

# The Liquidity and Credit Crunch 2007-2008

We have been experiencing the most severe financial crisis since the Great Depression

The Big Question:

Why did losses in the mortgage market lead to such turmoil in financial markets?

To answer that, we first look at the recent history.

# Factors Leading up to the Housing Bubble

1. Low Interest Rates due to large capital flows from abroad and a low interest rate policy adopted by the Fed after collapse of Dot Com Bubble in the stock market
2. Banking System underwent transformation: rather than holding loans, banks went to “originate and distribute” model in which securitization of assets increased dramatically.

# Securitization: Repackaging of Assets

XYZ Bank loans 10 people \$100,000 a piece, which they will use to buy homes.

From the perspective of XYZ, those loans are 10 different assets. They can hold them for 30 years and make a profit but at a risk. Or they could sell them to some other investor, and walk away.

In doing this, they would make less profit than if they held onto them long term, but they would benefit in that they make some profit while also getting their original investment back. They give up some of the reward (profit) in exchange for not having the risk.

# Securitization: Repackaging of Assets

So XYZ Bank decides they'd rather have the cash now. They could sell those 10 loans to 10 investors. Each investor would be taking a risk in buying those loans, because if any loan defaults, that one investor loses.

**SECURITIZE!!**

They combine the 10 loans into one entity, and then they split that one entity into 10 equal shares. For each share, instead of owning one loan, they will own 10% of all 10 loans. If one loan fails, every investor loses 10%. Less risk = Higher Price.

# Securitization: Repackaging of Assets

This is the basic idea of a Mortgage Backed Bond – it is a type of “pass-through security” in which the payments of the mortgage are passed through to the owners of the new security.

These type of assets were developed in the 1970's to help the supply of funds to the mortgage market. The Government Sponsored Enterprises (GSE's) played a big role in this:

GNMA – Government National Mortgage Association

FNMA – Federal National Mortgage Association

FHLMC – Federal Home Loan Mortgage Corporation

## Securitization: Creating a CDO

The basic MBB was replaced by CDO's: Collateralized Debt Obligations. These involved more sophisticated re-packaging. Create "tranches" which have different probabilities of payoffs.

An Example: Take two loans both of which have a probability of default,  $p_D$ , and pay \$0 if they default and \$1 otherwise.

Combine the bonds into a pool so the notional value of the pool is \$2 and then issue two tranches each of which will pay \$1.

## Securitization: Creating a CDO

**Junior Tranche:** It bears the first \$1 of losses. That is, it pays out only if both bonds do not default.

**Senior Tranche:** Bears losses only if the capital of the junior tranche is exhausted: It pays out \$1 if neither bond defaults or if only one bond defaults. Stated alternatively, it pays out nothing only if both bonds default.

The genius of this innovation is that by packaging bonds and changing the payoff structure, you change the risk characteristics of the new asset.

## Securitization: Creating a CDO

Suppose bond defaults are independent events, then the probability of not getting paid for the senior tranche is:

$$\Pr(\text{no payoff}) = p_D p_D$$

So if  $p_D = 10\%$  then  $\Pr(\text{no payoff}) = 1\%$

Less risk = Higher Price!!

What's the catch? It all depends on the correlation of defaults. If bond defaults are perfectly correlated, then there is no reduction in risk.



# Securitization: Creating a CDO

One of the main stories of the credit crisis is that the correlation of defaults on the underlying mortgages was much higher than estimated.

The Gaussian Copula Let Us Down!

Correlations were estimated using a short sample period and one in which housing markets experienced few shocks.

And things got very complicated: CDOs created by packaging CDOs.. CDO squared.

# Bond Rating Agencies – Good at Rating Bonds issued by Companies

*Table 1*

## Historical Default Experience of Bonds Rated by Fitch

<i>Rating at issuance</i>	<i>Investment-grade Bonds</i>									
	<i>AAA</i>	<i>AA+</i>	<i>AA</i>	<i>AA-</i>	<i>A+</i>	<i>A</i>	<i>A-</i>	<i>BBB+</i>	<i>BBB</i>	<i>BBB-</i>
10-year default probability	0.19%	0.57%	0.89%	1.15%	1.65%	1.85%	2.44%	3.13%	3.74%	7.26%
Default rate (annualized)	0.02%	0.06%	0.09%	0.12%	0.17%	0.19%	0.25%	0.32%	0.38%	0.75%
<i>Rating at issuance</i>	<i>Speculative-grade Bonds</i>									
	<i>BB+</i>	<i>BB</i>	<i>BB-</i>	<i>B+</i>	<i>B</i>	<i>B-</i>	<i>CCC+</i>	<i>CCC</i>	<i>CC</i>	<i>C</i>
10-year default probability	10.18%	13.53%	18.46%	22.84%	27.67%	34.98%	43.36%	48.52%	77.00%	95.00%
Default rate (annualized)	1.07%	1.45%	2.04%	2.59%	3.24%	4.30%	5.68%	6.64%	14.70%	29.96%

# Bond Rating Agencies – But CDOs introduced new complexities...and mistakes were made.

A simulation exercise: create a CDO and CDO squared and see how the default probabilities change when assumptions about default correlations change:

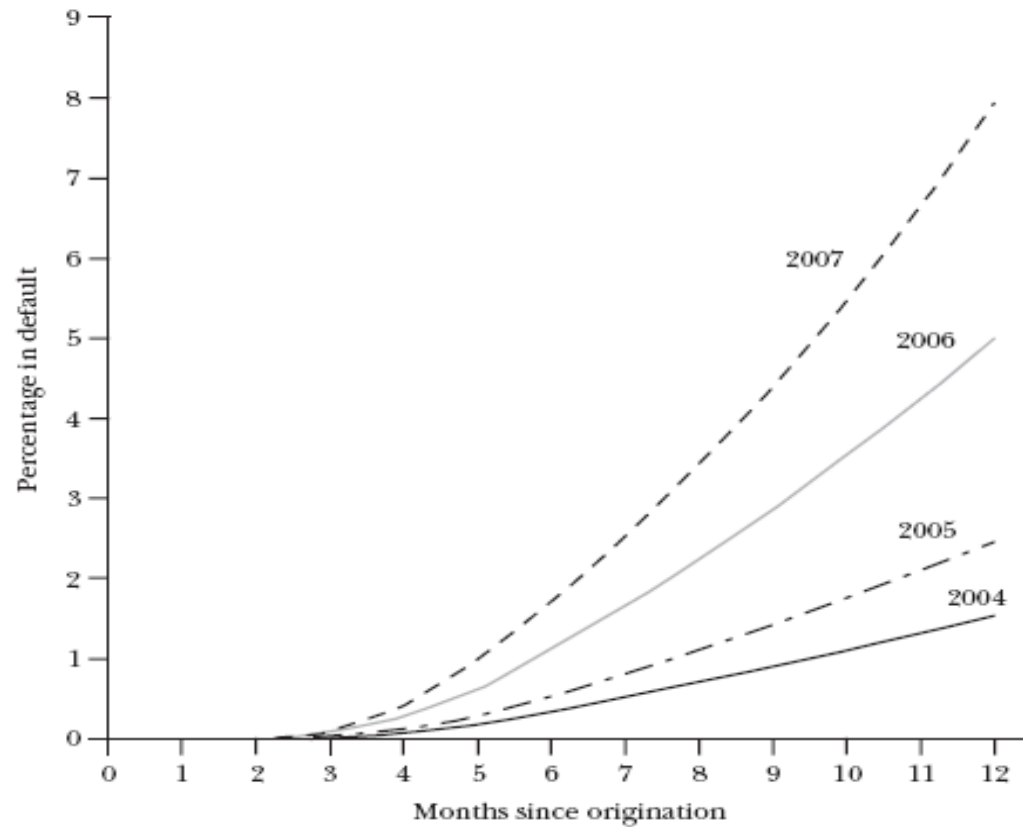
*Table 3*

**Effect of Changes in Underlying Parameters on CDO and CDO<sup>2</sup> Tranche Ratings**

	<i>Initial rating</i>	<i>Final rating</i>					
		<i>Default correlation (<math>\rho</math>)</i>			<i>Default probability (<math>pD</math>)</i>		
		<i>(<math>\rho = 20\%</math>, <math>pD = 5\%</math>)</i>	<i>40%</i>	<i>60%</i>	<i>80%</i>	<i>7.50%</i>	<i>10%</i>
<b>CDO</b>							
Junior	NR	D	C	CC	NR	NR	NR
Mezzanine	BBB-	BB-	B+	B+	B+	CCC	CC
Senior	AAA	A+	BBB-	BB	AAA	A+	BBB-
<b>CDO<sup>2</sup> ([6, 12])</b>							
Junior	C	D	NR	NR	NR	NR	NR
Mezzanine	AAA	B+	C	CC	BBB-	NR	NR
Senior	AAA	AAA	AAA	AA+	AAA	AAA	B-

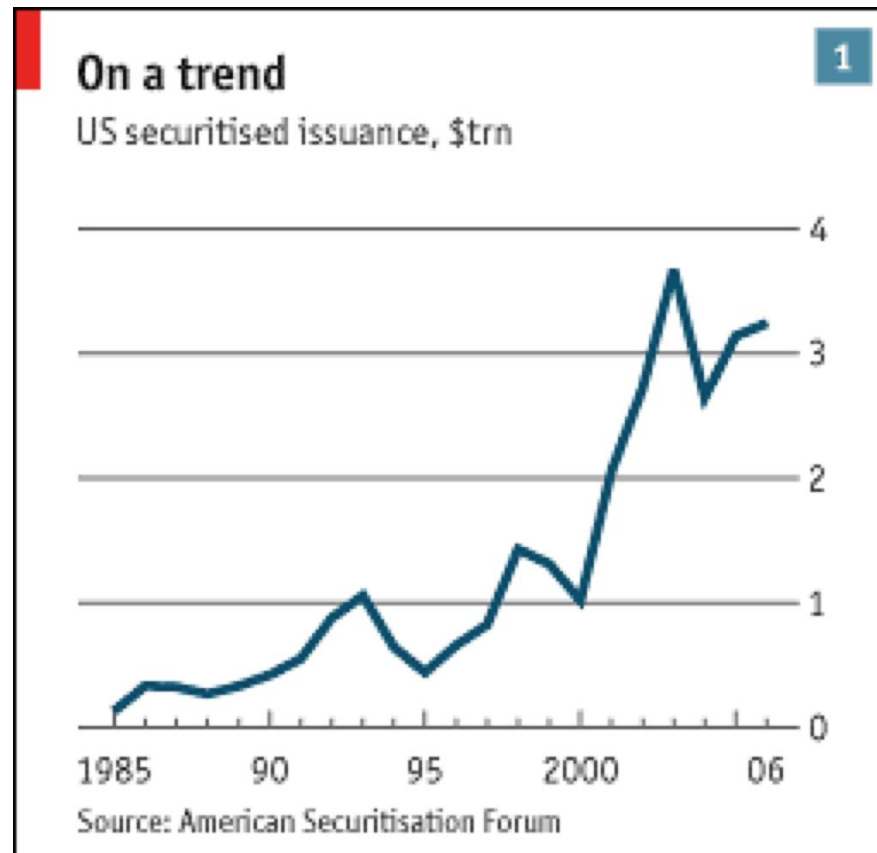
# Sub-Prime Mortgages...High Default Probability

