part of banks in the ability of their counterparties to honor contractual obligations. Securities wrapped by monoline insurers, such as auction rate notes, failed to re-auction and lost value, as monoline exposure to subprime was questioned. The entire financial system was engulfed when the ability to engage in repurchase agreements essentially disappeared. Collateral calls and the unwillingness to engage in repo transactions caused a scramble for cash. The bank-like system of off-balance sheet vehicles is beyond the reach of regulators, but migrates back to regulated institutions when things go bad.[9] The assets of SIVs and conduits were absorbed back onto bank balance sheets. Liquidity for asset-backed securities and mortgage-backed securities, both cash and synthetic, dried up. Absent reliable market prices, accountants forced firms to "mark-to-market," causing massive "write-downs" and resulting in reduced GAAP-based capital.[10] Financial firms had to issue securities (at unfavorable terms) and sell assets, with the latter causing a further declines in prices—and subsequent further write-downs. Meanwhile, underneath all of this, millions of Americans face foreclosure on their homes due to being unable to refinance their mortgages or to make payments on their current mortgages.[11]

The information setting is complicated, but I try to develop the following story. The sell-side of the market (dealer banks, CDO, and SIV managers) understands the complexity of the subprime chain, while the buy-side (institutional investors) does not. Neither group

knows where the risks are located, nor does either group know the value of every link in the chain. The chain made valuation opaque; information was lost as risk moved through the chain. The introduction of the ABX index revealed and aggregated values of the subprime bonds with centralized prices, until a breakdown of the index.[12]

At the root of the information story are the details of the chain. I detail the design of the various interlinked securities to develop the proposition that the uniqueness of these designs is at the root of the Panic. No other securitization asset class works like subprime mortgages, that is, no other asset class (e.g., credit card receivables, auto loans) is linked so sensitively to underlying prices. This distinction is important relative to the view of the Panic that seems to be coalescing into the common view. This view is known as the "originate-to-distribute" hypothesis, which very broadly claims that the last twenty–five years of change in banking has led to the current Panic because originators, it is alleged, have no incentive to maintain underwriting standards. I briefly discuss this hypothesis in a later section.

In Section II, I briefly look at some background on mortgage markets and the development of the subprime mortgage market. Section III is devoted to explaining how subprime mortgages work. The focus is on implicit contract features, which link the functioning of these mortgages to home price appreciation. Subprime mortgage originators financed their businesses via securitization, but the securitization of subprime mortgages is very different from the securitization of other types of assets (e.g., prime mortgages, credit cards, auto loans). Subprime securitization has dynamic tranching as a function of excess spread and prepayment and is sensitive to house prices as a result. This is explained in Section IV. That is not the end of the story, because tranches of subprime RMBS were often sold to CDOs. Section V briefly explains the link to CDOs and the inner workings of these vehicles, the issuance of CDOs, links to subprime, and the synthetic creation of subprime RMBS risk. Section VI presents a very simplified example of the interlinked payoff structure of the securities to show the complexity and loss of information. The crisis also involves a widespread problem of liquidity, which is a topic

deserving of much more attention than I have space for here. Section VII is about the Panic itself, the falling house prices, the role of the ABX indices, the runs on the SIVs. I also try to summarize the information argument of the paper. In Section VIII I briefly discuss the liquidity crisis and some exacerbating factors: accounting and collateral calls. Section IX is devoted to the competing hypothesis, called "originate-to-distribute." Concluding remarks are contained in Section X.

II. Some Background

In this section I begin with a very brief description of the evolution of subprime mortgages. Then I briefly look at the definition of "subprime" and the closely related category of "Alt-A" and review the issuance volumes and outstanding amounts of these mortgages.

II.A. The Development of Subprime Mortgages

Home ownership for low-income and minority households has been a long-standing national goal. Subprime mortgages were an innovation aimed at meeting this goal—and at making money for the innovators. The Harvard "1998 State of the Nation's Housing Report" put it this way:

> In addition to a buoyant economy, the overall housing industry owes its enduring vigor to innovations in mortgage finance that have helped not only expand homeownership opportunities, but also reduce market volatility. Under market and regulatory pressure to make homebuying more accessible to low-income and minority households, financial institutions have revised their underwriting practices to make lending standards more flexible. In the process, they have developed several new products to enable more income-constrained and cash-strapped borrowers at the margin to qualify for mortgage loans. (Joint Center for Housing Studies, 1998, p. 8).

In the same vein, Listokin, et al. (2000) noted:

> America's housing and mortgage markets are in the midst of a dramatic transformation. After generations of discrimination and disinvestment, low-income and minority borrowers and neighborhoods now represent growth potential for homeownership and mortgage lending. In a movement that seems to reconcile socioeconomic equity with the imperatives of profitability in a competitive and turbulent industry, mortgage lending has emerged as the key to revitalizing the inner city, opening access to suburban housing markets, and promoting household wealth accumulation. Prodded by policy makers, the housing finance industry is now racing to tap new markets for homeownership by reaching traditionally underserved populations of racial and ethnic minorities, recent immigrants, Native Americans, and low- to moderate-income (LMI) households (p. 19).

Subprime lending expanded during the 1990s, partly in response to changes in legislation affecting mortgage lending. See Temkin, et al. (2002) and Mansfield (2000) for the earlier history of subprime lending.[13] Much of the change in mortgage products was due to technological change, which achieved efficiencies in standardizing loan products and allowed for the routinization of application procedures. For example, underwriting became automated, based on credit scoring models.[14]

The main issue to be confronted in providing mortgage finance for the unserved population was clearly that these borrowers are riskier. Subprime borrowers are, by definition, riskier than "prime" borrowers, so even if this risk is priced, there must be a decline in underwriting standards in order to provide mortgages to this segment of the population. But, more specifically, potential subprime borrowers have a number of issues which make them difficult bank customers. A Bank of America Mortgage study (cited by Listokin, et al., 2000, p. 98) noted the following problems:

> 1. *Insufficient Funds for a Down Payment.* Low-income or minority customers often are not able to save enough money for a down payment, particularly in rapidly appreciating markets. Intermittent employment and employment at lower-paying jobs

often make it hard for many such households to save (Smith, 1998).[15]

2. *Credit Issues.* BAMG (bank of America Mortgage) finds that roughly two-thirds of the LMI (low- and middle-income) population that it deals with has either no credit or lesser-rated credit, as measured by bureau or FICO scores (Smith, 1998). While it is the industry standard, the calibration of credit performance in bureau reports and FICO scores is deemed by BAMG to be far from a perfect measure when dealing with traditionally underserved populations.

3. *Undocumented Income.* The cash economy in many traditionally underserved communities means that "they [prospective home buyers] are earning income but cannot prove it in the way most lenders want them to, with a W-2" (Smith, 1998).

4. *Lack of or Erroneous Information.* As previously described regarding the Hispanic focus group study, many LMI, ethnic, and immigrant households are totally unfamiliar with the home-buying process or, worse, are misinformed on such matters as how much house they can afford and the minimum down payments required. BAMG underscores that there is not a monolithic underserved community, but rather that different segments of that community have varying problems. Some have strong credit but low savings, while others have some credit issues but have been better savers. To meet these different needs, BAMG introduced two new Neighborhood Advantage mortgages, Zero Down (launched April 1998) and Credit Flex (launched July 1998).

Obviously, such households are risky propositions for lenders. If mortgages were to be extended to these borrowers, the underwriting standards would have to be different, and the structure of the mortgages would have to be different. For example, in 1998 Bank of America initiated two products to address this issue. One product, called the Neighborhood Advantage Zero Down, allowed low-to-moderate-income borrowers with good credit a 100 percent loan-to-value (LTV) as well as gifts or grants to cover closing costs. The other

product, called the Neighborhood Advantage Credit Flex, provided some flexibility to low-to-moderate-income borrowers subject to a documented alternative credit history. Other banks had similar products. See Listokin, et al. (2000).

While the interest rate on a mortgage can be set to price the risk, such a rate is not likely affordable for these borrowers. So, the challenge was (and remains) to find a way to lend to such borrowers. The basic idea of a subprime loan recognizes that the dominant form of wealth of low-income households is potentially their home equity. If borrowers can lend to these households for a short time period, two or three years, at a high, but affordable interest rate, and equity is built up in their homes, then the mortgage can be refinanced with a lower LTV ratio, reflecting the embedded price appreciation.[16] So, as detailed later, the mortgages were structured so that subprime lenders effectively have an (implicit) option on house prices. After the initial period of two or three years, there is a step-up interest rate, such that borrowers basically must refinance and the lender has the option to provide a new mortgage or not, depending on whether the house has increased in value. Lenders are long real estate, and are only safe if they believe that house prices will go up. This is detailed later.

II.B. Subprime and Alt-A Mortgages

The terms "subprime" and "Alt-A" are not official designations of any regulatory authority or rating agency. Basically, the terms refer to borrowers who are perceived to be riskier than the average borrower because of a poor credit history. However, the *Interagency Expanded Guidance for Subprime Lending Programs* defines a subprime borrower as one who displays one or more of the following features:

- Two or more 30-day delinquencies in the last 12 months, or one or more 60-day delinquencies in the last 24 months;
- Judgment, foreclosure, repossession, or charge-off in the last 24 months;
- Bankruptcy in the last five years;
- Relatively high probability of default as evidenced by, for example a FICO score of 660 or below;

- Debt service-to-income ratio of 50 percent or greater; or otherwise limited ability to cover family living expenses after deducting total debt-service requirements from monthly income.

The market has adopted a somewhat larger, more ambiguous definition, one that is not standard across banks.[17] As shown in Table 1, subprime borrowers typically have a FICO score below 640 and at some point were delinquent on some debt repayments in the previous 12 to 24 months, or they have filed for bankruptcy in the last few years.[18]

Whatever the definition, the innovation was successful, at least for a significant period of time. Tables 2 and 3, one for outstanding amounts and the other for issuance, show the size of the Alt-A and subprime mortgage markets relative to the total mortgage market and to the agency mortgage component of the market. The tables show:

- The outstanding amounts of subprime and Alt-A combined amount to about one-quarter of the $6 trillion mortgage market.
- Issuance in 2005 and 2006 of subprime and Alt-A mortgages was almost 30 percent of the mortgage market.
- Over the period 2000-2007, the outstanding amount of agency mortgages doubled, but subprime grew 800 percent!
- Since 2000, the subprime and Alt-A segments of the market grew at the expense of the agency share, which fell from almost 80 percent (by outstanding or issuance) to about half by issuance and 67 percent by outstanding amount.

Many seem to hold the view that subprime mortgages are homogeneous. Aside from the attributes in the table of characteristics, this is not the case. Certainly, as is well-known, vintage of the mortgage is important. But also, even cross-sectionally, subprime mortgages are not homogeneous. That is, while they are all "subprime," this does not mean that they are all the same across all dimensions, even holding vintage constant. Table 4 shows some of the heterogeneity of origination characteristics of the borrowers and the heterogeneity of experience of those borrowers across states from the 2006 vintage as of November 13, 2007. The table is from UBS (*Mortgage Strategist*, November 13, 2007,

Table 1
Market Description of RMBS Categories

Attribute	Prime	Jumbo	Alt-A	Subprime
Lien Position	1st Lien	1st Lien	1st Lien	Over 90% 1st Lien
Weighted Average LTV	Low 70s	Low 70s	Low 70s	Low 80s
Borrower FICO	700+ FICO	700+ FICO	640-730 FICO	500-660 FICO
Borrower Credit History	No credit derogatories	No credit derogatories	No credit derogatories	Credit derogatories
Conforming to Agency Criteria?	Conforming	Conforming by all standards but size	Non-conforming due to documentation or LTV	Non-conforming due to FICO, credit history, or documentation
Loan-to-Value (LTV)	65-80%	65-80%	70-100%	60-100%

Table 2
Non-Agency MBS Outstanding

			Outstandings in $ Billions				Percent of Total MBS				
			Non-Agency Outstanding					Non-Agency Outstanding			
Year	**Total MBS**	**Agency**	**Total**	**Jumbo**	**Alt-A**	**Subprime**	**Agency**	**Total**	**Jumbo**	**Alt-A**	**Subprime**
2000	3,003	2,625	377	252	44	81	87%	13%	8%	1%	3%
2001	3,409	2,975	434	275	50	109	87%	13%	8%	1%	3%
2002	3,802	3,313	489	256	67	167	87%	13%	7%	2%	4%
2003	4,005	3,394	611	254	102	254	85%	15%	6%	3%	6%
2004	4,481	3,467	1,014	353	230	431	77%	23%	8%	5%	10%
2005	5,201	3,608	1,593	441	510	641	69%	31%	8%	10%	12%
2006	5,829	3,905	1,924	462	730	732	67%	33%	8%	13%	13%
2007Q1	5,984	4,021	1,963	468	765	730	67%	33%	8%	13%	12%

Source: Federal Reserve Board, *Inside MBS&ABS*, LoanPerformance, UBS

Table 3
Gross Mortgage-Backed Security Issuance

	Non-Agency $ Bil.					Total MBS $ Bil.	Percent of Total					
Year	**Agency**	**Jumbo**	**Alt-A**	**Subprime**	**Other**		**Agency**	**Jumbo**	**Alt-A**	**Subprime**	**Other**	**Non-Agency**
2000	0.479	0.054	0.016	0.052	0.013	0.615	78%	8.7%	2.7%	8.5%	2.2%	22.1%
2001	1.09	0.142	0.011	0.087	0.027	1.35	80%	10.5%	0.8%	6.4%	2.0%	19.7%
2002	1.44	0.172	0.053	0.123	0.066	1.86	78%	9.2%	2.9%	6.6%	3.6%	22.3%
2003	2.13	0.237	0.074	0.195	0.080	2.72	78%	8.7%	2.7%	7.2%	2.9%	21.6%
2004	1.02	0.233	0.159	0.363	0.110	1.88	54%	12.4%	8.4%	19.3%	5.8%	45.9%
2005	0.965	0.281	0.332	0.465	0.113	2.16	45%	13.0%	15.4%	21.6%	5.3%	55.3%
2006	0.925	0.219	0.366	0.449	0.112	2.07	45%	10.6%	17.7%	21.7%	5.4%	55.3%
7m 2007	0.654	0.136	0.219	0.176	0.047	1.23	53%	11.0%	17.8%	14.3%	3.8%	46.9%

Source: *Inside MBS & ABS*

p. 31). The last row is the total for the balances and is the weighted average for the characteristics.[19]

Table 4 shows:

- The combined loan-to-value ratio (combo LTV) varies from about 80 percent to 91.5 percent.
- All the state FICO scores are around 620. They vary from a low of 604 in West Virginia to a high of 644 in Hawaii. Note, however, that West Virginia's percentage of loans that are 60 days or more delinquent is 6.67 percent, compared to a weighted national average of 16 percent.
- The percentage of mortgages that are full doc varies from a minimum of 43.6 percent in New York to a maximum of 80.9 percent in Indiana.
- Compared to "ALL," note that the states Minnesota, California, Florida, Nevada, Rhode Island, Georgia, and Ohio are worse than the weighted average, in terms of percentage cumulative 60 days delinquent. In terms of cumulative loss, the experience varies from three basis points of loss in West Virginia to a maximum of 1.2 percent cumulative losses in Missouri.
- House price appreciation (HPA) over the life of the loan, by state, shows a wide range of experience.
- These are state averages, so the dispersion is undoubtedly greater.

These observations are intended to convey the richness and complexity of the cross-sectional experience of different states. Even though subprime bond portfolios are fixed, and RMBS investors cannot easily choose state concentrations, there is some variation, which is relevant assuming house prices rise and defaults are idiosyncratic. But, portfolios tend to reflect the national concentrations of population, e.g., in California.

Table 4

State	Original Balance	Current Balance	Factor	Combo LTV	FICO	% Full Doc	%60D+	%Cum Def	%Cum Loss	HPA Life	%Cum 60D+
AK	$526,218,473	$399,461,897	76.4	88.4	620	70.4	10.01	0.96	0.28	4.99	8.60
AL	$1,849,884,555	$1,550,451,687	85.1	89.5	606	76.1	13.53	1.24	0.44	6.05	12.76
AR	$815,652,588	$697,886,978	87.5	89.9	615	73.1	11.46	1.50	0.44	4.37	11.53
AZ	$14,428,873,327	$11,553,251,475	83.2	85.8	622	58.7	15.07	1.53	0.45	1.52	14.07
CA	$102,766,337,717	$82,358,162,338	82.3	86.3	638	46.6	22.92	2.33	0.84	-1.15	21.19
CO	$5,292,370,638	$4,441,089,856	86.9	91.4	627	70.4	15.99	2.50	0.84	1.44	16.39
CT	$4,669,164,260	$3,861,877,916	85.2	84.7	614	60.8	14.05	1.20	0.30	0.95	13.17
DC	$1,194,568,797	$777,630,979	65.8	79.3	618	52.5	19.50	1.81	0.70	0.63	14.65
DE	$991,186,352	$794,565,683	83.8	85.8	607	71.1	11.74	0.77	0.08	4.39	10.61
FL	$43,832,887,130	$36,621,751,851	86.4	85.5	621	50.8	21.37	1.26	0.45	1.33	19.73
GA	$8,695,861,284	$6,981,317,691	81.5	91.3	618	67.1	18.22	2.51	0.98	4.11	17.37
HI	$3,018,554,281	$2,321,907,957	78.7	83.0	644	46.2	11.73	1.14	0.32	4.21	10.38
IA	$858,318,756	$683,838,875	81.0	90.6	608	80.9	13.85	0.94	0.25	3.13	12.16
ID	$1,415,015,589	$1,130,897,876	82.4	86.7	617	70.2	11.14	1.58	0.27	7.32	10.76
IL	$17,296,689,870	$11,903,745,425	69.7	88.7	625	56.9	18.21	1.16	0.41	3.71	13.85
IN	$2,885,253,658	$2,512,373,695	88.7	90.7	614	76.0	15.74	1.45	0.64	2.42	15.41
KS	$903,577,781	$699,004,465	79.7	90.8	613	78.8	12.80	1.05	0.31	3.56	11.26
KY	$1,317,753,384	$1,141,425,298	89.8	90.4	610	78.7	14.47	1.24	0.31	3.36	14.23
LA	$1,781,601,486	$1,539,635,309	89.0	89.1	609	68.8	10.61	0.65	0.15	5.93	10.09
MA	$9,065,659,267	$6,577,633,279	73.8	84.9	623	55.8	18.60	1.70	0.53	-1.82	15.42
MD	$16,017,510,459	$10,727,182,750	68.5	84.9	615	62.7	14.93	1.00	0.30	2.35	11.22

Table 4 (continued)

ME	$1,097,914,180	$793,716,799	74.4	84.2	615	62.7	15.16	0.61	0.15	2.55	11.90
MI	$6,820,690,521	$5,744,089,563	85.4	89.8	613	66.5	22.31	1.79	0.86	-2.56	20.83
MN	$4,667,272,065	$3,835,369,086	83.6	89.6	626	64.5	23.92	1.72	0.70	0.61	21.73
MO	$3,654,696,377	$2,912,862,041	81.4	89.5	607	74.0	15.40	2.91	1.20	3.43	15.45
MS	$980,156,949	$855,069,697	89.1	89.8	605	74.7	15.19	1.69	0.56	5.56	15.23
MT	$410,267,389	$323,274,332	81.5	85.5	617	65.7	8.64	1.45	0.10	8.06	8.49
NC	$4,597,544,803	$3,520,500,657	78.1	89.7	613	73.5	11.16	1.31	0.31	6.89	10.03
ND	$93,805,229	$81,770,280	88.2	91.3	616	77.4	8.59	1.09	0.15	5.96	8.67
NE	$511,569,008	$448,252,110	89.6	91.4	614	77.7	10.98	1.28	0.51	2.19	11.11
NH	$1,361,125,986	$1,131,525,707	86.3	85.0	614	63.8	13.34	1.27	0.35	0.38	12.78
NJ	$14,963,091,591	$10,011,731,473	68.0	83.8	620	48.8	18.12	1.10	0.26	1.77	13.41
NM	$1,377,416,203	$900,206,794	66.9	87.1	615	68.7	9.01	0.69	0.12	7.46	6.72
NV	$7,448,696,508	$6,276,562,378	87.6	88.2	631	54.5	19.61	1.89	0.60	-1.60	19.06
NY	$22,383,244,240	$17,544,608,248	79.7	84.3	633	43.6	18.58	1.60	0.38	1.49	16.42
OH	$5,483,111,567	$4,690,730,151	87.1	90.6	613	76.3	17.89	1.08	0.36	0.32	16.66
OK	$1,221,051,933	$1,071,559,556	90.5	90.3	610	76.8	12.39	1.12	0.33	3.61	12.34
OR	$4,427,876,513	$3,595,736,620	83.7	87.2	629	70.3	9.59	1.17	0.23	7.93	9.20
PA	$6,978,493,823	$5,809,560,356	86.0	85.5	608	70.0	10.88	0.53	0.12	4.57	9.89
RI	$1,935,464,210	$1,506,722,871	79.6	84.9	621	55.5	19.87	2.53	0.95	-1.45	18.34
SC	$2,359,469,767	$1,805,802,326	78.0	88.1	612	70.7	13.18	1.14	0.29	6.41	11.42
SD	$143,990,678	$125,448,463	88.5	91.0	616	75.7	11.53	0.28	0.07	4.37	10.49
TN	$3,863,653,816	$3,350,306,516	88.5	91.5	615	75.7	12.38	2.21	0.74	6.09	13.16
TX	$14,544,490,634	$12,691,323,091	90.4	89.6	616	66.7	11.51	2.05	0.74	6.43	12.46

Table 4 (continued)

UT	$3,185,604,205	$2,423,726,305	77.7	90.6	631	68.3	8.24	1.60	0.26	14.70	8.00
VA	$10,125,147,122	$7,702,473,341	78.7	85.8	616	59.7	17.95	2.21	0.82	3.11	16.33
VT	$309,867,790	$213,999,934	71.7	81.7	615	64.4	13.75	0.52	0.10	3.06	10.38
WA	$9,550,742,478	$7,505,680,840	81.1	88.0	625	69.5	9.40	1.58	0.26	9.13	9.20
WI	$3,511,477,290	$2,533,979,690	72.9	88.7	613	72.4	15.44	0.82	0.23	2.79	12.08
WV	$454,297,185	$347,335,187	78.9	86.1	604	76.7	13.38	1.13	0.31	2.47	11.69
WY	$296,835,000	$236,406,395	82.9	90.1	615	79.9	7.43	0.51	0.03	9.97	6.67
ALL	**$378,382,004,715**	**$299,265,424,087**	**81.1**	**86.8**	**625**	**56.5**	**18.35**	**1.71**	**0.57**	**1.72**	**16.60**

III. Subprime Mortgage Design

The security design problem faced by mortgage lenders was this: How can a mortgage loan be designed to make lending to riskier borrowers possible? The defining feature of the subprime mortgage is the idea that the borrower and lender can benefit from house price appreciation over short horizons. The horizon is kept short to protect the lender's exposure. Conditional on sufficient house price appreciation, the mortgage is rolled into another mortgage, possibly with a short horizon as well. The appreciation of the house can become the basis for refinancing every two or three years. In this section, I begin with an overview of subprime mortgages. The next subsection explains the details of how these mortgages work with a simple, stylized example.

III.A. Overview

The defining characteristic of a subprime mortgage is that it is designed to essentially force a refinancing after two or three years. Specifically, most subprime mortgages are adjustable-rate mortgages (ARMs) with a variation of a hybrid structure known as a "2/28" or "3/27." Both 2/28 ARM and 3/27 ARM mortgages typically have 30-year amortizations. The main difference between these two types of ARMs is the length of time for which their interest rates are fixed and variable.

In a 2/28 ARM, the "2" represents the number of initial years over which the mortgage rate remains fixed, while the "28" represents the number of years the interest rate paid on the mortgage will be floating. Similarly, the interest rate on a 3/27 ARM is fixed for three years after which time it floats for the remaining 27-year amortization. The margin that is charged over the reference rate depends on the borrower's credit risk as well as prevailing market margins for other borrowers with similar credit risks.[20]

These mortgages are known as "hybrids" because they incorporate both fixed- and adjustable-rate features. The initial monthly payment is based on a "teaser" interest rate that is fixed for the first two years (for the 2/28) or three years (for the 3/27). Two important points are noteworthy about 2/28s and 3/27s. First, the fixed rate for

the first 2 or 3 years, the teaser rate, was not particularly low compared to prime mortgages. For example, the national average rate on a 2006 subprime 2/28 mortgage was 8.5 percent, and would reset on average to 6.1 percent over the benchmark LIBOR. (See Rosengren, 2007.) These high initial rates are not surprising because most of these mortgages were refinanced or the homes were sold prior to the mortgage being reset.

As an example, on a 2/28 mortgage originated in 2006, the initial interest rate might have been 8.64 percent. After the initial period comes the rate "reset" (or step-up date), which is a higher interest rate, say LIBOR plus 6.22 percent. At the time of origination, LIBOR could have been 5.4 percent. So, the new interest rate at the reset would have been 11.62 percent. This rate floats, so it changes if LIBOR changes. The interest rate is updated every six months, subject to limits called adjustment caps. There is a cap on each subsequent adjustment called the "periodic cap" and a cap on the interest rate over the life of the loan called the "lifetime cap." The reset rate is significantly higher, but potentially affordable.

The above discussion emphasizes why the reset date on a hybrid ARM is so important. The higher payment for the borrower at the reset date comes from the significantly higher monthly mortgage payment that occurs at reset. Borrowers, thus, have an incentive to refinance their mortgage before the reset date. This is what I meant above by the term "essentially force" a refinancing.

Another important characteristic of subprime mortgages is the size and prevalence of the prepayment penalties. See, e.g., Farris and Richardson (2004). Fannie Mae estimates that 80 percent of subprime mortgages have prepayment penalties, while only 2 percent of prime mortgages have prepayment penalties (see Zigas, Parry, and Weech, 2002). Further evidence for this comes from the prevalence of net interest margin securities (NIMs) in subprime securitizations. NIMs are securitizations of the early excess cash flows and prepayment penalties in subprime RMBS transactions. They are interest-only strips that derive their cash flow from the excess or residual cash flows, including significantly the prepayment penalties. See Bear Stearns (September 2006B); Frankel (2008); Zelmanovich, et

al. (2007); and McDermott, Albergo, and Abrams (2001). I discuss NIMs further below.

It is worth briefly contrasting a subprime mortgage with a standard, prime, 30-year, fixed-rate mortgage. With a prime mortgage, the borrower repays principal over time, and the mortgage matures after 30 years. The borrower may prepay the mortgage, typically without penalty. The borrower may benefit from house price appreciation, but the lender does not (directly) benefit. In effect, the lenders are not long house prices.

I now turn to a simple, stylized example to try to understand how the design of the subprime mortgage addressed the riskiness of the borrowers.

III.B. A Simple, Stylized Example

The standard, prime mortgage is typically a fixed-rate 30-year loan. The usual way of thinking of mortgage design and pricing is to recognize the embedded optionality in these mortgages: The borrower has the right to prepay the mortgage (a call option to refinance) and the right to default (a put option).[21] That is, the mortgage can be purchased from the lender at par, via prepayment, which is a call option, depending on interest rates. Or, the mortgage can be sold by the borrower to the lender for the value of the house, via default, amounting to a put option. The literature on this is voluminous. See Kau and Keenan (1995) for a review.

A subprime mortgage is very different. Of course, borrowers can always prepay (but, subject to the prepayment penalty), and they can always default. But, as mentioned above, one important difference is that subprime mortgages typically have significantly higher prepayment penalties than prime mortgages (where it is typically zero). But, that is not the only important difference. The example below is intended to illustrate that a subprime mortgage contains an implicit embedded option on house prices for the lender. To the extent that this option is valuable, lenders may be willing to lend to riskier borrowers.

