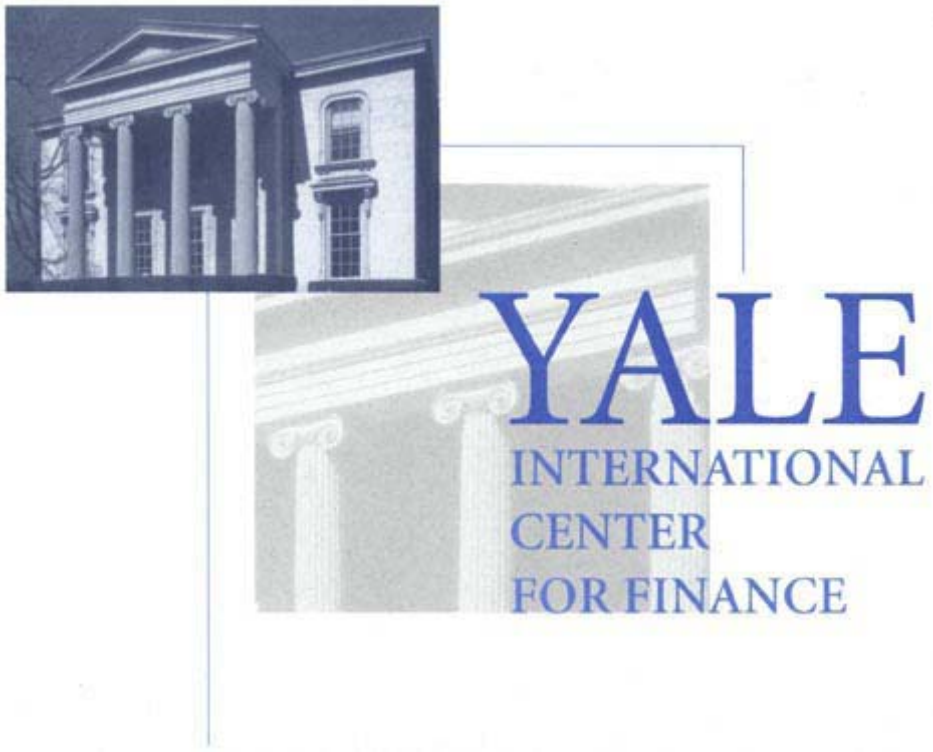

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The Subprime Panic+

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Abstract

Understanding the ongoing credit crisis or panic requires understanding the designs of a number of interlinked securities, special purpose vehicles, and derivatives, all related to subprime mortgages. I describe the relevant securities, derivatives, and vehicles to show: (1) how the chain of interlinked securities was sensitive to house prices; (2) how asymmetric information was created via complexity; (3) how the risk was spread in an opaque way; and (4) how trade in the ABX indices (linked to subprime bonds) allowed information to be aggregated and revealed. These details are at the heart of the origin of the Panic of 2007. The events of the panic are described.

[+] This paper is a much shorter, somewhat revised, version of a paper entitled "The Panic of 2007," which was prepared for the Proceedings of a Symposium on "Maintaining Stability in a Changing Financial System," Federal Reserve Bank of Kansas City, Jackson Hole Conference, August 2008. See http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1255362 . For comments, suggestions, and assistance with data and examples on the Jackson Hole paper, I thank 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.

1. Introduction

Subprime mortgages are a financial innovation designed to provide home ownership opportunities to riskier borrowers in the U.S. Such borrowers are indeed riskier (also poor and disproportionately minority), and lending to this group involved a particular mortgage design feature, that resulted in linking the outcome to house price appreciation. Subprime mortgages were then financed via securitization, which in turn has a unique design, reflecting the subprime mortgage design. Subprime securitization tranches were then often sold into CDOs. Tranches of CDOs were, in turn, often purchased by market value off-balance sheet vehicles, and money market mutual funds. Additional subprime risk was created (though not on net) with derivatives. This nexus of off-balance sheet vehicles, derivatives, securitization, and, in addition, the growth of the repo (repurchase agreement) market constitute what has come to be known as the "shadow banking system." When the U.S. housing prices did not rise as expected, this chain of securities, derivatives, and off-balance sheet vehicles could not be penetrated by most investors or counterparties in the financial system to determine the location and size of the risks. Faced with this lack of information, financial intermediaries refused to deal with each other and began to hoard cash. The panic began.

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.

At the root of the information story are the details of the chain of securities and vehicles through which the risk was distributed. In this paper I describe the relevant securities, derivatives, and vehicles and to show: (1) how the chain of interlinked securities was sensitive to house prices; (2) how asymmetric information was created via complexity; (3) how the risk was spread in an opaque way; and (4) how the ABX indices allowed information to be aggregated and revealed. I argue that these details are at the heart of the answer to the question of the origin of the Panic of 2007.

