A MODEL TO VALUE CREDIT DEFAULT SWAPS

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Credit Default Swaps once called by Warren Buffett “Financial Weapons of Mass Destruction” are exotic financial instruments that measure the market’s fears about certain company’s chance of defaulting on their debts.

The buyer of the CDS makes a series of payments, often referred as CDS "fee" or "spread", to the protection seller and, in exchange, receives a payoff if a credit instrument (typically a bond or loan) experiences a credit event. Investors can buy and sell protection without owning any debt of the reference entity.

Most CDSs are documented using standard forms promulgated by (ISDA), although some are tailored to meet specific needs. Credit Default Swaps have many variations.

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Banks and other financial institutions used to be in the position where they could do little once they had assumed credit risk, except wait and hope for the best.

Now, they can actively **manage their portfolios of credit risks** keeping some and entering into some derivatives contracts to protect themselves from others.

Banks have been the big buyers of credit protection and insurance companies the big sellers.

Credit default swaps have existed since the early 1990s, but the market increased tremendously starting in 2003. By the end of 2007, the outstanding amount was $62.2 trillion, falling to $38.6 trillion by the end of 2008.

Credit default swaps are not traded on an exchange and there is no required reporting of transactions to a government agency. During the 2007‑2010 financial crisis the lack of transparency became a concern to regulators, as was the trillion dollar size of the market, which could pose a systemic risk to the economy

This research paper will mainly focus on explaining what a Credit Default Swap is, its components and mechanics. A model that valuates credit default swaps will complete the task.

## What is a Credit Default Swap

A CDS is a credit derivative contract between two counterparties. The buyer makes periodic payments to the seller, and in return receives a payoff if an underlying financial instrument defaults or experiences a similar credit event. The CDS may refer to a specified loan or bond obligation of a reference entity, usually a corporation or government.



For example, imagine that an investor buys a CDS from Swed Bank, where the reference entity is Volvo Risky Corp. The investor—the buyer of protection—will make regular payments to Swed Bank—the seller of protection. If Volvo Risky Corp **defaults** the investor will receive a one‑time payment from Swed Bank, and the CDS contract is terminated.

If the reference entity Volvo Risky Corp defaults, one of two kinds of settlement can occur:

1. The investor delivers a defaulted asset to Swed Bank for payment of the par value, which is known as physical settlement.
2. Swed Bank pays the investor the difference between the par value and the market price of a specified debt obligation (even if Volvo Corp defaults there is usually some recovery, i.e. not all your money will be lost), which is known as cash settlement.

The "spread" of a CDS is the annual amount the protection buyer must pay the protection seller over the length of the contract, expressed as a percentage of the notional amount. For example, if the CDS spread of Volvo Risky Corp is 50 basis points, or 0.5% (1 basis point = 0.01%), then an investor buying $10 million worth of protection from Swed Bank must pay the bank $50,000 per year. These payments continue until either the CDS contract expires or Volvo Risky Corp defaults. Payments are usually made on a quarterly basis, in arrears.

All things being equal, at any given time, if the maturity of two credit default swaps is the same, then the CDS associated with a company with a higher CDS spread is considered more likely to default by the market, since a higher fee is being charged to protect against this happening. However, factors such as liquidity and estimated loss given default can affect the comparison.

## Credit Default Swaps and Insurance

CDS contracts have been compared with insurance, because the buyer pays a premium and, in return, receives a sum of money if one of the events specified in the contract occurs. However, there are a number of differences between CDS and insurance, for example:

1. The buyer of a CDS does not need to own the underlying security or other form of credit exposure.
2. The seller doesn't have to be a regulated entity.
3. The seller is not required to maintain any reserves to pay off buyers, although major CDS dealers are subject to bank capital requirements.
4. Insurers manage risk primarily by setting loss reserves based on the Law of large numbers, while dealers in CDS manage risk primarily by means of offsetting CDS (hedging) with other dealers and transactions in underlying bond markets.

The most important difference between CDS and insurance is simply that an insurance contract provides an indemnity against the losses actually suffered by the policy holder, whereas the CDS provides an equal payout to all holders, calculated using an agreed, market‑wide method.