The intuition is as follows. If house prices rise, and borrowers build up equity in their homes, they will become less risky, ceteris paribus. But, lenders are unwilling to speculate on house prices and borrower

repayment behavior for long periods, so they want the right to end the mortgage early, because foreclosure is costly. If borrowers "extract equity" through refinancing, after house prices have risen, then the plan of the lenders may not work. So, lenders incorporate high prepayment fees to try to prevent this. I develop these ideas with the example below.

In my example, mortgages to prime borrowers would be made for two periods, but the candidate borrower that I will consider is rated "subprime," and so the lender is unwilling to make a traditional two-period mortgage. The prospective borrower has a given income, which perhaps cannot be documented, and lacks money for a down payment. So, this mortgage, if made, would be to a borrower with no collateral. It is simply too risky to make a standard prime mortgage.

To see how a subprime mortgage works, consider a lender who operates in a competitive market and faces a financing cost of r_B per period. Let $r_{M,t}$ be the mortgage rate that the lender may offer for a subprime mortgage during period t. The amount of the mortgage is \$L. Over period t the probability of borrower default is $p(r_{M,ti}L, LTV_t)$, where the probability of default is increasing in the mortgage payment, $r_{M,t}L$ (implicitly relative to the borrower's income), and in the loan-to-value (LTV_t) ratio, which measures the equity stake the borrower has in the home.[22] Borrowers work harder if they have an equity stake. To summarize, a higher mortgage payment and more debt relative to the home value increase the chance of defaulting. If there is a default, the recovery rate on the home value, V_t, at the end of period t is 50 percent, so for a mortgage of size \$L, the lender would recover $R_t=\min[0.5V_t, L]$ if there is a default at the end of period t. Call R_t the "recovery amount" for period t.[23]

The subprime candidate borrower is applying for a mortgage of size \$L for a home worth \$L, so the LTV would be 100 percent. On a one-period mortgage, the lender breaks even if the mortgage rate, $r_{M,1}$, is such that:

$$(1+r_{M,1})(1- p(r_{M,1}L, LTV_1))L + R_1\, p(r_{M,1}L, LTV_1) - (1+r_B)L = 0. \quad (1)$$

Of course, there may be no mortgage rate that satisfies (1). The lender cannot simply increase the mortgage interest rate because this increases

the likelihood of default, as it becomes less likely that the borrower can make the higher mortgage payment. In any case, since, by assumption, the first period is rather short, realistically the borrower would have to refinance at the end of the first period, or default would be certain to occur. But, I have already ruled out granting long-term (two-period) mortgages to subprime borrowers as too risky.

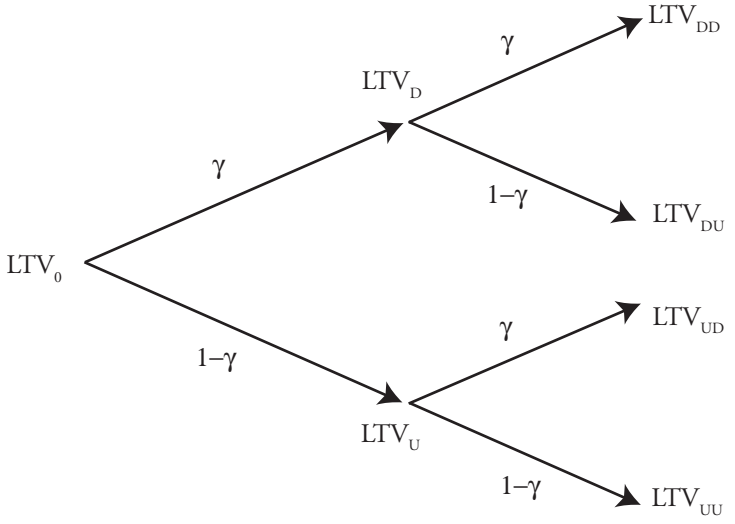
Suppose a subprime mortgage, as follows. The lender offers to extend a mortgage loan for the full two periods (imagine that period 1 is two years and period 2 is 28 years, though I omit the technicalities of discounting and so on), with an initial mortgage rate of $r_{M,1}$ for the first period. Assume that the mortgage rate for the second period (the "step-up" rate) is prohibitively high so that the borrower must refinance the mortgage or default at that time. This is by design. Also, I will assume that the prepayment penalty is high.

Suppose now that during any period there is a γ percent chance that house prices rise by Φ percent and a $1 - \gamma$ percent chance that they fall by Φ percent. During the first period, house prices will either rise or fall. For simplicity, assume that the house price change occurs an instant before the end of the first period, so that it does not affect the initial LTV ratio or the probability of default during the first period. Then, at the start of the second period, if house prices have risen, the LTV will have fallen to LTV_D (the "D" subscript is for "down"). This corresponds to the borrower having positive equity in the home. On the other hand, if during the first period house prices have fallen, then the LTV will be higher, LTV_U ("U" is for "up"), corresponding to the borrower having a negative equity position in the home.

The assumed evolution of home prices affects the first period outcome—default or refinance. The evolution of house prices does not affect the probability of default (by assumption), but it does affect the recovery amount. If there is a default at the end of the first period, then the value of the house is different in the two cases of whether home price appreciation occurred or did not. Following the notation shown in Chart 1, the expected value of the first period mortgage, $E(L_1)$ is:

$$(1+r_{M,1})(1- p(r_{M,1}L, LTV_0))L + \gamma R_{D,1}\, p(r_{M,1}L, LTV_0) + (1-\gamma)R_{U,1}\, p(r_{M,1}L, LTV_0) - (1+r_{B,1})L \qquad (2)$$

Chart 1
The Evolution of House Prices and the Loan-to-Value Ratio



where $R_{D,1}$=min[0.5(1+ Φ)V_t, L], in the case of house prices rising and LTV going down, and $R_{U,1}$=min[0.5(1– Φ)V_t, L]; note that the subscripts on "R" refer to the LTV going down (D) since house prices went up and house prices rising corresponding to the LTV going up (U).

If house prices fall at the end of the first period, assume that the initial lender will not refinance the mortgage (and neither will any other lender). The borrower now has negative equity and the likelihood of default going forward is (by assumption) too high for any lender. If home prices rise at the end of the first period, then the initial lender will be willing to refinance the mortgage.

A rise in home prices over the first period has two effects: (1) the borrower has positive equity in the house, which is collateral from the point of view of the lender; this makes the lender's recovery amount higher; (2) with a lower LTV going forward, the probability of default is lower, ceteris paribus, so the mortgage rate for the next period, $r_{M,2}$, may be lower, making the payment lower, which also

reduces the default likelihood. (Of course, as I discuss below, the borrower may extract the equity for consumption.)

House prices may rise or fall over the second period. As before, I assume that house prices change an instant before the end of the period, and so the change does not affect the probability of default during the period. It does affect the recovery amount at the end of the second period. The expected value of the second-period mortgage (conditional on it being made), $E(L_2)$, is:

$$(1+r_{M,2})(1- p(r_{M,2}L, LTV_D))L + \gamma R_{DD,2}\, p(r_{M,2}L, LTV_D) + (1-\gamma) R_{DU,2}\, p(r_{M,2}L, LTV_D) - (1+r_{B,2})L. \quad (2)$$

Note that the second-period mortgage rate, $r_{M,2}$ (and lender borrowing rate, $r_{B,2}$), may be different than the first-period rate, and that the LTV ratio at the start of the period is now LTV_D as house prices have risen. At the end of the second period, if house prices fell and the borrower defaults, the bank will recover $R_{DU,2}$; the bank will recover $R_{DD,2}$ if house prices rose.

The expected payoff to the lender over the two periods (omitting discounting and the prepayment penalty) is: $E(L_1) + \gamma E(L_2)$. Note that the second-period mortgage is only made if prices have risen during the first period. This occurs with probability γ.

At the end of the first period, the borrower is in a difficult spot because he either defaults or must refinance. The lender faces a choice, which depends on house prices. If house prices have risen (LTV goes down), the lender chooses $\max[R_{D,1}, E(L_2)] = E(L_2)$. If house prices have fallen (LTV goes up), the lender chooses $\max[R_{U,1}, E(L_2)] = R_{U,1}$. In other words, the lender decides whether to refinance or take the recovery value. This is the optionality in the mortgage for the lender. It is an implicit option, as the strike price is the recovery amount, which depends on what house prices did over the second period.

The lender does not take into account costs to the borrower from defaulting, if there are such costs.

The example makes the following points:

1. The key design features of a subprime mortgage are: (1) it is short term, making refinancing important; (2) there is a step-up mortgage rate that applies at the end of the first period, creating a strong incentive to refinance; and (3) there is a prepayment penalty, creating an incentive not to refinance early. If the step-up rate and the prepayment penalty are both sufficiently high so that without refinancing from the lender, the borrower will default, then the lender is in a position to decide what happens. The lender is essentially long the house, exposing the lender to house prices more sensitively than conventional mortgages.

2. In an important sense, the decision to default has effectively been transferred from the borrower to the lender. The step-up interest rate forces the borrower to come back to the lender after the first period, and the lender decides whether to extend another loan or not. Instead of the borrower having an option to default, the lender has an option to extend.

3. The design of the subprime mortgage creates the refinancing option. But, the borrower can refinance at the reset date with any originator. It may be that the subprime market is competitive with respect to initial mortgages, but not with respect to refinancing; borrowers are largely tied to their initial lenders.[24] In that case, the original lender can benefit from any home price appreciation.

4. If $E(L_1)<0$, i.e., the expected profit to the lender from the first-period loan is negative, then the refinancing must be tied to the original lender. The subprime mortgage, including the possible second-period refinancing, may be expected to be profitable if the probability of a house price increase, γ, is perceived to be sufficiently high. This happens if the borrower is tied to the original lender for refinancing. In fact, $r_{M,1}$, the first-period mortgage rate, may be set low (relative to the risk of loss due

to default), as a teaser rate, making $E(L_1)$ negative, and still the overall loan may have a positive expected value if the probability of a house price increase, γ, is perceived to be sufficiently high. This may be viewed as "predatory" lending; the borrower is attracted to borrow, but may not understand that effectively it is the lender who makes the choice to refinance or not at the end of the first period.

Refinancing does not mean that the borrower receives a long-term mortgage. The borrower could be rolled into another subprime loan. In fact, a borrower could receive a sequence of subprime loans, as house prices rise, each time building up equity and obtaining increasingly lower interest rates.[25] But, in such a sequence, the lender effectively has the right to opt out by not refinancing and taking the recovery amount. In other words, a sequence of refinancings into subprime mortgages corresponds to a compound option for the lender.

The borrower always has the right to prepay the mortgage, but with the higher prepayment fee. So far, I have assumed that this was prohibitively high. But, in practice, we do observe prepayments. In prime mortgages, this is usually the result of mortgage rates going down, as with prime mortgages. But, here there is another motivation as well. The borrower may want to extract equity value if house prices have risen.

In my example above, one can imagine that this corresponds to the borrower and lender agreeing to refinance the loan at the end of period 1, but that the new mortgage allows the borrower to extract equity in the process. At the end of the first period, the borrower owes \$L to the bank. If house prices have risen, the house is now worth $(1+\Phi)$L. If the lender is willing to make the same subprime mortgage that was made at the start of period 1, then the borrower can extract \$ ΦL. Such equity extraction is common in the prime market, but also very common—possibly more common, depending on the year—in the subprime market. In survey data, home equity extractions are often used for consumption. See Chomsisengphet and Pennington-Cross (2006, 2007) and Greenspan and Kennedy (2005, 2007). This is discussed further below.

III.C. Refinancing and Equity Extraction

Between 1998 and 2006, subprime mortgages worked as they were supposed to. During this period, house prices rose and prepayment speeds were high; at least half of these mortgages (of all types) were refinanced within five years, and up to 80 percent of some types were refinanced within five years. See Bhardwaj and Sengupta (2008A). In other words, the bulk of the "originations" in the subprime market were refinancings of existing mortgages.

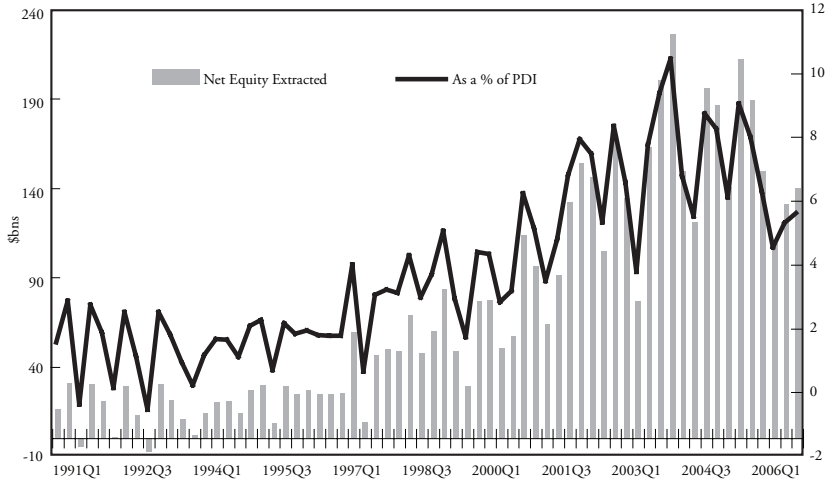
Who got the benefit of the option on house prices? To the extent that lenders are willing to refinance the house even with equity extraction, there is a split of the capital gain. In that case, the borrower gets cash. Lenders only face a possibly safer borrower if equity is built up. Note that if $E(L_1)<0$, then the lender will not want to allow equity extraction at the end of period 1 unless there is a large fee to compensate the lender for the foregone $\gamma E(L_2)$.

The benefits of refinancing were divided between lenders and borrowers, but we do not know the split. Greenspan and Kennedy (2007) estimate that during the period 1991-2005, $520 billion was extracted on average annually from all mortgages. Chart 2 shows the Greenspan and Kennedy estimates of net equity extraction and extraction as a percentage of personal disposable income.[26] These data do not distinguish between prime and subprime mortgage extractions, and so just convey a sense of the magnitudes. Bhardwaj and Sengupta (2008B) report that the fraction of subprime refinancings that involved some equity extraction ranged from 51.3 percent to 58.6 percent over the period 1998-2007, with no trend.[27] Chomsisengphet and Pennington-Cross (2006) examine the early period of the subprime market, prior to 2002, and show that a higher proportion of subprime refinancing involves equity extraction compared to prime refinancings.

III.D. Summary

To reiterate, no other consumer loan has the design feature that the borrower's ability to repay is so sensitively linked to appreciation of an underlying asset. This sensitivity to the market price, the house price, will have far-reaching implications. But, if this was the end of the story, there would not have been a systemic banking crisis

Chart 2
Net Equity Extraction and as a Percent of PDI



Source: Greenspan and Kennedy (2005, 2007)

(although obviously there would be the problem with foreclosures for many people).[28]

IV. The Design and Complexity of Subprime RMBS Bonds

The next link in the chain concerns how the subprime mortgages were financed. This too will require a unique security design, quite different from traditional securitizations.[29]

The originators of subprime mortgages were largely new entrants into mortgage lending, including many of the names that later became well-known, such as Countrywide Financial, New Century, Option One and Ameriquest. The main financing method for subprime originators was securitization. This will be important not only because the risk will be spread but also because the structure of the securitization will have special features reflecting the design of the subprime mortgages. This latter point means that there will be additional complexity.

Table 5
Mortgage Originations and Subprime Securitization

	Total Mortgage Originations (Billions)	Subprime Originations (Billions)	Subprime Share in Total Originations (% of dollar value)	Subprime Mortgage Backed Securities (Billions)	Percent Subprime Securitized (% of dollar value)
2001	$2 ,215	$190	8.6%	$95	50.4%
2002	$2,885	$231	8.0%	$121	52.7%
2003	$3,945	$335	8.5%	$202	60.5%
2004	$2,920	$540	18.5%	$401	74.3%
2005	$3,120	$625	20.0%	$507	81.2%
2006	$2,980	$600	20.1%	$483	80.5%

Sources: *Inside Mortgage Finance, The 2007 Mortgage Market Statistical Annual*, Key Data (2006), Joint Economic Committee (October 2007)

IV.A. Financing Subprime Mortgages via Securitization

Table 5 shows the extent to which lenders relied on securitization for the financing of the mortgages.

The table provides a snapshot of the quantitative importance of subprime securitizations. The table shows that subprime mortgage origination in 2005 and 2006 was about $1.2 trillion, of which 80 percent was securitized.

IV.B. The Design of Subprime RMBS

Subprime RMBS bonds are quite different from other securitizations because of the unique features that differentiate subprime mortgages from other mortgages. Like other securitizations, subprime RMBS bonds of a given transaction differ by seniority, but unlike other securitizations, the amounts of credit enhancement for each tranche and the size of each tranche depend on the cash flow coming into the deal in a very significant way. The cash flow comes largely from prepayment of the underlying mortgages through refinancing. What happens to the cash coming into the deal depends on triggers which measure (prepayment and default) performance of the underlying pools of subprime mortgages. The triggers can potentially divert cash flows within the structure. In some cases, this can lead to a leakage of protection for higher-rated tranches. Time tranching in subprime transactions is contingent on these triggers. The structure

makes the degree of credit enhancement dynamic and dependent on the cash flows coming into the deal. In this section, I briefly explain the structural features of subprime bonds.

The credit risk of the underlying mortgages is one important factor to understand in assessing the relative value of a particular subprime RMBS. Later, I will focus on the characteristics of the mortgages themselves, but here I focus on the securitization structure. However, the credit risk of the borrowers is intimately linked to the structure of the bond and, indeed, the structure of the particular transaction to which the bond is a part. Chart 3 shows the basic structure of a subprime RMBS transaction.[30]

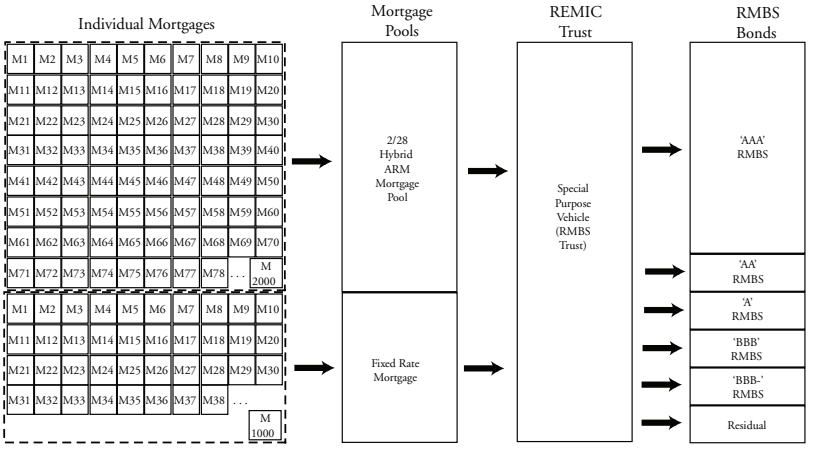
Overwhelmingly, asset-backed securities (ABS) and mortgage-backed securities (MBS) use one or both of the following structures:

- A senior/subordinate shifting of interest structure ("senior/sub"), sometimes called the "6-pack" structure (because there are 3 mezzanine bonds and 3 subordinate bonds junior to the AAA bonds), or
- An excess spread/overcollateralization ("XS/OC") structure. Overcollateralization means that the collateral balance exceeds the bond balance, that is, deal assets exceed deal liabilities.

Because credit risk is the primary risk factor, subprime RMBS bonds have a senior/sub structure, like prime RMBS, but also have an additional layer of support that comes from the excess spread, i.e., the interest paid into the deal from the underlying mortgages minus the spread paid out on the RMBS bonds issued by the deal.[31] Another important feature is overcollateralization, that is, there are initially more assets (collateral) than liabilities (bonds). (The overcollateralization reverts to an equity claim if it remains at the end of the transaction.)

In a prime deal with a senior/sub structure, basically the total amount of credit enhancement that will ever be present is in place at the start of the deal. The tranche sizes are fixed. In this setting, assuming that defaults and losses are bunched near the start of the deal is conservative. This assumption erodes the credit enhancement early

Chart 3
Sample Subprime MBS Structure



Source: Kevin Kendra, Fitch, "Tranche ABX and Basis Risk in Subprime RMBS Structured Portfolios," February 20, 2007

on, which cannot be replaced. Because of sequential amortization, senior tranches are being paid down over time in this structure.

Subprime transactions are different because the XS/OC feature results in a buildup of credit enhancement from the collateral itself during the life of the transaction. The allocation of the credit enhancement over time depends on triggers that reflect the credit condition of the underlying portfolio. Excess spread is built up over time to reach a target level of credit enhancement. Once the OC target is reached, excess spread can be paid out of the transaction (to the residual holder), and is no longer available to cover losses. Later, I discuss the triggers in more detail.

There are several key features of RMBS structures to be mentioned. First, there is a lockout period. Mezzanine and subordinate bonds are locked out of receiving prepayments for a period of time after deal settlement. In other words, during the lockout period, amortization is sequential. The period of time of the lockout, and other details, differ depending on the type of collateral in the deal. Second, there may be cross-collateralization. That is, some transactions contain

multiple loan groups. After interest payments are made on bonds in one group, available remaining funds can be used to pay interest to bonds in another group.[32]

Chart 4 displays the two types of transaction structures: senior/sub structure and the OC structure.

These transactions are quite complicated, so as a prelude to discussing XS/OC structures, I will very briefly start with the typical prime and Alt-A deal structure. I emphasize that what follows is a brief overview only.

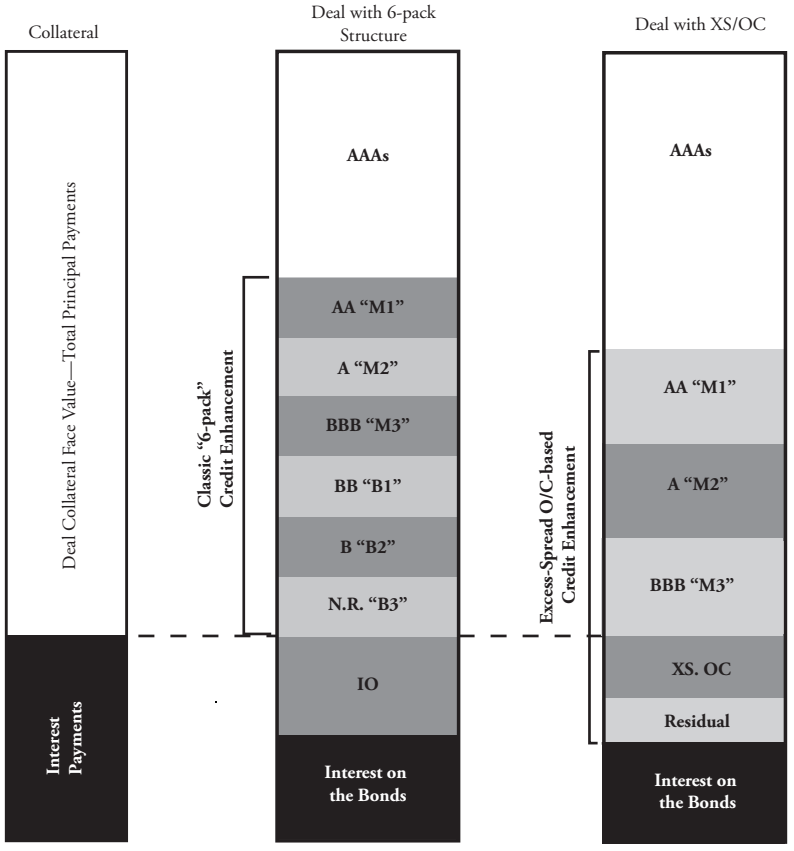
IV.C. Prime and Alt-A Deals

Most prime jumbo and Alt-A transactions use a 6-pack structure, and most subprime, and a few Alt-A deals, use the XS/OC structure. Choice of structure is mostly a function of the amount of excess spread in the deal. Excess spread is the difference between the weighted average coupon on the collateral and the weighted average bond coupons. In an XS/OC structure the excess spread is typically between 300 and 400 basis points.

There is no overcollateralization in a 6-pack structure. In a 6-pack deal, the mortgage collateral is tranched into a senior (AAA) tranche, mezzanine tranches (AA, A, BBB), and subordinated tranches (BB, B, and unrated). The most junior bond, essentially equity, is unrated because it is the "first loss" piece, meaning that it will absorb the first dollar of loss on the underlying pool of mortgages.

In a senior/sub, or 6-pack, structure, the mezzanine ("mezz") bonds and subordinate bonds are tranched to be thick enough to absorb collateral losses to ensure that the senior bonds have a probability of loss sufficiently low to justify a triple-A rating. This is accomplished by reversing the order of the priority of cash flow payments and losses in the transaction. In the early years of the transaction, prepaid principal is allocated from top down ("sequential amortization"), that is, only the senior bonds are paid, while the mezz bonds and sub bonds are "locked out" from receiving prepaid principal. Losses are allocated from the bottom up, that is, the lowest-rated class outstanding at the time will absorb any principal losses.

Chart 4
Senior/Sub 6-Pack Structure vs. the XS/OC Structure



Note: The scale in Chart 1 does not accurately reflect relative size of bonds, IO or interest flow.
Source: UBS

By using sequential amortization, the senior bonds are paid down first, and there is an increase in the percentage of the remaining collateral that is covered by the mezz and sub bonds. This continues during the lock-out period, which may be the first five years, in a fixed-rate transaction, or for as long as ten years in a prime ARM transaction.

In ARM deals, there may be triggers that allow for a reduction in the length of the lock-out period if certain performance metrics are satisfied. The two most common metrics in prime ARM senior/sub structures are (1) a Step-down Test and (2) the Double-down Test. A Step-down Test refers to when prepaid principal switches from sequential pay to pro rata amortization. Typically, prepaid principal switches from sequential pay to pro rata for all outstanding classes if: (a) the senior credit enhancement (CE) is twice the original percentage; and (b) the average 60+-day delinquency percentage for the prior six months is less than 50 percent of the current balance; and (c) cumulative losses are under a specified percentage of the original balance. The Double-down Test means that prior to the initial three-year period, 50 percent of prepaid principal can be allocated to the mezz and sub bonds if the above three criteria, (a)–(c), are satisfied.

IV.D. Subprime Deals

XS/OC deals are much more complex than straight senior/sub deals (which I have only briefly described above). As an overview, in contrast to a 6-pack deal in a, say, $600 million XS/OC transaction, the underlying mortgage pool might have collateral worth $612 million, a 2 percent overcollateralization. The $12 million of overcollateralization can be created in either of two ways: (1) it can be accumulated over time using excess spread; or (2) it is part of the deal from the beginning, when the face value of the bonds issued is less than the notional amount of the collateral.

XS/OC structures involve the following features (see, e.g., Bear Stearns, September 2006A):

- **Excess Spread:** Like senior/sub deals, the excess spread is used to increase the overcollateralization (OC) by accelerating the payment of principal on senior bonds via sequential amortization;

this process is called "turboing." Once the OC target has been reached, and subject to certain performance tests, excess spread can be released for other purposes, including payment to the residual holder.

- **The OC Target:** The OC target is set as a percent of the original balance and is designed to be in the second loss position against collateral losses. The interest-only strip (IO) is first. Typically, the initial OC amount is less than 100 percent of the OC target, and it is then increased over time via the excess spread until the target is reached. When the target is reached, the OC is said to be "fully funded." When the deal is fully funded, NIMs can begin to receive cash flows from the deal. Subject to passing certain performance tests, OC can be released to the residual holder.

