CHAPTER 19

Credit Products

Perhaps the fastest growing area within the derivatives industry is credit derivatives. Simply defined, a *credit derivative* is an agreement that transfers the credit risk of an asset from one party (the *protection buyer*) to another (the *protection seller*). The oldest form of a credit derivative is a guarantee. A *guarantee* is a contract in which the seller accepts responsibility of the buyer's payment obligation(s) in the event of default. While guarantees have been arranged for thousands of years, two new and different classes of credit derivative contracts began to appear in the early 1990s—credit default products and credit spread products. *Credit default products* are those whose payoffs are triggered by a "credit event." A *credit event* need not be default and can be defined in any way that the two counterparties agree. Some common credit risk realizations are bankruptcy, failure to pay a coupon or to repay the full amount of the bond's principal, an invocation of a cross-default clause such as a more junior bond issue within the firm defaulting, a corporate restructuring that leaves bondholders worse off, and credit deterioration in the form of a downgrade in bond rating.[1] In contrast, *credit spread products* are those whose payoffs are linked to a *credit spread*, that is, the difference between the yield to maturity on a corporate bond and the yield to maturity of a risk-free bond (e.g., U.S. Treasury bond) with same coupon rate and maturity date. Naturally, credit spreads depend on all credit risk realizations to varying degrees.

The purpose of this chapter is to describe the different types of credit derivatives that are now traded in the OTC market and how they are used.[2,3] In the first

[1] Credit event definitions are contained in International Swaps and Derivatives Association (2003).

[2] No exchange-traded credit risk futures and options listed. In November 1998, the Chicago Mercantile Exchange (CME) launched trading of futures and options on the Quarterly Bankruptcy Index (QBI). The QBI is reported quarterly and is the total number of bankruptcy filings (in 000s) in U.S. courts over the previous quarter. Since most bankruptcy filings are by individuals, this contract was intended to be a credit risk management vehicle for those holding portfolios with a significant amount of consumer debt (e.g., credit card debt). Unfortunately, the product was a resounding failure. In five years after the product launch, the QBI futures and options have never traded. The CME's Board of Directors approved delisting all contract months on September 3, 2003.

[3] This chapter is intended to be only a primer on credit derivatives. For more details regarding the intricacies of the different contracts and their uses, see Tavakoli (1998) and Meissner (2005).

section, we discuss the evolution, growth and current size of OTC credit derivatives markets. In the second, we discuss one of the first modern-day credit derivative contracts—a total rate of return swap. In a total return swap, the buyer transfers all of the risks of the asset (e.g., the market risk and default risk of a corporate bond) to the seller in return for a risk-free interest payment. We then turn, in the third section, to credit default products, the most prominent of which is credit default swaps. In a credit default swap, the protection seller agrees, for an upfront or a continuing premium, to compensate the protection buyer upon a defined credit event. Since the buyer retains ownership of the underlying asset, a credit default swap isolates the credit risk inherent in the asset (e.g., the default risk of a corporate bond) from market risk (e.g., the interest rate risk of a corporate bond). Credit default swaps are used in structuring two other types of credit risk products—credit-linked notes (CLNs) and collateralized debt obligations (CDOs). A *credit-linked note*, described in the fourth section, is a bond-like security structured by a bank to behave like a particular corporate or sovereign bond. This is done by buying a risk-free bond and selling a credit default swap. The success of this market is driven by the fact that corporate bond markets are relatively illiquid and that many firms and institutions do not have authorization to trade derivative contracts or to engage in off-balance sheet transactions. A synthetic *collateralized debt obligation*, described in the fifth section, is like a CLN, except that the CDO sells a portfolio of different credit default swaps and issues bonds of varying degrees of seniority. Credit spread products are discussed last. These products have payoff structures that depend on the credit spread.

CREDIT PRODUCT MARKETS

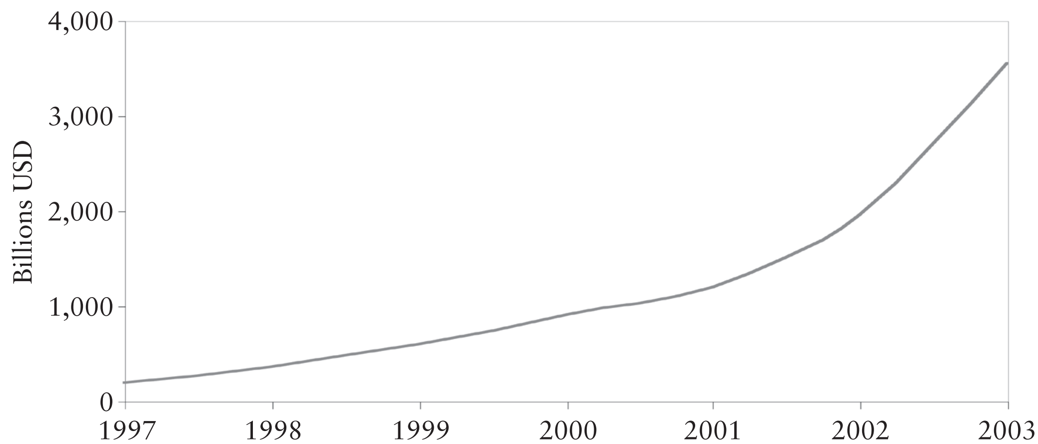
Like in most OTC markets, finding detailed information regarding credit derivative contract specifications and trading activity is difficult. The contracts are private negotiations and mandatory reporting is not required. Again, the International Swaps and Derivatives Association (ISDA) plays a significant role in the standardization of contract terms. More than 98% of all credit default swaps traded during 2003, for example, were based on ISDA documentation.[4]

Probably the most detailed information regarding the credit derivatives market is collected by the British Bankers' Association (BBA). Each year, the BBA surveys institutions regarding credit derivatives use. Most of the respondents are significant players in the international credit derivatives market. For the 2003/2004 survey, 30 institutions participated. More than a third had outstanding transactions in excess of USD 100 billion.

One important fact emerging from the 2003/2004 most recent BBA survey is that the size of the credit derivatives market is growing exponentially. Figure 19.1 shows the notional amount of credit derivatives at yearend during the period 1997 through 2003. Where only USD 180 billion were outstanding in 1997, the number had grown to 3,548 in 2003, nearly a 20-fold increase. The rate of increase from 2002 to 2003 was over 41% alone! Among the reasons cited for the rapid growth are increased market liquidity, a wider array of products, improved standardiza-

[4] See British Bankers' Association (2004, p. 27).

FIGURE 19.1 Notional amount of global credit derivatives outstanding (excluding asset swaps) by year in USD billions.



Source: The figure is based on information compiled from British Bankers' Association (2004, p. 11).

tion, and greater market understanding. While the growth in the credit derivatives market is unmistakable, with estimates tipping USD 8.2 trillion for the year ending 2006, the market remains small relative to other types of OTC products. The total notional amount of OTC derivatives outstanding was over USD 197 trillion for the year ending 2003. Thus, credit derivatives accounted for about 1.8%.

In general, a credit derivative is any financial contract that is designed to permit someone to change (increase or reduce) credit risk. The BBA's definition of credit derivatives, for survey purposes, includes:

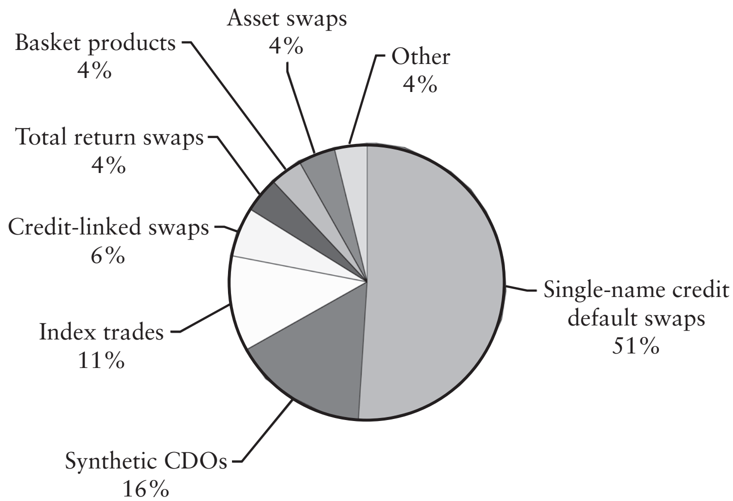
> Any instrument that enables the trading or management of credit risk in isolation from other types of risks associated with an underlying asset. The instruments may include: single-name credit default swaps, credit spread products, total return products, basket products, credit linked notes, synthetic CDOs, equity linked credit products, index products and asset swaps. They include both single-name and portfolio transactions.[5]

Single-name *credit default swaps* (CDSs) are by far the largest category. Figure 19.2 shows that 51% of the notional amount of credit derivatives outstanding at the end of 2003 was accounted for by single-name CDSs. The descriptor, "single-name," in the name arises from the fact that these agreements specify a single corporate bond or loan, a sovereign bond, or an asset-backed security as the reference obligation[6] in contrast with a portfolio, basket, or index. The second largest category is collateralized debt obligations (CDOs) at 16%, followed by index trades at 11%, and *credit-linked notes* (CLNs) at 6%. Total return

[5] See British Bankers' Association (2004, p. 10).