The panic poses challenges for economists as well as regulators and policymakers. None of the various layers of intertwined securities, off-balance sheet vehicles (and their liabilities), or derivatives are traded in markets that resemble those that economists tend to focus on, namely, the secondary market for equities. Nor does the banking system that I will describe look very much like what is taught in courses on "banking." Further, there is some empirical work on crises, but little if it weighted by the importance of the event. (I mention some of this work later.) The panic should be a momentous event for economic research.

Section 2 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 3. That is not the end of the story, because tranches of subprime residential mortgage-backed securities (RMBS) were often sold to

collateralized debt obligations (CDOs). Section 4 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 5 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 6 I briefly discuss the "originate-to-distribute" hypothesis. Some final discussion is contained in Section 7. A final section, Section 8, discusses the U.S. Treasury Secretary's proposed plan for addressing the crisis, as of this writing (September 28, 2008).

2. Subprime Mortgages

In this section 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. Then I discuss the design of subprime mortgages. The key point is to see how the design linked the mortgages to house prices through an implicit option to rollover the loan held by the lender.

A. Subprime and Alt-A Mortgages

Home ownership for low income and minority households has been a long-standing national goal in the U.S. Subprime mortgages were an innovation aimed at meeting this goal — and at making money for the innovators.[1] The main issue to be confronted in providing mortgage finance for this unserved population is clearly that these borrowers are riskier. They have the following problems: (1) insufficient funds for a down payment on the house; (2) credit issues, either no credit history or prior problems repaying debts; (3) an inability to document income; (4) a lack of information or erroneous information. 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. See Listokin et al. (2000).

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. As shown in Table 1 below, 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.[2]

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

[2] 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 FICO score the better the chance of loan repayment.

Table 1: Market Description of Mortgage 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%

Whatever the definition, the innovation was a successful, at least for a significant period of time. Tables 2 and 3 below, 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 outstanding amounts of Subprime and Alt-A combined amounted to about one quarter of the $6 trillion mortgage market in 2005-2007Q1. Over the period 2000-2007, the outstanding amount of agency mortgages doubled, but subprime grew 800 percent! Issuance in 2005 and 2006 of Subprime and Alt-A mortgages was almost 30 percent of the mortgage market. Since 2000 the Subprime and Alt-A segments of the market grew at the expense of the Agency (i.e., the government sponsored entities of Fannie Mae and Freddie Mac) share, which fell from almost 80% (by outstanding or issuance) to about half by issuance and 67 percent by outstanding amount.

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, Loan Performance, 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

B. 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 (implicitly, as discussed below) 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. The lender's option to rollover the mortgage after an initial period is implicit in the subprime mortgage contract.

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 time for which their initial 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.[3]

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). As an example, on a 2/28 mortgage originated in 2006, the initial interest rate might have been 8.64%. After the initial period comes the rate "reset" (or step-up date) which is when the rate becomes floating and higher; it resets to, say, LIBOR plus 6.22%. At the time of origination, LIBOR could have been 5.4%. So, the new interest rate at the reset would have been

[3] 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.

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 "life time cap". The reset rate is significantly higher, but potentially affordable, though burdensome.

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 two percent of prime mortgages have prepayment penalties (see Zigas, Parry, and Weech (2002)).

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. Implicitly, the lender has a "roll over" option at the end of the teaser period.

The refinancing option for the lender is very important, and distinguishes this mortgage from the usual mortgage. 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.[4] In that case, the original lender can benefit from any home price appreciation.

It may be that the expected profit to the lender from the loan during the teaser period is negative. But, the overall subprime mortgage, including the possible second period refinancing, may be expected to be profitable if the probability of a house price increase is perceived to be sufficiently high. This happens if the borrower is tied to the original lender for refinancing. In fact, the first period mortgage rate, may be set low (relative to the risk of loss due to default), as a teaser rate, and still the overall loan may have a positive expected value if the probability of a house price increase 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

[4] 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.

house prices rise, each time building up equity and obtaining increasingly lower interest rates. 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.

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 (2008). In other words, the bulk of the "originations" in the subprime market were refinancings of existing mortgages.

3. The Design and Complexity of Subprime RMBS Bonds

The main financing method for subprime originators was securitization. Table 4 shows the extent to which subprime lenders relied on securitization for the financing of the mortgages. Note the quantitative importance of subprime securitizations. The table shows that subprime mortgage originations. Note that in 2005 and 2006 originations were about $1.2 trillion of which 80 percent was securitized.

Table 4: 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).

