LEHMAN BROTHERS

STRUCTURED CREDIT RESEARCH

Credit Derivatives Explained

Market, Products, and Regulations

March 2001

Dominic O'Kane
44-0-20-7260-2628
dokane@lehman.com

HIGHLIGHTS

- Credit derivatives are revolutionizing the trading of credit risk.
- The credit derivative market current outstanding notional is now close to $1 trillion.
- **Credit default swaps** dominate the market and are the building block for most credit derivative structures.
- While **banks** are the major users of credit derivatives, **insurers and re-insurers** are growing in importance as users of credit derivatives.
- The main focus of this report is on explaining the mechanics, risks and uses of the different types of credit derivative.
- We set out the various bank capital treatments for credit derivatives and discuss the New Basel Capital Accord.
- We review the legal documentation for credit derivatives.
- We discuss the effect of FAS 133 and IAS 39 on credit derivatives.

TABLE OF CONTENTS

Acknowledgements: The author would like to thank all of the following for their help in preparing this report: Mark Ames, Georges Assi, Jamil Baz, Ugo Calcagnini, Robert Campbell, Sunita Ganapati, Greg Gentile, Mark Howard, Martin Kelly, Alex Maddox, Bill McGowan, Michel Oulik, Lee Phillips, Lutz Schloegl, Ken Umezaki, and Paul Varotsis.

1. INTRODUCTION

Market growth has been considerable and outstanding notional is now close to $1 trillion.

The credit derivatives market has experienced considerable growth over the past five years. From almost nothing in 1995, total market notional now approaches $1 trillion, according to recent estimates. We believe that the market has now achieved a critical mass that will enable it to continue to grow and mature. This growth has been driven by an increasing realization of the advantages credit derivatives possess over the cash alternative, plus the many new possibilities they present.

The primary purpose of credit derivatives is to enable the efficient transfer and repackaging of credit risk. Our definition of credit risk encompasses all credit-related events ranging from a spread widening, through a ratings downgrade, all the way to default. Banks in particular are using credit derivatives to hedge credit risk, reduce risk concentrations on their balance sheets, and free up regulatory capital in the process.

In their simplest form, credit derivatives provide a more efficient way to replicate in a derivative form the credit risks that would otherwise exist in a standard cash instrument. For example, as we shall see later, a standard credit default swap can be replicated using a cash bond and the repo market.

Credit derivatives enable the efficient transfer, concentration, dilution, and repackaging of credit risk.

In their more exotic form, credit derivatives enable the credit profile of a particular asset or group of assets to be split up and redistributed into a more concentrated or diluted form that appeals to the various risk appetites of investors. The best example of this is the tranched portfolio default swap. With this instrument, yield-seeking investors can leverage their credit risk and return by buying first-loss products. More risk-averse investors can then buy lower-risk, lower-return second-loss products.

With the introduction of unfunded products, credit derivatives have for the first time separated the issue of funding from credit. This has made the credit markets more accessible to those with high funding costs and made it cheaper to leverage credit risk.

Credit derivative documentation has been simplified and standardized by ISDA.

Recognized as the most widely used and flexible framework for over-the-counter derivatives, the documentation used in most credit derivative transactions is based on the documents and definitions provided by the International Swaps and Derivatives Association (ISDA). In a later section, we discuss in detail the key features of these definitions. We believe that it is only by being open about any limitations or weaknesses in market practice that we can better prepare our clients to participate in the benefits of the credit derivatives market.

Much of the growth in the credit derivatives market has been aided by the growing use of the LIBOR swap curve as an interest rate benchmark. As it represents the rate at which AA-rated commercial banks can borrow in the capital markets, it reflects the credit quality of the banking sector and the cost at which they can hedge their credit risks. It is, therefore, a pricing benchmark. It is also devoid of the idiosyncratic structural and supply factors that have distorted the shapes of the government bond yield curves in a number of important markets.

The regulatory treatment of banks has a major effect on the credit derivatives market.

Bank capital adequacy requirements play a major role in the credit derivatives market. The fact that the participation of banks accounts for over 50% of the market's outstanding notional means that an understanding of the regulatory treatment of credit derivatives is vital to understanding the market's dynamics. The 1988 Basel Accord, which set the basic framework for regulatory capital, predates the advent of the credit derivatives market. Consequently, it does not take into account the new opportunities for shorting credit that have been created and are now widely used by banks for optimising their regulatory capital. As a consequence, individual regulators have only recently begun to formalise their own treatments for credit derivatives, with many yet to report. We review and discuss the various treatments currently in use.

A major review of the bank capital adequacy framework is currently in progress: a consultative document has just been published by the Basel Committee on Banking Supervision. We summarize the proposed treatment and discuss what effect these changes, if implemented, will have on the credit derivatives market.

Investment restrictions prevent many potential investors from participating in the credit derivatives market. However, a number of repackaging vehicles exist that can be used to create securities that satisfy many of these restrictions and open up the credit derivatives market to a wider range of investors. We will discuss these structures in detail.

In some senses, the terminology of the credit derivatives market can be ambiguous to the uninitiated since buying a credit derivative usually means buying credit protection, which is economically equivalent to shorting the credit risk. Equally, selling the credit derivative usually means selling credit protection, which is economically equivalent to going long the credit risk. One must be careful to state whether it is credit protection or credit risk that is being bought or sold. An alternative terminology is to talk of the protection buyer/seller in terms of being the payer/receiver of premium.

Credit derivatives have required a more quantitative approach to credit.

Much of the growth of the credit derivatives market would not be possible without the development of models for the pricing and management of credit risk. Overall, we have noticed an increasing sophistication in the market as market participants have developed a more quantitative approach to analysing credit. This is borne out by the widespread interest in such tools as KMV's firm value model and the Expected Default Frequency (EDF) numbers it produces. We discuss some of the quantitative aspects in Section 3. A survey of the latest credit modelling techniques is available in the Lehman publication *Modelling Credit: Theory and Practice,* published in February 2001.

Over the past 18 months, the credit derivatives market has seen the arrival of electronic trading platforms such as CreditTrade (www.credittrade.com) and

It is now possible to trade credit derivatives on-line.

CreditEx (www.creditex.com). Both have proved successful and have had a significant impact in improving price discovery and liquidity in the single-name default swap market.

Our focus is on explaining the mechanics, risks, and pricing of credit derivatives.

Before any participant can enter into the credit derivatives market, a solid understanding of the mechanics, risks, and pricing of the various instruments is essential. This is the main focus of this report. We hope that those reading it will gain the necessary comfort to begin to profit from the new opportunities that credit derivatives present.

2. THE MARKET

2.1 Growth

In the past couple of years, the credit derivative market has evolved from a small and fairly exotic branch of the credit markets to a significant market in its own right.

The growth of the credit derivatives market has been recognised by a number of different surveys.

This is best evidenced by the latest British Bankers' Association (BBA) Credit Derivatives Report (2000). The BBA numbers were derived by polling international member banks through their London office and asking about their global credit derivatives business. Given that almost all of the major market participants have a London presence, the overall numbers should, therefore, be representative of global volume. One caveat, though: since they are based on interviews and estimations, they should be treated as indicative estimates rather than hard numbers.

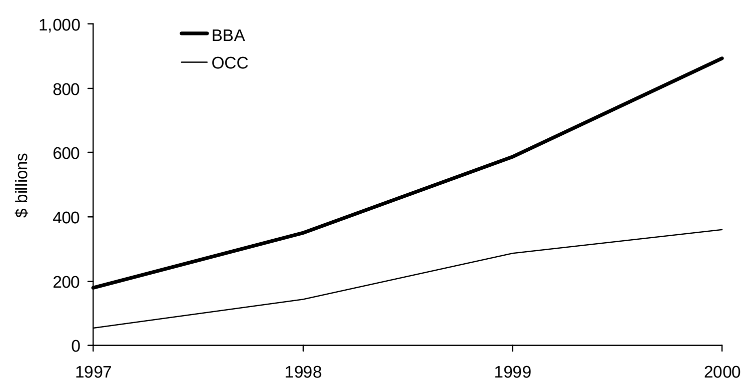
For this reason, in addition to the BBA survey, we have also studied the results of the U.S. Office of the Comptroller of the Currency (OCC) survey, which is based on "call reports" filed by U.S.-insured banks and foreign branches and agencies in the U.S. for 2Q00. Unlike the BBA survey, it is based on hard figures. However it does not include investment banks, insurance companies or investors. Both sets of results are shown in Figure 1.

Even more recently (January 2001) a survey by *Risk Magazine* has estimated the size of the credit derivatives market at year-end 2000 to be around $810 billion. This number was determined by polling dealers who were estimated to account for about 80% of the total market.

A market size close to $1.5 trillion is predicted for the end of 2001.

All of these reports show that the size of the credit derivatives market has increased at a phenomenal pace, with an annual growth rate of over 50%. It is estimated by the BBA survey that the market will achieve a size close to $1.5 trillion by the end of 2001. To put this into context, the total size of all outstanding dollar denominated corporate, utility, and financial sector bond issues is around $4 trillion.

Figure 1. **Total Outstanding Notional of the Credit Derivatives Market, 1997-2000**



2.2 Market Breadth

The market encompasses corporate and sovereign credits.

In terms of the credits actively traded, the credit derivative market spans across banks, corporates, high-grade sovereign and emerging market sovereign debt. Recent estimates show corporates accounting for just over 50% of the market, with the remainder split roughly equally between banks and sovereign credits.

U.S., European, and Asian-linked credit derivatives are all traded.

The 2001 survey by *Risk Magazine* provides a more detailed geographical breakdown. It reported that 41% of default swaps are linked to U.S. credits, 38% to European credits, 13% to Asian, and 8% to non-Asian emerging markets.

A 1998 survey by Prebon Yamane of all transactions carried out in 1997 reported that 93% of those referenced to Asian issuers were to sovereigns. In contrast, 60% of those referenced to U.S. issuers were to corporates, with the remainder split between banks (30%) and sovereigns (10%). Those referenced to European issuers were more evenly split, with sovereigns accounting for 45%, banks 29%, and corporates 26%.

Clearly, the credit derivative market is not restricted to any one subset of the credit markets. Indeed, it is the ability of the credit derivative market to do anything the cash market can do and potentially more that is one of its key strengths. For example, it is possible to structure credit derivatives linked to the credit quality of companies with no tradable debt. Companies with exposure to such credits can use this flexibility to hedge their exposures, while investors can diversify by taking exposure to new credits that do not exist in a cash format.

2.3 Participants

Banks continue to dominate the credit derivatives market.

The wide variety of applications of credit derivatives attracts a broad range of market participants. Historically, banks have dominated the market as the biggest hedgers, buyers, and traders of credit risk. Over time, we are finding that other types of player are entering the market. This observation was echoed by the results of the BBA survey, which produced a breakdown of the market by the type of participant. The results are shown in Figure 2.

Figure 2. **A Breakdown of Who Buys and Sells Protection by Market Share at the Start of 2000.**

Counterparty	Protection Buyer (%)	Protection Seller (%)
Banks	63	47
Securities Firms	18	16
Insurance Companies	7	23
Corporations	6	3
Hedge Funds	3	5
Mutual Funds	1	2
Pension Funds	1	3
Government/Export Credit Agencies	1	1

Source: British Bankers' Association Credit Derivatives Report 2000.

As in its earlier 1998 survey, the BBA found that banks easily dominate the credit derivatives market as both buyers and sellers of credit protection. Since banks are in the business of lending and thereby taking on credit exposure to borrowers, it is not surprising that they use the credit derivatives market to buy credit protection to reduce their exposure.

Credit derivatives can be used by banks to reduce regulatory capital.

Though the precise details may vary between different regulatory jurisdictions, banks can use credit derivatives to offset and reduce regulatory capital requirements. On a single asset level, this may be achieved using a standard default swap. More commonly, banks are now using credit derivatives to securitize whole portfolios of bonds and loans. This technology, known as the synthetic CLO and explained in detail in Section 5.8, can be used by banks with the purpose of reducing regulatory capital, reducing credit risk concentrations, and enhancing return on capital. Indeed, the 2001 *Risk Magazine* survey finds that banks as counterparties in synthetic securitisations account for 18% of the market.

At the same time, banks are also seeking to maximize return on equity, and credit derivatives provide an unfunded way for banks to earn yield from their underused credit lines and to diversify concentrations of credit risk. As a consequence, we see that banks are the largest sellers of credit protection.

For banks, credit derivatives present an unfunded way to diversify revenue.

Securities firms are the second-most dominant player in the market. With their market making and risk-taking activities, securities firms are a major provider of liquidity to the market. As they tend to run a flat trading book, we see that they are buyers and sellers of protection in approximately equal proportions.

Insurance and re-insurance companies have become major players in the credit derivatives market.

An interesting development in the credit derivatives market has been the increased activity of insurance and re-insurance companies, on both the asset and liability side. For insurance companies, selling protection using credit derivatives presents a new asset class that can be used to earn income and diversify revenue away from their core business of insurance. The credit derivatives market is ideal for this since through the structuring of second loss products, it creates the very highly rated securities that insurance companies require in order to maintain their high ratings. As compensation for their novelty and lower liquidity compared with Treasury bonds, these securities can return a substantially higher yield for a similar credit rating. On the liability side, re-insurance companies are also prepared to take leveraged credit risks, such as retaining the most subordinate piece on tranched credit portfolios. This is seen as just another way to write insurance contracts.

As protection buyers, this growth in usage by insurance companies has been driven by their desire to hedge various insurance risks. For instance, in the area of insuring project financing within developing economies, the sovereign credit derivatives market provides a good, though imperfect, hedge against any sovereign risk to which they may be exposed. Re-insurance companies who typically develop concentrations of credit risk can use credit derivatives to reduce this exposure and so enable them to take on new more diversified business without an overall increase in risk. Over the next few years, we expect to see re-insurance companies account for an even larger share of the credit derivatives market.

Equity hedge funds are active participants in the convertible asset swap market.

Hedge funds are another growing particpant. Some focus on exploiting the arbitrage opportunities that can arise between the cash and default swap markets. Others focus on portfolio trades such as investing in CDOs. Equity hedge funds are especially involved in the callable asset swap market in which convertible bonds have their equity and credit components stripped. These all add risk-taking capacity and so add to market liquidity.

2.4 Products

There are a number of different products that may be classified as credit derivatives, ranging from the simple asset swap to the synthetic CLO. Figure 3 shows the market share (as a percent of market notional) of the different credit derivative instruments as reported by the BBA for the start of 2000.

Default swaps dominate the credit derivatives market.

Dominating the market, credit default products—default swaps—account for more than twice as much of the market as the second-most popular product. In practice, default swaps have become the de facto unfunded credit derivative instrument, with credit spread options and similar spread driven products pushed down into last place.

The growth in usage of synthetic CLOs that have an embedded portfolio default swap has been very sudden—they did not even appear in the previous (1997-1998) BBA survey. Part of their prominence is attributable to the fact that a typical CLO portfolio default swap has a notional size of $2-$5 billion. This compares with the typical default swap trade, which has a notional of $10-$50 million.

Figure 3. **Market Share of Outstanding Notional for Credit Derivative Products**

Credit Derivative Instrument Type	Market Share (% Notional) at End 1999
Credit Default Products	38%
Portfolio/CLOs	18%
Asset Swaps	12%
Total Return swaps	11%
Credit Linked Notes	10%
Baskets	6%
Credit Spread products	5%

Source: British Bankers' Association Credit Derivatives Report 2000.

Portfolio default swap trades are much fewer in number, but are done in a very large size.

Another new entrant is the default basket. This is also a portfolio credit product that introduces a new way for investors to leverage their credit risk and earn yield. Though it constitutes only 6% of the outstanding market notional, we expect this percentage to increase over the next few years. The default basket is unique in the sense that it is the simplest credit derivative that allows investors to trade default correlation.

The credit derivatives market has achieved critical mass.

As these results have shown, the credit derivative market has evolved rapidly over the last five years in terms of increasing its size, broadening its base of participants, and expanding its list of products. We believe that the market has achieved critical mass and has become the most effective and efficient way to commoditize credit risk. The market is also converging rapidly towards standardised products, especially for the credit default swap. With the increased participation of the newer players such as insurance, re-insurance companies, and hedge funds, we expect further evolution and growth and increased liquidity in the credit derivatives market.

3. CREDIT RISK FRAMEWORK

3.1 Probability of Default and Recovery

To price credit risk, we need to have a quantitative framework.

The commoditization and transfer of credit risk has been one of the major achievements of the credit derivatives market. However, to be able to do this, we need a framework for valuing credit risk. It is clear that the compensation that an investor receives for assuming a credit risk and the premium that a hedger would need to pay to remove a credit risk must be linked to the size of the credit risk. This can be defined in terms of:

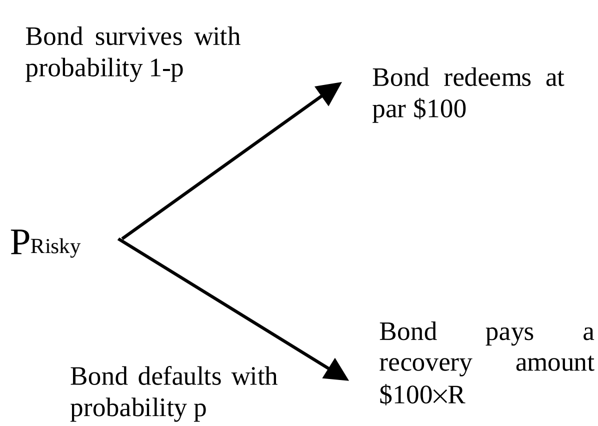
1) The likelihood of default
2) The size of the payoff or loss following default.

The best example is a one-year zero coupon defaultable bond. Let us assume that the probability that the bond will default over the next year is *p*. If the bond does default, we assume that it pays a recovery rate *R*, which is a fixed percentage of the face value. We further assume that this recovery is paid at the maturity date of the bond. One can model this as a simple single-period binomial tree, as shown in Figure 4, where the price of the bond, $P_{Risky,}$ is the expected payoff discounted off the risk-free curve. This gives:

$$P_{Risky} = \frac{1}{1+r}\left(p \times 100 \times R + (1-p) \times 100\right)$$

where *r* is the one-year risk-free rate. Note that the market uses the LIBOR swap curve as the risk-neutral default-free interest rate, since that is the level at which most market participants fund their hedges.

Figure 4. **Simple One-Period Model of Default That Pays Recovery at Maturity**



If the one-year probability of default is 0.75%, the recovery rate is assumed to be 50%, and the one-year risk-free rate is 5%, the price of the bond is given by

$$P_{Risky} = \frac{1}{1.05}\left(0.0075\times100\times0.50 + 0.9925\times100\right) = \$94.88$$

which is clearly lower than the risk-free zero coupon bond price:

$$P_{Risk-Free} = \frac{100}{1.05} = \$95.24 \cdot$$

For a zero coupon bond, we define the credit quality using the spread *s* as follows:

$$P_{Risky} = \frac{100}{(1+r)(1+s)}.$$

Using the above example, we find that $s = 37.7$ bp.

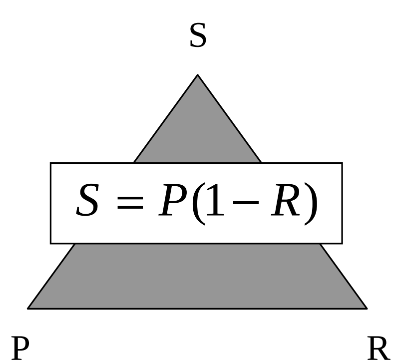
The credit spread equals the default probability times the loss in the event of a default.

It is possible to show that one can accurately approximate the credit spread using the **credit triangle** formula, shown in Figure 5, which states that the annualized compensation for assuming a credit risk, the credit spread, *S*, is equal to the probability of default (per annum), *P*, times the loss in the event of a default. For a par asset, the loss is par minus the recovery rate *R*. We call this equation the credit triangle because it has three unknowns, and we can solve for any one provided we know the other two.

If we substitute the probability of default and assumed recovery rate from the above example into the credit triangle equation, we find that

$$s \approx 0.0075\times(1-0.5) = 37.5bp \cdot$$

Figure 5. **The Credit Triangle**



The credit triangle can be used to examine relative value within the capital structure.

And we see that this "rule-of-thumb" is very accurate (correct to 0.2 bp). This is a simple, yet very powerful formula for analysing credit spreads and what they imply about default probabilities and recovery rates, and vice-versa. Within the credit derivatives market, understanding such a relationship is essential when thinking about how to price instruments such as fixed recovery default swaps.

It is also a very useful formula for examining relative value within the capital structure of a company. Since cross default provisions mean that it is almost always the case that all of the debt of a company defaults together, the only thing that differentiates between senior and subordinated debt is the expected recovery in the event of default. All of the company's bonds, therefore, have the same default probability. Using this fact, one can use the Credit Triangle to derive an equation expressing the subordinated "fair-value" spread as a function of the senior spread and the respective recovery rates of the senior and subordinated bonds.

$$S_{SUB} = \frac{(1-R_{SUB})}{(1-R_{SENIOR})} \times S_{SENIOR}$$

For example, if R_{SENIOR} = 50%, R_{SUB} = 20% and the senior LIBOR spread S_{SENIOR} = 50 bp, this implies that the subordinate spread should be 80 bp. One should qualify this result by noting that the LIBOR spread of a security may contain other factors such as liquidity and credit risk premia. Nevertheless, this simple relationship does provide a useful starting point for analysing relative value.

3.2 Empirical Studies of Recovery Rates

There is considerable variation in the recovery rate for bonds of the same seniority.

The market standard source for recovery rates is Moody's historical default rate study (see www.moodysqra.com), the results of which are plotted in Figure 6. It shows how the recovery rate of a defaulted asset depends on the level of subordination. By plotting the first and third quartiles, it is clear that there is a very wide variation in the recovery rate, even for the same level of seniority.

These results are based on U.S. corporate defaults and so do not take into account the variations in bankruptcy laws that exist between different countries. Note that these recovery rates are not the actual amounts received by the bondholders following the workout process. Instead, they represent the price of the defaulted asset as a fraction of par some 30 days after the default event.