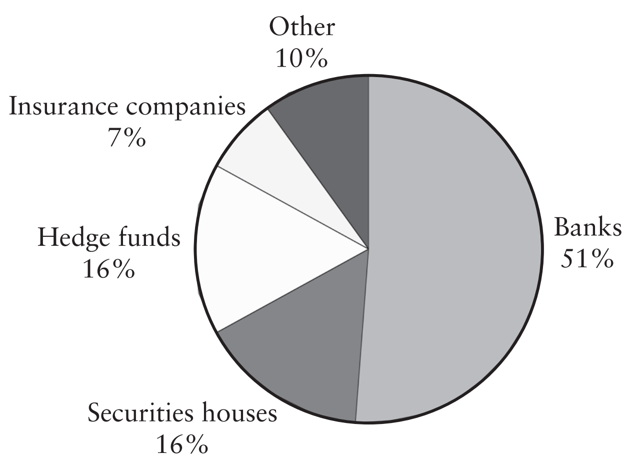
[6] A *reference entity* (or *reference issuer*) is the issuer of the security underlying the credit derivative (e.g., Ford Motor Co.). A *reference obligation* (or *reference asset*) is one of the issuer's outstanding securities (e.g., a specific Ford Motor Co. bond).

FIGURE 19.2 Proportional of notional value of credit derivatives outstanding at yearend 2003 accounted for by product category.



Source: Information compiled from British Bankers' Association (2004, p. 21).

FIGURE 19.3 Types of institutions using credit derivatives to buy credit protection for the year ending December 2003.

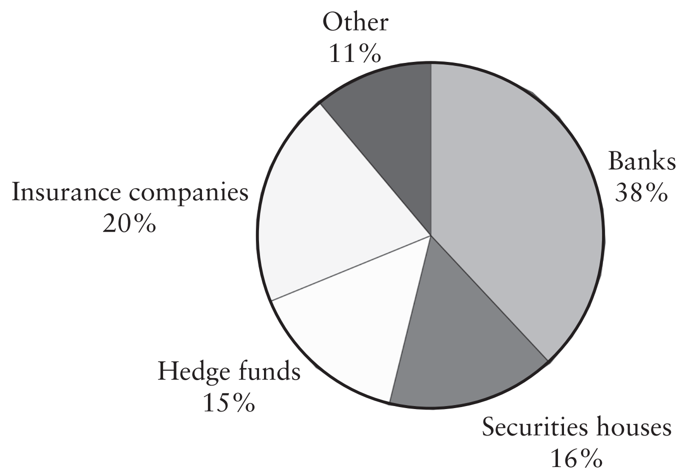


Source: Information compiled from British Bankers' Association (2004, p. 17).

swaps, basket products, and asset swaps account for 4% each, with the remaining credit products accounting for 4%.

Figures 19.3 and 19.4 give a flavor for who uses credit derivatives. The types of institutions using credit derivatives to *buy* credit protection are summarized in Figure 19.3. Like in previous years, banks buying credit protection accounted for the largest proportion of the total notional amount outstanding at the end of 2003—51%. Similarly, securities houses and insurance companies are large users,

FIGURE 19.4 Types of institutions using credit derivatives to sell credit protection for the year ending December 2003.



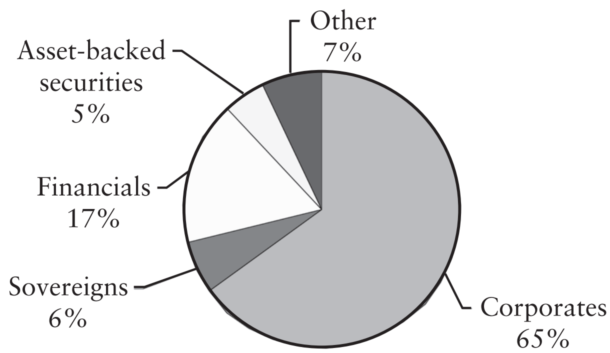
Source: Information compiled from British Bankers' Association (2004, p. 18).

accounting for another 23%. Interestingly, hedge funds accounted for 16% of total, up from 5% for the year ending 2001. The "Other" category includes entities such corporations, mutual funds, and pension funds. The types of institutions using credit derivatives to *sell* credit protection are summarized in Figure 19.4. Again banks are the single largest player, with 38% of total. Insurance companies are next with 20%. Comparing Figures 19.3 and 19.4, we find that banks are net buyers of protection, while insurance companies are net sellers.

Another useful source of information about the credit derivatives market is provided by FitchRatings (2004). Among the most interesting findings contained in their report are the tables and figures that break down credit derivatives by reference entity. Figure 19.5, for example, summarizes the FitchRating results for the end of year 2003 by reference entity type. Nonfinancial corporate exposures account for 65% of the notional amount of contracts outstanding, with financial corporate exposures accounting for another 17%. Sovereign risk[7] accounts for 6%, and asset-back securities, 5%. Table 19.1 summarizes the FitchRating information by gross value of protection sold and gross value purchased. Consistent with Figure 19.5, the most active reference entities are single names—either corporate or sovereign—with corporates taking the lion's share. At the top of the list are automobile and telecom companies, which should not be surprising considering the turbulent markets for these industries in recent years. The fact that company names appear in both columns simply reflects the fact the each agreement needs a counterparty. A little further down the list, sovereign debt begins to appear. Japan is the most used sovereign reference entity for both protection sales and purchases.

[7] *Sovereign risk* refers to the risk of default arising from changes in a country's foreign-exchange policies and/or regulations.

FIGURE 19.5 Global credit derivatives exposures by reference entity type for year ending December 2003.



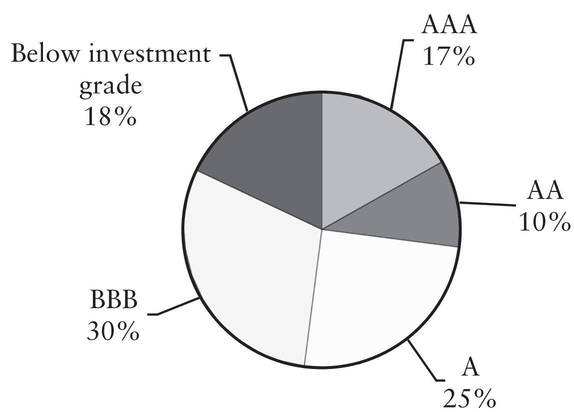
Source: Information drawn from FitchRating (2004, p. 8).

TABLE 19.1 Top 25 reference entities appearing in credit derivative contracts in 2003 by gross dollars sold and gross dollars purchased.

	Protection Sold	Protection Bought
1	Ford Motor Corp./Ford Motor Credit Co.	Ford Motor Corp./Ford Motor Credit Co.
2	General Motors/GMAC	DaimlerChrysler
3	France Telecom	General Motors/GMAC
4	DaimlerChrysler	France Telecom
5	Deutsche Telekom	Deutsche Telekom
6	General Electric/GECC	General Electric/GECC
7	Altria Group	Telecom Italia
8	Telecom Italia	Verizon
9	Japan	Altria Group
10	France	Japan
11	Italy	Merrill Lynch
12	Portugal	Volkswagen
13	Fannie Mae	Bayerische Hypo-und Vereinsbank
14	Verizon	Bayer
15	Allianz	Brazil
16	Merrill Lynch	BT
17	Volkswagen	Citigroup
18	AIG	Credit Suisse First Boston
19	Citigroup	JP Morgan Chase
20	Germany	Lehman Brothers
21	Spain	MBIA
22	BNP Paribas	Parmalat
23	Eastman Kodak	Repsol
24	Time Warner	Time Warner
25	ABN Amro	American Express

Source: Information drawn from FitchRatings (2004, p. 8).

