

INTRODUCTION TO CREDIT DEFAULT SWAPS

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This note is intended to introduce readers to credit default swaps (CDS), both the pricing basics and the role of CDS in the 2008 subprime financial crisis. The reader is not expected to have an understanding of quantitative finance, as this note does not address the details of different pricing models.

CDS are derivative instruments that provide investors with protection against credit events such as downgrades of, or defaults by, either single-name obligors or a basket of obligors. These instruments, which were estimated by the Bank for International Settlements (BIS) to be worth \$32.6 trillion in December 2009,¹ represent one of the largest and fastest growing financial product markets globally.

INTRODUCTION

Prior to the emergence of credit derivatives, the task of managing credit risk was limited to the use of traditional financial analysis, covenants and counterparty limits. These measures were typically undertaken by financial institutions or large investors and included the use of triggers and covenants, collateral and regular business review.

However, the high demand for structured solutions in the field of credit risk management led to the introduction, in the late 1980s, of credit risk instruments such as CDS, which were developed on the basis of complex statistical models. Although these instruments were initially used mainly by large financial institutions, it was not until the late 1990s that CDS gained popularity among different financial sector participants.

Rapid growth in the CDS market is shown in relation to the outstanding notional contract value in Exhibit 1. The decline in the market that started in 2008 was on account of the financial sector meltdown and is discussed later in this note.

¹ "Table 19: Amounts Outstanding of Over-the-Counter (OTC) Derivatives," *BIS Quarterly Review*, June 2010, p. A121; available at <http://www.bis.org/statistics/otcder/dt1920a.pdf>, accessed 29 August 2010.

CREDIT DEFAULT SWAPS

Credit default swaps function as insurance on debt that an investor (i.e., a buyer of protection) can purchase from the market (see Exhibit 2). Similar to the insurance mechanism, the investor is required to make regular premium payments (quoted in basis points per annum, or bppa) to the counterparty (i.e., seller of protection). In the case of a defined credit event, either a downgrade or a default of a third party (i.e., a reference entity), the insurer receives settlement on the exposure.

CDS are available for senior and subordinated debt on firms and financial institutions, in addition to sovereign risk for tenors from one year to 10 years. However, the most liquid market is for five-year subordinated debt followed by three-, seven- and 10-year tenors. CDS instruments are traded over-the-counter (OTC), and the International Swaps and Derivatives Association, Inc. (ISDA) manages the documentation and the legal and netting framework for this market.

Although CDS may be considered analogous to insurance products, one key difference distinguishes the two. In the case of insurance, protection is available only to the owner or user of the asset (e.g., home insurance can only be purchased by the homeowner), whereas asset ownership is not mandatory in the case of CDS because the instrument can be purchased by anyone in the market. The separation of ownership from participation in the CDS market has its benefits: investors can use these instruments to synthetically create or remove risk from portfolios, an option that has become a major driving force behind the growth in the CDS sector.

We use an illustration to explain the transaction dynamics of CDS. If an investor wants to hedge a five-year exposure on a \$100 million investment in a firm, CDS can be purchased from a protection seller at the prevailing market rate of 400 bppa. Under this structure, the CDS buyer will make quarterly payments of approximately \$1 million ($\$100 \text{ million} \times 0.04 \times 0.25$; ignoring day count conventions) to the CDS seller. These payments are made until either the contract expires (i.e., in five years) or a credit event occurs.

If an event of default occurs, the protection buyer will pay the premium outstanding until the date of default. In return, the protection buyer will receive a payment from the CDS seller depending on the settlement terms of the contract. Three main types of settlements are available:

1. Physical settlement. The protection buyer surrenders the asset or portfolio of assets to the protection seller to recover full face value of the exposure. Physical settlement is the most commonly used settlement method. In case of a multiple choice of assets (e.g., bonds) available, the buyer has the right to furnish the “cheapest to deliver” asset in return for face value of the investment. In the above example, the investor would deliver the bonds to the protection seller and receive \$100 million in return.
2. Cash settlement. If the credit event happens and the asset is trading at \$0.6 per dollar face value, the insurance buyer with \$100 million coverage will claim \$40 million from the CDS seller to cover the loss in value.
3. Fixed value (binary) settlement. In a fixed value settlement, the counterparties agree in advance on a fixed recovery level (e.g., 30 per cent) on the investment. If a credit event occurs, the insurance buyer receives \$70 million from the insurance seller, irrespective of the actual loss on the asset. This structure is seen only in some special CDS transactions.

