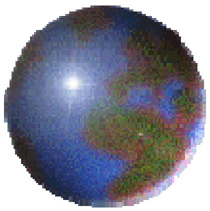

Credit Ratings and Securitization

IAFE Annual Conference

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John Hull

Agenda

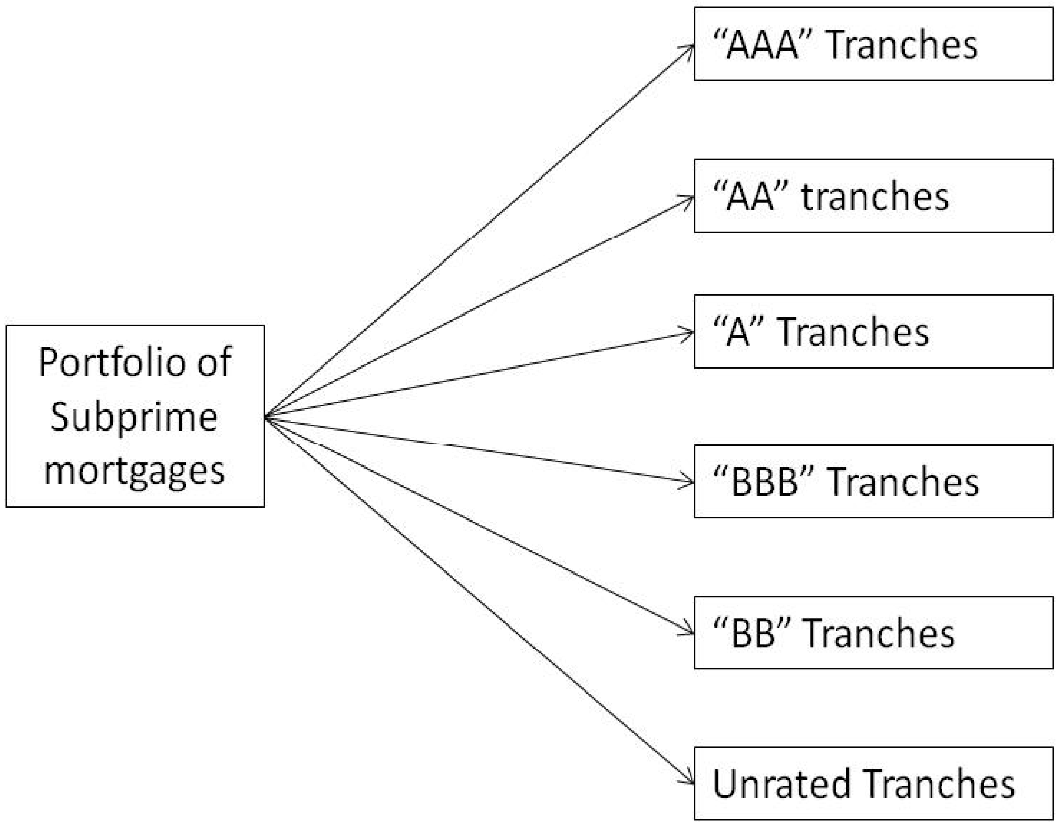
- To examine the derivatives that were created from subprime mortgages
- To determine whether the criteria used by rating agencies were reasonable
- To determine whether the AAA ratings assigned to tranches were reasonable, given the criteria used by rating agencies
- To identify some lessons for the future of structured finance

Papers Underlying Presentation

- "Ratings Arbitrage and Structured Products"
- "The Risk of Tranches Created from Residential Mortgages"