A. The Design of Subprime Residential Mortgage-Backed Securities (Subprime RMBS)

Securitization of subprime mortgages also required a unique security design, quite different from traditional securitizations.[5] Essentially, because the underlying mortgages are expected to refinance after two or three years, the securitization transaction will receive large amounts of cash early. This cash will be allocated in various ways within the securitization transaction, as detailed below. The credit enhancement for, and the size of, the tranches (and hence the degree of subordination) will depend on the incoming cash over time. The dynamics of this make the risk inherent in the securitization of subprime

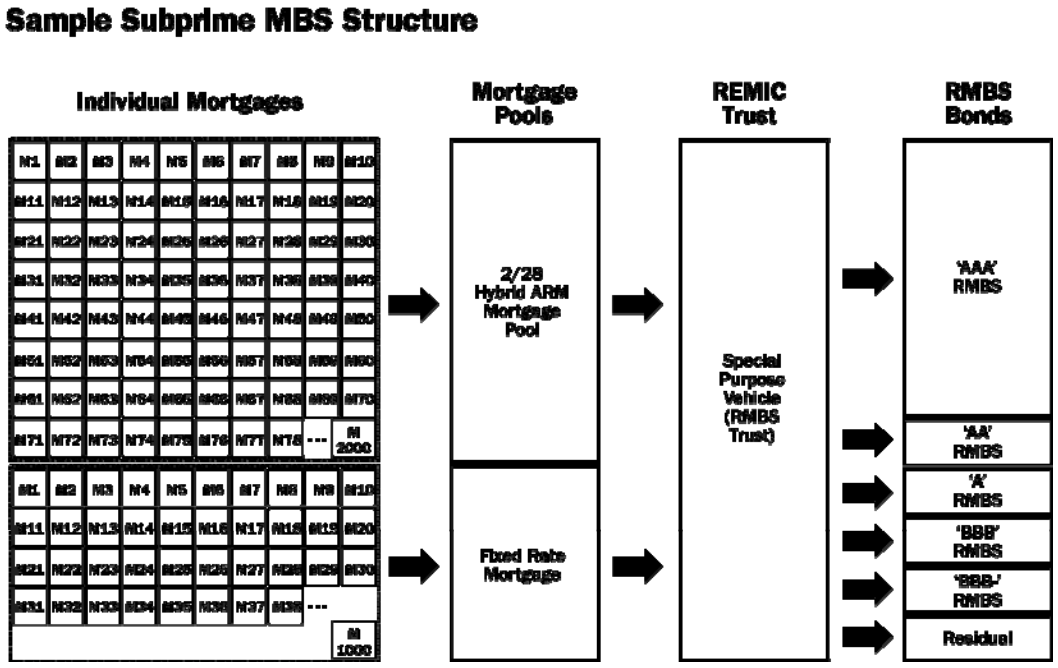
[5] Gorton and Souleles (2006) describe the mechanics of securitization.

mortgages dependent on the refinancing of the mortgages, which in turn depends on house prices. This is very briefly detailed below. Gorton (2008a) contains examples of specific transactions.

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 credit enhancement dynamic and dependent on the cash flows coming into the deal.

The credit risk of the underlying mortgages is one important factor to understand in assessing the relative value of a particular subprime RMBS. Figure 1 shows the basic structure of a subprime RMBS transaction.[6]

Figure 1



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

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

[6] A REMIC (Real Estate Mortgage Investment Conduit), shown in the figures, 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.

- 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. Over-collateralization 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 securitization deal from the underlying mortgages minus the spread paid out on the RMBS bonds issued by the deal.[7] 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.)

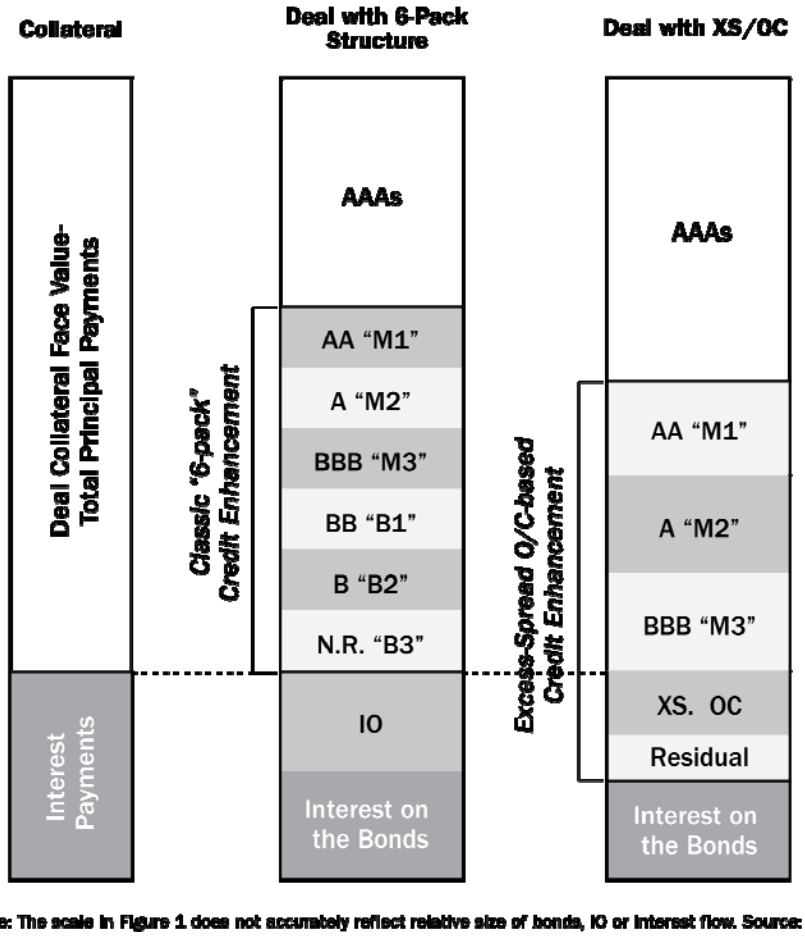
In a prime deal with a senior/sub structure, basically the total amount of credit enhancement that will ever be present is in place at the start of the deal. The tranche sizes are fixed. In this setting, assuming that defaults and losses are bunched near the start of the deal is conservative, as this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