There are also important differences in the approaches used to pricing. The cost of insurance is based on actuarial analysis. CDSs are derivatives whose cost is determined using financial models and by arbitrage relationships with other credit market instruments such as loans and bonds from the same 'Reference Entity' to which the CDS contract refers.

Further, to cancel the insurance contract the buyer can simply stop paying premium whereas in case of CDS the protection buyer may need to unwind the contract which might result in a profit or loss situation. Insurance contracts require the disclosure of all known risks involved. CDSs have no such requirement.

## Speculation with Credit Default Swaps



Credit default swaps allow investors to speculate on changes in CDS spreads of single names or of market indices such as the North American CDX index or the European iTraxx index.

An investor might believe that an entity's CDS spreads are too high or too low, relative to the entity's bond yields, and attempt to profit from that view by entering into a trade, known as a basis trade, that combines a CDS with a cash bond and an interest‑rate swap.

Finally, an investor might speculate on an entity's credit quality, since generally CDS　spreads　will increase as credit‑worthiness declines, and decline as credit‑worthiness increases. The investor might therefore buy CDS protection on a company to speculate that it is about to default. Alternatively, the investor might sell protection if it thinks that the company's creditworthiness might improve.

For example, a hedge fund believes that ICA Risky Corp will soon default on its debt. Therefore, it buys $10 million worth of CDS protection for two years from Nordea Bank, with ICA Risky Corp as the reference entity, at a spread of 500 basis points (=5%) per annum.　If ICA Risky Corp does indeed default after, say, one year, then the hedge fund will have paid $500,000 to Nordea Bank, but will then receive $10 million (assuming zero recovery rate, and that Nordea Bank has the liquidity to cover the loss), thereby making a profit. Nordea Bank, and its investors, will incur a $9.5 million loss minus recovery unless the bank has somehow offset the position before the default.

However, if ICA Risky Corp does not default, then the CDS contract will run for two years, and the hedge fund will have ended up paying $1 million, without any return, thereby making a loss. Nordea Bank, by selling protection, has made $1 million without any upfront investment.

Note that there is a third possibility in the above scenario; the hedge fund could decide to liquidate its position after a certain period of time in an attempt to fix its gains or losses.

For example, after 1 year, the market now considers ICA Risky Corp more likely to default, so its CDS spread has widened from 500 to 1500 basis points. The hedge fund may choose to sell $10 million worth of protection for 1 year to Nordea Bank at this higher rate.

Therefore over the two years the hedge fund will pay the bank 2 \* 5% \* $10 million = $1 million, but will receive 1 \* 15% \* $10 million = $1.5 million, giving a total profit of $500,000.

In another scenario, after one year the market now considers ICA Risky much less likely to default, so its CDS spread has tightened from 500 to 250 basis points. Again, the hedge fund may choose to sell $10 million worth of protection for 1 year to Nordea Bank at this lower spread. Therefore over the two years the hedge fund will pay the bank 2 \* 5% \* $10 million = $1 million, but will receive 1 \* 2.5% \* $10 million = $250,000, giving a total loss of $750,000. This loss is smaller than the $1 million loss that would have occurred if the second transaction had not been entered into.

Transactions such as these do not even have to be entered into over the long‑term. If ICA Risky Corp's CDS spread had widened by just a couple of basis points over the course of one day, the hedge fund could have entered into an offsetting contract immediately and made a small profit over the life of the two CDS contracts.

##  Galmer Arbitrage GT wallpaper imageArbitrage with Credit Default Swaps

Capital Structure Arbitrage is an example of an arbitrage strategy that utilizes CDS transactions. This technique relies on the fact that a company's stock price and its CDS spread should exhibit negative correlation; i.e. if the outlook for a company improves then its share price should go up and its CDS spread should tighten, since it is less likely to default on its debt. However if its outlook worsens then its CDS spread should widen and its stock price should fall. Techniques reliant on this are known as capital structure arbitrage because they exploit market inefficiencies between different parts of the same company's capital structure; i.e. mispricing between a company's debt and equity. An arbitrageur will attempt to exploit the spread between a company's CDS and its equity in certain situations. For example, if a company has announced some bad news and its share price has dropped by 25%, but its CDS spread has remained unchanged, then an investor might expect the CDS spread to increase relative to the share price. Therefore a basic strategy would be to go long on the CDS spread (by buying CDS protection) while simultaneously hedging oneself by buying the underlying stock. This technique would benefit in the event of the CDS spread widening relative to the equity price, but would lose money if the company's CDS spread tightened relative to its equity.