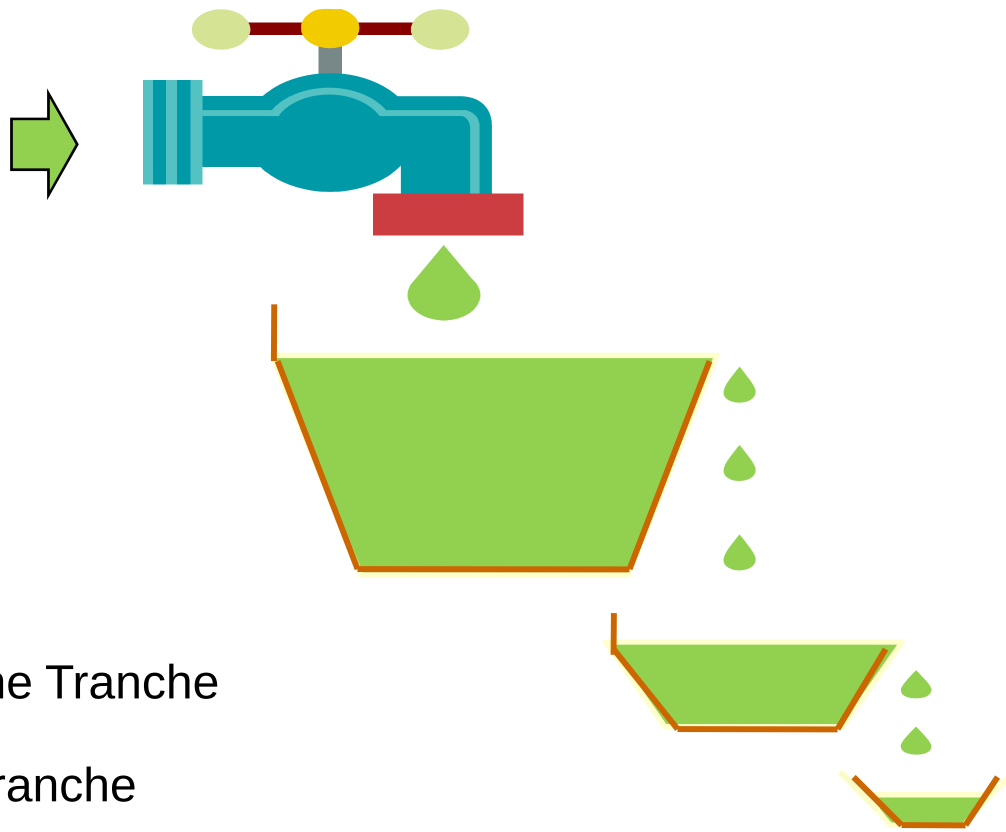
Both are joint with Alan White and can be downloaded from www.rotman.utoronto.ca/~hull

