A Guide to the CDS Package

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1 Introduction

Over the past three decades, **credit derivatives** have been increasingly common as tools that pass **credit risk** to investors willing to accept that risk at a certain premium. Credit risk, to put it simply, is the risk that a borrower will default on a loan. In the modern financial world, there are many types of credit derivatives such as Collaterized Debt Obligations (CDOs) or Collaterized Loan Obligations (CLOs). In this vignette, we will focus on **Credit Default Swaps** (CDS), a type of credit derivative that has become quite popular among a wide variety of financial institutions, such as pensions funds, hedge funds, investment banks et al (see 1). We will explain the mechanics of how this financial product works, and also show how our **CDS** package can be used to manipulate and calcuate relevant information associated with them.

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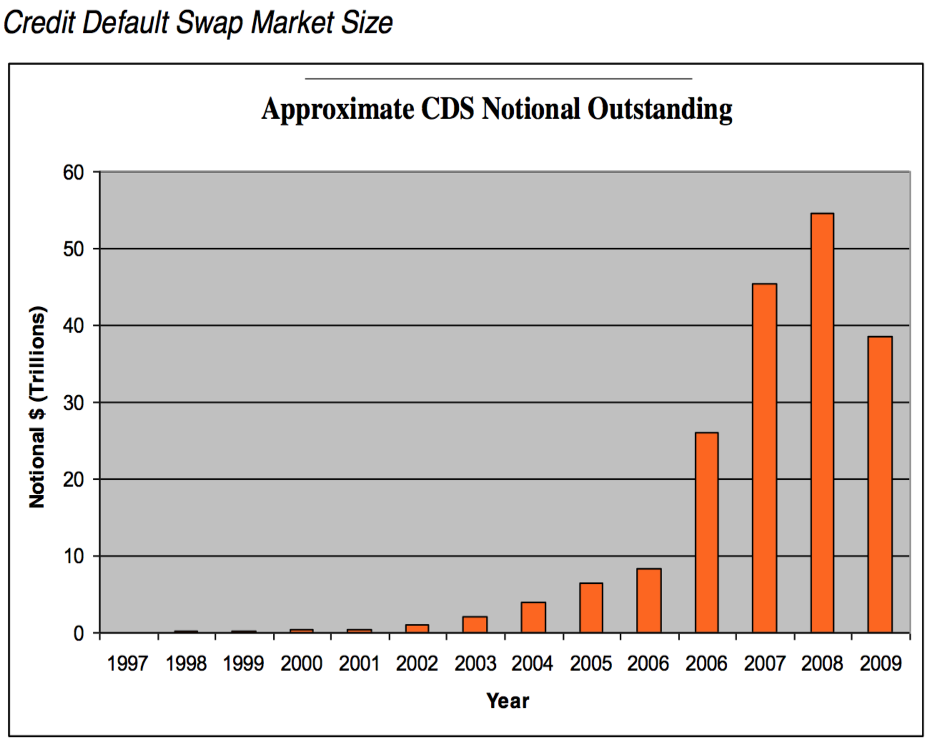

Figure 1: CDS notional outstanding from 1997-2009

CDSs originated in the late 1980s and were popularized by a team at J.P. Morgan including Blythe Masters.(Lenzner, 2009; Lanchester, 2009) The CDS market started to develop soon afterwards as banks used CDS contracts to hedge the credit exposures on their balance sheets. Many different types of CDS have since emerged including basket default swaps (BDSs), index CDSs, credit-linked notes, et cetera (Kallianiotis, 2013). In the **CDS** package, we focus on calculations related to a single-name, or corporate, credit default swaps.