3.3 Empirical Studies of Default Probabilities

Figure 7 shows Moody's cumulative default probabilities by rating and maturity. These are the average probability of a bond that starts in the given rating defaulting within the time horizon given. Clearly, we see that highly rated bonds have a lower cumulative default probability than lower-rated bonds.

Using the credit triangle, it is possible to imply out an implied cumulative default probability from market spreads. Typically, one finds that this default probability is

Market implied default probabilities are typically higher than historical default probabilities.

greater than that implied by empirical analysis. There are a number of reasons why this is the case. First, the credit spread of a bond will usually contain a liquidity component. After all, no bond is as liquid as a Treasury bond or a LIBOR swap. Then, there may be a component to account for regulatory capital effects. There will be a credit risk premium designed to protect the bond holder against changes in the credit quality of the issuer. Finally, market spreads are forward looking and asset specific, whereas the numbers in Figure 7 are based on historical defaults and are averaged over a large number of bonds within each rating class.

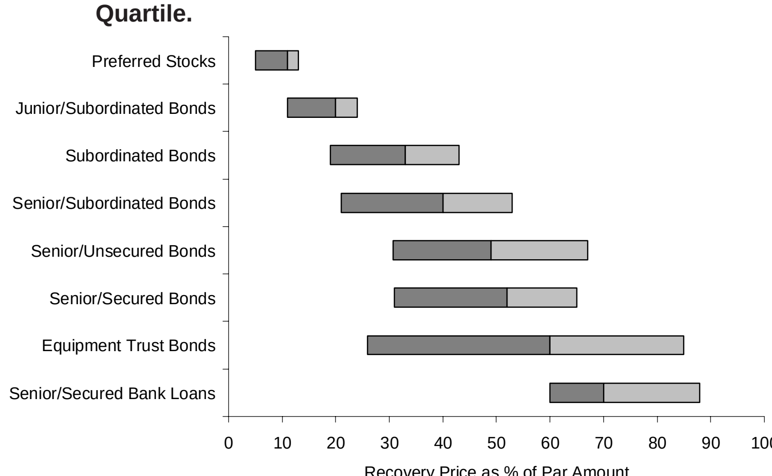
3.4 Credit Curves

Investors have different views about how the credit risk of a company will change over time. This is manifested in the shape of the credit curve: the excess yield over some benchmark interest rate of a credit as a function of the maturity of the credit exposure.

Credit curve shapes contain information about market expectations for the credit.

This excess yield, known as a **credit spread**, can be expressed in a variety of ways, including the asset swap spread, the default swap spread, the par floater

Figure 6. **Moody's Historical Recovery Rate Distributions, 1970-1999, for Different Levels of Subordination. Each Bar Starts at the 1st Quartile Then Changes Color at the Average and Ends at the 3rd Quartile.**



Source : Moody's Investors Services.

Figure 7. **Moody's Cumulative Default Probabilities by Letter Rating from 1-10 years, 1970-2000.**

				Cumulative Default Probability to Year (%)						
Rating	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Aaa	0.00	0.00	0.00	0.04	0.12	0.21	0.31	0.42	0.54	0.67
Aa	0.02	0.04	0.08	0.20	0.31	0.43	0.55	0.67	0.76	0.83
A	0.01	0.05	0.18	0.31	0.45	0.61	0.78	0.96	1.18	1.43
Baa	0.14	0.44	0.83	1.34	1.82	2.33	2.86	3.39	3.97	4.56
Ba	1.27	3.57	6.11	8.65	11.23	13.50	15.32	17.21	19.00	20.76
B	6.16	12.90	18.76	23.50	27.92	31.89	35.55	38.69	41.51	44.57

spread, and the option-adjusted or zero-volatility spread. The exact significance of these spreads will be defined in forthcoming sections. There are three main credit curve shapes, which are shown in Figure 8:

Upward Sloping: Most credits exhibit an upward sloping credit curve. This can be explained as expressing the view that within the short term, the quality of the credit is expected to remain constant. However, the further into the future we look, the less we can be certain that the credit will not deteriorate. The credit spread increases in order to compensate the investor for this increased uncertainty.

Humped: This shape is commonly observed for credits that are viewed as likely to worsen in the medium term—the chance of defaulting in the very short term is low. As the maturity increases, the credit spread then falls to reflect the view that should the credit survive the medium term, it will be more likely to survive the long term.

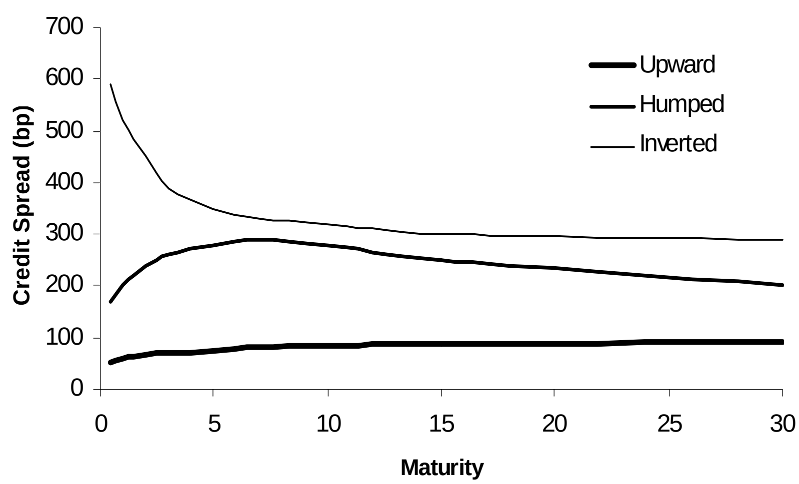
Downward Sloping (Inverted): The inverted curve is usually associated with credits that have experienced a significant deterioration to the extent that a default is probable. The bonds begin to trade on a **price basis** —bonds of the same seniority trade with the same price irrespective of their maturity and coupon. This has the effect of elevating short-maturity spreads and inverting the spread curve.

3.5 Credit Spreads

There are many different measures of credit spread, each with its own properties

There are a number of different measures of credit spread used in the credit markets. These may be real spreads associated with specific types of instrument or may be measures of excess yield. However, these different credit spreads may include effects other than pure credit risk. For example, Treasury credit spreads,

Figure 8. **The Three Main Credit Spread Curve Shapes.**



which measure credit risk versus the Treasury yield curve, may include effects of liquidity, coupon size, risk premia, and the supply and demand for Treasury bonds. We summarise the main spread types in Figure 9.

Figure 9. **Different Credit Spreads**

Spread Type	**Definition**	**Comment**
Yield Spread	Difference between the yield of the bond and the benchmark Treasury yield.	This is a spread to the Treasury curve so contains the swap spread. It is a measurement of the yield of a position consisting of long corporate and short the benchmark Treasury benchmark. May also involve a maturity difference between risky bond and benchmark Treasury.
Par Floater Spread	Spread over LIBOR paid by a floater issued today which prices to par.	See section 4.1.
Asset Swap Spread	Spread over LIBOR received by an asset swap buyer who swaps the fixed coupon of a fixed rate bond to floating for an up front cost of par.	If the underlying asset is valued at par, this equals the par floater spread. If the asset trades away from par, the asset swap spread also contains coupon-linked effects. Bonds with the same issuer, same seniority and same maturity but different coupons will have different asset swap spreads. See section 4.2.2 for discussion and section 8.3 for calculation details.
Default Swap Spread	The amortised premium for a contract that pays par minus recovery on an asset which defaults and nothing otherwise.	Ignoring funding and repo effects, the default swap is economically equivalent to a par floater and so should have the same spread. See Section 4.3 for details.
Discount Margin	The flat yield spread required to reprice a floating rate bond to par.	Calculation (see Section 8.2) ignores the shape of the LIBOR curve. Equals the Par Floater Spread for a bond trading at par.
Option Adjusted Spread (Zero Volatility Spread)	The flat continuously compounded spread to the LIBOR zero rate which reprices the bond.	Historically used to value the embedded issuer option in callable bonds but can also be used to quantify the effect of credit. Also known as the **Zero Volatility Spread**, this is a continuously compounded version of the par floater spread. A good measure of the excess yield due to credit. (see Section 8.4 for calculation details).

4. SINGLE-NAME CREDIT DERIVATIVE PRODUCTS

We begin this section with an instrument that is definitely *not* a credit derivative: the floating-rate note. Its inclusion is due to its importance as an instrument whose pricing is driven almost exclusively by credit. As such, it serves as a benchmark for much of credit derivative pricing, and no discussion of credit derivatives is complete without it.

4.1 Floating-Rate Notes

4.1.1 Description

LIBOR is the most commonly used benchmark variable interest rate index.

A **floating-rate note (FRN)** is a bond that pays a coupon linked to a variable interest rate index. As we shall describe below, this has the effect of eliminating most of the interest rate sensitivity of the note, making it almost a pure credit play. As a result, the price action of a floating-rate note is driven mostly by the changes in the market-perceived credit quality of the note issuer.

In many cases, the variable interest rate index used is the London Interbank Offered Rate - LIBOR. In continental Europe, the euro benchmark is called Euribor or Eibor. Although calculated slightly differently, all of these indices are a measure of the rate at which highly rated commercial banks can borrow. They therefore reflect the credit quality of the (roughly) AA-rated commercial banking sector.

Floating-rate notes have a very low interest rate sensitivity.

While the senior short-term floaters of AA-rated banks pay a coupon close to LIBOR flat and trade at a price close to par, in the credit markets, many floaters are issued by corporates with much lower credit ratings. Also, many AA-rated banks issue floating-rate notes that are subordinate in the capital structure. In either case, investors require a higher yield to compensate them for the increased credit risk. At the same time, the coupons of the bond must be discounted at a higher interest rate than LIBOR to take into account this higher credit risk.

Therefore, in order to issue the note at (or slightly below) par, the coupon on the floating-rate note must be set at a fixed spread over LIBOR. In fact, it is easy to show that this fixed spread, S, must be set equal to the spread over LIBOR at which the cash flows of the issuer are discounted (see Section 8.1 for details). This spread is known as the **par floater spread**, F. The par floater spread can be thought of as a measure of the market-perceived credit risk of the note issuer. The fixed spread of a floating-rate note therefore tells us the par floater spread and, hence, the credit quality of its issuer when it was issued at par.

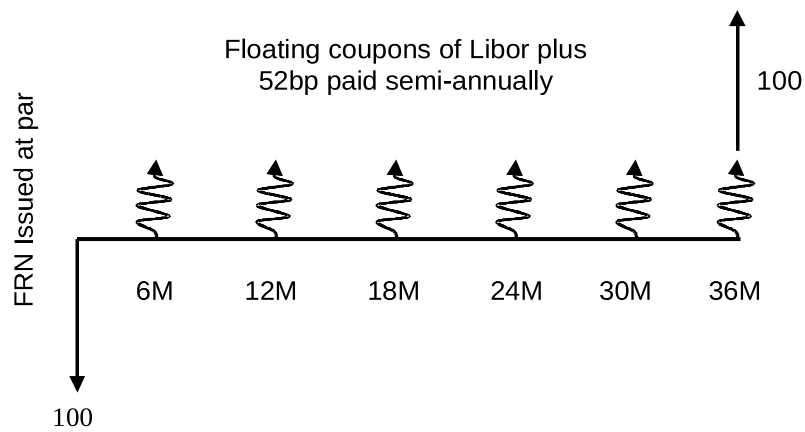
The interest rate sensitivity is higher between coupon dates.

In Figure 10, we show the cash flows for an example 3-year floating-rate note whose coupon resets and pays every six months—the variable rate is therefore 6-month LIBOR plus a fixed spread of 104bp (52bp semi-annually).

4.1.2 Pricing Aspects

Floating-rate notes have a much lower interest rate sensitivity than fixed-rate bonds. If LIBOR interest rates increase, the resulting increase in the implied future LIBOR coupons is almost exactly offset by the increase in the rate at which

Figure 10. **The Cash Flows of a 3-Year Floating-Rate Note.**



they are discounted. Similarly, when LIBOR falls, the implied future coupons decrease in value, but this is offset as they are discounted back to today at a lower rate of interest. As a result, the interest rate sensitivity of a floating rate note is much less than that of a fixed-rate bond of the same maturity.

On coupon dates, whether the price of a floating rate note is above or below par is determined solely by its par floater spread. If this is greater than the fixed spread paid by the floater, then it will trade below par. If the par floater spread is lower than the fixed spread, the floating rate note will trade above par. How far above or below par is determined by the note's maturity, coupon, par floater spread and the LIBOR curve. This is shown mathematically in Section 8.1.

Between coupon dates, the price of the floating rate note can deviate from par as a consequence of movements in LIBOR. As the LIBOR component of the next coupon has been fixed in advance, the value of the next coupon payment is known today. However we present-value it at a rate of LIBOR plus a spread. This rate changes as LIBOR changes, so we are exposed to interest rates. This exposure is known as **reset risk**. It is usually small, declining to zero as the next coupon is approached. Provided the par floater spread of the issuer does not change, the bond should always reprice to par on coupon payment dates.

If the credit curve of the note's issuer is upward sloping, the par floater spread will fall as the note approaches maturity. This will cause the bond to increase in price, as the fixed spread paid will remain unchanged but the note will be discounted at a lower par floater spread. Despite this, as the bond approaches maturity, the price will revert to par.

The discount margin is a commonly used measure of the credit spread for floating rate notes.

In addition to the par floater spread, another convention for quoting the credit spread of an FRN is to use the **discount margin**. This is a very similar idea to the par floater spread but is defined slightly differently. It is based on a calculation that assumes a flat LIBOR curve and so does not take into account the shape of the term structure of the LIBOR curve on the present-valuing of future cash flows. We describe this in more detail in Section 8.1.2. In practice, the difference between the LIBOR spread and the par floater spread is very small, but not small enough to ignore. It also means that the discount margin calculation differs from the approach used in pricing credit derivatives that use the full shape of the LIBOR curve.

4.1.3 Applications

A large proportion of the floating-rate note market is issued by banks to satisfy their bank capital requirements and may be fixed maturity or perpetual. Traditionally, perpetual bonds have consituted a sizeable portion of the floating rate note market. The advantage of a floating rate perpetual is that it has a low interest rate duration despite having an infinite maturity.

In addition to banks, a large number of corporate and emerging market bonds are issued in floating rate format. For example, some Brady bonds such as the Argentina FRBs of ’05 pay a coupon of LIBOR plus 13/16ths.

Floating-rate notes enable the investor to take a pure credit view.

In summary, floating rate notes are a way for a credit investor to buy a bond and take exposure to a credit without taking exposure to interest rate movements. This makes it possible for credit investors to focus on their speciality—understanding and taking a view about the credit quality of the issuer. However, most bonds are fixed rate and so incorporate a significant interest rate sensitivity. To turn them into pure credit plays, we need to use the asset swap.

4.2 Asset Swaps

4.2.1 Description

Asset swaps convert a fixed-rate bond into a pure credit play.

An asset swap is a synthetic floating-rate note. By this we mean that it is a specially created package that enables an investor to buy a fixed-rate bond and then hedge out almost all of the interest rate risk by swapping the fixed payments to floating. The investor takes on a credit risk that is economically equivalent to buying a floating-rate note issued by the issuer of the fixed-rate bond. For assuming this credit risk, the investor earns a corresponding excess spread known as the **asset swap spread**.

While the interest rate swap market was born in the 1980s, the asset swap market was born in the early 1990s. It continues to be most widely used by banks, which use asset swaps to convert their long-term fixed-rate assets, typically balance sheet loans and bonds, to floating rate in order to match their short term liabilities, i.e., depositor accounts. During the mid-1990s, there was also a significant amount of asset swapping of government debt, especially Italian Government Bonds.

The most recent BBA survey has estimated the size of the asset swap market to be about 12% of the total credit derivatives market, implying an outstanding notional on the order of $100 billion. This is believed to be a lower limit, as many institutions do not formally classify asset swaps as credit derivatives. This is a debatable point. However, what is well accepted is the fact that asset swaps are a key structure within the credit markets and are widely used as a reference for credit derivative pricing.

It is the combination of the purchase of an asset and the entry into an interest rate swap.

There are several variations on the asset swap structure, with the most widely traded being the par asset swap. In its simplest form, it can be treated as consisting of two separate trades. In return for an up-front payment of par, the asset swap buyer:

- Receives a fixed rate bond from the asset swap seller. Typically the bond is trading away from par.
- Enters into an interest rate swap to pay to the asset swap seller a fixed coupon equal to that of the asset. In return, the asset swap buyer receives regular floating rate payments of LIBOR plus (or minus) an agreed fixed spread. The maturity of this swap is the same as the maturity of the asset.

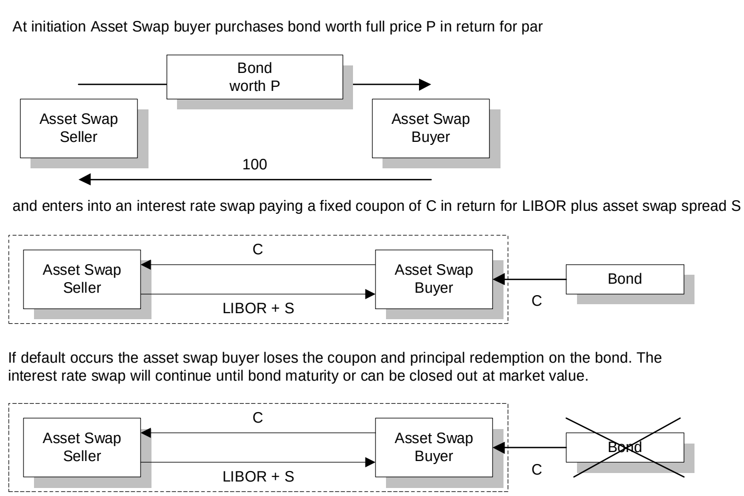
The transaction is shown in Figure 11. The fixed spread to LIBOR paid by the asset swap seller is known as the asset swap spread and is set at a breakeven value such that the net present value of the transaction is zero at inception.

In Figure 12, we show the cash flows for an example asset swap of a bond that has a maturity date of 20 May 2003 and an annual coupon of 5.625% and is trading at a price of 101.70. The frequency on the floating side is semi-annual. The breakeven value of the asset swap spread makes the net present value of all of the cash flows equal to par, the up-front price of the asset swap.

4.2.1 Pricing Aspects

The most important thing to understand about an asset swap is that the asset swap buyer takes on the credit risk of the bond. If the bond defaults, the asset swap buyer

Figure 11. **Mechanics of a Par Asset Swap**



The asset swap buyer has a default contingent exposure to the mark-to-market on the interest rate swap.

has to continue paying the fixed side on the interest rate swap that can no longer be funded with the coupons from the bond. The asset swap buyer also loses the redemption of the bond that was due to be paid at maturity and is compensated with whatever recovery rate is paid by the issuer. As a result, the asset swap buyer has a default contingent exposure to the mark-to-market on the interest rate swap and to the redemption on the asset. In economic terms, the purpose of the asset swap spread is to compensate the asset swap buyer for taking on these risks.

For most corporate and emerging market credits, the asset swap spread will be positive. However, since the asset swap spread is quoted as a spread to LIBOR, which is a reflection of the credit quality of AA-rated banks, for higher-rated assets the asset swap spread may actually be negative.

In Figure 13, we demonstrate an example of the default contingent risk assumed by the asset swap buyer. In the example, the bond is trading at $90. Assume that we are at the moment just after trade inception so that the value of the swap has not changed. If the bond defaults with $40 recovery price, the asset swap buyer loses $60, having just paid par to buy a bond now worth $40. However, he/she is also payer of fixed in a swap that is 10 points in his/her favor. The net loss is therefore $50, the difference between the full price of the bond and the recovery price.

The asset swap buyer takes on the credit risk of the fixed rate bond.

However, consider what happens if the bond has a high coupon and so is trading 20 points above par. This is shown in Figure 14. This time, if the bond defaults immediately with a recovery price of $10, the asset swap buyer will have lost a

Figure 12. **Cash Flows for 3-Year Tecnost Par Asset Swap Trade**

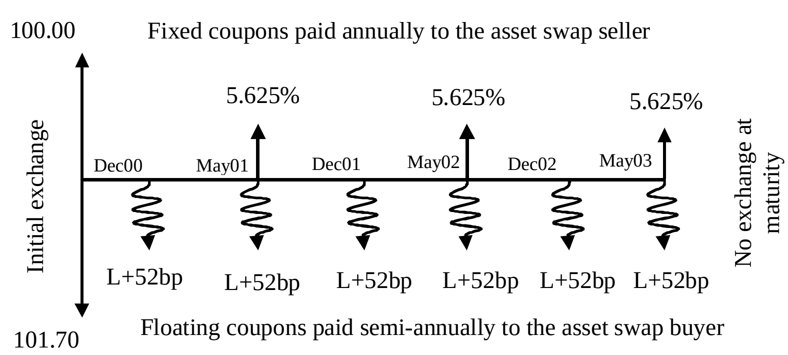


Figure 13. **Asset Swap on a Discount Bond**

	Bond	Swap	Total
Value At Inception	+$90	+$10	+$100
Value Following Default	+$40	+$10	+$50
Loss	-$50	$0	-$50

total of $110: the asset swap buyer paid par for a bond now worth $10 and is party to a swap which has a negative mark-to-market of 20 points. As a result, the investor has actually leveraged the credit exposure and can, therefore, lose more than the initial investment. However, he/she is compensated for this with a higher asset swap spread.

For a par bond, the maximum loss the asset swap buyer can incur is par minus the recovery price. In terms of expected loss, this makes an asset swap similar to a par floater since the expected loss on a floater that trades at par is also par minus recovery. However, in actual practice, this comparison is mostly academic since there will be wide differences between these spreads due to liquidity, market size, funding costs, supply and demand, and counterparty risk.

The asset swap buyer can leverage credit exposure.

As time passes and interest rates and credit spreads change, the mark-to-market on the asset swap will change. To best understand the LIBOR and credit spread sensitivity of the asset swap from the perspective of the asset swap buyer, we use the PV01, defined as the change in price for a one basis point upward shift in the par curve.

For example, consider a 10-year bond with a par floater spread of 50 bp and an annual coupon of 6.0%. As the bond is trading close to par, it will have an asset swap spread of about 50 bp. Using a LIBOR curve from October 1999, the PV01 sensitivities are calculated as shown in Figure 15.

