Recent Developments in the Credit Derivatives Market

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Outline

- A brief update on the credit derivatives market
- The growth of the CDS indices and their expansion into ABS.
- Finding value in static credit
    - CDOs to CDO squared
- Finding value in dynamic credit
    - CPPI and CPDO
- The challenge of pricing correlation products
- Any questions ?

How tradable indices are transforming the credit markets

The Credit Derivatives Market

Market Growth

We keep hearing that the credit derivatives market is large ...

- The BBA 2006 survey estimated the total market notional at the end of 2006 to be \$20.207 trillion.
- The ISDA mid-2007 survey estimated the size of the credit derivatives market to be \$45.25 trillion.
- The US OCC June 2007 survey of US commercial banks found that the total notional amount of credit derivatives held by US commercial banks was \$10.2 trillion.

Compare this to the size of the:

- US corporate bond market which is currently \$5.7 trillion
- US Treasury market which is currently \$4.3 trillion[1].
- Global equity derivatives market which ISDA estimated in mid-2007 to have a total notional of \$10.01 trillion.

Where has this all this growth come from ?

[1] Securities Industry and Financial Markets Association Research Quarterly, August 2007.

Explaining the Recent Growth

	Market Share(%)		
Product Type	2002 Survey	2004 Survey	2006 Survey
Credit linked notes	8.0	6.0	3.1
Single-name credit default swaps	45.0	51.0	32.9
Credit spread options	5.0	2.0	1.3
Equity linked credit products	-	1.0	0.4
Total Single-Name	58.0	60.0	37.7
Full index trades	-	**9.0** →	**30.1**
Swaptions	-	1.0	0.8
Basket products	6.0	4.0	1.8
Synthetic CDOs - full capital	-	6.0	3.7
Synthetic CDOs - partial capital	-	10.0	12.6
Tranched index trades	-	**2.0** →	**7.6**
Others	36.0	8.0	5.7
Total Multi-Name	42.0	40.0	62.3

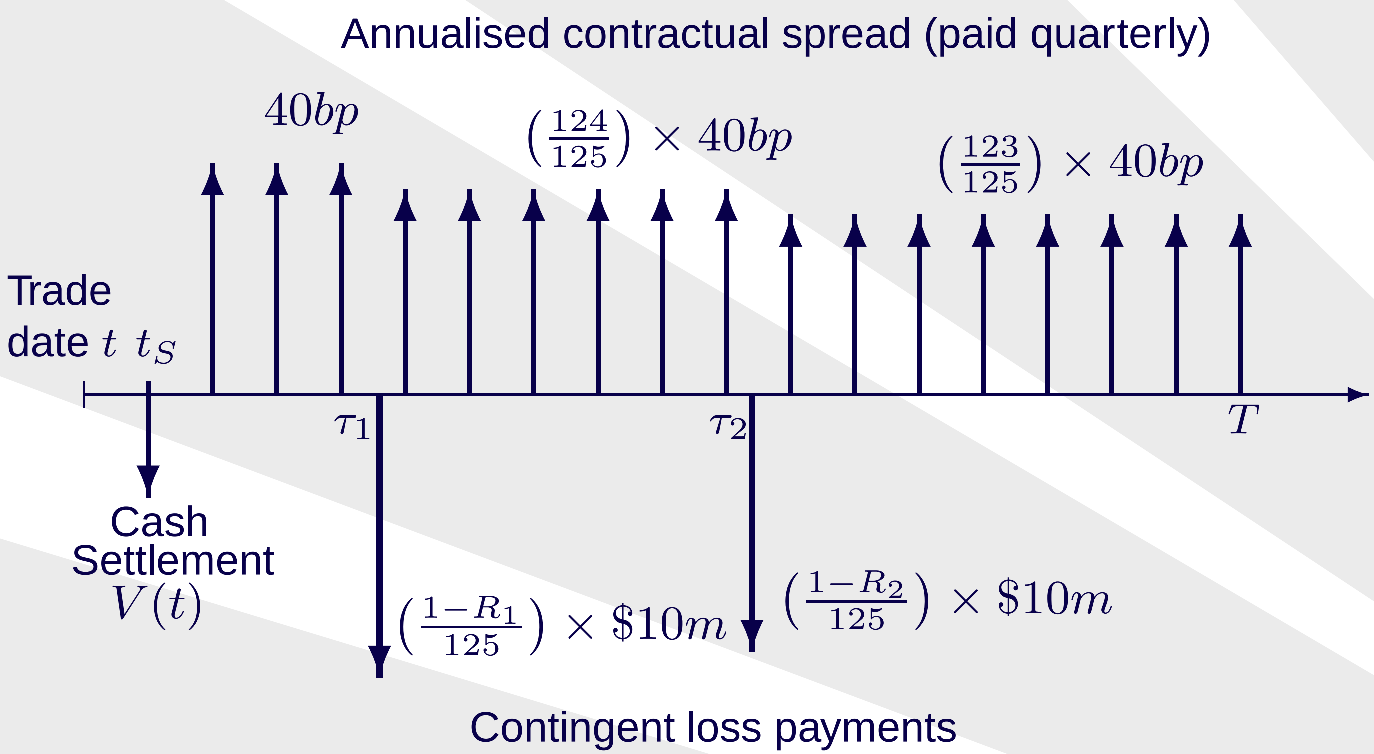
- This survey[2] makes it clear that the main drivers of growth have been the CDS indices and tranched indices.

[2] Source: BBA Credit Derivatives Report 2006.

CDS Indices

Mechanics of a CDS Index

Face value of \$10m and index coupon of 40bp and 125 credits in the index



- We consider a scenario with two defaults. After each:
  - There is a loss payment from the index buyer to the index seller based on the recovery value of the defaulted credit,
  - The size of the coupon is reduced by $1/125$.

