Do CDOs Work?

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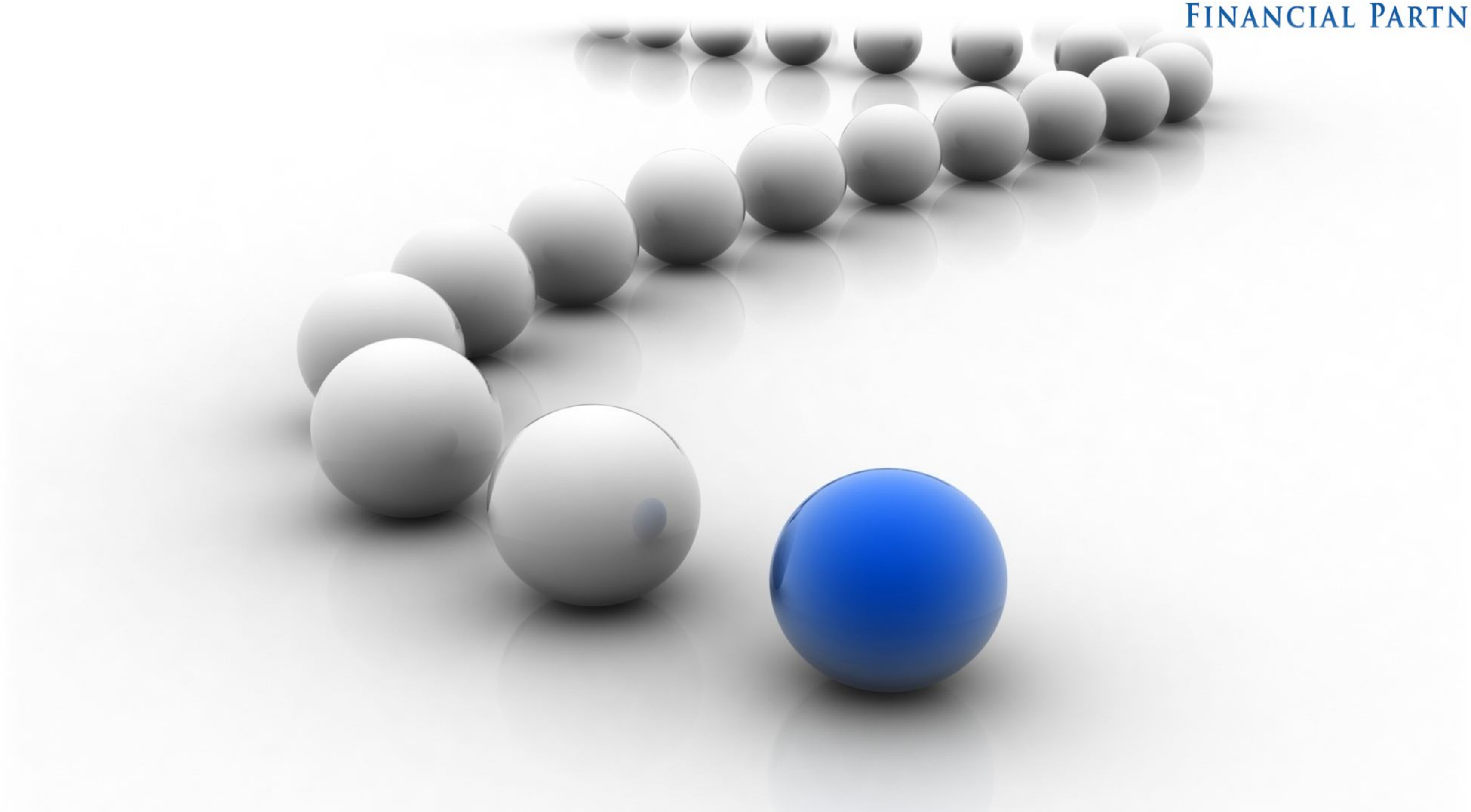

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Background

Economics of a CDO

Empirical test and examples

Conclusions

Aim

- **In the period 1998 to 2007, CDOs increased exponentially in both volume and diversity**
  - Prior to 2007, the CDO was seen as a successful financial innovation
- **However, the global financial crisis was partly catalysed by an implosion in the CDO market and caused massive losses for:**
  - Issuers (banks) through investments held, litigation, failed hedges, reputation
  - Investors, both in terms of default losses and those from forced liquidation
  - Third parties (e.g. rating agencies through loss of fees, reputation issues and litigation)
- **An obvious question is therefore:**
  - Is there something fundamentally wrong with the concept of a CDO?
  - Does it have economic value or is just a money making tool for investment bankers?