2 CDS Mechanics

2.1 Why CDSs?

To understand the benefits of CDSs as hedging tools, consider the following example. Let's say that there exists a portfolio manager of a pension fund who has to allocate the money of her clients in a manner that earns a steady return without putting their investments at a large risk. This portfolio manager decides to buy a large amount of bonds of a company that has a low credit risk or probability of default. A **bond** is an agreement in which one party lends money to another party in exchange for that same sum of money, plus interest, at a future date. In the case of a company's liquidation, bondholders are compensated before the company's shareholders. Bonds can be further categorized as "senior" and "junior". Typically, senior bonds have the greatest seniority in the issuer's capital structure, and are the first to be repaid in the case of a liquidation. Since our portfolio manager is risk averse, she chooses to buy the senior debt of a company that has a sound business model and a low probability of default or is, in other words, creditworthy. Such bonds are classified as **Investment Grade**. The creditworthiness of a company is often represented by the **credit rating** given to it by rating agencies such as Standard & Poor's (S&P) or Moody's. We will not go into the details of how these ratings are determined but only note that an Investment Grade bond has a rating of BBB- or higher from S&P or Baa3 or higher from Moody's. Let's say our portfolio manager purchases bonds of Alcoa Inc., with a maturity of five years and a coupon rate of (TBD). Alcoa Inc. has a credit rating of (TBD) from S&P.

However, six months after making the trade, the manager's confidence in the credit worthiness of Alcoa begins to waiver. In other words, the manager is worried about some **credit event** related to the company. A credit event is a term that encompasses the risk of a company's bankruptcy and resulting default; depending on the CDS contract. However, a credit event can be expanded to include failure to pay out debt within a certain amount of time, substantial decrease in credit rating, and confiscation of assets, among other events. The company's credit rating or some other indicator of the company's credit risk may incentivize the manager to hedge her position and reduce her portfolio's exposure. She could simply sell the bonds but that may be premature or even unprofitable. Instead, she could take a position that allows her to profit from an increase in credit risk, by purchasing a financial product whose value rises with a drop in the bond's intrinsic value. One convenitional techniques to do this is shorting of bonds. Shorting is the process of borrowing and selling a security, with obligation to repurchase it in the future and return it to the lender. Clearly, this is profitable if the value of the security drops by the time it is repurchased in the future. However, there are several issues associated with this method. It is difficult to short securities that are not liquid. The portfolio manager may not be able to find enough bonds that will mature at the same time. Moreover, she would have to spend $100 million to hedge her entire portfolio pf $100 million, which is a substantial opportunity cost.

2.2 CDS Basics

CDSs were invented in order to resolve the issues with hedging against risk described above.

As shown in Figure 2.2, a CDS is an agreement between two **counterparties**, or opposing groups, in which the buyer (in this case, the portfolio manager) pays a fixed periodic coupon or what is known as the **deal spread** to the seller in exchange for protection in the case of a credit event associated with the buyer's bond.

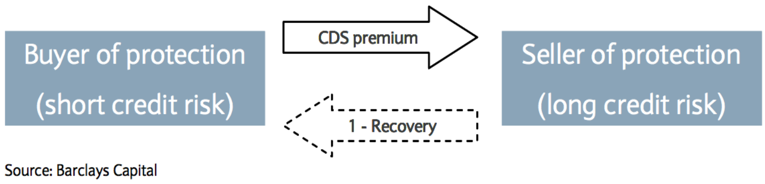

Figure 2: Cash flows in a single name CDS contract

In our example, the portfolio manager is the **protection buyer**. Let's say that the **protection seller** is a hedge fund. The hedge fund sells the portfolio manager protection for $10 million of "senior" debt; this amount is known as the **notional amount**. In return, she has to pay the hedge fund a coupon rate of over 1% or 100 basis points on this notional amount annually, which is $100000, for a period of 5 years. These payments are made quarterly, so she would have to 0.25% every quarter until the maturity date.

In the case of a default, the hedge fund would have to pay a compensation equal to the notional minus the company's **recovery rate**. The recovery rate is defined as the amount that the company is able to give back to its debt holders after a credit event has happened. When a company goes into bankruptcy and is forced to default on its debt, whatever remains in the company's assets is paid out according to the firm's capital structure. This transaction allows the portfolio manager to pass on the bond's associated credit risk while still keeping the bond within her possession. The hedge fund can receive a fee and walk away with no losses if Alcoa Inc. does not default.

The example described above is a single-name CDS contract, where the transfer of credit risk is taking place between two parties. The buyer of a CDS contract (protection buyer) transfers the credit risk to the CDS seller (protection seller) by paying a series of coupons until the contract terminates. In other words, the protection buyer is **short credit** by selling the credit risk of an underlying bond to the protection seller. What is clear is that there is no involvement of the Alcoa in the transaction; it is only taking place between the two counterparties.