An interesting situation in which the inverse correlation between a company's stock price and CDS spread breaks down is during a Leveraged buyout (LBO). Frequently this will lead to the company's CDS spread widening due to the extra debt that will soon be put on the company's books, but also an increase in its share price, since buyers of a company usually end up paying a premium.

Another common arbitrage strategy aims to exploit the fact that the swap‑adjusted spread of a CDS should trade closely with that of the underlying cash bond issued by the reference entity. Misalignments in spreads may occur due to technical reasons such as:

\*Specific settlement differences

\*Shortages in a particular underlying instrument

Existence of buyers constrained from buying exotic derivatives.

The difference between CDS spreads and asset swap spreads is called the basis and should theoretically be close to zero. Basis trades can aim to exploit any differences to make risk‑free profit.

## Auctions in Credit Default Swaps

When a credit event occurs on a major company on which a lot of CDS contracts are written, an auction (also known as a credit‑fixing event) may be held to facilitate settlement of a large number of contracts at once, at a fixed cash settlement price. During the auction process participating dealers (e.g., the big investment banks) submit prices at which they would buy and sell the reference entity's debt obligations, as well as net requests for physical settlement against par. A second stage Dutch auction is held following the publication of the initial mid‑point of the dealer markets and what is the net open interest to deliver or be delivered actual bonds or loans. The final clearing point of this auction sets the final price for cash settlement of all CDS contracts and all physical settlement requests as well as matched limit offers resulting from the auction are actually settled. According to the International Swaps and Derivatives Association (ISDA), who organized them, auctions have recently proved an effective way of settling the very large volume of outstanding CDS contracts written on companies such as Lehman Brothers and Washington Mutual.

## Naked Credit Default Swaps

A CDS in which the buyer does not own the underlying debt is referred to as a naked credit default swap, estimated to be up to 80% of the credit default swap market.

Critics assert that naked CDS should be banned, comparing them to buying fire insurance on your neighbor’s house, which creates a huge incentive for arson.

Critics say you should not be able to buy a CDS—insurance against default—when you do not own the bond. Short selling is also viewed as gambling and the CDS market as a casino. Another concern is the size of CDS market. Because naked credit default swaps are synthetic, there is no limit to how many can be sold. The gross amount of CDS far exceeds all “real” corporate bonds and loans outstanding. As a result, the risk of default is magnified leading to concerns about systemic risk.

Financier George Soros called for an outright ban on naked credit default swaps, viewing them as “toxic” and allowing speculators to bet against and “bear raid” companies or countries. His concerns were echoed by several European politicians who, during the Greek Financial Crisis, accused naked CDS buyers as making the crisis worse.

Despite these concerns, Secretary of Treasury Geithner and Commodity Futures Trading Commission Chairman Gensler are not in favor of an outright ban of naked credit default swaps. They prefer greater transparency and better capitalization requirements. These officials think that naked CDS have a place in the market.

Proponents of naked credit default swaps say that short selling in various forms, whether credit default swaps, options or futures, has the beneficial effect of increasing liquidity in the marketplace. That benefits hedging activities. Without speculators buying and selling naked CDS, banks wanting to hedge might not find a ready seller of protection. Speculators also create a more competitive marketplace, keeping prices down for hedgers. A robust market in credit default swaps can also serve as a barometer to regulators and investors about the credit health of a company or country.

## Pricing and valuation

Mid market CDS spreads on individual reference entities can be calculated from default probability estimates. Suppose that the probability of a reference entity defaulting during a year conditional on no eralier default is 2%.



Table 21.1 shows that survival probabilities and unconditional default probabilities(default probabilities as seen at time zero) for each of the five years. The probability of default during the first year is 0.02 and the probability that the reference entity will survive until the end of the first year is 0.98. The probability of a default during the second year is 0.02(0.98) = 0.0196 and the probability of survival until the end of the second year is 0.98(0.98)= 0.9604 and so on.