Assumptions

- **This analysis will be based on a CDO under the following assumptions**
  - Full capital structure (although this is not especially important)
  - Static portfolio (again particularly important as we care mainly about the initial portfolio)
  - Corporate credit risk (due to the richer data than for asset basked structures)
  - The ratings process used by ratings agencies for CDO structures during the period in question
- **A CDO is broadly speaking**
  - An investment at risk to a pre-defined range of losses on a certain portfolio
  - As such, the risk assessment requires an analysis of the multidimensional default distribution (which is quite complex)

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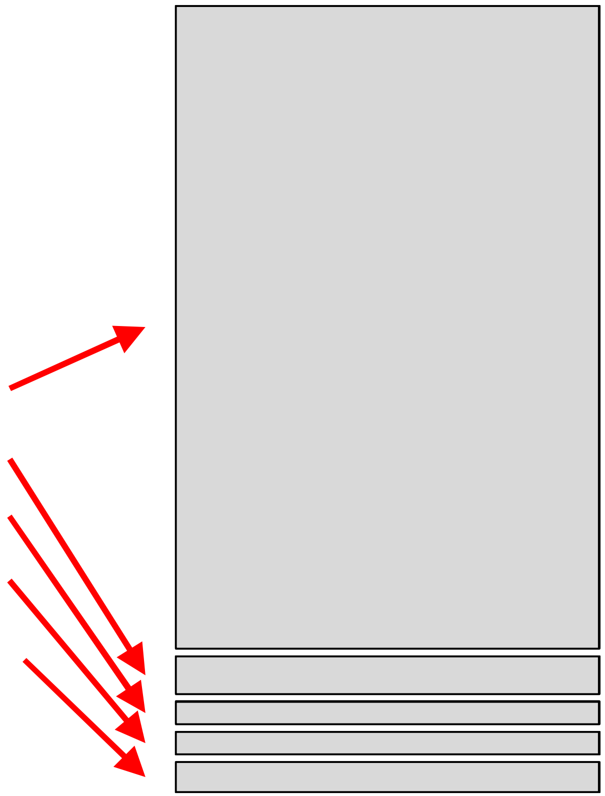
Example CDO

Class	Amount	Tranching	Rating	Funding
Super senior	850	[15-100%]	NR	Unfunded
Class A	50	[10-15%]	Aaa/AAA	Funded
Class B	30	[7-10%]	Aa2/AA	Funded
Class C	30	[4-7%]	Baa2/BBB	Funded
Equity	40	[0-4%]	NR	Funded



Example CDO Economics

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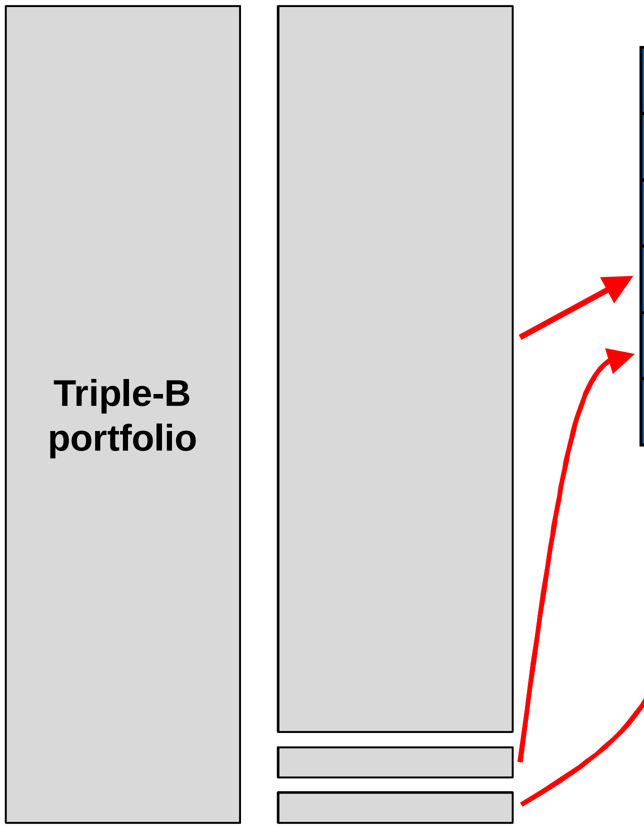
- **Very simple example (more rigorous one later)**