2.3 More on CDS Cash Flows

Although the cash flows involved in a CDS seem pretty simple in figure **??**, the mechanics of a CDS are a bit more complex. To understand this, let us look at the actual CDS data of Alcoa Inc. from Bloomberg[1]. Figure **??** below displays many different variables such as RED code, Reference Entity et al. on the CDS of Alcoa Inc. for June 02, 2014.

[1]The two most commonly used sources for CDS related data are Bloomberg and Markit, about which we will discuss extensively in a later section.

Figure 3: CDS figures from Bloomberg

Some of these variables seem rather straighforward. **Reference entity** refers to the name of the company on whose debt we are creating a Credit Default Swap, in this case Alcoa Inc. The **RED (Reference Entity Database) Code** is an alphanumeric code used to refer to that specific company. 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 matches the 6 digit code of the associated entity/seniority. Of the variables in this figure, we must pay attention to certain key terms:

1. **Reference Entity** 2. **tenor** or **maturity**: length of the contract, which in this case is five years. 3.

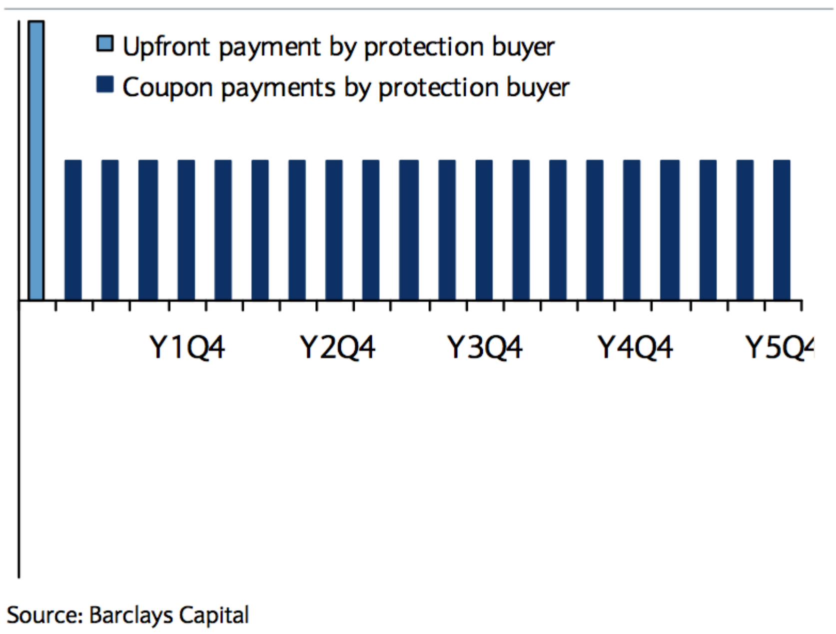

Figure 4: CDS cash flows when there is no credit event

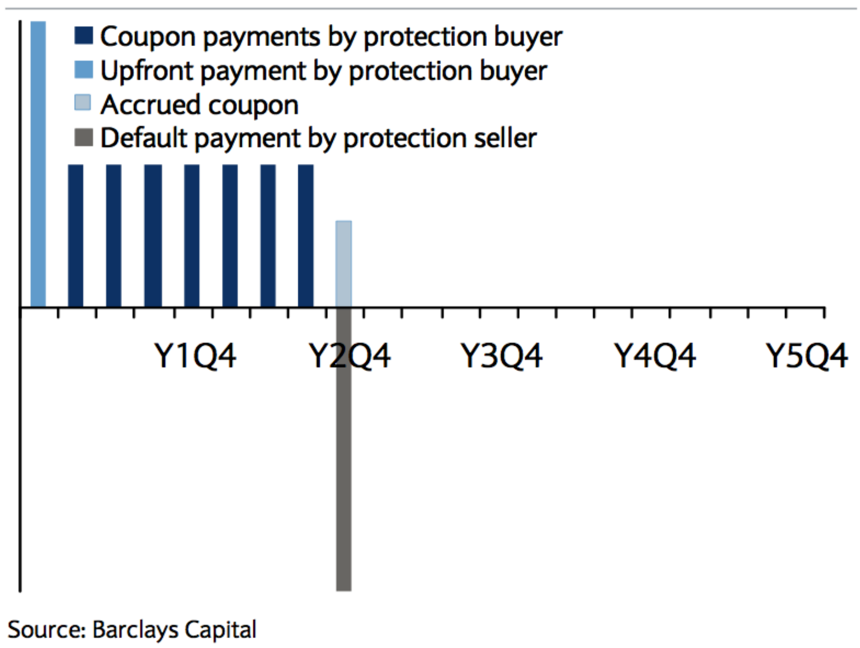

Figure 5: CDS cash flows when there is a credit event

3 CDS Terminology

This is a gloassary CDS terminology that is are necessary in determining the pricing and cash flows associated with CDSs[2]:

[2]Some of the definitions come from *Credit Derivatives Glossary* (Markit, 2009), *Standard Corporate CDS Handbook* (Leeming et al., 2010), *Credit Derivatives* (Green and Witschen, 2012), and *The Pricing and Risk Management of Credit Default Swaps, with a Focus on*

Reference Entity refers to the legal entity which is the subject of a CDS contract, in this case Alcoa Inc.

RED is a Markit product. It 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 matches 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. A user can input either the six-digit RED code or the nine-digit RED pair code. The input "014B98" is the six-digit RED code for "Alcoa Inc.".

Trade Date or **TDate** as shown in the argument of the `CDS` function indicates the trade date of the CDS contract and is June 02, 2014 in `cds1`.

Maturity refers to the fixed date on which a CDS contract terminates. However, speaking colloquially, it can also be the length of time remaining until that date. This length is also called the **tenor** of a CDS contract. The most commonly traded CDS are the 5 years. The protection buyer continues to make payments to the protection seller till maturity of the contract or the occurrence of a credit event. The maturity is 5 years in `cds1`.

Notional is the amount of the underlying asset on which the payments are based. It is $10 million in `cds1`.

Coupon is quoted in basis points. It specifies the payment amount from the protection buyer to the seller on an annual basis. Coupons are paid quarterly. This contract has a coupon of 100 bps.

Spread is quoted in basis points per year. If, instead of using a fixed coupon and exchanging upfront fees, the buyer and seller of protection were to agree on a variable coupon, then the spread is the coupon size that they would agree on. It is quoted as 50 bps in `cds1`.

Here the user enters the CDS contract with "Alcoa Inc." as the underlying entity and sets the spread at 50 bps and the coupon at 100 bps. However, the valuation of a CDS contract requires neither the entity name or the RED Code. She does not have to know the information to use the package. As shown below, insofar as she inputs the same `TDate`, `parSpread`, and `maturity` information, the valuation of the contract will be the same.

```
> library(CDS)
> cds2 <- CDS(TDate = "2014-04-15",
+             tenor = "5Y",
+             coupon = 100,
+             parSpread = 50)
```

Besides `parSpread`, a market paricipant can choose to specify either `ptsUpfront` or `upfront` to construct a `CDS` class object.[3] `ptsUpfront` or `upfront` refer to points upfront (in %), and upfront

the ISDA Model (White, 2013).

[3]See Section 4 for definitions on both terms.

payment (in dollar amount) of a CDS contract, respectively. One of the three arguments has to be specified in order to construct the `CDS` class object.

4 The ISDA Standard Model

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 spread 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.

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

An ISDA standard CDS contract specifies the following:[4]

Trade Date refers to the date of the trade.

Maturity is the length of the contract. The most commonly traded contracts have a maturity of 5 years.

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; the next available date among those four dates is the maturity date.

Backstop Date is the date from which protection is provided,

$$\text{Backstop Date} = \text{T - 60 Calender Days}.$$

Notional Amount is in millions.

Standard Coupon is either 100 or 500 bps per year for CDS contracts in North America.

Recovery Rate is the estimated percentage of par value that bondholders will receive after a credit event. It is commonly reported in percentage of notional value. CDS contracts for corporate bonds assume a 40% recovery rate for valuation purposes.

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

Upfront Payment 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 par spread. There are two types of upfront, dirty and clean. Dirty upfront (**Cash Settlement Amount**) refers to the market value of a CDS contract. Clean upfront is dirty upfront less any accrued interest payment, and is also called the **Principal**.

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

Points Upfront , or simply **points**, are quoted as a percentage of the notional amount. They represent the upfront payment excluding the accrual payment. High yield CDS contracts are often quoted in points upfront. 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.

The 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:[5]

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

Days of Protection is 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.

