A Guide to the CDS Package

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June 23, 2014

1 Introduction

Over the past three decades, **credit derivatives** have become increasingly common tools for finanical institutions that wish to pass on **credit risk** to investors who accept that risk for a premium, or fee. To put it simply, credit risk is the possibility that a borrower will default on his or her loan. In the modern financial world, there are many types of credit derivatives, including collaterized debt obligations (CDOs) and collaterized loan obligations (CLOs). In this vignette, we will focus on **credit default swaps** (CDSs), a type of credit derivative that has become quite popular among pensions funds, hedge funds, and investment banks, among other financial institutions (see Figure 1). We will explain the mechanics of this financial product and show how our **CDS** package can be used to manipulate and calcuate relevant information associated with CDSs.

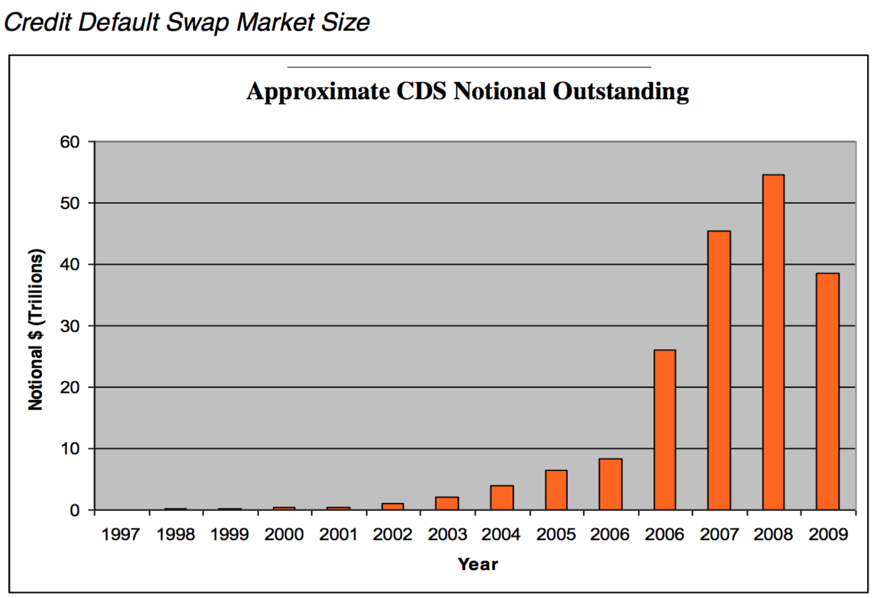

Figure 1: CDS notional outstanding from 1997-2009.

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CDSs originated in the late 1980s and were popularized by a team at J.P. Morgan that included Blythe Masters (Lenzner, 2009; Lanchester, 2009). The CDS market started to develop soon afterwards as banks used CDS contracts to hedge their credit exposures on balance sheets. Many different types of CDSs 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 single-name, or corporate, credit default swaps.

2 CDS Basics

2.1 Why CDSs?

To understand the benefits of CDSs as hedging tools, consider the following example:

Let's say that there is a manage of a pension fund who has to allocate her clients' money (a total sum of $100 million) such that it earns a steady return without taking . Therefore, this portfolio manager decides to buy several bonds from a company that has a low **credit risk**—say, Alcoa Inc. 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. The advantage of holding bonds instead of equity or stock is that bondholders are compensated before shareholders. Furthermore, both bonds can be categorized as "senior" or "junior" (there exist many other classifications, but we'll stick to these two for now). As the terms suggest, senior bonds usually have the greatest seniority in the issuer's capital structure and in the case of default, are repaid before junior bonds.