	Tranching	Rating	Coupon
Baa	[0-100%]	Baa	250
Aaa	[8-100%]	Aaa	100
Ba	[4-8%]	Ba	600
Caa	[0-4%]	Caa	1500

$$
\begin{aligned}
&\mathit{Excess\ Spread}\\
&= (250\\
&-100 \times 92\%\\
&-600 \times 4\%\\
&-1500 \times 4\%)\\
&\underline{= 74\ bps}
\end{aligned}
$$

If this number is large and positive then things are looking good

Due to the short duration of the equity tranche, the excess spread is a conservative measure of the profitability of a CDO

Economics of a CDO (1)

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- **Suppose there is a continuum of underlying tranches (full capital structure)**
  - Each tranche is denoted by *i*
  - The underlying portfolio is denoted by *p*
- **Consider expected loss as the main quantitative characteristic of the tranche**
  - Expected loss must be conserved across the structure

$$EL_P = \sum_i m_i EL_i \qquad \sum_i m_i = 1$$

Expected loss for unit tranche (under physical measure)

Tranche size

Economics of a CDO (2)

- **Investors will demand a premium for the losses they take**
  - Let us represent this as a multiplier α which varies for the different tranches and original portfolio and therefore represents the risk aversion for a particular seniority
  - Investors will be paid $\alpha_i m_i EL_i$
  - The CDO will "work" if

$$\alpha_p EL_P > \sum_i \alpha_i m_i EL_i$$

  - This basically requires that it is possible to buy protection cheaper via the CDO tranches than it is on the underlying portfolio
- **Note that the α will be determined via the coupon demanded on the various tranches by investors**

Risk aversion by seniority

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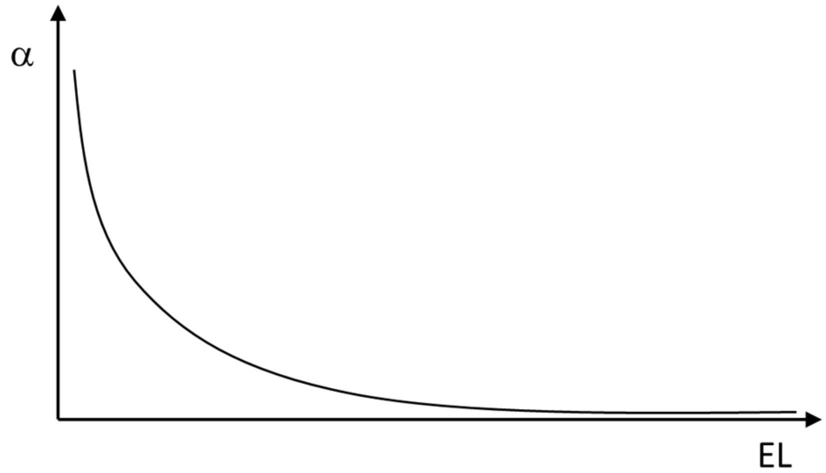
- **How do we represent α?**
  - The primary consideration of investors was the rating of the underlying tranche
  - In turn, the fundamental driver of ratings would be the expected loss of a tranche (or default probability in the case of Standard & Poor's)
  - Hence we assume

$$\alpha_j = \left(\frac{a}{EL_j}\right)^b$$



- **Properties**
  - Risk-neutral investors, $b = 0$
  - Risk aversion for a, $b > 0$
  - More relative risk aversion for small expected losses

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- **What parameters are required for a CDO to work?**
  - We require:

$$\alpha_p EL_P > \sum_i \alpha_i m_i EL_i \qquad \alpha_j = \left(\frac{a}{EL_j}\right)^b$$