FIGURE 19.6 Global credit derivatives exposures by bond rating for year ending December 2003.



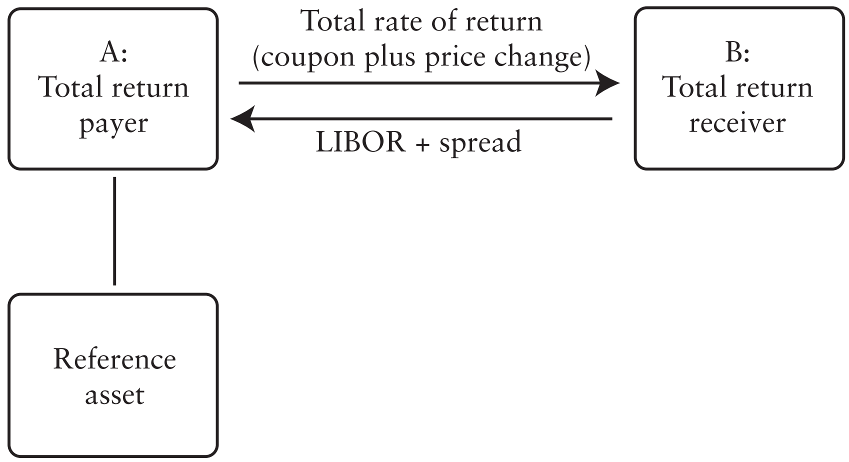
Source: Information drawn from FitchRating (2004, p. 9).

Finally, Figure 19.6 summarizes the notional amount of credit derivatives outstanding by bond rating. Interestingly, the size of the market for protection does not increase monotonically as the bond rating falls as one might expect—the lower the bond rating, the greater the credit risk and therefore the greater the need for credit protection. Noninvestment grade bonds, for example, account for only 18%, compared with 30% for the lowest-rated investment grade bonds BBB, and 25% for the second lowest rated investment grade bonds A. The most likely explanation for this phenomenon is that many institutions are barred from trading noninvestment grade issues. This has two consequences. First, it means that the size of the market for noninvestment grade bonds is smaller than investment grade bonds, hence the absolute demand for credit protection is lower. Second, it means that the market for protection in the BBB category will be highest. A rating downgrade from BBB means that the credit spread will rise not only from increased default risk but also from increased selling pressure brought about by institutions liquidating their holdings in bonds that have become noninvestment grade.

TOTAL RETURN SWAP

A *total rate of return swap* (TRORS) is frequently lumped into the category of credit derivatives, although, technically, it is more than that. The total return on a reference obligation such as a corporate bond is affected by both interest rate risk (i.e., the risk associated with movements in the level of risk-free interest rates) and credit risk (i.e., the risk associated with default and/or the spread between the corporate bond and Treasury bond yields). Figure 19.7 shows the general nature of a total return swap. The protection buyer A (also called "total return payer") owns the reference asset and pays its total return (e.g., coupon interest and price change) to the protection seller B (also called "total return receiver") In return, A receives the risk-free return (e.g., six-month LIBOR plus

FIGURE 19.7 Total rate of return swap.



a premium of, say, 30 basis points). In the absence of default, A passes on any dividends or coupon interest on the reference asset during the life of the agreement on to the TRORS receiver. In addition, A pays B the price change on the reference asset over the life of the contract. If the reference asset price is $75 at the beginning of the swap's life and $100 at the end, for example, A pays B $25. If the reference asset price is $75 at the beginning of the swap's life and $60 at the end, B pays A $15.

In the event of default of the reference obligation before the expiration date of the swap, B makes A "whole" for both the market risk and the default risk of the reference asset. Under cash settlement, this means B will pay A the difference between the reference asset's price at the beginning of the swap agreement and its price at the time of default. Occasionally, finding a reliable bond price quote to use for settlement purposes will be difficult to find due to market illiquidity. In such cases, B may agree to take delivery of the reference asset from A and pay A the reference price set at the swap's inception. Once settlement occurs, the swap is terminated.

For purposes of illustration, consider the total return swap confirmation that appears in Table 19.2. The terms of the swap say that A pays B "All cash flows of the reference obligation on the same day as the cash flows are received." This means that, as A receives the semiannual coupon payments on its Northrop bond, they must be immediately paid to B. In return, A receives from B six-month LIBOR plus 30 basis points. Finally, at the agreement's termination, any unpaid interest by either party is paid. In addition, if the market price of the Northrop bond is less than its initial price of 100% of par, B pays A the difference, and vice versa. The credit events are bankruptcy or payment failure.

To understand the benefits of using a total return swap in which the investor receives the total return and pays floating, compare it "cash-and-carry" T-bond position discussed in Chapter 17. In essence, the TRORS is nothing more than a long position in a corporate bond financed by short-term borrowing. It should not be surprising, therefore, to learn that hedge funds frequently use total returns

TABLE 19.2 Selected terms from the confirmation of a total return swap.

Transaction	Total return swap	
Trade date	January 6, 2005	
Effective date	January 7, 2005	
Termination date	March 20, 2008 or the "early redemption date"	
Total return payer	Party A	
Total return receiver	Party B	
Reference entity	Northrop Gruman Corporation	
Reference obligation	Guarantor:	Northrop Gruman Corporation
	Maturity:	February 15, 2011
	Coupon:	7.125%
	CUSIP/ISIN:	US666807AT91
Calculation amount	USD 20,000,000	
A pays	All cash flows of the reference obligation on the same day as the cash flows are received.	
B pays	Six-month LIBOR + 30 basis points	
Termination payment	On the termination date, any accrued interest payments due A or B will be paid. In addition, the following termination payment amount will be made: Calculation amount × (Initial price – Market value) If positive, B pays A. If negative, A pays B.	
Initial price	100%	
Market value	The market value of the reference obligation, including accrued interest, on the termination date. A dealer panel will determine the market value using the market bid price.	
Credit event(s)	The following credit event(s) shall apply to this transaction: Bankruptcy Failure to pay	

swaps as a means of financing credit exposures. In addition, TRORSs are frequently written on indexes. Like the index products discussed in Chapter 14, this offers the advantage of executing one swap transaction to implicitly buy or sell a basket of underlying securities. The TRORS is simple, efficient, and cost effective. Finally, for certain securities, a short sale of the security may be expensive or impossible to execute. Like selling a forward contract, entering a TRORS in which we pay the total return and receive floating is equivalent to shorting the security.

CREDIT DEFAULT SWAP

Single-named credit default swaps are the largest category of credit derivatives, accounting for more than one-half of the notional amount of all credit derivatives contracts outstanding at the end of 2003. A "single-name" product, as noted earlier, means that there is one reference obligation underlying the swap.

Basket credit default swaps are less popular (i.e., about 4% in Figure 19.2). With basket products, the reference obligation is a basket or portfolio of obligations (e.g., a corporate bond from each of 20 different issuers). The most important attribute of a credit default swap (CDS) is that it isolates the credit risk of the underlying reference asset. The term "swap," however, is a misnomer. More or less, it is a put option whose premium is paid upfront or amortized over the life of the agreement.

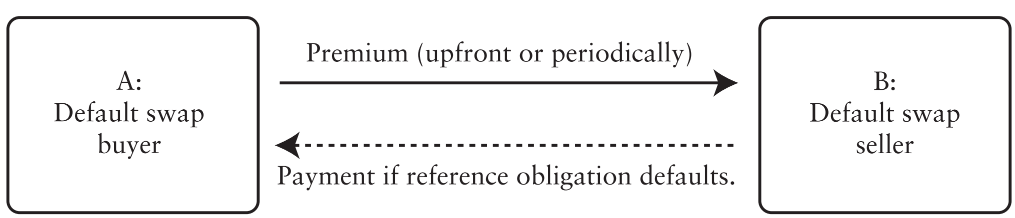
Figure 19.4 shows the general nature of a credit default swap. In the figure, the default swap buyer, A, is buying protection from the default swap seller, B. To do so, A pays to B either an upfront or a periodic premium (i.e., fee). For a standard CDS, the premium is amortized and paid quarterly. For a cash settlement contract, B pays A the difference between the *reference price* set at the inception of the CDS (typically, the par value of 100) and the *final price* (also called the *recovery rate*) in the event of default (or other credit event).[8] With physical settlement, A delivers the defaulted bond to B, and receives the reference price. In most default swaps, the buyer has the right to deliver one bond of a number of prespecified bonds. This protects the protection buyer from getting squeezed in the event he does not own the reference bond. In the event default does not occur, the contract terminates with no further payments/obligations.