- **Step-down Date:** The step-down date in an XS/OC deal is the later of a specified month (e.g., month 36) and the date at which the senior credit enhancement reaches a specified level (e.g., 51 percent). Prior to the step-down date, the senior bonds receive 100 percent of the principal prepayments. When the senior bonds are completely amortized away, prepaid principal continues to sequentially amortize, with the next class being the outstanding mezzanine bonds.

- **Performance Triggers:** Transactions are structured to include performance triggers that, under certain circumstances, will cause a reallocation of principal to protect or increase subordination levels. Generally speaking, there are two types of triggers: delinquency triggers and loss triggers. A trigger is said to "pass" if the collateral does not breach the specified conditions, and to "fail" if those conditions are hit or breached. If a trigger fails, principal payments to the mezzanine and subordinate bonds are delayed or stopped, preventing a reduction or credit enhancement for the senior bonds.[33] Loss triggers are target levels of cumulative losses as of specific dates after deal start. For example, the loss trigger in months 1-48 might be 3.5 percent, rise to 5.25 percent in months 49-60, 6.75 percent in months 61-72, and stay flat at 7.75 percent thereafter.

- **Available Funds Cap (AFC):** Generally, bonds in XS/OC deals pay a floating coupon. The underlying mortgages typically pay a fixed rate until the reset date on hybrid ARMs. This creates the risk that the interest paid in to the deal from the underlying collateral is not sufficient to make the coupon payments to the deal bondholders–"available funds cap risk." To prevent this situation, the deal is subject to an AFC. Investors receive interest as the minimum of index (e.g., 1-month LIBOR) plus margin or the weighted average AFC.

There are many nuances to these triggers. See, e.g., Moody's (November 22, 2002; May 30, 2003; September 26, 2006).

The structure can be summarized with a series of diagrams due to Fitch (2007). Then I will briefly present a sample transaction. Following that, I will show two other transactions to illustrate the cash flow dynamics and credit enhancement buildup.

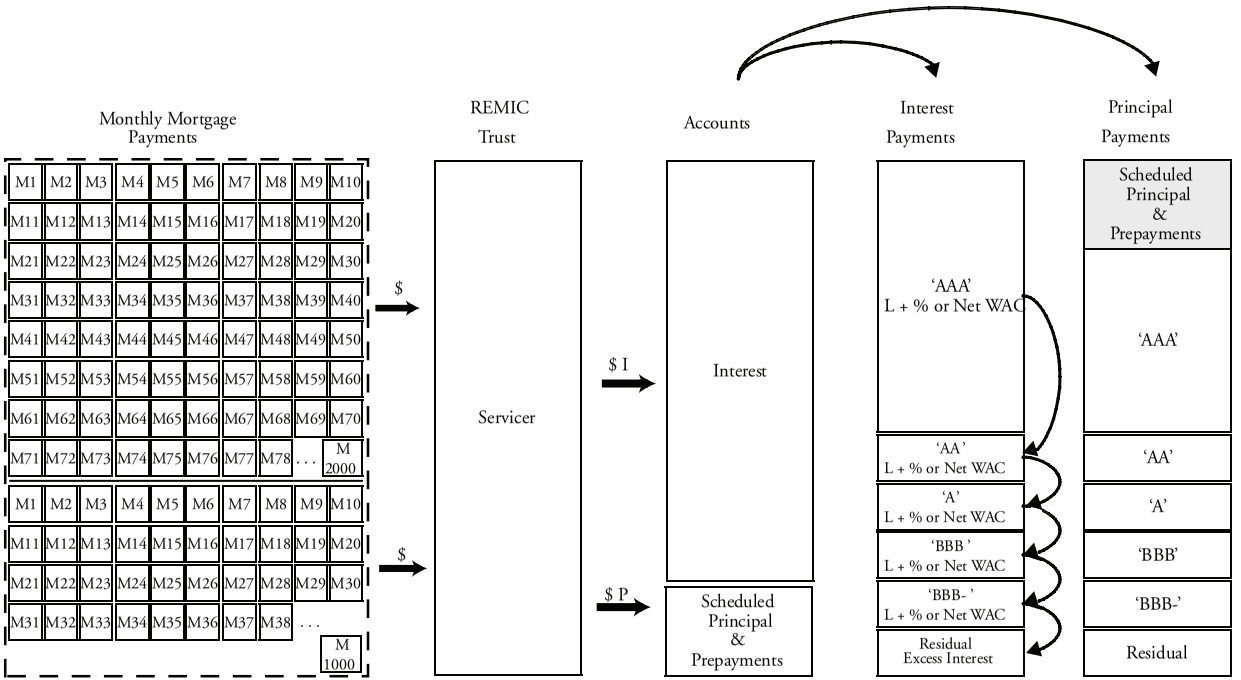
As shown in Chart 5, principal waterfalls are sequential-pay typically for the first three years. That is, all scheduled principal and prepayments go to repay the senior bondholders first, until they are paid in full. Then, principal payments go to the next senior note holder, until they are paid in full, and so on.

As discussed, after the first three years (scenario 1, Chart 6), credit enhancement (CE) "steps down," if certain performance tests have been met (scenario 2, Chart 6). For example, if overcollateralization (OC) targets have been met, the CE steps down by repaying subordinate bondholders. OC targets are set to double the original subordination.

Interest waterfalls involve regular interest that is paid sequentially to bonds, capped at the weighted average mortgage rate net of expenses (net weighted average coupon, WAC) or available funds cap (AFC), as discussed above.

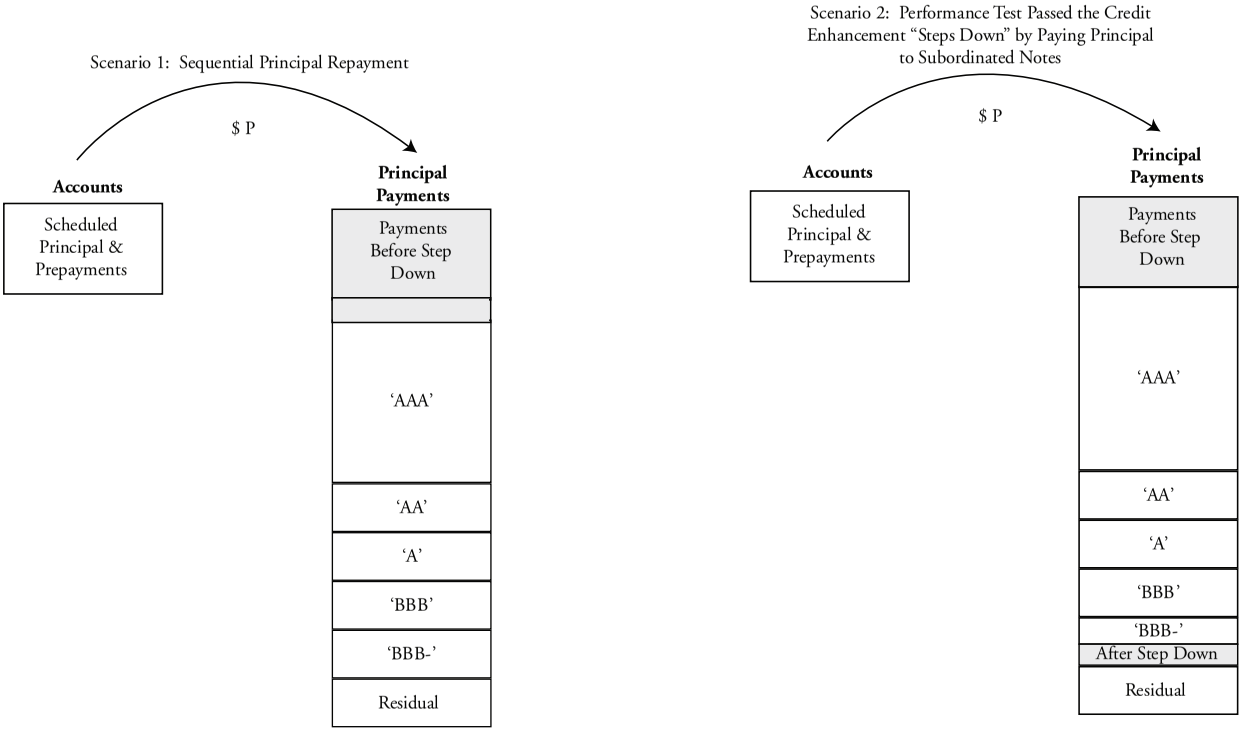
"Excess interest" is the remaining interest (which goes into the interest collection account) after paying bondholders regular interest. Excess interest (or "excess spread") is first used to cover realized collateral losses. Second, excess interest is used to cover any interest shortfalls due to the net WAC being lower than the stated bond coupon. Lastly, the

Chart 5
Sample Subprime RMBS Payments



Source: Kevin Kendra, Fitch, "Tranche ABX and Basis Risk in Subprime RMBS Structured Portfolios," February 20, 2007

Chart 6
Sample RMBS Interest Waterfall



Source: Kevin Kendra, Fitch, "Tranche ABX and Basis Risk in Subprime RMBS Structured Portfolios," February 20, 2007

remaining excess interest goes to the holder of the residual bond, typically the originator of the mortgages. (See Chart 7.)

The lock-out and step-down provisions are common structural features of subprime deals. To reiterate, the "lock-out" provision locks out the subordinate bonds from receiving principal payments for a period of time. After the lock-out period, deals are allowed to "step-down," that is, principal payments can be distributed to the subordinated bonds, provided that the credit enhancement limits are twice the original levels and the deal passes other performance tests, measured by triggers.

IV.E. Example of a Subprime RMBS Deal

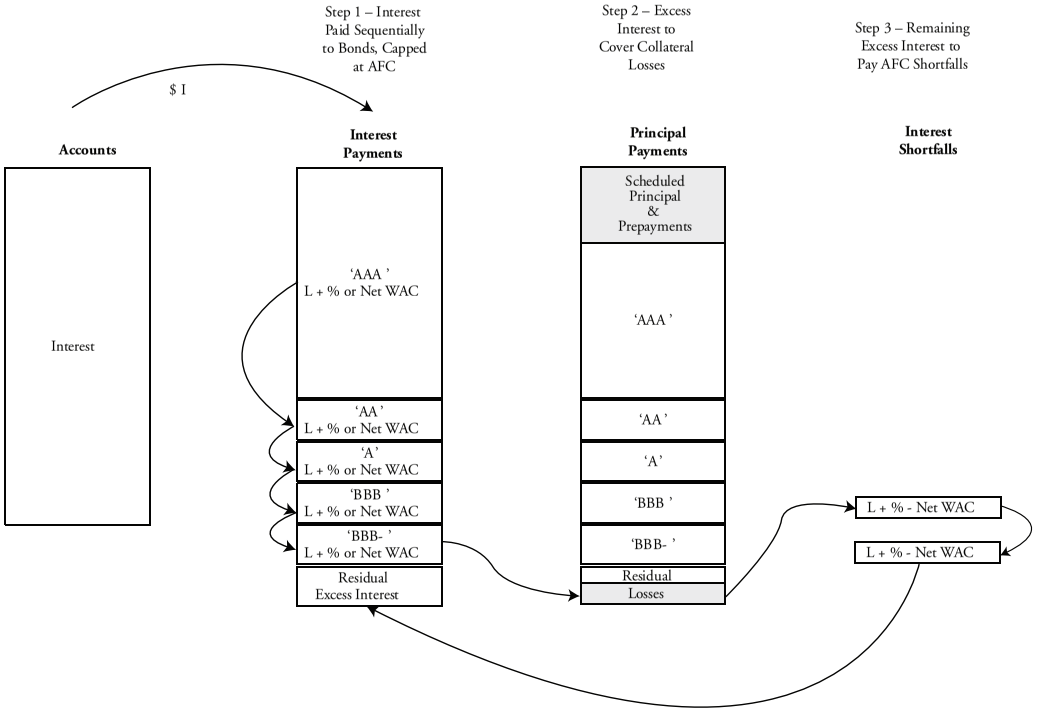
As a typical example of a subprime mortgage securitization, I briefly look at the Structured Asset Investment Loan Trust 2005-6, issued in July 2005. The capital structure of the bond is shown in Table 6.[34] Note how much of this deal is rated investment-grade and how much is AAA.

The certificates consist of the classes of certificates listed in the table, together with the Class P, Class X and Class R certificates. Only the classes of certificates listed in the table were offered publicly by the prospectus supplement.

Note the structure of the transaction. There are four mortgage pools, with only limited cross-collateralization. Principal payments on the senior certificates will depend, for the most part, on collections on the mortgage loans in the related mortgage pool. However, the senior certificates will have the benefit of credit enhancement in the form of overcollateralization and subordination from each mortgage pool. That means that even if the rate of loss mortgage pool related to any class of senior certificates is low, losses in the unrelated mortgage pools may reduce the loss protection for those certificates.

Note the thinness of the mezzanine tranches at inception; they are almost digital with respect to defaults, unless the amount of prepayment cash coming into the deal is quite significant in the early life of the transaction. For example, the M9 tranche thickness is only 50 basis points, and yet it is rated BBB-, an investment-grade rating. It is

Chart 7
Allocation of Interest



Source: Kevin Kendra, Fitch, "Tranche ABX and Basis Risk in Subprime RMBS Structured Portfolios," February 20, 2007

Table 6
Structured Asset Investment Loan Trust 2005-6
Capital Structure

Class	Related Mortgage Pool(s)	Principal Type	Principal Amount	Tranche Thickness	Moody's	S&P	Fitch
A1	1	Senior*	455,596,000	20.18%	Aaa	AAA	AAA
A2	1	Senior*	50,622,000	2.24%	Aaa	AAA	AAA
A3	2	Senior	506,116,000	22.42%	Aaa	AAA	AAA
A4	3	Senior, Sequential Pay	96,977,000	4.30%	Aaa	AAA	AAA
A5	3	Senior, Sequential Pay	45,050,000	2.00%	Aaa	AAA	AAA
A6	3	Senior, Sequential Pay	23,226,000	1.03%	Aaa	AAA	AAA
A7	4	Senior, Sequential Pay	432,141,000	19.14%	Aaa	AAA	AAA
A8	4	Senior, Sequential Pay	209,009,000	9.26%	Aaa	AAA	AAA
A9	4	Senior, Sequential Pay	95,235,000	4.22%	Aaa	AAA	AAA
M1	1, 2, 3, 4	Subordinated	68,073,000	3.02%	Aa1	AA+	AA+
M2	1, 2, 3, 4	Subordinated	63,534,000	2.81%	Aa2	AA	AA
M3	1, 2, 3, 4	Subordinated	38,574,000	1.71%	Aa3	AA-	AA-
M4	1, 2, 3, 4	Subordinated	34,036,000	1.51%	A1	A+	A+
M5	1, 2, 3, 4	Subordinated	34,036,000	1.51%	A2	A	A
M6	1, 2, 3, 4	Subordinated	26,094,000	1.16%	A3	A-	A-
M7	1, 2, 3, 4	Subordinated	34,036,000	1.51%	Baa2	BBB	BBB
M8	1, 2, 3, 4	Subordinated	22,691,000	1.01%	Baa3	BBB-	BBB-
M9	1, 2, 3, 4	Subordinated	11,346,000	0.50%	N/R	BBB-	BBB-
M10-A	1, 2, 3, 4	Subordinated	5,673,000	0.25%	N/R	BBB-	BB+
M10-F	1, 2, 3, 4	Subordinated	5,673,000	0.25%	N/R	BBB-	BB+

The Class A1 and Class A2 certificates will receive payments of principal concurrently, on a pro rata basis, unless cumulative realized losses or delinquencies on the mortgage loans exceed specified levels, in which case these classes will be treated as senior, sequential pay classes.

not that this rating is necessarily inaccurate, but that it assumes that the deal's cash flow mechanics have a reasonable chance of working.

Some of the characteristics of the pools are shown in Table 7.

The prospectus gives an overview of the triggers for this deal, as follows (italicized terms in original, which means they are defined elsewhere in the document):

> The manner of allocating payments of principal on the mortgage loans will differ, as described in this prospectus

Table 7
Summary of the Pools' Characteristics

	Pool 1	Pool 2	Pool 3	Pool 4
% First Lien	94.12%	98.88%	100.00%	93.96%
% 2/28 ARMS	59.79%	46.68%	75.42%	37.66%
% 3/27 ARMS	20.82%	19.14%	19.36%	9.96%
% Fixed Rate	13.00%	8.17%	2.16%	11.46%
% Full Doc	59.98%	56.74%	44.05%	35.46%
% Stated Doc	39.99%	37.47%	34.30%	33.17%
% Primary Residence	90.12%	90.12%	80.61%	82.59%
WA FICO	636	615	673	635

supplement, depending upon the occurrence of several different events or triggers:

- whether a distribution date occurs before or on or after the "*stepdown date*," which is the later of (1) the distribution date in July 2008 and (2) the first distribution date on which the ratio of (a) the total principal balance of the subordinate certificates plus any overcollateralization amount to (b) the total principal balance of the mortgage loans in the trust fund equals or exceeds the percentage specified in this prospectus supplement;

- a *"cumulative loss trigger event"* occurs when cumulative losses on the mortgage loans are higher than certain levels specified in this prospectus supplement;

- a *"delinquency event"* occurs when the rate of delinquencies of the mortgage loans over any three-month period is higher than certain levels set forth in this prospectus supplement; and

- in the case of pool 1, a *"sequential trigger event"* occurs if (a) before the distribution date in July 2008, a cumulative loss trigger event occurs or (b) on or after the distribution date in July 2008, a cumulative loss trigger event or a delinquency event occurs (p. S-7 emphasis in original).

This is the structure that was discussed above.

IV.F. How Subprime Bonds Work—Why Does the Detail Matter?

In this subsection, I briefly look at two subprime securitization deals; one is a 2005 transaction and the other is a 2006 transaction. The two examples are Ameriquest Mortgage Securities Inc. 2005-R2 (AMSI 2005-R2) and Structured Asset Investment Loan Trust 2006-2 (SAIL 2006-2). The point of the comparison is to show how these two transactions fared; one is 2005 vintage mortgages and the other is 2006 vintage mortgages. The 2006 vintage subprime mortgages have not fared well, as house prices started to turn down, as discussed further below. The examples show how the refinancing or lack of refinancing of the underlying mortgages impacts these securitizations.

Both AMSI 2005-R2 and SAIL 2006-2 have the basic structures discussed above, with overcollateralization and various triggers determining the dynamics of credit enhancement. AMSI 2005-R2 consists of three portfolios. Both deals have overcollateralization.

Tables 8 and 9 show the structure of each deal, what the deals looked like at inception with respect to tranche sizes and ratings, and then what the tranche sizes and ratings looked like in the first quarter of 2007. The BBB tranches are highlighted. Note the tranche sizes of the BBB tranches, as a percentage of collateral, at inception. They are very thin, almost unbelievably thin. Normally, the rating agencies would not allow such thin tranches, but these tranches are expected to build up as the more senior tranches amortize due to refinancing and sequential amortization. Also, note the subordination percentages for the BBB tranches at inception. For example, the M9 tranche of AMSI 2005-R2 has only 1.1 percent of subordination, unbelievably small. But, again, the dynamics of the transaction mean that this should grow as time passes, amortization occurs, and credit enhancement builds up.

These features, the thin tranches and low initial subordination levels, are acceptable if the underlying mortgages refinance as expected. In that case, the deals shrink as amortization occurs. Credit enhancement will build up, and after the step-down date, the BBB tranches will look acceptable. Of course, this depends on house prices.

Table 8
Ameriquest Mortgage Securities Inc. 2005-R2 (AMSI 2005-R2)

At Issue in 2005							2007Q1		
	Size	Related Mortgage Pool(s)	Ratings (Fitch, Moody's, S&P)	% of Collateral	Subordination	Size	Ratings (April 25, 2008)	Percent of Collateral	Subordination
Publicly Offered Certificates									
A-1A	258,089,000	I	AAA/Aaa/AAA	21.5%	35.48%	30,091,837	AAA/Aaa/AAA	8.3%	91.67%
A-1B	64,523,000	I	AAA/Aaa/NR	5.4%	19.35%	7,523,047	AAA/Aaa/NA	2.1%	89.58%
A-2A	258,048,000	II	AAA/Aaa/AAA	21.5%	35.48%	43,208,414	AAA/Aaa/AAA	12.0%	77.62%
A-2B	64,511,000	II	AAA/Aaa/NR	5.4%	19.35%	10,801,936	AAA/Aaa/NA	3.0%	63.56%
A-3A	124,645,000	III	AAA/Aaa/AAA	10.4%	19.35%	-	PIF/WR/NR*	0.0%	63.56%
A-3B	139,369,000	III	AAA/Aaa/AAA	11.6%	19.35%	9,597,506	AAA/Aaa/AAA	2.7%	63.56%
A-3C	26,352,000	III	AAA/Aaa/AAA	2.2%	19.35%	26,352,000	AAA/Aaa/AAA	7.3%	63.56%
A-3D	32,263,000	III	AAA/Aaa/NR	2.7%	19.35%	3,994,403	AAA/Aaa/AAA	1.1%	63.56%
M1	31,200,000	I,II,III	AA+/Aa1/AA+	2.6%	16.75%	31,200,000	AA+/Aa1/AA+	8.6%	54.92%
M2	49,800,000	I,II,III	AA/Aa2/AA	4.1%	12.60%	49,800,000	AA/Aa2/AA	13.8%	41.13%
M3	16,800,000	I,II,III	AA-/Aa3/AA-	1.4%	11.20%	16,800,000	AA-/Aa3/AA-	4.7%	36.48%
M4	28,800,000	I,II,III	A+/A1/A+	2.4%	8.80%	28,800,000	A+/A1/A+	8.0%	28.50%
M5	16,800,000	I,II,III	A/A2/A	1.4%	7.40%	16,800,000	A/A2/A	4.7%	23.85%
M6	12,000,000	I,II,III	A-/A3/A-	1.0%	6.40%	12,000,000	BBB/A3/A-	3.3%	20.53%
M7	**19,200,000**	**I,II,III**	**BBB+/Baa1/BBB+**	**1.6%**	**4.80%**	**19,200,000**	**B/Baa1/BBB+**	**5.3%**	**15.21%**

Table 8
Ameriquest Mortgage Securities Inc. 2005-R2 (AMSI 2005-R2) (continued)

M8	**9,000,000**	**I,II,III**	**BBB/Baa2/BBB**	**0.7%**	**4.05%**	**9,000,000**	**B/Baa2/BBB**	**2.5%**	**12.72%**
M9	**13,200,000**	**I,II,III**	**BBB/Baa2/BBB-**	**1.1%**	**2.95%**	**13,200,000**	**B/Baa3/BBB-**	**3.7%**	**9.06%**
Not Publicly Offered Certificates									
M10	7,800,000	I,II,III	BB+/Ba1/BB+	1.0%	1.30%	7,800,000	CCC/Ba1/BB+	2.2%	6.90%
M11	12,000,000	I,II,III	BB/Ba2/BB	1.3%	0.00%	12,000,000	CCC/Ba2/BB	3.3%	3.58%
CE	15,600,000		NR/NR/NR			12,928,188	NR/NR/NR	3.6%	0.00%
Total	1,200,000,000					361,097,331.00			
Collateral	1,200,000,147					361,097,430.00			

* PIF = tranche "paid-in-full"; WR= "withdrawn rating"; NR= "no rating."

Prospectus dated March 22, 2005. AMSI 2005-R2 closed March 24, 2005.

Table 9
Structured Asset Investment Loan Trust 2006-2 (SAIL 2006-2)

	At Issue 2006					2007Q1		
	Size	Ratings+(Moody's, S&P, Fitch)	% of Collateral	Subordination	Size	Ratings (April 25, 2008)	% of Collateral	Subordination
Publicly Offered Certificates								
A1	607,391,000	Aaa/AAA/AAA	45.3%	16.75%	89,285,238	Aaa/AAA/AAA	11.0%	26.16%
A2	150,075,000	Aaa/AAA/AAA	11.2%	16.75%	150,075,000	Aaa/AAA/AAA	18.5%	26.16%
A3	244,580,000	Aaa/AAA/AAA	18.2%	16.75%	244,580,000	Aaa/AAA/AAA	30.2%	26.16%
A4	114,835,000	Aaa/AAA/AAA	8.6%	16.75%	114,835,000	Aaa/A/A	14.2%	26.16%
M1	84,875,000	Aa2/AA/AA	6.3%	10.42%	84,875,000	Ba3/CCC/B	10.5%	15.70%
M2	25,136,000	Aa3/AA-/AA-	1.9%	8.55%	25,136,000	B3/CCC/CCC	3.1%	12.60%
M3	20,124,000	A1/A+/A+	1.5%	7.05%	20,124,000	Caa2/CCC/CCC	2.5%	10.12%
M4	20,124,000	A2/A/A	1.5%	5.55%	20,124,000	Caa3/CC/CC	2.5%	7.63%
M5	15,428,000	A3/A-/A-	1.1%	4.40%	15,428,000	Ca/CC/CC	1.9%	5.73%
M6	**15,428,000**	**Baa1/BBB+/BBB+**	**1.1%**	**3.25%**	**15,428,000**	**C/CC/CC**	**1.9%**	**3.83%**
M7	**11,404,000**	**Baa2/BBB/BBB**	**0.9%**	**2.40%**	**11,404,000**	**C/CC/C**	**1.4%**	**2.42%**
M8	**10,733,000**	**Baa3/BBB-/BBB-**	**0.8%**	**1.60%**	**10,733,000**	**C/D/C**	**1.3%**	**1.10%**

Table 9
Structured Asset Investment Loan Trust 2006-2 (SAIL 2006-2) (continued)

Not Publicly Offered Certificates								
B1	7,379,000	Ba1/?/?	0.6%	1.05%	7,379,000	C/D/C	0.9%	0.19%
B2	7,379,000	Ba2/?/?	0.6%	0.50%	1,534,646	WR/NR/NR	0.2%	0.00%
CE	6,708,733				98		11.0%	88.99%
Total	1,341,599,733.00				810,940,982.00			

Prospectus dated September 26, 2005.

There are also Class P, Class X, Class LT-R and Class R certificates. The Class X Certificates will be entitled to Monthly Excess Cash flow, if any, remaining after required distributions are made to the Offered Certificates and the Class B1 and Class B2 Certificates and to pay certain expenses of the Trust Fund (including any payments to the Swap Counterparty) and, on and after the Distribution Date in April 2016, to deposit any Final Maturity Reserve Amount in the Final Maturity Reserve Account. The Class P Certificates will solely be entitled to receive all Prepayment Premiums received in respect of the Mortgage Loans and, accordingly, such amounts will not be available for distribution to the holders of the other classes of Certificates or to the Servicers as additional servicing compensation. The Class LT-R and Class R Certificates will represent the remaining interest in the assets of the Trust Fund after the required distributions are made to all other classes of Certificates and will evidence the residual interests in the REMICs.

What happened? Looking at 2007Q1, things are very different for the two deals. AMSI 2005-R2 is, of course, older. By 2007Q1, AMSI 2005-R2 has passed its triggers. Note that the tranche thicknesses, measured as a percentage of collateral, have increased. And, very significantly, note the subordination level percentages have built up. For example, initially M9 had 1.1 percent subordination. In 2007Q1 its subordination percent is 9.06 percent. (Still, Fitch—ever conservative—has downgraded the BBB tranches to B!!)

Things are much different for SAIL 2006-2. Being a 2006 deal, it is younger. But, it is also a transaction that occurred during the period where house prices did not rise and refinancing was harder to accomplish. Neither the tranche size nor the subordination has increased significantly. This deal is in trouble, as reflected in the ratings of the mezzanine tranches.