  - Which becomes:

$$\left(\frac{a}{EL_p}\right)^b EL_P > \sum_i \left(\frac{a}{EL_i}\right)^b m_i EL_i$$

  - Simplifying to:

$$EL_P^{1-b} > \sum_i m_i EL_i^{1-b}$$

  - Which is satisfied when $b < 1$

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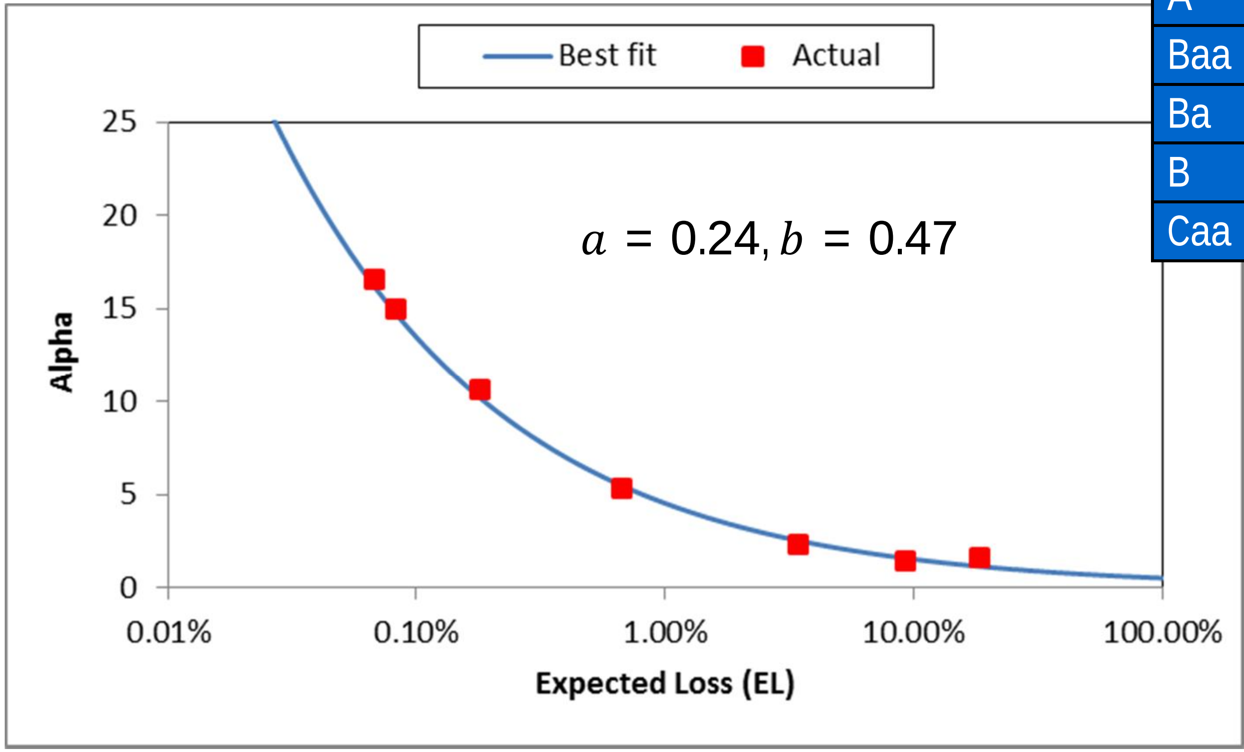
Example calibration

- **Hull, Predescu and White (2005)**
  - Time period, December 1996 to July 2004
  - Merrill Lynch bond indices and Moody's data



	Default intensity		
	Real world	Risk-neutral	Ratio
Aaa	4	67	16.8
Aa	6	78	13.0
A	13	128	9.8
Baa	47	138	5.1
Ba	240	507	2.1
B	749	902	1.2
Caa	1690	2130	1.3

Assume recovery rate of 40%

Back to a simple example

- **Rating assumptions**
  - Expected loss based
  - Gaussian copula approach with flat correlation of 20%