The net PV01 is much smaller than that of the fixed-rate bond. While a fixed rate bond will change in price by about 7.5 cents for a one-basis-point change in interest rates, the asset swap will change in price by only 0.17 cents, a reduction in interest rate sensitivity by a factor of about 44.

The key point here is that the sensitivity of the bond price to parallel movements in the yield curve will be less than the sensitivity of the fixed side of the swap to parallel shifts in the LIBOR curve. This is true only provided the issuer curve is above the LIBOR curve, which is typically the case. The asset swap buyer, there-

Figure 14. **Asset Swap on a Premium Bond**

	Bond	Swap	Total
Value At Inception	+$120	-$20	+$100
Value Following Default	+$10	-$20	-$10
Loss	-$110	$0	-$110

Figure 15. **PV01 Sensitivities of an Asset Swap**

Leg	PV01
Fixed Rate Bond	-7.540
Swap	+7.710
Net	+0.170

fore, has a very small residual exposure to interest rate movements, which only becomes apparent when LIBOR spreads widen significantly.

The interest rate sensitivity of an asset swap is very small.

While the sensitivity to changes in LIBOR swap rates is almost negligible (unless LIBOR spreads are very wide), the sensitivity to changes in the LIBOR spread is equivalent to being long the bond. This echoes the claim that an asset swap transforms a fixed-rate bond into a pure credit play.

An important consideration in par asset swaps is counterparty default risk. Paying par to buy a bond that is trading at a discount results in the asset swap buyer's having an immediate exposure to the asset swap seller equal to par minus the bond price. The opposite is true when the bond is trading at a premium to par. The size of this counterparty exposure can change over time as markets move. However these exposures can be mitigated or reversed using other variations of the standard par asset swap. Equally, one could use other traditional methods such as collateral posting, netting, and credit triggers.

Counterparty risk can be factored into the pricing or reduced using collateral.

4.2.2 Calculating the Asset Swap Spread

The breakeven asset swap spread A is computed by setting the net present value of all cash flows equal to zero. When discounting cash flows in the swap, we use the LIBOR curve, implying that the parties to the swap have the same credit quality as AA-rated bank counterparties. It is shown in Section 8.3 that the asset swap spread is given by

$$A = \frac{P^{LIBOR} - P^{MARKET}}{PV01}$$

where we define P^{LIBOR} to be the present value of the bond priced off the LIBOR swap curve, P^{MARKET} is the actual full market price of the bond, and PV01 is the present value of a one-basis-point annuity with the maturity of the bond, present valued on the LIBOR curve.

On a technical note, when the asset swap is initiated between coupon dates, the asset swap buyer does not pay the accrued interest explicitly. Effectively, the full price of the bond is at par. At the next coupon period, the asset swap buyer receives the full coupon on the bond and, likewise, pays the full coupon on the swap. However, the floating side payment, which may have a different frequency and accrual basis to the fixed side, is adjusted by the corresponding accrual factor. Therefore, if we are exactly halfway between floating side coupons, the floating payment received is half of the LIBOR plus asset swap spread. This feature prevents the calculated asset swap spread from jumping as we move forward in time through coupon dates.

4.2.3 Applications

The main reason for doing an asset swap is to enable a credit investor to take exposure to the credit quality of a fixed-rate bond without having to take interest rate risk. For banks, this has enabled them to match their assets to their liabilities. As such, they are a useful tool for banks, which are mostly floating rate based.

There are many applications for assets swaps.

Asset swaps can be used to take advantage of mispricings in the floating rate note market. Tax and accounting reasons may also make it advantageous for investors to buy and sell non-par assets at par through an asset swap.

Using **forward asset swaps**, it is possible to go long a credit at some future date at a spread fixed today. If the bond defaults before the forward date is reached, the forward asset swap trade terminates at no cost. The investor does not take on the default risk until the forward date. Since credit curves are generally upward sloping, a forward asset swap can often make it cheaper for an investor to go long a credit on a forward basis than to buy the credit today.

Another variation is the **cross-currency asset swap**. This enables investors to buy a bond denominated in a foreign currency, paying for it in their base currency, pay on the swap in the foreign currency, and receive the floating-rate payments in their base currency. The cash flows are converted at some predefined exchange rate. In this case, there is an exchange of principal at the end of the swap. This structure enables the investors to gain exposure to a foreign currency denominated credit with minimal interest rate and currency risk provided the asset does not default. However, for assets with very wide spreads, these residual risks can be material.

For callable bonds, where the bond issuer has the right to call back the bond at a pre-specified price, asset swap buyers will need to be hedged against any loss on the swap since they will no longer be receiving the coupon from the asset. In this case, the asset swap buyers will want to be able to cancel the swap on any of the call dates by buying a Bermudan-style receiver swaption. This package is known as a **cancellable asset swap**. Most U.S. agency callable bonds are swapped in this way.

Callable asset swaps can be used to strip out the equity and fixed income components of convertible bonds.

Callable asset swaps may also be used to strip out the credit and equity components of convertible bonds. The investor buys the convertible bond on asset swap from the asset swap seller and receives a floating rate coupon consisting of LIBOR plus a spread. The embedded equity call option is also sold separately to an equity investor. So that the equity conversion option can be exercised, the asset swap must be callable by the asset swap seller with a strike set at some fixed spread to LIBOR. This enables the asset swap seller to retrieve the convertible bond and convert it into the underlying stock in the event that the equity option holder wishes to exercise.

This example demonstrates how credit derivatives make it possible to split up a hybrid product such as a convertible bond, which has limited demand, into new exposures that better match the differing specialities and risk appetities of investors. Typically, fixed-income investors will be able to earn a higher yield from the stripped asset swap than otherwise available in the conventional bond market. Equity investors may be able to buy the conversion option more cheaply (at a lower implied volatility) than is available in the equity derivatives market.

The asset swap market continues to be a very active over-the-counter market where most trades can be structured to match the needs of the investor.

4.3 Default Swaps

4.3.1 Description

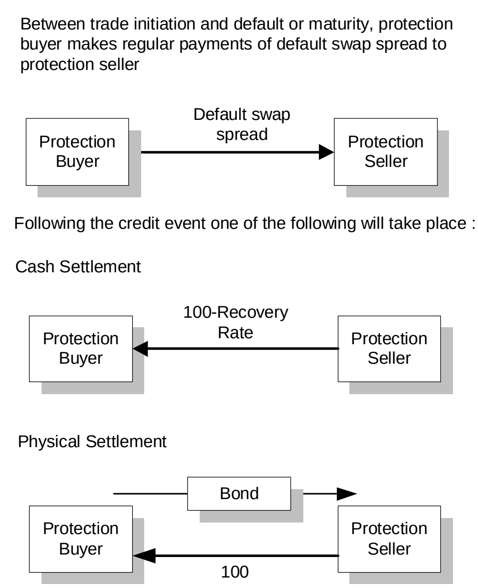
The default swap has become the standard credit derivative. For many, it is the basic building block of the credit derivatives market. According to the British Bankers' Association Credit Derivatives Survey, it dominates the credit derivatives market with over 38% of the outstanding notional. Its appeal is its simplicity and the fact that it presents to hedgers and investors a wide range of possibilities that did not previously exist in the cash market. In the forthcoming section, we set out in detail how it works. We also survey many of these new possibilities.

A default swap can be used to hedge out the default risk of an asset.

A default swap is a bilateral contract that enables an investor to buy protection against the risk of default of an asset issued by a specified **reference entity**. Following a defined **credit event**, the buyer of protection receives a payment intended to compensate against the loss on the investment. This is shown in Figure 16. In return, the protection buyer pays a fee. For short-dated transactions, this fee may be paid up front. More often, the fee is paid over the life of the transaction in the form of a regular accruing cash flow. The contract is typically specified using the confirmation document and legal definitions produced by the International Swap and Derivatives Association (ISDA).

Despite the rapid moves toward the idea of a standard default swap contract, a default swap is still very much a negotiated contract. There are, therefore, several important features that need to be agreed between the counterparties and clearly defined in the contract documentation before a trade can be executed.

Figure 16. **Mechanics of a Default Swap**



The first thing to define is the reference entity. This is typically a corporate, bank , or sovereign issuer. There can be significant difference between the legal documentation for corporate, bank, and sovereign linked default swaps.

The credit event triggers payment of the default swap and must be strictly defined.

The next step is the definition of the credit event itself. This is obviously closely linked to the choice of the reference entity and may include the following events:

- Bankruptcy (not relevant for sovereigns)
- Failure to pay
- Obligation acceleration/default
- Repudiation/Moratorium
- Restructuring

These events are now defined in the recent ISDA 1999 list of Credit Derivatives Definitions, which is described in great detail in Section 6.1.

Some default swaps define the triggering of a credit event using a **reference asset**. The main purpose of the reference asset is to specify exactly the capital structure seniority of the debt that is covered. The reference asset is also important in the determination of the recovery value should the default swap be cash settled (Figure 16). However, in many cases the credit event is defined with respect to a seniority of debt issued by a reference entity, and the only role of the reference asset is in the determination of the cash settled payment. Also, the maturity of the default swap need not be the same as the maturity of the reference asset. It is common to specify a reference asset with a longer maturity than the default swap.

Default swaps can be cash or physically settled.

The contract must specify the payoff that is made following the credit event. Typically, this will compensate the protection buyer for the difference between par and the recovery value of the reference asset following the credit event. This payoff may be made in a physical or cash settled form, i.e. the protection buyer will usually agree to do one of the following:

- Physically deliver a defaulted security to the protection seller in return for par in cash. Note that the contract usually specifies a basket of obligations that are ranked pari passu that may be delivered in place of the reference asset. In theory, all pari passu assets should have the same value on liquidation, as they have an equal claim on the assets of the firm. In practice, this is not always reflected in the price of the asset following default. As a result, the protection buyer who has chosen physical delivery is effectively long a “cheapest to deliver” option.
- Receive par minus the default price of the reference asset settled in cash. The price of the defaulted asset is typically determined via a dealer poll conducted within 14-30 days of the credit event, the purpose of the delay being to let the recovery value stabilize. In certain cases, the asset may not be possible to price, in which case there may be provisions in the documentation to allow the price of another asset of the same credit quality and similar maturity to be substituted.

- Fixed cash settlement. This applies to fixed recovery default swaps, which are described below.

The first two choices are shown in Figure 16. If the protection seller has the view that either by waiting or by entering into the work-out process with the issuer of the reference asset he may be able to receive more than the default price, he will prefer to specify physical delivery of the asset.

A detailed discussion of the legal documentation and a description of what happens following a credit event is set out in Section 6.

Unless already holding the deliverable asset, the protection buyer may prefer cash settlement in order to avoid any potential squeeze that could occur on default. Cash settlement will also be the choice of a protection buyer who is simply using a default swap to create a synthetic short position in a credit. This choice has to be made at trade initiation.

The premium leg terminates at the earlier of the default swap maturity or the time of a credit event.

The protection buyer stops paying the premium once the credit event has occurred, and this property has to be factored into the cost of the default swap premium payments. It has the benefit of enabling both parties to close out their positions soon after the credit event and so eliminates the ongoing administrative costs that would otherwise occur. Current market standards for banks and corporates require that the protection buyer pay the accrued premium to the credit event; sovereign default swaps do not require a payment of accrued premium.

The details of an example default swap trade are shown in Figure 17. It is a €50 million, 3-year default swap linked to Poland. The cost of the protection is 33 bp per annum paid quarterly. The cash flows are shown in Figure 18. The size of each cash flow is given by €50 million × 0.0033 × 0.25 = €41,250. The figure shows both the scenario in which no default occurs and the scenario in which default does occur. If default occurs and the recovery rate on the defaulted asset is 50% of the face value, then the protection buyer receives €25 million.

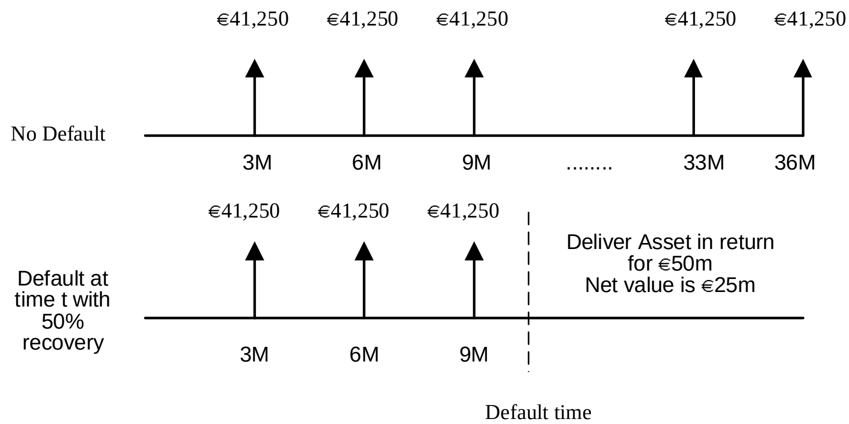
A default swap is a par product.

A default swap is a par product: it does totally not hedge the loss on an asset that is currently trading away from par. If the asset is trading at a discount, a default

Figure 17. **Details of an Example Default Swap Trade**

Default Swap Details	
Currency	Euro
Maturity	3 Years
Reference Entity	Poland
Notional	$50m
Default Swap Spread	33bp
Frequency	Quarterly
Payoff upon Default	Physical delivery of asset for par
Credit Event	see section 6.1 for a list of credit events

Figure 18. **Cash Flows on a Typical Default Swap.**



swap overhedges the credit risk and vice-versa. This becomes especially important if the asset falls in price significantly without a credit event. To hedge this, the investor can purchase protection in a smaller face value or can use an amortizing default swap in which the size of the hedge amortizes to the face value of the bond as maturity is approached.

4.3.2 Marking to Market a Default Swap

Even though the trigger for a default swap to pay out is defined in terms of a credit event, a default swap is very much a credit spread product. On a mark-to-market basis, the value of a default swap changes in line with changes in the credit quality of the issuer as reflected in the issuer's changing default swap spread. This is because the mark-to-market of a default swap has to reflect the cost of entering into the offsetting transaction. For a protection buyer, the mark-to-market of the default swap position incorpoates the cost of entering into a short protection position with the same maturity date as the long protection position. If a credit event occurs, then both positions net out and terminate, leaving the investor flat. Until the maturity date or the time of the credit event, the combined positions result in a net spread payment on each spread payment date. The mark-to-market is therefore given by

A default swap can be used to take a view on changes in credit quality which fall short of actual default.

$$MTM = (S(T) - S(0)) \times PV01$$

where *S(T)* is the current default swap spread to the maturity date and *S(0)* is the default swap spread at trade inception. We define the PVO1 as the present value of a zero-recovery, one-basis-point annuity with the maturity of the default swap that terminates following a credit event. Each cash flow in the annuity is weighted by the probability of the credit event's not occurring before the cash flow date. The consequence of this is that the PV01 has a slight dependence on the recovery rate used to compute the market implied survival probabilities from the default swap curve.

The spread sensitivity of a default swap is very much like that of a floating-rate bond. Over time, the mark-to-market of the default swap declines with its shortening maturity. At the same time, if the credit quality of an issuer deteriorates, the mark-to-market of a long protection position will increase and vice-versa.

There are three ways to monetize a P&L change from adefault swap

The owner of a default swap position can monetize a change in the default swap spread by:

1) Agreeing a price with the default swap counterparty to terminate the transaction.
2) Reassigning the default swap to another counterparty for a negotiated mark-to-market. This requires the new counterparty to agree to take on the counterparty risk of the party with whom the default swap was initially transacted.
3) Entering into the off setting transaction with another counterparty.

Unlike the first two methods, this last results in two open positions. Rather than receive a cash mark-to-market amount, the investor will instead then pay and receive a series of premium cash flows. At the time that the offsetting transaction is executed, the expected present value of these spread payments should be exactly the same as the mark-to-market of the position. However, if a credit event does happens, these premium payments will stop and any remaining P&L will be lost. The investor must also ensure that any legal or other basis risk between the two transactions is minimised.

4.3.3 Determining the Default Swap Spread

It is possible to price a default swap using what is known as a **static hedge**. This involves setting up a portfolio in which the cash flows of the default swap are exactly offset by the cash flows of the other instruments in the portfolio in all possible scenarios. This has to be true whether or not the reference asset defaults and triggers the default swap. Since the position has no net cash flow, pricing the default swap is then a matter of determining what default swap spread makes the net present value of the cash flows equal to zero.

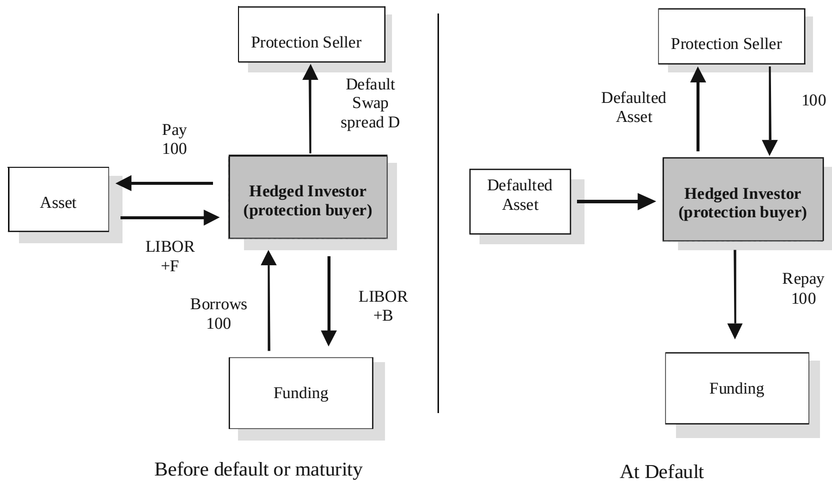
Consider the protection buyer, shown in Figure 19 as the Hedged Investor, who can statically hedge the payments of a default swap by purchasing a par floater with the same maturity as the protection or by purchasing a fixed rate asset trading at par on asset swap. Suppose this par floater (or asset swap) pays a coupon of LIBOR plus F bp and its default triggers the default swap.

The payments of a default swap can be hedged using cash instruments, and this can be used for pricing.

The purchase of this asset for par is funded on the balance sheet at a rate that depends on the borrowing costs of the protection buyer. Alternately, the asset may be funded on repo. Suppose that the funding cost of the asset is LIBOR plus B, paid on the same dates as the default swap spread D. Suppose also that the repo rate is fixed until to the term of the default swap. Consider what happens in the event of:

- **No Default**: The hedge is unwound at maturity at no cost since the protection buyer receives the par redemption from the asset and uses it to repay the borrowed par amount.

Figure 19. **Static Hedge for a Protection Buyer Showing the Payments Before and in the Event of Default**



- **Default:** The protection buyer delivers the defaulted asset to the protection seller in return for par and then repays the funding loan with this principal. The position is closed out with no net cost.

As the strategy has no initial cost and is net flat in the event of a default, the breakeven value for the default swap spread (or what the protection buyer can afford to pay for protection) has to be $D = F - B$.

For example, suppose the par floater pays LIBOR plus 25 bp and the asset can be repo'd at LIBOR flat so that $B=0$. The protection buyer is then able to pay the entire par floater spread for protection, making the breakeven default swap spread equal to 25 bp.

The static hedge is different from the side of the protection seller, who in this case, has to hedge by borrowing the asset in the repo market and shorting it. However, it is typically very difficult to locate the reference asset on repo, so such a strategy is usually unrealistic.

It may not easy to find the asset on repo in order to short it.

Using a static hedge strategy to price default swaps is not exact since it ignores technical effects such as accrued interest and coupon recovery. It is also not totally realistic as other effects such as availability of the cash, liquidity, supply, and demand, as well as counterparty risk also play a role in the determination of the default swap spread. However, this should not detract from the main point here, which is that knowing the asset swap spread or par floater spread of the cash bond and the spread at which it can be funded provides a good reference for where the default swap will trade. Indeed, if this relationship breaks down significantly, arbitrage opportunities will arise, which will be acted upon and which will have the effect of re-establishing this relationship.

The advantage of this approach is that it enables us to generate default swap spreads that are consistent with market prices and saves us from getting into the complexities of credit modelling. The disadvantage is that this replicating strategy does not always exist. For example, we may not be able to find prices for replicating instruments with the same maturity or seniority as the default swap we wish to price. In this case, credit modelling becomes the only viable pricing approach.

4.3.4 Market Dynamics

The relationship between cash and default swaps used in the pricing arguments above does not always hold. Significant deviations from this arbitrage-free relationship can and do occur. Differences between the cash and credit derivatives market are found in some of the less liquid credits and frequently in the emerging markets.

In some cases, it is possible for default swap spreads to trade significantly wider than the corresponding cash. This is often caused by a demand for protection on a credit due to some negative sentiment, as those seeking protection may be unable to sell the bond or may be exposed to the credit through loans that may be difficult to transfer. The default swap market becomes the sole way to hedge out this risk, so default swap spreads are driven higher. As a consequence, investors willing to take exposure to this credit can earn more in the default swap market by selling protection.

Market supply and demand can cause dislocations between the cash and default swap market.

For example, in Turkey, demand for protection on a number of project financings has grown. However, most of the cash bonds are locked up in Turkish banks so are difficult to short. Instead, hedgers of Turkey risk are turning to the credit derivatives market to buy protection. As a result, 5-year Turkey default swap spreads are about 100 bp wider than the cash.

The reverse scenario can also occur. If there is a lack of supply in the cash format of a credit to which investors would like to take exposure, one solution is for investors to create the same exposure synthetically in the default swap market. This can be achieved by investors' selling protection. This demand to sell protection can cause the default swap spread to tighten inside of the corresponding cash. Investors who own the cash can buy protection and so have a positive net carry position with no credit exposure to the reference asset.

Technical reasons can also drive the cash and default swap spreads apart.

There are also some more technical reasons why default swaps trade at different spreads to the cash market. Reasons why default swap spreads may be higher include the facts that the protection buyer is long a cheapest-to-deliver option, the protection buyer may not be able to find the asset on repo, and the protection buyer has locked in his funding cost over the life of the trade—there is no repo risk. Reasons why the default swap spread should trade inside the cash include the facts that a short protection default swap does not require funding and that asset swaps are riskier: there is a default contingent mark-to-market on the interest rate swap.