The figure below displays the two types of transaction structures: senior/sub structure and the OC structure.

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

Figure 2: Senior/Sub 6-Pack Structure vs. the XS/OC Structure



Source: UBS.

These transactions are quite complicated, so as a prelude to very briefly 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 overview only.

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 300-400 basis points.

There is no over-collateralization 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), 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.

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 10 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% 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.

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:

- **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% 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, Net Interest Margin securities (NIMs) can begin to

receive cashflows 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%). 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.[8] 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).

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, credit enhancement (CE) "steps down," if certain performance tests have been met. For example, if overcollateralization (OC) targets have been met, the CE steps down by repaying subordinate bonds holders. 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.

[8] 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.

"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 remaining excess interest goes to the holder of the residual bond, typically the originator of the mortgages.

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.

Subprime securitizations are very different from standard securitizations because the refinancing of the underlying subprime mortgages provides the securitization with a lot of cash, which can be used to build-up credit enhancement over time. It does this by storing cash in the securitization and by amortization, which builds up the lower-rated tranches' thickness over time. But, this dynamic credit enhancement depends on the subprime mortgages refinancing.

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 build-up, but this is not the main credit enhancement. See Gorton and Souleles (2007) for a description of standard securitization. But, subprime securitizations are very different story. They are not at all like standard securitization transactions. In particular, the difference illustrates how the lender's "rollover 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.

4. Collateralized Debt Obligations (CDOs)

The next link in the chain is collateralized debt obligations (CDOs), special purpose vehicles 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 (asset-backed securities, including mortgage-backed securities) 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 issue and look at the question of how much subprime RMBS went into CDOs. Subsection C looks at synthetic subprime risk. Subsection D 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.

