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 ISDA Standard Model, allowing users to value credit default swaps, to calculate various risk measures associated with these instruments and to compute rates of returns given a time series of spread quotations.

2 CDS Basics

We introduce an overview of CDS contracts and terminologies in this section.[1]

Long Credit : The position of the CDS Protection Seller who is exposed to credit risk and who receives periodic payment from the Protection Buyer. Economically, selling the CDS generates the same cash flows as owning the bond — periodic, coupon-like payments, with a risk of principal impairement. Since you are obviously "long credit" if you own the bond, then it follows that you are long credit if you sell the CDS. Also referred to as being **long risk** or as having **wrote protection** or **sold protection** or **bought risk**. Example: "Protection seller is long credit."

Short Credit : This is the credit risk position of the Protection Buyer, who sold the credit risk of a bond to the Protection Seller. Similar terms meaning the same thing are **long CDS**, **short risk** and having **bought protection** or **sold risk**. This is sometimes abbrieviated all the way to just **short**. That is, "short CDX IG" means buy protection on CDX IG. Another way to think about this is that, any time you "sell" something, you are "short" that something. In this case, you sold the credit risk, so you are short credit. "Short (or long) credit *risk*" is also common phrasing. Another way to think about this as being short credit "quality". As credit quality goes down — i.e., as spreads increase — protection buyers win. Example usage: "A long CDS position corresponds to being long protection and short credit."

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[1]Much of this is quoted from the appendix to *The Markit Credit Indices Primer*, and *The Bloomberg Guide*

Points Upfront or just 'points' refer to the upfront fee as a percentage of the notional. For example, a CDS might be quoted as 3 'points upfront' to buy protection. This means the upfront fee (excluding the accrual payment) is 3% of the notional. 'Points upfront' have a sign: if the points are quoted as a negative then the protection buyer is paid the upfront fee by the protection seller. If the points are positive it's the other way around. Anoter way to think of this is that the protection buyer is the one, you know, doing the buying. So, points upfront of $10,000 is what he has to pay. This is the *normal* understanding of what a "buyer" is: someone who pays a positive dollar price for something. Only in a weird situation would a "buyer" get paid, hence the need for a negative price in that example.

Price With price we quote 'like a bond': price = 100 – points. So in the example above where 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 of course. A CDS has 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. (Note that points are measured in percentages while spreads are in basis points.) 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.

Spread is the standard unit for quoting non-distressed CDS. Spreads are always in basis points.

Quoted Spread is the spread as defined with the standard ISDA model, meaning 40% recovery rate and flat term structure. "Par Spread" is mostly the same, except in cases of distress. In that case, the quoted spread won't be a good guide since the recovery rate that the market is anticipating might be very different from 40% (this is the major issue) and the shape of the curve might be far from flat. This may be connected to the fact that CMA can/does change the recovery rate assumption used in its daily pricing feed. HH then checks for, and reports on, these changes. Ought to learn more about this.

Probability of Default : Is it true that probability of default is just annualized CDS spread divided by loss severity, where the latter is 1 minus the recovery rate? Also, is it true (as the Bloomberg help files tell us) that, for a flat CDS curve, the default probability measured in years from the valuation date is:

$$dp = 1 - e^{\frac{-S*t}{1-R}}$$

where S is the spread and R is the recovery rate.

Duration : Recall that duration is a fixed income term with two different meanings, measured in two different units but with (confusingly!) similar numeric values. **Macaulay duration** is the weighted average time until repayment, measured in years. For a zero-coupon bond, Macaulay duration equals maturity. I don't *think* that this type of duration is used much in CDS. **Modified duration** is normally the percent change in price for a one percent change in yield. (Note that this is not the same thing as the derivative because it is not the instaneous slope. A 1% change in yield is often a big change.)

RED Codes are a Markit product. RED stands for Reference Entity Database. Each entity/seniority pair has a unique 6 digit RED code. Each deliverable bond has a 9 digit RED code, the first 6 digits of which match the 6 digit code of the associated entity/seniority. Each entity also has a "preferred reference obligation" that is the default reference obligation for CDS trades.

PV01 : Also known as **dollar duration**, **CDS duration** or **risky duration**. Unlike the two durations above (which are measured in years and percent, respectively), PV01 is measured in dollars. It is the change in value of the CDS (to the owner of protection) when the spread on a CDS goes up by 1 bps. Another way to think about this is that PV01 is the present value of a 1 bp payment at each coupon date.