Asset Backed Security



The Waterfall

Asset
Cash
Flows

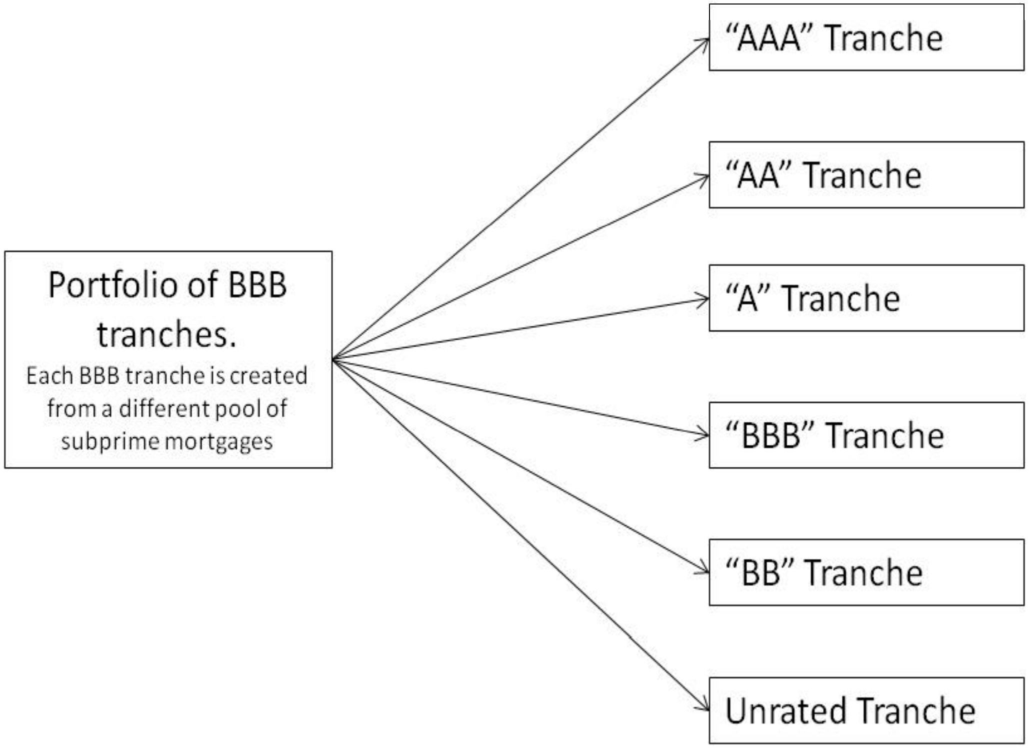


Senior
Tranche

Mezzanine Tranche

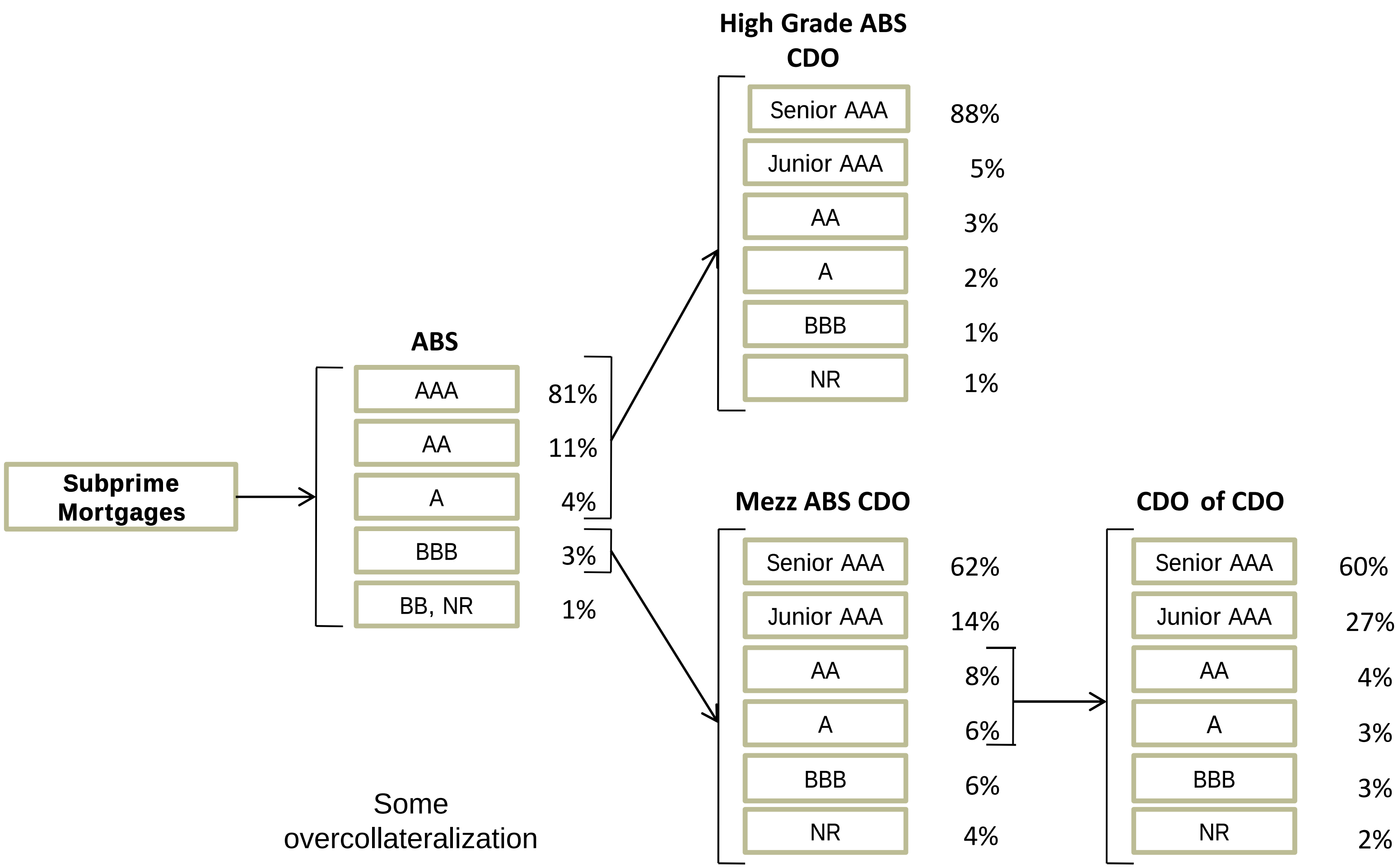
Equity Tranche

Mezz ABS CDO



Portfolio of BBB tranches.
Each BBB tranche is created from a different pool of subprime mortgages
“AAA” Tranche
“AA” Tranche
“A” Tranche
“BBB” Tranche
“BB” Tranche
Unrated Tranche