There are also Class P, Class X, Class LT-R and Class R certificates. The Class X certificates will be entitled to monthly excess cashflow, if any, remaining after required distributions are made to the offered certificates and the Class B1 and Class B2 certificates and to pay certain expenses of the trust fund (including any payments to the swap counterparty) and, on and after the distribution date in April 2016, to deposit any final maturity reserve amount in the final maturity reserve account. The Class P certificates will solely be entitled to receive all prepayment premiums received in respect of the mortgage loans and, accordingly, such amounts will not be available for distribution to the holders of the other classes of certificates or to the servicers as additional servicing compensation. The Class LT-R and Class R certificates will represent the remaining interest in the assets of the trust fund after the required distributions are made to all other classes of certificates and will evidence the residual interests in the REMICs.

Standard securitizations have fixed tranche sizes; that is, tranche thickness does not vary over time. To some extent, excess spread is used to create credit enhancement through reserve fund buildup, but this is not the main credit enhancement. See Gorton and Souleles (2007) for a description of standard securitization.

The above examples of subprime securitization show a very different story. They are not at all like standard securitization transactions. In particular, the difference illustrates how the "option" on house prices implicitly embedded in the subprime mortgages has resulted in very house price-sensitive behavior of the subprime RMBS. Unlike standard securitization transactions, here the tranche thickness and the extent of credit enhancement depend on the cash flow coming into the deal from prepayments on the subprime mortgages via refinancing. This depends on house prices.

This point about the link to house prices is dramatically illustrated by these two bonds. The 2005 bond passed its triggers and has achieved the levels of credit enhancement and subordination envisioned by the original structure. It has benefited from the refinancing and prepayments of the underlying mortgages. The 2006 bond has not. In 2006 subprime borrowers had not built up enough equity to refinance. They could not prepay, and the 2006 bond has not been able to pass its triggers. (This does not mean that the 2006 bond would be a bad buy. At fire sale prices it may well be a good buy.)

If this was the end of the story, it is not clear whether there would have been a systemic problem when the house price bubble burst. I suspect not, but in any case, it is not the end of the story.

V. Collateralized Debt Obligations (CDOs)

The next link in the chain is collateralized debt obligations (CDOs), SPVs that issue long-dated liabilities in the form of rated tranches in the capital markets and use the proceeds to purchase structured products for assets. In particular, ABS CDOs purchased significant amounts of subprime RMBS bonds. This section proceeds as follows. In subsection A, I start with a very brief description of how cash CDOs work (as opposed to synthetic or hybrid CDOs). In subsection B, I describe the amounts of CDOs issued. Subsection C concerns the question of how much subprime RMBS went into CDOs. Subsection D looks at synthetic subprime risk. Subsection E discusses the issue of the final location of the CDO tranches with subprime risk. This involves a discussion of some off-balance sheet

vehicles that purchased CDO tranches—another link in the chain. The final subsection, F, summarizes.

V.A. The Design of CDOs

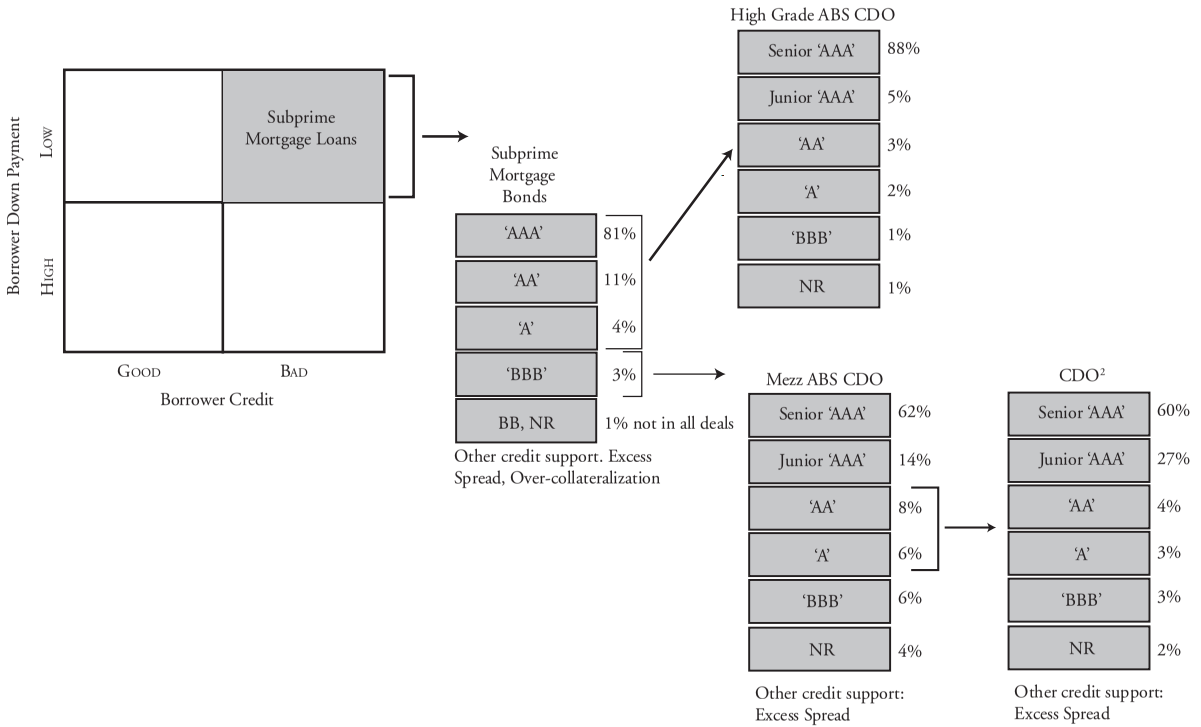
A cash CDO is an SPV which buys a portfolio of fixed-income assets and finances the purchase of the portfolio via issuing different tranches of risk in the capital markets. These tranches are senior tranches (rated Aaa/AAA), mezzanine tranches (rated Aa/AA to Ba/BB), and equity tranches (unrated). Of particular interest are ABS CDOs, CDOs which have underlying portfolios consisting of ABS, including RMBS and commercial mortgage-backed securities (CMBS).

CDO portfolios typically included tranches of subprime and Alt-A deals, sometimes quite significant amounts. The interlinking of subprime mortgages, the subprime RMBS, and the CDOs is portrayed in Chart 8 (due to UBS). To the left of the chart is a representation of the creation of a subprime RMBS deal. Some of the bonds issued in this subprime deal go into ABS CDOs. In particular, as shown on the right-hand side of the chart, RMBS bonds rated AAA, AA, and A form part of a "High Grade" CDO portfolio, so called because the portfolio bonds have these ratings. The BBB bonds from the RMBS deal go into a "Mezz CDO," so named because its portfolio consists entirely, or almost entirely, of BBB-rated ABS and RMBS tranches.

If bonds issued by Mezz CDOs are put into another CDO portfolio, then the new CDO—now holding Mezz CDO tranches—is called a "CDO squared" or "CDO^2."

There are some important features to ABS CDOs that make their design more complicated in ways which play a role later. Perhaps most importantly, many cash ABS CDOs are managed, which means that there is a manager (a firm) that oversees the CDO portfolio. In particular, this manager is allowed to trade—buy and sell—bonds, to a limited extent (say 10 percent of the notional amount per year) over a limited period of time (say the first three years of the transaction). The putative reason for this is that structured products amortize, so to achieve a longer maturity for the CDO, managers need to be allowed to reinvest. They can take cash that is paid to the CDO

Chart 8
Risk Profile of Subprime Mortgage Loans



Source: UBS, "Market Commentary," December 13, 2007

from amortization and reinvest it, and with limitations, as mentioned, they can sell bonds in the portfolio and buy other bonds. There are restrictions on the portfolio that must be maintained, however. CDO managers typically owned part or all of the CDO equity, so they would benefit from higher yielding assets for a given liability structure. Essentially, think of a managed fund with term financing and some constraints on the manager in terms of trading and the portfolio composition.

The restrictions on the portfolio composition would limit structured product asset categories to certain maximum amounts of the portfolio. Other restrictions would include maximums and minimum by rating category, restrictions on weighted average life (WAL), correlation factors, weighted average rating factor (WARF), numbers of obligors, etc.[35] Table 10 is a very simplified summary example.

Priority of cash flows in CDOs is first of all based on seniority, for allocating losses. Credit enhancement is also provided via other mechanisms such as sequential amortization. Finally, there are also coverage tests and triggers which divert cash flows from subordinate tranches, prevent reinvestment of new assets, and cause amortization to be sequential, if the tests are not met. Two common tests are overcollateralization (OC) tests and interest coverage tests. Roughly speaking, an OC test is the ratio of CDO assets at par to the par value of the A tranche, the most senior tranche (in the Tranche A overcollateralization test): $\frac{CDO\ Assets\ at\ Par}{Tranche\ A\ Par\ Amount}$. The Tranche B OC test is similar: $\frac{CDO\ Assets\ at\ Par}{Tranche\ A\ and\ B\ Par\ Amount}$, and so on. There are also interest coverage tests. For example, the Tranche A Interest Coverage Test is a ratio: $\frac{CDO\ Assets'\ Coupon}{Tranche\ A\ Coupon}$, and other interest coverage ratios are analogous. If coverage tests are not met, cash is diverted, and trading limited, until the tests are passed. For purposes here, I do not need to go into all the details of how CDOs work.

Table 10
Sample ABS CDO Portfolio Criteria

Correlation Factor/10-year WARF	23 max / 465 max
Collateral Items rated A3 or better	12.5% min
Collateral Items rated Baa3 or better	95.0% min
Collateral Items rated < Ba3	0.0%
Obligor Concentration Limit	1.5% max
Obligor Concentration of > 1.0% and ≤ 1.5%	15 obligors max
Number of Obligors	93 min
Obligations with WALs > 10 years	0.0%
Obligations with WALs of > 9.0 and ≤ 10.0 years	5.0% max, must be RMBS/CMBS
Obligations with WALs of > 6.5 and ≤ 10.0 years	25.0% max
Obligations with WALs of > 6.0 and ≤ 10.0 years	57.5% max
Obligations with WALs of > 5.5 and ≤ 10.0 years	70.0% max
Portfolio WAL in Years	5.65 max
CDO Securities	20.0% max
CLO Securities (subset of CDO Securities)	5.0% max

Portfolio restrictions are far from standardized.

Many CDOs are structured to experience an event of default (EOD) when a minimum OC ratio for senior liabilities is not maintained. This means that if the par value of assets falls below the face value of senior liabilities, an EOD occurs, allowing the senior investors (the controlling class) to take control of the CDO. Senior investors may choose to liquidate the assets.[36] Also, many CDO transactions that have OC-linked EODs also include ratings-based par haircuts in the calculation of the aggregate outstanding par amount of the underlying assets. As a result, downgrades of underlying collateral assets such as RMBS and ABS CDO tranches trigger EODs.

In the EODs that have occurred to date, the CDO has tripped a trigger that is related to the failure to maintain a minimum ratio of OC, namely, the ratio of the par value of assets to the face value of the CDO's senior obligations. The EODs that have occurred to date have not been due to the failure of the CDO to make payments to note-holders. Rather, the OC-related EOD triggers have been hit because their calculation is affected by certain rating-related par "haircuts."[37]

When an EOD occurs, the senior controlling classes of the CDO are in a position to decide what to do. They may: (1) do nothing, and continue to receive payment of principal and interest; (2) accelerate the maturity date of their notes; (3) liquidate the assets of the CDO and use the proceeds to pay off the notes following the order of priority. Currently, some CDOs are liquidating, but it is not clear what will happen in the remaining cases.[38]

There is no standardization of triggers across CDOs. Some have sequential cash flow triggers, others do not. Some have OC trigger calculations based on ratings changes; others do not. There is no straightforward template. In fact, each ABS CDO must be separately modeled. The above discussion provides a much abbreviated glimpse at the structure that must be modeled. This will play a role later when I discuss the problems investors face when they attempt a valuation of CDO tranches.[39]

Why would CDOs buy subprime RMBS bonds? Not surprisingly, it was profitable. With regard to the lower-rated tranches, the BBB tranches of subprime RMBS were difficult to sell. Perhaps this was because they were so thin when first issued (see the above examples), so that at first glance they seemed unreasonable. But, this would not be so obvious if they were purchased by a CDO. By 2005, spreads on subprime BBB tranches appeared to be wider than other structured products with the same rating, creating an incentive to arbitrage the ratings between the ratings on the subprime and on the CDO tranches.[40] CDO portfolios increasingly were dominated by subprime, suggesting that the market was pricing this risk inconsistently with the ratings. This was not common knowledge.

Also, concerning the higher-rated tranches, CDOs may have been motivated to buy large amounts of structured assets because their AAA tranches would be used as fodder for profitable negative basis trades. This may have increased the appetite of CDOs and of dealer banks underwriting the CDOs. In a negative basis trade, a bank buys the AAA-rated CDO tranche while simultaneously purchasing protection on the tranche under a physically settled CDS. From the bank's viewpoint, this is the simultaneous purchase and sale of a CDO security, which meant (for a while) that the bank could book

the NPV of the excess yield on the CDO tranche over the protection payment on the CDS.

If the CDS spread is less than the bond spread, the basis is negative. Here's an example. Suppose a bank borrows at LIBOR + 5 and buys a AAA-rated CDO tranche which pays LIBOR + 30. Simultaneously, the bank buys protection (possibly from a monoline insurer) for 15 basis points. So the bank makes 25 bps over LIBOR net on the asset, and they have 15 bps in costs for protection, for a 10 bps profit.[41]

Note that a negative basis trade swaps the risk of the AAA tranche to a CDS protection writer. Now, the subprime-related risk has been separated from the cash host. Consequently, even if we were able to locate the AAA CDO tranches, this would not be the same as finding out the location of the risk. We do not know the extent of negative basis trades.[42]

V.B. CDO Issuance

Table 11 shows CDO issuance. The first column of the table shows total issuance of CDOs. The next column shows total issuance of structured finance CDOs (also called ABS CDOs); these CDOs have RMBS, CMBS, CMOs, ABS, CDOs, CDS, and other securitized/structured products as collateral. This is the category of CDO that would include subprime mortgages.[43] Structured finance CDOs have consistently been the modal category.

Another way to divide CDOs is by their structure. Cash flow CDOs have assets and liabilities that are entirely cash instruments (i.e., physical bonds). Liabilities are paid with the interest and principal payments (cash flows) of the underlying cash collateral. Hybrid CDOs combine the funding structures of cash and synthetic CDOs. Synthetic CDOs sell credit protection via CDS rather than purchase cash assets.[44] The liability side is partially synthetic, in which case some protection is purchased on tranches from investors, on the most senior tranches. Mezzanine tranches are not synthetic, but paid-in in cash which is deposited in an SPV and used to collateralize the SPV's credit swap obligations, namely, potential losses resulting in write-downs of the issued notes. Note that synthetic funded CDOs would

Table 11
Global CDO Issuance ($ millions)

	Total Issuance	Structured Finance	Cash Flow and Hybrid	Synthetic Funded	Arbitrage	Balance Sheet
2004 Q1	24,982.5	NA	18,807.8	6,174.7	23,157.5	1,825.0
2004 Q2	42,864.6	NA	25,786.7	17,074.9	39,715.5	3,146.1
2004 Q3	42,086.6	NA	36,106.9	5,329.7	38,207.7	3,878.8
2004 Q4	47,487.8	NA	38,829.9	8,657.9	45,917.8	1,569.9
2004 Total	157,418.5	NA	119,531.3	37,237.2	146,998.5	10,419.8
% of Total			**75.9%**	**23.7%**	**93.4%**	**6.6%**
2005 Q1	49,610.2	28,177.1	40, 843.9	8,766.3	43,758.8	5,851.4
2005 Q2	71,450.5	46,720.3	49,524.6	21,695.9	62,050.5	9,400.0
2005 Q3	52,007.2	34,517.5	44,253.1	7,754.1	49,636.7	2,370.5
2005Q4	98,735.4	67,224.2	71,604.3	26,741.1	71,957.6	26,777.8
2005 Total	271,803.3	176,639.1	206,225.9	64,957.4	227,403.6	44,399.7
% of Total		**65.0%**	**75.9%**	**23.9%**	**83.7%**	**16.3%**
2006 Q1	108,012.7	66,220.2	83,790.1	24,222.6	101,153.6	6,859.1
2006 Q2	124,977.9	65,019.6	97,260.3	24,808.4	102,564.6	22,413.3
2006 Q3	138,628.7	89,190.2	102,167.4	14,703.8	125,945.2	12,683.5

Table 11
Global CDO Issuance ($ millions) (continued)

2006 Q4	180,090.3	93,663.2	131,525.1	25,307.9	142,534.3	37,556.0
2006 Total	551,709.6	314,093.2	414,742.9	89,042.7	472,197.7	79,511.9
% of Total		**56.9%**	**75.2%**	**16.1%**	**85.6%**	**14.4%**
2007 Q1	186,467.6	101,074.9	140,319.1	27,426.2	156,792.0	29,675.6
2007 Q2	175,939.4	98,744.1	135,021.4	8,403.0	153,385.4	22,554.0
2007 Q3	93,063.6	40,136.8	56,053.3	5,198.9	86,331.4	6,732.2
2007 Q4	47,508.2	23,500.1	31,257.9	5,202.3	39,593.7	7,914.5
2007 Total	502,978.8	263,455.9	362,651.7	46,230.4	436,102.5	66,876.3
% of Total		**52.4%**	**72.1%**	**9.1%**	**86.8%**	**13.3%**
2008 Q1	11,710.1	4,736.1	10,673.9	186.0	10,468.4	1,241.7
% of Total		**40.4%**	**91.2%**	**1.6%**	**89.4%**	**10.6%**

Source: Securities Industry and Financial Markets Association

be the location of synthetic subprime risk in the form of credit protection written on a subprime index (the ABX index).[45]

Finally, we can think of categorizing CDOs by the motivation for the transaction. As the name suggests, arbitrage CDOs are motivated by the spread difference between higher yielding assets and the lower yields paid as financing costs. This is often viewed as a rating agency-created arbitrage. Another motivation is regulatory bank capital relief or risk management. Balance sheet CDOs remove the risk of assets off the balance sheet of the originator, typically synthetically.

Looking at the table, the first point to note is that CDO issuance has been significant—and the bulk of it has been CDOs with structured products as collateral. The issuance volume that involves synthetically creating risk is also significant. As noted, the motivation has primarily been arbitrage.

It is also notable what data are missing. There is no data on the amount of subprime exposure in CDOs, whether cash or synthetic. This is a glimpse of part of the information problem. To figure out the subprime exposure in a CDO requires a "look through" to the subprime RMBS bonds in the portfolio of the CDO and then looking through those bonds individually to determine what subprime mortgages are associated with each RMBS bond in the portfolio.

V.C. Subprime RMBS Bonds and ABS CDOs

Issuance of ABS CDOs roughly tripled over the period 2005–07, and ABS CDO portfolios became increasingly concentrated in U.S. subprime RMBS. Table 12 shows estimates of the typical collateral composition of high-grade and mezzanine ABS CDOs.

As the volumes of origination in the subprime mortgage market increased, subprime RMBS increased, and so did CDO issuance (Table 13).

How pervasive is subprime collateral in ABS CDOs? Looking through the CDO portfolios for a sample of CDOs gives a sense of how many real estate-related bonds are in the CDO portfolios. UBS

undertook this exercise for a sample of 420 ABS CDOs. The results are shown in Table 14.

The important point of this analysis is that the amount of subprime RMBS bonds in ABS CDOs is very significant.

V.D. Synthetic Subprime Risk

Subprime risk can be traded via credit derivatives referencing individual subprime cash bonds, or via an index linked to a basket of such bonds. Dealer banks launched the ABX.HE (ABX) index in January 2006. The ABX Index is a credit derivative that references twenty equally-weighted RMBS tranches. There are also indices comprising sub-indices linked to a basket of subprime bonds with specific ratings: AAA, AA, A BBB and BBB-. Each subindex references twenty subprime RMBS bonds with the rating level of the subindex. Every six months the indices are reconstituted based on a pre-identified set of rules. The index is overseen by Markit Partners. The dealers provide Markit Partners with daily and monthly marks.[46]

For our purposes here, the main point is that subprime risk can be traded synthetically with credit derivatives. Risk cannot be created on net because these are derivatives, but the identities of the longs and shorts are not known as this market is over-the-counter. Table 15 shows approximations of the amount of BBB-rated subprime RMBS issuance over 2004–07 and the exposures of mezzanine CDOs issued in 2005–07 to those vintages of BBB-rated subprime RMBS. Note that the mezzanine CDOs issued in 2005–07 used CDS to take on significantly greater exposure to the 2005 and 2006 vintages of subprime BBB-rated RMBS than were actually issued. This suggests that the demand for exposure to riskier tranches of subprime RMBS exceeded supply by a wide margin. The additional risk exposure was created synthetically. (Though, on net, there is no new risk.)

In addition, synthetic CDOs, relying completely on derivatives, became increasingly important. Prior to 2005, the portfolios of ABS CDOs were mainly made up of cash securities. After 2005, CDO managers and underwriters began using CDS referencing individual ABS, creating synthetic exposures. "Synthetic CDOs" are CDOs

Table 12
Typical Collateral Composition of ABS CDOs (percent)

	High-Grade ABS CDO	Mezzanine ABS CDO
Subprime RMBS Tranches	50%	77%
Other RMBS Tranches	25	12
CDO Tranches	19	6
Other	6	5

Source: Citigroup, cited by Basel Committee on Banking Supervision (BIS) (April 2008)

Table 13
Subprime-Related CDO Volumes

Vintage	Mezz ABS CDOs ($ billions)	High-Grade ABS CDOs ($ billions)	All CDOs ($ billions)
2005	27	50	290
2006	50	100	468
Yr to 9/2007	30	70	330

Source: UBS, "Mortgage Strategist," November 13, 2007.

Table 14
Residential Mortgage Deals in 420 ABS CDOs

Number of Deals by Vintage and Mortgage Loan Type					
Vintage	**Subprime**	**Alt-A**	**Seconds**	**Prime**	**Total**
2003	215	63	7	144	429
2004	371	252	25	188	836
2005	488	452	62	209	1,211
2006	522	487	69	142	1,220
2007	150	113	21	28	312
Total	1,746	1,367	184	711	4,008

Source: UBS, "Mortgage and ABS CDO Losses," December 13, 2007

Table 15
BBB-Rated Subprime RMBS Issuance and Exposure in Mezzanine ABS CDOs Issued in 2005-2007 to BBB-Rated Subprime RMBS ($ billions)

	2004	2005	2006	2007
BBB-rated Subprime RMBS Issuance	12.3	15.8	15.7	6.2
Exposure of Mezzanine ABS CDOs issued in 2005-2007	8.0	25.3	30.3	2.9
Exposure as a Percent of Issuance	65	160	193	48

Source: Federal Reserve calculations, cited by Basel Committee on Banking Supervision (BIS) (April 2008)

with entirely synthetic portfolios; the portfolio of a "hybrid CDO" consists of a mix of cash positions and CDS. CDO managers and underwriters used synthetic exposures to meet the growing investor demand for ABS CDOs and to cater to investors' preferences to have particular exposures in the portfolio that may not have been available in the cash market. CDO managers and underwriters were able to use CDS to fill out an ABS CDO's portfolio when cash ABS, particularly mezzanine ABS CDO tranches, were difficult to obtain.

So far, the subprime mortgages have been securitized and tranches of these securitizations have been sold, in large part, to CDOs, and tranches of the CDOs have been sold to investors. Additional subprime risk has been traded via derivatives.

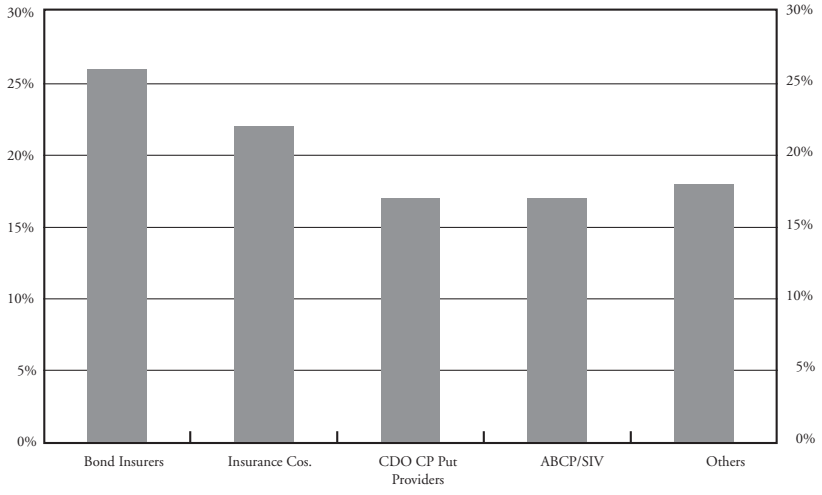
I now turn to the question of the identity of the investors in these risks. Who were these investors? Where did the risk go?

V.E. Where Did the CDO Tranches Go?

The short answer is that we do not know for sure. Investors around the world purchased rated tranches of CDOs. Lehman Brothers has estimates of the location of the AAA-rated CDO tranches (see Chart 9).

Investors in the AAA CDO tranche risk (synthetic, if not cash) include bond insurers, insurance companies, and other categories of institutional investors. The category labeled "ABCP/SIV" refers to Asset Backed Commercial Paper Conduits (ABCPs) and structured investment vehicles (SIVs), which I discuss briefly below.

Chart 9
Estimated Holdings of AAA CDO Tranches



Source: Lehman Brothers estimates, as of November 13, 2007, based on the 10-Qs of AMBAC, MBIA, ACA, XLCA, FGIC, and rating agency reports on bond insurers

The remaining category, "CDO CP Put Providers," refers to structures which transform long-dated CDO tranche paper into money market mutual fund eligible investments. This is accomplished by shortening the maturity of the CDO tranche via a liquidity put provider, sometimes called a 2A-7 put, after the part of the Investment Company Act that restricts money market funds to instruments that are 365 days or less in maturity.[47] Longer–term bonds are shortened by attaching a put option or tender feature allowing or requiring the investor to sell the security to the put provider, with a stated notice period. Rule 2A-7 allows the money market fund to treat the put notice period as being the maturity of the bond.

Note that in the crisis, money market funds exercised their puts, forcing put writers to buy the notes, putting further stress on their liquid resources.

One significant category of investors, shown Chart 9, consists of certain kinds of off-balance sheet vehicles, known as structured investment vehicles (SIVs), ABCPs, and SIV-lites. The nuances of the differences between these vehicles do not concern us here (see Moody's, February 3, 2003; Moody's, January 25, 2002; Standard

and Poor's, September 4, 2003). I provide the briefest of overviews to highlight one structural feature that is important.

An SIV is a limited-purpose operating company that undertakes arbitrage activities by purchasing mostly highly rated medium- and long-term fixed-income assets and funding itself with cheaper, mostly short-term, highly rated CP and MTNs. An SIV is a leveraged investment company that raises capital by issuing capital market securities (capital notes and medium-term notes) as well as ABCP. ABCP typically comprises around 20 percent of the total liabilities for the biggest SIVs.[48] A variant of an SIV is a so-called SIV-lite. SIV-lites share some similarities with collateralized debt obligations (CDOs) in that they are closed-end investments. SIV-lites issue a greater proportion of their liabilities as ABCP than SIVs (around 80 percent–90 percent), are typically more highly leveraged, and seem to have invested almost exclusively in U.S. RMBS. As a consequence, several SIV-lites have restructured their liabilities following the recent turmoil in U.S. mortgage markets. Appendix B lists the larger SIVs and their outcomes. Unlike conduits that issue only ABCP, SIVs and SIV-lites tend not to have committed liquidity lines from banks that cover 100 percent of their ABCP. Rather, they use capital and liquidity models, approved by ratings agencies, to manage liquidity risk. The lack of a full commercial bank guarantee has reportedly led to discrimination against SIV paper by ABCP investors.