To further clarify the terms of a CDS, consider Table 19.3, which contains selected terms from the confirmation of an actual credit default swap.[9] The format is similar to other swaps. At the top are the trade date, effective date, and termination date, as well as the identities of the two parties to the swap. Next is the reference entity, Northrop Gruman Corporation. The reference obligation is the Northrop Gruman Corporation bond with a 7.125% coupon and a February 15, 2011 maturity date. The bond's CUSIP number is also specified so there is no ambiguity regarding the identity of the bond.

In this particular agreement, A is the protection buyer and B is the protection seller. Each quarter, A pays

$$0.0017 \times \left(\frac{Actual}{360}\right) \times \text{USD}5{,}000{,}000$$

FIGURE 19.8 Credit default swap.



[8] Since the market for the bond may be illiquid, the settlement price is sometimes determined by a poll of several bond dealers.

[9] An ISDA Word document file containing all of the possible terms of a credit default swap confirmation can be downloaded at www.isda.org.

TABLE 19.3 Selected terms from the confirmation of a credit default swap.

Transaction	Credit default swap
Trade date	January 6, 2005
Effective date	January 7, 2005
Termination date	March 20, 2008
Fixed rate payer	Party A
Floating rate payer	Party B
Reference entity	Northrop Gruman Corporation
Reference obligation	Guarantor: Northrop Gruman Corporation Maturity: February 15, 2011 Coupon: 7.125% CUSIP/ISIN: US666807AT91
Reference price	100%
Fixed payments	
Fixed rate, payer calculation amount	USD 5,000,000
Fixed rate	0.17%
Fixed rate day-count fraction	Actual/360
Fixed rate payer payment dates	March 20, 2005, and thereafter the 20th of each March, June, September, and December
Floating payments	
Floating rate payer calculation amount	USD 5,000,000
Credit event(s)	The following credit event(s) shall apply to this transaction: Bankruptcy Downgrade Failure to pay
Default requirement	USD 10,000,000 as of occurrence of credit event
Settlement terms	
Settlement method	Physical settlement
Deliverable obligation category	Bond or loan
Deliverable obligation characteristics	Not subordinated Not contingent Maximum maturity 30 years

where *Actual* is the number of days in the quarter. The sum of the present values of these payments through time is the cost of the credit event risk insurance. In other words, the cost of the default risk put option is being paid on an installment plan, with the present value of the quarterly annuity payments being set equal to the cost of the put. There is an important distinction, however. The premium payments are suspended if a credit event occurs during the life of the swap.

Party B, the protection seller, has no obligation unless a credit event occurs. The events specified in Table 19.3 are bankruptcy, rating downgrade, and failure to pay. If a credit event occurs, the contract is settled with physical delivery.[10]

[10] British Bankers' Association (2004, p. 25) reports that 86% of credit derivative contracts have physical settlement.

The protection buyer A delivers the Northrop bond (or one of a number of eligible bonds) at par to the protection seller B and receives USD 10,000,000. As the table shows, eligible deliverable bonds have similar characteristics. The terms of the agreement say that the deliverable bond cannot be a subordinated issue, have embedded options, or have a term to maturity greater than 30 years.

The trade confirmation shown in Table 19.3 does not provide any indication about the motivation for the trade. All we know is that Party A is buying protection (i.e., going short the credit) and Party B is selling protection (i.e., going long the credit). Each side in the transaction could be hedging or speculating. Party A may have initiated the trade to eliminate the credit risk of a Northrop bond held in inventory. Naturally, A could have simply sold the Northrop bond, however, corporate bond markets are fairly illiquid and trading costs are high. Buying protection using a CDS is usually cheaper. In addition, the CDS absorbs the credit risk, but not the encumbrance of legal ownership, of the reference security. On the other side of the trade, rather than buy the bond directly incurring significant trading costs, Party B may have wanted a long position in the Northrop bond.

Quantifying the cost of credit event insurance is difficult, since the number of credit events is large. In the situation where credit event risk is default risk, we can use the Merton (1974) model discussed in Chapter 12 can be used as a starting point. In the Merton framework, we assumed that the firm had a single issue of debt outstanding—zero-coupon bonds maturing at time *T*. We also assumed that the firm's value is log-normally distributed at the end of the bond's life. Under such assumptions, the firm's stock can be modeled as a call option on the value of the firm's assets with an exercise price equal to face value of the bonds and a time to expiration equal to their term to maturity. The stock can be valued using the BSM formula,

$$S = VN(d_1) - Fe^{-rT}N(d_2) \tag{19.1}$$

where

$$d_1 = \frac{\ln(V/Fe^{-rT}) + 0.5\sigma_V^2 T}{\sigma_V\sqrt{T}}$$

$d_2 = d_1 - \sigma_V\sqrt{T}$, F is the face value of the firm's bonds, V is the overall value of the firm, σ_V is the volatility rate of the firm, and r is the rate of return on a risk-free bond. With the value of the stock known, the value of the risky bonds is, therefore, $B = V - S$.

In Chapter 12, we also showed that the value of a zero-coupon corporate bond equals the difference between (1) the value of a risk-free zero-coupon bond with face value F and (2) the value of a put that allows the managers of the firm to put the firm's assets to the bondholders if firm value falls below the bonds' face value at maturity, that is,

$$B = Fe^{-rT} - [Fe^{-rT}N(-d_2) - VN(-d_1)] \tag{19.2}$$

To understand the economic intuition underlying why the value of the put equals the default risk premium, note that the expression in squared brackets in (19.2) may be rewritten as

$$e^{-rT}\left[F - Ve^{rT}\frac{N(-d_1)}{N(-d_2)}\right]N(-d_2) \tag{19.3}$$

In (19.3), the term,

$$Ve^{rT}\frac{N(-d_1)}{N(-d_2)}$$

is the expected firm value at time T conditional on the value of the firm being less than the face value of the bonds, that is, $E(\tilde{V}_T | V_T < F)$. From a corporate bond perspective, this is called the bond's *expected recovery value*—what bondholders expect to receive in the event of default. The *expected loss* of the bond at time T conditional upon default is $F - E(\tilde{V}_T | V_T < F)$, which may be calculated using the term in squared brackets of (19.3). The full expression (19.3) is, therefore, the *present value of the expected loss* on the bond conditional on the value of the firm being less than the bond's face value at time T times the *probability of default*, $\Pr(V_T < F) = N(-d_2)$.

ILLUSTRATION 19.1 Compute cost of buying default protection.

Assume that the firm has a current value of 120, and its annual volatility rate is 30%. The firm has two securities outstanding—zero-coupon bonds and common stock. The bonds mature in five years and have a face value of 100. The stock pays no dividends, and the risk-free rate of interest is 5%. Compute the risk-neutral probability of default, the bond's credit spread, and the cost of buying default protection on a quarterly basis.

In the interest of completeness, we begin by computing the value of the firm's common stock, that is,

OV_CORP_STOCK_FIRM (120, 100, 5, 0.05, 0.30, 1) = 51.98

The value of the firm's bonds is therefore

$$B = 120.00 - 51.98 = 68.02$$

The value of risk-free bonds is

$$B_{\text{risk-free}} = 10e^{-0.05(5)} = 77.88$$

Consequently, the present value of the expected loss conditional on default times the risk-neutral probability of default is 77.88 − 68.02 = 9.86. This is the total cost of buying insurance, which we can amortize in quarterly installments. The promised yield to maturity on the bonds is

$$y = \frac{\ln(100/68.02)}{5} = 7.707\%$$

consequently, the bond's credit spread is 2.707%.

To verify the computation of the insurance premium, we will use equation (19.3). The risk-neutral probability of default can computed using the OPTVAL function,

OV_CORP_PROB_DEFAULT(*firm, face, t, alpha, vf*)

where *firm* is the value of the firm, *face* is the face value of the firm's zero-coupon bonds, *t* is the term to maturity of the bond's in years, *alpha* is the expected rate of appreciation in the value of the firm, and *vf* is the volatility rate of the firm. In a risk-neutral world, the expected rate of appreciation in the value of the firm is set equal to the risk-free interest rate, *r*. Its value is .3786. The expected recovery value conditional upon default is

$$120e^{0.05(5)}\left(\frac{0.1636}{0.3786}\right) = 66.56$$

and may be computed using

OV_CORP_RECOVERY_VALUE (120, 100, 5, 0.05, 0.30) = 66.56

where all of the function arguments are as defined above. The expected loss conditional upon default is 100.00 – 66.56 = 33.44. Alternatively, we can use the function

OV_CORP_EXPECTED_LOSS (120, 100, 5, 0.05, 0.30) = 33.44

The present value of the expected loss conditional upon default times the probability default is

$$e^{-0.05(5)}(33.44)(0./3786) = 9.86.$$ [11]

To determine the quarterly payment, we set this amount equal to the present value of an annuity of payments, that is,

$$9.86 = \sum_{t=1}^{20} PAYTe^{-0.05(0.25t)}$$

The quarterly payment is $PAYT = 0.561$.