We will assume that defaults always happen half a way through a year and that payments on the credits default swaps happen once a year, at the end of each year. The risk free interest rate is 5% with continuous compounding and the recovery rate is 40%.

Table 21.2 shows that calculation of the expected present value of the payments made on the CDS assuming that payments are made at the rate of s per year and the notional principal is $1. For example there is a 0.9412 probability that the third payment of s is made. The expected payment is therefore 0.9412s and its present value is 0.9412se^-0.05(3) = 0.8101s. The total present value of the expected payments is 4.0704s.



Table 21.3 shows the calculations of the expected present value of the payoff assuming a notional principal of $1. Defaults happen half through a year. For example there is a 0.0192 probability of a pay off half way through the third year. Since recovery rate is 40 %, the expected pay off at this time is 0.0192(0.6)(1) = 0.0115. The present value of expected pay off is 0.0115e^-0.05(2.5) =0.0102.

Table 21.4 shows the calculations of the present value of the accrual payments. For example there is a 0.0192 probability that there will be a final accrual payment half way through a third year. The accrual payment is 0.05s. The expected accrual payment at this time is therefore 0.0192(0.5)s= 0.0096s. etc.

From equation 21.2 and 21.3, the present value fo the expected payment is:

4.0704s + 0.0426s = 4.1130s

From Table 21.2 the present value of the expected payoff is 0.0511. Equating the two we obtain the CDS spread for a new CDS as 4.1130s = 0.0511 or s = 0.0124 . The mid market spread should be 0.0124 times the principal or 124 basis points per year.

## Criticisms

Critics of the huge credit default swap market have claimed that it has been allowed to become too large without proper regulation and that, because all contracts are privately negotiated, the market has no transparency. Furthermore, there have even been claims that CDSs exacerbated the 2008 global financial crisis by hastening the demise of companies such as Lehman Brothers and AIG.

 Credit default swaps have also faced criticism that they contributed to a breakdown in negotiations during the GM bankruptcy, because bondholders would benefit from the credit event of a GM bankruptcy due to their holding of CDSs. Critics speculate that these creditors were incentivized into pushing for the company to enter bankruptcy protection. Due to a lack of transparency, there was no way to find out who the protection buyers and protection writers were, and they were subsequently left out of the negotiation process.

Senior bankers have argued that not only has the CDS market functioned remarkably well during the financial crisis, but that CDS contracts have been acting to distribute risk just as was intended, and that it is not CDSs themselves that need further regulation, but the parties who trade them.

## Conclusion

Credit Default Swaps are the most widely used type of credit derivatives and a powerful force in the world markets. The liquidity they provide to the market and the decrease of risk they generate to all types of investors are its main strengths. Regulation of CDS is still an area where improvement is needed, it has been argued that naked CDS are toxic to the economic system since the default of corporations and governments is desired or even provoked.

## Simple CDS Valuation Model



The Calculations Continue below,



## Complex CDS valuation model

The term structure of default: PDs cumulative, marginal and seen from today

The term structure of PD (probability of default) – probabilities that default occurs at various dates in the future.

 - probability of default for each future period t as seen from today (t=0), where the superscript zero indicates today’s view.

Consider a pool of 100 issuers and suppose that you expect to see two defaults within the second year from today, then =2%. So is the probability to default between January 1 of year t and December 31 of year t as expected today.

 - cumulative PD over t years.

Suppose you expect a time-constant of 2%, then the probability to default over two years, , is 4%. In general,

 **= + (1)**

 **-** marginal PD in year t. It is the probability to default during year t conditional on having survived until the beginning of year t:

 **= / (1 - ) (2)**

Combining both equations, we obtain an expression for the cumulative PD in terms of the marginal PD:

 **= + \*(1 - ) (3)**

Finally, the marginal default probability in terms of the cumulative default probability:

 **= ( - ) / (1 - ) (4)**

To clarify all these formulas, consider Figure 1, where is PD as seen from today, colored by dotted line



**Figure 1. The term structure of defaults.**

Calculation of the risk-neutral default probabilities.