The important point is that these vehicles are very different from the SPVs used in securitization. Standard securitization SPVs are not managed; they are robot companies that are not marked-to-market; they simply follow a set of prespecified rules. See Gorton and Souleles (2007). Unlike securitization vehicles, these are managed and they are market value vehicles. They raise funds by issuing commercial paper and medium-term notes, and they use the proceeds to buy high-grade assets to form diversified portfolios. They borrow short and purchase long assets. They are required by rating agencies to mark portfolios to market on a frequent basis (daily or weekly), and based on the marks, they are allowed to lever more or required to delever. On SIVs, see Moody's (January 25, 2002), and on ABCPs, see Moody's (February 3, 2003).

Money market mutual funds apparently not only purchased various structured assets, via liquidity (or 2A–7) puts (as discussed above), but also sometimes invested in SIVs. Later, these money market mutual funds had to be bailed out by their sponsors to keep them from "breaking the buck." See the chronology in Appendix A.

V.F. Summary

Investors purchased CDO tranches based on ratings, portfolio criteria, and the identity of the CDO manager. Purchasers of CDO bonds receive trustee reports detailing the portfolio of the CDO, which changes over time as the manager trades. CDOs are not market value structures.[49] It is literally not possible for a buyer of a CDO tranche to do the double look-through to determine, say, the extent of subprime exposure. That would require looking through each of the bonds in the CDO portfolio, and if the CDO owns other CDO tranches, looking through those as well. Imagine also an investor in an SIV. The SIV has a portfolio of structured assets, which may include CDO tranches. The investor cannot answer the question: Is my SIV investment sensitive to 2006 subprime mortgages?

VI. Complexity, the Loss of Information, and the Current Crisis

Now we come to the first information issue. What is the loss of information? The information problem is that the location and extent of the (2006 and 2007 Q1-2 vintage) subprime risk is unknown to anyone. It is very hard to determine the location of the risk, partly because of the chain of interlinked securities, which does not allow the final resting place of the risk to be determined. But also, because of derivatives, it is even harder: Negative basis trades moved CDO risk, and credit derivatives created additional long exposure to subprime mortgages.

Determining the extent of the risk is also difficult because the effects on expected losses depend on house prices as the first–order risk factor. Simulating the effects of that through the chain of interlinked securities is basically impossible. In this section I start by illustrating this last point with a very simple description of the payoffs to the interlinked securities. I then discuss the implications.

VI.A. A Simple, Stylized Example of the Interlinking of Security Designs

As before, I will give an extremely simplified example to (hopefully) convey the essence of the complexity problem and the loss of information. I will ignore the dynamic aspects of subprime RMBS transactions. I will consider extremely simple tranching: a subordinated (or, synonymously, junior or first loss) tranche (called the "sub" tranche) and a senior tranche. The subprime RMBS deal will securitize a single subprime mortgage.

There are three financial instruments: (1) a subprime mortgage; (2) a senior/sub tranche RMBS securitization of the single subprime mortgage; (3) a senior/sub tranche CDO, which has purchased the senior tranche of the RMBS. I omit a fourth step, of an SIV buying the senior CDO tranche or a CDO tranche having a 2A-7 put attached, and so on. The transactions all last for one period and all payoffs are at the end of the period. I will ignore discounting.

The mortgage has a face value of 100. At the end of the period, the mortgage has a step-up rate and will be refinanced, or not. If it is not refinanced, then it defaults, in which case the lender will recover \$R. So, the loss is 100–R ≡ Loss if there is a default. If it is refinanced, then the new mortgage is worth M (in expected value), to the lender.

Ignoring, for a moment, the dependence of R and M on home prices, the payoff to the lender at the end of the period on the current mortgage is: Max(R, M). If the new mortgage is worth less than the recovery value of the home, then the lender does not refinance (nor will any other lender), and the homeowner defaults.

The lender finances the mortgage by securitizing it. It is sold at par of 100. The lender retains the refinancing option as discussed above, and the securitization will either receive par or R at the end of the period.

The subprime RMBS transaction has two tranches: The first tranche attaches at 0 and detaches at \$N; the second tranche attaches at \$N (e.g., N=30 means that the first \$30 of loss are absorbed by the sub piece) and goes to the end, 100. The par value of the senior

tranche is, therefore, 100-N. In other words, the first $N of loss will be borne by the sub piece.

Looking at the senior tranche, the loss on this tranche at the end of the period, L_S, is given by:

$$L_S = Max[Loss - N, 0].$$

The payoff or redeemed amount, V, on this senior tranche at the end of the period is:

$$V = Min\begin{cases} Max[100 - N, 0], \\ 100 - N - L_S \end{cases}.$$

Since 100 – N is always greater than 0, Max[100-N, 0] is always equal to 100 – N. L_S is always greater than or equal to 0, so 100 – N – L_S is always less than or equal to 100 – N. Therefore, $V = 100 - N - L_S$. Substituting in for L_S: $V = Min[100 - N, 100 - Loss]$.

So, for example, if Loss=50 and N=30, then if the mortgage is not refinanced and defaults, then the senior tranche will have a $20 loss since the first loss tranche only absorbs the first $30 of loss. The final value, V, of the senior tranche is $50.

The senior tranche of the subprime RMBS is sold to a CDO, which has two tranches: the first tranche attaches at 0 and detaches at $\$N_{CDO}$; the second tranche attaches at $\$N_{CDO}$ and goes to the end, 100-N. Note that the size of the CDO is 100-N (=70 in the example), since it only purchases the senior tranche of the subprime RMBS. Note that N_{CDO} will be less (in dollars) than N because the CDO portfolio is smaller; the sub tranche of the CDO may be larger in percentage terms though.

Looking at the senior tranche, the loss on this tranche at the end of the period, L_{CDO}, is given by:

$$L_{CDO} = Max[Min(L_S, 100\text{-}N) - N_{CDO}, 0].$$

At the end of the period, the payoff on the senior tranche of the CDO, V_{CDO}, is given by:

$$V_{CDO} = Min\begin{cases} Max[(100 - N - N_{CDO}),0], \\ 100 - N - N_{CDO} - L_{CDO} \end{cases}.$$

Substituting for L_{CDO}:

$$V_{CDO} = Min\begin{cases} Max[(100 - N - N_{CDO}),0], \\ N - N_{CDO} - Max[\,Min(L_S, 100 - N) - N_{CDO} \end{cases},$$

and substituting now for L_S:

$$V_{CDO} = Min\begin{cases} Max[(100 - N - N_{CDO}),0] \\ N - N_{CDO} - Max[\,Min(Max[\,Min(100 - Loss,100) - N,0],100 - N) - N_{CDO},0 \end{cases}.$$

Looking at this final expression, we can see the dependence of the senior CDO tranche on the structure of the securitization, i.e., the tranching (N), and on the underlying single subprime mortgage, namely, its loss, Loss. And keep in mind that Loss depends on house price appreciation. Nowhere does M appear, because if the loan is refinanced at the end of the period, then it is paid off and there are no losses. M is the expected value of the new loan. In the simple formulation above, the dependence on house prices only appears in terms of the recovery value of the house if there is a default. In the real structure, the refinancing results in M being paid into the securitization which is cash that would be allocated following the priority rules and the triggers, which determine the amortization. So, that aspect is lost in the simplified example.

Here's a very simple numerical version of the example. Assume that the subprime mortgage par amount is 100; assume the size of RMBS sub tranche is $20, so, the size of the senior RMBS tranche is $80. The senior RMBS tranche is sold to a CDO, which only buys this tranche, so, the size of the CDO is $80. The size of CDO sub tranche is $15 and so the senior tranche size is $65. I maintain these parameters and vary the recovery amount in Table 16. The table shows the loss the senior RMBS tranche, the payoff to the senior RMBS tranche, the loss on the senior CDO tranche, and the payoff on the senior CDO tranche—all at the end of the period.[50]

The example is not realistic because it is too simplified, but it does convey the intuition for a few points. What does the example show?

Table 16

Parameters								
Recovery Amount ($)	**90**	**70**	**60**	**50**	**40**	**30**	**20**	**10**
Outcomes								
Loss on Senior RMBS Tranche (L_S)	0	10	20	30	40	50	60	70
Payoff on Senior RMBS Tranche (V)	80	70	60	50	40	30	20	10
Payoff on Sr. Tranche as % of par	100%	87.5%	75%	62.5%	50%	37.5%	25%	12.5%
Loss on Senior CDO Tranche (L_{CDO})	0	0	5	15	25	35	45	55
Payoff on Senior CDO Tranche (V_{CDO})	65	65	60	50	40	30	20	10
Payoff on Sr. Tranche as % of par	**100%**	**100%**	**92.3%**	**76.9%**	**61.5%**	**46.2%**	**30.8%**	**15.4%**

First, the effects of tranching are apparent. The sub tranche of the RMBS absorbs the first loss. Since the "inner" RMBS tranche (i.e., the one in the CDO) is a senior tranche, the losses on the senior CDO tranche are always less than (or, in the extreme, equal to) the losses on senior RMBS tranche.[51] However, conversely, if the CDO had purchased a mezzanine tranche, say going from 10 to 20, then the example would be very different. A senior CDO tranche could easily be at risk of loss if the portfolio consisted of mezzanine RMBS tranches.

Obviously, the example could be extended to include an SIV which purchases the senior tranche of the CDO.

VI.B. Discussion

Valuation of V_{CDO} requires integrating the above expression over a distribution of house prices. There are two practical problems with this. First, as a practical matter, the dependence on house prices creates a practical valuation problem—even if one takes a stand on the distribution of house prices. Imagine, for example, that the subprime securitization has four portfolios, each with thousands of mortgages, as in the above examples. The CDO has purchased 100 tranches of different securitizations, including, say, twenty senior subprime tranches from different deals. In principle, the issue is how to evaluate the senior CDO tranche (even ignoring all the OC tests and other complications

of the CDO structure). Not only is that valuation very difficult to do, but even linking the three structures together in a meaningful way is nigh impossible. An investor who actually purchased a particular CDO tranche or a particular subprime RMBS tranche would receive trustee reports and would, therefore, know the underlying portfolio.[52] The subprime RMBS investor could, with some difficulty, look through to the underlying mortgages and try to determine the value of his tranche.[53] The computational complexity is very high.

The second problem is taking all of the structure into account. There are vendor-provided packages that model the structure of structured products, but the valuation is based on (point estimate) assumptions that are input by the user, rather than simulation of the performance of the underlying portfolios.

VII. The Panic

> *A bank is…a manufacturer of credit. The cornerstone of credit is confidence—confidence of men in men. A panic is a collapse of credit. It is an intensely human affair, and many of the determining influences are of a personal and confidential character, and very inadequately reflected in the cold figures of the bank statement.*
>
> — E.W. Kemmerer (1911)

Like Tolstoy's family, economic good times are all alike, but every crisis is bad in its own way.[54] What triggered the Panic of 2007? How did it develop? The Appendix contains a brief chronology of the events of the Panic. I argued above that a complex chain of securities, derivatives, and SPVs resulted in asymmetric information and a loss of information: The structurers understood the chain, but investors did not. But, valuation is difficult for all parties. The chain began to unravel when house prices did not rise and foreclosures began. In this section I begin by briefly documenting these developments.

House price declines and foreclosures do not explain the Panic. I argue that the information story is more complicated. Dealer banks had the information about the subprime-related structures, and about the placement of the various bonds. But, there was no way to learn the consensus value of these bonds and structures. There was

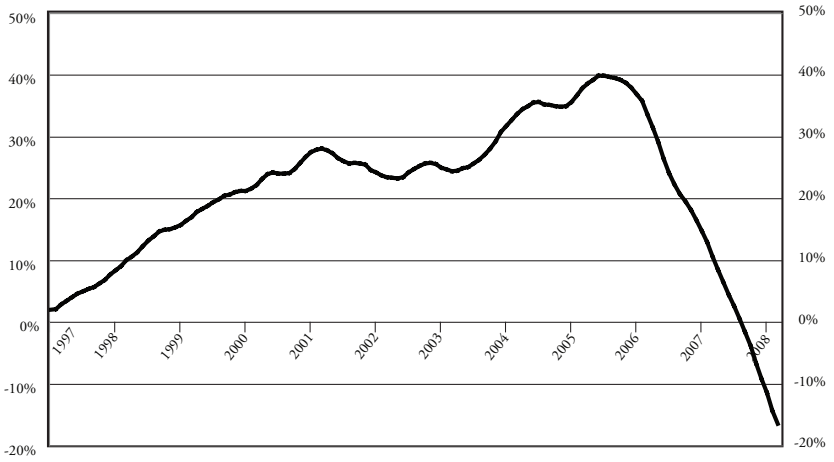
no mechanism for the revelation and aggregation of diverse information about the effects of the house price decline and the foreclosures. This created a pivotal role for the ABX index, which started trading in early 2006 around the time that house prices began to fall. I review the role of this index in creating common knowledge that the situation of subprime borrowers was deteriorating quickly and that the value of subprime-related bonds and structures was going down. By 2007 the ABX indices had become the focal point of the crisis. I discuss the role of the ABX index in revealing information. This is followed by a brief discussion of the runs on SIVs—the Panic itself. Finally, I try to summarize the information argument of the paper.

VII.A. House Prices Do Not Rise

House prices were supposed to always go up. Between 2001 and 2005 homeowners enjoyed an average increase of 54.4 percent in the value of their houses, as measured by the Office of Federal Housing Enterprise Oversight (OFHEO).[55] In terms of the two-year fixed-rate part of a 2/28 subprime mortgage, from January 1997 to July 2007 every rolling two-year period showed positive house price appreciation, according to the S&P/Case-Shiller (U.S. National) Index. In fact, from March 1998 to March 2007, every rolling two-year period displayed double digit house price appreciation. There was no appreciation or depreciation in August 2007, and starting in September 2007 house price appreciation has been negative. Chart 10 shows a plot of the lagging two-year house price appreciation.

But, then house prices declined. In fact, the S&P/Case-Shiller (U.S. National) quarterly home price index declined by 4.5 percent in Q3 2007 versus Q3 2006—the largest drop since the index started recording data in 1988.[56] Home prices, as measured in the 20 U.S. metropolitan areas, declined by 4.9 percent, the largest drop since the index was started in 2001, with 15 of the 20 cities showing year-on-year declines in prices. The two largest declines occurred in Tampa (-11.12 percent Y-o-Y) and Miami (-9.96 percent Y-o-Y). U.S. home prices declined 6.7 percent in October from a year earlier, a record drop for the ten-city S&P/Case-Shiller index (Chart 10).[57]

Chart 10
Lagging Two-Year House Price Appreciation (%)



Source: S&P

The ability of subprime and Alt-A borrowers to sustain their mortgage payments depends heavily on house price appreciation because of the need for refinancing. When house prices did not appreciate to the same extent as in the past, and in many areas they have recently gone down, the ability of borrowers to refinance has been reduced. In fact, now because of the crisis, underwriting standards have become much tougher, and many lenders are in bankruptcy, meaning that the mortgage market for these borrowers to refinance has effectively closed.

Currently, almost all the major issuers of subprime mortgages are either out of business or have stopped making subprime loans unless they conform to government sponsored enterprise (GSE) underwriting criteria. Problems in the Alt-A market are still mostly in the future, and it is likely that this market will also shut down. The unwillingness to originate subprime mortgages is significantly driven by the impossibility of a securitization take-out of the loans. This shutdown means that borrowers in the subprime and Alt-A mortgages will have a very difficult time refinancing when their hybrid ARMs are reset.

The shutdown of the subprime mortgage market is very important because of the number of borrowers who will soon reach their reset date, that is, the date at which the initial fixed teaser rate ends and the

mortgage rate resets to a significantly higher floating rate. Evidence of the shutdown in the refinancing market comes from remittance data. Remittance data shows that the shutdown is dramatically reducing subprime prepayment speeds.[58] A decline in prepayment speed means that borrowers cannot refinance either because they no longer can find a lender or because they have no equity built up on their houses. Delinquencies and foreclosures are the result. (Table 17.)

We now turn to the issue of how the information about house prices and delinquencies and foreclosures was linked to valuations of the various parts of the chain. Keep in mind that house price and mortgage performance information arrives with a lag, not in real time.

VII.B. Information and Common Knowledge

It was widely understood that the structures along the chain were sensitive to house prices, that house prices were likely a "bubble." Not everyone had the same view on whether house prices would continue to rise, or if they were to stop rising, on when this would occur. Or what the effects would be. Different parties made different bets on this. But, they did this without knowing the views of other participants. That is, there was a lack of common knowledge about the effects and timing of house price changes and about the appearance of increases in delinquencies. This explains why the interlinked chain of securities, structures, and derivatives did not unravel for a while.

In an important way, this changed with the introduction of the ABX indices at the start of 2006. As mentioned earlier, the ABX Index is a credit derivative that references twenty equally weighted RMBS tranches. There are also indices that comprise subindices: AAA, AA, A, BBB, and BBB-. Each subindex includes twenty subprime home equity bonds. The reference obligations in each subindex comprise bonds at the rating level of the subindex. Every six months the indices are reconstituted based on a pre-identified set of rules. The ABX.HE indices that reference lower-rated RMBS tranches typically carry higher coupons than those referencing higher-rated tranches due to the higher expected likelihood of default. (Table 18.)

Table 17
Delinquency Rates (%)

	Home Mortgage Delinquency Rate: Total (%)	Delinquency Rate: Prime Borrowers (%)	Delinquency Rate: Subprime Borrowers (%)
2003Q1	4.92	2.62	13.04
2003Q2	4.97	2.60	12.35
2003Q3	4.65	2.44	11.74
2003Q4	4.49	2.37	11.53
2004Q1	4.46	2.26	11.66
2004Q2	4.56	2.40	10.47
2004Q3	4.54	2.32	10.74
2004Q4	4.38	2.22	10.33
2005Q1	4.31	2.17	10.62
2005Q2	4.34	2.20	10.33
2005Q3	4.44	2.34	10.76
2005Q4	4.70	2.47	11.63
2006Q1	4.41	2.25	11.50
2006Q2	4.39	2.29	11.70
2006Q3	4.67	2.44	12.56
2006Q4	4.95	2.57	13.33
2007Q1	4.84	2.58	13.77
2007Q2	5.12	2.73	14.82
2007Q3	5.59	3.12	16.31
2007Q4	5.82	3.24	17.31

Source: Mortgage Bankers Association

Chart 11 portrays the creation of a vintage of the ABX Index and the subindices for the different ratings: AAA, AA, A, BBB, and BBB-. Each subindex includes twenty subprime home equity bonds.

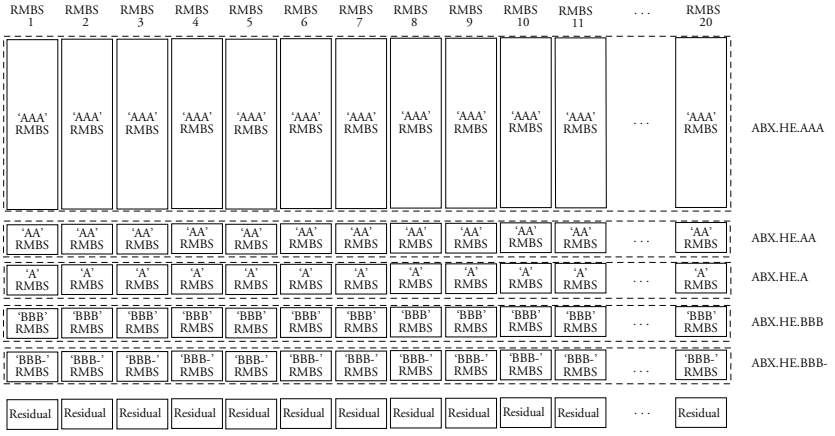
The introduction of these indices is important for two reasons. First, they provided a transparent price of subprime risk, albeit with liquidity problems (see Gorton, 2008). Second, it allowed for efficiently shorting of the subprime market. In addition to outright shorting, parties with long positions could hedge. The common knowledge problem concerning the value of subprime bonds may have been solved, but not the location problem. This is, of course, conjecture.[60]

As with CDS generally, entering into an ABX index contract is analogous to buying or selling insurance on basket of the underlying

Table 18
ABX.HE Index Overview

	ABX.HE
Portfolio	20 deals in basket, with a new ABX.HE series expected to be launched approximately every 6 months
Credit Score	Each deal must have a maximum average FICO equal to 660
Age	Each tranche must have settled within 6 months of the roll date
Weighting	Reference obligations equally weighted by initial par amount, with subsequent weightings evolving as a function of prepayment and credit experience of underlying transactions
Lien Type	The pool must consist of at least 90% first lien loans
Diversification	–Limits same originator to 4 deals –Limits master servicer to 6 deals
Minimum Deal Size	$500mm
Average Life	Each tranche must have a weighted average life of 4-6 years as of the issuance date (except AAAs which must be greater than 5 years)
Credit Events	Failure to Pay Principal, Write-down
Settlement	Pay-as-you-go (PAUG)[59]

Chart 11
ABX.HE Indices



Source: Kevin Kendra, Fitch, "Tranche ABX and Basis Risk in Subprime RMBS Structured Portfolios," February 20, 2007

RMBS tranches. An investor wanting to hedge an existing position, or otherwise establish a short credit position using the index (known as the "protection buyer"), is required to pay a monthly coupon to the other party (the "protection seller"). The payment is calculated based on the outstanding notional amount of the index and the fixed coupon. In exchange for the payment, the protection buyer in an ABX index contract is compensated by the protection seller when any interest or principal shortfalls or write-downs on the underlying mortgages affect the constituent RMBS. Unlike with conventional "single name" CDS, the index contract does not terminate when these credit events occur; rather it continues with a reduced notional amount until maturity. If credit events are subsequently reversed —for example, a principal shortfall is made up—then the protection buyer reimburses the protection seller.

The ABX tranche coupon is determined on the initiation date. Subsequently, trades require an upfront exchange of premium/discount. In a typical transaction, a protection buyer pays the protection seller a fixed coupon at a monthly rate on an amount determined by the buyer. When a credit event occurs, the protection seller makes a payment to the protection buyer in an amount equal to the loss. Credit events include the shortfall of interest or principal as well as the write-down of the tranche due to losses on the underlying mortgage loans.

The initial coupon is determined at the launch of each ABX.HE index based on an average quote from a survey of the market makers, the dealer banks. Knowledge about the structure of the subprime RMBS, CDOs, and off-balance sheet vehicles is held by the dealer banks, who structure these transactions. They are the ones polled to determine the initial coupons on the ABX indices. The polling process works as follows:

> At or about 9:00 a.m. on the Business Day immediately prior to the Roll Date (the "Fixed Rate Determination Date"), the fixed rate for each sub-index for the new ABX.HE Index for purposes of the ABX Transactions Standard Terms Supplement will be determined by the Administrator by soliciting each ABX.HE Participant to submit an

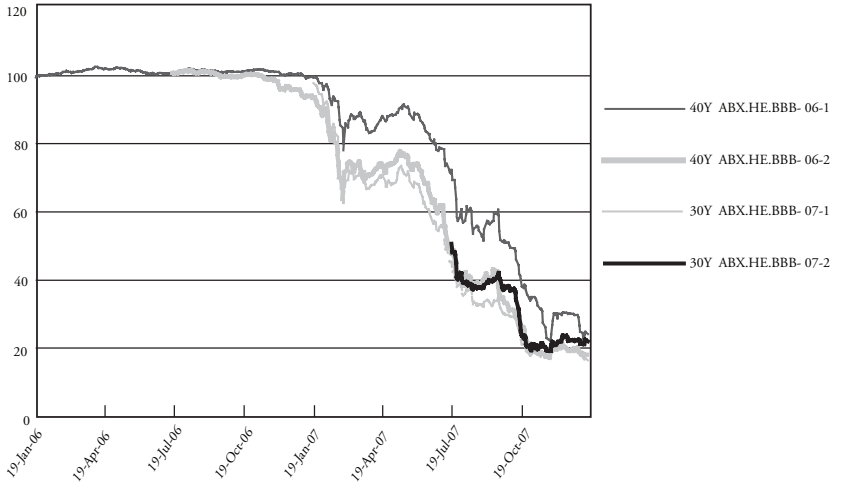
> average mid-market spread for each sub-index (in increments of 1 basis point). The Administrator will re-solicit ABX.HE Participants until at least two-thirds of the ABX.HE Participants (rounded down) have submitted such spreads. The Administrator shall rank such submissions for each sub-index from lowest to highest spread and discard the top and bottom quartiles thereof (the number of submissions q in each discarded quartile will be given by q=int(NS/4) where NS is the total number of submissions). The fixed rate for each sub-index shall be the lesser of (i) average of the remaining submissions for such sub-index (rounded up to the nearest basis point), as determined by the Administrator and (ii) 500 basis points.
>
> —Markit, *ABX Index Rules*

The ABX.HE 06-1 (this is the official name for the 2006 first vintage) began trading on January 19, 2006. So, unfortunately, there are no observations on early index subprime product, such as the 2005 vintage. Moreover, the company administering the ABX, Markit, announced that the roll of the new ABX.HE, ABX.HE 08-1, would be postponed for three months from the date it was scheduled to launch, January 19, 2008. Markit said that: "The decision to postpone its launch was taken following extensive consultation with the dealer community. It follows a lack of RMBS deals issued in the second half of 2007 and eligible for inclusion in the forthcoming Markit ABX.HE roll. The Markit ABX.HE 07-2 remains the on-the-run series until further notice." See *http://www.markit.com/information/products/abx/contentParagraphs/04/document/20071219%20Markit%20ABX.HE.pdf*. No subsequent vintage has been issued.

Chart 12 shows the prices of the 2006-1, 2006-2, 2007-1, and 2007-2 vintages of the index for the BBB- tranche. These are the only vintages available. In three of the four cases, the index starts trading at par of 100. In the case of the 2007-2 index, it opened at a price significantly below par.[61]

The time pattern of prices in this chart is very interesting. The first vintage ABX 2006-01 trades near par, as does the 2006-02 vintage

Chart 12
ABX BBB– Prices



initially. During 2006, there is little evidence of a major crisis. But, the 2007-01 BBB- ABX nosedives upon issuance, and the 2007-02 vintage opens trading below 60. The dealers got the coupons badly wrong. One interpretation of this is that the fundamentals of subprime were weakening during 2006, as the ABX drifted down somewhat in the second half of 2006. But, starting in 2007 it seems clear that there were major problems. I view the ABX indices as revealing hitherto unknown information, namely, the aggregated view that subprime was worth significantly less. In fact, some of the dealer banks themselves, we now know, were shorting the index to hedge their long positions—of course so was everyone else.[62]

The ABX indices also allow all parties, e.g., hedge funds, to express their views on the value of subprime RMBS bonds. Kiet Tran (no date) of Markit put it this way:

> The sub-prime debacle in the U.S. brought about a global credit crunch this summer with the ABX leading the charge. Subordinate tranches of the 06-2 and 07-1 series have lost over 75% of their value since the end of May. Even with the Fed rate cuts, the ABX free fall continues, particularly for

> the lower rated tranches. Early signals were seen in February 2007, a month where prices of the ABX BBB- tranches plunged more than 20%. Shareholder values of sub-prime mortgage lenders deteriorated in the following weeks, with the stock price of Accredited Home Lenders Holding Corporation dropping just over 80% between February month-end and the mid-March low.
>
> ABX.HE acts as a vehicle for investors to hedge their sub-prime exposure and to express their views on the sub-prime market using a liquid and transparent instrument. The recent performance of the ABX does not bode well for the outlook for the sub-prime mortgage market but time will tell how far losses will extend. For the time being, the ABX.HE index is the acting weatherman of the sub-prime mortgage market, predicting a rough storm ahead.