In the model used to value the cost of protection, we made the implicit assumption that default, if it were to occur, would happen on the bond's maturity date. In reality, default may occur during the life of the bond when the firm's assets deteriorate in value to, say, level *H*. When it does, default occurs and the bondholders receive *H*. While this complicates matters, we provided the solution to this problem in Chapter 8. Instead of the valuing the firm's stock as a standard call option, we value the stock as a knockout or barrier option. Specifically, the firm's stock is a down-and-out call. When the value of the assets sinks down of barrier *H*, the stock's life ends worthless. The value of such a call is given by equation (8.44) in Chapter 8.

ILLUSTRATION 19.2 Compute cost of buying credit protection with early default.

Assume that the firm has a current value of 120, and its annual volatility rate is 30%. The firm has two securities outstanding—zero-coupon bonds and common stock. The bonds mature in five years and have a face value of 100. The stock pays no dividends, and the risk-

[11] To check this computation, compute the value of the put option on the right-hand side of (19.3) using OV_OPTION_VALUE(120, 10, 5, 0.05, 0.0, 0.30, "p", "e") = 9.86.

free rate of interest is 5%. Compute the bond's credit spread and the total cost of buying default protection assuming the bonds default if the value of the assets drops below 60 during the bond's life or if the value of the firm's assets is below the face value of the bonds at maturity. Explain why the results differ from those in Illustration 19.1.

The value of a down-and-out call option can be computed using the OPTVAL function

OV_NS_BARRIER_OPTION(*s, x, h, t, rebate, r, i, v, TypeFlag*)

where *s* is the asset price, *x* is the exercise price, *h* is the barrier level, *t* is the time to expiration, *r* is the risk-free rate of interest, *i* is the income rate, and *v* is the volatility rate. The *TypeFlag* consists of three contiguous lower case letters. The first is a (c)all/(p)ut indicator, the second is a (d)own/(u) indicator, and the third is a (i)n/(o)ut indicator. For a down-and-out call, *TypeFlag* is "cdo." Given the parameters of this illsutration, the value of a down-and-out call is

OV_NS_BARRIER_OPTION(120, 100, 60, 5, 0, .05, .00, .30, "cdo") = 50.972

and the value of a down-and-in call is

OV_NS_BARRIER_OPTION(120, 100, 60, 5, 0, 0.05, 0.00, 0.30, "cdi") = 1.007

Note that the sum of the values of the down-and-out call and the down-and-in call (with no rebate) equals the value of a standard European-style call option, 51.980.

To find the value of the firm's bonds, we subtract the value of the down-and-out call from the value of the firm, that is,

$$B = 120 - 50.972 = 69.028$$

The bond's promised yield to maturity is 7.413%, and its credit spread is 2.413%. The bond's value increases (yield decreases) from Illustration 19.1 because we have, in essence, imposed the constraint that the bond's value will neven fall below 60. While extremely unlikely, the bond's value in Illustration 19.1 can fall as low as 0.

In some instances, credit default swaps specify that the protection seller pays a pre-specified amount of cash, *CASH*, rather than the difference between the reference price and price in the event of default in the event of default. Again, assuming that the firm has a single issue of debt outstanding—zero-coupon bonds maturing at time *T*, we can value the credit default option as a cash-or-nothing put, that is,

$$p_{con} = CASHe^{-rT}N(-d_2) \tag{19.4}$$

where

$$d_2 = \frac{\ln(V/Fe^{-rT}) - 0.5\sigma_V^2 T}{\sigma_V\sqrt{T}}$$

ILLUSTRATION 19.3 Value fixed payment credit option.

Value a credit option that pays 50 if default occurs. Assume that the firm's value is 120 and its volatility rate is 30%. Assume the firm's debt is a five-year, discount bond issue with a principal amount of 100, and the risk-free rate of interest is 5%.

The value of the fixed payment, put credit option is

$$p_{con} = 50e^{-0.05(5)}N(-d_2) = 14.744$$

where

$$-d_2 = \frac{\ln(120/100e^{-0.05(5)}) - 0.5(0.5^2)5}{0.50\sqrt{5}} = -0.3091$$

and $N(-d_2) = 0.3786$.

CREDIT-LINKED NOTES

A *credit-linked note* (CLN) is simply a note (or a bond or a loan) with an embedded credit feature. They come in a wide variety of structures. One of the simplest is illustrated in Figure 19.9. In the figure, the CLN issuer, B, buys a corporate or sovereign bond from the issuer, A. The issuer gets paid in cash and is required to make periodic interest payments of, say, 6%. B does not want to incur the credit deterioration and default risk of the bond, so he creates a credit-linked note that he sells to the CLN buyer, C. B receives the cash and promises to pay an 8% coupon if the bond experiences no rating downgrade and a 4% coupon if the bond is downgraded but the bond issuer does not default. In the event the bond defaults, B receives the recovery rate from A and passes it along to C. Presumably, the CLN buyer enters the trade because he believes the probability of a ratings downgrade (or default) is low and wants to earn the incremental coupon interest of 2%.

Credit-linked notes can also be created synthetically using risk-free bonds and a credit default swap. To see an example of a *synthetic credit-linked note* is structured, consider Figure 19.10. In this figure, a bank, A, owns a corporate or a sovereign bond (i.e., the reference asset) and wants to hedge its credit risk. It does so by buying a credit default swap from B. B is a trust whose sole purpose is to issue a note linked to the credit of the reference asset (i.e., a CLN). C wants a synthetic exposure to the reference asset, and, therefore, buys the CLN, paying B in cash. B, in turn, takes the cash, invests it in a risk-free asset. B's role is only as an intermediary. B's profit equals the default premium, x%, plus the risk-free return, y%, less the coupon interest paid to the CLN holder, z%.

The success of the credit-linked note markets, like many other derivatives markets, is driven by three key factors. The first is trading costs. The cash markets for corporate and sovereign bonds are relatively illiquid and trading costs are

FIGURE 19.9 Credit-linked note.

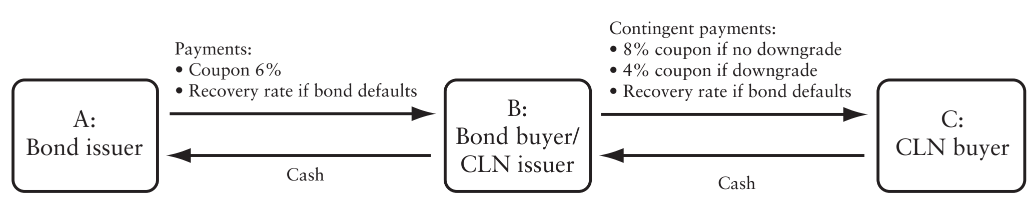
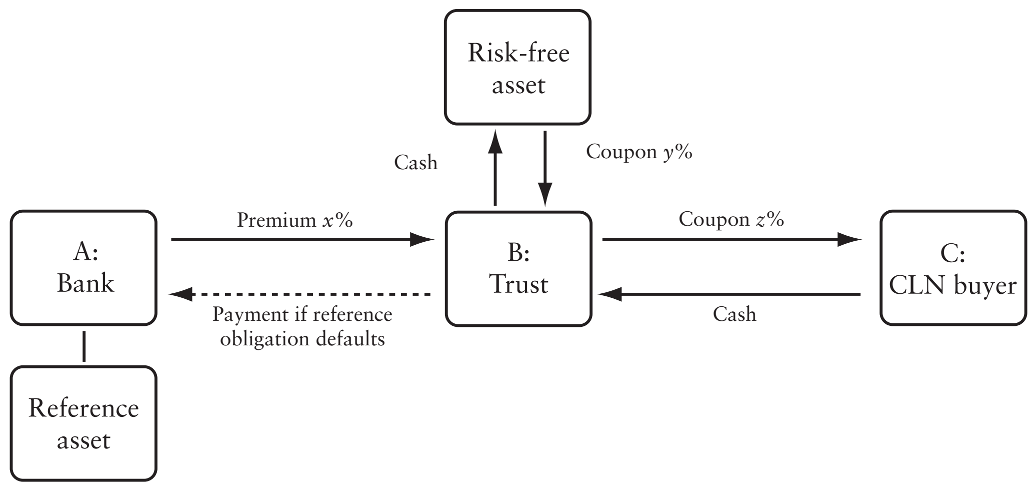


FIGURE 19.10 Synthetic credit-linked note.



high. Synthetic CLNs can mimic the cash flows of such bonds exactly, but the cost of trading CLNs is lower. Second, CLNs circumvent trading restrictions. Many firms and institutions, for example, are not authorized to engage in derivatives trading or off-balance sheet transactions, and, therefore, are not able to replicate credit exposures synthetically. For these firms, CLNs, being a cash instrument, remain part of the investment opportunity set. Third, CLNs may increase the investment opportunity set for many investors since they can be created on bonds that are publicly traded but in limited supply or not publicly traded at all.