CDS MARKET PARTICIPANTS

For a snapshot of the main buyers and sellers of CDS, see Exhibit 3.

We can see from the pie charts in Exhibit 3 that banks remain the primary buyers and sellers in the CDS market. Trading activity reflected in the pie charts refers primarily to the market-making function carried out by banks; as a result, the banks tend to purchase as much protection as they sell. Banks also use CDS to hedge credit exposure on loans and occasionally to take on additional risk by selling CDS.

Insurance companies treat CDS as investment opportunities especially in the case of lower-risk businesses. We therefore see insurance companies as having a significant share in the CDS sales market. Hedge funds are also major players in the CDS market because they look at both buying and selling protection, to increase or decrease leverage and generate income for their businesses.

TYPES OF CDS

Three main types of CDS are traded in the market:

1. Single-name CDS: These are the simplest form of credit derivatives. They provide the buyer with insurance against credit events involving a firm or government.
2. CDS basket: These typically consist of three to 10 reference entities grouped together into a basket of CDS. These are known as nth to default baskets where, if $n=2$, the basket is called a second to default basket. In this case, an event of default is said to be triggered when the second firm in the basket of firms defaults. When such an event happens, the buyer surrenders the reference asset and receives face value from the CDS seller. The premium on this type of CDS increases as (i) the number of firms in the basket increases, (ii) the value of n decreases and (iii) the default correlation increases among the firms in the basket.
3. CDS indices: These represent the fastest growing product in the CDS market. A CDS index consists of an index of firms for different markets (e.g., North America, Europe, Japan) in addition to different types of firms (e.g., diversified, high volatility). The index constituents are typically updated every six months by the large dealers and the selection is based on CDS liquidity rather than on market capitalization. The firms are usually equally weighted in the index.

Assuming a \$10 million cover on an index of 125 firms, if one of the firms defaults, the spread will decrease to 124/125 of the original level. In terms of the payoff to the protection buyer, the tranche could be defined as 0-3, 3-7, 7-10 per cent and so on. If the holder has a 3-7 per cent tranche, then nothing happens for the first \$3 million of losses, after which the holder will be compensated for any loss in excess of \$3 million but not greater than \$7 million.

CDS PRICING MODELS

Although some CDS pricing models may be more commonly used than others, no single pricing model can currently be considered the primary pricing tool for the market. Given the absence of a dominant pricing tool, an investor may be quoted different prices for the same contract by two different banks, both using their proprietary models.

To understand the reasons for the lack of a uniform pricing tool, we highlight two of the key inputs needed for pricing credit risk: the time to default and the subsequent recovery rate. A credit event is not limited to default and may also include rating downgrades. Thus, an accurate forecast of the evolution of the credit risk is required, a task that is difficult to model. Additionally, the recovery rates for the loans should be estimated. Although estimates for both inputs can be determined in various ways, they are typically based on historical data and therefore include proprietary data unique to each firm and its experiences.

Most of the valuation models can be grouped into one of the following two categories (or a hybrid of the two):

1. Structural models
2. Reduced form models

The main difference between the two models is that structural models base default on the firm's asset-liability evolution process, whereas reduced form models assume that default is a stochastic event independent of the firm's financial position but dependent on the general level of interest rates.

Structural Models

Structural models are characterized by modeling of a firm's total value to develop an estimate for the probability of default. According to these models, the source of credit risk is the uncertainty concerning the market value of the firm, and the valuing of risky debt is built on Merton's model.

The underlying Merton model is built on insights from the Black-Scholes options pricing model using the following premises:

1. Default events are predictable based on the value of debt and the value of the firm.
2. The value of the assets of the firm evolves randomly.

A firm with debt and equity in its capital structure will pay the bondholders, on maturity, the lower of the face value of debt or the market value of the firm, the latter representing a default scenario. In other words, if the market value of the firm is greater than the face value of debt, the bondholders' debt is repaid and the residual value flows to the equity holders. On the other hand, if the market value of the firm is less than the face value of debt, the bondholders take over the firm, thereby, receiving the market value of the firm, whereas the equity holders receive nothing.

Using the following notation, we can replicate the position of the equity holders and the bond holders through options.