Since our portfolio manager is risk averse, she purchases senior bonds of Alcoa Inc., which she believes will not **default** on its debt. A company with a low credit risk, such as Alcoa Inc., is considered to be **credit worthy** and its bonds are classified as **Investment Grade** (IG). The creditworthiness of a company is often represented by the **credit rating**—a score determined 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; we 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 that our portfolio manager's bonds have 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 the manager bought the bonds, her confidence in the creditworthiness of Alcoa Inc. begins to waiver. In other words, the manager is worried about some **credit event** related to the company. A credit event can signify the risk of a company's bankruptcy and resulting default, but the term can also expand to include failure to pay out debt within a certain amount of time, a credit downgrade or the confiscation of assets, among other events. Of course, she could simply sell the bonds; however, that may be premature or even unprofitable. Instead, she could textbfhedge her position by purchasing a financial product whose value rises with a drop in the bonds' value. In other words, she could take a position that allows her to *profit* from increased credit risk.

One conventional technique of doing this is shorting bonds. Shorting is the process of borrowing and selling a security with the 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 bonds 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 of $100 million, which is a substantial opportunity cost.

2.2 CDS Mechanics

CDSs were invented in order to resolve these issues associated with hedging against risk (as described in Section 2.1).

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** to the seller in exchange for protection against a credit event associated with the buyer's bond.

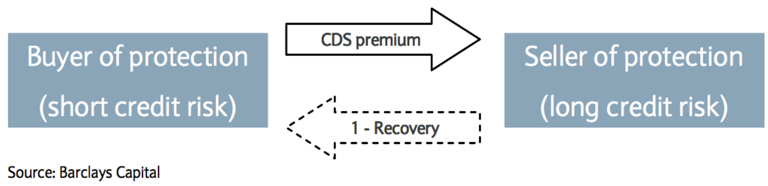

Figure 2: Cash flows in a single name CDS contract.

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 protection to the portfolio manager for $10 million of senior debt. This amount known as the **notional amount**. In return, she has to pay the hedge fund an annual coupon rate of over 1%, or 100 basis points, for a period of five years. These $100,000 payments are made quarterly, so she would have to pay 0.25% every quarter until the maturity date.

In the case of default, the hedge fund would have to pay a compensation equal to the notional amount 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 default. 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 protects the portfolio from the bonds' associated credit risk without having to sell them. The hedge fund, on the other hand, receives a fee and walks away without any losses if there is no credit event.

Our example above can be described as a single-name CDS contract, in which the transfer of credit risk takes place between two parties. The protection buyer of a CDS contract transfers the credit risk to the CDS 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. Note that there is no involvement of the Alcoa Inc. in the transaction; this exchange only takes place between the two counterparties.

3 CDS Terminology and Cash Flows

Although the cash flows involved in a CDS seem pretty simple in figure 2.2, the underlying mechanics of a CDS are a bit more complex. To understand this, let's look at actual CDS data for Alcoa Inc., from Bloomberg. Bloomberg and Markit are the two most commonly used sources for CDS related data; we will discuss these extensively in a later section. Figure 3 below displays many different variables such as RED Pair Code, REF Entity, Trade Date, Debt Type etc. for the CDS of Alcoa Inc. for June 02, 2014. These are standard terms of CDS contracts that were set by the **International Swaps and Derivatives Association (ISDA)**, the organization that regulates over-the-counter derivatives such as CDSs.

Figure 3: CDS figures from Bloomberg

Some of these variables seem self-explanatory. **REF Entity** (Reference Entity) refers to the name of the company (Alcoa Inc., in this case) that the buyer wants protection against. **Trade Date** is the date on which we are making the trade – June 02, 2014. **Maturity** refers to the **tenor**, or length, of the contract. The most commonly traded contracts have a maturity of five years. The Bloomberg screenshot displays the length of the contract, as well as the equivalent maturity date. So the maturity date for the CDS of Alcoa on June 02, 2014 is June 20, 2019. This seems odd since we would expect it to be on June 02, 2019, exactly five years from the Trade Date. However, the maturity date always falls on one of the four **roll dates**: March 20, June 20, September 20 and December 20. Therefore, the maturity date for this contract will be on the roll date after June 02, 2019, which is – June 20, 2019.