Rating	Tranche	5-year exp loss	Multiplier	Protection value	Size	Spread (bps)
Baa	[0-100%]	1.296%	5.1	6.610%	100%	144
Aaa	[8-100%]	0.072%	16.8	1.210%	92%	26
Ba	[4-8%]	6.702%	2.1	14.074%	4%	321
Caa	[0-4%]	36.498%	1.3	47.447%	4%	1376

$$Excess\ Spread = (144 - 26 \times 92\% - 321 \times 4\% - 1376 \times 4\%) = \underline{52\ bps}$$

Hamilton, D., P. Varma, S. Ou., and R. Cantor, "Default & Recovery Rates of Corporate Bond Issuers, A Statistical Review of Moody's Ratings Performance, 1920-2003", 2003, Moody's Investor Research, January.

Hull, J., M. Predescu and A. White, 2005, "Bond Prices, Default Probabilities and Risk Premiums" Journal of Credit Risk, Vol. 1, No. 2, pp. 53-60.

$$Net\ protection\ value = 6.610\% - 1.210\% \times 92\% + 14.074\% \times 4\% + 47.447\% \times 4\% = \underline{3.036\%}$$

Implication

- **Assuming investors demand a return based on the expected loss (via the rating) of a tranche**
  - A CDO always "works" due to the risk preferences of investors (the equity tranche is relatively cheap to get rid of due to the small alpha multiplier)
- **Another implication of this is that rating agency modelling assumptions cannot cause the CDO to fail**
  - For example, let us look at correlation assumptions

