A Guide to the CDS Package (Draft)

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1 Introduction

A Credit Default Swap (CDS) is a financial swap agreement between two counterparties in which the buyer pays a fixed periodic coupon to the seller in exchange for protection in the case of a credit event. The International Swaps and Derivatives Association (ISDA) has created a set of standard terms for CDS contracts, the so-called "Standard Model." This allows market participants to calculate cash settlement from conventional spread quotations, convert between conventional spread and upfront payments, and build the yield curve of a CDS. The **CDS** package implements the Standard Model, allowing users to value credit default swaps and calculate various risk measures associated with these instruments.

2 CDS Basics

A CDS is a simple and popular form of credit derivative. It was invented by Blythe Masters from J.P. Morgan in 1994. The CDS market started to develop in the 1990s as banks used CDS contracts to hedge their credit exposures on the balance sheets. Many different types of CDS have since emerged including basket default swaps (DBSs), index CDSs, credit-linked notes, et cetera. In the **CDS** package, we focus on calculations related to a single-name CDS contract.

A single-name CDS contract a private contract between two parties, which provides a transfer of credit risk. The buyer of a CDS contract transfers the credit risk to the seller by paying a series of payments before the contract terminates. In other words, the protection buyer is short credit by selling the credit risk of an underlying loan to the protection seller. As shown in the diagram(?), the buyer pays a stream of coupon payments, called the premium leg in order to receive a one-off, contingent payment (protection leg) in the case of a credit event.

A CDS contract between two counterparties typically specifies the following key terms:[1]

Reference Entity refers to the legal entity which is the subject of a CDS contract.

Notional is the amount of the underlying asset on which the payments are based.

Maturity a.k.a tenor. It refers to length of a CDS contract. Most CDSs are written within 5 years maturity. The protection buyer continues to make payments to the protection sell till maturity of the contract or the occurrence of a credit event.

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[1]Partially adatped from *Credit Derivatives Glossary* by Markit and *Standard Corporate CDS Handbook* by Barclays.

Coupon is often quoted in basis points. It specifies the amount of payment from the protection buyer to the seller on a regular basis.

Premium Leg refers to the cashflows of the fixed payments made by the protection buyer.

Contingent Leg , a.k.a. **Protection Leg**, is the payment of notional less recovery amount by the protection seller after a credit event.

Par spread is quoted in basis points per annum. It represents the fair rate for a contract of 1 year beginning on the trade date.

Seniority specifies the order of which the debt will be paid in liquidation or bankruptcy. In general, there are four different levels of seniority - Senior, Subordinated, Junior, and Preferred.

Credit Event triggers the settlement under a CDS contract. Possible credit events specified by the ISDA Credit Derivatives Definitions include:

- Bankruptcy - It typically occurs when the reference entity has filed under bankruptcy law (or equivalent law).
- Failuer to pay - The reference entity fails to make interest or principal payments when due after the applicable grace period expires.
- Debt restructuring - The specifications of the debt obligations are changed such that the protection buyer is unfavorably affected.
- Obligation acceleration - A debt obligation becomes due before it would otherwise have been because of a default.
- Obligation default - A debt obligation becomes capable ofbeing declared due before it would otherwise have been because of a default.
- Repudiation/Moratorium - The reference entity announces repudiation or moratorium on debt obligation and subsequently fails to pay.

3 The ISDA Standard Model

In April 2009 in North America and June 2009 in Europe, the ISDA introduced a series of mandatory modifications to the CDS contract known as the "Big Bang Protocol." Among these changes were the standardization of the first accrual dates, fixed coupon (100 bps or 500 bps), and recovery rate (40 %).

This section provides the specifications of an ISDA standard CDS contract and an introduction of the ISDA standard CDS model.[2] The default calculations and parameters in the **CDS** package follow the ISDA Standard Model. Additional default settings in the package that are not specified by the Standard Model, such as the default notional amount, are also listed.

3.1 Standard Model Specifications

The ISDA Standard CDS Contract specifies the following:

Trade Date refers to the date of the trade.

Maturity : most of the standard contracts have a maturity of 5 years.

[2]Refer to the *ISDA Standard CDS Converter Specification* for details.

Maturity Date falls on one of the four dates (Mar/Jun/Sep/Dec 20th) in a year. One can add the maturity of the contract to the trade date and find the next available date among those four dates.

Backstop Date is the date from which protection is provided.

Backstop Date = T - 60 Calender Days.

Notional Amount is denoted in millions.

Standard Coupon is quoted either 100 bps or 500 bps per annum for CDS contracts in North America, and 25 bps, 100 bps, 500 bps or 1000 bps in Europe.

Recovery Rate is the estimated percentage of par value that bondholders will receive after a credit event. It is commonly reported in percentages. A CDS for investment grade bonds are assumed a 40% recovery rate when it is valued. The recovery rate is assumed to be 20% when valuing a subordinate level CDS. 25% is assumed for emerging markets' CDSs (both senior and subordinate).