A = market value of the firm's assets
 S = market value of equity
 B = market value of debt
 F = face value of debt (on maturity, T)

Where $A = B + S$

The payoffs to the respective investor groups are shown in Exhibit 4.

From the payoffs shown in Exhibit 4, we can see that the position of the equity holders is similar to holding a call option on the firm's assets, with strike price equal to the face value of the outstanding debt (F) and maturity identical to the debt's maturity (T). Applying put-call parity, the value of the firm's equity (or the call option on the firm's assets) can be stated as follows:

$$S = P + A - Fe^{-rT}$$

Fe^{-rT} is the present value of the debt's face value F , calculated using the risk-free rate, r , and continuous compounding.² Substituting for S in the above equation leads to the following result:

$$A - B = P + A - Fe^{-rT}$$

$$B = Fe^{-rT} - P$$

Therefore, the defaultable bond is equivalent to holding a risk-free bond along with a short put position on the assets of the firm. Merton uses this relationship to arrive at a value for the risky debt. The yield on the risky debt, when deducted from the yield from a matching term risk-free instrument, represents the credit spread because it is the return that an investor requires for taking on the additional risk.

Although Merton's model is groundbreaking in the area of pricing defaultable debt, it suffers from two major limitations. Firstly, it allows for a default to occur only on maturity of debt; however, in the real world, default or credit events can happen at any time during the life of a loan. Additionally, one of the inputs in the model is the market value of the firm. This value is difficult to estimate especially if the firm has privately placed debt. Thus, this difficulty in estimating a firm's market value may lead to valuation errors in the pricing process. Another limitation in the model is that, in the case of multiple class debt, absolute priority of settlement is required to be maintained in case of a default, which may not necessarily be the case, especially when debt is secured through multi-tiered security structure.

Subsequent structural models have tried to relax some of the assumptions underlying Merton's model, especially the limitation that default may occur only at maturity. Black and Cox first developed a model that allows for default to occur as soon as the firm value falls below a threshold level during the term of the loan. However, their model assumes a constant interest rate and does not address issues regarding the seniority of debt and its subsequent impact on recovery rates.

Despite improvements on Merton's model, critics of structural models argue that these models require data on parameters related to the firm's value, which may be difficult to estimate. Additionally, not all defaults occur from a gradual deterioration in credit quality. Often, surprise events force a firm to file for bankruptcy, and these situations are difficult to capture through the structural models.

Reduced-Form Models

Limitations to the structural models led to the development of another line of pricing models that do not condition credit events on the value of the firm and related parameters. However, as with other arbitrage-based models, reduced-form models are best suited for highly liquid assets and may not be as accurate in cases of low market liquidity.

² The continuous compounding convention is common in options markets. If the risk-free rate were expressed instead with annual compounding as R , the present value of F would then be written as $F/(1+R)^T$. Both expressions are equivalent by definition.

Unlike in a structural model, where the evolution of credit may help identify possible default, in a reduced-form model, the default event is stochastic with the probability of default linked to variations in the level of interest rates.

CDS AND THE CREDIT CRISIS

Similar to markets for other financial products, the CDS market was also hit hard by the subprime financial crisis. To understand the impact of the crisis on the CDS market, it is necessary to review the events leading to the crisis.

A low interest-rate environment in the United States resulted in a boom in the real estate market because investors were able to acquire cheap funding to purchase investment properties. This growth in the property market was also helped by the development of an asset-backed commercial paper (ABCP) market that allowed lenders to package mortgages and sell them through structured investment vehicles (SIVs). The sell-down of the mortgages from their balance sheets allowed lenders to book fresh mortgages to generate additional fee income, resulting in an increased supply of funds to borrowers.

To provide funding to new borrowers, the lenders gradually lowered their lending criteria and offered easy terms, such as “interest only” loans, which resulted in an increase in the subprime loans (i.e., funds provided to higher-risk borrowers). This market worked well while the property market was in a boom and interest rates were low.

As interest rates started increasing, the subprime borrowers started to default on their home loans. These defaults then resulted in defaults on the ABCP tranches that had been sold to investors. As a result of these defaults, the demand for ABCPs dried up, resulting in a slowdown in the property market, which triggered a decline in home prices. This drop in home’s selling prices resulted in further defaults in the market, and the problem snowballed into a property market collapse. This collapse was no longer restricted to the subprime loans, as declining property prices also led to defaults in the lower-risk Alt-A and prime mortgage markets.