We can also note the label **Debt type**, marked as 'Senior'. Clearly, this refers to the seniority of the debt. The **notional amount** is printed as '10' or \$10 million USD (US Dollars). The 'MM' between the amount and the currency refers to the type of restructuring of the contract—in this case, 'Modified

Modified' Restructuring.

The two terms in this figure that are essential for understanding the cash flow are **Trd Sprd** (Trade Spread) and **Coupon**, both given in basis points (bps). In section **??**, we stated that the protection buyer pays the protection seller a fixed coupon for purchasing protection. Until 2009, the two counterparties in a CDS contract would agree on the coupon level before the trade. Then, as the market moved, this tradable coupon would vary. In this type of contract, the present value of the contract (the current worth of a future sum of money) would be zero. So if our portfolio manager was purchasing a CDS before 2009, she would have had to negotiate a fixed coupon with the hedge fund, which would then vary as the company's credit risk varied.

In April 2009 in North America, the ISDA introduced a series of mandatory modifications to the CDS contract known as the "Big Bang Protocol." Under the new rules, coupon rates were standardized in North America, and even in Europe from June 2009. Dealers would now have to quote **standard coupons** of 100bps or 500bps in North America, or 25bps, 100bps, 500bps or 1000bps in Europe. The **Coupon** printed in the figure above is the fixed coupon for Alcoa Inc., which is 100bp or 1% of the notional amount. However, the dealers may not feel that this is the fair premium for protection. For instance, the hedge fund selling protection to the portfolio manager may feel that the fair premium should be 160bps, and not 100bps. This fair premium rate is known as **Trade Spread** (or **Par Spread**, or just **Spread**), labeled as 160 in the figure above.

Naturally, if the hedge fund believes that the fair premium should be 160bps, it would like to be compensated for receiving just 100bps. As a result, the portfolio manager would have to make what is known as an **Upfront Payment** at the trade inception. Therefore, in the absence of a credit event, the cash flow between the two parties, over the life of the contract, would look like Figure 3.

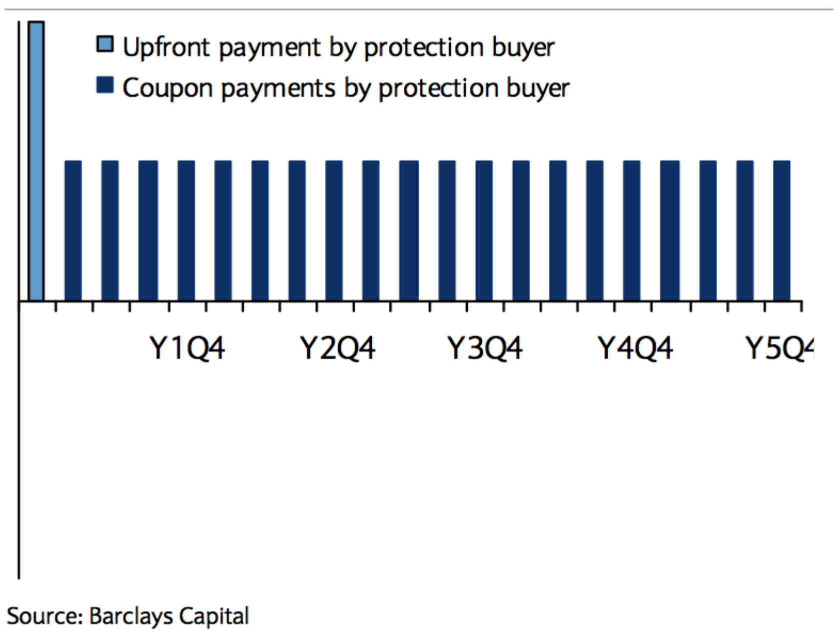

Figure 4: CDS cash flows when there is no credit event.

If, however, there is a credit event, the cash flow would look like Figure 3.

