<u>Management</u> <u>during The Subprime Crisis</u>

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Presentation partly based on *M. Crouhy, R. Jarrow and S. Turnbull: The Subprime Crisis, Journal of Derivatives, Fall 2008, 81-110, and*

M. Crouhy: Risk Management Failures during the Financial Crisis, to appear in the proceedings of the International Banking Conference sponsored by the FRB of Chicago and the European Central Bank: The Credit Market Turmoil of 2007-08: Implications for Public Policy – Chicago, September 25-26, 2008.



I. Introduction

- The credit crisis of 2007 started in the subprime mortgage market in the U.S. but has affected investors all over the world and shut down the ABCP market, securitization. Hedge funds have halted redemptions or failed, SIVs have been wound-down:
 - The amount of write-off could reach \$ 2 trillion
 - Banks have been taken over in Germany (Satchen and IKB) and Great Britain had its first bank run in 140 years and ended up nationalizing the troubled bank (Northern Rock)
 - Libor and spreads over Libor for inter-bank lending has skyrocketed as banks don't trust each other
 - U.S. banks had to call global investors such as "sovereign funds" for massive capital infusions
 - Contagion affects other segments of the credit market
 - Credit crunch and fear of deep economic recession



Source: Bloomberg (WDCI)



Background – Delinquencies in the Subprime Market

There were four reasons why delinquencies began to increase after mid 2005.

- 1. Typical subprime borrowers are not very credit worthy often highly levered with high debt to income ratios, and often had mortgages with high loan-to-value ratios (often 100% or more).
- 2. In 2005/6 teaser loans had low fixed rates for the first two or three years, then re-set semi annually to an index plus margin. Short term mortgage rates began to increase from mid 2004.
- 3. Many borrowers had counted on being able to re-finance or to sell their home. However in April 2005, home price appreciation began to decline.
- 4. A decline in lending standards and increased fraud.



Trigger to the Crisis

- The current crisis was thus an accident waiting to happen. The trigger was a series of events that striked out of the blue:
 - In June 2007, attempt by Bear Sterns to bail out two hedge funds hurt by subprime mortgage losses – then, attempt by Merrill Lynch to liquidate some of the funds' assets revealed how illiquid the market for such securities has become.
 - In July, first bailout by German regulators of IKB.

- In July also, BNP Paribas froze three investment funds with assets of 2 billion euros because the bank could not value the subprime assets in the funds.
- It seems that all of a sudden the market realized that MBSs,
 CDOs of ABS and other structured products were mispriced

Subprime index: 2007-2, AAA

markit 55 \$2.5-50 47.5 45 42.5-Price 48 37.5 35-32.5 38-27.5 25-22.5 80 95 80 01 Dec 08-12 Jan 09-23 Feb 09-20 Oct 08-

- ABX.HE.AAA.07-2

06 Apr 09-

Subprime index: 2007-2, BBB





II. Basics of securitization and the manufacturing of triple-A securities







Sources: Bloomberg, IFR Markets, InformaGM, S&P, and CIRA.





Sources: S&P and CIRA.

Basic Structure of a CDO of ABS or Mezz CDO



A total of 90% of triple-A rated securities has then been created: 75% + 0.2 * 75% = 90%

In practice:

- RMBS: pools of approximately 3,000 individual mortgages
- Mezz CDO: pools of approximately 100 mortgage bonds (80%) + a few CMBS, CDOs,...





III. What went wrong in risk management and risk modeling?



• Over-reliance on:

- 1. Wrong ratings from rating agencies;
- 2. Unrealistically simple risk models, i.e., models which were not designed to deal with the complexity of structured credit products;
- 3. Inaccurate data;
- 4. Short-term financing with little consideration for liquidity risk.
- 5. Myopic risk analysis with no consideration to systemic risk

As a consequence risks were massively underestimated



1. Over-reliance on suspicious ratings:

1. Example of a RMBS deal from New Century

Example of a deal from New Century

GSAMP 2006-NC2

•2nd largest subprime lender 2004-2006

•Filed for bankruptcy April 2007

•3949 subprime loans

•\$881 million principal

•originated 2006:Q2

New Century Financial Originator Initial Servicer

> **Goldman Sachs** Arranger Swap Counterparty

GSAMP Trust 2006-NC2 Bankruptcy-remote trust Issuing entity Moody's, S&P Credit Rating Agencies

Ocwen Servicer

Wells Fargo Master Servicer Securities Administrator

Deutsche Bank Trustee Mezz tranches downgraded severely in historical rating action by Moodys in July 2007

From Ashcraft and Schuermann (2008): "Understanding the Securitization of Subprime Mortgage Credit." *Foundations and Trends in Finance*