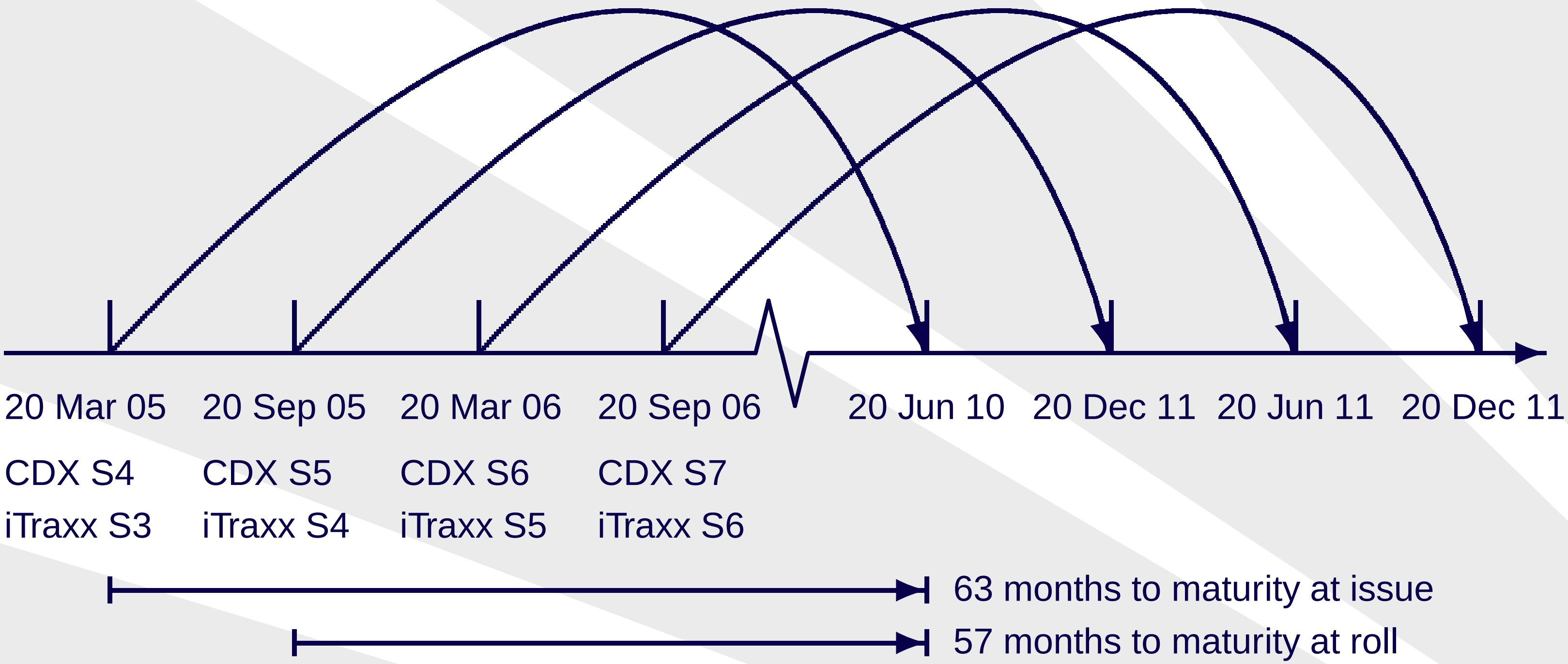
The Value of a CDS Index

- The value of a CDS Index is the expected value of the cash received if we enter into an off-setting position.
- This is given by

$$MTM(t) = (S(0) - S(t)) \times \mathrm{RPV01}(t, T)$$

where $S(0)$ is the coupon on the index, $S(t)$ is the current index spread, and $\mathrm{RPV01}(t, T)$ is the risky PV01 of the index.

Each CDS Index is one of a series



- 5 year maturity CDS index swaps are issued in March and September for maturity in the June and December respectively in 5 years time.
- Index constituents change based on eligibility - mainly investment grade status and liquidity.
- Each issue has a coupon set so that the index price is par on issue date.
- The most recently issued index is the *on-the-run* - it has the greatest liquidity.

The Family of CDS Indices early 2006

There is a broad range of CDS indices

Name	Type of Credit	Number of credits
CDX.NA.IG	North American investment grade	125
CDX.NA.HY	North American high yield	100
CDX.NA.XO	North American crossover	35
CDX.EM	Emerging market sovereign	15
CDX.EM.Diversified	Emerging market sovereign and corporate	40
iTraxx Europe	European investment grade	125
iTraxx Europe XO	European crossover	40
iTraxx Japan	Japanese investment grade	50
iTraxx Asia ex-Japan	Asian non-Japan investment grade	50
iTraxx Australia	Australian investment grade	25

- Though the credits are different, they all obey the same mechanics.
- Many of these indices are now on their 9th Series.
- Considerable liquidity with bid-offer spreads typically 0.25-0.5bp.

Reasons for success of the CDS Indices

- Since the indices contain as many as 125 credits, the portfolio CDS index allows investors to take a broad exposure to the credit markets in a single transaction.
- The portfolio CDS index allows hedgers to go short the credit markets in a single transaction. This is useful for credit funds, hedge funds or banks who wish to hedge a broad exposure to the credit markets.
- Since the portfolio CDS indices have a small initial cost, they can be used to take a leveraged credit exposure.
- More efficient for those who fund above LIBOR.
- Portfolio CDS indices can be used as the underlying for other derivative products such as Single Tranche CDOs, CPPI, CPDOs as we discuss later ...