It is not clear whether the housing price bubble was burst by the ability to short the subprime housing market or whether house prices were going down and the implications of this were aggregated and revealed by the ABX indices. As discussed below, the indices were the sole source of information for marking-to-market. It seems that the indices played a central informational role.

VII.C. The Run on the SIVs

The runs began on ABCP conduits and SIVs. These vehicles were funded with short maturity paper and the "run" amounted to investors not rolling over the paper. Following the implicit (state dependent) contract, discussed below, SIVs were absorbed back onto the balance sheet of their sponsors. The SIV sector essentially disappeared during the panic. See Appendix B.

As of December 2007, ABCP had declined by $404 billion from a peak of $1.2 trillion—a decline of about 34 percent (See Chart 13). How much of this decline is due to SIVs unwinding? According to UBS:

> …in August, SIV outstandings were $400 billion ($130 billion ABCP + $270 billion MTNs). Current SIV outstandings are $300 billion ($75 ABCP + $225 billion MTNs).

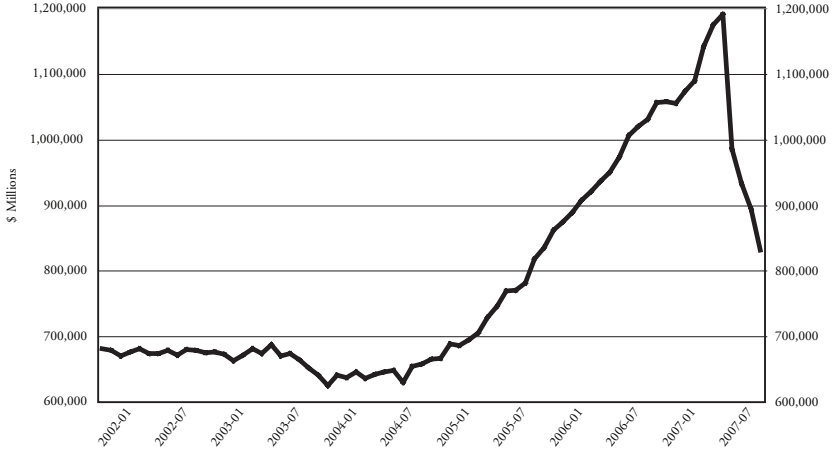
> This is, however, illusory; a large percentage of the $75 billion current outstanding SIV ABCP is no longer held by the intended investors (such as money market funds), but rather by bank sponsors themselves (which, of course, also ties up bank balance sheets), and to a lesser extent, by ABCP dealers and capital note holders. (UBS, "Mortgage Strategist," December 18, 2007, page 10.)

Appendix B describes the outcomes for the major SIVs. Concurrently with the run on these vehicles, prices of subprime-related bonds began to decline. Highly levered hedged funds that held these bonds began to incur write-downs, and face margin calls. A number of hedge funds liquidated. Dealer banks began to announce write-downs.

Why were there runs on SIVs? Did they hold massive amounts of subprime-related paper? In August 2007, a few months prior to the runs, S&P reported on the portfolio composition of SIVs:

> We reviewed the portfolios specifically with an eye toward mortgage assets and CDO of ABS assets, which have recently experienced considerable pricing pressure in the markets. In the aggregate, SIV portfolios remain well diversified. Portfolio exposure to residential mortgage assets and CDOs of ABS average 24%. The exposure to subprime and home equity-backed RMBS assets forms a small proportion of the portfolios. Assets backed by prime RMBS form the largest proportion of the portfolios. On average, portfolios hold approximately 21% exposure to the U.S. RMBS prime markets, of which the vast majority is 'AAA' rated prime assets.
>
> Two vehicles have significant above-average exposure to home equity and subprime assets. On Aug. 28, Standard & Poor's took a rating action on Cheyne. The other vehicle, Rhinebridge, recently received an infusion of capital.
>
> In aggregate, across the portfolios of all rated SIVs, the weighted averages of the portfolio rating exposures are rounded to approximately 61% invested in 'AAA' rated assets, 27% invested in 'AA' rated assets, 12% invested in 'A' rated assets, and a residual of less than 1% in lower-rated assets. These numbers exclude Eaton

Chart 13
Asset-Backed Commercial Paper Outstanding



Source: Federal Reserve

> Vance because it focuses on the non-investment-grade corporate market and has lower leverage guidelines. The financial sector comprises a weighted average of 41.5% of SIV portfolios.

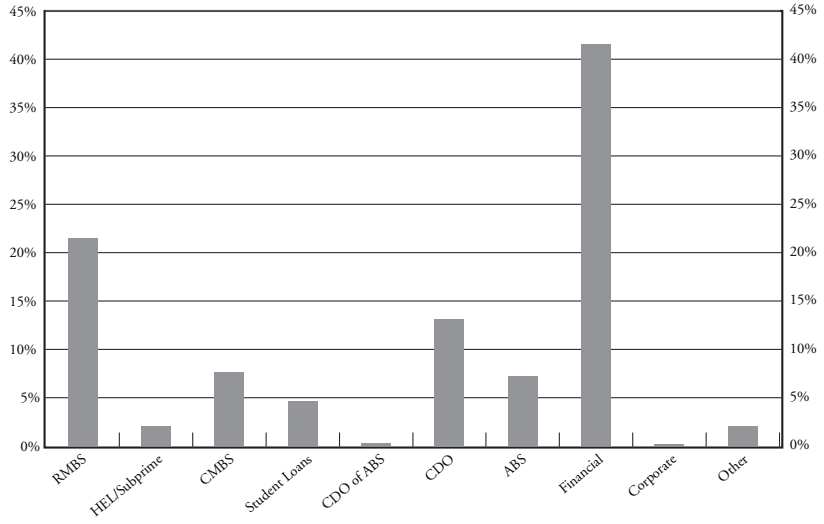
Chart 14 shows the average asset distribution by sector across all SIV portfolios.

SIVs did not have significant exposure to subprime in aggregate. Home equity loans and subprime were 2.01 percent. CDOs of ABS amounted to 0.28 percent. Perhaps the problem was the exposure to the financial sector, 41.50 percent. The basic problem was that investors could not penetrate the portfolios far enough to make the determination. There was asymmetric information. The run on SIVs does resemble pre-Federal Reserve panics, and it is not surprising that the "super SIV" was a proposed solution. That resembled the 19th century clearinghouses.[63]

VII.D. Summary Overview

I have written throughout about information being "lost" due to complexity, while at other times I have described a situation as

Chart 14
Composition of SIV Portfolios



Source: S&P (August 2007)

being characterized as "asymmetric information." Finally, I argued that the introduction of the ABV revealed and aggregated information. I said it created "common knowledge" about subprime risk pricing. I also argued that no one knows the location of subprime risk. In this subsection I try to clarify and focus what I mean by these terms, and in the process, summarize the information story. Table 19 may help organize these thoughts.

Prior to the introduction of the ABX, there was no liquid, publicly visible market where subprime risk was directly priced. Individual transactions were priced, but these prices were not widely seen. Only the direct participants saw the prices. Moreover, parties wishing to hedge or short subprime had no easy way of doing this. To the extent that there was hedging and shorting, again the prices were not seen by a wider audience. The value of subprime mortgages, and subprime-related instruments, was not common knowledge. The ABX started trading in 2006, and started drifting downwards in the second half of that year. In 2007 all the indices showed a distinctly negative view. This negative view became known, and it became known that everyone knew

Table 19
Summary of the Chain of Subprime Risk

Step in the Chain	Information Created	Parties Involved
Origination of mortgages	Underwriting Standards: Risk characteristics of mortgages	Mortgage originators; brokers
Securitization of mortgages	Portfolio of mortgages selected and RMBS Structured	Dealer banks; servicers; rating agencies; investors buy the deal
Securitization of ABS, RMBS, CMBs in CDOs of ABS	Portfolio of ABS selected, manager selected, and CDO Structured	Dealer Banks; CDO managers; Rating Agencies; Investors buy the deal
Possible transfer of CDO risk via CDS in Negative Basis Trade	CDO and tranche selected; counterparty risk introduced	Dealer banks; banks with balance sheets; CDO
Possible sale of CDO tranches to SIVs and other such vehicles	CDO and tranche selected for SIV portfolio	SIV manager; SIV investors buy SIV liabilities
Possible investment in SIV liabilities by money market funds	Choice of SIV and seniority	Only the parties directly involved: buyer and seller
Possible sale of CDO tranches to money market funds via liquidity puts	CDO and tranche selected	Dealer banks; money market funds; put writer
Final resting place of the cash RMBS tranches, cash CDO tranches, and synthetic risk	Location of risk	Only the parties directly involved: buyer and seller

this. Once the ABX indices started to drift downwards, accountants required market participants to use these indices for mark-to-market purposes, which may have led to a feedback effect, discussed later.

"Asymmetric information" is a familiar term, referring simply to a situation where one side of a transaction knows more relevant information than the other side about the object being traded, potentially leading to well-known agency problems. Referring to the table above, investors purchased tranches of RMBS, CDOs, SIV liabilities, money market funds, and so on, and did so without knowing everything known by the structurers of the securities they were purchasing. These investors likely relied on repeated relationships with bankers and on ratings. Essentially, investors do not have the resources to individually analyze such complicated structures and, in the end, rely to a lesser extent on the information about the structure and the fundamentals and more on the relationship with the product seller. Agency relationships are substituted for the actual information. To emphasize this is not surprising, and it is not unique to structured

products. But, in this case the chain is quite long. Below I discuss whether incentives were aligned in these agency relationships along the chain.

No one knows where the subprime risk ultimately ended up, except that the final buyers and sellers of the risk of a particular transaction know. The final investor is invariably an agent acting as a delegated portfolio manager. Even if the final investor is a regulated entity, the entity may not report in a way which would make the risk clear to outsiders or regulators.

In economics we often think of information as being exogenous payoff relevant information, such as the distribution of payoffs or the type of a manager, which affects the distribution of payoffs. Economists think of information as a "signal" about the future payoff of a security. Agents obtain signals by expending resources. If they expend resources, they learn the signal plus noise. The costs of learning the signal are recovered by trading on this private information. In the process the price aggregates the information. This is the gist of Grossman and Stiglitz's (1980) paper.

There is also information about the actions of other agents, that is, the strategies of other agents can affect payoffs, and so agents must form beliefs about what other agents are going to do. These are all familiar notions.

I have argued that one problem leading to the current crisis was the loss of information. What does it mean for information to be "lost" due to "complexity"? "Lost" implies that the information was known at one point, and then it became "lost." By "lost" I mean that for CDO investors and investors in other instruments that have CDO tranches in their portfolios, it is not possible to penetrate the chain backwards and value the chain based on the underlying mortgages. The structure itself does not allow for valuation based on the underlying mortgages, as a practical matter. There are (at least) two layers of structured products in CDOs. Information is lost because of the difficulty of penetrating to the core assets. Nor is it possible for those at the start of the chain to use their information to value the chain "upwards" so to speak.

To be a bit more precise, the Grossman-Stiglitz story is about secondary market security trading. But, the securities and derivatives relevant to the subprime panic are not traded in secondary markets. The chain is a sequence of primary markets. In this chain, how are the signals propagated? The initial "signal" concerns the underwriting standards for the mortgages. At each step of the way, signals are somehow combined, as different portfolios are formed, each requiring multiple signals. Economists simply have no theories about the aggregation and transmission of "signals" in this context. Essentially incentive-compatible arrangements are substituted for the actual signals, which are too complex to be transmitted.

VIII. The Panic Continued: Liquidity, Accounting, and Collateral Calls

The Panic was rooted in the fear of losses, the location and extent of which can't be determined. But there was also a virulent knock-on effect, which is a significant force in its own right: Liquidity dried up. With no liquidity and no market prices, the accounting practice of "marking-to-market" became highly problematic and resulted in massive write-downs based on fire sale prices and estimates. Collateral calls, also based on "marking-to-market" were massive, creating liquidity problems for some and windfall funding for others. Finally, there was an inability to raise cash because of a refusal to lend, especially in terms of repurchase agreements (repo).[64] I review these issues in this section.

VIII.A. Liquidity

Aside from actual experiences of watching the repo market disappear, the evidence for the liquidity crisis is the sharp increase in spreads in important short-term funding markets, such as the interbank market. A number of observers point to the spread between Libor and the overnight indexed swap (OIS) rate of the same maturity.[65] The OIS rate embeds the expectation of the overnight rate at that maturity but does not reflect credit and liquidity risks, so the idea is that the spread takes account of interest rate expectations. The increase in the spread is viewed as evidence of the stress in the interbank market, though

whether it is "liquidity" or counterparty risk, to the extent that these are different, is less clear. See Mishkin (2008), Taylor and Williams (2008A, B), Michaud and Upper (2008).[66]

The 3-month Libor-OIS spread is shown in Chart 15. This spread had a multi-year average of 11 basis points, and was 15 basis points on August 8, 2007. On August 10 it was over 50 basis points, and it was over 90 basis points by mid-September.

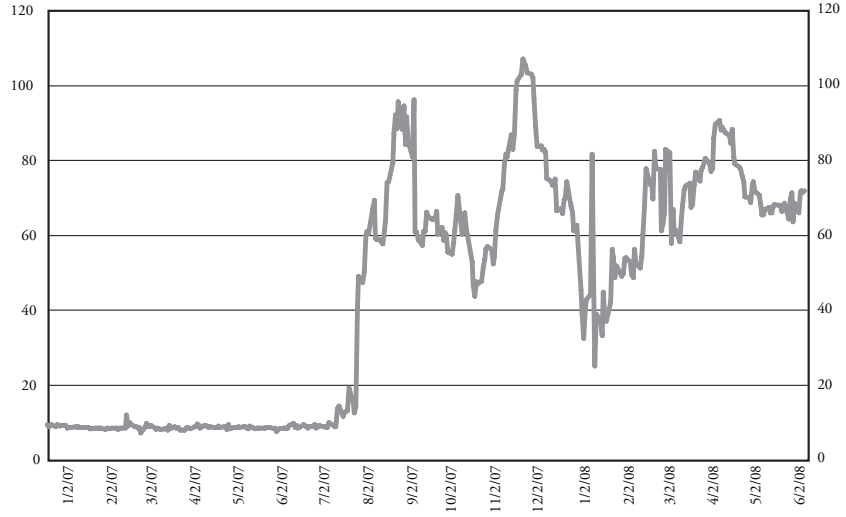
This liquidity crisis was magnified by several factors, which I discuss next. The first is the accounting practice of marking-to-market. I briefly discuss this issue; a thorough discussion is beyond the scope of this paper.[67] A second factor in the liquidity crisis is collateral calls.[68]

Illiquidity causes "mark-to-market" losses to differ significantly from expected losses based on credit fundamentals. The difference is the liquidity premium. Of course, the problem is that we have no sure measure of the illiquidity discount, nor do we have a sure measure of the expected losses based on fundamentals. The Bank of England (2008) estimated, based on actuarial methods, that the realized subprime-related losses would eventually reach $170 billion. On the other hand, an estimate based on the usual market value method gives an expected loss of $380 billion. See Bank of England (2008). This result is hardly unique: Every comparison between market–price–based measures and actuarial measures gives the same result, namely, that write-downs calculated with market-price-based measures are significantly higher than expected losses calculated using any other approach. This is no surprise—it is exactly the effect of illiquidity on prices.

VIII.B. The Impact of Accounting

The relevant accounting rule (in the U.S.) is the U.S. Financial Accounting Standards Board Rule 157, which was introduced in September 2006, to become effective for fiscal years that began after November 15, 2007. So, the rule was coming into effect essentially in the middle of the Panic.[69] The rule requires that (most) positions be "marked-to-market" under FASB 157.[70] The logic follows from the idea that if markets are efficient, that is, if prices aggregate the information and beliefs of market participants, then this is the best

Chart 15
3-Month Libor-OIS Spread (bps)



Source: Bloomberg

estimate of "value."[71] I leave aside the issue of whether "efficient markets" is an accurate description of any market other than perhaps stock markets. This accounting view creates an obvious problem during a banking panic when market participants withdraw from markets, a problem which has been much commented on. See, e.g., Fitch (2008), Euromoney (March 3, 2008), Norris (2007), and Standard and Poor's (2007, 2008), to name just a few.[72]

The accounting rules put the accountants at the forefront of decision-making about the valuation of complex financial instruments. While the accounting outcome is basically negotiated, the rules put management at a bargaining disadvantage. As Pollock (2008) put it:

> There is no doubt that the move to FAS 157 and similar rules has resulted in a shift of power toward accounting firms and away from corporate management, a shift that only adds to the change put in place by Sarbanes-Oxley. At the same time, we have this perverse situation where the accountant has to opine on accounting treatment, but they cannot provide advice to the client because that would violate their "independence."

Accounting is supposed to produce information.[73] How can that happen in a panic? In a panic, no one wants to trade; there are no markets. And hence there are no market prices. Think of a 19th century banking panic. In a 19th century banking panic, the banking system was insolvent; the system could not honor depositor demands for withdrawal. There is no place to sell the assets of the banking system. Obviously, "marking-to-market" would confirm this. In the U.S. during the 19th century this problem was solved by clearinghouses (something the short-lived "super SIV" attempted to imitate). During the 19th century, the institution of the clearinghouse evolved to the point where banks' response to panics was fairly effective. In the face of the insolvency of the banking system, the banks suspended convertibility and issued clearinghouse loan certificates. Clearinghouse loan certificates created a market price, one which valued the assets of the banking system. These certificates traded at a discount to par initially. When the discount to par disappeared, corresponding to the market's view that the banking system was solvent, suspension was lifted. In other words, it took time for the asymmetric information to dissipate, and when it did, suspension was lifted. This system was abandoned with the founding of the Fed and the subsequent adoption of deposit insurance. These were institutions aimed at preventing a panic from happening. But, they are not equipped to solve the information problem that arises if a panic does happen.

Clearinghouse loan certificates served an important function in producing information about the aggregate banking system. There is no modern equivalent to clearinghouses. There is no information-producing mechanism that is implemented during panics. Accountants follow rules. So, accountants enforced "marking." Accountants initially seized on the ABX indices as the "price," even for earlier vintages, but later were willing to recognize the difficulties of using the ABX indices.

Marking-to-market, however implemented during a panic, has very real effects because regulatory capital and capital for rating agency purposes is based on GAAP. There are no sizable platforms that can operate ignoring GAAP capital. In the current situation, partly as a result of GAAP capital declines, banks are selling assets or are

attempting to sell assets—billions of dollars of assets—to "clean up their balance sheets," raising cash and delevering. This pushes down prices, and another round of marking down occurs, and so on. This downward spiral of prices—marking down, selling, marking down again—is a problem when there is no other side of the market, as has been often noted of late.[74]

VIII.C. The Scramble for Cash—Collateral Calls

A scramble for cash ensued, not just from delevering and hoarding balance sheet, but also from collateral calls.[75] E.g., Bear Stearns Form 10-K, November 30, 2007:

> … investors lost confidence in commercial paper conduits and SIVs causing concerns over large potential liquidations of AAA collateral. The lack of liquidity and transparency regarding the underlying assets in securitizations, CDOs and SIVs resulted in significant price declines across all mortgage-related products in fiscal 2007. Price declines were further driven by forced sales of assets in order to meet demands by investors for the return of their collateral and collateral calls by lenders. (p. 16)

Accredited Home Lenders Holding Co. SEC filing Schedule 14D-9, June 19, 2007:[76]

> … these events with the continued heavy repurchase demands from whole loan purchasers experienced during this period created a cycle beginning with a significant increase in the amount of distressed loans for sale in the market. This increase in loan supply reduced whole loan prices, providing a basis for warehouse line providers to mark down the collateral value of loans held in inventory and, as a result, to place margin calls on non-prime lenders. These increased margin calls resulted in more distressed sales which, in turn, put further downward pressure on whole loan sale prices, regenerating the cycle with escalating negative results. (p. 8)

There are many examples like this.

Collateral usage in derivative transactions has increased significantly. Collateral usage in derivative transactions is governed by the Credit Support Annex (CSA) to the ISDA Master Agreement. A CSA provides credit protection by setting forth the rules governing the mutual posting of collateral.[77] The ISDA Margin Survey of 2007 estimates that the gross amount of collateral in use at the end of 2006 was $1.335 trillion, an increase of 0.4 percent over the previous year. The 2007 survey reported a 10 percent increase. The number of collateral agreements in 2007 was 133,000, compared to 110,000 in 2006. Cash is the most common kind of collateral.

In the credit derivatives market, buyers of protection can make collateral calls when spreads increase, that is, when marks suggest an increase in the likelihood that protection seller will have to pay. (The mechanics of this are governed by the CSA.) Dealer banks, which have written and purchased protection, will both make collateral calls and face collateral calls. Collateral typically earns Libor, so a collateral call means paying Libor in an environment where the bank will have to pay much more than Libor to borrow. So, there is a lot at stake in collateral calls.

This issue cannot be underestimated. The credit derivatives market is sizeable, indeed, and is based on collateral provisions in ISDA CSAs. The British Bankers' Association 2006 survey estimated the total market notional at the end of 2006 to be $20.207 trillion. The ISDA mid-2007 survey estimated the size of the credit derivatives market to be $45.25 trillion. In the June 2007 survey, the U.S. Office of the Comptroller of the Currency found that the total notional amount of credit derivatives held by U.S. commercial banks was $10.2 trillion. To put these numbers in a broader perspective, keep in mind that the U.S. corporate bond market is currently $5.7 trillion, and that the U.S. Treasury market is currently $4.3 trillion.[78]

For the party calling for collateral, collateral becomes a form of funding. Because Libor is paid on collateral, firms receiving collateral can fund themselves at Libor, when issuing debt in the market would cost them much more. This is one reason that the scramble for cash in the form of collateral calls is very important. In fact, it is difficult to convey the ferocity of the fights over collateral.

VIII.D. Panic in the Repo Market

Aside from collateral calls creating a scramble for cash, the basic form of lending, repo, disappeared. The most important part of the panic occurred in the repo market.

Repos are essentially secured loans, so counterparty risk is not an issue. All general collateral (GC) repos have the same rate, the GC repo rates, or simply the repo rate. Typically, repos can be rolled over easily and indefinitely, though the repo rate may change. Repo is integral to intermediation by dealer banks because when assets are purchased for sale later the assets are financed by repo.

Repo is likely one of the largest financial markets, though there are no official statistics on the size of the market. Tripartite repo was $2.5 trillion in 2007 (see Geithner, 2008).[79] Tripartite repo is estimated to be about 15–20 percent of the repo market.[80] With respect to the financing activities of primary dealers, reporting to the New York Fed, the average daily outstanding repo and reverse repo contracts totaled $7.06 trillion in the first quarter of 2008, a 21.5 percent increase over the same period in 2007. See the Securities Industry and Financial Markets Association (2008, p. 9). The Bond Market Association (since renamed the "Securities Industry and Financial Markets Association") (2005) conducted a dealer survey in September 2004 to determine the size of the repo market. As of June 30, 2004, the repo and securities lending market was $7.84 trillion. It is generally believed that this market has grown at around 10 percent per year, making it about $11.5 trillion today.

The repo market virtually disappeared in August 2007, and the drought has lasted for months. The repo market dried up because dealer banks would not accept collateral because they rightly believed that if they had to seize the collateral, there would be no market in which to sell it. This is due to the absence of prices. The amount lent depends on the perceived market value of the asset offered as security. If that value cannot be determined, because there is no market—no liquidity—or there is the concern that if the asset is seized by the lender, it will not be saleable at all, then lender will not engage in repo.

Why did the repo market disappear, if the problem was uncertainty about the valuation of subprime bonds? One can understand that dealers would not want to take subprime RMBS as collateral in repo, but what about ABS, RMBS, and CMBS generally? Repo traders report that there was uncertainty about whether to believe the ratings on these structured products, and in a very fast moving environment, the response was to pull back from accepting anything structured. If no one would accept structured products for repo, then these bonds could not be traded—and then no one would want to accept them in a repo transaction. This externality is reminiscent of Pagano (1989).

Without repo, assets cannot change hands, because the intermediaries cannot function. The only way to sell assets is at extremely low prices. But low prices then have a feedback affect, as they cause the mark-to-market value of all assets to fall, making it even less likely that repo can be done.

Like repo, collateral calls, against credit derivative positions for example, are also based on marks. That leads to fights over collateral due to disagreements about prices (such fights are ultimately governed by the Credit Support Annex). E.g., the VCG Special Opportunities hedge fund sued Wachovia after the fund was asked to post $750,000 of collateral, but then was asked for an increase to $8.2 million. The fund refused the final call of $1.49 million and Wachovia foreclosed on the fund (see *Wall Street Journal*, March 4, 2008, p. C1).

IX. Explaining the Panic: A Competing Hypothesis

I have argued that the design of subprime mortgages and subprime securitizations are unique in that they are particularly sensitive to declines in house prices, leading to an information problem for investors when the house price bubble burst, particularly due to the distribution methods, including CDOs, off-balance sheet vehicles, and derivatives. In my view, it is precisely the particularity of the underlying subprime mortgage design and its transmission through the chain of structures that explains the problem. There is a specific

sensitivity to house prices embedded in the design of these securities, structures, and derivatives. There are no such issues with securitization generally, or with the use of off-balance sheet vehicles for the securitization of those asset classes. Other securitizations are not so sensitive to the prices of the underlying assets and so they are not so susceptible to bubbles. So, my claim is that a very specific set of interlinked security designs made the chain susceptible to a house price decline. House prices stopped increasing in 2006, and the effects were revealed by ABX prices.

There is, however, another hypothesis about the panic, and in this section, I very briefly discuss this competing hypothesis.

The dominant explanation for the Panic is the "originate-to-distribute" view, which is the idea that banking has changed in such a way that the incentives have been fundamentally altered as a general matter. It is argued that originators and underwriters of loans no longer have an incentive to pay attention to the risks of loans they originate, since they are not residual claimants on these loans. In this view, investors apparently do not understand this and have been fooled (fingers point to the rating agencies).