Example of a deal from New Century

GSAMP 2006-NC2: mortgage pool at origination

- 98.7% of the mortgage loans are first-lien
- 43.3% are purchase loans
- 90.7% owner-occupied

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- 73.4% single-family homes
- 38.0% and 10.5% CA and FI, respectively
- Mean FICO of 626, 31.4% below 600, 6.7% above 660.
- Mean CLTV of 80.34%, 62.1% of 80% or lower, 28.6% between 80% and 90%, and 9.3% between 90% and 100%.
- Average DTI is 41.78%.
- Relatively typical portfolio composition
 - 76% 2/28 ARMs (2/3 with 40-yr balloon)
 - 11% ARM IO
 - 12% fixed

Tranching for GSAMP Trust 2006-NC2

Tranche description				Credit Ratings		Coupon Rate	
Class	Notional	Width	Sub	S&P	Moody's	-1	-2
A-1	\$239,618,000	27.18%	72.82%	AAA	Aaa	0.15%	0.30%
A-2A	\$214,090,000	24.29%	48.53%	AAA	Aaa	0.07%	0.14%
A-2B	\$102,864,000	11.67%	36.86%	AAA	Aaa	0.09%	0.18%
A-2C	\$99,900,000	11.33%	25.53%	AAA	Aaa	0.15%	0.30%
A-2D	\$42,998,000	4.88%	20.65%	AAA	Aaa	0.24%	0.48%
M-1	\$35,700,000	4.05%	16.60%	AA+	Aa1	0.30%	0.45%
M-2	\$28,649,000	3.25%	13.35%	AA	Aa2	0.31%	0.47%
M-3	\$16,748,000	1.90%	11.45%	AA-	Aa3	0.32%	0.48%
M-4	\$14,986,000	1.70%	9.75%	A+	A1	0.35%	0.53%
M-5	\$14,545,000	1.65%	8.10%	А	A2	0.37%	0.56%
M-6	\$13,663,000	1.55%	6.55%	A-	A3	0.46%	0.69%
M-7	\$12,341,000	1.40%	5.15%	BBB+	Baa1	0.90%	1.35%
M-8	\$11,019,000	1.25%	3.90%	BBB	Baa2	1.00%	1.50%
M-9	\$7,052,000	0.80%	3.10%	BBB-	Baa3	2.05%	3.08%
B-1	\$6,170,000	0.70%	2.40%	BB+	Ba1	2.50%	3.75%
B-2	\$8,815,000	1.00%	1.40%	BB	Ba2	2.50%	3.75%
Χ	\$12,340,995	1.40%	0.00%	NR	NR	N/A	N/A

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2. Reliance on oversimplified models which did not capture the full dimensionality of the risk being undertaken

UBS: 2nd largest bank in the world by total assets, end of 2006, winner of Euromoney magazine's "Global Best Risk Management House" award for excellence in 2005

As of August 2008: write-downs of \$45 billion and capital infusion of \$28 billion

Post mortem shareholder report on UBS's write-downs indicates that "short cuts" were taken to speed up the production of risk reports. But these short cuts were systematically gamed so that risks were structured in such a way they did not show up at all in the calculations of risk.

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"Cliff" effect or non-linearities in the risk of subprime CDO tranches

- Perhaps one of the biggest failing in the crisis was the failure to understand the binary (zero-one) nature of mortgage CDOs.
- The assets of a mortgage related CDO were subprime asset backed bonds. These bonds were themselves tranches on a pool of individual subprime mortgages. The typical CDO had pools of mortgage backed bonds rated double B to double A, average triple B.
- Average attachment point for the MB tranches was between 3 to 5% and the width was very thin from 2.5 to 4%. Assuming a recovery rate of 50% and a default rate of 20%, a realistic number in the current environment, then it was to be expected that triple B tranches would be hit.



In the current downturn in the housing market and a recessionary economic environment, if one triple B tranche is hit, then it is likely that other triple B tranches will be hit during the same period, especially given the thin width of the tranches.



Either the cumulative default of the subprime mortgages keeps the MB bonds untouched and the super senior tranches will not incur losses, or the default rate wipes out the bonds and the super senior tranches.