The ISDA also standardizes the interest rates used by the Standard Model in valuing 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, and 30 years, and are provided by ICAP (Markit, 2013). The Standard Model follows the conventions below for interpolation of the entire USD yield curve:

- The day count convention (DCC) for money market instruments and floating legs of the swaps is **ACT/360**.
- DCC for floating legs of the swaps is **30/360**.
- Payment frequency for fixed legs of the swaps is 6 months.
- Payment frequency for floating legs of the swaps is 3 months.[6]
- 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).

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

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

5 CDS Indices

Holding a portfolio of a disproportionate number of bonds of just Alcoa Inc.. is naturally a risky idea. In the real world, most successful portfolio managers prefer to distribute their risk by holding a portfolio with hundreds, if not thousands, of different positions. Instead of holding a 100 million USD of Alcoa Inc.. bonds, let's say our portfolio manager decides to reduce her risk by holding bonds of 100 different Investment Grade companies. These could include This is known as **diversification**. Although, this strategy reduces her exposure to the credit risk of any particular company, she hasn't reduced her exposure to factors that might affect a the credit risk of a wide variety of assets simulatenously, such as interest rate risk or political risk. A single-name Credit Default Swap will only protect her from the credit risk of a single company. Fortunately, in the modern financial world, she has the option of purchasing multi-name CDSs or CDS indices which contain a basket of CDSs.

Moreover, if our portfolio manager has a higher risk appetite and wants to earn a higher return for her investors, she may invest a portion of her portfolio in bonds that have a lower credit rating but provide a higher yield. There CDS indice indices for this tranche as well, such as CDX.NA.HY.

6 Using the CDS package

In the **CDS** package, we call the function `CDS` to construct an object of a class `CDS`. Below we show an example of how to construct a CDS contract in the package.

```
> library(CDS)
> cds1 <- CDS(entityName = "Alcoa Inc.",
+             RED = "49EB20",
+             TDate = "2014-04-15",
+             tenor = "5Y",
+             notional = 1e7,
+             coupon = 100,
+             parSpread = 50)
```

Currently, a market participant can conduct CDS-related calculations by using the **CDSW Calculator** on a Bloomberg Terminal or the Markit CDS Calculator.[7] The **CDS** package provides tools for valuing a single-name CDS contract. The default setting allows a user to value a USD-denominated CDS contract following the Standard Model as mentioned in Section 4. She can also specify her own set of parameters to customize the calculation. We have illustrated the construction of a CDS contract using the **CDS** package in previous sections. In this section, we will demonstrate the use of the **CDS** package in more detail and provide a series of examples.

Recall that in Section 'Using the CDS package', a `CDS` class object called `cds1` has been constructed. Its maturity is 5 years. Its spread is set at 50 bps and the coupon, 100 bps. The notional amount is $10 million. A user can call `summary` on a `cds1` to view essential information on the contract.

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

```
> summary(cds1)
Contract Type:                      SNAC    TDate:                     2014-04-15
Entity Name:                 Alcoa Inc.     RED:                           49EB20
Currency:                            USD    End Date:                  2019-06-20
Spread:                               50    Coupon:                           100
Upfront:                        -256,577    Spread DV01:                    5,086
IR DV01:                           66.14    Rec Risk (1 pct):               90.03
```

In the summary output, it shows that the type of the CDS contract is "SNAC". `TDate` refers to the trade date and is April 15, 2014. `entityName` refers to the entity name of the CDS contract and is "Alcoa Inc.". The `RED` code is "48EB20" as specified by the user. `spread` shows that the quoted spread for the contract is 50 bps and the coupon is 100 bps as shown in the `coupon` field. `upfront` indicates the dirty upfront payment in dollars or the cash settlement amount. It is -256,577 dollars, which means that from a buyer's perspective, the net present value of the remaining expected cashflows is -$256,577.

To understand the remaining three items from the `summary` output (`Spread DV01`, `IR DV01`, and `Rec Risk (1 pct)`), one needs to understand **PV01**, an essential component to the mark-to-market calculation of a CDS contract. PV01 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 (clean upfront payment) paid from the protection buyer to the seller using the following formula:

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

Using the concept of PV01, we show the calculation of the main risks (exposures) of a CDS position, **Spread DV01**. Spread DV01 reflects the risk duration of a CDS trade, also known as **Sprd DV01**, **Credit DV01**, **Spread Delta**, and just **DV01**.