Par Spread is the spread value which makes the present value of a CDS contract zero. It is quoted in basis points.

Upfront Payment or **Cash Settlement Amount** is quoted in the currency amount. Since a standard contract is traded with fixed coupons, upfront payment is introduced to reconcile the difference in contract value due to the difference between the fixed coupon and the conventional par spread. The protection buyer pays the upfront payment if points upfront are positive, and the buyer is paid by the seller if the points are negative. There are two types of upfront, dirty and clean. Dirty upfront refers to the market value of a CDS contract. Clean upfront is dirty upfront less any accrued interest payment.

Points Upfront are quoted as a percentage of the notional amount. They represent the upfront payment excluding the accrual payment. High Yield (HY) CDS contracts are often quoted in points upfront.

3.2 Standard Model Pricing

The ISDA Standard Model allows market participants to convert between the par spread and the upfront payment, and compute the cash settlement amount for a standard contract. A few key assumptions and definitions used when valuing a Standard CDS contract are the following:[3]

Trade Date (T) means 11:59pm on the trade date.

Days of Protection is the difference in the number of days from Maturity Date to Trade Date.

Mark-to-market (MTM) represents the contract value to the protection buyer. It is computed by discounting the expected protection leg and premium leg cashflows to T.

Accrued Premium is the premium that has accrued from accrual begin date to T where both dates are inclusive.

[3]Please refer to `http://bit.ly/1kg5qPw` for more infrmation on the ISDA standard CDS model assumptions.

The ISDA also standardizes the interest rates used by the Standard Model in valuting a CDS contract. There are two types of rates used in valuing a USD denominated CDS contract - cash rates and swap rates. Cash rates are of maturity 1, 2, 3, 6 months, and 1 year. They are provided by the British Bankers' Association (BBA). Swap rates are of maturity 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 15, 20, 25, 30 years and are provided by ICAP. The Standard Model follows the conventions below for interpolation of the entire USD yield curve:[4]

- The day count convention (DCC) for money market instruments and the floating legs of swaps is **ACT/360**.
- DCC for the floating legs of swaps is **30/360**.
- Payment frequency for fixed legs of swaps is 6 months.
- Payment frequency for floating legs of swaps is 3 months.[5]
- A business day calendar of weekdays (Monday to Friday) is assumed. Saturdays and Sundays will be the only non-business days.
- If a date falls on a non-business day, the convention used for adjusting coupon payment dates is **M** (Modified Following).

One component essential to the MTM calculation of a CDS contract is the PV01. It is the present value of a stream of 1 basis point payments at each CDS coupon date. It is sometimes referred to as the **CDS duration** or **risky duration**.

Analytically, $PV01$ can be calculated by

$$PV01 = \sum_t Df(t_i)S(t_i)B(t_i),$$

where

- $i =$ coupon index,
- $t_i =$ coupon date,
- $Df(f_i) =$ discount factor until t_i,
- $S(t_i) =$ survival probability until t_i,
- $B(t_i) =$ day count fraction at t_i.

We can thus calculate the principal amount paid from the protection buyer to the seller using the following formula:

$$\text{Principal Amount} = (\text{Par Spread} - \text{Coupon}) \times \text{PV01}.$$

Using the concept of PV01, we show the calculation of the main risks (exposures) of a CDS position, which are also called **DV01**. DV01 reflects the risk duration of a CDS trade, also known as **Sprd DV01**, **Spread DV01**, **Credit DV01**, and **Spread Delta**. It is the sensitivity of the CDS contract to a parallel shift in the CDS spreads. This should always be positive if you are a protection buyer because, if you

[4]See `http://bit.ly/1iuI8ZA` for details on the interest rate sources and calculation used by the Standard Model.

[5]See `http://www.fincad.com/derivatives-resources/wiki/swap-pricing.aspx` for details on floating and fixed legs calculation.

own the CDS, you are short credit. A rising spread is a sign of credit deterioration, which makes you money. Starting with PV01 and taking the derivative with respect to spread give us:

$$\begin{aligned} PV &= (S-C)*PV01 \\ DV01 &= \frac{\partial PV}{\partial S} \\ &= PV01 + (S-C)\frac{\partial PV01}{\partial S}, \end{aligned}$$

where S is the spread of the contract and C is the coupon.

Both DV01 and PV01 are measured in dollars and are equal if the spread equals the coupon. In other words, the relationship between spread (on the x-axis) and dollars (on the y-axis) is identical when the spread is equal to the coupon. That is where these two lines cross.

Some other related risk measures of a CDS contract are as follows:

IR DV01 is the change in value of the CDS contract for a 1 bp parallel increase in the interest rate curve.

Spread DV01 , aka spread delta, measures the sensitivity of a CDS contract MTM to a parallel shift in the term structure of the par spread. Spread DV01 in Bloomberg is, typically, a much larger dollar value than IR DV01 because moves in overall interest rates have a much smaller effect on CDS value than does a move in the CDS spread itself.

Recovery Risk 01 is the dollar value change in market value if the recovery rate used in the CDS valuation were increased by 1%.