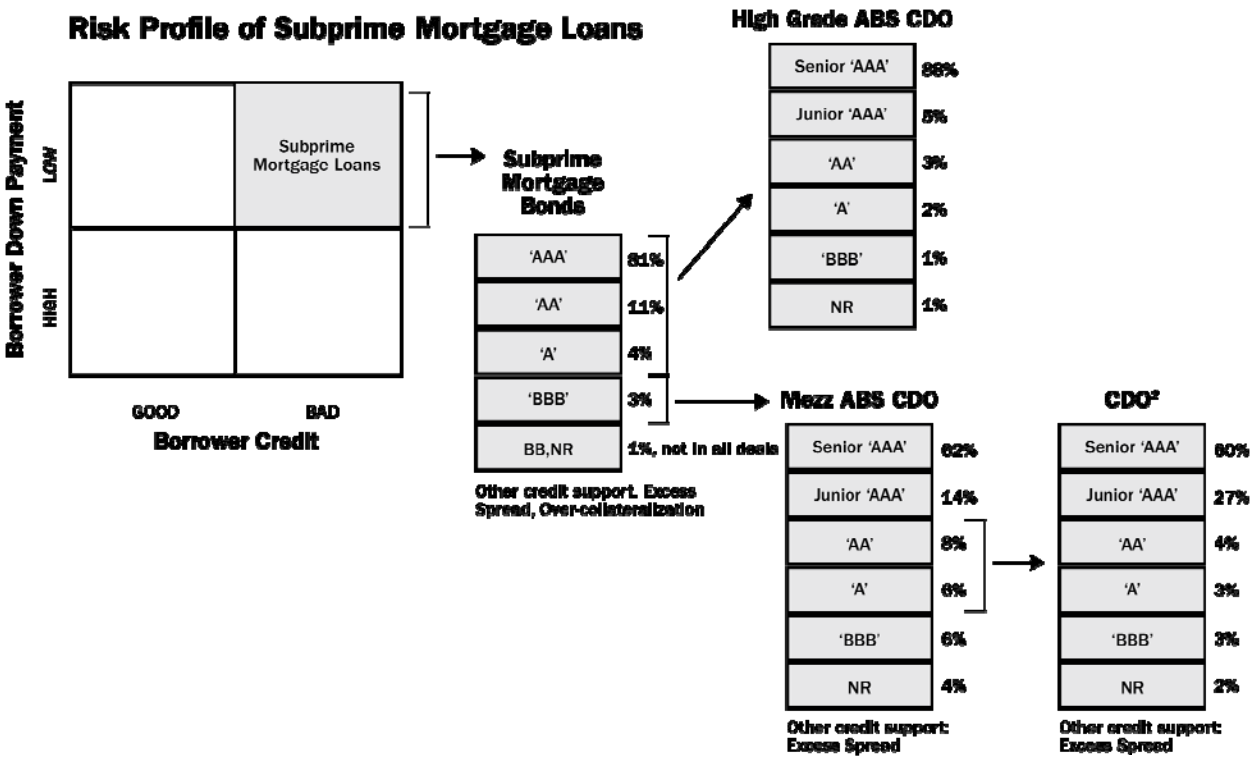
A. The Design of CDOs

A cash CDO is a special purpose vehicle, 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 asset-backed securities (ABS), including residential mortgage-backed securities (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 Figure 2 below. To the left of the figure 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 figure, 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."

Figure 2



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

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 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, Correlation Factors, weighted average weighting factor, numbers of obligors, etc.[9]

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 in new assets, and cause amortization to be sequential, if the tests are not met. 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 in the panic when investors attempt a valuation of CDO tranches.[10]

Why would CDOs buy subprime RMBS bonds? 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, 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.[11] CDO portfolios increasingly were dominated by subprime, suggesting that the market was pricing this risk inconsistently with the ratings.

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 credit default swap (CDS). From the bank's viewpoint, this is the

[9] The weighted average weighting 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.

[10] 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.

[11] 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.

simultaneous purchase and sale of a CDO security, which meant (for awhile) 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 15bps in costs for protection, for a 10 bps profit.[12]

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.[13]

B. CDO Issuance

The next table below, Table 5, 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 (for Asset-Backed Securities); 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.[14] 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 credit default swaps (CDS) rather than purchase cash assets.[15] 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 writedowns of the issued notes. Note that Synthetic Funded CDOs would be the location of synthetic subprime risk in the form of credit protection written on a subprime index (the ABX index).[16]

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

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

[13] We do know that these were a source of writedowns 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, writedowns on these positions represented approximately 10% of the total Super Senior losses" (p. 14).

[14] 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.

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

[16] The residual category, which has been excluded, consists of Market Value CDOs. Fully synthetic CDOs are not included.

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.

Table 5: Global CDO Issuance ($ millions)

	Total Issuance	Structured Finance	Cash Flow and Hybrid	Synthetic Funded	Arbitrage	Balance Sheet
2004	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	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	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	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

Issuance of ABS CDOs roughly tripled over the period 2005–07 and ABS CDO portfolios became increasingly concentrated in U.S. subprime RMBS. Table 6 provides estimates of the typical collateral composition of high grade and mezzanine ABS CDOs.

Table 6: 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).

As the volumes of origination in the subprime mortgage market increased, subprime RMBS increased, and so did CDO issuance, as shown in Table 7.

Table 7: 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.

How pervasive is subprime collateral in ABS CDOs? By looking through the CDO portfolios for a sample of CDOs, 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 below in Table 8.

Table 8: 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

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

C. 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 20 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 sub-index references 20 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.[17]

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

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 9 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 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.

Table 9: 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).

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

D. 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. Investors in the AAA CDO tranche risk (synthetic, if not cash) include bond insurers, insurance companies, and others, 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.

One significant category of investors consisted of certain kinds of off-balance sheet vehicles, known as structured investment vehicles (SIVs), asset-backed commercial paper conduits, 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 asset-backed commercial paper (ABCP). ABCP typically comprises around 20% of the total liabilities for the biggest SIVs.[18] 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%–90%), are typically more highly leveraged, and seem to have invested almost exclusively in US RMBS. As a consequence, several SIV-lites have restructured their liabilities following the recent turmoil in US mortgage markets. Unlike conduits that issue only ABCP, SIVs and SIV-lites tend not to have committed liquidity lines from banks that cover 100% 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 special purpose vehicles (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-&) puts (as discussed above), but also sometimes invested in SIVs.[19] Later, these money market mutual funds had to be bailed out by their sponsors to keep them from "breaking the buck."

[18] 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 .

[19] CDO tranches were also bifurcated into the credit risk and the funding of the tranche via "negative basis trades." The risk is borne by the entity writing protection on the tranche via a credit derivative, and the tranche itself is funded by a different entity. See Gorton (2008a) for some details.

5. The Panic

What triggered the Panic of 2007? How did it develop?[20] 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 and the repo market — the panic itself. Finally, I try to summarize the information argument of the paper.