It measures the sensitivity of a CDS contract mark-to-market to a parallel shift in the term structure of the par spread. DV01 should always be positive for a protection buyer since she is short credit and a rising spread is a sign of credit deterioration. Starting with PV01 and taking the derivative with respect to the 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. The Spread DV01 of `cds1` is $5,086.

IR DV01 is the change in value of a CDS contract for a 1 bp parallel increase in the interest rate curve. IR DV01 is, typically, a much smaller dollar value than Spread DV01 because moves in overall interest rates have a much smaller effect on the value of a CDS contract than does a move in the CDS spread itself. In `cds1`, the IR DV01 is $66.14. **Recovery Risk 01** or `Rec Risk (1 pct)` as shown in the `summary` output, is the dollar value change in market value if the recovery rate used in the CDS valuation were increased by 1%. It is $90.03 in `cds1`.

The default settings of valuing a CDS contract in the **CDS** package follow the Standard North American Corporate (SNAC) CDS Contract specifications.[8] Below we list the ISDA specifications implemented in the **CDS** package. Additional default settings in the package which are not specified by the Standard Model, such as the default notional amount, are also listed.

- Currency: USD.
- Trade Date (T): the current business day.
- CDS Date: Mar/Jun/Sep/Dec 20th of a year.
- Maturity: 5 years.
- Maturity Date (End Date): It falls on a CDS date without adjustment.
- Coupon Rate: 100 bps.
- Notional Amount (MM): 10MM.
- Recovery Rate (%): 40% for senior debts.
- Premium Leg:
  - Payment Frequency: quarterly
  - DCC: ACT/360
  - Pay Accrued On Default: It determines whether accrued interest is paid on a default. If a company defaults between payment dates, there is a certain amount of accrued payment that is owed to the protection seller. "True" means that this accrued will need to be paid by the protection buyer, "False" otherwise. The defalt is "True,"

[8] See `http://www.cdsmodel.com/assets/cds-model/docs/Standard%20CDS%20Contract%20Specification.pdf` for details.

  – Adjusted CDS Dates: "F." It means that it assumes the next available business day when a CDS date falls on a non-business day except the maturity date.
  – First Coupon Payment: It is the earliest Adjusted CDS Date after T + 1.
  – Accrual Begin Date (Start Date): It is the latest Adjusted CDS Date on or before T + 1.
  – Accrual Period: It is from previous accrual date (inclusive) to the next accrual date (exclusive), except for the last accrual period where the accrual end date (Maturity Date) is included.

- Protection Leg:
  – Protection Effective Date (Backdrop Date): T - 60 calendar days for credit events.
  – Protection Maturity Date: Maturity Date.
  – Protection Payoff: Par minus Recovery.

6.1 More on CDS pricing

`CS10` is a method which calculates the change in value of the CDS contract when the spread of the contract increases by 10%. `CS10` takes in a `CDS` class object formed by calling the `CDS` function. The CS10 of `cds1` is $25385.2.

```
> cds1.CS10 <- CS10(cds1)
> cds1.CS10
[1] 25385.2
```

A market participant can also update the `CDS` class objects she has constructed by calling the `update` method. It updates a `CDS` class object with a new spread, points upfront or upfront by specifiying the relevant input.

```
> cds3 <- update(cds1, spread = 55)
```

`cds3` is a new `CDS` class object with a spread of 55 bps; all other specifications of the contract are the same as those in `cds1` since it is updated from `cds1`. One can also specify `upfront` (in dollar amount) or `ptsUpfront` (in bps) in the `update` method.

Besides calling the `summary` method, one can type in the name of the `CDS` class object in the current **R** Session and obtain a full description of the CDS contract.

```
> cds3
CDS Contract
Contract Type:                    SNAC   Currency:                        USD
Entity Name:                Alcoa Inc.   RED:                          49EB20
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:              102.24
Spread:                            55   Pts Upfront:       -0.0224
Principal:                   -223,692   Spread DV01:         5,064
Accrual:                       -7,500   IR DV01:             59.35
Upfront:                     -231,192   Rec Risk (1 pct):    88.87
Default Prob:                   0.047   Default Expo:    6,223,692

Credit curve effective of 2014-04-15
 Term      Rate Term      Rate
   1M 0.001517   7Y 0.022630
   2M 0.001923   8Y 0.024580
   3M 0.002287   9Y 0.026265
   6M 0.003227  10Y 0.027590
   1Y 0.005465  12Y 0.029715
   2Y 0.005105  15Y 0.031820
   3Y 0.009265  20Y 0.033635
   4Y 0.013470  25Y 0.034420
   5Y 0.017150  30Y 0.034780
   6Y 0.020160
```

There are three parts of the output. The first part "CDS Contract" provides basic information on the contract including "Contract Type", "Currency", "Entity Name", "RED", "TDate", various dates related to the contract, and the day count conventions for `cds3`.