Price refers to the clean dollar price of the contract.

$$\begin{aligned} \text{Price} &= (1 - \text{Principal}/\text{Notional}) * 100 \\ &= 100\tilde{}\text{points}. \end{aligned}$$

For example, if a CDS is quoted as 3 points to buy protection, the price will be 97. The protection buyer still pays the 3% as an upfront fee. A CDS has a price greater than 100 if the points upfront are negative, that is, if the CDS buyer needs to receive money to get protection because he is promising to pay a coupon of, say, 100 even if the spread is 60. This is analogous to a bond investor paying more than the face value of a bond because current interest rates are lower than the coupon rate on the bond.

4 Using the CDS package

Currently, a portfolio manager can conduct CDS-related calculations by using the **CDSW Calculator** on a Bloomberg Terminal or the Markit CDS Calculator.[6] The **CDS** package provides tools for valuing a single-name CDS contract based on the Standard Model. The user can also specify her own set of parameters to customize the calculation. In this section, we will demonstrate the use of the **CDS** package with a series of examples.

The default settings of a CDS contract in the **CDS** package follow the ISDA Standard Model and are defined as follows:

- Trade Date: the current business day

[6]The Markit CDS Calculator is available at `http://www.markit.com/markit.jsp?jsppage=pv.jsp`.

- Maturity: 5 years
- Currency: USD
- Notional Amount (MM): 10MM
- Recovery Rate (%): 40%
- Par Spread (bp), Points Upfront (%), or Upfront Payment/Cash Settlement Amount (currency value): User has to input one of the three.
- Bay Day Conversion for the CDS Contract is **F**, which means that it assumes the next available business day when a date falls on a non-business day.

For illustrative purposes, we call the function `CDS` to construct an object of class `CDS`. Below we use the specifications according to the ISDA Standard Model.

```
> cds1 <- CDS(TDate = "2014-04-15",
+             parSpread = 50,
+             couponRate = 100)
> summary(cds1)
```

```
Contract Type:                      SNAC   TDate:                    2014-04-15
Currency:                            USD   End Date:                 2019-06-20
Spread:                               50   Coupon Rate:                    100
Upfront:                        -256508.4   Spread DV01:                5084.23
IR DV01:                            66.11   Rec Risk (1 pct):             89.99
```

```
> cds1Rates <- getRates(date = "2014-01-13", currency = "USD")
> cds1Rates[[1]]
```

```
   expiry matureDate     rate type
1      1M 2014-02-17   0.0016    M
2      2M 2014-03-17 0.002078    M
3      3M 2014-04-16 0.002389    M
4      6M 2014-07-16 0.003384    M
5      1Y 2015-01-16 0.005736    M
6      2Y 2016-01-16 0.004735    S
7      3Y 2017-01-16  0.00836    S
8      4Y 2018-01-16 0.012665    S
9      5Y 2019-01-16   0.0167    S
10     6Y 2020-01-16 0.020275    S
11     7Y 2021-01-16 0.023235    S
12     8Y 2022-01-16 0.025575    S
13     9Y 2023-01-16 0.027525    S
14    10Y 2024-01-16   0.0291    S
15    12Y 2026-01-16  0.03165    S
16    15Y 2029-01-16 0.034065    S
17    20Y 2034-01-16 0.036085    S
18    25Y 2039-01-16  0.03703    S
19    30Y 2044-01-16  0.03749    S
```

```
> t(cds1Rates[[2]])
```

	text
badDayConvention	"M"
mmDCC	"ACT/360"
mmCalendars	"none"
fixedDCC	"30/360"
floatDCC	"ACT/360"
fixedFreq	"6M"
floatFreq	"3M"
swapCalendars	"none"

```
> cds1
```

CDS Contract

Contract Type:	SNAC	Currency:	USD
TDate:	2014-04-15	End Date:	2019-06-20
Start Date:	2014-03-20	Backstop Date:	2014-02-14
1st Coupon:	2014-06-20	Pen Coupon:	2019-03-20
Day Cnt:	ACT/360	Freq:	Q

Calculation

Value Date:	2014-04-18	Price:	102.49
Spread:	50	Pts Upfront:	-0.0249
Principal:	-249008.4	Spread DV01:	5084.23
Accrual:	-7500	IR DV01:	66.11
Upfront:	-256508.4	Rec Risk (1 pct):	89.99
Default Prob:	0.0429	Default Expo:	6249008.4

Credit Curve

Term	Rate
1M	0.001514
2M	0.001920
3M	0.002264
6M	0.003209
1Y	0.005455
2Y	0.005130
3Y	0.009420
4Y	0.013595
5Y	0.017270
6Y	0.020190
7Y	0.022585
8Y	0.024505
9Y	0.026105
10Y	0.027445
12Y	0.029545
15Y	0.031575

```
20Y 0.033330
25Y 0.034120
30Y 0.034480
```

5 Conclusion

6 Bibliography

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The Markit Credit Indices Primer

The Bloomberg Guide