

**SAMPLE**

CREDIT DERIVATIVES:  
THE MARCH TO MATURITY

Edited by Duncan Wigan

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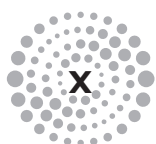


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## Introduction

*By Duncan Wigan, assistant professor, International Centre for Business and Politics, Copenhagen Business School*

Credit derivatives complete the markets for financial risk, referencing in addition to the price and rate risks seen in other financial derivatives, the risk of default. The market provides the opportunity for corporations, governments and financial institutions to actively manage or trade pure credit exposures by taking on or laying off repayment risks associated with bonds or loans. More than two years after the first eruption of the global financial crisis, this report takes stock of the development of the credit derivatives market in a fast-changing environment, outlining the evolving regulatory context, specifying the latest technologies in terms of correlation and pricing, and providing actionable and state-of-the-art advice as to how best to use credit derivatives in portfolio optimisation processes, to hedge, and to trade credit exposures.

As the financial system now emerges from the worst crisis since the Great Crash of 1929 and credibility is restored, this report gathers together the best minds in the field to, on one hand, explore the weaknesses that the crisis revealed and how these are being addressed, and on the other, point to the way forward with a constant eye on practical insights. Credit derivatives play a systematic role in the operations and architecture of contemporary global finance to provide investment opportunities and facilitate financial strategies and optimisation processes that simply would not exist in their absence. As such, the authors here, a veritable world select, take on and execute an urgent and pressing task.

### Market development

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Until 10 years ago, the credit derivatives market remained the preserve of a handful of the most sophisticated market participants able to price, design and manage contracts individually and according to their idiosyncratic requirements. Developments in pricing, documentation and the market's legal infrastructure meant that, into the new century, credit derivatives became a broadly popular asset class hosting a wide variety of instruments from the plain vanilla to exotic structured products. The market grew from approximately US\$180bn in 1996 to a high of US\$58–62trn in 2007, just prior to the onset of the systemic crisis. Today, the value of the credit derivative market is approximately one half of that high and it might seem, on the face of it, that the market is in decline. Recall that similar conclusions were drawn



ultimately buffers losses and is intended to make banks more resilient against financial stress.

### Hybrid Tier 1 before the crisis

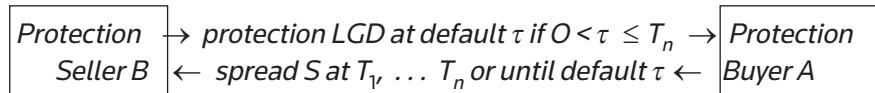
Nevertheless, a consistent definition of regulatory capital, especially with respect to Tier 1 capital, did not really exist in the past. The only guidelines that were actually published date back to the year 1998 when the BCBS published its so-called Sydney Press Release which provided a brief summary of the most important features hybrid instruments must meet to be eligible for inclusion in Tier 1 capital. However, as the two-page document obviously left some room for interpretation, national implementation with respect to rules on Tier 1 hybrids across the EU differed widely. As bank failures were rare and a longer period of stress within the entire banking sector, as well as skipping coupons or not calling Tier 1 hybrids at the first possible call date was considered rather unlikely, market participants usually did not attach great importance to inconspicuous but sometimes very important differences in the legal documentation of Tier 1 instruments. However, with the development of the crisis, the existing differences in legal terms became more and more important. While the uncertainty about the interpretation of legal documentation was important for investors, banking regulators were more concerned about the actual quality of the instruments included in Tier 1 capital. As regulatory capital can be seen as a last line of defence for a bank in a crisis, it is crucial that it really holds. Nevertheless, with no real definition and definite rules regarding what can be included in Tier 1 capital, in the recent past it was quite common that banks paid coupons to investors or avoided nominal write-downs, even if the issuing bank was unprofitable and had to release reserves in order to make these payments. Another problem with Tier 1 hybrids was that banks called outstanding instruments at the first possible date, despite the fact that the market conditions prevailing at the call date were disadvantageous.