The Pattern of Securitization



Rating Structured Products vs Rating Bonds

- Bond ratings are based on judgment and analysis; structured product ratings are based on a model
- Structured products required an assumption about correlation
- Design of structured products can easily be changed to achieve desired ratings
- Structured products are arguably more likely to be downgraded than bonds

The Criteria Used By Rating Agencies

- Moody's calculates the expected loss as a percent of principal, EL, on a tranche and tries to ensure that this is consistent with the expected loss on a similarly rated bond
- S&P and Fitch calculate the probability of a loss on a tranche PD and try to ensure that this is consistent with the probability of loss on a similarly rated bond

Were the Criteria Used by Rating Agencies Reasonable?

- What properties do we want a credit quality measure (EL or PD or something else) to have?
- Define the credit quality measure as q (credit quality goes down as q increases)
- We can measure the credit quality of a single asset or a portfolio of assets
- For a portfolio, there is a probability distribution, F, for the credit quality of the assets in the portfolio

Credit Quality Dominance

- Portfolio Y dominates Portfolio X with respect to a particular credit quality measure if

$$F_Y(q) \geq F_X(q)$$

  for all q with strict inequality for some q where F_X and F_Y are the probability distributions of q for the assets in Portfolios X and Y, respectively
- Credit quality dominance corresponds to strong first order stochastic dominance between the probability distributions of q for Y and X

Example

	Portfolio *A*	Portfolio *B*	Portfolio *C*
Asset 1 (q=1)	0%	80%	0%
Asset 2 (q=2)	100%	10%	90%
Asset 3 (q=3)	0%	10%	10%

B dominates *C* and *A* dominates *C*. There is no dominance between *A* and *B*

No-Arbitrage Condition

A necessary condition for a credit quality measure to be arbitrage-free is that, for every Portfolio X and every Portfolio Y that can be restructured from X, there be no credit quality dominance between X and Y.

Probability of Loss Does Not Satisfy the No-Arbitrage Condition

- To see this, we can restructure any Portfolio X into a new Portfolio Y consisting of two securities (or tranches)
- The first security is responsible for losses in the 0 to 50% range
- The second security is responsible for the remaining losses.
- Portfolio Y dominates portfolio X

Further Restructuring

- Every time we create a new tranche we achieve an extra level of dominance
- If Portfolio Z has three tranches (0 to 25%, 25% to 50%, and 50% to 100%) it dominates Portfolio Y

Expected Loss Percentage (EL)

- Satisfies our necessary condition for no arbitrage (as does any monotonic function of EL)
- Allows bond portfolios to be rated in the same way as bonds
- Has much better properties than probability of loss
- But market participants that base valuations solely on EL are still liable to be arbitraged by market participants that use more complete valuation models

Relationship

- EL=PD LGD
- For bonds an LGD of 60% is often assumed
- For the wide AAA tranche LGD<60%
- For thin junior tranches LGD is close to 100%
- S&P and Fitch were more conservative than Moody's for AAA tranches
- Moody's is more conservative for the thin junior tranches

Were AAA Ratings Reasonable: Assumptions

- Principal payments are sequential so that losses are borne by tranches in order of reverse seniority (not unreasonable as we are mostly concerned with high-default-rate situations)
- Homogeneity for mortgage defaults, mortgage principals, number of mortgages per pool, etc
- All mortgage pools have a 5 year weighted average life
- Mortgage pool is sufficiently large that actual default rate equals PD
- ABS losses modeled with one-factor copula model for default correlation.
- ABS CDO losses modeled with a two-factor copula model of default correlation

Constructing a General One-Factor Copula Model for the Default Rate

- To construct a one-factor copula model for the mortgage default rate, we define independent variables M and Z_i.
- M is a factor affecting all mortgages while Z_i affects only mortgage i. The transformed time to default is