A. House Prices

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).[21] 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. The figure below 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.[22] 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% Y-o-Y) and Miami (-9.96% 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.[23]

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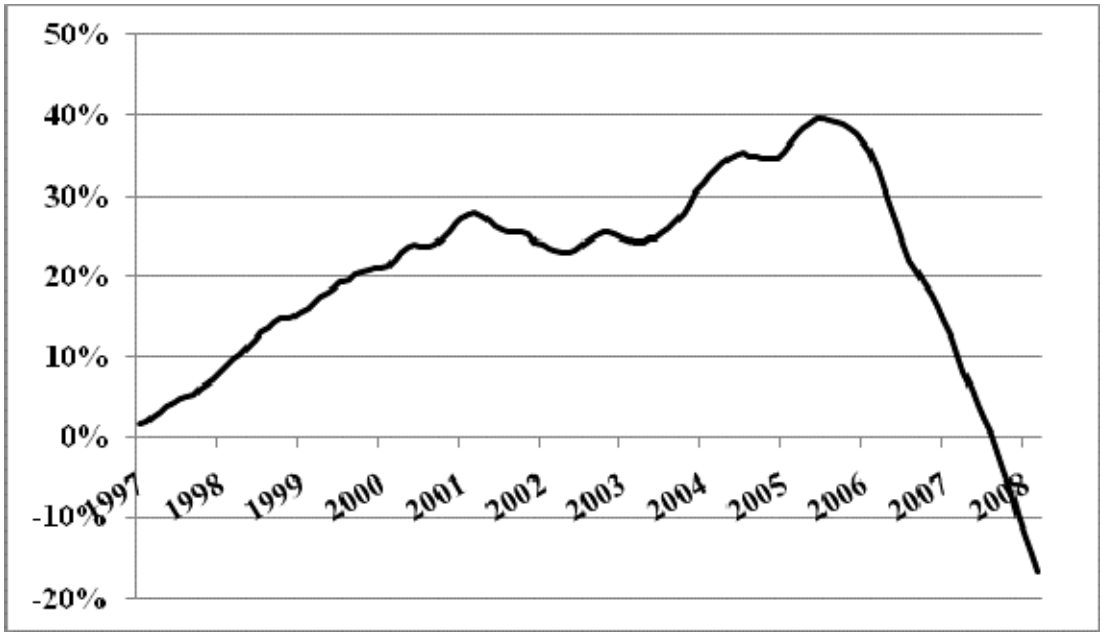
[20] Gorton (2008a) contains a chronology.

[21] 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 .

[22] 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.

[23] The United States has not experienced 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).

Figure 3: 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 appreciated 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 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.

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.

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 awhile.

In an important way this changed with the introduction of the ABX indices at the start of 2006. The introduction of these indices is important for two reasons. First, they provided a transparent price of subprime risk, albeit with subsequent liquidity problems (see Gorton (2008b)). 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.[24]

As with credit default swaps (CDS) generally, entering into an ABX index contract is analogous to buying or selling insurance on basket of the underlying 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.

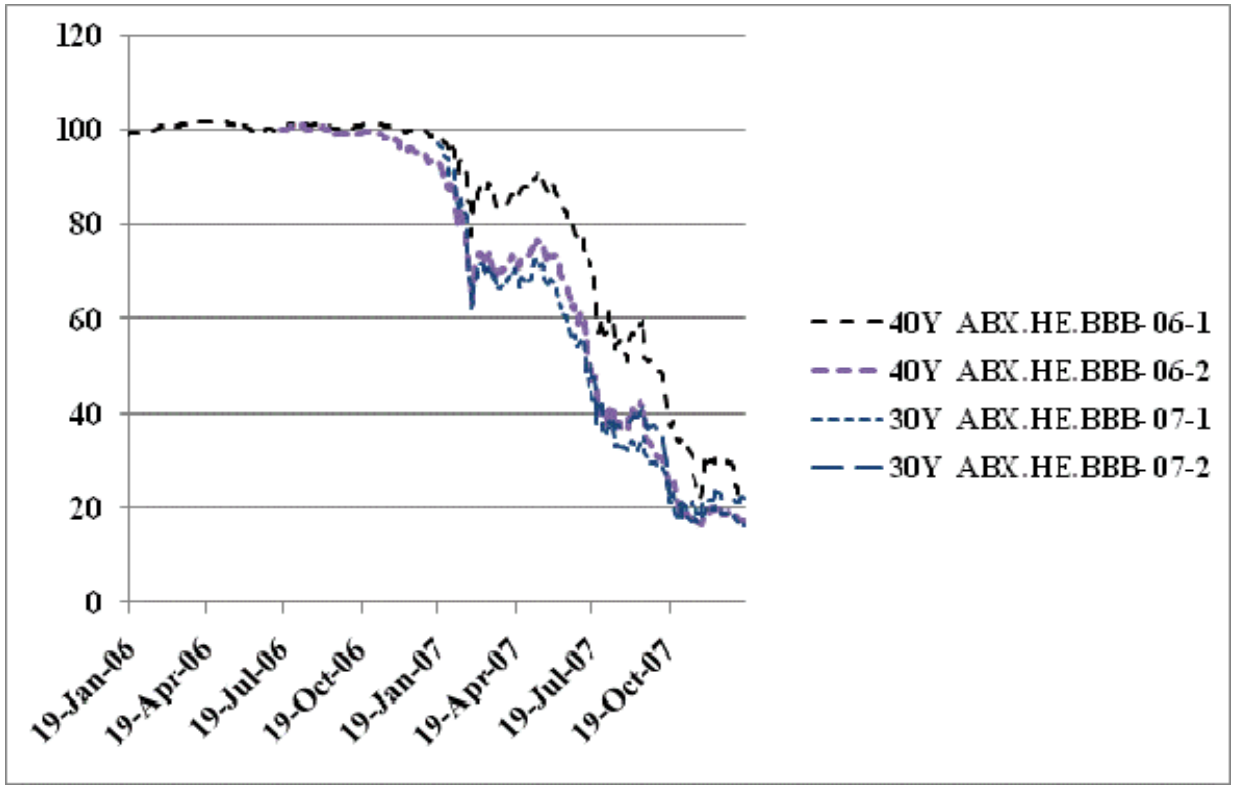
The ABX tranche coupon is determined on the initiation date. Subsequently, trades require an upfront exchange of premium/discount. In a typical transaction, a protection buyer pays the protection seller a fixed coupon at a monthly rate on an amount determined by the buyer. When a credit event occurs, 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 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. No new vintages were introduced after 2007. The graph below, Figure 4, 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.