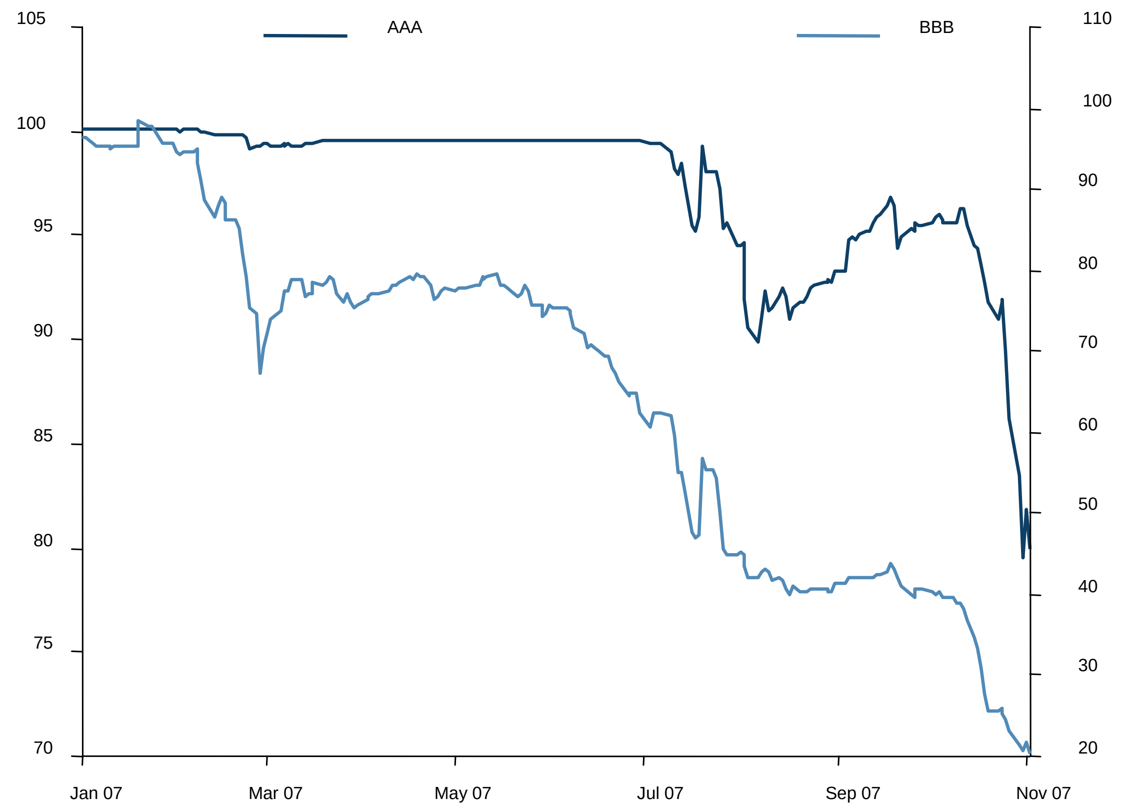
The New Additions

- **LCDX** : This index references the US loan CDS market
  - 100 loan-only CDS (LCDS)
  - Linked to syndicated first-lien North American loans selected for liquidity.
- **LevX**: This index references the European loan CDS market.
  - Senior index references the 35 most liquid 1st lien credit agreements traded in the European LCDS market.
  - Subordinated index references the 35 most liquid 2nd and 3rd lien credit agreements traded in the European LCDS market.
- **ABX.HE** : An index which references the US sub-prime home equity market.
  - Family of 5 sub-indices each based 20 US sub-prime home equity deals.
  - Sub-indices contain the different rated tranches of the deals
  - Consist of RMBS tranches with initial ratings of AAA, AA, A, BBB and BBB-.

The Mechanics of the ABX.HE indices

- First ABX.HE index started trading in January 2006 and a new series is produced every 6 months.
- The ABX *events* are
  - Writedown
  - Principal short-fall
  - Interest short-fall with fixed cap
- The first two trigger a loss payment from protection seller to protection buyer. The third allows the protection buyer to reduce or skip a coupon payment.
- Indices are issued with a fixed coupon which is paid monthly set so that price close to par at issue.
- The outstanding principal is captured using a Current Factor Q. Initially $Q = 1.0$. Captures amortization in the underlying reference obligations.
- Quoting convention: A coupon of 30bp and price of $101.5 means that the protection seller pays $\$1.50 \times Q$ to enter into the index swap and then receives an annualised spread of $30\mathrm{bp} \times Q$.

The ABX.HE Index



Source: Barclays Capital

- For those who could not sell, ABX.HE was the only way to hedge the sub-prime crisis
- Not an exact hedge for a specific security since ABX.HE is based on 20 different reference obligations, i.e. it captures the market 'beta'.

The Robustness of the Credit Derivative Market

The credit derivative market has seen other crises too. In the past 10 years the credit derivatives market has weathered

- The 1997 Asian Crisis
- The 1998 Russian default
- The events of 11th September 2001
- Railtrack bankruptcy in October 2001
- Default of Enron in December 2001 ...
- The downgrade of Ford and GM in May 2005

Two observations:

1. These events have demonstrated that credit derivatives are the only realistic credit hedging tool.
2. Following each event, the market has adapted to agree new standards which solve any problems which these events may have exposed. The milestones were the adoption of the ISDA 1999 and then the ISDA 2003 standards.