The property market collapse had two effects on investors in the market. First, the higher loan payments resulted in an increase in defaults in the ABCP market. Second, because ABCP investments had been used as collateral by investors, the decline in their value led to margin calls being made on these investors. If the margin calls went unheeded, the banks were forced to sell off the security, thereby increasing the supply of ABCPs in the market, which added to their slide in value.

With the collapse of both the ABCP investments and real estate markets, credit spreads started to widen, and the stock market went into a slump. The inability of banks to sell off ABCP investments meant that they had to carry these loans on their own balance sheet, which resulted in a liquidity crunch.

This situation had a spillover effect on the corporate market because the reduced liquidity in money markets meant that corporate borrowers were also unable to acquire financing for their everyday operational funding requirements. This contagion resulted in bankruptcies, especially for smaller and medium-sized businesses that were unable to finance their operations, and added to the recessionary pressure on the general economy. Therefore, CDS spreads on banks and corporates also increased.

Because CDS had been used to insure the ABCP tranches, defaults in the property market meant that these CDS were called by the protection buyers. Additionally, CDS sold on the now bankrupt businesses were also called by the CDS buyers.

The calls on CDS put pressure on the insurance sellers, which included banks, insurance companies and hedge funds. The best example of this effect is the experience of American International Group (AIG), which had been one of the largest dealers in the CDS market. Because calls were made on the CDS AIG had sold, the company was forced to make payments on these contracts. With an ongoing liquidity crunch, AIG was unable to make payments on all its outstanding contracts and the entire CDS market was at risk of collapsing. This event was one of the contributing factors to the U.S. government's bailout of AIG.

This scenario was repeated for other CDS sellers who had previously assumed the probability of default in the CDS market to be very low. As a result, the CDS market also came to a standstill with little trading occurring at the time of the subprime financial crisis. This liquidity squeeze in the CDS market is evident in Exhibit 1, where the market size is seen to decline in 2008.

Another issue with CDS emerged as a result of the crisis regarding mispricing of the instruments. One of the key spread determinants in CDS models is the probability of default. Because the period leading up to the subprime crash was marked by unusually few bankruptcies, the default probability used in the models was lower than it should have been. As a result, the CDS spreads were underpriced in the market.

FUTURE OF CDS

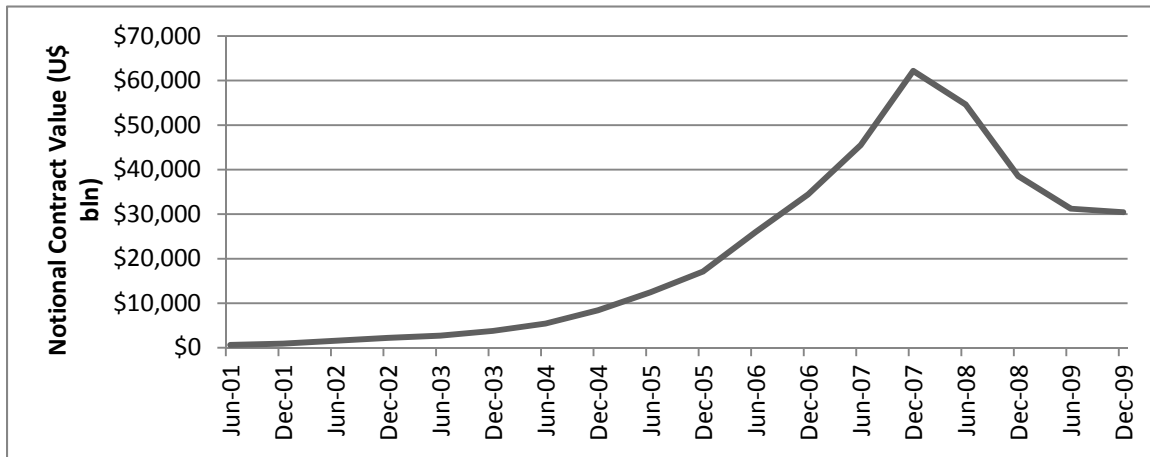
The United States and other governments are trying to regulate the CDS market to avoid similar issues in the future. As a result, some of the suggested changes to the CDS market include the following:

- Taking the market to an exchange-based environment and setting up a central clearinghouse as the central counterparty.
- Standardization of the CDS contracts to avoid any subsequent legal issues and to add transparency to the market.