*Figure 2*  
**Early Payment Defaults on Subprime Loans**



# Back to our story: The Growth of Securitization

## ABS – Asset Backed Securities



## In addition to Securitization, Shortening the Maturity Structure of Liabilities.

Securitization is typically done by creating a separate entity: an off-balance sheet vehicle (i.e. company). These are referred to as Structured Investment Vehicle (SIV) or Special Purpose Vehicle (SPV).

Two critical factors:

1. Banks issue credit lines to the SIV – SIV can borrow if needed.
2. SIV finances its assets by borrowing short term. Either by issuing commercial paper (short term debt) or Repos – repurchase agreement.

Repo: sell an asset and agree to buy it back later.

## In addition to Securitization, Shortening the Maturity Structure of Liabilities.

These arrangements implied that banks were subject to liquidity risk.

And since much of this was off the balance sheet, the liquidity risk was not obvious.

But some knew the day of reckoning would come:

Citigroup's former chief executive officer, Chuck Prince, summed up the situation on July 10, 2007 : "When the music stops, in terms of liquidity, things will be complicated. But as long as the music is playing, you've got to get up and dance. We're still dancing."

# The Music Stops: Event Logbook

The trigger for the liquidity crisis was an increase in subprime mortgage defaults in February 2007.

This event – and the ones that followed – can be seen by looking at the price of credit default swaps (CDS).

These are insurance contracts on securities – they pay out if the security defaults. The price is determined by the ABX index. For our purposes:

$$\text{Price of insurance} = 100 - \text{Price of ABX}$$



# The Music Stops: Event Logbook

Figure 1

## Decline in Mortgage Credit Default Swap ABX Indices

(the ABX 7-1 series initiated in January 1, 2007)