  $U_i = \sqrt{\rho} M + \sqrt{1-\rho} Z_i$ where ρ is the copula correlation
- The default rate DR conditional on M is

$$DR = H\left(\frac{F^{-1}(EDR) - \sqrt{\rho} M}{\sqrt{1-\rho}}\right)$$

where H is the cumulative probability distribution of Z_i and EDR is the expected default rate

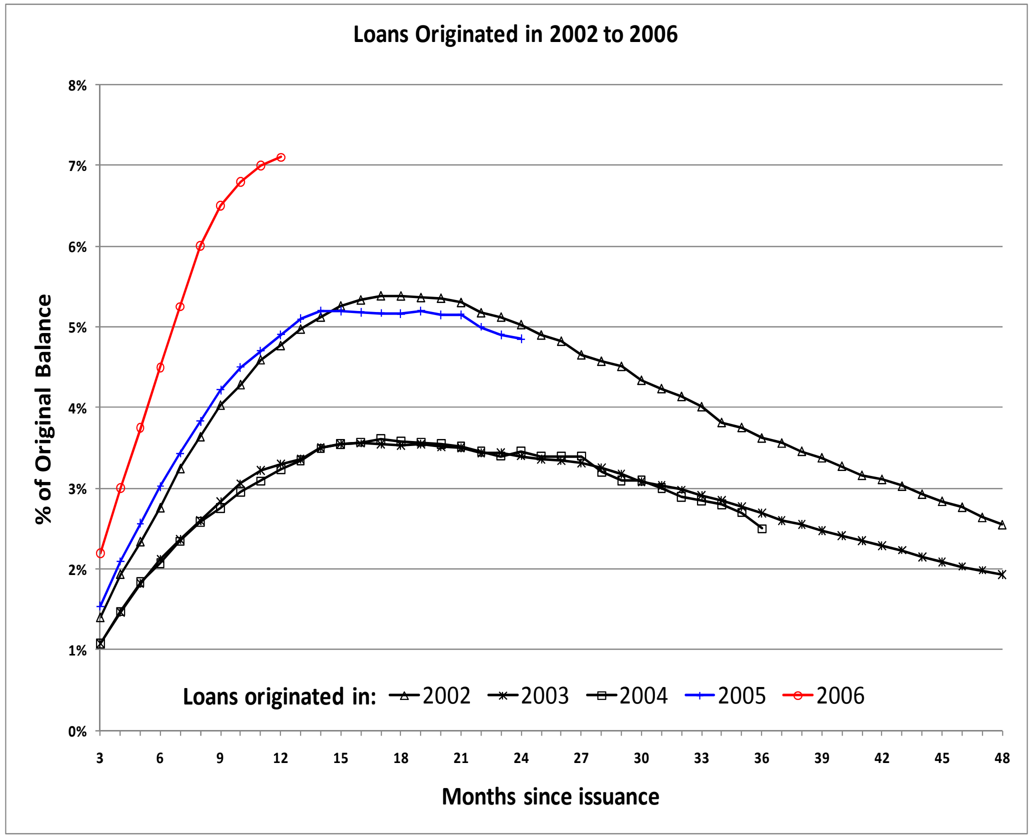
Constructing a General One-Factor Copula Model for the Default Rate continued

- In the market standard Gaussian copula M and Z_i have standard normal distributions
- But any zero mean unit variance distributions can be used
- We find that choosing both M and Z_i to have t distributions with four degrees of freedom works well for synthetic CDOs.
- This gives a default rate distribution with much heavier tails than the Gaussian copula

