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Citi Presentation on Risk View of CDOs on ABS Alan Smillie

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Risk View of CDOs on ABS

Confidential – not for distribution

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Market Risk Analytics
16 Nov 2007



Executive Summary

- What happened:
 - Product Description: My understanding of what the products are, and what we are exposed to
 - Model Description: The ‘intrinsic value’ model used by the desk for ABS CDOs is very basic, limiting our risk management options. Cannot compute factor sensitivities, or even market value.
 - Model systematically underprices tail risk, which may have contributed to the ABS CDO losses.
 - Even if the model was adequate, there is no market price to calibrate a VaR model to

Executive Summary

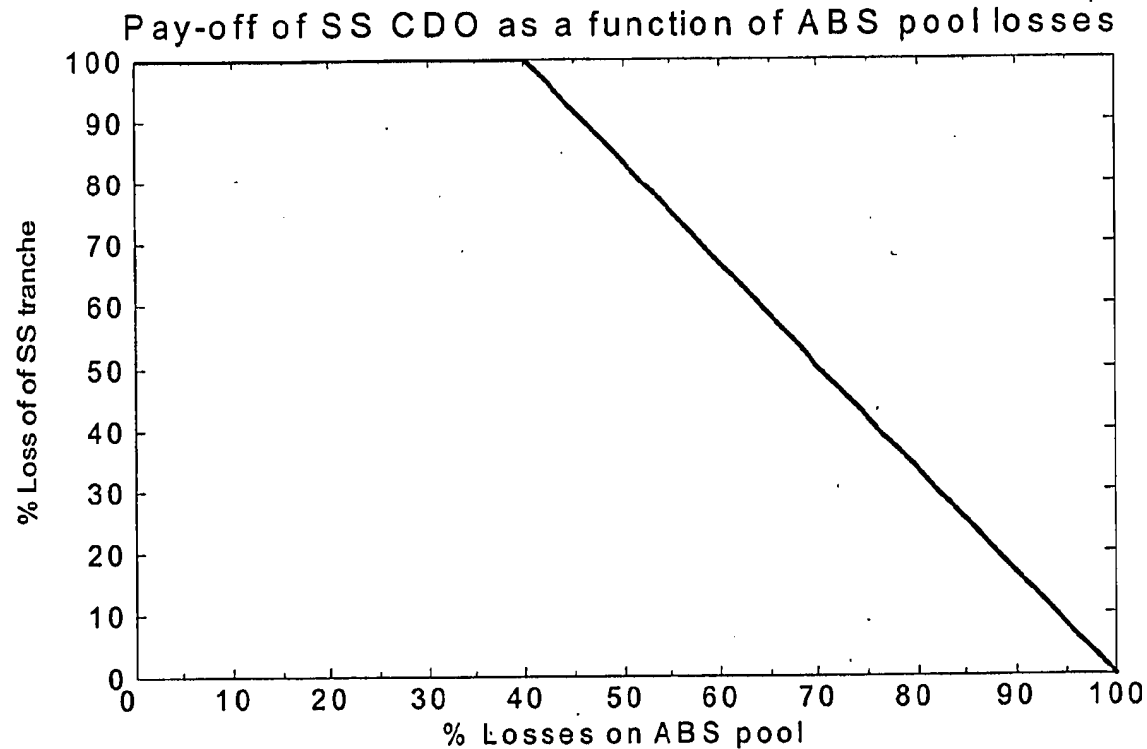
- What's next:
 - VaR: Not feasible to compute a VaR in the short term, due to limitations of desk model and lack of liquidity in the market
 - Risk Monitoring: We can track the 'spread' exposure of each CDO tranche in order to at least measure the magnitude of our exposure
 - Regulatory Capital: no chance of VaR-model approval, so have to stick with standard rules. Also presents a challenge for IDR modelling.
 - Risk Capital: Should be based on VaR for this Trading Book product, but we don't have VaR. Instead look at stress testing to 99.97th percentile equivalent
 - Going Forward: Help the desk to build a better model!