High-level credits rated AAA-AA typically asset swap to sub-LIBOR levels. However, the default swap spread for these issuers is not negative. After all, the protection seller does have an exposure, albeit a small one, and administration costs have to be covered. In practice, the default swap spread will be very small, of the order of 3-4 bp.

4.3.5 Market Liquidity

The cash and default swap market have very different liquidity characteristics.

When discussing liquidity in the credit derivatives market, the reference is not the interest rate swaps or treasury bond markets, but the cash credit market. Unlike those of the swap and government bond markets, the dynamics of the credit markets exhibit a much greater tendency to move in sudden jumps caused by event news about a particular credit or a sector, or a sudden injection of liquidity caused by new issuance.

What can be said is that the liquidity of the single-name default swap market has grown substantially over recent years. The relative liquidity between the cash and default swap market depends on the specific issuer and changes over time as bond issues mature or new issues come to the market. For example, in December 1997, Korean default swaps were more liquid than the cash since the market was driven by protection buyers unable to short the cash bond. By contrast, following Russia's default in late 1998, the Russian default swap market totally dried up due to legal documentation problems.

Large trades may be easier to execute in the default swap market.

Compared with the cash market, the default swap market is sometimes more easy to transact in for large trades. This is because default swaps are usually transacted in single blocks of $10 million that can be executed without moving the market. This is not always possible in the cash market.

Default swap liquidity is usually concentrated on the 2-, 3-, 5-, and 10-year maturities. Non-standard maturities are less liquid and demand a wider bid-offer spread. This also depends on the type of credit. For banks and corporates, liquidity is greatest around the 5-year maturity. For sovereign credits, liquidity is concentrated on the 1-, 3-, and 5-year points. Bid-offer spreads are linked to the size of the bid-offer in the cash market.

4.3.6 Fixed Recovery Default Swaps

Default swap liquidity is concentrated on certain maturities.

Some default swaps have a different payoff from the standard par minus recovery price. The main alternative is to have a predetermined amount. This is known as a **fixed recovery**, **digital,** or **binary default swap**. By fixing the payoff in advance, uncertainty about the unknown recovery amount is removed. This is useful for both buyers and sellers of protection.

Fixed recovery default swaps enable investors to leverage their credit exposure and, by doing so, earn a higher yield. For example, Moody's default statistics find that senior secured debt has an average recovery rate of about 52%. An investor who sells protection on a senior bond with a fixed recovery rate of 20% is assuming a larger loss in the event of default than history would imply. The investor is leveraged and should be compensated accordingly.

For example, selling protection with a 5-year default swap on a bank's senior secured debt pays a default swap spread of 35 bp. Assuming an average senior recovery rate of 50%, a fixed recovery default swap with the recovery rate set at 0% loses twice as much in the event of a default. It therefore pays around 70 bp. In both cases, the protection seller has a maximum downside loss of 100% of the notional, since even though the expected recovery rate on the senior debt is 50%, it could in practice turn out to be as low as 0%. In some countries, the regulatory treatment of fixed recovery default swaps requires the capital to be allocated in proportion to the maximum loss. For banks, this can make the return on capital for selling protection with digital default swaps very attractive. More details about treatments are provided in Section 6.2.

Fixed recovery default swaps remove recovery risk and can be used to leverage yield

A fixed recovery default swap can be used to express a view on recovery rates. Selling protection with a default swap and buying protection with a fixed recovery of 50% on the same reference credit, both trades done at the same spread, makes a profit if the recovery rate of the senior defaulted asset is more than 50%. Suppose the asset defaults with a recovery of 60%, the fixed recovery default swap pays 50%, while 40% is paid on the actual default swap, making a profit of 10%. Note also that the same fixed recovery trade can be expressed in many different ways. For example, a zero recovery fixed recovery default swap at 30 bp on $10 million is equivalent to a 15 bp, 50% recovery fixed recovery default swap on $20 million.

Digitals are also useful from a pricing perspective, since as we know the payoff in advance, the price of the digital depends only upon the probability of default. We can therefore use digital default swaps to extract the market implied default probability. Using the default swap spread, we can then derive the market implied recovery rate.

4.3.7 Applications

There are many applications for default swaps, which we now summarise:

Hedging

- Default swaps can be used to hedge concentrations of credit risk. This is especially useful for banks that wish to hedge the large exposures that may exist on their balance sheet.
- Buying protection with a default swap is a private transaction between two counterparties, whereas assigning a loan may require customer consent and/or notification. Banks may therefore prefer to hedge loans through the default swap market, as this confidentiality may help to maintain good client relations.
- Default swaps can be used to hedge credit exposures where no publicly traded debt exists.

Investing

- Default swaps are an unfunded way to take a credit risk. This makes leverage possible and helps those with high funding costs.
- Since default swaps are customisable over-the-counter contracts, investors can tailor the credit exposure to match their precise requirements in terms of maturity and seniority.
- Default swaps can be used to take a view on both the deterioration or improvement in credit quality of an reference credit.

- Investors may not be allowed to sell short an asset but may be allowed to buy protection with a default swap.
- Fixed recovery default swaps make it possible for investors to leverage their credit exposure and remove recovery rate uncertainty.
- Dislocations between the cash and derivatives markets can make the default swap a higher yielding investment than the equivalent cash instrument.

Arbitrage/Trading

- For most credit names, buying protection in the default swap market is easier than shorting the asset.
- Traders can take advantage of the price dislocations between the cash and default swap market either by buying the cash and protection or by shorting the cash and selling protection, earning a net positive spread if the default swap market is trading respectively inside or outside where the cash trades.

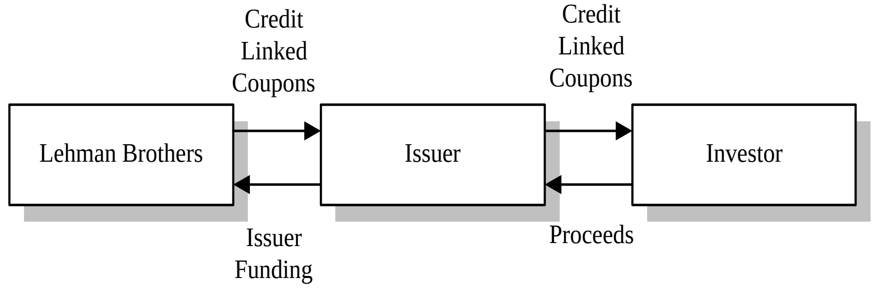
4.4 Credit-Linked Notes

For investors who wish to take exposure to the credit derivatives market and who require a cash instrument, one possibility is to buy it in a funded credit-linked note form. A credit-linked note is a security issued by a corporate entity (bank or otherwise) agreed upon by the investor and Lehman Brothers. The note pays a fixed- or floating-rate coupon and has an embedded credit derivative. Unlike the SPV structure that we explain below, the investors retain an exposure to the note issuer: if the note issuer defaults, then the investors can lose some or all of their coupon and principal. The basic structure is shown in Figure 20.

Credit linked notes can be used to embed credit derivatives in a fully funded note format.

The standard credit-linked note contains an embedded default swap. The investor pays par to buy the note, which then pays LIBOR plus a spread equal to the default swap spread of the reference asset plus a spread linked to the funding spread of the issuer. This issuer funding spread compensates the investors for their credit exposure to the note issuer. It will be less than the issuer spread to the note maturity to take into account the fact that the credit event may cause the note to terminate early. The issuer will also impose a certain cost for the administrative work.

Figure 20. **Structure of a Credit-Linked Note**



Like an asset swap, the credit-linked note is really a synthetic par floater. If the reference asset defaults, the credit-linked note accelerates, and the investor is delivered the defaulted asset. Unlike an asset swap, there is no default contingent interest rate risk.

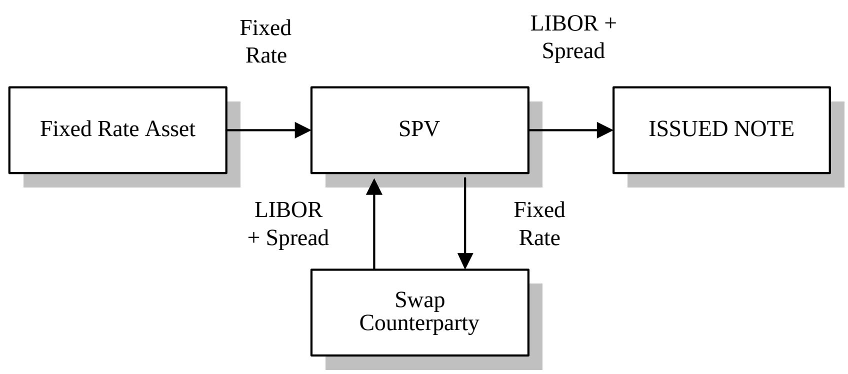
4.5 Repackaging Vehicles

Repackaging vehicles are used to convert or create credit risk structures in a securitized form that is accessible to a broad range of investors. They can be used to convert existing credit derivative products into the cash form required by many investors. They can also be used to increase liquidity and to make liquid risks that do not currently exist in a traded format. The generic structure for doing this is the **Special Purpose Vehicle (SPV)**.

An alternative to the credit-linked note is the special purpose vehicle (SPV). Unlike the credit-linked note, an SPV is a legal trust or company that is bankruptcy remote from the sponsor: any default by the sponsor does not affect payments on the issued note. Therefore, the only credit exposure of the investor is to the underlying assets and/or embedded derivatives. Where the SPV has entered into an interest rate swap, there is also a potential exposure to the swap counterparty. Notes issued by an SPV can be rated and can be listed on an exchange.

SPVs have a number of applications and play an important role in the structured credit market. A classic illustration of the use of an SPV is in the securitization of an asset swap. Investment restrictions prevent certain investors from entering into an interest rate swap, as a result of which they cannot purchase asset swaps directly. However, if an SPV purchases the underlying security and enters into the interest rate swap, the same investor can purchase notes in the SPV that represent the combined economics of the asset swap package. This structure is shown in Figure 21.

Figure 21. **Securitised Asset Swap Issued out of an SPV**



The asset swap buyer has a default contingent exposure to the mark-to-market on the cross-currency interest rate swap.

If the asset in the SPV defaults, the interest rate swap is closed out, with the swap counterparty usually having first recourse to the liquidation proceeds of the defaulted asset to cover any negative mark-to-market on the termination of the swap contract. The investor receives the remaining value of the asset.

A simple extension of this is the SPV that converts an asset denominated in one currency into the investors' preferred currency. The trust buys the foreign currency asset and enters into a cross-currency swap to swap the cash flows (fixed or floating) into the desired currency. In the event of a default, the cross currency swap is terminated, with the swap counterparty usually having first recourse to the liquidation proceeds from the defaulted asset to cover any negative mark-to-market on the swap. The exact details of how this is done may vary. The investors receive what is left as their recovery. Since a cross-currency swap has to be terminated in the event of a default, the investors are exposed to currency and interest rate risk on the recovery amount.

SPVs can be used to securitise asset swaps for investors who cannot enter into swaps.

An SPV can also be used to issue credit-linked notes, which may embed anything from default swaps to first-to-default basket swaps. These types of credit-linked notes are different from those described in the previous section, as they have no exposure to the sponsor. Instead, the note is collateralized using securities. In a standard credit-linked SPV, the SPV purchases underlying securities selected by the investor as collateral. At the same time, the SPV enters into a default swap with Lehman Brothers. Typically the SPV sells default protection to Lehman. In the event of a credit event, the SPV liquidates the underlying securities. The proceeds are first used to pay Lehman Brothers the par minus recovery on the defaulted asset. Any remaining proceeds are then paid to the investor.

As the assets in the SPV serve as collateral for the SPV's obligations under the default swap, they eliminate the counterparty exposure between the note issuer and the investor by exposing the investor to the underlying collateral. This broadens the range of investors who can participate in the default swap market and opens it up to retail customers.

An SPV can be used to make an illiquid asset more liquid.

An SPV can be used to make an illiquid asset more liquid. For example, where there is a restriction on the number of times debt may be traded, or where transference of the debt requires notification or approval, an SPV structure can purchase the asset and issue freely transferable notes that pass through the economics of underlying asset. An example is the funding agreement securitizations that have become common in the Euromarkets. Another way to make debt more liquid is to use the SPV as the issuer in the securitization of loans and trade receivables that do not exist in any traded form.

In legal terms, an SPV is either a Trust or a Company. The Trust form of SPV is most relevant to the U.S. market and is usually organized under the law of Delaware or New York. The trustee is typically a large, highly rated bank that has a fiduciary duty to investors. Market-wide standardization of this type of product means that banks other than the arranger are familiar with the framework and are able to purchase the product. A summary of Lehman's repackaging programs is shown in Figure 22.

In Europe, tax rules differ from those in the U.S. and enable SPVs to be incorporated companies rather than trusts. These structures are therefore also known as Special Purpose Companies (SPCs). The same SPC can issue any number of deals. However, within the company structure, the legal documentation of the SPC enforces a compartmentalization of the risk—each deal is collateralised separately and has recourse only to a defined pool of assets. This means that no deal can be contaminated by another.

One of the purposes of the structure is to make it tax neutral to the investor. For this reason, Lehman Brothers has established a number of SPCs in both the Cayman Islands and the Channel Islands. We are also able to issue out of Gibraltar, the Netherlands, and Ireland.

Other groups of investors may only be allowed to purchase loans or may prefer to make loans for regulatory or other reasons. Lehman Brothers has vehicles that enable investors to take exposure to a package of assets and/or derivatives by making a loan to the SPV, rather than by purchasing notes. The net economics to the investor are identical, but the regulatory treatment can be very different.

An SPV can be used to convert a credit derivative into an insurance contract.

More recently, the SPV structure has been used by Lehman to make it possible for an insurance company to buy a credit derivative. The SPV acts as a "transformer" that converts an ISDA credit derivative into an insurance contract that complies with the requirements of the insurance company.

4.6 Principal Protected Structures

4.6.1 Description

Investors who prefer to hold high-grade credits like to hold principal protected structures that guarantee to return the investor's initial investment of par. The credit derivatives market can be used to provide this protection to credit investors through a principal protected credit-linked note. The note can be issued out of some highly rated entity. Where necessary, it may be possible to get the principal

Figure 22. **Lehman Brothers Repackaging Programs**

Name	Type	Domicile	Comments
RACERS	Trust	Delaware or NY Certificates	Issues Certificates or Notes and
MARBLE	Company	Cayman Islands	Rated
GRANITE	Company	Cayman Islands	Unrated
QUARTZ	Company	Jersey	Rated
CRYSTAL	Company	Jersey	Unrated
SEQUOIA	Company	Cayman Islands	Issues loans

protection feature of the note rated by a rating agency and to use the BIS risk weighting of the issuing entity (20% for an OECD bank), rather than that of the reference credit, which may be 100% risk-weighted.

The principal protected structure is a funded credit derivative similar to a credit linked note. In a 100% principal protected note with an embedded default swap, the coupon of the note teminates following a credit event. The note then redeems at par on its maturity date. In Figure 23, we show a 5-year principal protected note linked to the default of a reference credit. The note pays a spread of 50 bp over LIBOR. If a credit event occurs before the maturity of the note, some or part of all further coupons terminate, and the investors wait until maturity to receive the full redemption.

4.6.2 Pricing Aspects

Adding principal protection enables the investor to protect their principal at the cost of a reduced spread

The inclusion of a principal protected feature can significantly reduce the investors' participation in the reference credit. For this reason, principal protected structures are best suited to assets with very wide spreads, such as some emerging market sovereign assets, low-grade corporate credits, or first-loss products such as default baskets. For higher quality assets where principal protection is still a requirement, it is possible to increase participation in the spread of the reference credit while still maintaining principal protection by allowing the maturity of the note to extend if there is a credit event.

The **Lehman Adjustable Redemption Principal Protected Structure** (**ARPPS**) does exactly this. Following a credit event, all of the coupons terminate, and the note's maturity extends by an additional five years, at the end of which the full final redemption is paid, as shown in Figure 24. This default-contingent delay can significantly increase the investors' when compared with the standard principal protected structure.

It is equally possible to embed other credit derivatives, such as default baskets and portfolio default swaps, which we shall discuss later, within such a principal protected note.

Principal protection can be added to high-yielding credit derivatives such as baskets and portfolio default swaps

Figure 23. **Principal Protected Note**

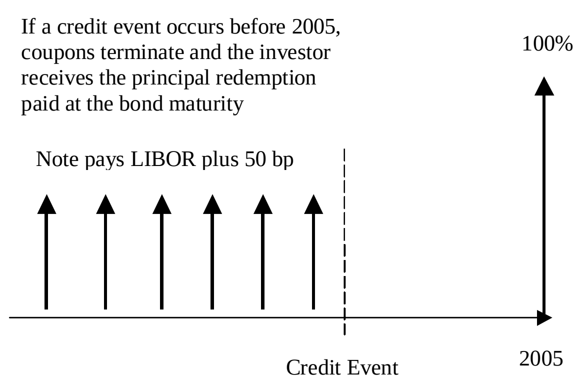
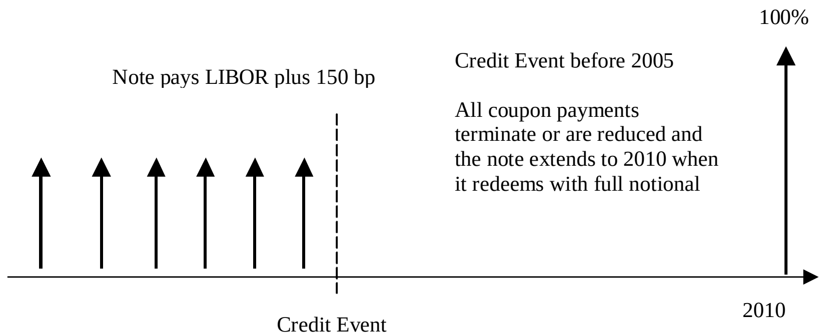


Figure 24. **The Adjustable Redemption Principal Protected Structure (ARPPS).**



4.7 Credit Spread Options

4.7.1 Description

A Credit Spread Option is an option contract in which the decision to exercise is based on the credit spread of the reference credit relative to some strike spread. This spread may be the yield of a bond quoted relative to a Treasury or may be a LIBOR spread. In the latter case, exercising the credit spread option can involve the physical delivery of an asset swap, a floating-rate note, or a default swap.

This reference asset may be either a floating rate note or a fixed rate bond via an asset swap. As with standard options, one must specify whether the option is a call or put, the expiry date of the option, the strike price or strike spread, and whether the option exercise is European (single exercise date), American (continous exercise period), or Bermudan style (multiple exercise dates). The option premium is usually paid up front, but can be converted into a schedule of regular payments.

A call on the spread (put on the bond price), expressing a negative view on the credit, will usually be exerciseable in the event of a default. In this case, it would be expected to be at least as expensive as the corresponding default swap premium. For a put on the spread (call on the bond price), expressing a positive view on the credit, the option to exercise on default is worthless and, hence, irrelevant.

The strike for a credit spread option is normally quoted in terms of a spread to LIBOR. For example, one may purchase an option to enter into an asset swap on a reference asset struck at a spread of 20 bp to LIBOR, as shown in Figure 25. This option will be in the money provided the asset swap spread is less than 20 bp. A call on an asset swap, therefore, expresses a bullish credit view.

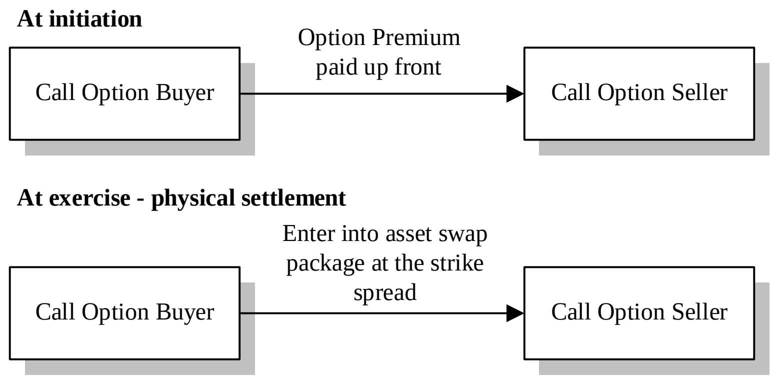
4.7.2 Pricing Aspects

In a credit spread option, the decision to exercise is based on the value of the credit spread

The payoff at the exercise of a credit spread put option is given by

$$Payoff = MAX[K-S(T),0] \times PV01 \times Notional$$

Figure 25. **Mechanics of a Call Option on an Asset Swap**



where *S(T)* is the spread of the asset on exercise, *K* is the strike spread, and PV01 is the present value of a 1 bp annuity priced off the issuer curve. Note that a call option on the bond price is a put option on the credit spread. Equally, a put option on the bond price is a call option on the credit spread.

Because of the optionality, pricing credit-spread options requires a model for the evolution of credit spreads. For European-style options, the simplest such model is a variation on Black's model for valuing interest rate caps and floors where instead of forward rates, we model the forward credit spread at option exercise as a random variable with a lognormal distribution. For American-style options, a tree-based approach must be used to take into account the early exercise decision. Other more sophisticated approaches exist that take into account other factors such as the correlation between interest rates and credit spreads.

Because the seller of the option will typically have to hedge the short option position dynamically and because the reference credit may not be highly liquid, transaction costs will also have to be factored into the price of the option.

4.7.3 Applications

Credit spread options present an unfunded way for investors to express a pure credit view. Unlike options on fixed rate bonds, which we discuss in the next section, the decision to exercise has no dependency on interest rates. It simply depends on where the credit spread of the reference credit is relative to the strike spread.

The value of a 1-year option to enter into a 5-year asset swap is determined by the 5-year asset swap spread one year from today. It is, therefore, a play on the forward asset swap spread and so can be used to take a view on the shape of the credit curve.

The more volatile the credit spread, the more time-value the option will have, and the more the option will be worth. And if the investors hedge the option by trading the underlying, they will be long volatility. As a result, credit spread options allow investors to express a view about spread volatility separate from a view about the direction of the credit spread.