The second part of the output contains relevant risks measures of `cds3`. `Price` refers to the clean dollar price of the contract and is calculated by

$$\text{Price}\& = (1 - \text{Principal}/\text{Notional}) * 100$$
$$\& = 100 - \text{Points Upfront}.$$

The price of `cds3` is 102.24, greater than 100. A CDS will have a price greater than 100 if the points upfront are negative, that is, the CDS buyer needs to receive money to obtain protection because he promises 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.

"Default Prob" refers to the default probability which is the estimated probability of default for each maturity by a given time. It can be approximated by

$$\text{Default Prob} \approx \left[1 - exp\left(\frac{rt}{1-R}\right)\right],$$

where r is the spread, t is the time to maturity, and R is the recovery rate. The default probability for `cds3` is 4.7%.

"Default Expo" refers to the expoure to the default of a CDS contract based on the formula below.

$$\text{Default Exposure} = (1 - \text{Recovery Rate}) * \text{Notional} - \text{Principal}.$$

The last part of the output reports the interest rates used in the calculation.

Calling the function `getRates` also produces the rates used in building a curve for CDS valuation.

```
> cds3Rates <- getRates(date = "2014-04-15")
```

The output consists of two list objects. The first list contains rates of various maturities. They are directly obtained from the Markit website based on the specifications (Markit, 2013).

```
   expiry matureDate     rate type
1      1M 2014-05-19 0.001517    M
2      2M 2014-06-17 0.001923    M
3      3M 2014-07-17 0.002287    M
4      6M 2014-10-17 0.003227    M
5      1Y 2015-04-17 0.005465    M
6      2Y 2016-04-17 0.005105    S
7      3Y 2017-04-17 0.009265    S
8      4Y 2018-04-17  0.01347    S
9      5Y 2019-04-17  0.01715    S
10     6Y 2020-04-17  0.02016    S
11     7Y 2021-04-17  0.02263    S
12     8Y 2022-04-17  0.02458    S
13     9Y 2023-04-17 0.026265    S
14    10Y 2024-04-17  0.02759    S
15    12Y 2026-04-17 0.029715    S
16    15Y 2029-04-17  0.03182    S
17    20Y 2034-04-17 0.033635    S
18    25Y 2039-04-17  0.03442    S
19    30Y 2044-04-17  0.03478    S
```

The second list reports the specific day count conventions and payment frequencies regarding the interest rate curve used.

```
                 text
effectiveDate    "2014-04-15"
badDayConvention "M"
mmDCC            "ACT/360"
mmCalendars      "none"
fixedDCC         "30/360"
floatDCC         "ACT/360"
fixedFreq        "6M"
floatFreq        "3M"
swapCalendars    "none"
```

7 Pricing Sources

We compared the results from our package with results from Bloomberg and Markit. Interestingly, the results from Markit and Bloomberg were not always identical.