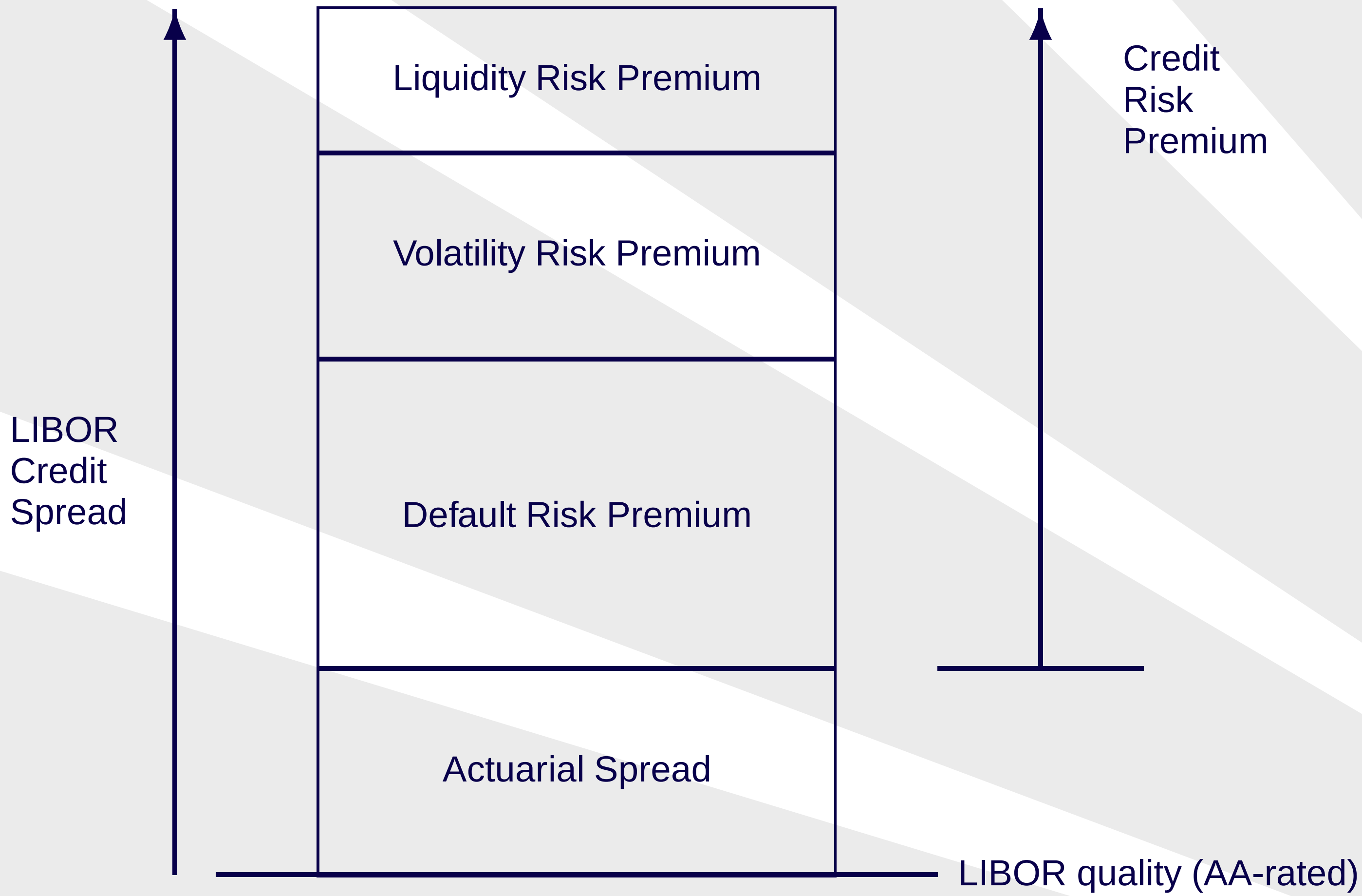
Finding Value in Static Credit

The Credit Risk Premium

We can decompose the credit spread of an issuer (versus LIBOR) into the following components:

- **The Actuarial Spread**: The spread implied by the expected loss based on historical data.
- **Default Risk Premium**: The risk that the historical default statistics do not reliably predict the default risk of the credit to which the investor is exposed. This uncertainty, and the fear that the true default risk is higher than the actuarial spread implies.
- **Volatility Risk Premium**: The risk that the credit quality of the issuer changes, as evidenced by a change in the market spread of the issuer. This may cause the value of the position to fall, even if there is no default. If the investor then wishes to sell the credit position, this will result in a realised loss.
- **Liquidity Risk Premium**: The risk that a reduction of the liquidity of the instrument prevents the investor from being able to sell the bond when they wish due to a lack of demand for the credit.

The Credit Risk Premium



- We use the *credit risk premium* to capture the additional spread over the actuarial spread.
- We use the credit spread against LIBOR. This excludes the swap spread ... but this does not change the overall picture.

Defining Measures of the Credit Risk Premium

- We can then define two measures:

$$\begin{aligned} Spread\ Premium &= Libor\ credit\ spread - Actuarial\ spread \\ Coverage\ Ratio &= \frac{Libor\ credit\ spread}{Actuarial\ spread} \end{aligned}$$

- In *Spread Premia for Portfolio Tranches*[3], we took a large pool of credits with liquid 5Y CDS quotes and bucketed them by rating and calculated the average spread.
- We also used Moody's cumulative default probabilities to compute the actuarial spread by rating assuming an average recovery of 40%.