Product Description

- Residential mortgages are pooled and placed in to tranced products: ABS
- ABS tranches rated by agencies by location in the capital structure and quality of underlyings. Most of the ABS underlying our ABS CDOs are A or BB rated.
- These are in turn pooled and placed into tranced products: ABS CDO. Again, tranches are given risk rating
- Sometimes this happens again: ABS (CDO)²
- Bank sells the tranches of the ABS CDO to investors, offers a low coupon on AAA-rated tranches since they have very low risk.
- Few investors purchase this tranche, so we are left with it on our books

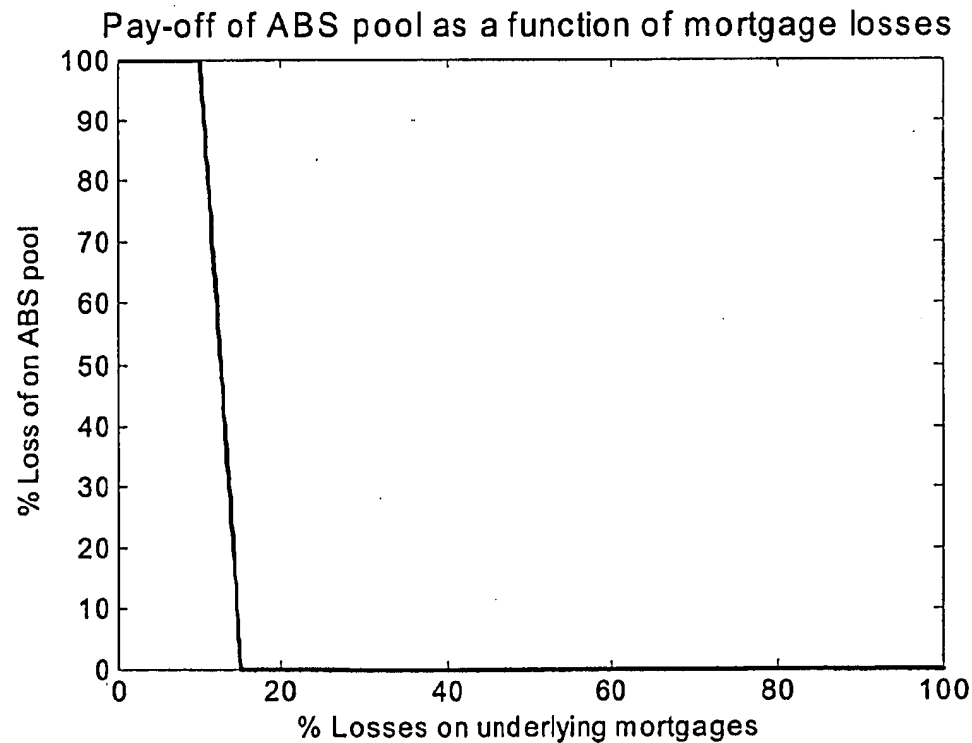
Product Description

- On the face of it, the super senior tranche is a safe product, since it is protected from (typically) the first 40% of losses on the ABS