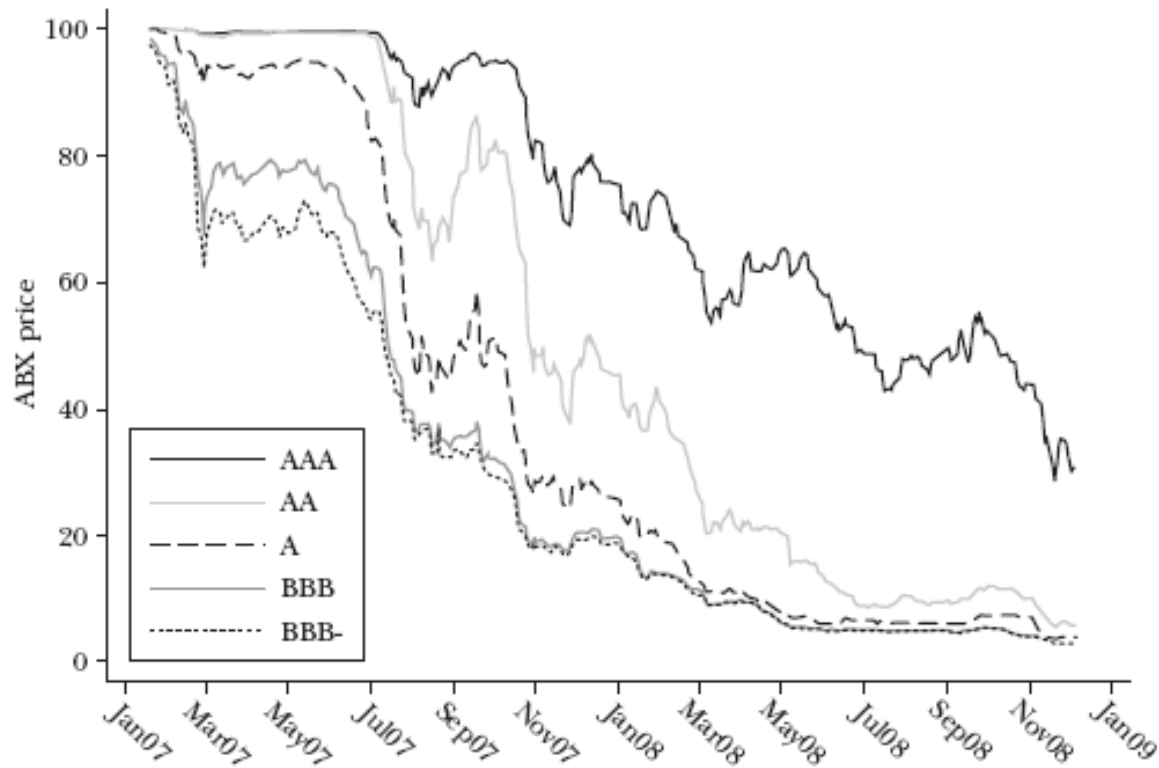
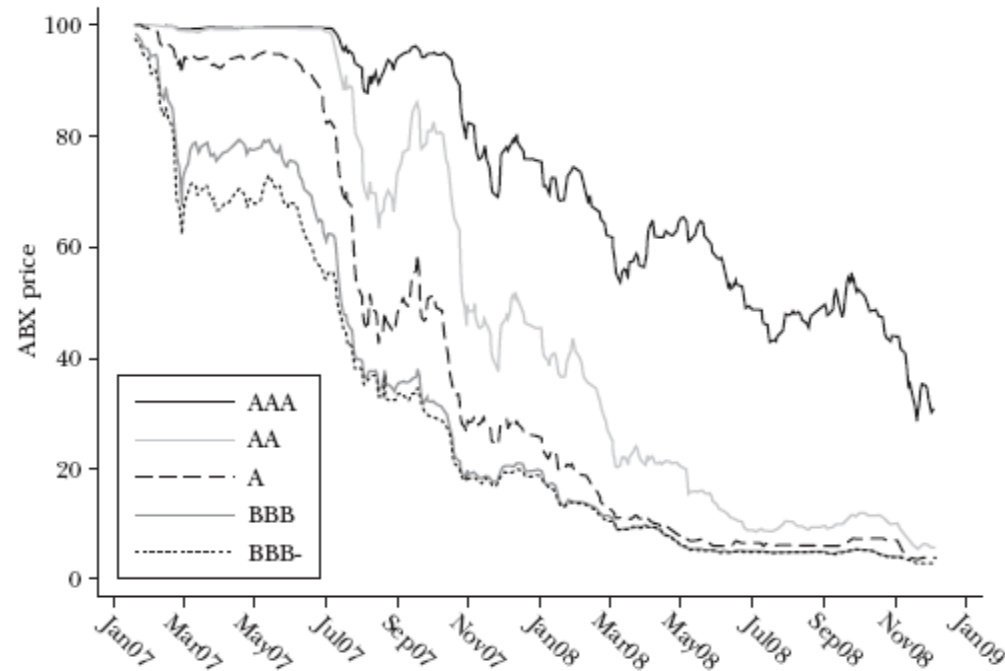


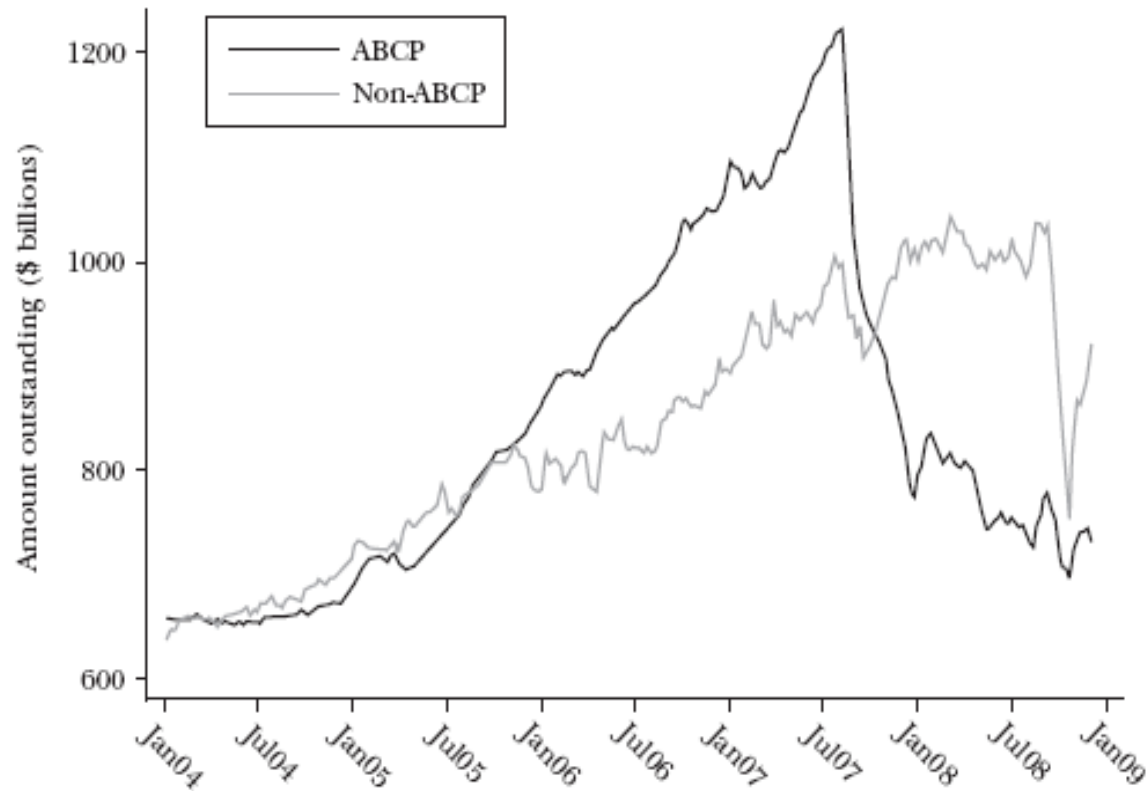
Figure 1  
**Decline in Mortgage Credit Default Swap ABX Indices**  
(the ABX 7-1 series initiated in January 1, 2007)