Although the CDS market has gone through a slump and a downsizing, if the instrument is moved to an exchange from its current OTC structure, liquidity is expected to increase, and the market will be able to experience another boom period.

Exhibit 1

VALUE OF OUTSTANDING NOTIONAL CREDIT DEFAULT SWAP CONTRACTS, 2001–2009



Source: International Swaps and Derivatives Association, Inc., "ISDA Market Survey: Notional Amounts Outstanding, Semiannual Data, All Surveyed Contracts, 1987–Present," 2010; available at <http://www.isda.org/statistics/pdf/ISDA-Market-Survey-historical-data.pdf>, accessed 29 August 2010.

Exhibit 2

CREDIT DEFAULT SWAP TRANSACTION STRUCTURE

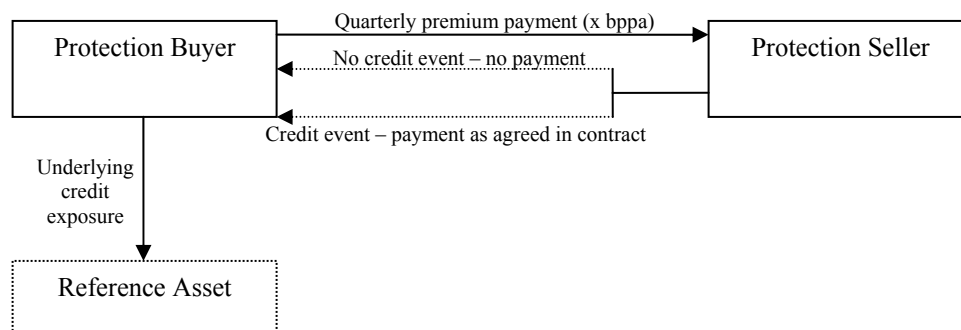
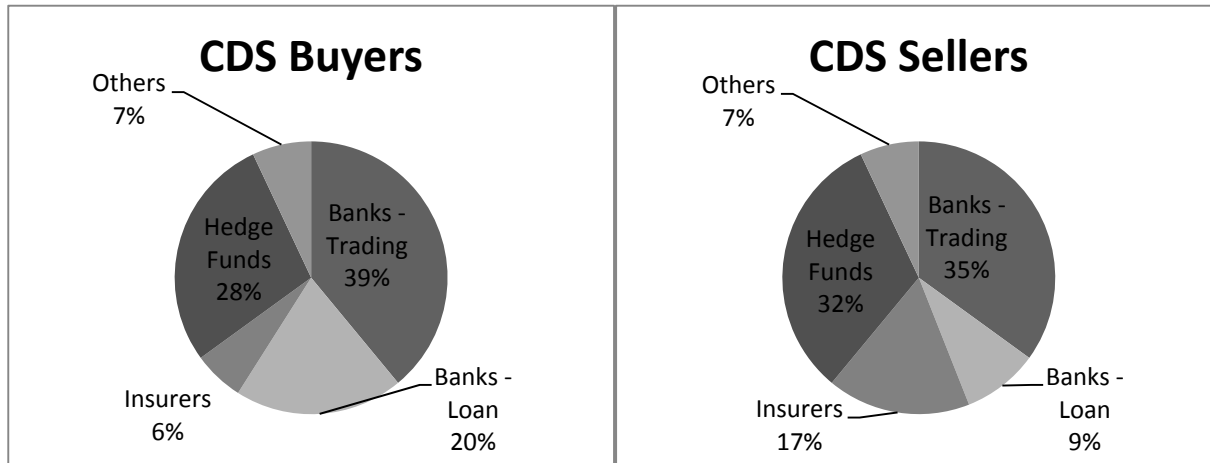


Exhibit 3

KEY MARKET PARTICIPANTS



Source: David Mengle, "Credit Derivatives: An Overview," available at http://www.frbatlanta.org/news/conferen/07fmc/07FMC_mengle.pdf, accessed 29 August 2010.

Exhibit 4

PAYOFF TO BOND AND EQUITY INVESTORS IN A FIRM

	Equity Holders Receive	Bond Holders Receive
If $A_T > F$	$A_T - F$	F
If $A_T < F$	0	A_T
Net Position	$\text{Max}(0, A_T - F)$	$\text{Min}(F, A_T)$