The "originate-to-distribute" viewpoint has been described by The Joint Forum (which includes the Basel Committee on Banking Supervision, the International Organization of Securities Commissions, and the International Association of Insurance Supervisors) as follows:

> …under the "originate-to-distribute" model, banks frequently no longer have significant retained exposures, nor have they necessarily retained the personnel specializing in workouts who can steer creditor negotiations. (*Credit Risk Transfer*, April 2008, p. 20)

> Since 2005, the growth of CRT [Credit Risk Transfer] continues to provide banks and securities firms with opportunities to profit from originating, structuring and underwriting CRT products. They can earn fees while not having to hold the associated credit risk or fund positions over an extended

> time period. This has been termed the "originate-to-distribute" model. (*Credit Risk Transfer*, April 2008, p. 41)

Here is a slightly fuller articulation of the view, by Mishkin (2008):

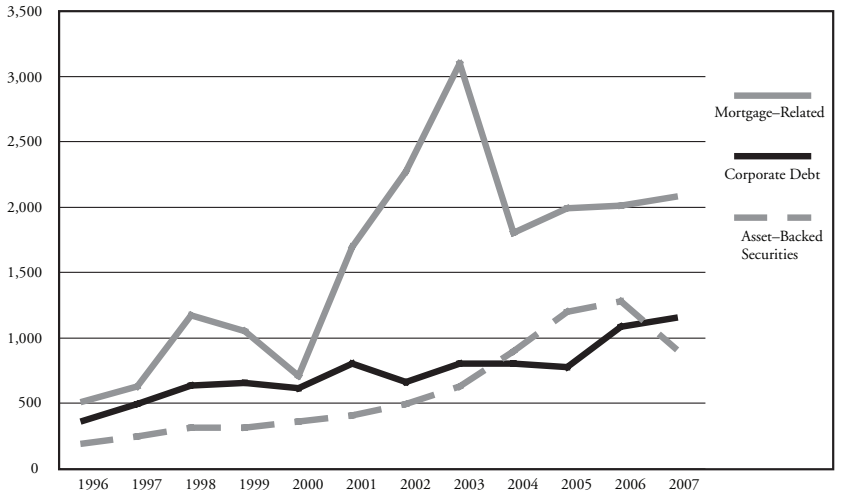
> The originate-to-distribute model, unfortunately, created some severe incentive problems, which are referred to as principal-agent problems, or more simply as agency problems, in which the agent (the originator of the loans) did not have the incentives to act fully in the interest of the principal (the ultimate holder of the loan). Originators had every incentive to maintain origination volume, because that would allow them to earn substantial fees, but they had weak incentives to maintain loan quality.

All major bank regulators and central bankers appear to subscribe to this view, though their views have some differences and nuances.[81]

There is no question that banking has changed, and that these changes are very significant.[82] Chart 16 conveys a sense of the magnitudes of these changes. Issuance of asset-backed securities, excluding mortgage-backed securities, has exceeded the issuance of corporate debt in the U.S. in the past few years. Broadly, "originate-to-distribute" refers to this change. Twenty-five years ago, there were no asset-backed securities. In addition, banks sell loans. The syndicated loan market was $1.5 trillion in 2005 for non-financial corporations. Secondary loan trading in 2005 had a market volume of $176.3 billion. See Drucker and Puri (2007). Clearly, the old model of the bank, in which loans were held to maturity, does not exist as it used to.

The issue is whether these changes somehow explain the panic. The "originate-to-distribute" seems to refer to the general trend in banking that has been going on for at least twenty years, possibly starting with the junk bond market becoming a major competitor for bank loans.[83] In response to this, and other competition, banks began selling loans and securitizing assets.[84] The originate-to-distribute view proposes nothing specific to explain why problems arose with the securitization of subprime mortgages, as opposed to any other category

Chart 16
Issuance of Various Securities ($ billions)



of assets that are securitized. In fact, in securitization generally, there does not seem to have been the same problems as with subprime mortgages. The "severe incentive problems" and "principal-agent problems" would seem to be present in all securitizations.

IX.A. Were Incentives Aligned?

The "originate-to-distribute" view argues that the risks of loans were passed along to investors, leaving the originators with no risk. But, this can be immediately rejected. Significant losses have been suffered by many up and down the subprime chain. Originators, securitization structurers, and underwriters—firms and individuals—have suffered. The subprime originators/underwriters that went bankrupt include, e.g., Option One, Ameriquest, New Century, and to the likes of Citibank, UBS, and Merrill Lynch, with billions of write-downs.[85] The following "agents" were fired: Chuck Prince, Ken Thompson, Marcel Ospel, James Cayne, Huw Jenkins, Stanley O'Neal, and a host of others. Thousands of other employees up and down the chain have lost their jobs. If these firms and individuals took excessive risk, they have realized losses. The fact there have been losses on subprime mortgages is not ipso facto evidence of a lack of incentives.

How are interests aligned in securitization? There is direct exposure to the originated risk, and there are implicit contracts making the arrangements incentive-compatible. I very briefly review these points.

Originators of subprime mortgages face a number of direct risks. The mortgages must be warehoused by the originator prior to securitization. In other words, loans must be held before they are securitized. See Gordon (2008). When the pool of mortgages is large enough, they are transferred to the underwriter, who will assemble the securitization. The underwriters of the securitizations then must warehouse the RMBS tranches. In later stages, securitization tranches will be warehoused by the dealer banks, who underwrite the CDOs.

In 2006 and early 2007 some banks kept the most senior portions of CDOs on their balance sheets. Along this chain, these firms have significant risks in warehousing the different securities. Much of the write-downs by banks came from such warehousing. For example, UBS "Shareholder Report on UBS's Write-Downs," April 18, 2008:

> UBS acquired its exposure to CDO Warehouse positions through its CDO origination and underwriting business. In the initial stage of a CDO securitization, the desk would typically enter into an agreement with a collateral manager. UBS sourced residential mortgage backed securities ("RMBS") and other securities on behalf of the manager. These positions were held in a CDO Warehouse in anticipation of securitization into CDOs. Generally, while in the Warehouse, these positions would be on UBS's books with exposure to market risk. Upon completion of the Warehouse, the securities were transferred to a CDO special-purpose vehicle, and structured into tranches. (p. 13)

> The CDO Warehouse was a significant contributor to Value at Risk ("VaR") and Stress limits applicable to this business relative to other parts of the CDO securitization process and warehoused collateral was identified as one of the main sources of market risk in reviews by IB Market Risk Control ("MRC") conducted in Q4 2005 and again in Q3 2006. (p. 13)

Similarly, the CFO of Bear Stearns, during the Earnings Conference Call of December 20, 2007: "…of the $1.9 billion in writedowns… about $1 billion of that came from the writedowns of CDOs and the unwinding of the CDO warehouse."

Warehousing is not the only risk. Originators of mortgages retain significant interests in the mortgages they originate due to servicing rights and retained interests. Mortgage servicing rights are valuable, and retained interests are also significant. When loans are sold in the secondary market, the mortgage servicing rights that are created are typically not sold.[86] An example of the value of mortgage servicing rights is provided by Countrywide. Countrywide Form 10-K, December 31, 2007:

> When we sell or securitize mortgage loans, we generally retain the rights to service these loans. In servicing mortgage loans, we collect and remit loan payments, respond to customer inquiries, account for principal and interest, hold custodial (impound) funds for payment of property taxes and insurance premiums, counsel delinquent mortgagors and supervise foreclosures and property dispositions. We receive servicing fees and other remuneration in return for performing these functions. (p. 7)

In October 2007 Countrywide recorded write-downs of $830.9 million in the value of mortgage servicing rights. As of March 31, 2008, Countrywide had an estimated value of mortgage servicing rights of $17 billion and a total assets of $199 billion, about 9 percent of total assets (see SEC Form 10-K, April 29, 2008).

More formally, see Kohlbeck and Warfield (2002), calculate the present value of mortgage servicing rights for a sample of banks and show its relation to abnormal earnings. They find that the present value of mortgage servicing rights, as a percentage of equity, ranges from 2.7 percent to 3.5 percent.

Other financial interests are often retained as well, including, for example, interest-only securities, principal-only securities and residual securities. These retained financial interests are also significant.

Missal (2008): "New Century's residual interests were large assets of the Company (worth hundreds of millions of dollars)" (p. 234). The overcollateralization gives the sponsor a Credit Enhancement Security—a claim on the OC. These could be securitized in NIMs. Then the sponsor of the NIMs would retain a residual interest in the NIMs trust, which would remain on the balance sheet.

Perhaps a more detailed example can summarize this point. The information below and Table 20 are from page 35 of the 2007 Merrill Lynch Annual Report:

> **Residuals:** We retain and purchase mortgage residual interests which represent the subordinated classes and equity/first-loss tranche from our residential mortgage-backed securitization activity. We have retained residuals from the securitizations of third-party whole loans we have purchased as well as from our First Franklin loan originations.
>
> **Residential mortgage-backed securities ("RMBS"):** We retain and purchase securities from the securitizations of loans, including sub-prime residential mortgages.
>
> **Warehouse lending:** Warehouse loans represent collateralized revolving loan facilities to originators of financial assets, such as sub-prime residential mortgages. These mortgages typically serve as collateral for the facility.
>
> Table 20 provides a summary of our residential mortgage-related net exposures and losses, excluding net exposures to residential mortgage-backed securities held in our U.S. banks for investment purposes.

Note the sizes of "Warehouse Lending," "Residuals," and "Mortgage Servicing Rights" (the numbers are in millions of dollars). The losses are clearly significant.[87]

All along the chain, from originators to underwriters, there are very significant risks involved in creating and maintaining securitized products.

There are also implicit contractual arrangements in securitization, between the investors in the securitized assets—buyers of tranches—

Table 20
Residential Mortgage-Related Net Exposures and Losses
($ millions)

	Net Exposure as of Dec. 29, 2007	Net Losses for the Year ended Dec. 28, 2007
U.S. Subprime		
Warehouse Lending	$137	$(31)
Whole Loans	994	(1,243)
Residuals	855	(1,582)
Residential MBS	723	(332)
Total U.S. Subprime	**2,709**	**$(3,188)**
U.S. Alt-A	2,687	(542)
U.S. Prime	28,189	N/A
Non-U.S.	9,582	(465)
Mortgage Servicing Rights	389	N/A
Total	**$43,556**	**$(4,195)**

Source: Merrill Lynch Annual Report, 2007, p. 357

and the sponsors of the deals.[88] Gorton and Souleles (2007) argue that there is an implicit contract between the sponsor and investors in the liabilities of the SPVs used for securitization. The implicit contract exists precisely to address the agency problems that could arise when assets are sold, essentially is that the sponsor of the securitization guarantees it.

How do we know that such implicit contracts exist? Gorton and Souleles, empirically analyzing credit card securitizations, argue that this implicit contract is understood by investors and provide evidence that it is priced. Implicit contractual arrangements have also been argued to explain loan sales. Loan sales are not supposed to happen according to the traditional theories of banking, but following the advent of the junk bond market, banks began to sell loans. Although not required to retain part of the loan, banks in fact do retain pieces, more so for riskier borrowers. Also, loan covenants are tighter for riskier borrowers, whose loans are sold. See, e.g., Gorton and Pennacchi (1995, 1989); Calomiris and Mason (2004); Drucker and Puri (2007); and Chen, Liu and Ryan (2007). Jiangli and Pritsker (2008) "find that banks use mortgage securitization to reduce insolvency risk."

With respect to subprime specifically, the implicit contractual arrangement between SIV sponsors and investors led sponsoring banks to take the off-balance sheet SIVs back onto their balance sheets, when there was no explicit obligation to do so, consistent with the arguments of Gorton and Souleles (2007). See Appendix B.

IX.B. Did Underwriting Standards Decline?

The evidence cited for the alleged "originate-to-distribute" agency problems is the deterioration of the 2006 and early 2007 subprime mortgages. Subprime performance during the period 2001-2005 was good by historical (subprime) standards. While delinquency and foreclosure rates for subprime mortgages were higher than for prime mortgages, their experience was as expected, i.e., delinquencies and foreclosures rose during the recession of the early 2000s. But, the 2006 vintage of subprime mortgages is much worse.

The extreme deterioration of the 2006 vintage has been attributed to a decline in underwriting standards and to outright fraud. For example, the President's Working Group on Financial Markets (March 2008) concluded that "The turmoil in financial markets was triggered by *a dramatic weakening of underwriting standards for U.S. subprime mortgages, beginning* in late 2004, and extending into early 2007" (p. 1; emphasis in original). Or, another example, according to Fitch (2007):

> Fitch attributes a significant portion of this [2006] early default performance to the rapid growth of high-risk "affordability" features in subprime mortgages…. In addition to the inherent risk of these products, evidence is mounting that in many instances these risks were not controlled through sound underwriting practices. Moreover, in the absence of effective underwriting, products such as "no money down" and "stated income" mortgages appear to have become vehicles for misrepresentation or fraud ….(p. 1)

The evidence often cited are statistics like those in Table 21, which shows the time profile of some subprime mortgage characteristics.

Table 21
Underwriting Standards for Subprime Mortgages

	ARM Share	Interest Only Share	Low/No Doc Share	Debt-to-Income Ratio	Average Loan-to-Value Ratio
2001	73.%	0.0%	28.5%	39.7	84.0
2002	80.0%	2.3%	38.6%	40.1	84.4
2003	80.1%	8.6%	42.8%	40.5	86.1
2004	89.4%	27.2%	45.2%	41.2	84.7
2005	93.3%	37.8%	50.7%	41.8	83.2
2006	91.3%	22.8%	50.8%	42.4	83.4

Source: Freddie Mac; see Joint Economic Committee (October 2007).

Looking separately at these characteristics, it seems that standards were lowered. Note, for example, the increase in the percentage of mortgages with less than full documentation. But, such statements are problematic because there are many dimensions to borrower risk and there are trade-offs between them. For a given aggregation of risk, there is a trade-off between risk and return. So, it seems difficult to define a "decline in lending standards."

Bhardwaj and Sengupta (2008B) attempt to address the multidimensional nature of lending standards. Before getting to econometric tests, however, they point out the difficulties of casual observation. For example, "…borrowers with lower documentation have on average higher FICO scores" (p. 12). Or, "For a given vintage, mortgages with a smaller LTV have a lower FICO score on average" (p. 14). FICO scores trend gradually up over the period 1998-2006 (see Bhardwaj and Sengupta, 2008B). Their final conclusion is: "Noticeably, there is little to suggest anything particularly remarkable about underwriting standards for mortgages of 2005-2007 vintages…" (p. 16).

So, what does explain the performance of the post-2005 vintage subprime mortgages? House price appreciation (HPA), or more specifically depreciation, is the biggest single factor explaining defaults. For example, according to UBS: "…HPA alone is able to explain ~60% of the credit performance variance across states. Combined with combined LTV and percentage Full Doc, the three variables account for ~74% of credit performance variance. Also, interestingly, FICO score is statistically insignificant in interpreting the credit

performance." See UBS, "Mortgage Strategist," Nov. 13, 2007, p. 33. The conclusion that HPA is the most important factor explaining default and loan severity is confirmed with econometric evidence. See Bhardwaj and Sengupta (2007A):

> Using a competing risk hazard model, we show that an appreciation in house price had a positive and significant effect on the likelihood of prepayment but a negative and significant effect on the likelihood of default. In a regime of rising house prices, a financially distressed borrower could avoid default by prepaying the loan (either through a refinance or a property sale). Conversely, a sudden reversal in prices increased default in this market because it made this prepayment exit option cost-prohibitive.

The conclusion that HPA is the most important factor explaining default and loan severity is evidenced by Demyanyk and Van Hemert (2007).

If underwriting standards were declining, then "first payment default" mortgages would increase. These are mortgages where the borrower defaults right away, missing the very first monthly payments. But, most securitization contracts stipulate that if there is an early payment default, or some other defect in the mortgage (e.g., incorrect documentation), then the mortgage originator must repurchase the mortgage from the SPV. Because it is a defective mortgage, its value declines, so the originator incurs a realized loss; it has repurchased a loan for the same amount at which it was sold to the SPV, but has received back a mortgage worth less. It is difficult to see how a dramatic decline in underwriting would not result in a large number of first payment defaults that the originators would have to absorb. Since the originators would, in fact, absorb these mortgages, they have no incentive to make them in the first place.

Finally, it is worth noting that evidence of a decline in lending standards is only a piece of the puzzle. The argument must be that, if this did occur, it was not reflected in the structure of the RMBS bonds. Somehow, the structurers would have to have been fooled into not increasing the credit enhancement to reflect this decline. This has never been systematically examined.

IX.C. Summary

Securitization is an efficient, incentive-compatible response to bankruptcy costs and capital requirements. Although there are only a few studies, the evidence to date is consistent with the experience of a quarter century of securitization working very well. The assertions of the "originate-to-distribute" view simply are not consistent with what we know.

The idea that there is a moral hazard due to the alleged ability of originators to sell loans without fear of recourse, and with no residual risk, also assumes that the buyers of these loans are irrational. That may be, but the irrationality, it turns out, had to do with the belief that house prices would not fall.

X. Concluding Remarks

> *It might very properly be urged that the present is too early a date for us to draw wise conclusions from the lessons of the recent financial crisis. Indeed, one can hardly speak of it, as I did just now, as the recent crisis. It is the present crisis.… Domestic exchanges are still seriously disorganized. After the most heroic measures for relief, taken by the Treasury and by banks generally, we continue to be surrounded by abnormal conditions, and the day is somewhere in the future when we can look back with anything like academic interests and comment with intelligence on the true lessons which have been taught by this extraordinary financial event.*
>
> —Frank Vanderlip, Vice-President, National City Bank, New York, speaking of the Panic of 1907; see Vanderlip (1908, p. 2).

> *When I read the numberless projects for our financial well being that fill the newspapers, our book shelves, and the Congressional Record, I ask myself on what do these men base their plans, on observation or actual contact and familiarity with the subject they talk about, and I must conclude that much of it is spun out of their inner consciences.*

> —William Nash (1908, p. 61), speaking of the Panic of 1907.

The Panic of 1907 led to the founding of the Federal Reserve System. In 1908 Congress passed the Aldrich-Vreeland Act, which, among other things, created the National Monetary Commission. This commission published a voluminous report that served as the major impetus for the founding of the Fed. (See Weston, 1922, for a review.) The Federal Reserve Act passed in December 1913. But, it was then followed by a panic in 1914. (See Sprague, 1915, and Silber, 2007.) And, of course, the Great Depression came later, followed by large institutional changes, with the advent of deposit insurance being foremost among them.

A century after the Panic of 1907 we again contemplate the causes of a panic. Identifying the causes of the Panic of 2007 will in large part determine the policy response to the crisis. I have argued that the subprime crisis was caused by information problems related to declining house prices, which prevent subprime mortgages from being refinanced. The design of subprime mortgages is unique in that they are linked to house price appreciation. The securitization of subprime mortgages is also unique. Because subprime mortgages are financed through a chain of securities and structures, investors could not easily determine the location and extent of the risk. Information was lost. The house price declines led to a fear of losses that could not be measured because the subprime risk had been spread around the globe opaquely. The available information was on the side of the market that produced the chain of structures; outside investors know much less. The problem is that the magnitude of the structures, and their impenetrability by outsiders, was not completely understood; it was not common knowledge. The introduction of the ABX indices created a set of market prices that aggregated and revealed that subprime-related securities were worth a lot less than had been thought. The ability to short subprime risk may have burst the bubble and, in any case, resulted in the market crowding on the short side to hedge, driving ABX prices very low. The Panic was then on.

There is much work to be done to understand the ongoing panic, to formally test my (sometimes admittedly vague) conjectures, and

it will be surely be some time before researchers can sort through the events. As Mr. Vanderlip wrote, above, the lessons to be learned are likely only going to be known when there is more distance from the events. But, since panics are rare, it may be that we never have the ability to formally test in the way that is acceptable to academic economists. The scholars who studied panics before us, many of whom I have quoted, described the events with narratives. Perhaps that is the best we can do.

I have tried to convey the richness of the information and agency setting in which the crisis is taking place. At this point a few tentative conclusions can be drawn.

- Subprime mortgages were a financial innovation designed to be profitable by serving a constituency that had previously not had access to mortgage financing and hence could not own homes. This point is very important because the future regulatory response to the crisis will have implications for whether this constituency's needs will be met in the future or not. The re-regulation of the financial system is intertwined with national housing policy and this should be recognized. The current situation with Fannie Mae and Freddie Mac also stresses this point.

- The crisis was caused by house prices not rising and then falling. The introduction of the ABX index revealed that the values of subprime bonds (of the 2006 and 2007 vintage) were falling rapidly in value. But, it was not possible to know where the risk resided, and without this information, market participants rationally worried about the solvency of their counterparties. This led to a general freeze of intra-bank markets, write-downs, and a spiral downwards of the prices of structured products as banks were forced to dump assets.

- The crisis illustrates and emphasizes the extent to which the traditional banking system is no longer as central to the savings-investment process as it once was. The capital markets, through the sale of intermediary-originated loans via securitization and the distribution of risk through derivatives, highlight the centrality of capital markets and illustrate the flexibility of structured

products. This evolution has been going on for at least 25 years and should be viewed favorably.

- Securitization generally is not the problem currently. It is not the cause of the crisis. Securitization is an efficient form of financing, and there is no evidence that there is a systematic agency problem in its functioning. Rather, the particular form of the design of subprime mortgages is at the root of the problem. It was highly sensitive to house prices, and this sensitivity was passed through to a variety of other financial structures.

- Structured products and derivatives allow for the distribution of risks globally in a way which is opaque. In principle, this is not different than in, say, the 19th century U.S. banking system, in which the particular loans that banks held was also opaque. Opaqueness and innovation probably go together, and there is a danger that innovation will be squelched if we do not recognize that there is likely a trade-off here. The lesson, perhaps, is that we should be looking at the sectors that are very opaque, such as the hedge fund world, more closely.

- At the heart of many academic analyses of the functioning of capital markets and crises is the notion of "collateralizable" wealth, roughly the amount of verifiably riskless assets or bonds that an economic agent has available to borrow against. The current crisis shows that in the case of financial collateral, it can be the case that portfolios thought to be safe, collateralizable wealth in all states of the world, ex ante, turn out not to be collateralizable in the crisis. Even agency bonds, for example, were not acceptable as collateral in the repo market in August 2007. What is "collateralizable" is very intimately related to information. There is simply no financial wealth that can be thought of as "collateralizable" in all states of the world.

- The crisis also illustrates that "states of the world" may best be viewed as endogenous. The chain of securities and structures created a "state of the world" that many agents did not recognize as existing ex ante. So, the notion of "incomplete markets" may be more complicated than we generally recognize.

- Institutional investing, in general, must rely on representations from underwriters because each investor cannot afford extensive staffs of analysts. This would be excessively duplicative. As a result, when an investment is at the end of a chain, or perhaps early in the chain, the investment is made on the basis of a repeated agency relationship (with the seller and the rating agency) rather than on extensive and costly production of information. The complexity of the design makes this substitution of agency for information more likely. Information is lost. This is not a problem during normal times, as incentives are aligned. But, in a crisis, it makes it very difficult for investors to understand and value the risk.

- Accounting is widely recognized as having a great deal of difficulty measuring firm value in a world of derivatives. The crisis also reveals that marking-to-market, based on the notion of "efficient markets" is flawed and needs to be rethought. At some point, double-entry bookkeeping as a paradigm will be recognized as inappropriate for financial firms, which are already moving aggressively to risk management as a replacement. Risk management, of course, is not perfect by any means, but looking at firms' behavior the revealed preference of managements is that this is a more informative way of looking at firms.

- As Merton Miller (1986) pointed out over twenty years ago, financial innovation is largely driven by regulation and taxes. Regulation means constraints and costs. Imposing capital requirements on banks, for example, that are not consistent with their competitive environment accelerates disintermediation (see Gorton and Winton, 2000). Imposing costs, such as Sarbanes-Oxley, may have led to a competitive disadvantage for U.S. capital markets. See, e.g., Zingales (2007). Entrepreneurs will take risk in some form, somewhere. In a global environment, one where capital is extremely fluid, and risk can be moved quickly with derivatives, it will be difficult for national regulators to constrain entrepreneurs. The trends are already clear. Talent is increasingly moving to the least regulated platform: hedge funds. See, e.g.,

Hester and Burton (June 19, 2008) and Guerrera and Brewster (April 30, 2008).

Postscript (written October 4, 2008)

Since the above was written, the Panic has continued almost out of control, and the economy has noticeably deteriorated. Lending has stopped almost completely. There is no doubt that we are now in a recession. The financial landscape has been completely altered by failures, mergers, and de facto nationalization. The "Emergency Economic Stabilization Act of 2008" has been passed. The logic of the plan seems to be that by buying distressed assets from banks, the uncertainty about the value of the banks will be removed, possibly enticing new investors to recapitalize the banks. The success or failure will depend on the exact details of how this is implemented. If the money allocated to the Troubled Assets Relief Program is used to try to shore up the weakest bank, the government may quickly use up the money allocated by Congress. That is the danger. If the money shores up banks that are stronger, it may be possible to entice lending again.

Author's Note: Thanks to Geetesh Bhardwaj, Omer Brav, Adam Budnick, Jared Champion, Kristan Blake Gochee, Itay Goldstein, Ping He, Bengt Holmström, Lixin Huang, Matt Jacobs, Arvind Krishnamurthy, Tom Kushner, Bob McDonald, Hui Ou-Yang, Ashraf Rizvi, Geert Rouwenhorst, Hyun Shin, Marty Wayne, Axel Weber, and to those who wished to remain anonymous, for comments, suggestions, and assistance with data and examples.

In the interests of full disclosure, the author has, for the last twelve years, been intimately involved in modeling, structuring, and transacting very significant synthetic credit portfolios, as a consultant to AIG Financial Products Corp. The views expressed are those of the individual author and do not necessarily reflect the official positions of AIG Financial Products Corp.

Appendix A: A Brief Chronology of the Events of the Panic of 2007

Date	Event
December 2006:	Ownit Mortgage Solutions files for bankruptcy.
March 13, 2007:	Mortgage Banker Association data for the last three months of 2006 shows late or missed payments on mortgages rose to 4.95 percent, rising to 13.3 percent in the subprime market. Subprime lender Accredited Home Lenders loses 65 percent of its value, having lost 28 percent a day earlier.
April 2:	Mortgage originator New Century Financial Corporation files for bankruptcy.
April 18:	Ellington Capital Management, large hedge fund, buys $2.9 billion of nonprime mortgage loans from Fremont General Corp.
May 3:	UBS closes its hedge fund Dillon Read Capital Management.
June 10-12:	Moody's downgrades the ratings of $5 billion worth of subprime RMBS bonds and places 184 CDO tranches on review for downgrade. S&P places $7.3 billion of 2006 vintage RMBS bonds on negative watch and announces a review of CDO deals ex posed to subprime RMBS bonds.
June 20:	News reports suggest that two Bear Stearns-managed hedge funds invested in securities backed by subprime mortgage loans are close to being shut down.
June 22:	One of the troubled hedge funds is bailed out through an injection of $3.2 billion in loans.
July10:	S&P places $7.3 billion worth of 2006 vintage ABSs backed by residential mortgage loans on negative ratings watch and announces a review of CDO deals exposed to such collateral; Moody's downgrades $5 billion worth of subprime mortgage bonds.
July 11:	Moody's places 184 mortgage-backed CDO tranches

	on downgrade review; further reviews and downgrades are announced by all major rating agencies in the following days.
July 24:	U.S. home loan lender Countrywide Financial Corp. reports a drop in earnings and warns of difficult conditions ahead.
July 26:	The NAHB index indicates that new home sales slid by 6.6 percent year on year in June; DR Horton, the largest homebuilder in the United States, reports an April–June quarter loss.
July 30:	Germany's IKB warns of losses related to the fallout in the U.S. subprime mortgage market. Its main shareholder, Kreditanstalt für Wiederaufbau (KfW), assumes its financial obligations from liquidity facilities provided to an asset-backed commercial paper (ABCP) conduit exposed to subprime loans.
July 31:	American Home Mortgage Investment Corp. announces its inability to fund lending obligations; Moody's reports that the loss expectations feeding into the ratings for securitizations backed by Alt-A loans will be adjusted. Hedge fund Sowood capital informs investors it will shut down after losing 57 percent during the month (Sowood Alpha Fund). Sowood went from $3 billion to $1.5 billion in less than four weeks.
August 1:	Further losses exposed at IKB lead to a €3.5 billion rescue fund being put together by KfW and a group of public and private sector banks.
August 3-10:	Massive deleveraging causes quant hedge funds to suffer losses.
August 6:	American Home Mortgage Investment Corp. files for Chapter 11 bankruptcy, leading to a term extension on outstanding ABCP by one of its funding conduits.
August 9:	BNP Paribas freezes redemptions for three investment funds, citing an inability to appropriately value them in the current market environment; the ECB injects €95 billion of liquidity into the inter-

bank market; other central banks take similar steps.