Upfront Payment (in dollars) = (Spread - Coupon) * PV01

DV01 : Risky Duration, also known as **Sprd DV01**, **Spread DV01**, **Credit DV01** and, **Spread Delta**. The change in the mark-to-market value of a CDS trade for a 1 bp parallel shift upward in CDS spreads. (This should always (?) be a positive number (if you are buying protection) because, if you own the CDS, you are short credit. A rising spread is a sign of credit deterioration, which makes you money. Being short credit is like being short a stock. Going down is good for you.) Starting with PV01 and taking the derivative with respect to spread give us:

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

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 equals the coupon. That is where these two lines cross. DV01 will be great than PV01 when spread is greater than coupon, I guess?.

IR DV01 is the change in value of the CDS contract for a 1 bp parallel increase in the interest rate curve. Spread DV01 in Bloomberg is, typically, a much larger dollar value than IR DV01 because moves in overall interest rates, which is what the "IR" stands for, have a much smaller effect on CDS value than does a move in the CDS spread itself.

Rec Risk (1%) is the dollar value change in market value of the CDS contract if the recovery rate in the spreads section were increased by 1%.

Def Exposure is the loss in dollar amount in the event of a default the following day and can be calculated by the formula (1 - Recovery Rate) * Notional - Principal.

Z-spread : Short for zero-volatlity spread. Spread over spot treasuries if held to maturity. A simple spread is only the difference between bond yield and treasuries at a single point in time. Z-spread aggregates over the entire curve.

OAS : Abbreviation for option-adjusted spread. If rates were guaranteed to be stable, the OAS would equal the Z-Spread. But rates can move. If they do, then the bond holder (and/or issuer?) may be able to take advantage of this movement by putting/calling the bond. So, Z-Spread equal the OAS plus the cost of the option, which might be positive or negative. If there are no options, then Z-Spread equals OAS.

DTS : is **d**uration **t**imes **s**pread. We want a measure of bond riskiness. Bonds with longer duration are riskier because a lot of stuff can happen before we get paid. Bonds with larger spreads are riskier because the market has doubts about whether or not we are going to get paid back. Bonds with both large duration and high spreads are especially risky. Bonds with low duration and low spreads (think commercial paper for a AAA issuer) are very safe. Carvalho argues that low DTS bonds outperform high DTS bonds around the world. We suspect the same is true for CDS.

Gamma : Recall that delta is the change in value of the derivative for a small change in value of the underlying. Gamma is the second derivative. It is unclear to me how to use this concept in CDS.

Convexity : Another word for gamma. In practice, most important kind of convexity is bond convexity: the second derivative of the change in price with respect to the change in interest rates. Recall that duration (besides being the weighted average time until repayment) is also the (first) derivative of price with respect to yield. (I am using duration colloquially)

3 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.[2] The **CDS** package provides tools for valuing a single-name CDS contract based on the ISDA 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.

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 = "2014-01-14",
+             currency = "USD",
+             maturity = "5Y",
+             dccCDS = "ACT/360",
+             freqCDS = "Q",
+             stubCDS = "F",
+             badDayConvCDS = "F",
+             calendar = "None",
+             parSpread = 50,
+             couponRate = 100,
+             recoveryRate = 0.4,
+             isPriceClean = FALSE,
+             notional = 1e7,
+             payAccruedOnDefault = TRUE)
> summary(cds1)
```

```
Contract Type:                      SNAC TDate:                       2014-01-14
Currency:                            USD End Date:                    2019-03-20
Spread:                               50 Coupon Rate:                        100
Upfront:                      -256244.55 Spread DV01:                    5084.47
IR DV01:                           66.12 Rec Risk (1 pct):                 89.95
```

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

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

```
   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:                        2014-01-14 End Date:                 2019-03-20
Start Date:                   2013-12-20 Backstop Date:            2013-11-15
1st Coupon:                   2014-03-20 Pen Coupon:               2018-12-20
Day Cnt:                         ACT/360 Freq:                              Q

Calculation
Value Date:                   2014-01-17 Price:                        102.49
Principal:                    -249022.33 Spread DV01:                 5084.47
Accrual:                        -7222.22 IR DV01:                       66.12
Upfront:                      -256244.55 Rec Risk (1 pct):              89.95
```

```
Default Prob:                          0.0428 Default Expo:                  6249022.33

Credit Curve
 Term     Rate
   1M 0.001590
   2M 0.002055
   3M 0.002368
   6M 0.003355
   1Y 0.005681
   2Y 0.004960
   3Y 0.008810
   4Y 0.013220
   5Y 0.017375
   6Y 0.020875
   7Y 0.023840
   8Y 0.026155
   9Y 0.028045
  10Y 0.029695
  12Y 0.032195
  15Y 0.034545
  20Y 0.036550
  25Y 0.037420
  30Y 0.037880
```

4 Conclusion