“As regulatory capital can be seen as a last line of defence for a bank in a crisis, it is crucial that it really holds”

### The new definition of hybrid Tier 1 capital

The lack of a consistent definition of what features an instrument must meet to be eligible for inclusion into regulatory Tier 1 capital is not new and had been an area of discussion for international banking supervisors long before the crisis emerged. However, due to the events following the summer of 2007, banking supervisors accelerated their work towards creating one single set of rules for all banks within the EU and finally introduced new rules by amending the CRD in September 2009. With the new rules, regulators take a principle-based approach and will focus on three key characteristics that Tier 1 hybrids must meet going forward, referred to as ‘permanency’, ‘loss absorption capacity’ and ‘flexibility of payments’.

protection buyer the notional amount minus recovery. The leg which pays upon default is called the protection leg or default leg and the leg which pays the coupons is called the premium leg. The lost notional minus recovery is called the loss given default,  $LGD$  and can be expressed in terms of a recovery rate,  $R$ , as  $LGD = N(1-R)$ . The spread  $S$  associated with the coupon payments  $C(T_j)$  is called the contractual or fixed spread. This spread is typically fixed when the trade is executed and held constant to maturity .



The dates  $T_j$  are typically fixed as quarterly dates during the year called IMM-dates (20 March, 20 June, 20 September, 20 December) where adjustments are made should any date fall on a holiday.

We explicitly point out that we assume the offered protection amount  $LGD$  to be independent of the default time  $\tau_i$ , thus we can do calculations with a deterministic  $LGD$ . The time  $T_i$  is computed by the number of days to the  $i$ -th coupon payment date and divided by the daycount convention (e.g. 360).

Using terminology from the market, the deal is struck on the trade date for protection starting on a specified effective date. Upfronts and accrued amounts are exchanged on the cash settlement date. In the mathematical exposition that follows we make the simplifying assumption that all three dates coincide.

This form of the CDS contract, that has been dominant until 2009, is expected to be replaced by the upfront CDS contract described below, at least for North American corporate CDS.

### Premium and protection legs, and spot running CDS spreads

Let  $D(t, T)$  denote the discount factors at time  $t$  for maturity  $T$  and assume them to be independent of the default time  $\tau$ .

As we are going to illustrate, all CDS valuation terms, observed at time 0, can be expressed using survival probabilities, also observed at time 0:

$$Surv(T) := Prob(\tau > T),$$

i.e. the probability that the name survives time  $T$ . It follows that the default probability is

$$Prob(\tau \leq T) = 1 - Surv(T). \tag{1}$$

Let the interval between coupon payment  $i-1$  and  $i$  be denoted  $\Delta_i = T_i - T_{i-1}$  with  $T_0 = 0$ . The value of the premium leg of a CDS at time 0 can be decomposed into the value of the premium leg paying one basis point, the  $DV01^2$ , scaled by the spread (in basis points):

“The severe market environment at present is putting pressure on many regions and industries simultaneously”

Moody’s continues to follow closely any changes in future corporate default rate expectations and macroeconomic outlooks. We intend to make necessary adjustments to the default probability stress factor as is considered appropriate. However, no change was anticipated at the time of writing.

#### *Recovery rates*

The recovery rates assumed in the rating process are stochastic variables whose distribution is determined according to the seniority of the debt and the country of jurisdiction. Those recovery rates follow a beta distribution, and they are all correlated through a Gaussian copula with 10% correlation. In most cases, the assumed average recovery rates of CSO portfolios are between 30% and 40%.

#### *Correlations*

In recent years there has been a remarkable increase in the complexity and global nature of financial markets, which has made credit markets much more interdependent than was the case only a decade or so ago. This increase in correlation among different markets has led to a substantial increase in the extent to which stress in one sector can impact another. Additionally, the severe market environment at present is putting pressure on many regions and industries simultaneously. Both factors have led to a sharp increase in observed default correlation among and between corporate and structured finance credits.

Moody’s has raised asset correlation assumptions in the investment-grade rating categories and in the financial sector in order to generate default correlations that are consistent with its current observations. Accordingly, asset correlation assumptions have been updated as follows.