Rating	AA+	AA	AA-	A+	A	A-	BBB+	BBB
5Y Average Spread (bp)	19	28	37	47	61	75	116	164
Expected Loss (%)	0.21	0.45	0.53	0.59	0.67	0.80	1.10	1.50
Actuarial Spread (bp)	5	9	11	12	13	16	22	30
Coverage Ratio	4.47	3.12	3.52	4.05	4.67	4.77	5.33	5.54
Spread Premium	14	19	26	36	48	59	94	134

[3] O'Kane and Schloegl, 2001, Lehman Brothers Quantitative Credit Research Quarterly

Static Credit - Leveraging the Spread Premium

We were able to make a number of observations:

- First-loss correlation products leverage the credit risk premium of the underlying portfolio.
- The amount of credit risk premium is typically larger than that of single-name credits paying the same market spread.
- Second-loss products leverage the coverage ratio of the underlying portfolio. Although the market spread is usually much lower than a first-loss product, the actuarial risk per unit of spread is much lower.
- Note that rating agencies determine the credit rating of a structured product on the basis of actuarial loss.
- This was a driver of much of the innovation seen in the credit derivatives market and drove the creation of products such as:
  - CDO squared
  - Leveraged super-senior

Finding Value in Dynamic Credit

Credit CPPI

The credit derivatives market has seen a growth in dynamic credit products

- There is no long-dated options market in the credit indices.
- Most traded options on CDS indices have times-to-expiry of 6-12 months.
- For investors seeking principal protected structures, there is no zero-coupon bond + long-dated option strategy.
- The liquidity and unfunded nature of the CDS indices has made CPPI possible.
- CPPI stands for Constant Proportion Portfolio Insurance and is a well-known dynamic trading strategy which produces a principal protected and leveraged exposure to an underlying asset.
- There was a considerable amount of CPPI issuance in 2005-2006.

Credit CPDO

- In late 2006, the Credit CPDO arrived.
- CPDO = Constant Proportion Debt Obligation.
- Aim is not to protect principal but to earn a high return.
- Initial products were able to pay LIBOR plus 200bp and get a AAA rating on the principal and coupon.
- Very attractive, especially for banks who under Basel II are charged capital according to the credit rating of the asset.
- How is this risk-return profile possible ?

Need to understand the mechanics of the CPDO.

Mechanics of the CPDO

1. At initiation of a CPDO deal, the investor pays $100 to the issuer of the CPDO.
2. This issuer invests the $100 in a deposit account at some short term rate, e.g. 3 month LIBOR. This cash is to be used as collateral for the leveraged investments undertaken within the CPDO structure. The value of the deposit account at time t is $D(t)$.
3. The CPDO then takes a leveraged long index (short protection) exposure to a credit index. We denote the notional of the index portfolio at time t with $N(t)$. We also assume that coupons which have been received minus any default losses have been included in the value of the deposit account $D(t)$ which continues to grow at a short-term LIBOR rate.
4. The issuer checks to see if the trade should terminate.
5. If the trade does not terminate, the issuer waits until the next rebalancing time and returns to step (3).

Trade Termination

This can happen in one of three ways:

1. **Cash-in**: The NAV is greater than the target value. Once this happens, the assets in the CPDO are liquidated and used to purchase a risk-free investment, which will guarantee payment of the specified coupons and principal. There is no further credit risk.
2. **Cash-out**: The NAV of the CPDO falls below a certain threshold, say $10. A value of $10 is chosen so as to minimise the gap risk to the issuer who does not want the NAV to fall below zero. The CPDO is liquidated and the proceeds are paid to the investor. This is the CPDO's version of a default event.
3. **Maturity**: The CPDO structure reaches maturity without either a cash-in or cash-out event having occurred. This usually means that the target value has not been reached, and there is not enough cash to pay all of the principal. This is also a default.

Determining the CPDO Leverage

The size of the leveraged position in the credit index is given by

$$N = \min\left[K, \frac{\mathrm{TV} - \mathrm{NAV} + B}{\mathrm{PV01} \cdot C}\right]$$

where

- TV is the target value. It equals the present value of the CPDO coupons and principal discounted on the risk-free curve.
- K is an upper limit on the amount of leverage,
- NAV is the value of the deposit account (which grows at Libor and collects the index coupons. It also pays out the investor coupons) plus the index portfolio value.
- C is the coupon on the current index.
- PV01 is the time t value of a 1 bp LIBOR annuity to maturity time T,
- B is a buffer used to increase the leverage.

To put it in words, N is how much index we would need in order to earn the carry needed to close the gap between the target value and the NAV by the end of the trade's life.

Understanding the Leverage

At time 0, when the contract begins:

- Assuming that the CPDO pays a floating coupon of LIBOR plus S_{CPDO}

$$\mathrm{TV} = 100 + \mathrm{PV01} \cdot S_{CPDO}$$

  where $\mathrm{PV01}$ is the present value of a 1 basis point annuity to time T present valued on the LIBOR quality curve.

- Initially, $D = \$100$ and $V = 0$. Assuming $B = 0$ and K is large, we have

$$N = \frac{S_{CPDO}}{C}.$$

- The leverage is simply the ratio of the CPDO spread and the index spread. If $S_{CPDO} = 200$bp and $C = 40$bp then the leverage is 5.0.
- If the index spread was fixed at 40bp, and there was no risk of default, then the leverage would remain fixed for the life of the contract and the contract would be risk-free !
- This leverage only just gets us to the target at the trade maturity. The buffer B can help us to get there sooner.

Leverage

- We calculate the post-index roll leverage assuming an initial leverage of 5.
- Initial 5Y index coupon is 40bp. New index spread has changed to value shown.