The most straightforward way of determining risk-neutral probabilities is to take market prices of corporate bonds or other default-risky instruments. If we know those prices and the risk-free rates of return, and if we assume the recovery rates to be constant over time and across different issues, the only unknowns in the risk-neutral pricing equation are the risk-neutral default probabilities.

Generally, the price of bond today is then obtained as the sum of discounted cash flows as they are expected today:



 **(5)**

If the bond defaults at time τ < T, the subsequent cash flows are zero, i.e. = 0, i ≥ τ.

When valuing a risk-free bond, we drop the expectations operator. To distinguish risky and risk-free bonds, we denote the price of the latter by :



**(6)**

For a corporate bond maturing in one year, we can easily express the expectation in equation (5) in terms of a one-year default probability PD and a recovery rate. Consider a zero-coupon bond with notional 100 maturing in one year. There are two possible states of the world in one year. First case, the bond survives and the bondholder receives the notional. In the other case, the bond defaults and the bondholder receives 100 times the recovery rate, denoted by R. The second state’s probability is the risk-neutral default probability .

Today’s price of the bond is:



**(7)**

Rearranging and using = 100 / (1+r) for the price of a risk-free zero-coupon bond with the same notional as the corporate bond, we obtain:



**(8)**

In words, the difference between the price of a risk-free bond and a risky one (both having the same promised cash flows) is equal to the discounted expected loss from holding the risky rather than the risk-free bond; the loss associated with default is that one gets 100 · R rather than 100, and this happens with probability PD.

In general, with more than one possible default date, the formula becomes:



**(9)**

**τ** – date of default. In principle, default could occur on any date during the life of a bond. But in practice it’s enough to assume that default can only occur at discrete dated, e.g. quarterly.

 **-** observed market price of the corporate bond.

 **–** price of hypothetical risk-free bond with the same features as the risky corporate bond.

 **-** probabilities of default as seen from today, corresponding to the expectation in (5). The goal of the analysis is to solve (9) for . If we have only one bond, we have only one equation of type (9), so we can only solve it if we impose some structure on how PD evolves over time. The simplest structure is that it is constant. If we have more than one bond, we will assume that it is stepwise constant.

 **-** price of the risk-free bond that is expected to prevail at date τ. The standard procedure is to determine this price with implied forward rates. Forward rates are rates for lending/borrowing contracts that start at some date a and last until date b. Forward rates f are derived from spot rates r via 

 **-** the claim that bondholders have upon default.

**R -** recovery rate, i.e. the percentage of the claim that bondholders receive in case of a default on average. Assumptions can be based on average historical recovery rates or multivariate prediction models.

**r –** spot rates. A common choice are spot rates derived from AAA-rated government bonds, such as treasury bills (T-bills) or treasury bonds (T-bonds) for the US. An alternative would be the LIBOR rate or swap rates.

We can slightly reformulate (9) to simplify the implementation. One component of (9) is the forward price of the risk-free bond, which is then discounted with the risk-free rate. The way we construct forward prices, a discounted forward price from time τ is just today’s present value of the payments from time τ onwards. We can thus avoid the explicit computation of forward rates and instead use:



**(10)**

where denotes today’s PV of the payments to the risk-free bond that accrue after τ.

Consequently, we can solve (10) for PD assuming it to be constant across time:



**(11)**

Valuation of CDS

With PD estimates in hand, we can go on to price the CDS. For doing so, we compare the expected payoffs of the protection buyer and seller.

For the sake of exposition, we assume that the default dates considered are also CDS payment dates. We then do not have to model accrued fees.

The present value of premium leg, the expected payments made by the protection buyer, can be written as:



**(12)**

freq=4 the frequency of CDS payments,

Let’s take a look at the other side of the coin, the expected gain of the CDS buyer.

Abstracting from details connected with physical or cash settlement, we express the gain as

(1 – Recovery rate) × Claim. If we define the claim to be the notional principal plus accrued

interest, we get



**(13)**

where A(τ) is the accrued interest as a percentage of the notional principal.

When two parties agree on the CDS spread s, they should settle on a value that sets equations (9.12) and (9.13) to equal value. Otherwise, one party will gain (on expectation) at the expense of the other. To avoid arbitrage, the spread therefore has to follow through:



**(14)**

REFINING THE PD ESTIMATION

In practice, issuers often have several traded bonds outstanding. We can hope to increase the

precision of the PD estimates if we make full use of the available bond price information.