For synthetic CDOs, Moody’s derives its default correlation from an analysis of the historical evolution of default rates:

- ▶ The variance of those historical default rates allows us to determine the value of the asset correlation;
- ▶ In addition those historical default rates allow us to check the resilience of our Aaa rated tranche according to the parametrisation of the asset correlation chosen.

The dependency between defaults of individual debt instruments is captured through a Gaussian copula approach. In this approach, each entity default in the referenced portfolio is represented as a threshold on a standard normal variable that has a binary outcome; if that random variable goes below the threshold level the entity defaults, otherwise it does not. The dependency is then characterised by correlations between those Gaussian variables, with two

The super senior tranche is particularly sensitive. Note that a recovery of rate of 40% implies a maximum loss of 48.7179% on the super senior tranche.

Table 11.7

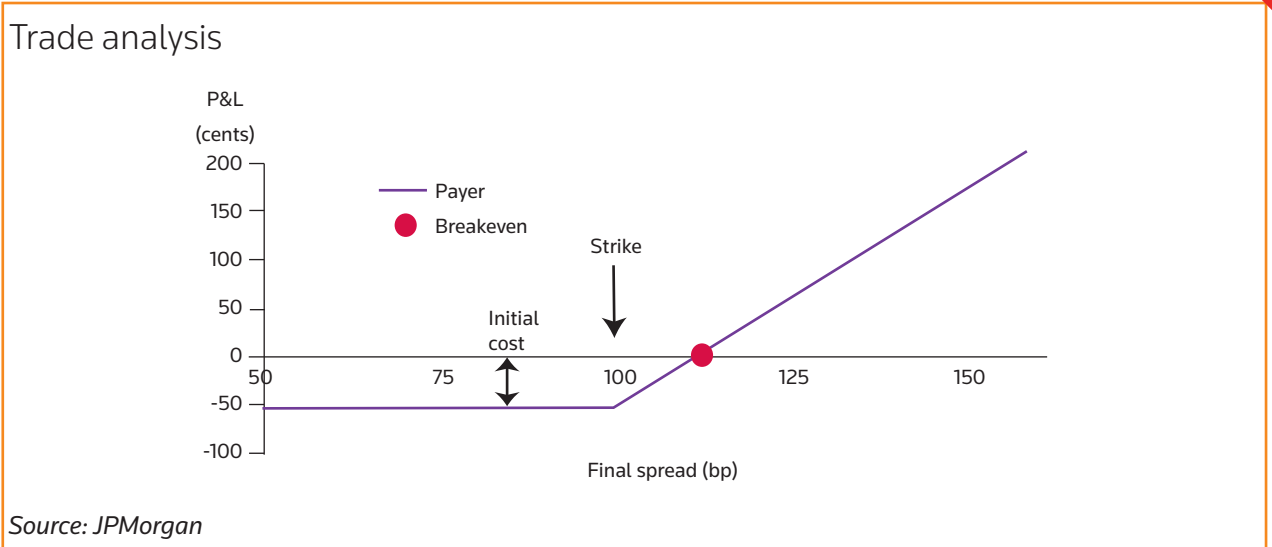
Unit variance Gamma versus standard normal distribution