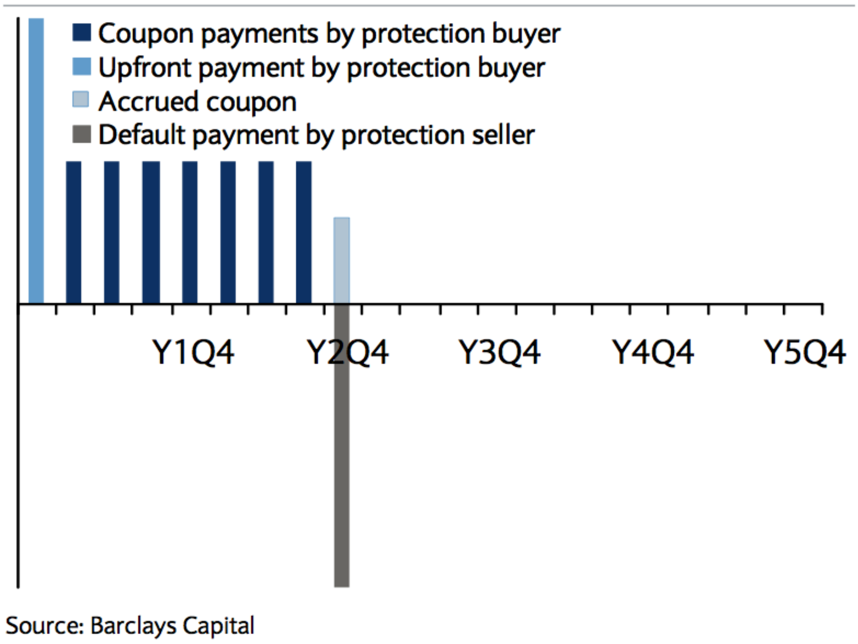

Figure 5: CDS cash flows when there is a credit event.

The ISDA protocol, since April 2009, specifies that all premium payments, by default, start on the roll date before the Trade Date. So if the Trade Date is June 02, 2014, the **Accrual Begin Date** is, by default, March 20, 2014. Now if the Accrual Begin Date is 75 days before the Trade Date, the portfolio manager would not want to pay interest for the 75 days she has not received protection for.

We must note that we are dividing 75 by 360 instead of 365 in the above calculation. This is to do with the **Day Count Convention** (**Day Cnt** in Figure 3) of the contract, which specifies that the accrual factor between two dates is ACT/360 or Actual/360.

If we subtract the **Accrued Interest** over the past 75 days from the upfront payment, we get the **Dirty Upfront** or **Cash Settlement Amount**. With the information for Alcoa given in the Figure 3, the dirty upfront value for this contract is $258478. **Clean upfront**, on the other hand, is the dirty upfront less any accrued interest payment, and is also called the **Principal**. In this case, it is $279311.

4 CDS Terminology

Here is a glossary of CDS terminology necessary for determining the pricing and cash flows associated with CDSs[1]:

Reference Entity refers to the legal entity that is the subject of a CDS contract (Alcoa Inc., in our example).

[1]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 the ISDA Model* (White, 2013).

RED is a Markit product that stands for Reference Entity Database. Each entity/seniority pair has a unique six-digit RED code that matches the first six digits of the nine-digit RED pair code. Each entity also has a "preferred reference obligation," which 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 indicates the trade date of the CDS contract, as shown in the argument of the `CDS` function. In our exmaple, the trade date is June 02, 2014 in `cds1`.

Maturity refers to the fixed date on which a CDS contract terminates. However, colloquially speaking, it can also represent the length of time remaining until that date. This length is also called the **tenor** of a CDS contract. The most commonly traded CDSs have maturities of five years. The protection buyer continues to make payments to the protection seller until the maturity of the contract or the occurrence of a credit event. The maturity is five 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 (bps). 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 would be the coupon size that they 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 Reference Entity or the RED Code. She does not have to know that information to use the **CDS** package. As shown below, as long as she inputs the same `Trade Date`, `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.[2] `ptsUpfront` or `upfront` refer to points upfront (in %), and upfront 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.