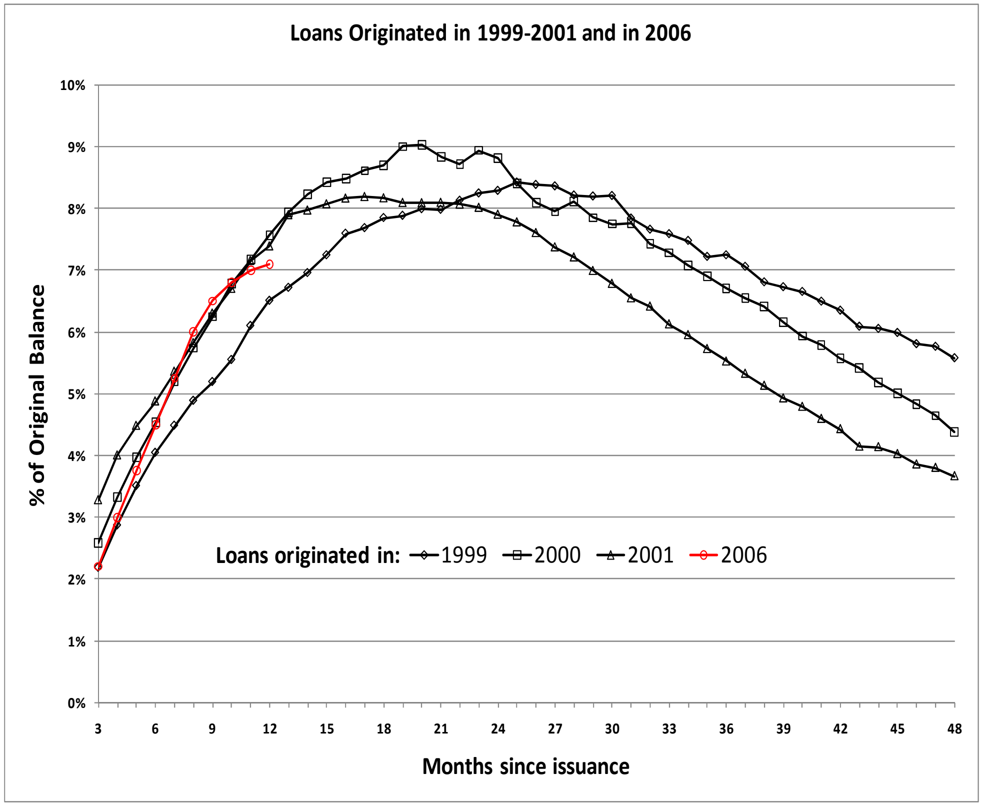
Rating Requirements Assumed for Instruments (5-year Expected Life)

	Probability of Loss	Expected Loss
AAA	0.1%	0.06%
BBB	1.8%	1.08%

Subprime History (as seen in March 2007) Loans originated in 2002 to 2006



Subprime History (as seen in March 2007) Loans originated in 1999-2001 and 2006



Results for Gaussian Copula Model with Constant Recovery.

Table shows the minimum attachment point for the AAA tranche of ABS when probability of default is the criterion. Recovery rate is constant at 75%.

	EDR = 5%	EDR =10%	EDR=20%
ρ=0.05	4.1%	6.8%	11.0%
ρ=0.1	6.0%	9.4%	13.9%
ρ=0.2	9.6%	13.6%	18.2%
ρ=0.3	13.1%	17.2%	21.2%

Results for Double t Copula Model with Constant Recovery. *Table shows the minimum attachment point for the AAA tranche of ABS when probability of default is the criterion. Recovery rate is constant at 75%.*

	EDR = 5%	EDR =10%	EDR=20%
ρ=0.05	7.6%	13.0%	18.2%
ρ=0.1	13.6%	18.7%	21.9%
ρ=0.2	21.1%	23.2%	24.1%
ρ=0.3	23.7%	24.4%	24.7%

Results for Gaussian Copula Model with Stochastic Recovery. Table shows the minimum attachment point for the AAA tranche for ABS when probability of default is the criterion. Recovery rate model links recovery rate to default rate

	EDR = 5%	*EDR* = 10%	*EDR*=20%
ρ=0.05	7.3%	11.6%	17.1%
ρ=0.1	11.6%	17.3%	23.8%
ρ=0.2	19.1%	26.6%	33.4%
ρ=0.3	26.1%	34.1%	40.0%

Results for Double t Copula Model with Stochastic Recovery. ***Table shows the minimum attachment point for the AAA tranche of ABS when probability of default is the criterion. Recovery rate model links recovery rate to default rate***

	EDR = 5%	EDR = 10%	EDR=20%
ρ=0.05	15.0%	25.3%	33.4%
ρ=0.1	27.2%	37.2%	41.8%
ρ=0.2	42.2%	46.3%	46.6%
ρ=0.3	47.4%	48.7%	48.9%