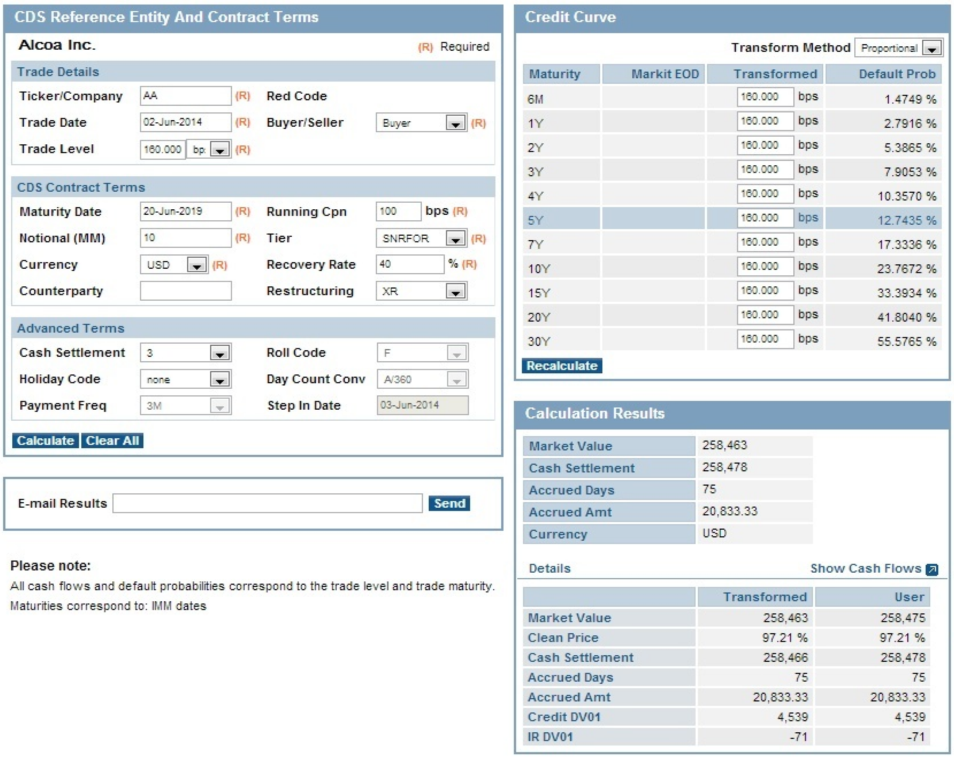

Figure 6: CDS figures from Markit.com

Figure 7: CDS figures from Bloomberg

The interest rate results were identical, at least till the fourth decimal place.

Default Swap Calculator User Guide

Yield Curve

Date 01-Jun-2014

Snap 1600 TimeZone: New York

Recalculate

Period	Type	Rate
1M	Deposit	0.1510 %
2M	Deposit	0.1908 %
3M	Deposit	0.2274 %
6M	Deposit	0.3219 %
1Y	Deposit	0.5344 %
2Y	Swap	0.5105 %
3Y	Swap	0.9095 %
4Y	Swap	1.2895 %
5Y	Swap	1.6175 %
6Y	Swap	1.8915 %
7Y	Swap	2.1165 %
8Y	Swap	2.2995 %
9Y	Swap	2.4525 %
10Y	Swap	2.5810 %
12Y	Swap	2.7885 %
15Y	Swap	2.9970 %
20Y	Swap	3.1825 %
25Y	Swap	3.2670 %
30Y	Swap	3.3055 %

Interest Rate Conventions

Spot Date: 04-Jun-2014	Swap DCC: 30/360
MM DCC: A/360	Swap Interval: 6M
Floating DCC: A/360	Holidays: none
Floating Interval: 3M	Bad Day Conv: MF

Figure 8: Interest Rate figures from Markit.com

Benchmark S260 (USD ISDA Standard Curve - Mid)

Date 06/02/2014

Term	Rate	Term	Rate
1 Month	0.1510	12 Year	2.7885
2 Month	0.1908	15 Year	2.9970
3 Month	0.2274	20 Year	3.1825
6 Month	0.3219	25 Year	3.2670
12 Month	0.5344	30 Year	3.3055
2 Year	0.5105		
3 Year	0.9095		
4 Year	1.2895		
5 Year	1.6175		
6 Year	1.8915		
7 Year	2.1165		
8 Year	2.2995		
9 Year	2.4525		
10 Year	2.5810		

Figure 9: Interest Rate figures from Bloomberg

8 Conclusion

In this paper, we describe the basics of a CDS contract and the ISDA Standard Model. We also provide a simple collection of tools to implement the Standard Model in **R** with the `CDS` package. Moreover, the flexibility of **R** itself allows users to extend and modify this package to suit their own needs and/or create their preferred models for valuing CDS contracts. An **R** package, `backtest` Campbell et al. (2007), provides facilities to explore portfolio-based conjectures about credit default swaps. It is possible to use the `backtest` package based on the output from the `CDS` package. Before reaching that level of complexity, however, `CDS` provides a good starting point for valuing credit default swaps.

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