a	0.1	1	10	N
v	13.5025	7.1117	4.5972	3.4316
k	60	6	0.6	0

Source: Authors

These approaches share the fact that the default time  $\tau_i$  is found by inverting (1) for a given probability  $p$ . Hence the strongest dependence between probabilities, i.e, 100% correlation or equal probabilities, does not lead to the strongest dependence in terms of default times as the default intensities  $\lambda_i(u)$  may be different. The worst case is clearly equal default times. To this end, we introduce a common shock that knocks out the whole portfolio. Let us consider the survival probability of firms which are subject to an idiosyncratic and a systematic shock common to all firms. The shocks are assumed to follow independent Poisson processes. The idiosyncratic shock intensity is  $\lambda_i$  for firm  $i$  and the systematic shock intensity is  $\lambda_s$ . The individual survival probability for firm  $i$  becomes  $P_i(t) = P(\min(\tau_i, \tau_s) > t) = \exp(-(\lambda_i + \lambda_s)t)$ . Working out the joint survival probability of two firms we arrive at the Marshall-Olkin survival copula. Contrary to the Gaussian copula that has no tail dependence unless the correlation coefficient is one, the Marshall-Olkin copula has upper tail dependence. Hence the introduction of a common systemic shock creates a heavy tail dependence. Figure 11.4 shows the detail of the tail of the loss distribution for portfolios of 20 tranches where the collateral is subject to a common shock with an intensity of  $\lambda_s = 2bp$ . The time horizon is  $T = 5$ , five years. The systematic correlation,  $\rho_a = 0\%$ , is zero. Hence, except for the common shock, all the underlying credits are independent. Observe that the probability of surviving the common shock  $P_s(T) = \exp(-\lambda_s T)$  is higher than 99.9%. Hence, the effect of the common shock is not visible at the 99.9% quantile  $Q_{99.9\%}$ . The corresponding TVaR  $T_{99.9\%}$  correctly measures the risks associated with this common shock. Table 11.9 shows the results. Obviously, the super senior tranche is most affected by this systematic risk of a common shock.

Figure 13.11



### The adjusted-forward – accounting for ‘no knock-out’

A CDS option is an option on the forward spread of the CDS at the expiry of the options. The option model we use is a Black model based on the distribution of the forward spread. However, as we noted earlier, CDS index options do not ‘knock-out’ on expiry, meaning that we get a cash payout in the case where there is a default between the trade entry date and the option expiry. Since the option is an option on the forward, which does not include this payout, the buyer of the payer option would be getting free protection from trade date to option expiry date. We therefore make an adjustment to the forward spread, increasing it by the value of the expected default payout over the period. This adjustment to the forward spread can be approximated by the carry from today to option expiry divided by the duration.

### Option pricing model

We use option pricing models either to calculate option prices from volatility levels, or to calculate implied volatility levels from input prices. A simple option pricing model is available from Bloomberg (CDSO <GO>). This model allows users to input the option characteristics and then, given the market level of implied volatility, to calculate a price. Alternatively, the implied volatility level can be backed out from the market price of the option. The reader is referred to Bloomberg's own documentation for a more in-depth model description.

- ▶ Calculate the cash bond spread given by the CDS term structure; that is, price the bond according to the CDS curve, and compare this spread to the bond market spread; or
- ▶ Calculate the CDS price given by the bond yield curve; that is, price the CDS on the bond curve and then compare it to the CDS market price.

In theory, the basis should be the same whichever approach is used.

Either approach can be adopted in principle, although the first approach is more problematic because the bond price (yield) does not make explicit which term default probability is being priced. Under the latter approach, we can use the CDS term structure to build a default probability curve.

### General pricing framework

First, we need to set the relationships for CDS and bond pricing. With a CDS, the contract is terminated on occurrence of a credit event, with settlement taking place upon payment of the accrued premium.

If

$$D(t) = \sum_i (T_i - T_{i-1}) \times P(T_i) \quad (2)$$

is the duration of an interest-rate swap of maturity  $t$  and  $T_i$  is the fixed-rate payment dates, then we therefore write the duration of the CDS contract at the termination date as

$$D_{\min}(t) = \sum_{(i)} (\min(t, T_i) - \min(t, T_{i-1})) \times P(t, T_i) \quad (3)$$

where

$P(t)$  is the price of a zero-coupon risk-free bond of maturity  $t$   
 $T$  is the maturity date of both CDS and cash bond.

The net present value (NPV) of the CDS fixed-rate premiums is given by

$$S(t) E_{\tau} [D_{\min}(\tau)] = S(t) \times \left[ \int_0^T D_{\min}(t) f_{\tau}(t) dt + Q(\tau > T) D(T) \right] \quad (4)$$

where

$S(t)$  is the credit spread for contract of maturity  $t$   
 $\tau$  is the date of the credit event  
 $f_{\tau}$  is the unconditional rate of default at any given time  
 $E_{\tau}$  is the expectations operator at the date of the credit event.