[2]See Section 5 for definitions on both terms.

5 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.

An ISDA standard CDS contract specifies the following:[3]

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,

Backstop Date = 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**.

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.

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

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:[4]

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 the following maturities: one, two, three, and six month(s), and one 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.[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).

6 CDS Indices

Holding a portfolio of a disproportionate number of Alcoa Inc. bonds 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. This is known as **diversification**. Although this strategy reduces her

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

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

exposure to the credit risk of any particular company, she hasn't reduced her exposure to factors that might affect a wide variety of assets simulatenously, such as interest rate risk or political risk. 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 high-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. She may consider investing in a tranche of CDS indices known as CDX.NA.HY.

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.

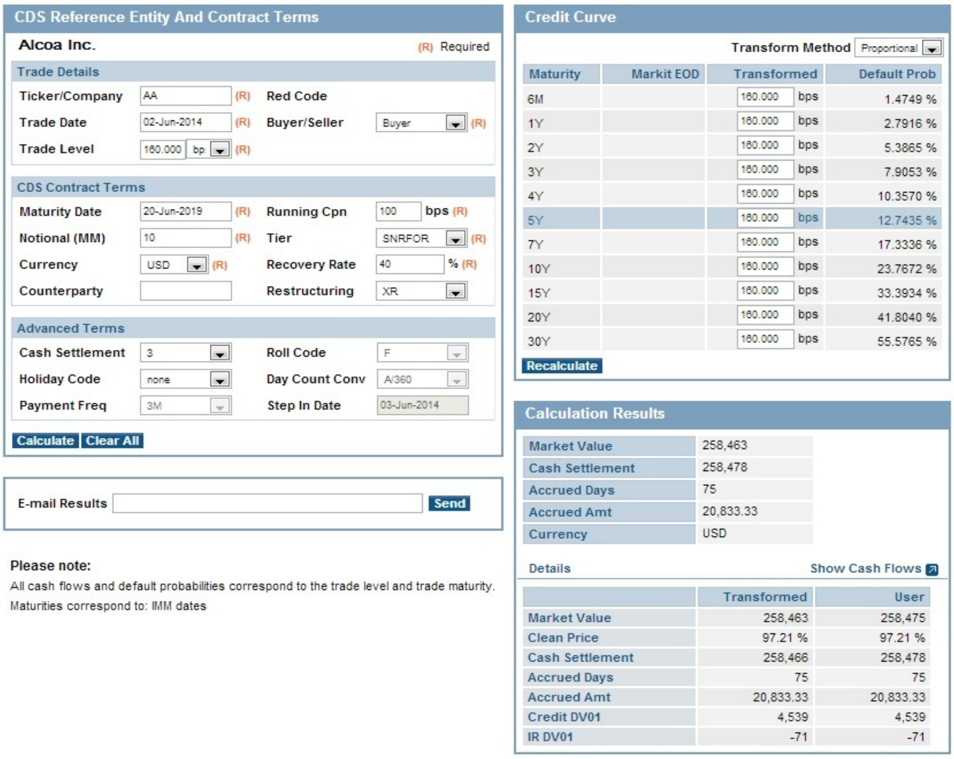

Figure 6: CDS figures from Markit.com

Figure 7: CDS figures from Bloomberg

The interest rate results were identical, at least until 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 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.[6] 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 5. 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 five years. Its spread is set at 50 bps and its coupon at 100 bps. The notional amount is $10 million. A user can call `summary` on a `cds1` to view essential information on the contract.

```
> 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". `Trade Date` refers to the trade date and is April 15, 2014. Reference Entity (called `entityName` in the package) 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

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

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 he or 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 gives us:

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

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.[7] 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: five 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,"
  - 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.

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

8.1 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 and points 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", "Reference Name" (called Entity Name in the package), "RED", "Trade Date", 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

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

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"
```

9 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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