3. Lack of data and inability to calibrate the models

- No history
- Regime change ignored by rating agencies, monolines and structurers in risk assessment and pricing



					No		
	CLTV	Full Doc	Purchase	Investor	Prepayment Penalty	FICO	Silent 2 nd lien
A. Alt-A Loans							
1999	77.5	38.4	51.8	18.6	79.4	696	0.1
2000	80.2	35.4	68.0	13.8	79.0	697	0.2
2001	77.7	34.8	50.4	8.2	78.8	703	1.4
2002	76.5	36.0	47.4	12.5	70.1	708	2.4
2003	74.9	33.0	39.4	18.5	71.2	711	12.4
2004	79.5	32.4	53.9	17.0	64.8	708	28.6
2005	79.0	27.4	49.4	14.8	56.9	713	32.4
2006	80.6	16.4	45.7	12.9	47.9	708	38.9
B. Subprime Loans							
1999	78.8	68.7	30.1	5.3	28.7	605	0.5
2000	79.5	73.4	36.2	5.5	25.4	596	1.3
2001	80.3	71.5	31.3	5.3	21.0	605	2.8
2002	80.7	65.9	29.9	5.4	20.3	614	2.9
2003	82.4	63.9	30.2	5.6	23.2	624	7.3
2004	83.9	62.2	35.7	5.6	24.6	624	15.8
2005	85.3	58.3	40.5	5.5	26.8	627	24.6
2006	85.5	57.7	42.1	5.6	28.9	623	27.5

Table 5: Underwriting Characteristics of Loans in MBS Pools

All entries are in percentage points except FICO. Source: LoanPerformance (2007)











Predicting Losses Across Mortgage Products

Loan Losses by Mortgage Product and Vintage

Vintage	Subprime	Alt-A	Seconds	Prime	Total
2003	2.7%	0.3%	4.4%	0.1%	1.6%
2004	3.0%	0.5%	6.3%	0.1%	1.7%
2005	7.5%	1.3%	17.2%	0.2%	4.5%
2006	19.3%	4.5%	43.9%	0.3%	12.7%
2007	22.9%	5.4%	62.2%	0.8%	17.4%
Total	10.3%	2.4%	28.5%	0.2%	6.9%



Predicting Losses of Mezz ABS CDOs

Results of 110 2006-7 Vintage Subprime Mezz ABS CDOs - Losses by Tranche Rating

	Threshold Collateral	% of CDOs Whose	Loss	Tranche
	Losses That	Predicted Losses	Given	Expected
Tranche	Threaten Tranche	Exceed Threshold	Default	Losses
Sr. AAA	37% +	78%	42%	33%
Jr. AAA	24% +	92%	93%	85%
AA	16% +	95%	99%	94%
Α	12% +	99%	98%	97%
BBB	7% +	99%	100%	99%



- 4. Huge reliance of banks and "off-balance sheet vehicules on shortterm wholesale funding (Sachsen Bank, Northern Rock, Bear Sterns,...)
- SIVs invest in medium and long term highly rated assets and fund these purchases with short term asset backed commercial paper (ABCP), medium term notes (MTNs) and capital.
- The rating of the ABCP and MTNs relies on the ability of the SIV to roll over its debt. Each SIV must have multiple back stop lines of credit.
- However the ability to roll over debt also depends on the value of the collateral – the assets of the SIV. The rating agencies do not consider valuation issues.

Risk management systems ignored this as a credit or liquidity risk – at best consider this risk as an operational risk.

In the case of Sachsen the Dublin's affiliate engaged in investing in subprime CDOs had a back-up *Ioan facility from the parent bank Sachsen itself approaching 25% of the total balance sheet of the* parent bank! 33



5. Over-reliance on myopic risk analysis with no consideration to systemic risk.

Monolines and insurance companies, e.g. AIG, sell insurance to guarantee timely payment on municipal bonds. During the last decade moved into the business of providing surety wraps for asset backed bonds and CDOs. Viewed as a "highly profitable" business.

Systemic risk: If a monoline is downgraded, all of the paper it has insured must be downgraded.

1. This will cause holders of the paper to mark down their holdings under fair value accounting.

2. Enhanced money market funds that must hold assets rated at least triple-A, this means selling downgraded assets.

3. As more and more assets are marked down primary dealers, and other counterparties, are asking for more collateral, forcing selling assets (good and bad) at distressed prices in illiquid markets.

4. This downward spiral in asset prices triggers deleveraging and contagion to markets that are not directly related to subprime mortgages.



IV. Lessons from this fiasco



1. CDO tranches are different from corporate bonds :

It is therefore necessary to model:

- 1. the cash flows generated by the assets in the collateral pool.
- 2. prepayments
- 3. default dependence among the assets
- 4. how the covariates that explain default by the assets varies over the life of the structure
- 5. the waterfall structure of the CDO

The use of well understood assets, such as corporate bonds, as proxies for the risk of CDO tranches led to mistakes and underappreciation of risk.



1. CDO tranches are different from corporate bonds (cont.):

Subprime ABS ratings differ from corporate debt ratings on a number of dimensions:

- Corporate bond ratings are largely based on firm-specific risk, while CDO tranches represent claims on cash flows from a portfolio of correlated assets.