Buying an out-of-the money put option on a bond is similar to a buying protection with a default swap with one advantage—it can be exercised even when the credit deterioration is significant but formal default has not occurred.

Investors can use credit spread options to take a view about credit spread volatility.

One extension of the credit-spread option is the exchangeable asset swap option. This gives the purchaser the right but not the obligation to swap one asset swap package for another asset swap package linked to a different credit. This makes it possible for the purchaser of the option to take a view on the difference between two asset swap spreads.

As the hedge fund market for credit spread products grows, we expect to see more growth and development of the credit spread option market.

4.8 Bond Options

4.8.1 Description

For certain liquid credits, such as some of the Latin American Brady bonds and large corporates, there is a well-developed bond option market. These options are usually traded by hedge funds taking proprietary positions. Options on fixed-rate bonds can be used to express a view on the credit spread of an issuer, interest rate movements in the currency of denomination of the bond, and interest rate and credit spread volatility. For many investors, it is cheaper to buy a call option on the bond rather than fund the bond on balance sheet.

These bond options are price based. For example, a 2-year European-style call option on the Argentina Eurobond of Sep 2027 struck at a price of $101 will expire in the money if the price of the bond is greater than $101 in two years. As this bond pays a fixed coupon of 9 ¾%, its price action is driven by both the market perceived credit quality of Argentina and by U.S. dollar interest rates. It is a position that combines two different views: a bullish credit play and a reduction in U.S. interest rates. It is, therefore, a correlation play on movements between interest rates and credit spreads.

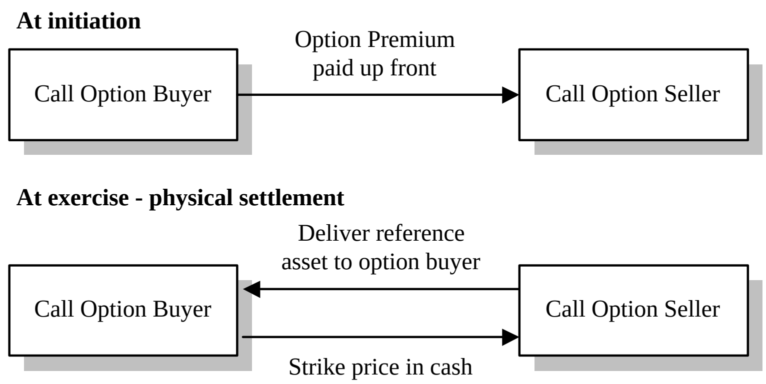
Bond options are typically physically settled. For example, when a call option is exercised, the option seller delivers the reference asset to the option buyer in exchange for the strike price, as shown in Figure 26.

4.8.2 Applications

Bond options can be used to express a view about the relationship between credit spreads and interest rates

Retail investors who are already long the underlying bond like to sell bond options to enhance their yield. For example, an investor may sell an out-of-the-money call to earn some premium. If the bond price rises sufficiently, the option is exercised, and the investor sells the bond at the option strike. While the investor may

Figure 26. **Mechanics of a Bond Option**



not be able to enjoy the full benefits of the rise in the bond price beyond the option strike, they will have profited from selling the option and from the increase in the bond price.

A strategy of selling out-of-the money put options can be used to enhance yield

Investors can also use bond options to take a view on volatility. By using the bond to delta hedge a long option position, an investor is long volatility and can profit from increased uncertainty about the reference credit, as expressed through the volatility of the bond yield. Such a strategy is indifferent to the direction of movement of the yield: it is neither bullish nor bearish.

4.9 Total Return Swaps

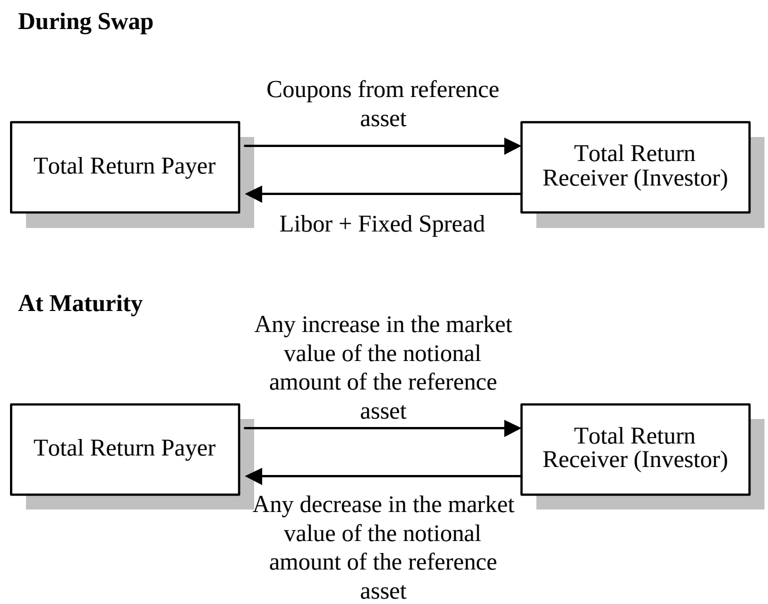
4.9.1 Description

A total return swap is essentially a balance sheet arbitrage trade

A **Total Return Swap (TRS)** is a contract that allows investors to receive all of the cash flow benefits of owning an asset without actually holding the physical asset on their balance sheet. As such, a total return swap is more a tool for balance sheet arbitrage than a credit derivative. However, as a derivative contract with a credit dimension—the asset can default—it usually falls within the remit of the credit derivatives trading desk of investment banks and so becomes classified as a credit derivative. Before discussing why this product may be of interest to investors, we describe the mechanics of the structure, which are shown in Figure 27.

At trade inception, one party, the total return receiver, agrees to make payments of LIBOR plus a fixed spread to the other party, the total return payer, in return for the coupons paid by some specified asset. At the end of the term of the total return swap, the total return payer pays the difference between the final market price of the asset and the initial price of the asset. If default occurs, this means that the total return receiver must then shoulder the loss. The

Figure 27. **Mechanics of a Total Return Swap**



asset is delivered or sold and the price shortfall paid by the receiver. In some instances, the total return swap may continue with the total return receiver posting the necessary collateral.

4.9.2 Pricing Aspects

The static hedge for the payer in a total return swap is to buy the asset at trade inception, fund it on balance sheet, and then sell the asset at trade maturity. Indeed, one way the holder of an asset can hedge oneself against changes in the price of the asset is to become the payer in a total return swap. This means that the cost of the trade will depend mainly on the funding cost of the total return payer and any regulatory capital charge incurred.

Pricing is determined by the cost of funding the hedge

We can break out the total cost of a TRS into a number of components. First, there is the actual funding cost of the position. This depends on the credit rating of the total return payer that holds the bond on its balance sheet. If the asset can be repo'd, it depends on the corresponding repo rate. If the total return payer is a bank, it also depends on the BIS risk weight of the asset, with 20% for OECD bank debt and 100% for corporate debt.

If the total return payer is holding the asset, then the total return receiver has very little counterparty exposure to the total return seller. However, the total return payer has a real and potentially significant counterparty exposure to the total return receiver. This can be reduced using collateral agreements or may be factored into the LIBOR spread coupon paid.

4.9.3 Applications

There are several reasons why an investor would wish to use such a total return structure:

Funding/Leverage

As unfunded transations, total return swaps make it easy to leverage a credit view

- Total return swaps make it possible to take a leveraged exposure to a credit.
- They enable investors to obtain off-balance-sheet exposure to assets to which they might otherwise be precluded for tax, political, or other reasons.

Trading/Investing

- Total return swaps make it possible to short an asset without actually selling the asset. This may be useful from a point of view of temporarily hedging the risk of the credit, deferring a payment of capital gains tax, or simply gaining confidentiality regarding investment decisions.
- Total return swaps can be used to create a new synthetic asset with the required maturity. Credit maturity gaps in a portfolio may, therefore, be filled.

5 MULTI-NAME CREDIT DERIVATIVES

5.1 Index Swaps

5.1.1 Description

Total return swaps do not necessarily have to be linked to a single security. For example, one may wish to link the total return to an index such as the Lehman Brothers Corporate Bond Index, thereby creating what is known as an index swap. Example indices are listed in Figure 28. From a credit perspective, this gives investors exposure to the total return of a broad universe of corporate securities without exposing them to the default of any one issuer.

Investors can take an exposure to a large universe of credits using an index swap.

An index swap can be structured in one of several ways, depending on the requirements of the investor. In the example presented here, the buyer of the index receives the gain or loss in the value of the index plus any coupon accrual in return for floating-rate payments of LIBOR plus a fixed spread, as shown in Figure 29.

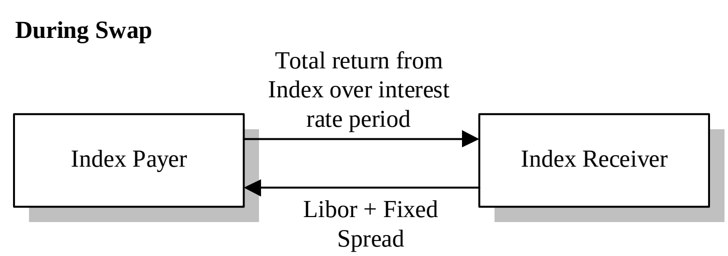
5.1.2 Pricing Aspects

The total return payer will have to hedge by buying the index. The funding cost of these assets will, therefore, have a significant effect on the price, and for a bank will include a component that depends on the BIS risk weight of the asset: 0% for government securities, 20% for OECD banks, and 100% for corporates.

Figure 28. **Example Indices**

Lehman Indices	**Description**
Corporate component of the Lehman U.S. Credit Index	All $US industrial, financial, and utility investment-grade securities with more than one year to maturity
Corporate component of the Lehman EuroAgg Index	All €-denominated industrial, financial, and Utility investment grade securities with more than one year to maturity

Figure 29. **Index Swap Mechanics**



Another factor that determines the cost is that as the index actually contains several thousand actual bonds, replicating it will usually involve buying some optimal subset of less than 100 bonds. The effect of the transaction costs incurred will have to be included in the price. Buying a subset of the actual index means there will, therefore, always be a small tracking error that will also have to be factored into the cost.

The price of an index swap includes the costs of replicating the index on balance sheet.

One reason for using index swaps is that for the investor, the bid-offer spread of replicating the index is usually much greater than the bid-offer spread of the total index swap. Consider the cost of replicating a long position in a high-yield bond index. Suppose that funding the purchase of the 50 most representative bonds in the index occurs at LIBOR plus 30 bp, the bid-offer cost of buying the bonds is 100 bp and the basis risk is 60 bp. The overall cost of this is then LIBOR plus 190 bp.

To replicate a short position in the index, we borrow the bonds at LIBOR minus 100 bp, the bid-offer cost of selling the bonds is 100 bp, and the basis risk is 60 bp, giving a total cost of LIBOR minus 260 bp. The bid-offer spread of the replicating the index is therefore 260-(-190)=450 bp. In comparison, the index swap market would have a bid-offer spread of about 100 bp. This is because the index swap dealer will be more willing to take outright market risks and basis risks than the investor. Also, by having a reasonably balanced book in index swaps, the dealer will be able to aggregate risks and so reduce hedging costs.

5.1.3 Applications

The bid-offer spread of the index swap will usually be lower than that of the underlying assets.

There are several reasons why index swaps are an efficient alternative to cash:

- Asset managers without a significant amount of capital can buy a much more diversified portfolio than is possible through the cash market. They can also avoid the high bid-offer spreads faced in these smaller transactions.
- Buying and selling index swaps may be more liquid than trading all of the underlying assets. Bid-offer spreads will usually be much tighter.
- Clients can use the index swap to benchmark their portfolio to standard fixed income indices.
- Portfolio managers can replicate an index without incurring a tracking error.
- Asset managers can quickly gain exposure to a sector in which they do not have specialised knowledge.
- Investors can gain access to asset classes from which they might otherwise be precluded.

5.2 Basket Default Swaps

5.2.1 Description

A basket default swap is similar to a default swap in which the credit event is the default of some combination of the credits in a specified basket of credits. In the particular case of a **first-to-default basket**, it is the first credit in a basket of reference credits whose default triggers a payment to the protection buyer. As in the case of a default swap, this payment may be cash settled. More commonly, it will involve physical delivery of the defaulted asset in return for a payment of the par amount in cash.

First-to-default baskets have grown in popularity over the past few years. As we shall see, they enable investors to leverage their credit risk and earn a higher yield while being exposed to well-known, good-quality names.

In return for protection against the first-to-default, the protection buyer pays a basket spread to the protection seller as a set of regular accruing cash flows. As with a default swap, these payments terminate following the first credit event.

The basket spread paid is usually 2-3 times the average spread of the assets in the basket.

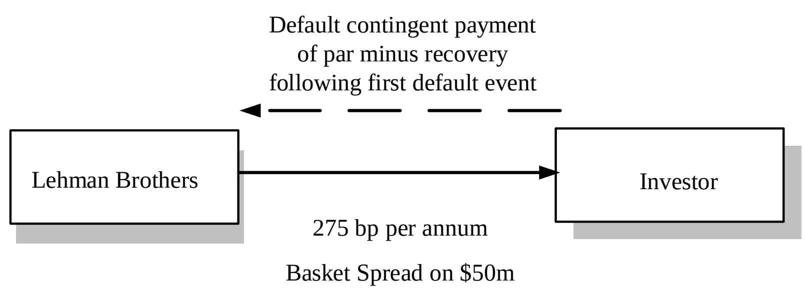
The advantage of the basket structure is that it enables investors, who sell first to default protection, to leverage their credit risk without increasing their downside risk. The most that the investors can lose is par minus the recovery of the first asset to default, which is the same as they would have lost had they simply purchased this asset in the first place. However, the advantage is that the basket spread paid can be a multiple of the spread paid by the individual assets in the basket. This is shown in Figure 30, where we have a basket of five well-diversified names paying an average spread of about 100 bp. The basket pays a spread of 275 bp.

More risk-averse investors can use default baskets to construct low risk assets: second-to-default baskets trigger a credit event after two or more assets have defaulted. As such, they are lower-risk second-loss exposure products that may pay a higher return than other similar risk assets.

Figure 20. **Example of a First-to-Default Basket on Five Reference Credits.**

Basket

Company Type	**Rating**	**Spread(bp)**
Airline	(Baa2/BBB-)	120
Household Appliances	(Baa2/BBB)	100
Consumer Products	(A2/A+)	80
Transport Services	(Baa2/BBB)	110
Machinery	(A3/A-)	80



5.2.2 Pricing Aspects

Baskets are essentially a **default correlation** product. This means that the basket spread depends on the tendency of the reference assets in the basket to default together. It is natural to assume that assets issued by companies within the same country and industrial sector would have a higher default correlation than those within different industrial sectors. After all, they share the same market and the same interest rates and are exposed to the same costs. There is also an argument that within the same industry sector, the default correlation can actually be negative since the default of one company can take out capacity and so strengthen the remaining players. However, we believe that the systemic sector risks far outweigh this possibility so that default correlation is always positive.

A lack of defaults means that default correlation is very difficult to measure.

Research has shown that default correlation is linked to the credit rating of the company—lower-rated companies are generally more leveraged, so in an economic downturn, they would be more likely to default together. However, the sheer lack of default events makes it very difficult to determine default correlation from empirical analysis.

If the assets in the basket have a low default correlation, then the investors are exposed to each of the credits as though they were long each credit but only exposed a loss amount equal to that on one asset. In this limit, the basket spread is close to the sum of the spreads of the reference credits in the basket.

The basket spread is very dependent on the default correlation between the assets in the basket.

If the default correlation is high, assets tend not to default alone, but together. In this limit, the basket behaves like the worst asset in the basket. We find that the basket spread will approach the widest spread of the assets in the basket. This is when the basket spread is at its lowest.

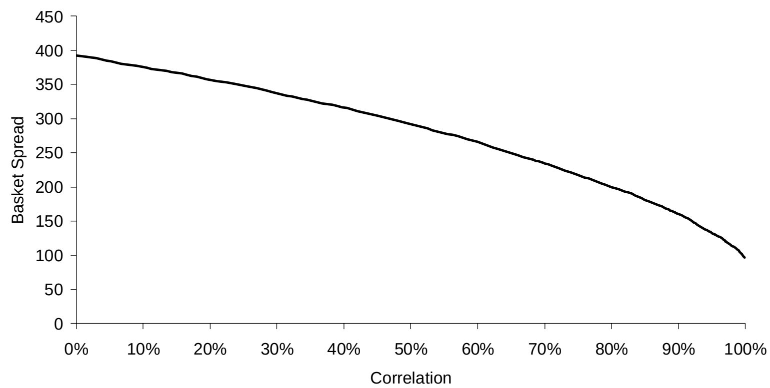
It is not possible to use static hedge arguments to value the basket spread. There is no static hedge that can be used to eliminate both the spread risk and the default risk of the basket using single-name default swaps. A dynamic hedging strategy is necessary, and a valuation model must be used to compute the appropriate hedge ratios. These hedging costs will be factored into the pricing.

To understand how the spread interpolates between the two limits of minimum and maximum default correlation, we need to use a valuation model of correlated default. In Figure 31, we have plotted the first-to-default basket spread as a function of default correlation for a basket of five assets, with a 5-year default swap spread ranging from 65 bp-95 bp. At low default correlation, the basket spread is close to the sum of the default swap spreads, which is 400 bp. At the maximum correlation, the spread is close to that of the worst asset: this is 95 bp.

5.2.3 Applications

Investors are motivated to sell protection in basket form since this makes it possible for them to leverage their credit exposure and earn a higher yield. The yield spread paid to the investor can be a multiple of the average spread of the individual assets in the basket. What makes baskets especially attractive is that this

Figure 31. **Model-Based Calculation of the First-to-Default Basket Spread as a Function of Default Correlation for a 5-Name Basket with Asset Spreads of 65 bp-95 bp.**



The assets in the basket can be well-known, high-grade credits, while the spread paid is equal to that of a lesser-known, lower-quality asset.

leverage can be achieved with a maximum downside equal to that of the defaulted asset. Furthermore, while the assets in the basket can be well-known, good-quality credits with which the investor's credit analysts are familiar, the yield paid can be comparable with a lesser-known, lower-quality asset.

In most jurisidictions, the bank capital treatment for baskets is very conservative, with bank investors required to hold capital against each of the assets in the basket. However, in some countries, for example Italy, the capital treatment is that of the highest risk weighted asset in the basket. Such a treatment enhances the return on capital and can make baskets an attractive investment for banks. As treatments vary widely, they must be confirmed with the appropriate regulating authority. We direct the reader to section 6.2 for a fuller discussion of bank regulatory capital treatments.

As with default swaps, baskets can also be issued in a funded form as a credit-linked note or issued as a security out of an SPV. They can also be issued in a principal protected form.

A second-to-default basket is a simple extension of the first-to-default stucture in which the triggering credit event is the default of two of the assets in the basket. Following this credit event, it is the second asset to default that is delivered in return for a payment of par. Second-to-default baskets are part of a class of credit derivative known as second-loss products. Because they require two or more defaults to trigger a credit loss, for small baskets they are usually considered to be much less risky than standard single credit products and so appeal to investors who wish to buy high quality assets that return a higher yield than other equally high quality assets.

Default baskets have become increasingly popular over the past few years as investors have realised how they can be used to enhance yield while being exposed to familiar credits. The recent BBA survey estimates that they already constitute a total outstanding notional in excess of $50 billion. We believe that they provide a unique and invaluable way for investors to trade default correlation and enhance yield.

5.3 Understanding Portfolio Trades

As the number of assets in a portfolio increases, its default characteristics become increasingly complex. The bottom line is that we need a quantitative framework to analyze the credit properties of the whole portfolio. Specifically, we need to understand the effect of the following four factors—the number of assets in the portfolio, the default probability of the individual assets, the recovery rate of the assets, and the default correlation between the assets.

The loss distribution encapsulates the default characteristics of a portfolio.

For credit derivatives and other portfolio credit structures that tranche up the credit risk of the portfolio into first and second loss products, it is the **loss distribution** that encapsulates the default characteristics of the portfolio. Understanding the shape of the loss distribution and how it is affected by these four factors enables the investor to understand the pricing and risk of tranched portfolio credit derivatives.

To illustrate how the shape of the loss distribution depends on default correlation, we have modelled a collateral pool of 100 defaultable assets. For simplicity, we have assumed that all of the assets have the same notional and the same probability of default of 14%. Note that this is about the 6-year cumulative default probability of a Ba-rated asset (source: Moody's Investor Services). We have also assumed that the assets are senior in the capital structure so have an average recovery rate of 50%.

As assets become more correlated they tend to default together - this makes larger losses more likely

For zero default correlation, the shape of the loss distribution is the symmetric binomial distribution and is centered on the expected loss of 7%, the probability of default times the loss in the event of a default (i.e., 14% x 50%). Figure 32 illustrates the shape of the loss distribution for the portfolio if the assets are assumed to have a default correlation of 15%. Once again, the expected loss is 7%. However, there is now a tail developing on the loss distribution since there is a greater likelihood of assets' defaulting together.

If we increase the default correlation of the assets in the collateral to 40%, the assets in the collateral pool become more likely to default together and larger losses become more probable. The shape of the loss distribution is shown in Figure 33. Once again, the expected loss, which is independent of the correlation, is 7% of the portfolio. Because of the tendency of the assets to default together, the tail of the distribution has now been stretched out, and losses in excess of 25% of the portfolio are now much more likely.

In the limit of 100% default correlation, shown in Figure 34, the assets either all survive or they all default with a 50% recovery rate. The loss distribution becomes bimodal—there are two peaks—one at zero loss with a probability of

86% and one at 50% loss with a probability of 14%. In this limit, the portfolio behaves exactly like a single asset. There is no diversification.