Product Description

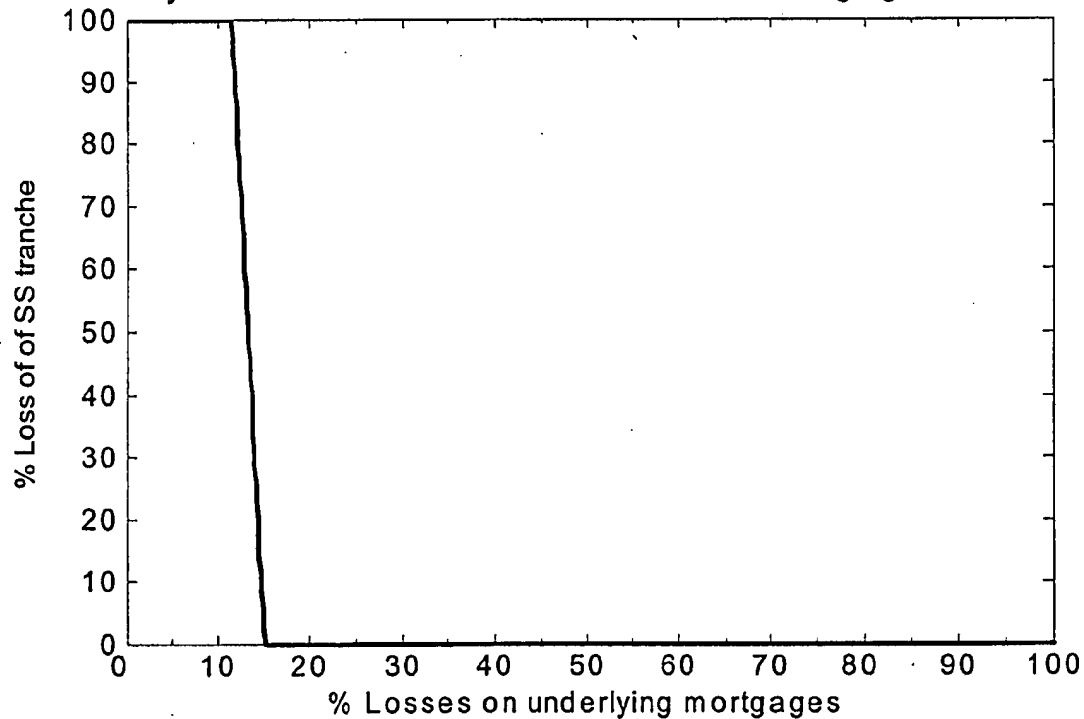
- But remember that the reference ABS are themselves only A or BBB. They are protected from roughly 10% of mortgages only, then take 100% of loss from next 5% of mortgage losses