Recall (10):



With one bond, we assumed the PD to be constant across maturities. With several bonds, we will assume that they are stepwise constant. Assume that we have three bonds, maturing at T1, T2 >T1 and T3 >T2, respectively.

From the first bond, we estimate the constant , from time zero (today) to time T1. For default dates τ ≤ T1, we insert this estimate into the equation as an input for bond 2, and back out the constant between T1 and T2. Similarly, we proceed with the third bond.

If we want to estimate a PD structure over T years, we would take into account the bonds that mature before T as well as the one with the earliest maturity after T.

We can use refined PD term structure to estimate CDS spread more carefully. The new spread is 16.34%, the old one is 18.50%. The reason is that the use of the three bonds leads to a lower average PD for the life of the CDS.

## VBA code

Function INTSPOT(spots, year)

'Interpolates spot rates to year

Dim i As Integer, spotnum As Integer

spotnum = spots.Rows.Count

If Application.WorksheetFunction.Count(spots) = 1 Then 'Single rate given

 INTSPOT = spots

Else 'Term structure given

 If year <= spots(1, 1) Then

 INTSPOT = spots(1, 2)

 ElseIf year >= spots(spotnum, 1) Then

 INTSPOT = spots(spotnum, 2)

 Else

 Do

 i = i + 1

 Loop Until spots(i, 1) > year

 INTSPOT = spots(i - 1, 2) + (spots(i, 2) - spots(i - 1, 2)) \* \_

 (year - spots(i - 1, 1)) / (spots(i, 1) - spots(i - 1, 1))

 End If

End If

End Function

Function MYPRICE(settlement As Date, maturity As Date, rate, spots, \_

 notional, freq As Integer, Optional compound As Integer, \_

 Optional fromdate As Date, Optional basis As Integer)

'Determines present value of bond cash flows accruing after fromdate

Dim t As Date, y As Double

'Set default values and some error checking

If compound = 0 Then compound = freq

If fromdate = 0 Then fromdate = settlement

If fromdate > maturity Or settlement > maturity Then End

'Determine PV of payment at maturity

t = maturity

y = Excel.WorksheetFunction.Yearfrac(settlement, maturity, basis)

MYPRICE = (notional + notional \* rate / freq) / \_

 (1 + INTSPOT(spots, y) / compound) ^ (y \* compound)

'Add PVs of coupon payments

t = Excel.WorksheetFunction.Couppcd(t - 1, maturity, freq, basis)

Do While t > settlement And t >= fromdate

 y = Excel.WorksheetFunction.Yearfrac(settlement, t, basis)

 MYPRICE = MYPRICE + rate / freq \* notional / \_

 (1 + INTSPOT(spots, y) / compound) ^ (y \* compound)

 t = Excel.WorksheetFunction.Couppcd(t - 1, maturity, freq, basis)

Loop

End Function

Function ACI(settlement As Date, maturity As Date, rate, freq As Integer, \_

 Optional basis As Integer)

'Calculates the accrued interest at settlement

If settlement < maturity Then

 ACI = 100 \* rate / freq \* (1 - Excel.WorksheetFunction.Coupdaysnc(settlement, maturity, freq, basis) \_

 / Excel.WorksheetFunction.Coupdaysnc(settlement, maturity, freq, basis))

End If

If ACI = 0 Or settlement = maturity Then ACI = 100 \* rate / freq

End Function

Function LOSS(settlement As Date, maturity As Date, rate, spots, notional, \_

 freq As Integer, compound As Integer, fromdate As Date, \_

 R As Double, Optional basis As Integer)

Dim price, A, y

If fromdate <= maturity Then

 y = Excel.WorksheetFunction.Yearfrac(settlement, fromdate, basis)

 price = MYPRICE(settlement, maturity, rate, spots, notional, \_

 freq, compound, fromdate, basis)

 A = ACI(fromdate, maturity, rate, freq, basis)

 LOSS = price - R \* (100 + A) / \_

 (1 + INTSPOT(spots, y) / compound) ^ (compound \* y)

Else

 LOSS = 0

End If

End Function

See [2] for the technical details.

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