SYNTHETIC COLLATERALIZED DEBT OBLIGATIONS

In principle, a *collateralized debt obligation* (CDO) has the same structure as a CLN.[12] An intermediary directly or synthetically buys bonds of various issuers and then repackages them as credit-linked instruments that it sells to investors. The key differences between the two products are twofold. First, in place of a single corporate or sovereign bond, a CDO holds a diversified portfolio of bonds. Second, in place of a single credit-linked note, a CDO is usually tranched,[13] providing investors with specific return/risk profiles.

Like CLNs, CDOs involve an intermediary. With CDOs, the types of intermediaries vary. Sometimes it is investment advisory firms. They earn fees based on the amount of assets they manage. By creating a CDO, they can increase their income by increasing its assets under management. Such a CDO is usually called an *arbitrage CDO* because, presumably, there is a spread between the yield it earns on assets and the yield it pays on its debt securities. At other times,

[12] A comprehensive review of CDOs is contained in Lucas, Goodman, and Fabozzi (2006).

[13] *Tranche* is the French word for slice. In CDO markets, the terms *tranche* and *class* are synonymous.

CDOs are created by banks as a way to remove assets from their balance sheets. These are called *balance sheet CDOs*.

Also like CLNs, CDOs come in two basic forms—cash and synthetic. In a *cash CDO*, the intermediary purchases the assets directly, as shown in Figure 19.11. The number of assets purchased varies, but can range up to 100 or more. Some CDOs hold only a single type of bond (e.g., U.S. investment-grade corporate bonds, high-yield corporate bonds, emerging market bonds, and so on). Others include more than one type. The collateral manager is usually required to maintain an average portfolio rating of B or higher.

On the right-hand side of Figure 19.11 are the buyers of the CDO. They are divided into a number of different tranches, with each tranche having a specific return/risk profile. Suppose a CDO issues four classes of securities: (1) senior debt (75% of principal), (2) mezzanine debt (10%), (3) subordinate debt (10%), and (4) equity (5%). Each class protects the ones senior to it from losses on the underlying portfolio. In the event of default losses, the equity holders absorb the first 5% of default losses since they own 5% of the principal of the portfolio. The subordinate debt-holders have 10% of the principal and, hence, absorb the next 10% of default losses. The mezzanine debt have 10% and absorb the next 10% of default losses. Finally, the senior debt has the remaining 75% of principal and absorbs the residual default losses. The sponsor of the CDO usually sets the size of the senior class so that it can attain a triple-A rating. Likewise, the sponsor of a CDO generally designs the other classes so that they achieve successively lower ratings. The equity tranche is sometimes called "toxic waste" because it has significant default risk. A default loss of 4% of the principal of the portfolio, for example, translates into an 80% loss to the equity holders.

FIGURE 19.11 Cash collateralized debt obligation.

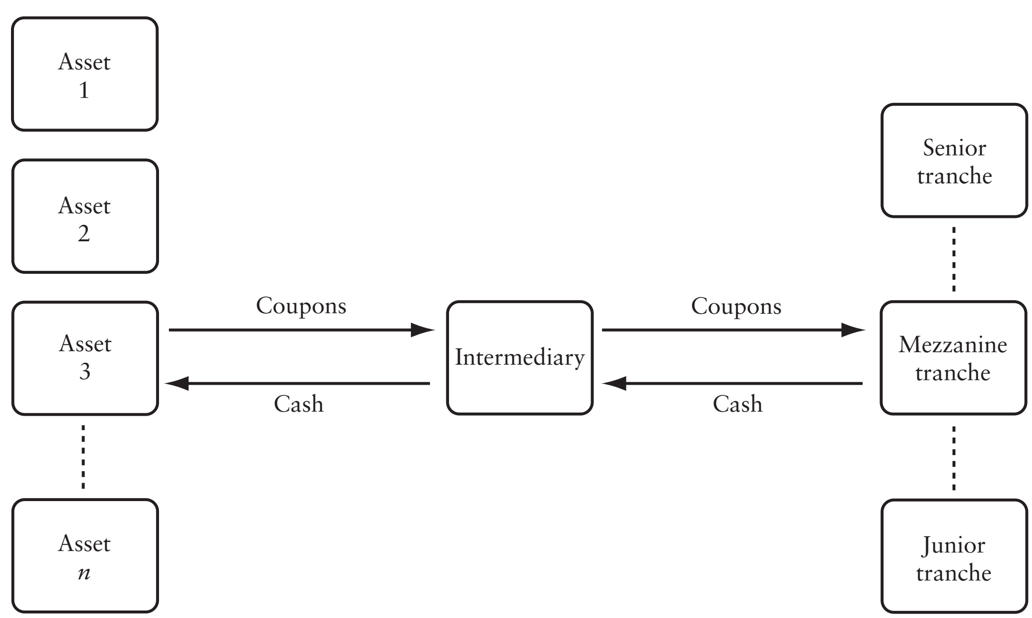
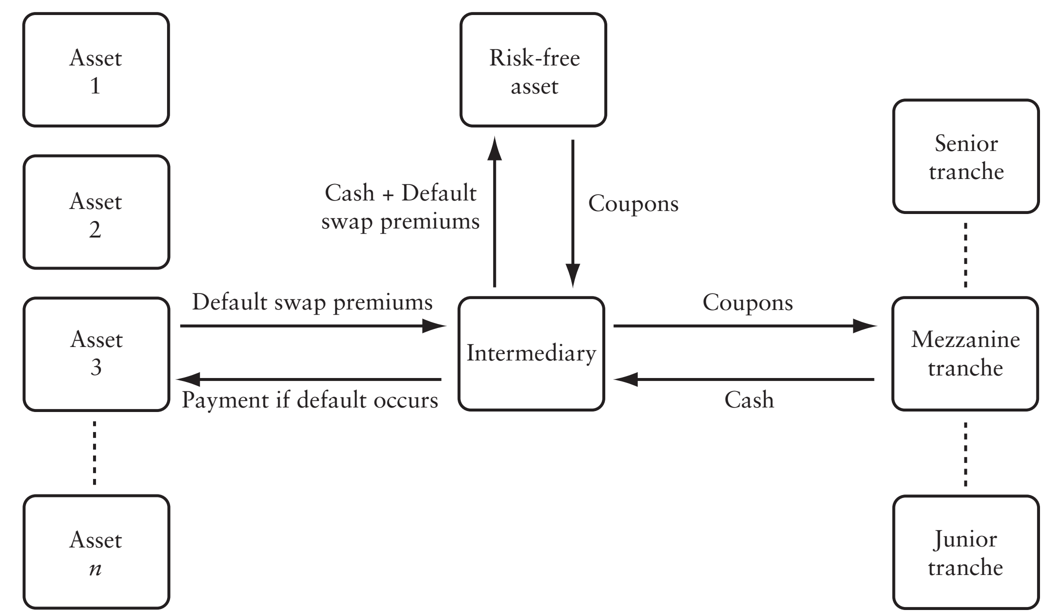


FIGURE 19.12 Synthetic collateralized debt obligation.



With a *synthetic CDO*, the proceeds from the sale of the CDOs are used to buy risk-free rather than risky bonds. The *n* different credit risk exposures are created by selling *n* different credit default swaps. The default risk premiums collected from credit protection buyers together with the cash generated from the sale of the CDOs are placed in risk-free bonds, as shown in Figure 19.12. The coupon payments generated from the risk-free bonds are then used to make the coupon payments to the various tranches of CDO holders. If default occurs, the shortfall is paid from the collateral. The reduction in the amount of collateral is then passed on to the appropriate tranche.