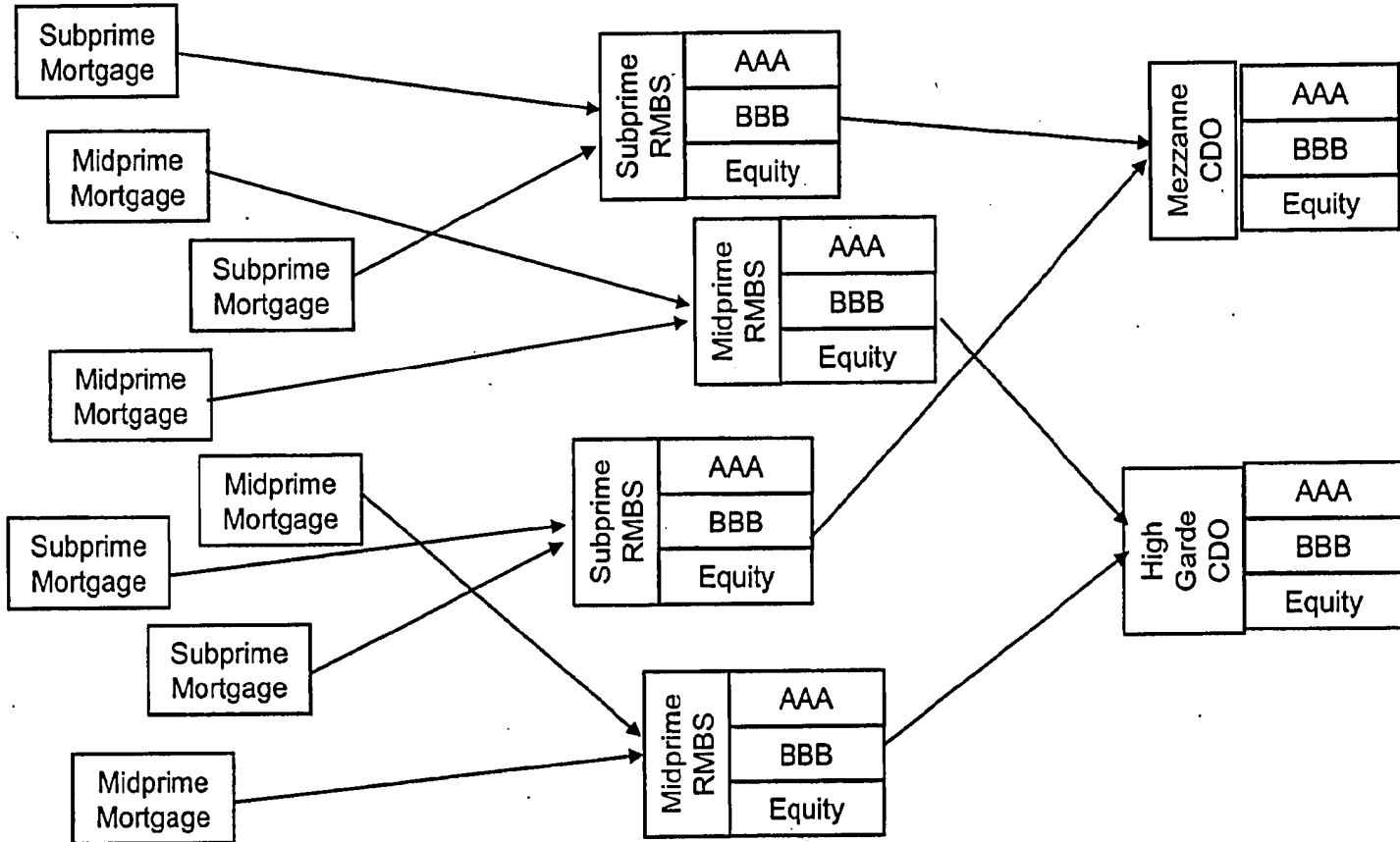
Product Description

- So the apparently 'super senior' CDO is actually protected from only 10% (from junior ABS tranches) + 40% * 5% (from junior CDO tranches) = 12% of the underlying mortgages – more like a mezzanine product!

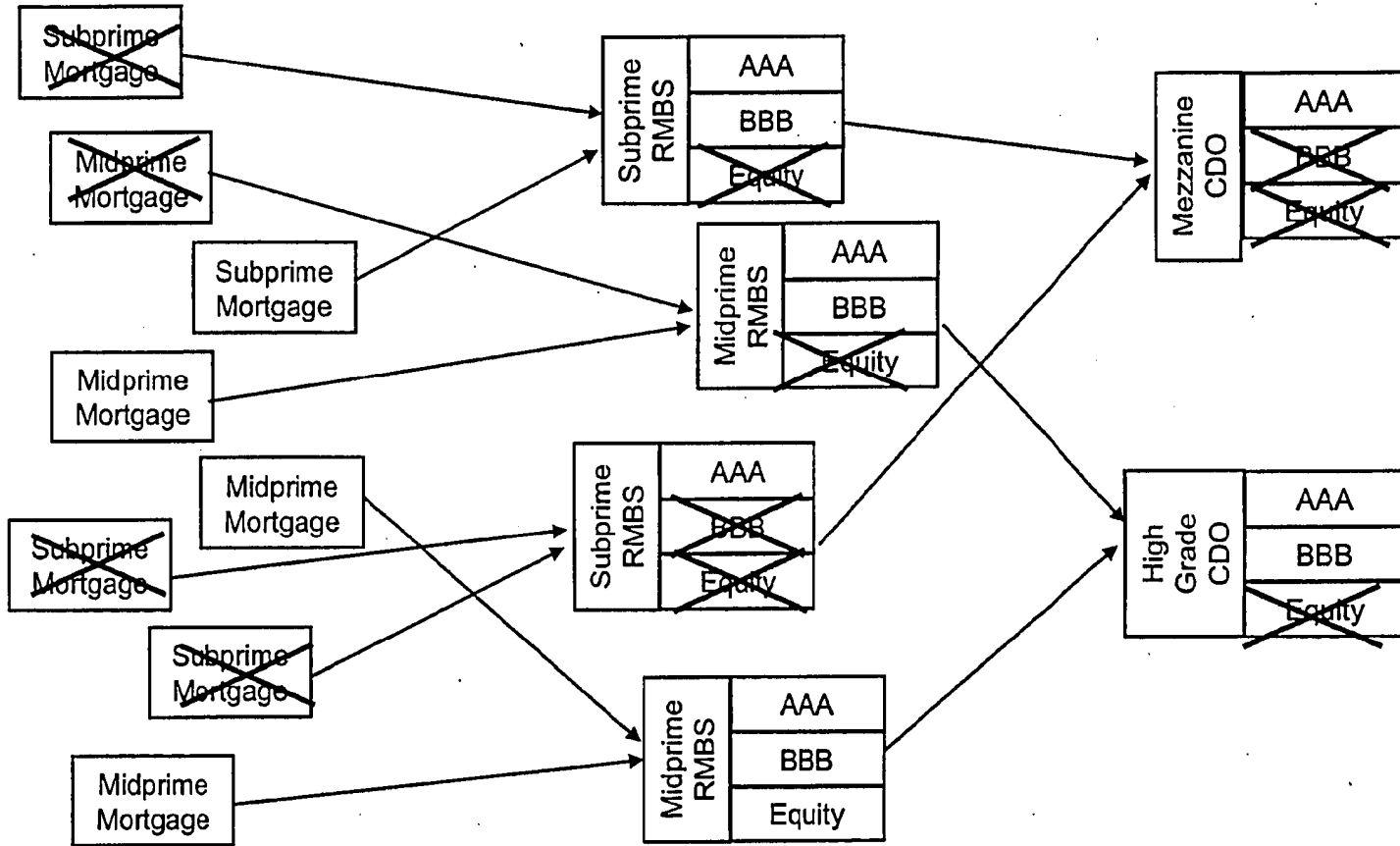
MV is banked Caveat: defaults take time to occur, over this time SS balance is being repaid and some
Pay-off of SS CDO as a function of mortgage losses