- June-July 07: Tranches downgraded. Bear Stearns hedge funds required \$3.2 billion. German Bank IKB can not provide liquidity to its SIV – must be bailed out by government.
- August 07: American Home Mortgage Investment Corp. declares bankruptcy. French bank, BNP Paribus freezes redemptions for 3 investment funds citing the inability to value structured products.

Figure 2

### Outstanding Asset-Backed Commercial Paper (ABCP) and Unsecured Commercial Paper



- So far the disruption is primarily in mortgage related markets. As the graph above shows, commercial paper market not related to ABS continued to function well until August 2008.

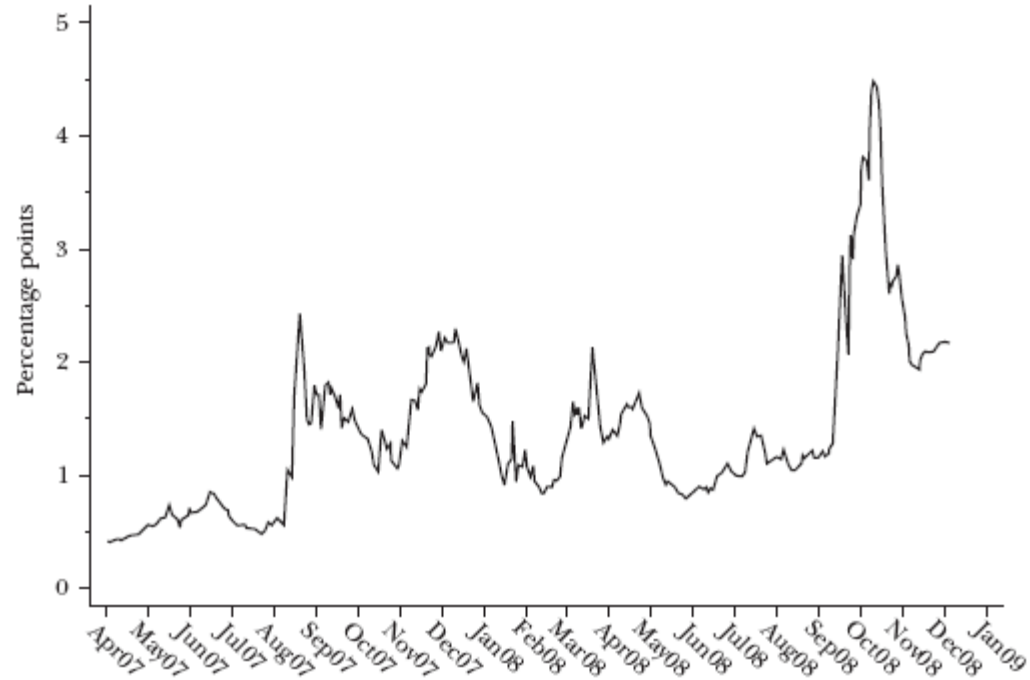
## Another indication of conditions in the credit markets: The TED Spread

Banks finance short term liquidity by issuing commercial paper, borrowing reserves from other banks (the Fed Funds Market) and by borrowing in the international bank market – London Interbank Offered Rate – LIBOR.