CREDIT SPREAD FORWARD

A *credit default forward* is a forward contract whose value at expiration depends on a credit spread, that is, the difference between the yield to maturity of a corporate bond and the yield to maturity of a U.S. Treasury bond with a similar coupon interest rate and maturity date.[14] As credit risk rises, the credit spread grows wide, and vice versa. For such contracts, it is important to isolate credit risk from the other factors influencing the bond price. On face appearance, the difference between the yield of a corporate bond and the yield of a comparable U.S. Treasury seems reasonable since subtracting the Treasury yield negates the effect of

[14] Occasionally, the credit spread is erroneously called the *credit risk premium*. This is somewhat misleading in the sense that the credit risk premium is more frequently thought of as the difference between the expected rates of return of a corporate and a Treasury with identical coupons and maturity dates. The credit spread equals the difference between the promised yields to maturity.

interest rate risk. But, this assumes that neither the corporate nor Treasury bonds has any other factor that influences price such a callability, convertibility, extendibility, and so on. If they do, the effects of the option-like features must be modeled. With sovereign bonds, we must control not only for the effects any embedded options but also for the effects of exchange rate risk since the sovereign bond's payments are in a different currency.

RISK MANAGEMENT LESSON: STATE OF WISCONSIN INVESTMENT BOARD

On March 17, 1995, the State of Wisconsin Investment Board (SWIB) announced that it had incurred a $95 million loss from derivatives trading.[15] The losses arose from a dozen or so swaps based on foreign/domestic interest rate differentials. Specifically, SWIB was betting on the direction of sovereign risk premium movements. While such speculation may seem an odd activity for a money-market fund, we will see precisely how SWIB did it using their Mexican par bond swap contracts as an illustration.

By way of introduction, SWIB is a Wisconsin state agency responsible for investing the assets of the Wisconsin Retirement System, the State Investment Fund (SIF), and five smaller trust funds established by the state. The derivatives losses reported in March 1995 were incurred in the SIF. The $6.7 billion SIF contained operating cash for the state, part of its pension fund, and money from some 1,000 Wisconsin municipalities, county governments, and school districts.[16] For funds managing operating cash, preservation of principal and market liquidity are paramount. SWIB explicitly recognized this fact in its 1994 Annual Report:[17]

> Safety of principal and liquidity in the State Investment Fund are achieved by adherence to rigorous quality standards, careful attention to maturity schedules, and emphasis on high market-ability. Enhanced return is sought through intensive portfolio management, which considers probable changes in the general structure of interest rates.

With the market for risk-free securities being highly competitive, even an extremely successful fund manager would not perform much better than generic money market rates. In the years leading up to the losses, however, SWIB's performance was substantially better than expected. In the 12 years preceding the loss, "state officials say that the fund earned almost one percentage point more than traditional money-market funds."[18] Like in the case of Orange County, AWA Ltd., Barings Bank, and ABN Amro, this should have been a red flag to supervisors. Business activities such as cash management (SWIB and Orange County), minimum-risk foreign currency hedging (AWA Ltd.), stock index futures arbitrage (Barings Bank), and option market making (ABN Amro) are

[15] For details regarding the SWIB controversy, see Chance (1998).
[16] *Wall Street Journal* (March 24, 1995).
[17] SWIB 1994 annual report (p. 21).
[18] *Wall Street Journal* (March 24, 1995).

supposed to be relatively risk-free. If abnormally high returns are earned, chances are that the trading involved risk-taking.

In January 1994, SWIB began entering a series of derivatives trades based on foreign/domestic bond yield differentials. Presumably, these bets were designed to enhance expected return. Some of the contracts were linked to "Brady bonds." These bonds were named after former U.S. Treasury Secretary Nicholas Brady, who in 1989 created a plan to help several countries restructure their external debt into bonds with U.S. Treasury bonds as collateral. In February 1990, Mexico became the first country to issue Brady bonds.

SWIB's first Brady bond swap was linked to the 6.25% coupon Mexican par bond maturing in 2023. The swap was entered on January 27, 1994, and was called a "Stripped Mexican Par Spread." The key terms are summarized in Table 19.4. The swap had a notional amount of $10 million and expired on January 31, 1995. Peculiarly, under the terms of the first swap, SWIB both paid and received six-month LIBOR on a semiannual basis. Naturally, these payments netted to zero and, consequently, they did not contribute to the agreement's economic value. Perhaps, the reason why these periodic payments were included was to give the agreement the appearance of a swap. The only payment in the agreement with any economic significance, however, occurs at expiration when SWIB receives

$$\$10{,}000{,}000 \times \left(\frac{2.95\% - MEXSPD}{2.95\%} \right) \tag{19.5}$$

With only a single payment involved in the structure, the contract is simply a forward contract, not a swap.

Regardless of the misnomer, the terminal payment (19.1) depends on the quantity, 2.95% – *MEXSPD*. If the quantity is positive, SWIB receives the payment, and, if the quantity is negative, SWIB pays. The term, *MEXSPD*, is defined as the difference between (1) the internal rate of return (IRR) of the 6.25% Stripped Collateralized Fixed Rate USD Par Bonds due 2023; and (2) the yield to maturity of the UST 6.25% due 2/15/2003. Here is where the credit risk comes into play. The Brady bonds are USD-denominated, with the principal repayment at the end of the bond's life being guaranteed by the U.S. government.[19] Consequently, the value of a Brady bond can be thought of as being the sum of two components: the present value of a coupon stream discounted at the credit risk-adjusted Mexican yield (U.S. risk-free rate plus a credit risk premium) and the present value of the principal amount discounted at the zero-coupon, U.S. risk-free yield to maturity. Since the second component is nothing but a U.S. strip bond, the terms of the agreement reduce the Mexican par bond price by the market price of a U.S. Treasury strip bond with the same maturity to determine the price of the so-called "Stripped Collateralized Fixed Rate USD Par Bond." Setting the present value of the coupon stream equal to the difference between the Mexican bond price and the UST strip bond price and solving for yield provides the IRR (i.e., the credit risk-adjusted yield on the Mexican par bond). If we fur-

[19] Eighteen months of nearby coupon interest payments were also guaranteed, however, we ignore this consideration in our discussion.

TABLE 19.4 Selected terms of the stripped Mexican par spread entered by the State of Wisconsin Investment Board on January 24, 1994.

Calculation amount	USD 10,000,000.00
Trade date	January 24, 1994
Effective date	January 31, 1994
Termination date	January 31, 1995
First floating rate payer pays	
First floating rate payer	Bankers Trust Company (“BTCO”)
Payment dates	Commencing on July 31, 1994 and semiannually thereafter
Floating rate option	USD-LIBOR-BAA
Designated maturity	6 months
Rounding factor	One-thousandth of 1%
Floating rate day convention	Actual/360
Reset dates	The first day of the relevant calculation period
Second floating rate payer	
Second floating rate payer	State of Wisconsin Investment Board State Investment Fund
Payment dates	Commencing on July 31, 1994 and semiannually thereafter
Floating rate option	USD-LIBOR-BAA
Designated maturity	6 months
Rounding factor	One-thousandth of 1%
Floating rate day convention	Actual/360
Reset dates	The first day of the relevant calculation period
Final exchange amounts	On January 31, 1995, the final exchange amount will be paid in accordance with the following formula:
	USD 10,000,000.00 × (2.95% − MEXSPD)/2.95%
	If MEXSPD $>$ 2.95%, then SWIB will pay BTCO.
	If MEXSPD $<$ 2.95%, then BTCO will pay SWIB.
	Where: “MEXSPD” is the difference, expressed as a percentage, between the Internal Rate of Return of the Stripped Collateralized 6.25% Fixed Rate USD Par Bonds due 2023 issued by the United Mexican States, (the “Mexican Par Bond”) and the yield to maturity of the U.S. Treasury Bond 6.25% due February 15, 2003.

ther subtract the yield to maturity of the UST 6.25% due February 15, 2003, we isolate the risk-premium of Mexican coupon stream over the next 30 years.[20]

For SWIB to enter this swap, they must have held the directional view that the credit risk of Mexico would decline relative to the U.S.[21] But, while we have

[20] The UST 6.25% due February 15, 2003 is presumably chosen to have the same duration as the Mexican par bond coupon stream ending March 31, 2023.

discussed how the agreement isolates the credit risk premium expressed as a percent, we have not discussed the scale of the bet that SWIB was putting into place. Table 19.4 says the notional amount of the swap is \$10 million—a small amount relative to the \$6.7 billion in the fund. But this is no plain-vanilla swap. The expression in parenthesis is a ratio, not an interest rate. It should come as no surprise, therefore, that such swaps are called *ratio swaps*. Note the effect of the ratio. The only economic purpose of the interest rate in the denominator of the ratio is to increase the notional amount of the swap, that is, we can rearrange SWIB's cash receipt (19.5) to read

$$\$338{,}983{,}051 \times (2.95\% - MEXSPD) \tag{19.6}$$

The expression in parenthesis is now an interest rate, as is standard in interest rate swap agreements,[22] but the notional amount of this swap is more than 33 times higher than what is stated in the agreement! If the *MEXSPD* were to move to a level about 300 basis points above 2.95%, the notional amount stated in the original term sheet, \$10 million, would be completely wiped out. It should come as no surprise, therefore, that ratio swaps are also called *leveraged swaps*. For a money-market fund, the potential of losing more than 100% of principal is unusual, to say the least.