August 13: Coventree, the largest nonbank sponsor of Canada's asset-backed commercial paper market announces that it is unable to place any asset-backed commercial paper on behalf of its conduits, including Aurora, Comet, Gemini, Planet, Rocket, Slate, SAT, and SIT II.

August 16: Countrywide draws its entire $11.5 billion credit line.

August 17: The Federal Reserve's Open Market Committee issues a statement observing that the downside risks to growth have increased appreciably; the Federal Reserve Board approves a 50 basis point reduction in the discount rate and announces that term financing will be provided for up to 30 days;
Run on Countrywide: "Anxious customers jammed the phone lines and website of Countrywide Bank and crowded its branch offices to pull out their savings because of concerns about the financial problems of the mortgage lender that owns the bank," *Los Angeles Times*, August 17, 2007.

August 23: Countrywide gets $2 billion cash injection from Bank of America.

September 4: Overnight Libor reaches 6.7975 percent, the highest level since the LTCM crisis. Bank of China reveals $9 billion in subprime losses.

September 9: Run on Northern Rock; see *Telegraph.co.uk*, September 14, 2007.

September: Cheyne Finance SIV goes into receivership, the first SIV to do so.

September 15: There is a run on British bank Northern Rock, the first in 150 years; £1 billion, amounting to 4-5 percent of retail deposits, are withdrawn (see BBC News: *http://news.bbc.co.uk/2/hi/business/6996136.stm*).

September 18-
November: Repeated large write-downs by major financial firms, leading to several high-profile CEOs to leave their positions.

October 15: Citigroup writes down additional $5.9 billion.

October 18: Rhinebridge Plc, the IKB SIV, suffers a "mandatory acceleration event" after IKB determines that the SIV may be unable to repay its debt.

November 13: Bank of America, Legg Mason, SEI Investments, and SunTrust Banks step in to prop up their money market funds against possible losses to debt issued by SIVs.

November 26: HSBC takes $41 billion in SIV assets onto its balance sheet.

November 27: Citigroup agrees to sell shares worth $7.5 billion to an investment fund owned by Abu Dhabi.

November 29: E-Trade, the online brokerage that was teetering at the edge of the subprime mortgage abyss, received a $2.55 billion bailout package led by Citadel Investment Group, a large hedge fund.

December 3: West LB and HSH Nordbank bailout $15 billion of their SIVs.

December 10: UBS announces a further $10 billion write-down. Bank of America announces it is shutting a $12 billion money-market mutual fund after losses on subprime-related instruments, including investments in SIVs.

December 15: Citibank says it will take its seven SIVs back onto its balance sheet, $49 billion.

December 19: Morgan Stanley writes off $9.4 billion. ACA, a financial guarantor rated A, is downgraded to CCC by S&P, triggering collateral calls from its counterparties.

January 3, 2008: Peloton Partners, a $3 billion hedge fund, forced to liquidate.

January 15: Citigroup announces a fourth quarter loss, partly due to $18 billion of additional write-downs on mortgage-related exposure.

February 27: Hedge fund Sailfish Capital Partners announces it is liquidating. Sailfish had managed $1.9 billion in the

	previous year.
March 3:	Thornburg Mortgage Asset Corp. announces that it could not meet margin calls.
March 7-16:	Fed announces an increase of $40 billion in the size of its new Term Auction Facility, and then expands its securities lending activities through a $200 billion Term Securities Lending Facility that lends Treasuries against a range of eligible assets.
March 14:	Failure to roll repos causes a liquidity crisis at Bear Stearns. Bear Stearns announces $30 billion in funding provided by JP Morgan and backstopped by the government.
March 17:	JP Morgan announces purchase of Bear Stearns for $2 a share, a little more than $236 million.
April 2:	New Century files for bankruptcy.
June 5:	MBIA and Ambac lose their triple A ratings from S&P.
June 9:	Lehman says it expects to lose $2.8 billion in the quarter ending May 31.
June 30:	Legg Mason announces another $240 million in capital contributions to support three money market funds.
July 11:	IndyMac Bank, a large mortgage lender, is seized by federal regulators. The cost to the Federal Deposit Insurance Corporation is estimated to be between $4 billion and $8 billion, potentially a loss of 10 percent of the FDIC's insurance fund for banks. Freddie Mac and Fannie Mae lost half their value in the week ending July 11. Moody's and S&P affirm that the U.S. would retain its AAA rating even if forced to rescue Fannie Mae and Freddie Mac.
July 14:	Federal Reserve Board grants authority to New York Fed to lend to Fannie Mae and Freddie Mac should the need arise.

Sources: Various, including Fender and Hördahl (2007), BIS Annual Report 2007-2008, Bloomberg; *Financial Times*; *The Wall Street Journal*; BBC (*http://news.bbc.co.uk/2/hi/business/7096845.stm*), company press releases.

Appendix B
Main SIV Outcomes

SIV	Manager/adviser	Initial rating date	Senior debt (mil. $)*	Current Status	Source
Beta Finance Corp.	Citibank International PLC	Sept. 8, 1989	20,175.95	Back on Balance Sheet	Citi Press Release 12/13/07
Sigma Finance Corp.	Gordian Knot Ltd.	Feb. 2, 1995	52,641.87	Must refinance $20 bil. by Sept.; S&P and Moody's downgrade	Bloomberg 4/8/08
Orion Finance Corp.	Eiger Capital Management	May 31, 1996	2,298.43	Defaulted	Reuters 1/16/08
Centauri Corp.	Citibank International PLC	Sept. 9, 1996	21,838.84	Back on Balance Sheet	Citi Press Release 12/13/07
Dorada Corp.	Citibank International PLC	Sept. 17, 1998	12,484.15	Back on Balance Sheet	Citi Press Release 12/13/07
K2 Corp.	Dresdner Kleinwort	Feb. 1, 1999	29,056.47	Back on Balance Sheet	Reuters 2/21/08
Links Finance Corp.	Bank of Montreal	June 18, 1999	22,301.10	Back on Balance Sheet	SEC 6-K 2/20/08
Five Finance Corp.	Citibank International PLC	Nov. 15, 1999	12,843.06	Back on Balance Sheet	Citi Press Release 12/13/07
Abacas Investments Ltd.	N.S.M. Capital Management/ Emirates Bank	Dec. 8, 1999	1,007.95	S&P affirms ratings	Reuters 6/17/08
Parkland Finance Corp.	Bank of Montreal	Sept. 7, 2001	3,414.43	Back on Balance Sheet	SEC 6-K 2/20/08
Harrier Finance Funding Ltd.	WestLB	Jan. 11, 2002	12,343.37	Back on Balance Sheet	Reuters 6/17/08
White Pine Corp. Ltd. (merged with Whistlejacket Capital Ltd.)	Standard Chartered Bank	Feb. 4, 2002	7,854.63	See below under Whistlejacket	
Victoria Finance Ltd.	Ceres Capital Partners	July 10, 2002	13,243.95	Chapter 11 in April 08	Reuters 6/17/08
Premier Asset Collateralized Entity Ltd.	Societe Generale	July 10, 2002	4,312.70	Moody's threatens downgrade: S&P affirms	Reuters 6/17/08
Whistlejacket Capital Ltd.	Standard Chartered Bank	July 24, 2002	8,844.63	Insolvent Feb. 15, 08	Reuters 6/17/08

Appendix B
Main SIV Outcomes (continued)

Tango Finance Corp.	Rabobank International	Nov. 26, 2002	14,039.75	Back on Balance Sheet	Reuters 6/17/08
Sedna Finance Corp.	Citibank International PLC	June 22, 2004	14,415.28	Back on Balance Sheet	Citi Press Release 12/13/07
Cullinan Finance Ltd.	HSBC Bank PLC	July 18, 2005	35,142.00	Back on Balance Sheet	Reuters 6/17/08
Cheyne Finance PLC	Cheyne Capital Management Ltd.	Aug. 3, 2005	9,726.18	Goldman leads restructuring	Reuters 6/17/08
Eaton Vance Variable Leveraged Fund	Eaton Vance	Sept. 23, 2005	542.76	Moody's cuts ratings	Reuters 6/17/08
Carrera Capital Finance Ltd.	HSH Nordbank	June 30, 2006	4,283.48	Restructured	Reuters 6/17/08
Kestrel Funding PLC	WestLB/Brightwater Capital	Aug. 2, 2006	3,315.86	Back on Balance Sheet	Reuters 6/17/08
Zela Finance Corp.	Citibank International PLC	Sept. 18, 2006	4,188.70	Back on Balance Sheet	Citi Press Release 12/13/07
Cortland Capital Ltd.	IXIS/Ontario Teachers	Nov. 1, 2006	1,344.19	S&P affirmed ratings in Feb.; now on negative watch	Reuters 6/17/08
Vetra Finance Corp.	Citibank International PLC	Nov. 15, 2006	2,616.94	Back on Balance Sheet	Citi Press Release 12/13/07
Hudson-Thames Capital Ltd.	MBIA	Dec. 5, 2006	1,767.33	Ceased Operations Dec. 07	Reuters 6/17/08
Nightingale Finance Ltd.	Banque AIG	March 15, 2007	2,330.23	Back on Balance Sheet	Reuters 6/17/08
Axon Financial Funding Ltd.	Axon Asset Management Inc.	March 30, 2007	11,193.76	S&P cuts rating to default	Reuters 6/17/08
Rhinebridge PLC	IKB Credit Asset Management GmbH	April 13, 2007	2,199.63	Defaulted Oct. 07	Reuters 6/17/08
Asscher Finance Ltd.	HSBC Bank PLC	May 11, 2007	7,330.00	Back on Balance Sheet	Reuters 6/17/08
Total			$274,896.99		
*As of July 13, 2007, S&P.					

Endnotes

[1]My use of the phrase "no trade theorem" is an abuse of its original meaning. The "no trade theorem" is the theoretical result that in most circumstances it is not possible for an agent with superior information to profit from trading on that information. See Grossman and Stiglitz (1980) and Milgrom and Stokey (1982). Here, I mean to imply that counterparties assumed their trading partners were better informed and hence refused to trade. "Every banker knows that if he has to prove that he is worthy of credit, however good may be his arguments, in fact his credit is gone." Walter Bagehot, Lombard Street (1873, chapter II, paragraph II): *http://www.econlib.org/Library/Bagehot/bagLom.html.*

[2]See Gorton (1984, 1985, 1988) and Gorton and Mullineaux (1987) for discussion of the clearinghouses issue of their own emergency currency. Gorton and Huang (2006) provide a theory.

[3]I have described these changes in banking, with various coauthors, including the rise of loan sales and securitization, the use of derivatives, and the regulatory implications of a declining bank charter values. See Gorton and Pennacchi (1989, 1995), Gorton and Souleles (2006), Gorton and Rosen (1995), Gorton (1994).

[4]See Gorton (1988), Gorton and Mullineaux (1987), Calomiris and Gorton (1991), and Gorton and Huang (2006).

[5]The details are also important in the study of historical panics generally. Little work has been done. Exceptions include, for example, Kelley and Ó Gráda (2000) and Ó Gráda and White (2003). Ó Gráda and White (2003) conclude: "The outcome is partly at variance with the stylized facts of the theoretical literature on banking panics. Banking panics were not characterized by an immediate mass panic of depositors…" (p. 238). Other examples of empirical work include Calomiris and Schweikart (1991), Moen and Tallman (1992), Calomiris and Mason (1997), Richardson (2005), and Richardson and Troost (2005).

[6]I do not address the issue of bubbles in this paper. Although I have written about bubbles (see Allen and Gorton, 1993), I don't think we really understand how they start, or are sustained, or why they end. In any case, others are more capable than I on this topic. See, e.g., Shiller (2007) and Case and Shiller (2003).

[7]As Andrew argued a century ago: "The unique dimensions of the recent panic among the experiences of the present generation render important the preservation for future study of all records concerning its phenomena" (1908A, p. 291).

[8]See *Inside Mortgage Finance, The 2007 Mortgage Market Statistical Annual*, Key Data (2006), Joint Economic Committee (October 2007).

[9]See Gorton and Souleles (2006) for a discussion of off-balance sheet vehicles and the implicit contracting between investors and vehicle sponsors.

[10]Andrews (1908A), speaking of the Panic of 1907: "As there was no common market for money, there were no regular quotations …" (p. 292).

[11]A survey of the Panic is provided by the Bank of England (2008). Appendix A of this paper provides a chronology of events.

[12]By "breakdown" I mean that the arbitrage relations between the ABX indices and the underlying cash bonds broke down, as described in Gorton (2008).

[13]In fact, the first subprime crisis occurred in 1998 when a number of subprime originators failed. See Temkin et al. (2002) and Moody's (October 1998). This first crisis did not result in a systemic problem emanating from subprime mortgages, though it was part of the larger Asian and Long Term Capital Management (LTCM) crises.

[14]On automated credit evaluation and other technological change in mortgage underwriting see LaCour-Little (2000); Straka (2000); and Gates, Perry, and Zorn (2002).

[15]Smith (1998) is a Bank of America national manager of community lending, who was interviewed for the Listokin, et al. study. The citations in the quotations are to that interview.

[16]Raiter and Parisi (2004) find a significant, nonlinear relationship between FICO scores and coupon differentials: "We find that risk-based pricing has become more rational since 1998. The data show a trend towards greater differentiation in mortgage coupons over time" (p. 1).

[17]Some borrowers in the subprime market may have been "prime" borrowers but without documented income, for example.

[18]FICO is a credit score developed by Fair Isaac & Company (*http://www.fairisaac.com/fic/en*). FICO scores range from 300 to 850. The higher the score, the better the chances of repayment of a loan.

[19]The difference between the original balance and the current balance is the amount that has defaulted or has prepaid. The factor is the percentage remaining (current balance divided by original balance). The factor varies from 65.8 percent to 90.5 percent, reflecting differing speeds of prepayment.

[20]There are other types of subprime loans, such as hybrid interest-only, 40-year hybrid ARMs, and piggyback second liens. These types are less important quantitatively.

[21]There is also an option to delay payment, in which case the mortgage becomes delinquent.

[22]The probability of default is also a function of other factors, but I do not include other variables, to ease notation.

[23]To ease notation, I will omit the prepayment penalty.

[24]There is no hard evidence on this that I know of, but casually, this seems to be the case. The initial bank may have an information advantage over competitors. Gross and Souleles (2002), for example, show the additional explanatory power of bank internal information, over publicly available information like FICO scores, in predicting consumer defaults in credit card accounts. Other evidence concerns the originating bank waiving prepayment fees. For example: "Some lenders may waive the prepayment penalty if you refinance your loan with them and you have held the mortgage for at least one year." Pena Lending Group, see *http://www.penalending.com/cash-out_refinance.html*. Or: Mark Ross, president and CEO of Tucson lender Prime Capital Inc.: Prepayment penalties are most often found on subprime loans made to buyers with less-than-perfect credit histories, Ross said. However, some lenders may be willing to waive prepayment penalties to let borrowers refinance, Ross said. See *http://www.azstarnet.com/business/226559*. However, if a loan is securitized, then the prepayment fee cannot be waived because there is a claimant on that cash flow stream in the RMBS.

[25]As far as I know, there is no data set which tracks this. LoanPerformance, the mortgage data set for securitized mortgages, is careful not to allow individual lenders to be identified.

[26]Updated estimates provided by Jim Kennedy of the mortgage system presented in "Estimates of Home Mortgage Originations, Repayments, and Debt On One-to-Four-Family Residences," Alan Greenspan and James Kennedy, Federal Reserve Board FEDS working paper no. 2005-41.

[27]Their data set does not allow them to determine how much was extracted.

[28]An interesting question is whether house price increases in some parts of the country were in part caused by the granting of mortgages. Mayer and Pence (2008) is relevant here.

[29]Gorton and Souleles (2006) describe the mechanics of securitization.

[30]A REMIC (Real Estate Mortgage Investment Conduit), shown in the charts, is an investment vehicle, a legal structure that can hold commercial and residential mortgages in trust, and issue securities representing undivided interests in these mortgages. A REMIC can be a corporation, trust, association, or partnership. REMICs were authorized under the Tax Reform Act of 1986.

[31]This is true of securitization generally; see Gorton and Souleles (2007).

[32]Two other features are: (1) the clean-up call and (2) compensating interest. (1) The clean-up call gives the owner of the call, generally the residual owner, the option to purchase the remaining bonds in a deal at a predetermined price, when the collateral factor reaches a certain level, i.e., when the deal has amortized down to a sufficiently low level. Normally, the call is to purchase the bonds at par plus accrued interest, when the factor is at or below 10 percent. (2) The day that

a borrower prepays his loan, interest payments on that loan stop. The mortgage servicer, in a non-agency deal, is normally required to compensate investors for this foregone interest, using funds paid to the service as fees.

[33]Delinquency triggers are classified as either "soft" or "hard." The trigger is hit if serious delinquencies, defined as 60+ days, foreclosure, and REO, are at or exceed certain limits. With a soft trigger, the delinquency limit is defined relative to the current amount of senior credit enhancement: the balance of the mezz and subordinate classes, plus OC, expressed as a percentage of the balance of the collateral, e.g., serious delinquencies exceed 50 percent of the senior credit enhancement). With a hard trigger, the delinquency limit is defined as a specific percentage of the current collateral balance, e.g., if serious delinquencies exceed 12 percent of the current balance.

[34]See the prospectus: *http://www.secinfo.com/d12atd.z3e6.htm#1stPage*.

[35]The weighted average rating factor refers to a weighted average rating where ratings have been converted to numbers by a rating agency (in such a way that the ratings are not equidistant apart). Similarly, "correlation factors" refers to rating agency stated correlation assumptions. The details do not concern us here.

[36]During the panic, this will be problematic, as the senior investors may choose to liquidate even though they know that the prices are fire sale prices, and their sale will push prices down further, causing another round of marking down—as discussed later.

[37]See Moody's, "Impact of Subprime Downgrades on OC-linked Events of Default in CDOs," Special Report, November 1, 2007.

[38]As of January 10, 2008, about $58 billion worth of CDOs have hit "events of default" (EOD) (see *Financial Times*, January 10, 2008). Moody's reported on January 7, 2008, that "more than 50 structured CDOs ('ABS CDOs') have experienced an Event of Default ('EOD') …" (see Moody's, "Understanding the Consequences of ABS CDO Events of Default Triggered by Loss of Overcollateralization," Special Report, January 7, 2008).

[39]When investors indicate an interest in investing in a CDO, and even when they invest, the CDO is not completely "ramped up," that is, all the ABS bonds for the portfolio have not been purchased yet. Investment will be made based on the criteria restricting the portfolio's composition.

[40]I recognize that this is a causal observation. Though I believe this view is widely held by traders, I know of no formal documentation of this.

[41]Gorton (2008) discusses negative basis trades in more detail.

[42]We do know that these were a source of write-downs for banks. For example, UBS (2008): "Negative Basis Super Seniors: these were Super Senior positions where the risk of loss was hedged through so-called Negative Basis (or "NegBasis")

trades where a counterparty, such as a monoline insurer, provided 100% loss protection. The hedge resulted in a credit exposure towards the protection seller. As of the end of 2007, write-downs on these positions represented approximately 10% of the total Super Senior losses" (p. 14).

[43]The difference between total issuance and structured finance issuance would be other categories such as investment–grade loans, high-yield loans, investment-grade bonds, high–yield bonds, etc.

[44]Synthetic CDOs are not included in the table.

[45]The residual category, which has been excluded, consists of market value CDOs. Fully synthetic CDOs are not included.

[46]See *http://www.markit.com/information/products/abx.html.*

[47]The rule also restricts the credit quality of the securities that a money market fund may purchase.

[48]There was a maximum of 30 SIVs that existed, of which 21 were run by 10 banks, including Citigroup, Dresdner, and Bank of Montreal. The approximate size of the SIV sector at its peak was $400 billion in November 2007, having grown from $200 billion three years earlier. See S&P, transcript of teleconference, "Update on U.S. Subprime and Related Matters," November 1, 2007, *http://www2.standardandpoors.com/spf/pdf/media/teleconference_transcript_110107.pdf.*

[49]There were market value CDOs, but they died out.

[50]The example is simplified with only one mortgage in the subprime RMBS, and only one RMBS tranche in the CDO. This ignores a number of important issues in practice, which need not concern us here.

[51]The example does not display the "cliff" risk that can occur when the CDO contains many tranches of various ABS, RMBS, and CMBS bonds. "Cliff" risk refers to the phenomenon of a tranche being wiped out quickly once losses reach it.

[52]Though note that the investor in a CDO tranche would know the underlying ABS, RMBS, and CMBS bonds, but would not know the underlying portfolios of those instruments.

[53]When I say "value" I usually mean to compute an expected loss or expected payoff using historical information. "Marking-to-market" is another matter, briefly discussed later.

[54]Leo Tolstoy, *Anna Karenina*, "Happy families are all alike; every unhappy family is unhappy in its own way."

[55]The calculation is the percentage change in the seasonally adjusted OFHEO repeat-sales house price index for purchase transactions only between the fourth quarters of 2000 and 2005. See *www.ofheo.gov/HPLasp*.

[56]There are two indices that measure house price appreciation, S&P/Case-Shiller and the OFHEO House Price Index. Both of these indices are based on repeat sales. The two indices differ in important respects. Case-Shiller does not cover the entire U.S., and the omitted areas seem to be doing better than the included areas. Case-Shiller omits 13 states altogether and has incomplete coverage of 29 other states (see Leventis, 2007). The OFHEO index is not value-weighted and only includes homes with conforming mortgages.

[57]The United States has not experienced a large, nationwide decline in house prices since the Great Depression of the 1930s. In 1940 the median nonfarm housing value was 48.6 percent below the 1930 median value (based on the 1940 Housing Census). Over the same decade, the Consumer Price Index had fallen 17.4 percent and food prices had fallen 27 percent. In other words, even adjusting for the deflation during the period, housing prices had not recovered to the levels at the beginning of the Depression by 1940. See Fishback, Horrace, and Kantor (2001).

[58]The trustees for transactions make monthly reports known as remittance reports. Remittance reports detail scheduled and unscheduled remittances of principal, servicer advances, loan repurchases, realized losses, delinquencies, and so on.

[59]PAUG is a form of settlement used in asset-backed CDS. It allows two-way payments between the protection buyer and protection seller during the life of the contract. If the reference obligation is affected by interest shortfalls or principal write-downs, the protection buyer compensates the protection seller. These amounts are paid back to the protection buyer if the interest shortfalls or principal writedowns are reversed. The protection buyer has the option of physically settling the CDS if there is a principal write-down.

[60]This is related to some ideas of Grossman (1988) about the 1987 stock market crash. Grossman argues that portfolio insurance, in synthetically creating a put option, does not reveal to market participants the amount of such puts outstanding, something that would be known if actual put options were traded.

[61]The initial coupons for the BBB- and AAA tranches are shown below:

ABX-HE BBB -	Coupon (bps)
2006-1	267
2006-2	242
2007-1	389
2007-2	500
ABX-HE AAA	
2006-1	18
2006-2	11
2007-1	9
2007-2	76

Source: Markit

[62]"… as the ABX has widened and gone down in price, on some bad fundamental news, we've gotten quite a nice mark to market benefit on that move," Ralph Cioffi, manager of the Bear Stearns hedge funds that subsequently were liquidated; Bear Stearns Investor Conference Call, April 25, 2007.

[63]The "super SIV" was the Master-Liquidity Enhancement Conduit (M-LEC), which was an attempt to create the incentive-compatible structure of a 19th century clearinghouse, but failed. See *The Economist*, October 18, 2007, "Curing SIV," *http://www.economist.com/displaystory.cfm?story_id=9993423*.

[64]For background on repurchase agreements (repo), see Bank for International Settlements (1999).

[65]See Mishkin (February 15, 2008) and Taylor and Williams (2008A, B). Libor stands for "London interbank offered rate." It is the most widely used benchmark for short-term interest rates in major currencies worldwide. Libor is compiled, for ten currencies over a range of maturities from overnight to twelve months, by the British Bankers' Association (BBA) and is published daily between 11:00 a.m. and 12 noon London time. Libor rates are averages of interbank rates submitted by a panel of banks. For each currency, panels comprise at least eight contributor banks. Sterling, dollar, euro, and yen panels contain sixteen banks. See *http://www.bba.org.uk/bba/jsp/polopoly.jsp?d=141*. OISs are interest rate swaps in which the floating leg is linked to a published index of daily overnight rates. The two parties agree to exchange at maturity, on an agreed notional amount, the difference between interest accrued at the agreed fixed rate and interest accrued through the geometric average of the floating index rate.

[66]The question of what the spread represents is addressed by Taylor and Williams (2008A, B) and Michaud and Upper (2008). I do not pursue this here.

[67]In fact, there is a general question concerning double-entry bookkeeping as a paradigm in a world of derivatives.

[68]I know of no direct evidence on either of these issues.

[69]Many banks had implemented it earlier, in anticipation of the rule coming into effect.

[70]Statement 157 defines "fair value" as: "The price that would be received to sell an asset or paid to transfer a liability in an orderly transaction between market participants at the measurement date." See Statement of Financial Standards No. 157 *http://www.fasb.org/pdf/fas157.pdf*.

[71]See Gorton, He, and Huang (2008) and Plantin, Sapra, and Shin (2006) for discussions.

[72]Haldeman (2007) provides background, dating back to Enron.

[73]See Committee of European Banking Supervisors (2008) and Bond Market Association and the American Securitization Forum (2006) for descriptions of the marking process and the data inputs.

[74]Obviously, this would not occur if there was another side to this market. But, investors are the very agents facing asymmetric information.

[75]On trends in the use of collateral, also see BIS (2001).

[76]See *http://www.sec.gov/Archives/edgardata/1174735/000119312507138443/dsc14d9.htm#rom81455_10*.

[77]CSAs are used in documenting collateral arrangements between two parties that trade privately negotiated (over-the-counter) derivative securities. The trade is documented under a standard contract called a master agreement, developed by the International Swaps and Derivatives Association (ISDA). The two parties must sign the ISDA master agreement and execute a credit support annex before they trade derivatives with each other. See, also, ISDA "2005 ISDA Collateral Guidelines," *http://www.isda.org/publications/pdf/2005isdacollateralguidelines.pdf*.

[78]Keep in mind that long credit derivative positions cannot be delivered to the discount window.

[79]In triparty repo, a custodian bank or clearing organization acts as an intermediary between the two repo parties. There is no data that I know of that quantifies the amount of bilateral repo.

[80]Private communication from a repo trader.

[81]See, e.g., Bernanke (2008); Wellink (2007), President of the Netherlands Bank and Chairman of the Basel Committee on Banking Supervision; Knight (2008), General Manager of the BIS; Gieve (2008), Deputy Governor of the Bank of England.

[82]See, e.g., Gorton (1988); Berger, Kashyap, and Scalise (1995); and Boyd and Gertler (1994) for some discussion of these trends.

[83]See Benveniste, Singh, and Wilhelm (1993) for a description of this competition.

[84]For the sake of space I do not review these developments.

[85]Eighty subprime mortgage lenders have exited the business since the end of 2006—many going bankrupt (see Worth Civils and Mark Gongloff, "Subprime Shakeout," *Wall Street Journal* online, *http://online.wsj.com/public/resources/documents/info-subprimeloans0706-sort.html*.

[86]Mortgage servicing rights may also be securitized.

[87]Note that losses can exceed exposures due to the timing of the numbers. Net losses are for the year ending December 28, while net exposure is for December 29.

[88]In addition, the sponsors hold the residuals of the securitizations.

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