TED spread: LIBOR – U.S. T-Bill rate

*Figure 3*

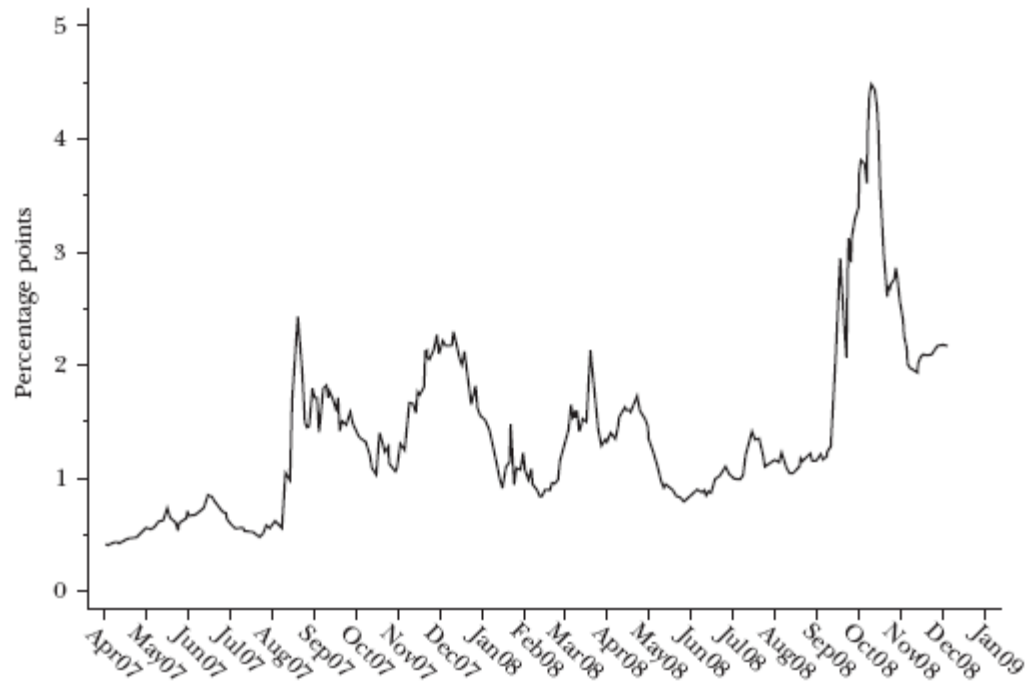
### The TED Spread



Source: Bloomberg.

Note: The line reflects the TED spread, the interest rate difference between the LIBOR and the Treasury bill rate.

Figure 3  
The TED Spread



Source: Bloomberg.

Note: The line reflects the TED spread, the interest rate difference between the LIBOR and the Treasury bill rate.

In August 07, liquidity in the interbank market froze up as default and liquidity risk rose. Central Banks step in: ECB injects 95 billion in Euros, Fed injects \$24 billion. Fed also lowers the discount rate and Fed Funds rate.

Markets stabilize until November 2007 when it becomes apparent that the losses in the mortgage market are greater than initially thought.

## A new concern arises: The Monoline Insurers

In January and February 2008 a new problem developed: Default of the monoline insurers.

Monoline insurance companies specialize in providing insurance on municipal bonds so that these bonds receive AAA ratings. They had recently also started to provide default insurance on MBS.

Why is this important: money market mutual funds are mutual funds that invest in short term assets and they promise to maintain the value of every \$1 invested. Hence investment banks are required to buy back the assets at face value if needed. BUT this is only true if the assets have AAA ratings.

## A new concern arises: The Monoline Insurers

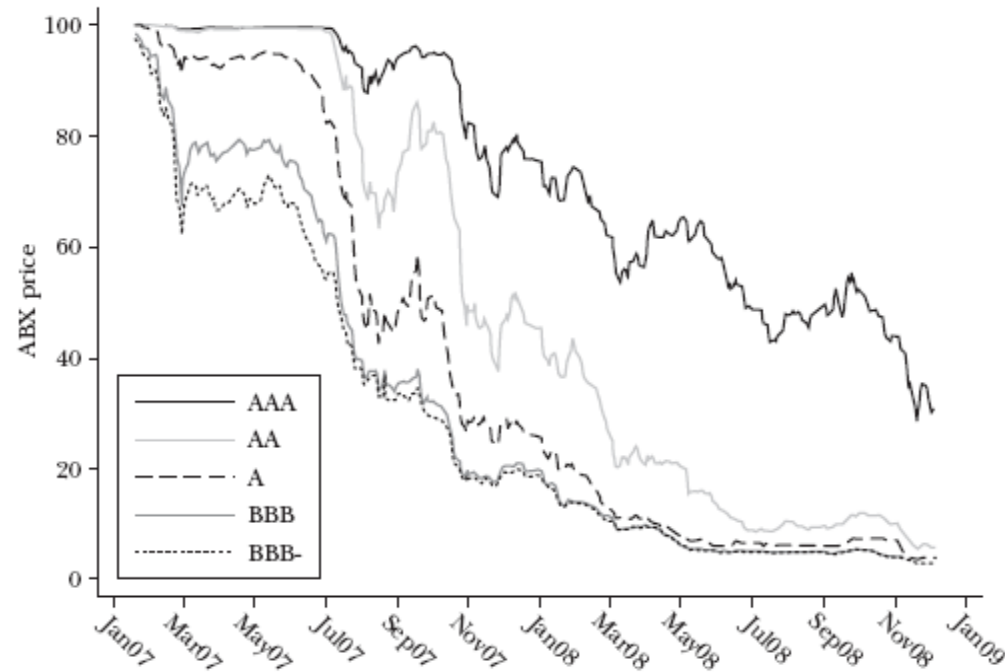
So – as the losses mounted on the monoline insurers (because of the insurance they were providing on MBS), their credit ratings were lowered.

BUT this implied that the insurance they were providing to municipal bonds, corporate bonds was in doubt so these bonds were in jeopardy of losing their AAA rating.

If they lost their AAA rating, money markets would want to unload them. These financial instruments had a face value of \$2.4 TRILLION!!!

Fed increased efforts to supply liquidity to the markets and lowered the Fed Funds Rate (to be discussed later).