- The rating of CDO tranches rely heavily on quantitative models, while corporate debt ratings rely essentially on the analyst's judgement.

- Although the rating of a CDO tranche should have the same expected loss as a corporate bond for a given rating, the volatility of loss (unexpected loss) is quite different and strongly depend on the correlation structure of the underlying assets in the pool of the CDO.

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1. CDO tranches are different from corporate bonds (cont.):

Rating agencies, structurers and investors occulted the fact that:

- the securitization process substitutes specific risks which are largely diversifiable in a benign economic environment, for systemic risk which is not diversifiable during a severe economic downturn – as correlations increase risk is shifted from junior to senior tranches;

- contrary to a corporate bond, small errors in the evaluation of PDs, LGDs, correlations can result in major changes in the expected loss of the senior tranches of a CDO, and consequently their rating (sensitivity is even higher for CDO-squareds such as subprime CDOs).

As a consequence senior tranche holders should demand far larger risk premia than for holding a corporate bond with the same rating.

Basic Structure of a CDO of ABS or Mezz CDO



A total of 90% of triple-A rated securities has then been created: 75% + 0.2 * 75% = 90%

Leverage effect: Assume a loss rate on the underlying mortgage portfolios of 20%

- MBS: 5% of losses borne by the equity tranche and 15% by the mezzanine tranche The mezz has 20% of principal so that 15/20 = 75% of the principal of each MBS is lost
- ABS CDO: Each underlying asset bears a 75% lost 5% is borne by the equity, 20% by the mezz and 50% by the senior tranche, i.e. 50/75 = 66.7% of its principal₃₉



2. Check the quality of the data about the underlying assets and make sure it is complete and timely

- Given the use of historical data, it did not reflect the changing nature of the subprime market – declining lending standards, the growing number of no document mortgages, high loan to value mortgages.
- Normally mortgages have high recovery rates. But with high debt to value ratios, declining home prices, this was not longer the case. Again, this was not reflected in the data used to rate the CDOs.
- Rating agencies receive data from the issuers and arrangers and assumed that appropriate due diligence has been performed. They do not check the quality of the data.



2. Check the quality of the data about the underlying assets and make sure it is complete and timely (Cont.)

It is essential to perform due diligence on the raw data – neither the rating agencies nor the banks which structured the CDOs have done it.

(The situation is analogous to an accountant accepting at face value the figures given to them - no auditing function)



3. A major source of model risk is the accuracy of the key parameters in the valuation of a CDO:

Need to calibrate "forward looking" PDs, LGDs, default correlations, prepayment rates.

PDs:

For CDOs we can extract the term structure of PDs from the term structure of CDSs (assuming some recovery rate).

But for MBSs there is only one maturity – the maturity of the bond.



• LGDs:

For mortgages, LGDs depend more than for corporates on the state of the economy and of the housing market at the time of default.

Default correlations:

Clearly, there are at least two regimes:

- Normal markets (20%)
- « crisis » regime where correlation jump to a level close to 1 (at least in some geographic areas with similar socio-professional characteristics)



• Prepayment:

Prepayment is hard to predict because it will depend on the future course of interest rates and also on "non-economic" factors. These include:

- people move,
- borrowers default
- transactions costs affect the refinancing decision
- "non-rational" reasons, such as lack of information, may cause suboptimal prepayment behavior



4. In a market that can produce unprecedented price moves and significant tail risk:

- Risk assessment cannot rely on a single risk metric, i.e., VaR
- At least, there is a need to complement traditional risk measures by well designed, consistent, stress testing and scenario analysis that include business cycle stresses as well as event specific "tail risks".

Ensure that the methodology identifies and takes into account:

- concentration risk
- correlation risk
- liquidity risk (need a dynamic framework)

and covers on-balance sheet as well as off-balance sheet assets.



5. Do not neglect "wrong-way correlation risk":

In the light of what happened with the monolines it is important to account for the risk that the deterioration of the quality of the assets is concomitant with a significant increase in the risk of default of the counterparty.



6. Derivatives are "marked-to-market" or "marked-to-model"

Risk Management should run worst-case scenarios to measure the risk of future collateral calls and write-downs which can have a devastating effect on the finances of the firm.

AIG has been forced to post about \$50 billion in collateral to its trading partners to offset drops in the value of securities it insured with credit default swaps, and has written-down several billion dollars. No scenario was run that considered a sharp drop in housing prices.



V. Concluding Remarks





- Detailed analytic description of Risk Management
- Policy, Methodology and Infrastructure framework

Comprehensive user friendly description of Risk Management

Conclusion