[24] 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.

Figure 4: ABX BBB- Prices



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

The ABX indices also allow all parties, e.g., hedge funds, to express their views on the value of subprime RMBS bonds. 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. It seems that the indices played a central informational role.

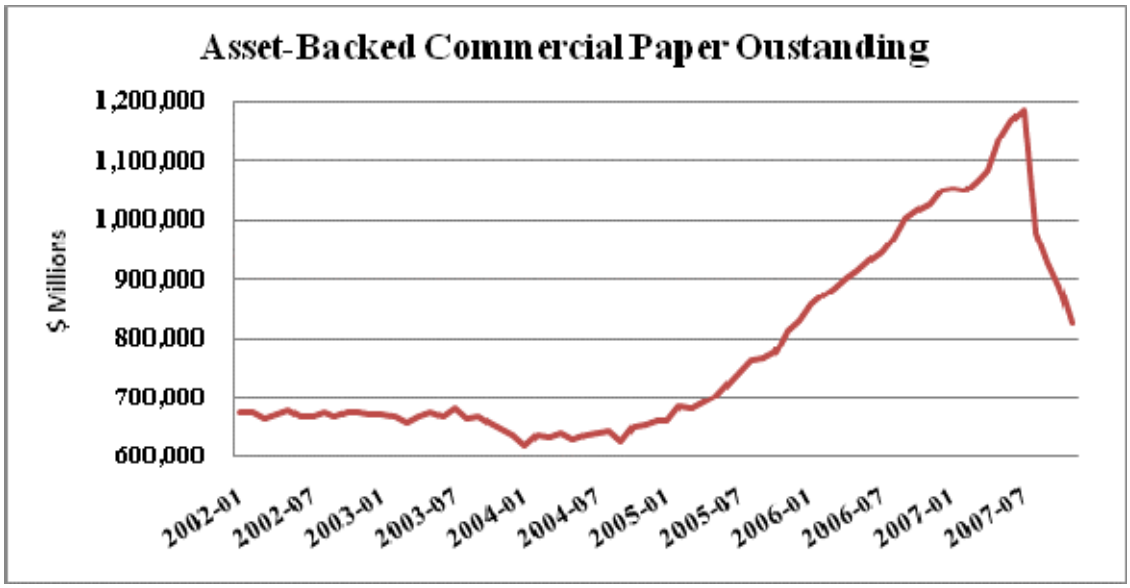
B. The Run on the SIVs

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 of Gorton (2008a).

As of December 2007, asset-backed commercial paper (ABCP) had declined by $404 billion from a peak of $1.2 trillion – a decline of about 34 percent. See Figure 5. 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.

Figure 5



Source: Federal Reserve.

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 (August 30, 2007) 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 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.

SIVs did not have significant exposure to subprime in aggregate. Home equity loans and subprime were 2.01%. CDOs of ABS amounted to 0.28%. Perhaps the problem was the exposure to the financial sector, 41.50%. The basic problem was that investors could not penetrate the portfolios far enough to make the determination. There was asymmetric information.

D. Panic in the Repo Market

The panic manifested itself in a scramble for cash, causing a basic form of lending, repurchase agreements (repo), to almost disappear.[25] 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)).[26] Tripartite repo is estimated to be about 15 – 20 percent of the repo market.[27] 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.

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

[26] In tripartite 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.

[27] Private communication from a repo trader.

The repo market almost completely 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 than 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.

E. Summary

In economics we usually 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 asset price aggregates the information. The panic is somewhat at odds with how financial economists think of security markets, which is largely in terms of 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.

In the current crisis there was a loss of information due to the complexity of the chain. 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.

"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. 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 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.

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 this.

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.