Figure 1  
Decline in Mortgage Credit Default Swap ABX Indices  
(the ABX 7-1 series initiated in January 1, 2007)

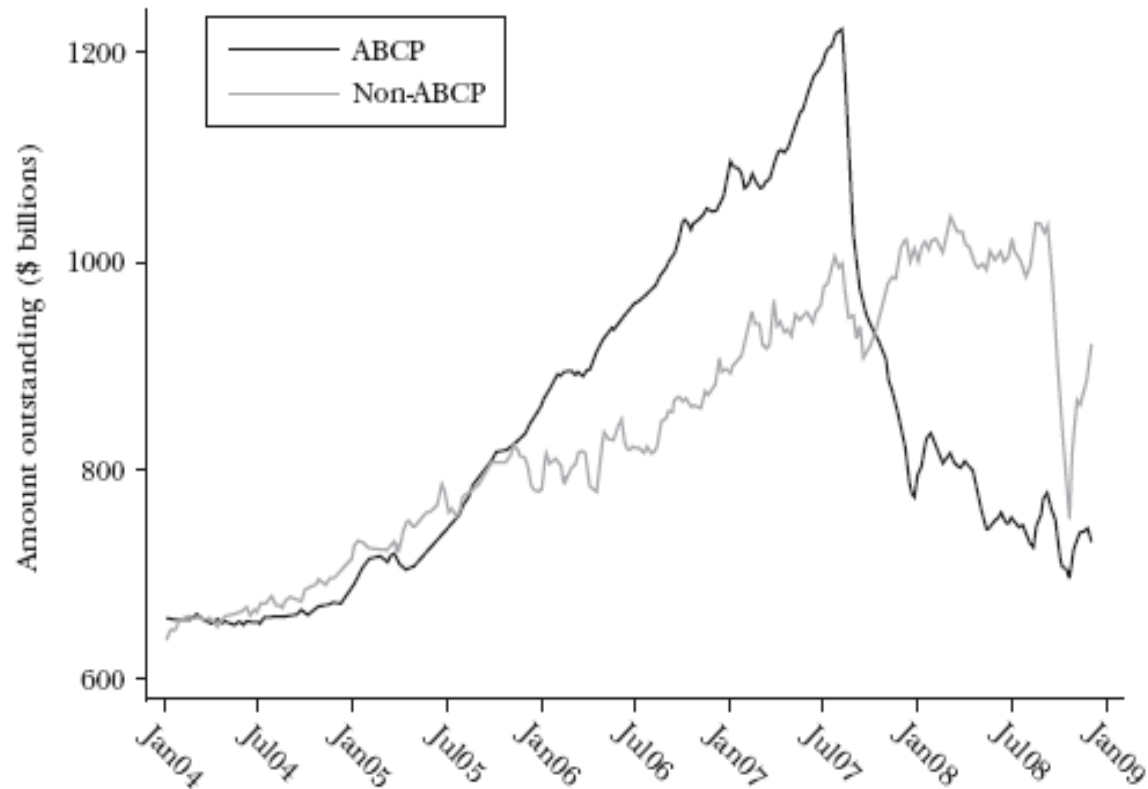


- March 2008: Bear Stearns liquidity situation deteriorates rapidly. Bear Stearns had **150 million** trades spread across various counterparties: Too Interconnected to Fail. JP Morgan Chase buy Bear Stearns for \$2/share. A year earlier, the share price was \$150.
- Fannie Mae and Freddie Mac receive full government backing (guarantee of their debt) in July.



Figure 2

## Outstanding Asset-Backed Commercial Paper (ABCP) and Unsecured Commercial Paper



- In September 2008, Lehman Brothers declares bankruptcy. AIG – a large international insurance company, had become very active in the credit default swaps business. The exposure resulted in their share price falling by 90%. Because of their interconnectedness in the derivatives market, the government arranged a bailout

# What happened? A discussion of the amplifying mechanisms

Shocks get amplified when liquidity evaporates. Brunnermeier divides the concept of liquidity into two components.

1. **Funding Liquidity:** describes the ease with which expert investors and arbitrageurs can obtain funding from (possibly less informed) financiers. Traders buy on *margin*: they finance only a small part of the asset with their own money. The remainder is borrowed – typically short term. The difference between the amount borrowed and the value of the security as collateral is the haircut.

# Funding Liquidity Risk – 3 Forms

Funding Liquidity risk has 3 forms:

1. Margin/haircut funding risk, or the risk that margins and haircuts will change,
2. Rollover risk or the risk that it will be more costly or impossible to roll over short-term borrowing.
3. Redemption risk, or the risk that demand depositors of banks—or even equity holders of hedge funds, for example—withdraw funds.

All three incarnations of funding liquidity risk are only detrimental when the assets can be sold only at fire-sale prices—that is, when market liquidity is low.

# Market Liquidity

Market Liquidity is low when selling the asset depresses the sale of the asset and it, therefore, becomes costly to shrink the balance sheet.

The mechanisms that explain why liquidity can suddenly evaporate operate through the interaction of market liquidity and funding liquidity. Through these mechanisms, a relatively small shock can cause liquidity to dry up suddenly and carry the potential for a full-blown financial crisis.