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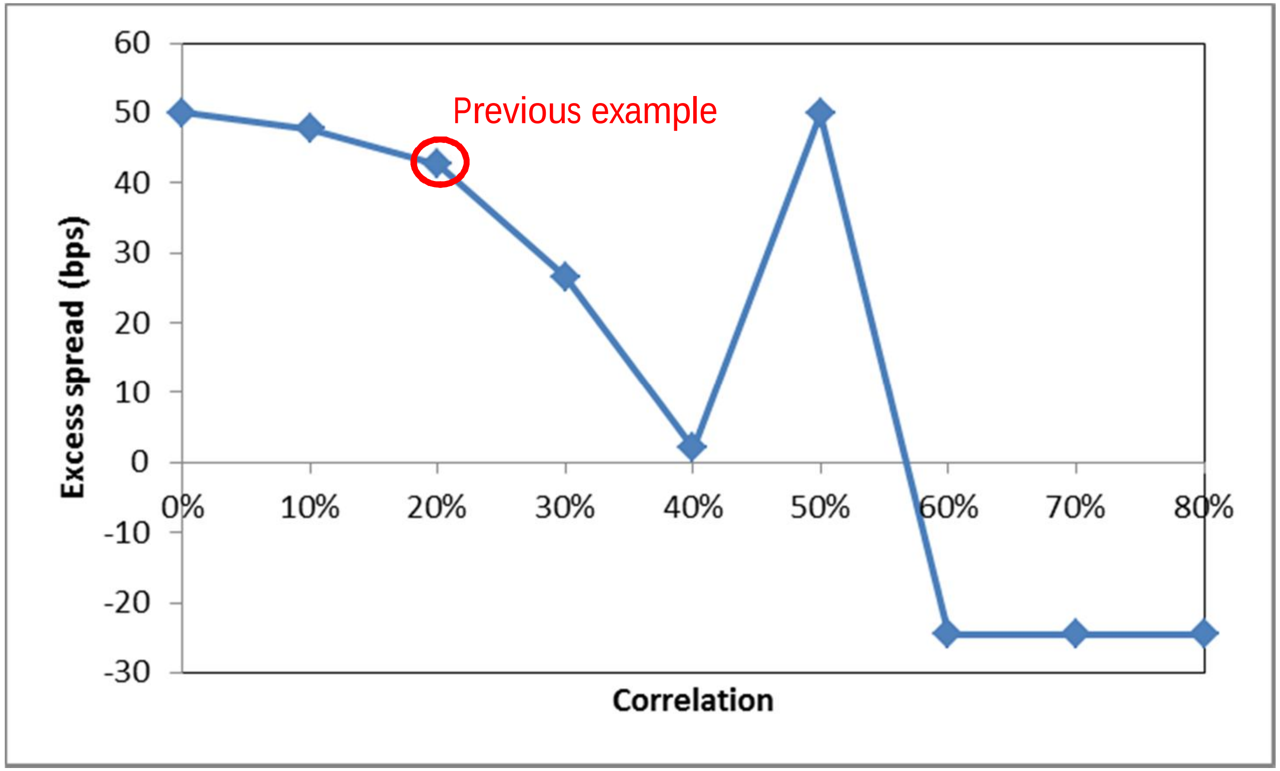
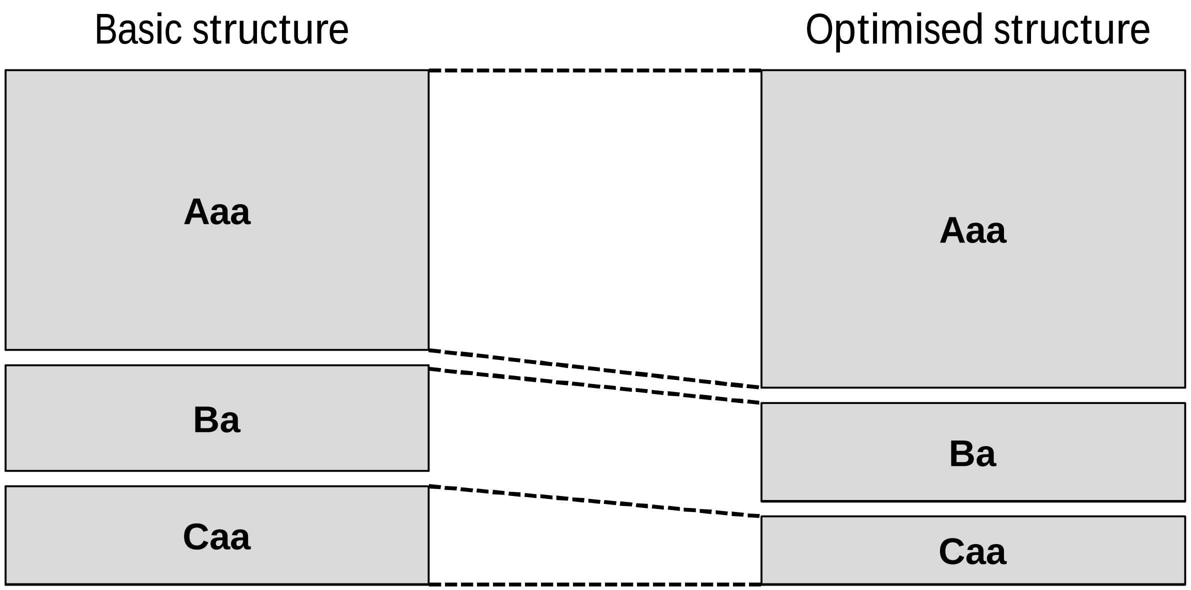
- **Excess spread as a function of flat correlation assumptions in rating model**
  - CDO clearly "fails" at high correlation



Optimized structure (1)