We must then analyze how these different shapes affect the expected loss on each tranche. For example, suppose that the junior tranche assumes the first 10% of

Figure 32. **The Loss Distribution for a Portfolio of 100 Assets with a Default Correlation of 15%. Each Asset Has a 6-Year Default Probability of 14% and a Recovery Rate of 50%.**

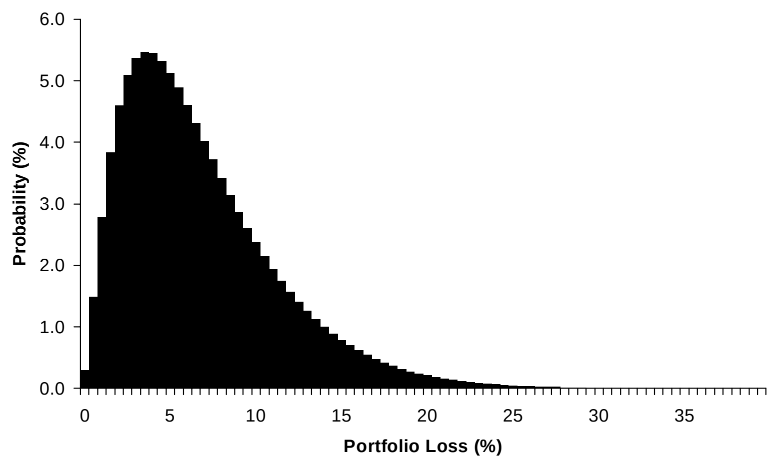


Figure 33. **The Loss Distribution for a Portfolio of 100 Assets Each with a 40% Default Correlation**

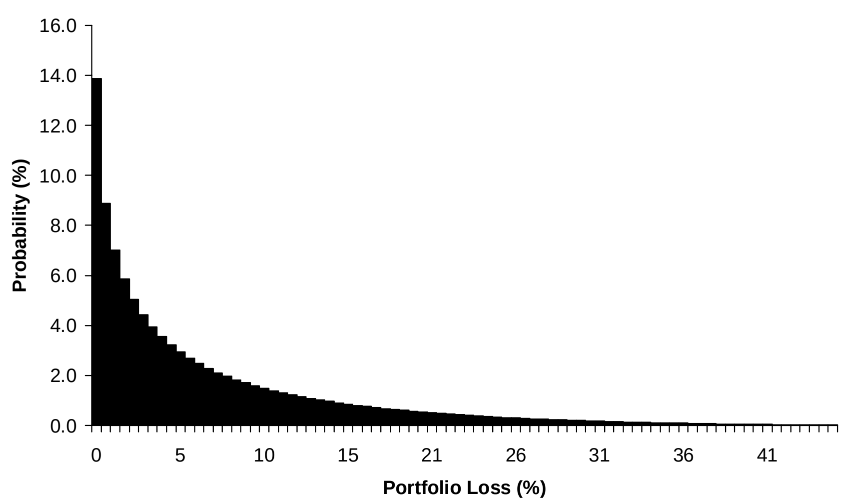
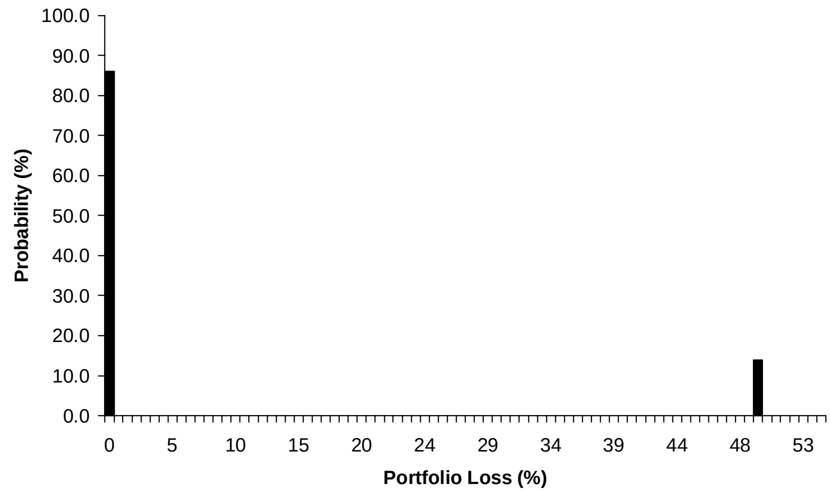


Figure 34. **The Loss Distribution for a Portfolio of 100 Assets with a 100% Default Correlation**



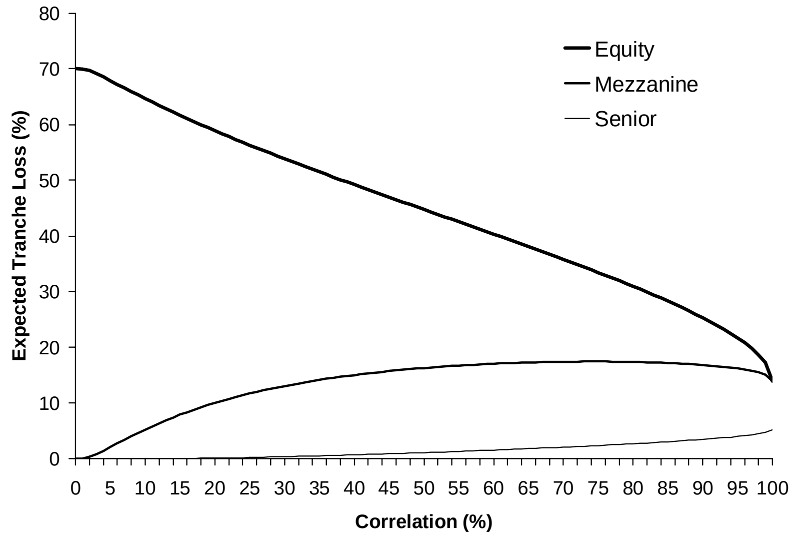
losses, the mezzanine tranche takes the next 10%, and the senior tranche takes the final 80%. The expected loss is shown as a function of the portfolio default correlation in Figure 35. Clearly, the equity tranche has a higher expected loss than the mezzanine and senior. At low correlation, we see that most of the loss distribution is beyond the equity tranche and there is an expected loss of up to 70% of the notional of the equity tranche. The investor must be compensated for this through a higher spread. At low correlation, there is very little likelihood that the mezzanine or senior tranche will be affected by defaults, so their expected loss and, hence, the spread that they should pay, is small.

The higher the default correlation the more likely that losses will affect the senior tranches.

As the correlation increases, the assets in the portfolio become more likely to default together, and the tail of the distribution is pushed out, pushing more of the risk into the mezzanine tranche. Accordingly, the spread on the mezzanine tranche must increase. We also see that the senior spread begins to increase as the correlation moves beyond 30% as losses of more than 20% of the portfolio become possible.

In the limit of 100% correlation, the portfolio behaves like one asset which either survives with an 86% probability or defaults with a 14% probability and a recovery rate of 50%. In this limit, the equity tranche has a 14% expected loss, as it will all be lost if the whole portfolio defaults. The mezzanine also has a 14% expected loss, as it, too, will all be lost if the whole portfolio defaults. The senior note can benefit from the 50% recovery rate on the underlying assets. Its maximum loss is limited to 30% of the portfolio. As a fraction of its face value, the expected loss on the senior note is therefore 5.25%. Not only is the senior note protected from losses below 15% of the portfolio, the non-zero recovery rate on the underlying collateral means that it is also protected from losses beyond 50% of the portfolio. This shows why senior tranches can be very highly rated.

Figure 35. **The Percentage Expected Loss of Each of the Tranches of the Portfolio as a Function of the Default Correlation Between the Assets in the Collateral Pool**



5.4 Portfolio Default Swaps

A portfolio default swap will typically contain 40-100 names

For investors, the main alternative to baskets is the tranched portfolio default swap. These are similar to default baskets in the sense that they take a portfolio of credit names and redistribute the credit risk into first and second loss products. However, they differ from default baskets in two ways: first, the size of the underlying basket or portfolio is usually much larger, typically consisting of 40-100 credit names. Second, the redistribution of the risk is specified in terms of the percentage of the portfolio loss to which the investor is exposed, rather than the number of assets.

For example, consider a portfolio of 50 credit names, each name with a face value of €5 million, which has been tranched into a 10% first loss tranche and a 90% second loss piece. The investor in the first loss piece is exposed to whatever number of defaults would be required to reduce the portfolio notional by 10%. If the credit names are referenced to senior debt, we can assume a recovery rate of 50% on each. It therefore takes the default of 10 of the names to result in a loss of 10% - each default loses €2.5 million, and 10% of the portfolio corresponds to €25 million.

Pricing is driven by the default swap market and where the other tranches can be placed

The tranche in a portfolio default swap can be transacted as an unfunded credit derivative similar to a default swap. It can also be done in a fully funded note format. How the coupon on a tranche is paid can be specified in a number of ways. The most common is for the notional of the tranche to amortize down as defaults happen, while the spread paid remains a constant percentage of the notional of the tranche. For example, in the example portfolio of 50 names described in the previous paragraph, the default of the first asset will cause the loss of €2.5 million, which will be lost by the investor in the first-loss tranche whose notional will step down by the loss amount, €2.5 million. At the same time, the notional on the senior tranche will be reduced by the recovery amount, also €2.5 million. The spread on each tranche will remain constant.

5.4.1 Pricing Aspects

The spread paid by a tranche is set in such a way that the expected present value of the spread leg equals the expected loss on the tranche, where the expected loss is a function of the credit quality of the credit names in the portfolio, the number of names in the portfolio, and their default correlation. The role of default correlation is explained in more detail in Section 5.3

Unlike the portfolio trades described in the following section on CDOs, there are no actual bonds and, therefore, no coupons, differing maturities, embedded options, or any other features that need to be taken into account. In this sense, a portfolio default swap is a much easier structure to understand from a pricing and risk perspective.

5.4.2 Uses

Portfolio default swaps are a new and powerful tool for enabling investors to take an exposure to large groups of assets in a form that either leverages or deleverages the credit risk of the underlying portfolio. This can be done in either an unfunded or fully funded format.

The highly leveraged, high-coupon, first-loss tranche can be purchased by yield-hungry investors. It can also be principal protected, in which case the investor can enjoy a significant, but lower coupon with the benefit of knowing that the downside is limited to a loss of the coupons.

Portfolio default swaps are the tool used in the synthetic CLO, which has become the standard credit derivative technology for bank balance sheet securitization. It will be described in greater detail in Section 5.6. However, to put the synthetic CLO into its proper context, we must first describe the process of securitization of defaultable assets.

5.5 Collateralized Debt Obligations

5.5.1 Description

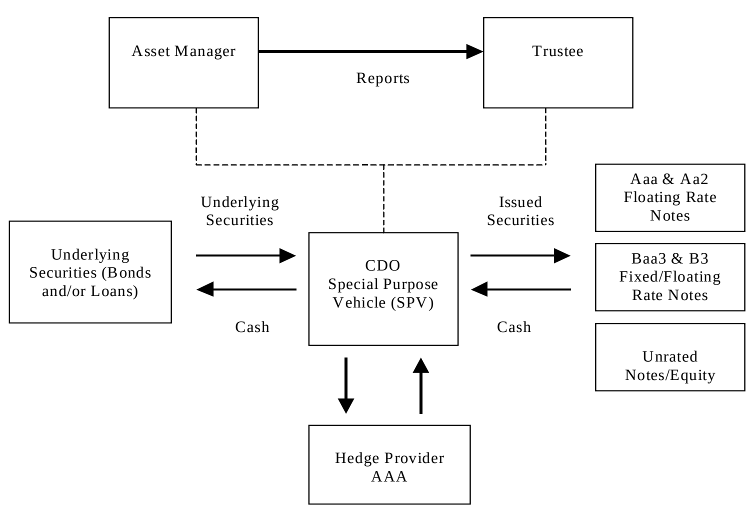
A collateralized debt obligation (CDO) is a structure of fixed income securities whose cash flows are linked to the incidence of default in a pool of debt instruments. These debts may include loans, revolving lines of credit, other asset-backed securities, emerging market corporate and sovereign debt, and subordinate debt from structured transactions. When the collateral is mainly made up of loans, the structure is called a Collateralised Loan Obligation (CLO), and when it is mainly bonds, the structure is called a Collateralised Bond Obligation (CBO).

The fundamental idea behind a CDO is that one can take a pool of defaultable bonds or loans and issue securities whose cash flows are backed by the payments due on the loans or bonds. Using a rule for prioritizing the cash flow payments to the issued securities, it is possible to redistribute the credit risk of the pool of assets to create securities with a variety of risk profiles. In doing so, assets that individually had a limited appeal to investors because of their lack of liquidity or low credit quality can be transformed into securities with a range of different risks that match the risk-return appetites of a larger investor base.

The structure of a typical CDO is shown in Figure 36. The bond or loan collateral is placed in a special purpose vehicle (SPV), which then issues several tranches of notes. These notes have different levels of seniority in the sense that the senior tranche has coupon and principal payment priority over the mezzanine and equity tranches. This means that the income from the collateral is paid to the most senior tranches first as interest on the notes. The remaining income from the collateral is then paid as interest on the mezzanine tranche notes. Finally, the remaining income is paid as a coupon on the notes in the equity tranche. The rules governing the priority of payments are known as the **waterfall structure** and may be quite complicated. For example, they may contain interest coverage tests.

As a consequence, defaults in the underlying collateral will first affect the coupon and principal payments on the equity tranche. As a result, this first-loss tranche is typically unrated and may be retained by the sponsor of the deal. The mezza-

Figure 36. **Structure of a Typical CDO**



nine tranche typically achieves an investment-grade rating, and the senior tranche may even achieve a AAA rating.

A waterfall structure is used to redistribute the credit risk and return of the underlying collateral.

These tranches will typically pay floating-rate coupons to investors. If the payments from the collateral are fixed rate, interest rate risk will be hedged through interest rate swap agreements with a highly rated counterparty.

While the equity tranche is the most subordinated tranche and so is the first to absorb losses following default, it is also the note that pays the highest spread. It receives the excess spread—the difference between the interest received on the collateral and the interest paid to the senior tranches after losses.

The pricing of CDOs is typically determined by the rating. As discussed in section 5.3, in order to reflect the risk of the portfolio, the rating methodology must take into account the shape of the portfolio loss distribution.

5.5.2 Rating Methodologies

The determination of the rating category of CDOs is undertaken by the rating agencies, which have full access to data about the structure of the underlying collateral pool and use this to model the credit quality of the various tranches. Their approach must take into account the role of default correlation in the riskiness of the issued securities.

For example, Moody's applies its Binomial Expansion Technique, which combines a measure of default correlation across the collateral pool, a knowledge of the average credit quality of the different assets in the pool, and the details of the waterfall structure to determine an expected loss for each tranche. The default correlation is measured using the **Diversity Score**. This is calculated using a methodology that takes into account how many of the assets are in the same industry and is intended to represent the number of independent assets that would have the same loss distribution as the actual portfolio of correlated assets. For example, a porfolio of 50 assets might have a diversity score of 30 meaning, that 50 correlated assets have the same loss distribution as 30 independent assets.

Moody’s uses a modelled approach to rate portfolio trades based on the concept of a diversity score.

The output of the model is an expected loss for the portfolio tranche being rated. This must be less than the target expected loss that Moody’s specifies for the required rating. The actual pricing of a CDO tranche is then determined by examining where similarly rated CDO tranches trade in the secondary market.

Standard and Poor's does not use a Diversity Score approach. Instead, it sets concentration limits for the maximum number of obligors in the same industry. Typically, it is comfortable with an 8% concentration limit on a single industry. Default correlation is also taken into account implicitly by stressing the default probabilities of the assets in the portfolio. The portfolio loss distribution is computed using a multinomial probability distribution.

The market for CDO's is divided into three main classes: arbitrage CDOs, cash flow CLOs, and synthetic CLOs. We consider each of these types in turn.

5.6 Arbitrage CDOs

Arbitrage CDOs exploit relative value credit spread opportunities between sub-investment- and investment-grade assets.

Insurance companies, commercial banks, and money managers issue a CDO to leverage their high-yield portfolios. Its purpose is to exploit the differences in credit spreads between high-yield sub-investment-grade securities and less risky investment-grade securities. They are thus termed "arbitrage" CDO's. For money managers, these structures create a high return asset, create stable fee income, increase assets under management, and lock in funding for a 3- to 7-year term.

Arbitrage CDO's can have either cash flow or market value structures. With the former, the principal on tranches is repaid using cash generated from repayments on the underlying loans. The primary risk in cash flow CDO's is, therefore, to the default of the underlying collateral.

In market value CDOs, the principal is paid by selling the collateral. As a result, investors are exposed to the market value of the underlying collateral that must be marked to market weekly or bi-weekly. The debt ratings are, therefore, a function of price volatility, as well as the diversity and credit quality of collateral. Cash flow CDOs are more common than market value CDOs.

The composition of a typical arbitrage CDO contains 30-50 loans or securities. The credit of the pool in arbitrage CDOs tends to be lower quality than a balance sheet CDO, typically BB to B. Transaction sizes also tend to be smaller, e.g., $200 million-$1 billion, compared with $1-$5 billion for a balance sheet CDO.

5.7 Cash Flow CLOs

Cash flow CLOs are all about moving credit risk off the balance sheet of a bank for the purpose of regulatory capital reduction.

In general, the purpose of a cash flow CLO is to move a portfolio of loans off the balance sheet of a commercial bank. This is done in order to free up the regulatory and/or economic capital that the bank would otherwise be obliged to hold against these loans. This allows banks to use this capital to fund other higher-margin business, new product lines, or share repurchase plans. It furthermore transfers the credit risk of these loans to the investor, thereby reducing the bank's concentrations of credit risk.

For example, a bank has a loan book worth $500 million and is required to hold 8%, i.e., $40 million, as regulatory capital. By doing a CLO transaction, the bank sells 98% of its loan book, retaining an equity piece worth 2% of the $500 million. It is required to hold 100% of the equity piece, i.e., $10 million, for regulatory capital purposes. The bank has therefore reduced its regulatory capital charge from $40 million to $10 million, a saving of $30 million.

In general, these pools of loans are very large and consist of mostly commercial and industrial loans with short maturities, which are rated between BB and BBB.

Being of investment grade but usually trading with tight spreads, these loans are an inefficient use of regulatory capital. They are often revolving lines of credit where the members of the pool are anonymous, but investors are provided with a set of statistics about the distribution of credit quality to enable them to analyse the default and prepayment risks of the pool. Furthermore, banks have the ability to add or take away collateral from the pool as the loans repay.

Balance sheet CLOs tend to trade tighter to LIBOR than other CBOs/CLOs since the pools of assets tend to be better quality than arbitrage CDOs due to their shorter average average life and early amortization triggers.

Moving the loans off the balance sheet can be difficult: the bank may need to obtain permission from the borrower to transfer the ownership of its loans, and this can be expensive, time-consuming, and potentially harmful to customer relationships. For this reason, banks are increasingly turning to the synthetic CLO structure.

5.8 Synthetic CLOs

The synthetic CLO is also used to transfer the credit risk from the balance sheet of a bank. As in a cash flow CLO, the motivations are regulatory capital relief, freeing up capital to grow other businesses, and the reduction of credit risk. In the case of a synthetic CLO, this is achieved synthetically using a credit derivative. It therefore avoids the need to transfer the loans, which can be problematic. Instead, the bank retains the loans on balance sheet and uses a portfolio default swap structure to transfer out the credit risk to an SPV, which issues notes into the capital markets. Another factor in favor of the synthetic CLO is the flexibility of default swaps, which can be tailored to create the required risk-return profile for the bank.

Synthetic CLOs accomplish the same objective as cash flow CLOs, but do so using portfolio default swap technology.

5.8.1 Structuring and Pricing Aspects

One main objective has to be achieved when structuring a synthetic CLO: the protection provided by the portfolio default swap needs to be purchased by the bank in a way that satisfies the bank's regulator that the credit risk of the underlying loans has been removed from the bank and so is granted the desired reduction in regulatory capital.

The current market standard structure for a CLO is shown in Figure 37. The credit risk of the portfolio of loans held by the sponsoring bank is tranched up. The riskiest tranche, which may comprise up to 2%-3% of the first losses in the portfolio, is usually retained for reasons including the facts that its high risk may make it difficult to sell, the bank may also believe that it is best able to judge the risk due to its close relationship with the borrower, and investors in other tranches may require the bank to hold the first loss for reasons of moral hazard. Under bank regulatory capital rules, the first-loss tranche is classified as equity and incurs a one-for-one capital charge.

The second tranche assumes the credit risk of the portfolio usually starting after the first 2%-3% of losses with a maximum loss of about 10%. This risk is moved off the bank's balance sheet through the use of a portfolio default swap. The counterparty to this portfolio default swap is an SPV, which then transfers

The SPV is collateralised with AAA OECD government bonds and so the subordinate default swap obtains a 0% capital charge

this risk into the capital markets by issuing notes to the face value of the portfolio default swap. These notes can be tranched into several levels, with, for example, a AAA-rated senior and two mezzanine level notes, as shown in Figure 37. The proceeds from selling these notes and used to borrow AAA-rated OECD government securities from a repo counterparty. Because of the high credit quality of this collateral and the fact that it is OECD government issued with a 0% BIS risk-weight (see Section 6.2), the counterparty risk in the portfolio default swap is negligible and, subject to the regulator's approval, may obtain a 0% percent risk-weighting.

The remaining credit risk of the portfolio is hedged throught the use of a second (senior) credit default swap with an OECD bank as the counterparty. This portion obtains a 20% risk-weighting. As shown in Figure 38, the total regulatory capital charge falls from 8% of the portfolio notional to 3.4%. Given that these trades typically have a notional of $3 billion-$5 billionn, this can be a substantial saving.