# Balance Sheet Effects: Loss Spiral and Margin Spiral

Loss Spiral Example: Consider an investor with a leverage ratio of 10 and assets worth \$100 million. Suppose the value of assets falls by \$5 million to \$95 million.

Then equity has fallen by \$5 million and to maintain a leverage ratio of 10, the investor needs to liquidate \$45 million of assets.

If other investors are facing similar shocks, then asset prices fall...perhaps dramatically.

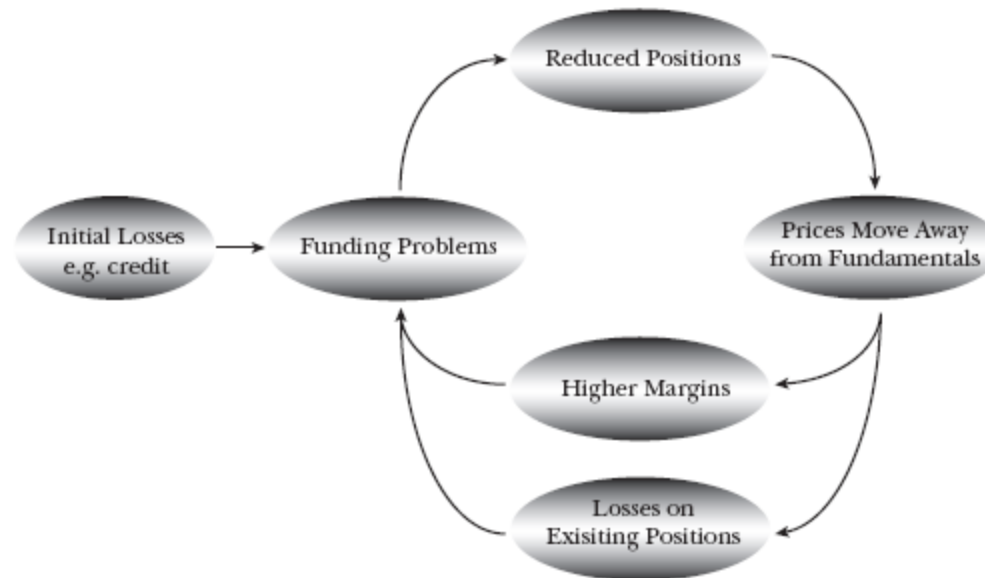
But, due to higher risk, now the investor must hold a higher margin (or take a bigger haircut). Say lenders require a margin implying a leverage ratio of 5.

# Balance Sheet Effects: Loss Spiral and Margin Spiral

Since equity is only \$5 million, then this means assets must total \$25 million = Sell another \$20 million in assets!

Figure 4

The Two Liquidity Spirals: Loss Spiral and Margin Spiral



Source: Brunnermeier and Pedersen (forthcoming).

Note: Funding problems force leveraged investors to unwind their positions causing 1) more losses and 2) higher margins and haircuts, which in turn exacerbate the funding problems and so on.

# Temporary Shock – why not lend since asset prices are expected to rise?

1. Unexpected price shocks may forecast higher price volatility in the future which, imply higher margins.

An extreme example in August 2007, when the asset-backed commercial paper market dried up completely. Prior to the crisis, asset-backed commercial paper was almost risk-free because of overcollateralization. However, in August 2007, the overcollateralization cushion evaporated, making the assets much more risky. Lenders were unwilling to let SIV's roll over their debt.

2. Lemons Problem: Borrowers only offer “bad” assets as collateral. Lenders require a greater haircut.

The effect of liquidity loss on other investors creates an externality: The Fire Sale Externality – A primary reason for banking regulation (and will certainly be discussed more!)

# Two other amplifying mechanisms

In addition to borrowers' problems, lenders also have their own set of issues which can amplify shocks:

1. **Moral Hazard in Lending:** Intermediaries play an important monitoring role. But if their investment falls too low, then monitoring role becomes too costly and banks reduce lending.
2. **Precautionary hoarding:** Lenders are afraid that shocks will increase their need for funds. So rather than lend, they keep funds for their own needs. (This explains the movements in the TED spread we saw earlier.)



# Bank runs: It's not just for banks anymore!

Banks are subject to runs since they do not have enough liquid assets on hand to satisfy all depositors. It is advantageous to be a “First Mover” but this may be socially inefficient. Deposit insurance is the primary tool to stop bank runs – and it has been successful.

But the current crisis has seen runs on other types of financial institutions.

# Bank runs: It's not just for banks anymore!

Bear Stearns saw funds evaporate as investors (hedge funds) pulled out their money.

AIG faced a “margin run” as counterparties requested greater collateral for its credit default swap positions.

Also extends to equity holders: Hedge Funds and Mutual Funds.

Consider a hedge fund with \$50 million in liquid assets and \$50 million in illiquid assets. If this latter group must be sold quickly, they sell for \$30 million. There is an advantage to being a First Mover and getting your money out early (while full asset values remain).

# Conclusion

Trigger: Increase in mortgage delinquencies led to nationwide fall in housing prices.

Effect has been close to a classical banking crisis in which liquidity dries up.

What is new is the way in which securitization led to an opaque level of interconnectedness between assets and liabilities.

The Next Step: Increased Regulation...but what form?