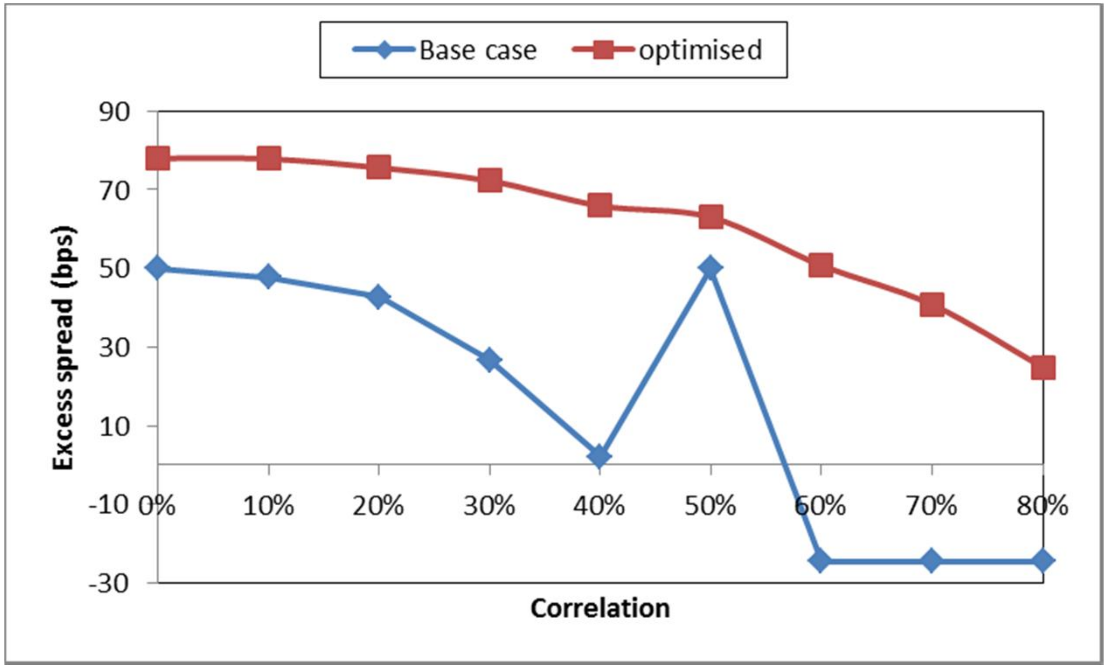
- **Previous failure was due to the granularity in the ratings process**

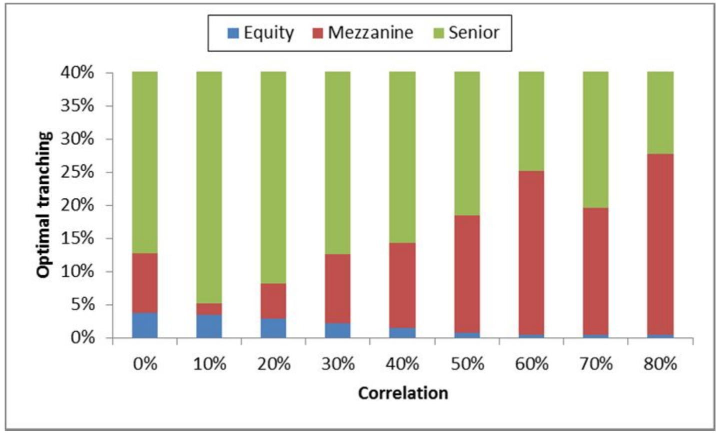


- **Therefore we assume a simple optimisation**
  - Make the equity tranche small enough to just support a given rating (Caa is best)
  - Find the size of the mezzanine tranche to give the best excess spread

Optimized structure (2)

- **Now the CDO works at all correlation levels**





- **Note there is still some inherent granularity**
  - Can't get any worse than Caa or better than Aaa

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- **A CDO works due to**
  - The risk preferences of investors
  - The expected loss methodology used in the ratings process
- **A CDO is not a zero sum game**
  - Both issuers and investors (and third parties) can gain
  - Just because an issuer makes money, no direct implication that investors are getting a bad deal
- **Rating agencies were not at fault?**
  - No modelling assumptions would have caused CDOs to be unprofitable
  - Although rating agencies primary reliance on quantitative models based on expected loss as the only metric could be seen as too simplistic and a fundamental flaw

So what did go wrong? (with CDOs at least)

- **Lack of proper assessment of counterparty risk in the structuring process**
  - The more senior the tranche, the more counterparty risk (relatively) – see my book!
  - Large senior tranches were offloaded to monoline insurers without any collateral terms to mitigate the counterparty risk
  - E.g. see Gregory, "A free lunch and the credit crunch", Risk, August 2008
- **Lack of appreciation of the systemic risk in senior tranches**
  - Were investors sufficiently compensated for this?
  - Gibson, M., 2004, "Understanding the risk of synthetic CDOs", Finance and Economics Discussion Paper, 2004–36, Federal Reserve Board, Washington DC / Coval et al, 2009, "Economic catastrophe bonds," American Economic Review, 99(3), 628—66.
- **Maybe there is sufficient value in a CDO to overcome the above problems**
  - But the market was too greedy and now it may be too late!