Years to Maturity	10	9	8	7	6	5	4	3	2	1
LIBOR PV01	7.67	7.07	6.43	5.76	5.06	4.31	3.54	2.72	1.86	0.95
Target Value	115.3	114.1	112.8	111.5	110.1	108.6	107.1	105.4	103.7	101.9
Index Spd(bp)	Leverage									
10	12.2	11.5	10.7	9.6	8.1	6.1	3.0	-	-	-
20	7.4	7.2	6.9	6.5	6.0	5.4	4.3	2.6	-	-
30	5.8	5.7	5.6	5.5	5.3	5.1	4.8	4.2	3.1	-
40	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
50	4.5	4.6	4.6	4.7	4.8	4.9	5.1	5.5	6.2	8.2
60	4.2	4.3	4.4	4.5	4.7	4.9	5.2	5.8	6.9	10.3
70	4.0	4.1	4.19	4.3	4.6	4.8	5.3	6.0	7.5	11.9
80	3.8	3.9	4.1	4.2	4.5	4.8	5.3	6.2	7.9	13.0
90	3.7	3.8	4.0	4.2	4.4	4.8	5.4	6.3	8.2	13.9
100	3.6	3.7	3.9	4.1	4.4	4.8	5.4	6.4	8.5	14.6
110	3.5	3.6	3.8	4.0	4.3	4.8	5.4	6.5	8.7	15.2
120	3.4	3.6	3.7	4.0	4.3	4.8	5.4	6.6	8.9	15.7

- The greater the widening in the index spread, the greater the loss.
- The wider the index spread, the greater the carry earned to make up the loss in the remaining years.
- The target value falls and so does the gap as we approach maturity.

Simulation Dynamics

To assess the risk of this trading strategy, we set up a simulation.

- The index spread is modelled as a single mean-reverting normal process with jump diffusion

$$dS = \kappa(S_\infty - S)dt + \sigma_S dW_t + J(dN - \lambda dt)$$

  where κ is the speed of mean-reversion, S_∞ is the level of the long term spread, σ_S is the basis point spread volatility of the Brownian motion W_t, N_t is a Poisson process with intensity λ and the jump size is J.
- The positive jumps and the mean-reversion make it almost impossible for the spread to drift below zero (in any case we floor the dynamics at 0 just to be sure).
- The interest rate dynamics obey

$$dr = \sigma_r r dW_r$$

  where we allow for a correlation between the processes

$$\rho = \mathbb{E}^Q \left[dW_S dW_r\right]$$

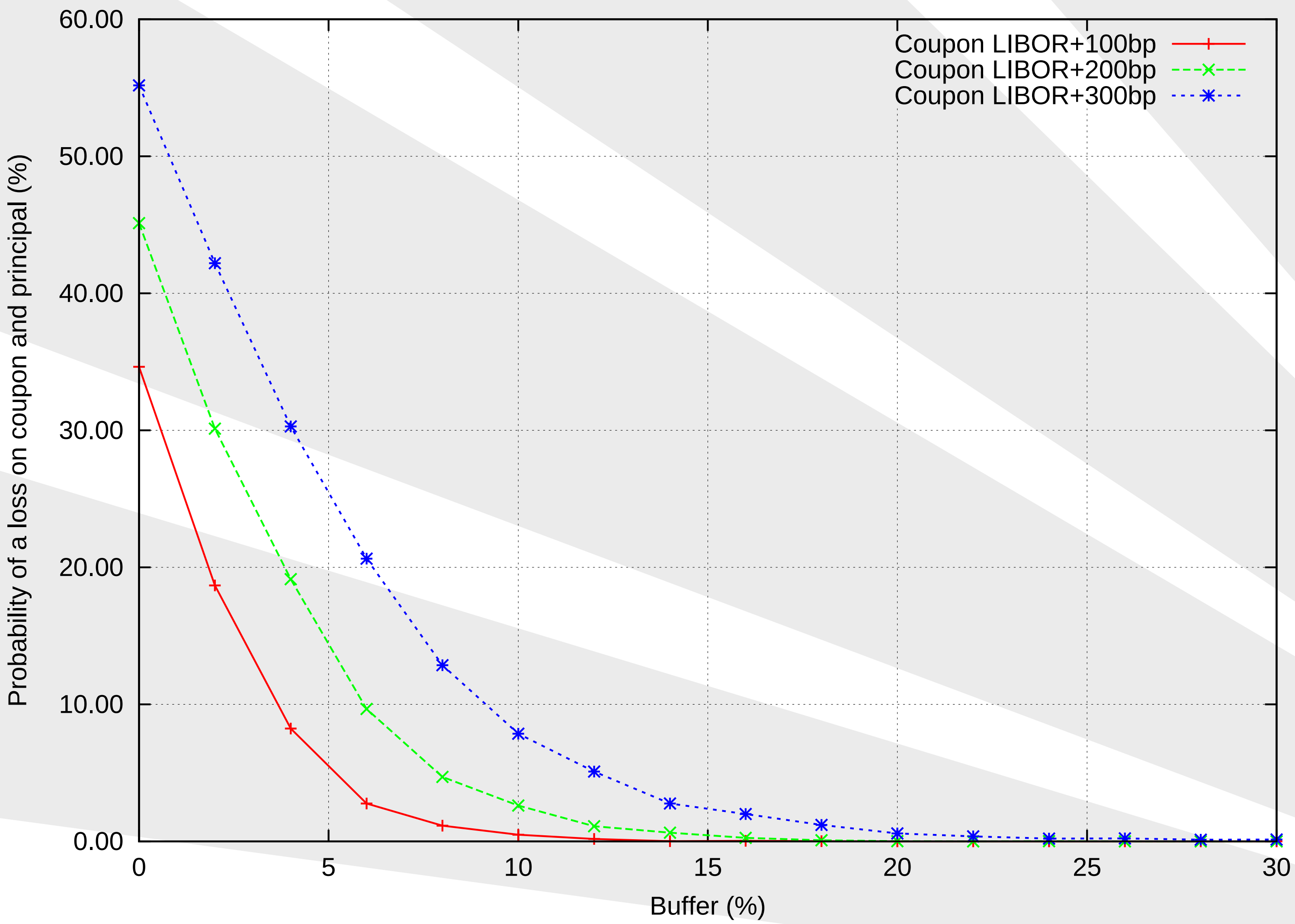
Model Parameters

- We performed a simulation with the following parameters:

$$
\begin{aligned}
\kappa &= 1.0 \\
S_0 &= 40\text{bp} \\
S_\infty &= 40\text{bp} \\
r_0 &= 5\% \\
\sigma_S &= 20\text{bp } (\simeq 50\% \text{ volatility}) \\
\lambda &= 1.0 \text{ corresponds to about 1 jump per year} \\
J &= 10\text{bp} \\
\sigma_r &= 20\% \\
\rho &= 0\%
\end{aligned}
$$