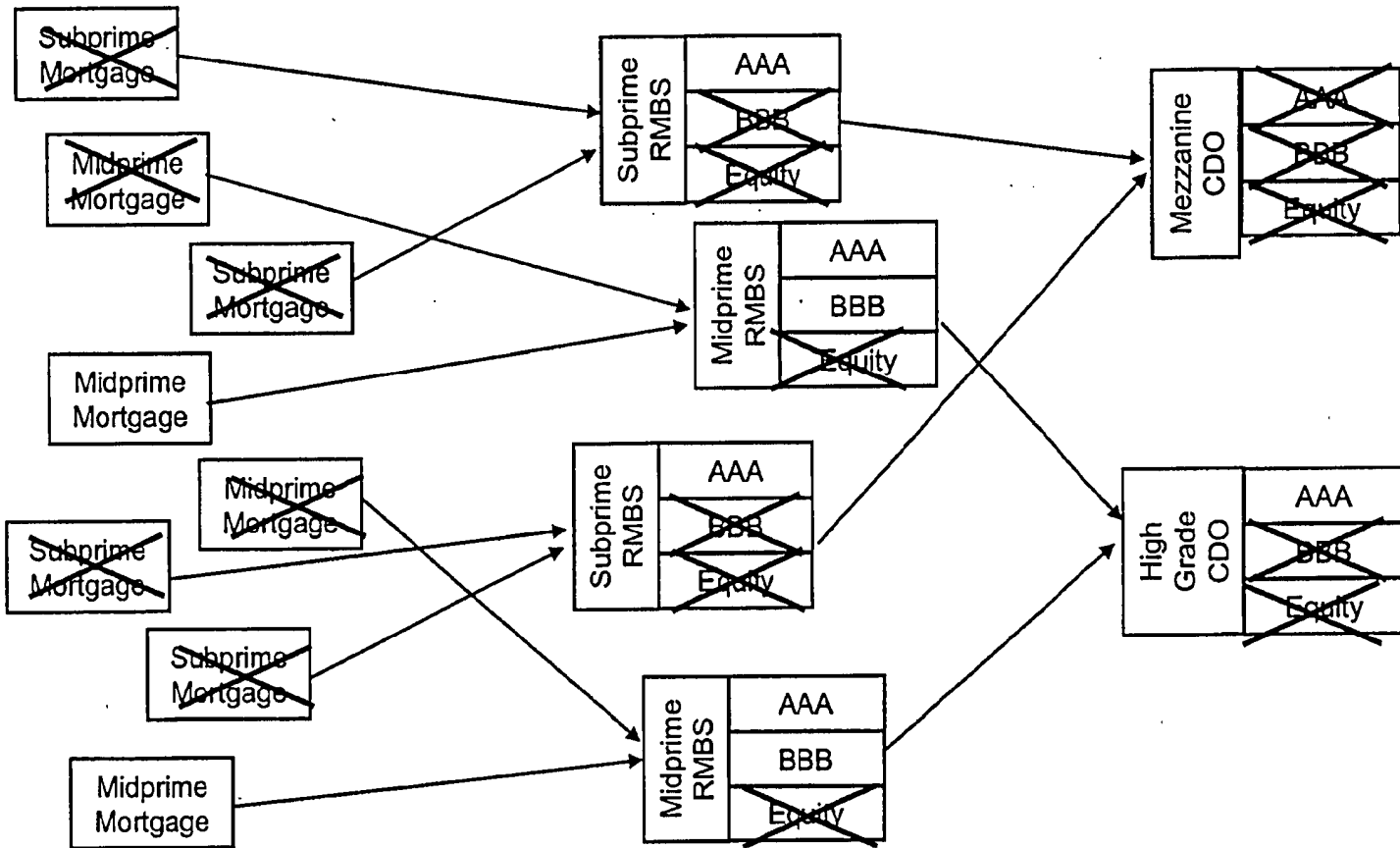
Product Description – Before Credit Crunch