Figure 37. **Synthetic CLO Structure**

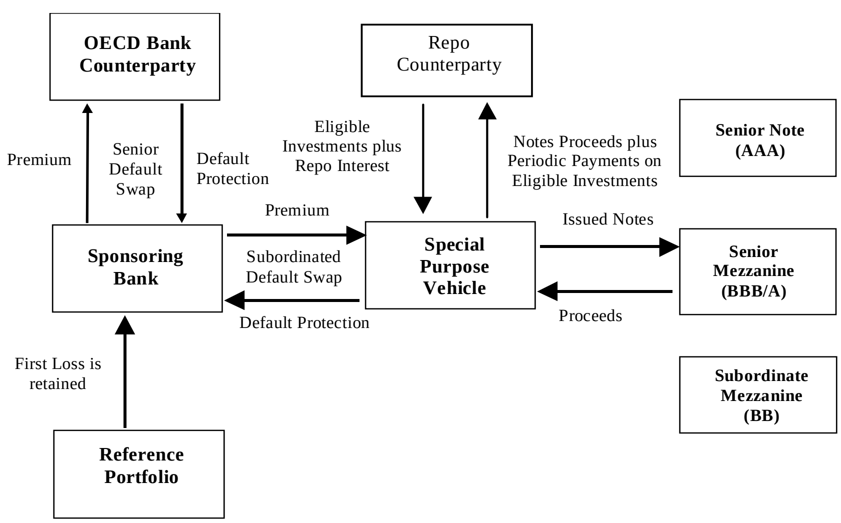


Figure 38. **Example Regulatory Charge for a Synthetic CLO**

Subordination Level	Tranche Rating	% of Pool	BIS Risk Weight	Capital Charge (% notional)
Super Senior	AAA	90%	20%	1.44%
Offered Notes	Ba2-AAA	8%	0%	0.00%
Equity	Not-Rated	2%	One-for-one	2.00%
			Total	**3.44%**

5.8.2 Discussion

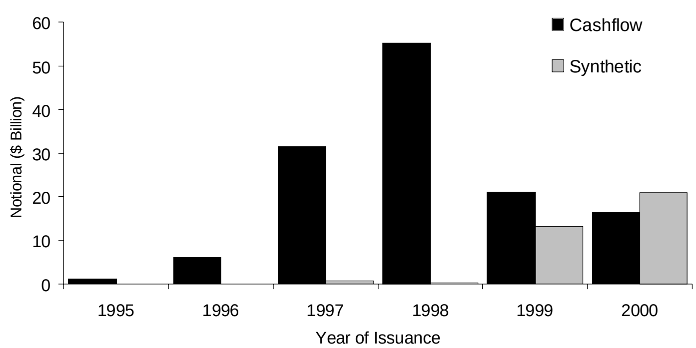
Use of the synthetic CLO structure has grown substantially over the past two years, as shown by the issuance numbers in Figure 39. As a synthetic CLO only requires about 10% of the balance sheet to be securitized, the notional of the issued securities is much less than the size of the collateral pool for which regulatory capital has been obtained. Despite this, we see that by 1999, the synthetic CLO actually accounted for a larger issuance notional than the cash flow CLO. This testifies to the dominance of the synthetic CLO as the preferred choice for balance sheet CLOs.

To summarize, the main advantage of using a synthetic structure is that the bank is not required to transfer each loan into the SPV. Such a transfer is often difficult from a legal and relationship perpective. It also enables the bank to fund the assets more cheaply on balance sheet than by issuing a cash flow CLO.

The synthetic CLO has become the preferred choice for balance sheet CLOs

In conclusion, synthetic CLOs are a huge growth area and a perfect example of what is now possible using the credit derivative technology developed over the past few years. We expect to see continued usage of this structure by banks though we expect that the economics of these trades may not be quite as appealing once the new Basel Capital Accord comes into action. The Basel Capital Accord is discussed in Section 7.

Figure 39. **Issuance Volumes of Bank Balance Sheet CLOs, 1995-2000, Showing Cash Flow and Synthetic Transactions Separately.**



Sources: Moody's Investors Service, Lehman Brothers.

6. LEGAL, REGULATORY, AND ACCOUNTING ISSUES

6.1 Legal Documentation

In recent years, one of the main problems hindering the growth of the default swap market has been the lack of standard documentation containing clear and legally watertight definitions. This problem was first addressed in 1998 by the International Swaps and Derivatives Association (ISDA) which issued a standardized Long Form Confirmation that made it possible to trade default swaps within the framework of the ISDA Master Agreement.

In recent years, default swap documentation has been standardised and simplified by ISDA.

More recently, and partly in response to many of the documentation problems highlighted by the Russian crisis of August 1998, ISDA has published updated credit swap documentation that aims to standardize definitions. Until then, much of the default swap documentation had been developed in-house, resulting in differences that led to concerns in the market about legal basis risk. Legal basis risk is that the definitions or legal structure used in the purchase of protection differ from one's hedge, leaving one exposed to legal risk.

The new definitions, introduced by ISDA in July 1999, are widely seen as an important step forward in the elimination of legal basis risk and the standardization of default swap documentation. By standardising the documents, it has reduced the requirement for expensive legal expertise, so it has opened the credit derivatives market to a wider range of participants.

At the same time, ISDA published a short-form confirmation that is only five pages, compared with the previous 15-page confirmation document. This new confirmation employs a "tick-the-box" approach, and this has considerably simplified and speeded up the whole confirmation process.

6.1.1 What Triggers the Default Swap?

The default swap is triggered by a **Credit Event**. The ISDA definitions provide for six credit events that are usually defined in relation to a reference entity. Typically, only four or five will be used, depending on whether the reference credit is a corporate or sovereign. They are shown in Figure 40.

6.1.2 What is an Obligation?

There are currently six ISDA specified credit events which trigger a default swap.

The obligation used in the definition of a credit event needs itself to be defined. In order to get evidence of a credit event as it relates to an obligation, we need to specify the different categories of obligation. There are six possible categories: bond, bond or loan, borrowed money, loan, payment, and reference obligations only. Most trades will specify the obligations using bond, bond or loan, or borrowed money. A further eight obligation characteristics, listed in Figure 41, are used to refine the nature of the obligation.

The obligations must be clearly defined using the list of characteristics

6.1.3 Deliverable Obligations

Following a credit event of a physically settled default swap, the protection buyer has to deliver the deliverable obligations to the protection seller. In order to specify

Figure 40. **A List of the ISDA Specified Credit Events**

Credit Event	Description
Bankruptcy	Corporate becomes insolvent or is unable to pay its debts. The bankruptcy event is, of course, not relevant for sovereign issuers.
Failure to Pay	Failure of the reference entity to make due payments greater than the specified payment requirement (typically $1 million), taking into account some grace period to prevent accidental triggering due to administrative error. A grace period may be specified, which may extend the maturity of the default swap if there is a potential failure to pay.
Obligation Acceleration/ Obligation Default	Obligations have become due and payable earlier than they would have been due to default or similar condition, or obligations have become capable of being defined due and payable earlier than they would have been due to default or similar condition. This latter alternative is the more encompassing definition and so is preferred by the protection buyer. The aggregate amount of obligations must be greater than the default requirement (typically $10 million).
Repudiation/Moratorium	A reference entity or government authority rejects or challenges the validity of the obligations.
Restructuring	Changes in the debt obligations of the reference creditor but excluding those that are not associated with credit deterioration, such as a renegotiation of more favorable terms.

Figure 41. **A List of the ISDA Obligation Characteristics**

Characteristics	Meaning	Comment
Pari Passu Ranking	Pari passu means senior unsecured if no reference obligation is specified. It means at least as senior as the reference obligation if it is defined.	Expected to be used widely.
Specified Currencies	The credit event has to occur on obligations denominated in the specified currency.	Also expected to be widely used. The default is G7 & Euro unless otherwise specified.
Not Sovereign Lender	The obligation is not a loan from another sovereign.	Applies to sovereign reference entities.
Not Domestic Issuance	The obligation is not issued in the domestic market.	Used for emerging market credits.
Not Domestic Law	The legal framework used for the obligation is not that of the issuing country.	Used for emerging market credits.
Not Contingent	There are no issuer options or other contingencies in the obligation	Used to exclude structured notes and zero coupon bonds.Convertible bonds are not considered to be contingent since the investor has the conversion option.
Listed	Refers to whether or not obligation must be listed on a recognised exchange	Likely to be used for European corporates and some sovereigns.
Not Domestic Currency	Requires that obligations are not denominated in the domestic currency	Used to cover Eurobond issues.

what these are, we use many of the same types of categories and characteristics as were used for obligations. However, there are some additional characteristics that are specific to the deliverable obligations. These additional characteristics are listed in Figure 42.

6.1.4 Current Market Standards

The legal definitions for default swaps are rapidly evolving toward a standard. In Figures 43 and 44, we set out what these are for sovereign credits and for corporate/bank credits. **Investor should be warned that while these standards are evolving, they should keep abreast of the latest developments by contacting us**.

6.1.6 The Settlement Process

Once a credit event has occured, either one or other or both parties to the default swap must send a Credit Event Notice to the other. This can be sent up to 14 calendar days after the scheduled termination of the default swap, provided the credit event happened prior to the scheduled termination date.

If the credit event happens just before the scheduled termination date (maturity) then this can be 14 days after the grace period extension period if a grace period is applicable. If a bond fails to pay a coupon, it is not technically a failure to pay until a grace period is up during which no coupon payment is made. This grace period is typically 30 days. A grace period extension prolongs the life of the transaction to enable the protection buyer to confirm whether a failure to pay has really occurred.

Notice must usually also be given of Publicly Available Information; i.e., public reports of a credit event must have occurred in certain specified news sources. What happens next depends on whether the default swap is to be cash or physically settled.

Figure 42. **Additional Characteristics for Deliverable Obligations**

Additional Characteristics	**Comment**
Assignable Loans Consent Required Loan Direct Loan Participation Indirect Loan Participation	These are used to specify the type of loan or interest in a loan that is delivered.
Maximum Maturity	Used to specify the maturity of the deliverable obligation.
Accelerated or Matured	
Transferable	Specify whether the deliverable obligation is freely transferable.
Not bearer	Can be used to eliminate illiquid bearer securities. Note that if a security settles through a major clearing system then it will be considered not-bearer even if it is, e.g., Eurobonds.

Figure 43. **Current Market Standard Definitions Used for Sovereign Credits**

Obligation Categories
Bond (Bond or Loan)

Obligation Characteristics
Pari Passu
Not Domestic Issuance
Not Domestic Law
Not Domestic Currency
Not Sovereign lender

Deliverable Obligation Categories
Bond (Bond or Loan)

Deliverable Obligation Characteristics
Pari Passu
Standard Specified Currency
Not Contingent
Not Bearer
Transferable
Maximum Maturity (10 or 30 years)
(Not Sovereign Lender)
(Assignable Loan)
(Consent Required Loan)

Figure 44. **Current Market Standard Definitions for Corporate/Bank Names**

Obligation Categories
Borrowed Money

Obligation Characteristics
None

Deliverable Obligation Categories
Bond or Loan

Deliverable Obligation Characteristics
Pari Passu
Standard Specified Currency
Not Contingent
Not Bearer
Transferable
Maximum Maturity (30 years)
Assignable Loan
Consent Required Loan

6.1.7 Cash Settlement

The main task in the cash settlement process is to establish the final price of the reference obligation(s). Typically, a single valuation date is used. A valuation time of 11.00am is used, and the price used is the bid (though other choices are offer and mid-market).

The definitions require the calculation agent to obtain quotations from five dealers, and the final price is obtained by using the highest or averaging them after discarding the highest and lowest. For multiple deliverable obligations, the prices are blended.

The market is rapidly moving towards a standard set of definitions for a default swap

If two or more of the dealers are unable to quote, the definitions provide a fallback where weighted average quotations can be used. As many quotes from as many dealers as possible are obtained that aggregate to the total notional amount, with each quotation size exceeding $1 million. If no quotation is obtained from the calculation agent within 13 days of the original valuation date and the parties cannot obtain quotations within a further five days, then the quotation is zero.

Cash settlement is then made three days after the final price has been set.

6.1.8 Physical Settlement

Following the notification of the credit event, the protection buyer must determine what obligations will be delivered and send a Notice of Intended Physical Settlement to the protection seller. Typically, the obligations will then be delivered within the standard settlement period; e.g., if the Notice of Intended Physical Settlement is delivered on trade date, physical settlement occurs on T+3, i.e., three days after notification was given.

The amount of deliverable obligations delivered will be a principal amount equal to the notional amount of the trade (unless accrued interest is included, in which case fewer bonds would be delivered). Note that the delivered portfolio can contain different bonds provided they each satisfy the requirements for the deliverable obligations.

If the protection buyer fails to deliver the bonds within five business days after the original physical settlement date, then the default swap terminates without payment from the seller. The only exception to this is in the case that the failure to deliver the defaulted assets was due to an impossibility or illegality. A lack of liquidity is not an excuse. If impossibility or illegality prevents delivery for 30 days after the original physical settlement date, then the definitions allow for cash settlement based on the final price of the obligations that could not be delivered.

6.1.9 Discussion

As shown above, the market is moving toward standard terms for legal documentation, with sovereign and corporate/bank credits treated differently. There is widespread agreement that the publication of the ISDA 1999 definitions and short-form confirmation have led to an increased level of confidence regarding legal basis risk. The short-form confirm has also led to a streamlining of the confirmation process, adding to liquidity and making it easier for new participants to enter the market.

Nonetheless, a number of legal issues still remain outstanding. One of the main bones of contention at the moment is the definition of the restructuring event and whether it should be included in the list of credit events. The problem is that applying the restructuring event to loans can be problematic since loans are generally private, bilateral contracts. Clearly those using credit derivatives to assume credit risk would prefer to remove restructuring while those using credit derivatives to hedge would prefer to keep it. Recently, U.S. brokers removed restructuring from the standard list of credit events, although we now believe that it has been reintroduced by some and we expect ISDA to establish a consensus within the next few months. The inclusion of the restructuring event remains standard in both the European and Asian markets.

Another issue is the delivery time allowed for loans. While a 30-day settlement period is usually adequate for bonds, loans can take longer to settle, especially if the borrower refuses to approve the loan's reassignment, or some other obstacle prevents the loan from being transferred within 30 days. These issues are currently being examined by ISDA.

6.2 Bank Regulatory Capital Treatment

Most banks are required by legislation to hold capital against the various risk exposures held on their banking and trading book positions. The purpose of this is to ensure that the banking sector is sufficiently capitalized against any unexpected losses. As credit derivatives can be used both to assume and to mitigate credit risk, it is important for banks to know what the corresponding charges and offsets are. Since banks are such a significant player in the credit derivatives market, it is also important for other players to be aware of the regulations surrounding credit derivatives, as these can have a significant effect on the dynamics of the market.

Credit derivatives were not covered by the 1988 Capital Accord.

The regulatory capital framework for banks was first established by the July 1988 Basel Capital Accord produced by the Basel Committee on Banking Supervision. With some amendments, this is still the framework in use today. While universally recognised as a major step forward in the international regulation of banks, a number of weaknesses have been exposed. Furthermore, the 1988 Capital Accord predates the advent of the credit derivatives market and so does not take into account the new methods for mitigating and shorting credit risk which now exist. Work is currently in progress to produce a revised framework that will address these problems. At the end of this section, we discuss this new framework and how it may affect the credit derivatives markets if implemented in its current proposed form.

Currently, the BIS risk weights shown in Figure 45 underpin the calculation of the regulatory charge. The risk weightings are determined according to the type of reference entity and are then multiplied by 8% to determine the percentage of notional that contributes to the overall capital charge.

These risk weights are quite crude and can lead to results that are actually counter to their aim. For example, both Turkey and the U.S. are OECD members whose government debt is 0% risk-weighted. However, Turkey is viewed as a much riskier credit , with bond yields about several hundred basis points higher than the equivalent U.S. Treasury bond. Another weakness of the current risk weights

Figure 45. **The BIS Risk Weights**

Type of Reference Entity	BIS Risk Weight	Charge as % of Notional
OECD Government	0%	0.0%
OECD Bank	20%	1.6%
Other	100%	8.0%

is that all corporate debt, irrespective of its credit quality, has a 100% risk weight. This has resulted in banks with large holdings of high-quality, low-yielding corporate loans moving them off balance sheet using techniques such as cash flow or synthetic CLOs.

Treatments, where they exist, are specified by national regulators and so may vary from country to country.

The regulatory capital guidelines provided by the Basel Committee are used by regulators as the basic framework for local bank capital treatments. Within various countries, local legislation has generally enforced these as the minimum standard that regulators should adopt for banks within their jurisdictions. For credit derivatives, which were not covered in the original accord, the local regulator usually has discretion to define the precise treatment, which should, where possible, be consistent with the Basel Accord. Despite this, differences have emerged in the credit derivative treatments between different regulators, and we examine these below.

The 1988 Capital Accord distinguishes between assets held on the **banking book** and assets held on the **trading book**. The former relate mainly to loans held by banks as part of their lending operations and that are usually held for extended periods of time. Assets held on the trading book are generally more liquid bonds and loans that are held for shorter periods of time as part of the market making and brokerage business of the bank. There is usually a requirement to mark-to-market the trading book daily.

6.2.1 Banking Book Treatment

In the following section, we have compiled the latest regulatory treatments as they apply to the banking book. **Whilst we have done our utmost to ensure the accuracy of the information, we stress that investors must verify the precise treatment with their regulator before acting upon this information.** What they all have in common is the treatment of a short protection credit default swap as an (artificial) position in the reference asset, in which case BIS risk weights, shown in Figure 45, apply.

6.2.1 Default Swaps

A number of countries have issued guidance on the use of default swaps. For a banking book position, the assumption of credit risk via a sale of protection using a default swap is commonly treated as a direct credit substitute, i.e., we apply the same treatment as if we were long the reference asset. For corporates, this is to take 100% of the notional, which is then weighted at 8%.

For a protection buyer who is seeking to hedge a cash position, capital relief is usually granted provided it can be demonstrated that the credit risk of the reference asset has been transferred to the protection seller. The exact form of the capital relief is to allow the hedger to reduce the risk weighting from that of the reference credit to that of the counterparty protection seller. If the reference asset is a corporate and the protection seller is an OECD bank, this means that the risk-weight falls from 100% to 20% and the size of the regulatory capital charge falls from 8% of the notional to 1.6%.

This is still a high charge since it implies that the protection buyer is now exposed to the default of an asset with the credit quality of an OECD bank. However this is not true: the protection buyer is exposed to the **joint event** in which the reference asset and the OECD bank both default, which is a much less likely occurrence. Equally, this treatment means that a bank will gain no benefit from buying protection from a corporate even if its credit quality is higher than that of an OECD bank.

Most regulators allow the use of credit derivatives to mitigate credit risk and so reduce regulatory capital.

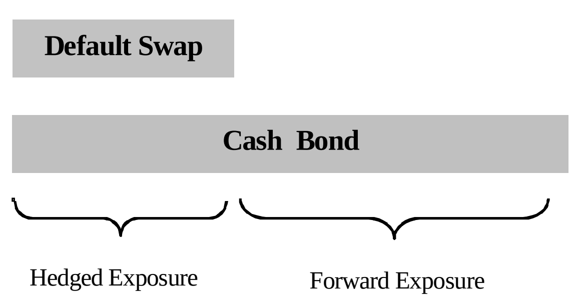
The treatment for funded default swaps (as credit-linked notes or SPV issued notes) is the same for the protection seller as being long the reference credit in cash format. Where the funded default swap is used to buy protection, the risk weighting of the reference asset is substituted by that of the collateral to the default swap.

The regulatory capital charge is always proportional to the maximum loss. So for a fixed recovery default swap, the capital charge is linked not to the notional, but to the maximum loss, i.e., (100%-R) times the notional, where R is the fixed percentage recovery.

The capital charge is typically proportional to the maximum loss.

Some regulators recognize that the credit risk of an asset is reduced even when the maturity of the default swap is shorter than that of the asset. This creates a forward credit exposure as shown in Figure 46. A lower risk weight is usually imposed for hedged term equal to that of the protection seller, with a second risk-weighting used for the unhedged forward exposure. The exact treatment varies from country to country, and, where available, we detail the treatment in Figure 47.

Figure 46. **Cash Bond Hedged with a Shorter-Maturity Default Swap**



6.2.2 Total Return Swaps

Most of the countries that have issued guidance specifically address the total return swap (TRS). Subject to certain conditions, all treat a purchase of protection achieved through being the payer in a TRS as a guarantee in which the risk-weight of the asset is replaced with that of the total return receiver.

This is equivalent to the treatment for a default swap protection buyer. The receiver in a TRS has to treat the position as a direct credit substitute, i.e., equivalent to actually holding the reference asset on balance sheet.

Where the maturity of the TRS is shorter than the maturity of the asset being held, there is a forward credit exposure. Details of how this is treated vary with the various treatments described in Figure 47.

6.2.3 Basket Default Swaps

For baskets, the charge varies between that of the highest risk-weighted asset and the sum of the risk-weights

Basket default swaps are treated differently by different regulators. For the protection seller, the capital charge can be between that of the highest risk-weighted asset in the basket and the capital charge of all of the assets in the basket subject to some maximum.

For the protection buyer, the basket provides a partial hedge to a portfolio of the assets and so should achieve a partial offset. The precise details are given in Figure 47.

6.2.4 Trading Book Treatment

In the trading book, the capital requirement for credit derivatives is split across a Position Risk Requirement (PRR) and a Counterparty Risk Requirement (CRR). The size of the PRR is supposed to reflect the amount of interest rate and credit risk in the position. The CRR is designed to reflect the amount of counterparty risk in a derivative position and so is a function of the credit quality of the counterparty and the size of the counterparty exposure.

Since the introduction of the second Capital Adequacy Directive in 1996, EU banks have been allowed to use an approved value-at-risk (VaR) model to calculate the PRR. The nature of the VaR approach means that it takes into account the diversification effects of imperfectly correlated assets and so may result in a lower capital requirement than implied under the banking book rules.

It is expected that a new capital adequacy framework will be in place sometime in 2004

For those without an approved VaR model, the standard trading book treatment is similar to that for the banking book. For a cash position hedged with a default swap, the precise treatment depends upon the regulating body for the entity into which the trade is booked. Regulators have in general tended to be conservative regarding offsets, only allowing them for positions hedged with no asset mismatch; i.e., the triggering credit event for the default swap must be identical in terms of issuer and seniority to the asset being hedged. In some cases, regulators will allow no offset where the maturity of the hedge is shorter than that of the asset being hedged. In other cases, a partial offset may be permitted. Investors must check the exact treatment with their own regulators.