The contract's leverage, together with adverse market movements (i.e., being on the wrong side of a big bet), laid the groundwork for disaster. During the course of the year, the *MEXSPD* rose slowly as is shown in the figure below. SWIB entered the agreement when the *MEXSPD* was near its lowest level during 1994. Subsequently during the year, the *MEXSPD* rose to an average level of about 4%. Then, on December 20, 1994, the Economic Growth and Stability Pact (PECE)—a joint government, business and labor body in Mexico—decided to devalue the Mexican peso by 15% to promote economic stability. The credit risk premium of the Mexican par bonds spiked upward, and continued to rise further over the next three months. To stem the tide, SWIB restructured its agreement in May 1994 and then again in February 1995, however, both new structures maintained the directional view that Mexico's credit risk premium would fall. SWIB finally attempted to cut its losses. On March 16, 1995, they entered an off-market, 10-year, fixed-for-floating swap whose value was \$35 million in Bankers Trust's favor. Essentially, this transformed the \$35 million loss into an annuity of monthly payments over a 10-year period. Coincidently, on March 16, 1995, the *MEXSPD* reached its highest level in Figure 19.13—17.15%.

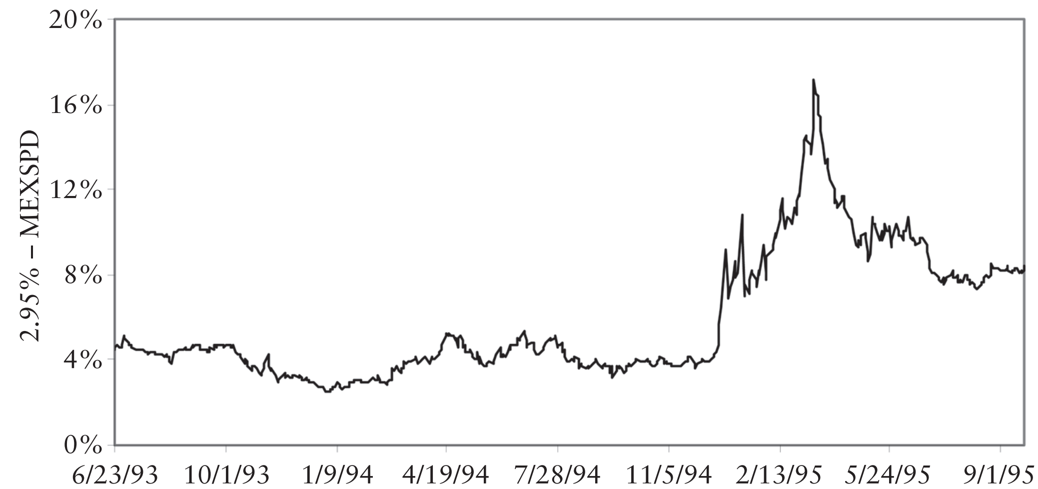
CREDIT SPREAD OPTIONS

A *credit spread option* is a contract whose value at expiration depends on a the difference between the yield to maturity of a corporate bond and the yield to

[21] Alternatively, if SWIB had a long exposure to the credit risk of Mexico, the swap may have provided a hedge. The composition of the SIF portfolio on June 30, 1994, however, suggests that no such exposure existed. See Chance (1998, p. 6).

[22] Indeed, the payoff is like the inverse floater discussed in Chapter 18.

FIGURE 19.13 Daily levels of MEXSPD during the period June 23, 1993 through September 22, 1993.



maturity of a U.S. Treasury bond with a similar coupon interest rate and maturity date. A *credit spread call option*, for example, has a payoff of

$$D \max(X - S_T, 0) \tag{19.7}$$

where S_T is the level of the credit spread at the option's expiration, X is the exercise price, and D is a risk factor used to translate the spread into price. D can be closely related to the underlying reference bond's duration. Because the payoff structure (19.7) is expressed in terms of yield, the contingencies are those of a put rather than a call. The call's value increases with an increase in the price of the underlying asset, or, equivalently, a decrease in the yield spread.

Assuming that the credit spread conditional on no default is log-normally distributed at expiration, credit spread options can be valued using the Black (1976) version of the Black-Scholes/Merton (1973) option valuation formulas. Once the Black formula value is computed, we multiply by the probability of no default during the life of the option to arrive at the final option value.

ILLUSTRATION 19.4 Value credit spread option.

Compute the value of a three-month European-style credit spread put option with an exercise price of 12%, a risk factor of 5, and a notional amount of \$10 million. Assume the current credit spread is 10%, and its volatility rate is 40%. Assume also that the probability of the firm defaulting during the life of the option is 0.1. The three-month risk-free interest rate is 5%.

Using the Black (1976) call option valuation formula, the value of a put is

$$p = e^{-0.05(0.25)}[0.11N(d_1) - 0.12N(d_2)] = 0.004948$$

where

$$d_1 = \frac{\ln(0.11/0.12) + 0.5(0.40^2)0.25}{0.40\sqrt{0.25}}$$

and $d_2 = d_1 - 0.40\sqrt{0.25}$. This value can be verified using the OPTVAL function

OV_FOPTION_VALUE(0.11, 0.12, 0.25, 0.05, 0.40, “c”, “e”) = 0.004948

The put option value assumes a risk factor of 1 and a $1 notional amount. The next step is to scale the value to the terms of the contract. With a risk factor of 5 and a $10 million notional amount, the put option value is

$$0.004948 \times 5 \times 10{,}000{,}000 = 247{,}408$$

Finally, the computed value thus far assumes the firm will not default during the put option’s life. If it does, the put will expire worthless. Adjusting for the probability of default/no-default, the put option value is 247,408 × 0.9 = 222,667.

SUMMARY

Credit derivatives are currently the fastest growing area within the derivatives industry. A *credit derivative* is an agreement that transfers the credit risk of an asset from one party (the *protection buyer*) to another (the *protection seller*). While historically credit risk products focused exclusively on default risk, the payoffs of the products introduced beginning in the early 1990s may be triggered by a variety of credit events including bankruptcy, failure to pay a coupon or to repay the full amount of the bond’s principal, an invocation of a cross-default clause such as a more junior bond issue within the firm defaulting, a corporate restructuring that leaves bondholders worse off, and credit deterioration in the form of a downgrade in bond rating. The purpose of this chapter is to provide an overview of the different types of credit derivatives that are now traded in the OTC market and how they are used. We focus on credit default swaps, which constitute the single largest credit derivative contract. In a credit default swap, the protection seller agrees, for an upfront fee or a continuing premium, to compensate the protection buyer upon a defined credit event. Since the buyer retains ownership of the underlying asset, a credit default swap isolates the credit risk inherent in the asset (e.g., the default risk of a corporate bond) from market risk (e.g., the interest rate risk of a corporate bond). We show how credit default swaps are used, in turn, in structuring two other popular types of credit risk products—credit-linked notes (CLNs) and synthetic collateralized debt obligations (CDOs). We also focus on forward and option contracts on credit spreads. Credit spread contracts are contracts whose payoff is proportionally related to the spread between the yield to maturity on a corporate bond and the yield to maturity of a risk-free bond (e.g., U.S. Treasury bond) with same coupon rate and maturity date. The credit spread is a continuous variable that is sensitive to all credit events including bankruptcy, failure to pay, an invocation of a cross-default clause, a corporate restructuring that leaves bondholders worse off, and changes in bond rating.

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