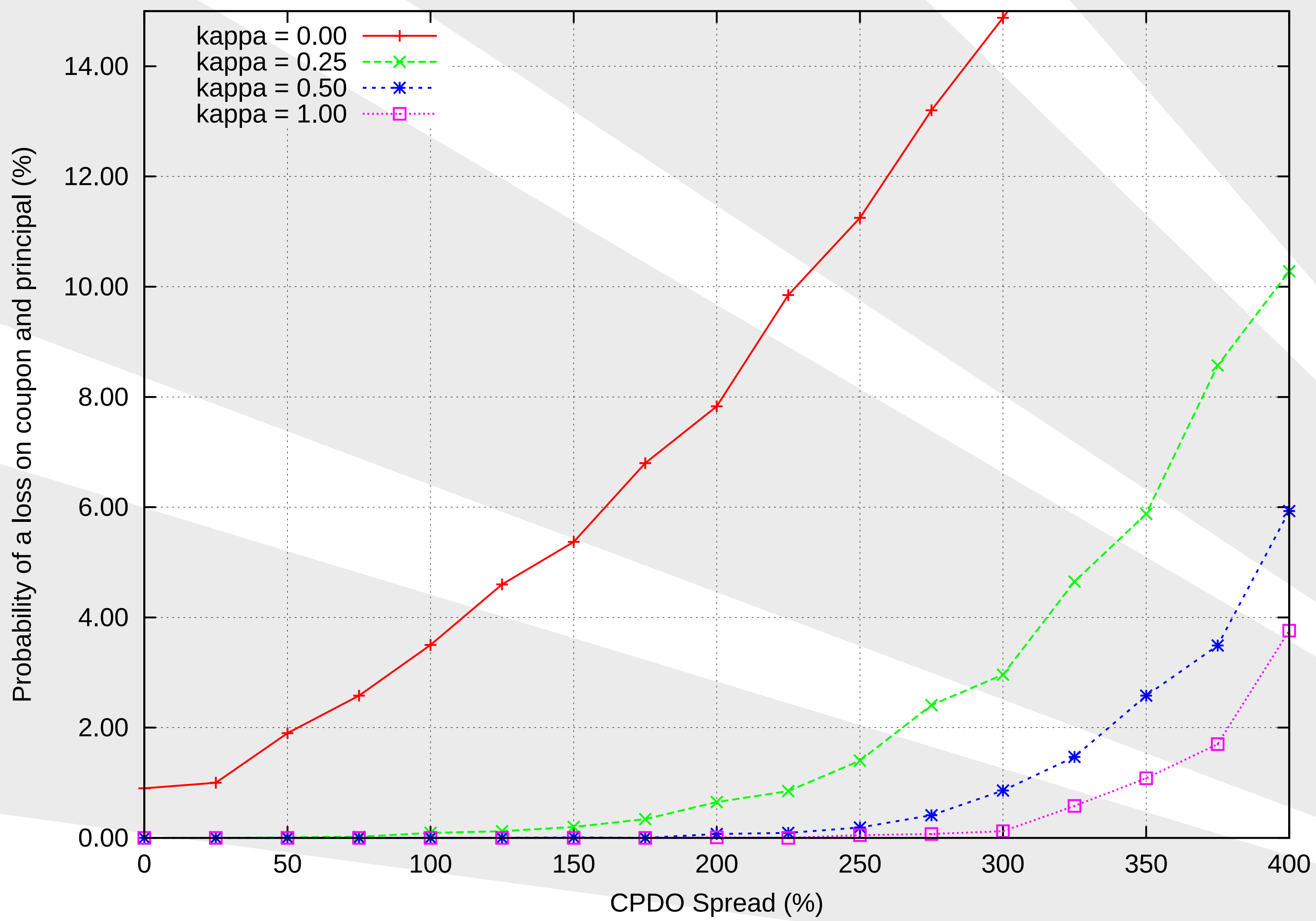
- We have not modelled default - it is implicit in spread jump dynamics.
- We ran 10,000 Monte-Carlo paths for each result.
- We rebalanced every 3 months and assumed an index roll every 6 months.
- We ignore fees and hedging costs.
- We examine the probability of a loss on coupon or principal.