6. An Alternative Hypothesis and Incentives

Another 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 long 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 (February 29, 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.[28]

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.[29]

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 writedowns 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

[28] 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.

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

> 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.[30] 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 writedowns 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% to 3.5%.

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

[30] Mortgage servicing rights may also be securitized.

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 and table, below, 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…
>
> The following table 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 ….
>
> **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.

Note the sizes of "Warehouse Lending," "Residuals," and "Mortgage Servicing Rights," (the numbers are in millions of dollars). The losses are clearly significant.[31]

[31] 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.

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—and the sponsors of the deals.[32] Gorton and Souleles (2007) argue that there is an implicit contract between the sponsor and investors in the liabilities of the special purpose vehicles used for securitization. The implicit contract exists precisely to the 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).

7. Discussion

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 earlier panics, 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.[33] 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.

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

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

[33] 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).

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.[34]

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.[35] That is what I have tried to provide here, in the case of the Panic of 2007.

8. Final Note: The Current Situation and Ending the Crisis

How do banking panics come to an end? Some history is instructive. During the 19th century, in the United States, the solution to banking panics was the institution of the private bank clearinghouse, which evolved over the century to the point where banks' response to panics was fairly effective. In the face of the illiquidity of the banking system, the banks suspended convertibility and issued clearinghouse loan certificates. Clearinghouse loan certificates replaced individual bank liabilities with certificates which were the liabilities of the group of banks. 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 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 attacked the information problem directly. Depositors, now knowing which banks were insolvent, were insured against the failure of their individual bank by receiving a claim on the group of banks rather than their bank.

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[34] See Gorton (1988, 1985, 1984), Gorton and Mullineaux (1987), Calomiris and Gorton (1991), and Gorton and Huang (2006).

[35] 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 Gorton (1988), Calomiris and Gorton (1991), Calomiris and Schweikart (1991), Moen and Tallman (1992), Calomiris and Mason (1997), Richardson (2005) and Richardson and Troost (2005).

Since the advent of the Federal Reserve System in the United States in 1914, the government has played the key role in alleviating the asymmetric information and attendant illiquidity during panics. After the spectacular failure to do this during the Great Depression, deposit insurance was enacted and the U.S. experienced half a century of relative quiet in banking – until the savings and loan crisis of the mid-1980s. The Resolution Trust Corporation (RTC) was a U.S. government owned asset management company set up to liquidate the assets (primarily real estate-related assets, including mortgage loans) of insolvent savings and loan associations (S&Ls). Between 1989 and mid-1995 the RTC sold $394 billion of assets from 747 S&Ls. Before the RTC was created in 1989, the Federal Savings and Loan Insurance Corporation (FSLIC), the insurer of the thrift industry, closed or otherwise resolved 296 institutions with total assets of $125 billion. Overall, the S&L crisis required that $519 billion of assets be sold. But, the RTC was taking charge of the assets of failed institutions. The current crisis is largely about institutions that are still solvent, with of course some notable exceptions.

Since the S&L crisis there have been other panic-like crises in developed economies. The approach taken in Sweden is instructive in this regard. A key part of the Swedish bailout plan was to the stipulation that in order to become eligible for government funding banks had to give up equity in return. It appears that this part of the Swedish plan and possibly other parts of the Swedish response, may be incorporated into the "Paulson Plan" though not in the plan originally. On the Swedish experience, see, e.g., Bäckström (1997), Englund (1999), and Ingves and Lind (1996).

As of this writing (September 28, 2008), the U.S. Congress is still contemplating Treasury Secretary Henry Paulson's plan to spend $700 billion to buy distressed bonds in a reverse auction, i.e., banks would specify the lowest price that they would accept for a certain type of bond (e.g., first half of 2006 vintage first lien subprime BBB tranches) and the Treasury would choose to buy an amount starting at the lowest prices. The original plan, just three pages, appears to be in the process of being modified to include government equity interests in the firms participating in the auction, executive pay limits, oversight, and more details about the structures and authority of the entities that will manage the program. A key point in the plan is simply the commitment to do something significant, rather than be purely reactive. By buying the securities that face the most uncertainty as to their value, the plan aims to remove the uncertainty and replace the securities with cash. The process of the auction would create transparency with respect to the prices of these securities (if not the value).

The Paulson plan seeks to buy and isolate the bonds which are viewed as the contaminants, bonds of highly uncertain value. The plan seeks to remove the uncertainty about the value of subprime-related securities by buying them at transparent prices. But, on the one hand, the weakest institutions may have the greatest an incentive to offer to sell bonds at the lowest price, to obtain cash, so auction prices are likely to reflect the weakest institutions rather than the "value" of the bonds. On the other hand, institutions may not want to reveal their weakness by offering to sell at the lowest price. Such a stigma has been viewed as a problem with regard to borrowing at the Federal Reserve's discount window. Another issue is whether all institutions will have to value their assets ("mark-to-market") based on the auction prices at which the government buys bonds. There are many details of the plan to be worked out – details that may well determine the success or failure of the plan.

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