Product Description – Where we are now



Product Description – Where the market thinks we are going



Model Description – Usual CDO model

- A standard synthetic CDO pricing model would price tranches by simulating the loss distribution of the underlyings, and taking risk neutral expectation of the pay-off (like any other derivative).
- Required Inputs:
 - Probability of Default: extracted from single-name CDS spreads
 - Recovery Rate: not traded, based on historical observation
 - Default Correlation: key ‘free parameter’ in CDO pricing. In the early days this was guesstimated by looking at historical data, now we can extract an implied correlation by tranche.
- Outputs:
 - Market Value
 - Sensitivity to spreads on the underlying, recovery rate and default correlation

Model Description – ABS CDO model

- Three key risk factors affect cashflows from underlying mortgage pool:
 - Conditional Pre-payment Rate (CPR)
 - Conditional Default Rate (CDR)
 - Loss Severity (LS)
- Not priced by market, need a historical model.
- Desk assumes that all of the above are driven by fixed property of the issuer (credit score, LTV, etc) plus a single variable: House Price Appreciation (HPA)
- HPA is specified according to evolution over four years
 - Worst case scenario in model is [-2.5%, -2.5%, 0%, +3%]

Model Description – ABS CDO model

- Mortgage Research group produces a look-up table mapping HPA scenario plus loan characteristics to CPR, CDR & LS
- Several limitations:
 - Calibration data are very limited, no large fall in nominal house prices in the US since 1930s.
 - Structural change in US housing market as mortgages are issued by brokers not banks, more floating rate mortgages, teaser rates etc.
 - CPR, CDR, LS are likely to be sensitivity to other variables that are not modelled e.g. interest rates, unemployment
- Can test model by implying net four year HPA from ABX
 - A-rated tranche (as of 8/14) implies net HPA \approx -30%
 - Recall that worst scenario run in the IV model: net HPA = -2%
 - -2% is too low, but -30% seems quite extreme, suggests that HPA-based model is incomplete

Model Description – ABS CDO model

- Given evolution of HPA we get CPR, CDR & LS, and hence we can in principle compute probability distribution of cash flows through CDO, and hence get a price
- But, cash flows from Mortgage Pool to ABS are opaque
 - We send our CPR, CDR & LS assumptions to a third party (www.intex.com), who tell us the resulting cash flows (!)
 - These are then run through CDO spreadsheet to get cash flow to tranches
- Process is time consuming and expensive so only a few scenarios are run
 - No probability is assigned to HPA scenarios, so no expectation can be computed
 - Instead we compute the value of the cash flow given some discount factor = Libor + spread
 - This is called the “Intrinsic Value” of the product