Role of the Buffer



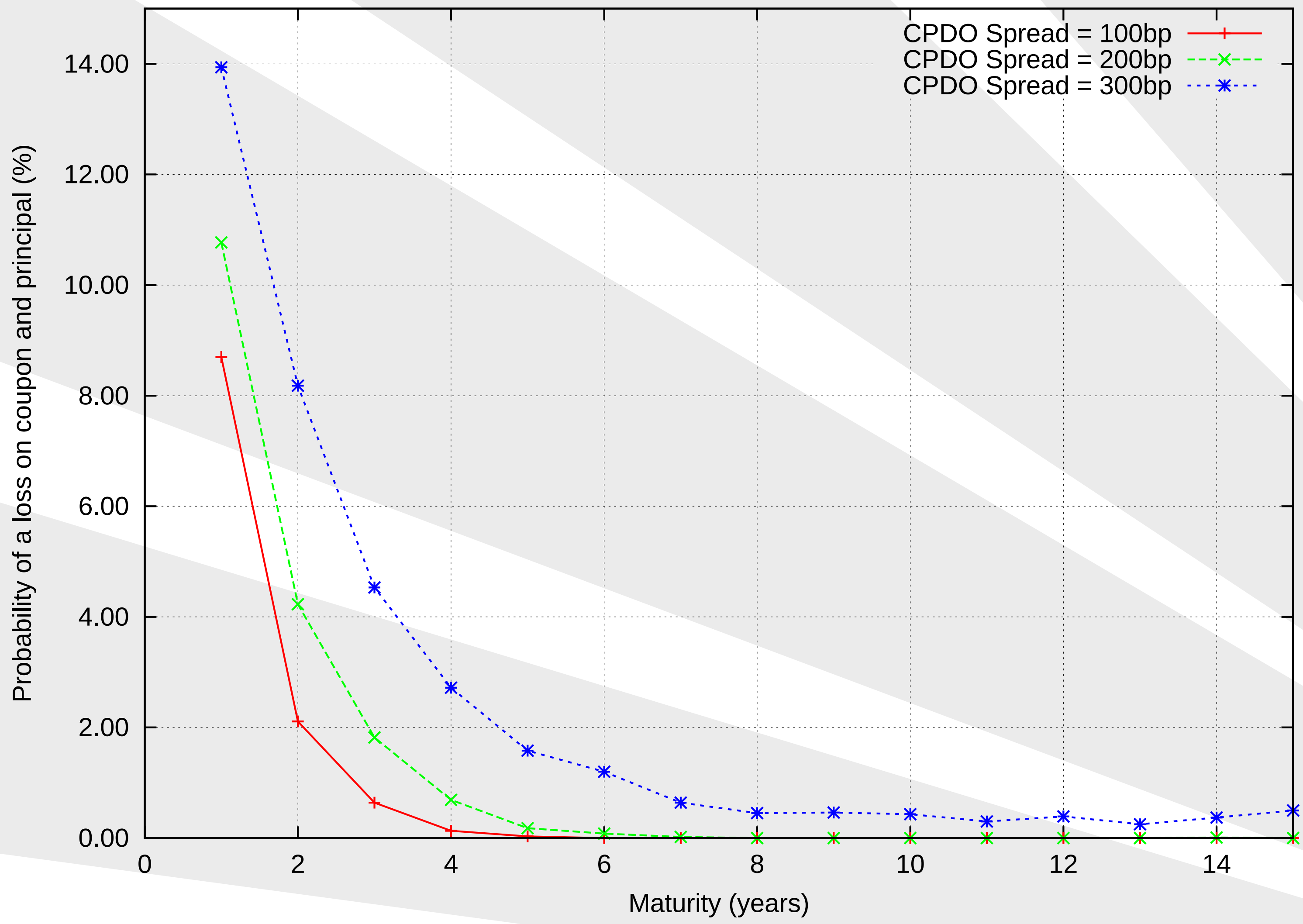
The value of the buffer plays an important role in *boosting* the leverage.

Role of Mean-Reversion



The mean-reversion of spreads is essential for the success of this strategy.

Role of Tenor



This strategy needs time to work ... very different to traditional credit loss probability profile !

CPDO Conclusions

- Only works if we have an index - single credits can default!
- Rolling the index ensures that we have a survival bias.
- The CPDO is an ingenious exploitation of the mean-reverting dynamics of credit spreads.
- Large issuance and leverage means that it has a real effect on dampening spread movements.
- The CPDO product is generating the mean-reversion it needs!
- No need to rebalance as often as in a CPPI and hence lower transaction costs.
- CPDO trades can present a lot of mark-to-market volatility.
- They also need to be given time to work.

The challenge of modelling correlation

The Index Tranche Market

Since mid-2003, there has been a market for tranches on the standard indices

	CDX Investment Grade North America Series 7			iTraxx Europe Series 6		
Tranche	Lower-Upper Strike	Upfront Payment (%)	Running spread (bp)	Lower-Upper Strike	Upfront Payment (%)	Running spread (bp)
Equity	0-3	24.88	500.00	0-3	12.12	500.00
Junior Mezzanine	3-7	-	90.00	3-6	-	55.00
Senior Mezzanine	7-10	-	18.25	6-9	-	14.62
Senior	10-15	-	8.00	9-12	-	6.50
Super Senior	15-30	-	3.50	12-22	-	2.75

Market prices for the CDX NA and iTraxx Europe tranches in March 2007.

- Each price implies a correlation - we have an implied correlation market.

The challenge of correlation modelling

- In addition to the standard index tranches, there has been a considerable amount of product innovation over the past few years, e.g. CDO-squared and leverage super senior.
- Further development is hampered by the use of *base correlation* which is not an arbitrage-free consistent model.
- While just about acceptable for index tranches, using it for anything more complicated is pretty heroic.
- There is a need for models which have realistic dynamics:
  - Realistic spread dynamics
  - Default clustering
  - Relationship between macro default rates and recovery rates
  - Combine spread and default risk in a consistent manner.

  ... and can fit the market price of index tranches.
- This necessitates moving beyond the copula approach.
- There are two approaches being considered.

Next generation correlation models

- *Top-down* approaches.
  - Model the evolution of the index loss distribution directly without modelling the individual credits.
  - Can therefore be calibrated exactly to market index tranche prices.
  - Dynamics link default and spread risk.
  - Examples include recent papers by Schonbücher and Sidenius et al.[4]
- *Bottom-up* approaches.
  - Start with single-name spread/default dynamics of each credit
  - Model the index loss distribution as the aggregate behaviour of the single-name credits.
  - See recent papers by Joshi & Stacey, and Chapovsky, Rennie & Tavares.

Maybe the next generation of products will leverage the spread premium dynamically !

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[4] Check out www.defaultrisk.com