Multi-Pool Model

- In the multi-pool model we must define three sets of variables M_{bp}, $M_{wp,j}$, *and* Z_{ij}
  - M_{bp}, is the "between pool" factor that applies to all mortgage pools
  - $M_{wp,j}$ is the within pool factor that applies only to pool *j*
  - Z_{ij} affects only mortgage i of pool j
- There are two correlation parameters α and ρ
- Roughly speaking
  - ρ measures the total within pool correlation
  - α measure s the proportion of the correlation that comes from a factor common to all pools

Minimum Attachment Point for AAA-rated ABS CDO Tranche Created from BBB Rated Tranches (att=4%, det =5%).

Prob Loss=0.1% over 5 yrs. ρ is copula correlation. α is proportion of correlation that comes from a factor common to all mortgage pools

		α = 0.05	α = 0.25	α = 0.50	α = 0.75	α = 0.95
Gaussian Copula	ρ = 0.05	17.1%	42.7%	73.5%	96.2%	99.9%
Constant Recovery	ρ = 0.10	29.7%	62.3%	89.7%	99.8%	99.9%
EDR=10%	ρ = 0.20	39.7%	73.6%	95.4%	99.9%	99.9%
	ρ = 0.30	43.5%	77.2%	96.7%	99.9%	99.9%
Gaussian Copula	ρ = 0.05	0.9%	2.6%	5.9%	10.1%	10.4%
Constant Recovery	ρ = 0.10	5.3%	16.1%	36.2%	66.3%	98.3%
EDR=5%	ρ = 0.20	14.5%	37.9%	69.1%	95.2%	99.9%
	ρ = 0.30	20.5%	48.8%	80.2%	98.7%	99.9%

Minimum Attachment Point for AAA-rated ABS CDO Tranche Created from BBB Rated Tranches (att=4%, det =5%) *continued*

Prob Loss=0.1% over 5 yrs. ρ is copula correlation. α is proportion of correlation that comes from a factor common to all mortgage pools

		α = 0.05	α = 0.25	α = 0.50	α = 0.75	α = 0.95
Triple *t* copula	ρ = 0.05	95.9%	100.0%	100.0%	100.0%	100.0%
Stochastic Recovery	ρ = 0.10	93.8%	100.0%	100.0%	100.0%	100.0%
EDR=10%	ρ = 0.20	92.0%	100.0%	100.0%	100.0%	100.0%
	ρ = 0.30	90.3%	100.0%	100.0%	100.0%	100.0%
Triple *t* Copula	ρ = 0.05	82.9%	99.0%	100.0%	100.0%	100.0%
Stochastic Recovery	ρ = 0.10	84.1%	99.0%	100.0%	100.0%	100.0%
EDR=5%	ρ = 0.20	85.0%	99.0%	100.0%	100.0%	100.0%
	ρ = 0.30	80.0%	99.0%	100.0%	100.0%	100.0%

Explanation of Results

- When BBB tranches are thin the probability distribution for the loss on a tranche is quite different from that for the loss on a BBB bond
- Consider an extreme situation when tranches are very thin and α=1 so that all mortgage pools have the same default rate….

How Reasonable Were the Ratings, Given the Criteria Used?

- ABS ratings were not too unreasonable
- Mezz ABS CDOs ratings are much more difficult to defend
- Mezz ABS CDOs accounted for only about 3% of all securitizations
- But the tranches were widely used to create synthetic products.

Lessons from the Crisis for Structured Products

- When evaluating credit derivatives (particularly, when evaluating how they will perform in extreme market conditions), it is important to take account of
  - tail default correlation
  - dependence of recovery rates on default rates
- Thin tranches have "all or nothing" risk characteristics and should be treated with caution
- Structured products should not be considered to be equivalent to similarly rated bonds
- It is important to understand what ratings measuree and their limitations

Lessons from the Crisis for Structured Products continued

- Resecuritization was a badly flawed idea
- We should aim to achieve diversification benefits with the first level of securitization
- Can we securitize across asset classes? Basing securitization on the price of a single good is dangerous
- Transparency is important. Issuers should provide scenario analysis software