Model Description – Why this is a problem

- Imagine the Intrinsic Value approach were applied to pricing equity options. What would happen?
 - Value the options by specifying a few forward scenarios for the absolute value of the FTSE (spot = 6300), and discount
 - Say the worst forward scenario is [5700, 5300, 5000, 5400]
 - A written four year put with strike 4500 never expires out-of-the-money => option is priced very cheaply!
 - Even if the FTSE falls to 6000, we don't change the forward scenario, so no fall in intrinsic value => zero delta or gamma => zero risk!
- Correct approach is of course to specify *probability distribution of changes in* forward prices, and take discounted expectation
 - Non-zero price, non-zero FS, non-zero risk, even for deep out-of-the-money

Model Description – Why this is a problem

- The Intrinsic Value approach was applied by the desk (and rating agencies?) What happened:
 - Owning a Super Senior tranche is a bit like writing a deep out-of-the-money put, where premium is paid at expiry
 - Specify a few forward CPR, CDR & LS scenarios, none of which are bad enough to generate losses on the SS tranche
 - “Intrinsic value” is then just the notional less discount rate, only factor sensitivity is to the choice of discount rate
 - Model prices these options very cheaply, so we sell lots (tens of billion USD) of them
 - US housing market falls, underlyings fall in value
 - Projected HPA scenario still generates no SS loss, so model still shows no change in intrinsic value
 - But the market value of the puts falls, Citi loses billions.

Risk View – Measuring the Risk

- Risk Reporting
 - Existing Model cannot compute Factor Sensitivities to the underlyings, but does have sensitivity to the discount factor
 - This gives an indication of the magnitude, direction and tenor of exposure -> can be used to track the risk, maybe via GMR?
 - Does not capture the optionality in the tranches
- VaR
 - We have no pricing model, no factor sensitivities and no market price
 - Hard to see how we can build a VaR model in the short term

Risk View – Regulatory Capital

- Regulatory Capital
 - ABS CDO are currently covered under standard rules. Will this RAP go up if (when) rating agencies downgrade them?
 - Will continue to use standard rules going forward, no chance of Fed granting model approval for these products
 - ABS CDO (and all structured credit) present a challenge for modelling Incremental Default Risk
 - Tempting to use ratings to calibrate PD and default correlation and hence compute loss distribution
 - But all of the credit risk models are calibrated to corporate credit
 - We have no justification for assuming that the credit rating on structured credit is in any way equivalent to the same rating on corporate credit
 - Better to simulate the defaults on the underlyings (under some asymptotic large portfolio approx)
 - However opacity of ABS and ABS CDO could be a problem

Risk View – Going Forward

- Can only progress beyond the stress testing approach if we have some kind of pricing model, not an intrinsic value model
- What might this look like?
 - Start with HPA scenario based on house price forwards, as traded on the CME
 - Simulate changes in this using historical vols of HPA
 - Map the simulated HPA plus other factors like rates and macro-economy (?) to CDR, CPR & LS and value the deal
- Or, simulate CDR, CPR and LS directly? But how to calibrate these? And what about implied correlation?
- Need to work with the desk and with risk management to verify what I've said in this report, and work on a model that can estimate price and sensitivities

Risk View – Economic Risk Capital

- Would normally be based on 99.97th percentile VaR for Trading Book products, but VaR is not feasible in the short term
- More realistic to use stress loss, under a severe (99.97% equivalent) shock to the housing market
 - Need to estimate CDR, CPR, LS due to interest rates, macro-economic factors and HPA falls.
 - Could base on Citi's Global Real Estate Stress Test, or try to get data on historical real estate shocks (e.g. UK 1989-1993, Japan 1991-1995)
 - Might need to make more severe to get good estimate of true potential losses on SS tranche