Figure 47. **Summary of Banking Book Capital Treatment of Maturity Mismatches and First-to-Default Baskets. Banks Must Confirm Treatments with Their Own Regulator.**

	Regulator	Maturity Mismatch	Baskets
USA	Federal Reserve Board (August 1996/June 1997)	Case by case treatment by examiners. If protection is for a long maturity then an offset may be possible.	If all of underlying assets are held, protection buyer can replace risk-weight of asset with smallest dollar amount to the risk category of guarantor (e.g. 20% for OECD bank). Protection seller must hold capital against highest risk-weighted asset.
UK	Financial Services Authority (July 1998)	Hedged portion has risk-weight of counterparty. Forward exposure achieves 50% of risk-weight of asset.	Protection buyer can select asset that achieves preferential treatment. For protection seller the regulatory capital is the sum of the charge on the individual assets. This may be reduced if it can be demonstrated that there is a high default correlation between the assets.
Germany	Bundesaufsichtsamt fur das Kreditwesen (BaKred) (October 1999)	20% risk weight on hedged exposure plus 50% of risk weight on forward exposure provided residual maturity of protection > 1 year	Not addressed.
France	Commission Bancaire (1998)	20% risk weight on hedged exposure plus 50% of the risk weight of reference asset on the forward credit exposure	Same as UK
Italy	Banca D'Italia (June 2000)	20% risk-weight on hedged exposure plus 20% on forward exposure	Protection seller incurs charge of highest risk-weighted asset in basket
Ireland	Central Bank of Ireland (**Draft** July 2000)	If residual maturity > 1 year protection is recognised. Future credit exposure receives a 50% credit conversion factor against the risk weight of the underlying asset.	For a protection seller the capital should be held against each of the assets in the basket. The sum of the capital held against each asset in the basket would be capped at the maximum payout under the basket.
Canada	Office of the Superintendent of Financial Institutions (Oct 1997/Nov 1999)	20% for hedged period and a credit risk factor of 50% of risk weight for residual maturity > 1 year. If forward exposure starts >3 years from today, no capital charge is incurred.	Protection buyer obtains relief on smallest dollar notional, lowest risk-weighted asset. Protection seller must hold capital against asset with highest risk-weight
Sweden	Finansinspektionen - The Swedish Financial Supervisory Authority (June 2000)	A forward unhedged credit exposure is treated as an off-balance sheet liability and is assigned a conversion factor of 50%.	Protection buyer is deemed to hold a short position in the asset in the basket with the highest risk charge. Protection seller - sum of all the charges of all the assets in the basket, subject to a limit equal to the maximum payout on the contract if there is a credit event.
Austrialia	Australian Prudential Regulation Authority (April 2000)	Provided the credit protection has a residual maturity greater than 1 year, the reduction is proportional to the ratio of the maturity of the hedged period to the maturity of the credit e.g. 9 years protection on 10 year asset requires a charge of 90% of risk weight of protection seller and 10% of risk weight of underlying asset	Protection buyer is hedged against asset of choice. For a protection seller the capital charge is the sum of capital charges on all of the assets in the basket subject to a maximum equal to the maximum payout on the contract

Web-based sources on regulatory capital treatments:

For US guidelines see http://www.federalreserve.gov/boarddocs/SRLETTERS/1997/SR9718.HTM
For German Guidelines see http://www.bakred.de
For Canadian guidelines see http://www.osfi-bsif.gc.ca/eng/publications/guidelinesandbulletins/pdf/99-11-05.pdf
For Australian guidelines see http://www.apra.gov.au/mediareleases/00_08c1.pdf
For Swedish guidelines see http://www.fi.se/finansinsp/

The Counterparty Risk Requirement is determined by taking the Credit Equivalent Amount (CRA) and weighting it by the BIS risk weighting of the counterparty. The CRA is determined by taking the positive mark-to-market value of the default swap and adding on a percentage of the notional amount (the potential future exposure). This percentage can be a function of the maturity and credit quality of the underlying asset. It varies between regulator.

6.2.5 Changing the Capital Adequacy Framework

The Basel Committee on Banking Supervision is currently working on a major revision of the 1988 Capital Accord. In January 2001, it released a proposed framework for consultation, the aim being to increase the alignment between economic risk and the required amount of regulatory capital. This New Accord, also known as Basel 2, is open for consultation until May 31, 2001. Following revisions, it is expected to come into force sometime in 2004.

The new capital adequacy framework will be based on the use of either external or internal ratings.

In the New Accord, the committee suggest three new methods for computing the capital charge. The simplest, known as the **Standard,** treatment proposes replacing the current risk weights shown in Figure 45 with new risk weights linked to external credit ratings. These are shown in Figure 48. Banks that satisfy certain requirements will be allowed to use an **Internal Ratings Based (IRB)** approach that will allow the bank to use its own internal ratings methodology. It is believed that this approach will result in a reduction in overall regulatory capital. The IRB approach is itself split into two: a foundation approach and an advanced approach. The advanced approach gives the bank more discretion in its modelling assumptions. However, the hurdle in terms of systems and model requirements is higher.

It is clear that the standard treatment would go some way to correct the situation in which low-rated OECD sovereigns such as Turkey, Mexico, and Poland obtain the same treatment as high-rated sovereigns such as the U.S. AA and AAA-rated corporates become 20% risk weighted just as OECD banks. Sub-investment-grade credits would incur risk weights in excess of 100%. However, rather than penalize issuers whose debt has not been rated, all unrated assets would gain a 100% risk-weight.

A number of problems with using external ratings have been raised. The main problem is that far fewer issuers are rated outside the U.S. than within. For example, 47% of the corporates included in the German DAX30 index are rated, compared with 94% of the corporates in the S&P100 index. Another problem is that ratings are not an absolute measure of credit risk—in some cases, AAA represents the highest quality credit in a particular country. This has been one of the reasons that has led the Basel committee to consider an internal ratings approach.

There will be a stronger link between regulatory capital and economic capital.

In addition to significantly overhauling the current framework and adding more granularity, these proposals, if implemented, will create a greater need for the transference of low-quality credit exposures out of the banking sector and a desire for higher credit quality assets. This should increase the demand for the risk mitigation abilities of credit derivatives, either on a single name basis or in a portfolio form using the synthetic CLO structure.

6.2.9 Credit Derivatives in the New Accord

The proposed New Accord permits the reduction of credit risk by means that include the use of collateral, credit derivatives, guarantees, or netting agreements. The framework for recognizing these credit risk mitigation techniques is consistent across both the standardised approach and the foundation IRB approach.

For credit derivatives as a tool for credit risk mitigation, the new capital accord allows the substitution of the risk weighting of the counterparty with whom the hedging credit derivative has been transacted. The risk weight is calculated using the formula:

$$r^* = w \times r + (1-w) \times g$$

Credit derivatives are handled within the new accord, with explicit treatments for credit risk mitigation.

where r^* is the effective risk-weight, r is the risk weight of the obligor, w is the weight applied to the underlying exposure, and g is the risk weight of the protection provider.

While it permits a value of w=0% for guarantees, for credit derivatives, the New Accord imposes a capital floor of w=15% even when the protection matches exactly the characteristics of the reference asset being hedged. For example, within the current approach, the purchase of default swap protection on an A-rated, 100% risk-weighted corporate from an OECD bank reduces the capital charge to 20%. In the newly proposed standardized approach, the A-rated asset will have a risk-weight of 50%. Purchasing protection from a AA-rated bank with a risk weighting of 20% gives a new capital charge of

$$r^{**} = 0.15 \times 50\% + (100\%-15\%) \times 20\% = 24.5\%$$

which is higher than that under the current accord. There is concern that this could adversely affect liquidity in the default swap market. It should be noted that these proposals are currently open for consultation and may be amended in the final document.

Maturity mismatches are explicitly covered by the New Accord with hedges of a shorter maturity than the underlying exposure being recognized, provided they have a maturity of one year or more. A simple scheme is provided which interpo-

Figure 48. **Proposed Basel 2 Standardised Approach Risk Weights by Claim Type and Rating**

	AAA to AA-	A+ to A-	BBB+ to BBB-	BB+ to B-	Below B-	Unrated
Sovereigns	0%	20%	50%	100%	150%	100%
Banks Option 1[1]	20%	50%	100%	100%	150%	100%
Banks Option 2[2]	20%	50%	50%	100%	150%	50%
Corporates	20%	50%	100%	150%	150%	100%

1 - Risk weighting based on risk weighting of sovereign in which bank is incorporated
2 - Risk weighting based on assessment of the individual bank
Option 1 or 2 is to be chosen by the national regulator.

lates as a function of the maturity of the protection between an unhedged risk-weight and the maturity matched risk weight. The risk weight is given by:

$$r^{**} = r \text{ when } t \text{ is less than 1 year.}$$

Otherwise,

$$r^{**} = (1-t/T) \times r + (t/T) \times r^{*}$$

where r^{**} is the risk weight of the maturity mismatched position, r is the risk weight of the unhedged position, r^{*} is the risk-weight of the hedged position with no maturity mismatch, t is the maturity of the hedge, and T is the (longer) maturity of the exposure. So using the A-rated corporate in the above example, assuming that T is 10 years and the protection has been purchased for the first three years, the risk weight for the combined position will be

$$r^{**} = (1-3/10) \times 50\% + (3/10) \times 24.5\% = 42.4\%$$

which is less than the current treatment would require. This would typically be 70%: a 20% charge for the hedged exposure and a 50% weighting of the 100% risk-weight for the forward exposure.

6.3 Accounting for Derivatives

FAS 133 and IAS 39 accounting standards require companies to mark to market derivatives.

Over the past decade or so, international accounting bodies have been looking to amend their rules to require more transparent reporting of derivatives exposures. The existing treatment was viewed by some as inconsistent and inadequate, as it left most derivatives exposures off balance sheet. The massive growth in usage of derivatives and some of the well-publicized derivative losses made the resolution of this issue a priority for accounting bodies.

In response, in June 1998, the U.S. accounting body the Financial Accounting Standards Board (FASB) issued Financial Accounting Standard 133, entitled *Accounting for Derivative Financial Instruments and Hedging Activities*. This new standard, known as **FAS 133**, applies to all companies which report under U.S. Generally Accepted Accounting Principles (GAAP) and went into effect on June 15, 2000. For calendar year companies, the “live” date was January 1, 2001.

Pursuing the same initiative, the London-based International Accounting Standards Committee (IASC) produced International Accounting Standard 39 (IAS 39) in December 1998. These apply to firms that report under IAS and went live on January 1, 2001.

The main thrust of these new accounting standards is to require companies to mark to market (fair-value) all free-standing derivatives contracts. In conjunction with this new requirement, the FASB redefined the concept of **hedge accounting**. The idea is that if a company can demonstrate that a derivative contract is being used to hedge a specific risk, then there is the opportunity either to postpone the derivative’s gain and loss from currently affecting the income statement

Hedge accounting can be used to offset the mark-to-market of hedged derivative transactions

or to recognize in income gains and losses on the underlying hedged item. Hedge accounting has two approaches, depending on whether the underlying risk is a fixed or a forecasted cash flow.

In the case in which the risk is to a fixed cash flow, such as a fixed-rate bond, the typical hedge is to use an interest rate swap to convert it into a floating rate risk. This is termed a **fair value hedge**. The mark-to-market of the derivative and the offsetting item for the risk being hedged are both booked to the income statement. For effective hedges, the mark-to-markets should more or less cancel, and the effect on earnings volatility should be minimal.

When the underlying risk is a forecasted cash flow such as a floating-rate note, a hedge may be used to swap this to known fixed rate cash flows. The hedge is referred to as a cash flow hedge, and the mark-to-market of the derivative is recorded to other comprehensive income (OCI) within shareholders' equity until cash flows on the hedged item change and are recorded in the income statement. The hedge gain or loss is then released from the OCI to the income statement so that the risk and the offsetting hedge affect the income statement in the same period.

Bifurcation requires the embedded derivative in certain cash instruments to be accounted for separately.

To comply with these new standards for hedge accounting, firms are required to designate and document all hedging transactions and monitor their compliance with FAS 133. All positions are subject to this treatment irrespective of when they were initiated—there is no grandfathering. The hedge must be expected to be highly effective in offsetting the risk exposure. The types of risk that qualify for hedge accounting are 1) the price risk of a fully hedged item, 2) interest rate risk, 3) credit risk, and 4) foreign currency risk.

Certain cash instruments with embedded derivatives are subject to bifurcation: the derivative component must be accounted for separately and marked to market through earnings. This can be avoided only if the embedded component would not be considered a derivative if it were freestanding, if the combined instrument is carried at fair value through earnings, or if it is "clearly and closely related to the host contract."

FAS 133 is a complicated standard and may be seen as an interim step in the process of introducing fair-value accounting for all financial instruments. To help clarify and resolve issues concerning FAS 133, the FASB formed the FAS 133 Derivatives Implementation Group (DIG). Following its work, a new standard, **FAS 138**, containing amendments to FAS 133, was released in June 2000.

6.3.1 Treatment for Credit Derivatives

The first question is to determine whether a credit derivative qualifies as a derivative that needs to be fair-valued under FAS 133 and IAS 39. In almost every case, the answer is yes. The only exception is where the default swap is likened to an insurance contract, where the loss is related to a failure to pay or bankruptcy event, and where the contract has written into it the requirement that the protec-

Credit derivatives qualify as derivatives which must be fair valued under FAS 133 and IAS 39.

tion buyer must be exposed to the loss on the reference asset at all times. All other credit derivatives, including default swaps, total return swaps, and spread options, are all derivatives under both FAS 133 and IAS 39 and so must be marked to market.

In June 2000, the FASB updated its position on hedge accounting for cross-currency interest rate swaps. It previously stated that currency risk on recognized assets and liabilties could not be hedged. In its updated statement, the FASB permits hedge accounting treatment for these risks. As an extension, both interest rate and currency risk may now be hedged when using a single cross currency swap. This is of importance to those hedging the currency and interest rate risk of a credit risky foreign asset.

Comments by the DIG addressing the issue of default swaps state that hedge accounting would be available only when the purchased default protection can be designated against an identifiable risk; i.e., the buyer of protection can identify a potential loss that the default swap is hedging. As the risk being hedged is the change in the fair-value of an instrument due to changes in the credit quality of a third party, then the hedge may qualify for fair value treatment.

Credit risk is the full price risk minus the interest rate risk.

A default swap used to hedge a fixed-rate bond is treated as a fair-value hedge. Credit spread options and forward asset swaps are used to hedge futures cash payments whose value depends on the change in credit quality of the reference asset and may also qualify for a fair-value hedge.

When accounting for a fixed-rate defaultable bond hedged with a default swap, we have to separate the interest rate and credit risk components. The credit risk component is defined as the full price risk minus the benchmark interest rate risk. To define the benchmark interest rate risk, we can use either the LIBOR swap curve or a government Treasury curve, provided the bond does not price off another index such as prime. When hedging risk with credit derivatives the former is the preferred since all credit derivatives are priced relative to the LIBOR curve.

Consider the case of a fixed-rate bond with ten years remaining to maturity and an annual coupon of 7% where the credit risk of the bond has been hedged with a 10-year default swap. At the end of the last accounting period, the price of the bond was priced at par, implying a yield to maturity of 7.0%, and the 10-year LIBOR yield was observed to be trading at 6.15%. At the end of this accounting period, the bond price is observed to be trading at a lower price of $97.32. The change in the bond price is -2.68 points. Over this period, the LIBOR yield has increased to 6.33%.

How, then, to apportion the change in mark-to-market to interest rate and credit components? If we examine the effect of the increase of the LIBOR yield while keeping the credit spread fixed, we see that the bond price falls to $98.76, a change of -1.24 points. The effect of the increase in the credit spread, therefore, has been to decrease the bond price by (-2.68)-(-1.24)=-1.44 points.

Meanwhile, the default swap position has changed in value. Assuming that the LIBOR default swap spread was 79 bp at trade initiation and is now 99 bp, the mark-to-market of the default swap position is given by (see Section 4.3.2)

MTM = (99-79) x 6.90 = +1.38 points

where 6.90 is the PV01 of the default swap calculated using a model of default and recovery. As a result, we see that the default swap hedges out almost all of the credit risk component of the fixed rate bond, leaving a small residual of about 6 cents, which is recorded in income as ineffectiveness. This small difference arises due to reasons that include the fact that the default swap mark-to-market also has an interest rate exposure. More importantly however, differences will also arise because the cash and default swap market do not follow eachother exactly—there may be dislocations as described in section 4.3.4. The interest rate component can be hedged out separately with an interest rate swap that can also be marked to market.

Hedge accounting requirements may bias companies towards simpler hedging strategies

For more complicated non-vanilla hedges, it may be more difficult to obtain a hedge accounting treatment, and this may hinder the use of more exotic credit derivative structures.

The other major issue is bifurcation. Convertible bonds as investments are one main candidate for bifurcation requiring that the equity call option be accounted for separately. For credit investors who purchase the credit component of the stripped convertible, there is no equity option, so bifurcation should not be an issue. Credit-linked notes with embedded credit derivatives would be subject to bifurcation. However, instruments with credit-sensitive payments embedded do not require bifurcation provided these payments are sensitive only to issuer credit risk. The DIG is still working on many of the details concerning these issues, and further updates are expected.

Looking forward, the Joint Working Group of regulators (JWG), representing accounting regulators from a number of countries including Germany, Japan, the U.K. and the U.S. has recently proposed removing all special accounting treatments for financial instruments. Their proposal removes the idea of hedge accounting and replaces it with the requirement that all financial instruments be marked to market with hedges being recognized naturally through their offsetting mark-to-markets.

7 GLOSSARY OF TERMS

Arbitrage CDO
A collateralized bond obligation that exploits spread differences between high-yield sub-investment grade bonds and less risky investment-grade securities. Can be either cash flow—coupons are paid from cash flows of the bonds—or market value—the principal is paid by selling the underlying bond assets.

Asset Swap
A combination of purchase of a fixed coupon asset and entry into an off-market interest rate swap that has the effect of transforming the asset into an almost pure credit play.

Asset Swap Spread
The spread over the LIBOR rate received by the asset swap buyer in an asset swap. It reflects the price and credit quality of the asset.

Basel Capital Accord
The framework of rules within which banks calculate their regulatory capital requirement. These rules where produced by the Basel Committee on Bank Supervision in 1988, known as the Basel Capital Accord. The current rules are under review and will be superceded by a new framework in 2004.

Cash Flow CLO
A collateralised loan obligation that is used by banks to obtain regulatory capital relief on a pool of loans held on balance sheet. The loans are moved off the balance sheet into an SPV, and the credit risk is transferred to the purchasers of the issued notes.

Credit Event
A legal definition that is used to characterise the nature of the event that triggers the payout on a credit derivative. It may include such events as bankruptcy, default, and restructuring.

Credit Spread Option
A derivative contract in which the option buyer has the right but not the obligation to enter into a credit spread position at a predetermined credit spread. The credit position may be a default swap, par floater, or an asset swap.

Collateralised Debt Obligation
A note whose cash flows are linked to the incidence of default in a pool of debt instruments is called a CDO. When the underlying collateral in a CDO is made up of bonds, it is called a Collateralised Bond Obligation (CBO). When the underlying collateral in a CDO is made up of loans, the CDO is usually called a Collateralised Loan Obligation (CLO).

Default Swap
A bilateral contract in which one party (the protection buyer) makes periodic payments to the protection seller. In return, the protection seller compensates the protection buyer for any loss on a par amount of a reference asset following a credit event.

Digital Default Swap
A bilateral contract in which one party (the protection buyer) makes periodic payments to the protection seller. In return, the protection seller compensates the protection buyer with a fixed payment following a credit event. It is also known as a fixed recovery or binary default swap.

Equity
The lowest (usually unrated) tranche of a portfolio trade, which is exposed to the first losses in the portfolio. Due to the high level of risk, the equity tranche is often retained by the sponsor and for banks, resulting in a one-for-one capital charge.

FAS 133
The new U.S. accounting framework for all financial derivatives, which came into effect in June 2000. It requires companies to mark to market their derivative positions and to post gains or losses to earnings.

First-to-Default Basket
A bilateral contract in which one party (the protection buyer) makes periodic payments to the protection seller. In return, the protection seller compensates the protection buyer for any loss on a par amount of the first asset in a group of assets to default. It is also possible to trade second, third, etc..., to-default baskets.

Fixed Recovery Default Swap
See digital default swap.

Floating-Rate Note
A bond that makes periodic coupon payments linked to a variable interest rate index. Typically, the bond pays an additional "spread" that is intended to bring the price of the bond to (or close to) par on the issue date of the bond. It can be shown that this "par floater spread" reflects the credit quality of the note issuer.

IAS 39
International Accounting Standard 39, the new European accounting framework. Like FAS 133, it requires companies to report and mark to market their derivative exposures, with the results being posted to company earnings.

Index Swap
A bilateral contract in which one party pays to the other the return on a specified index usually representing a large universe of bonds.

Interest Rate Swap
A bilateral derivative contract involving the exchange of fixed-rate payments for floating rate payments typically linked to the LIBOR interest rate index. Typically used to hedge interest rate risk.

LIBOR
The London Inter-Bank Offered Rate. This is an interest rate at which highly rated (typically AA-rated) banks can borrow. It is calculated by polling 16 banks daily (through their London branches) to determine the rate at which they can borrow for various terms and in various currencies. For each term and currency, the received rates are ranked in ascending order, the top and bottom four are rejected, and an average of the remaining eight is taken.

Mezzanine
The intermediate tranche of a portfolio trade that is protected from losses by having a subordinate equity piece below it.

Portfolio Default Swap
A default swap that hedges some portion of the credit risk of a portfolio of credits, typically consisting of 40-100 names. The credit risk is tranched up and sold to investors. Each tranche is exposed to losses on the portfolio between two bands. For example, a senior tranche may be exposed to all of the losses occurring between 20%-100% of the portfolio. A riskier mezzanine tranche may be exposed to the losses in the portfolio beginning at 5% of the portfolio and ending at 20%. The riskiest equity tranche is the exposed to the first loss, say the first 5%.

Principal Protected Note
A security that guarantees to return all of the investor's principal at maturity. This feature is often attached to credit-linked notes where the spread paid by the asset is very high and the investor wishes to protect his/her downside. For a credit-linked note, the cost of the protection is usually a loss or reduction in the coupon on the note following the credit event. The only principal exposure that the investor has is to the issuer of the note.

Synthetic CLO
Similar to a cash flow CLO except that the loans are not moved into an SPV. Instead, the credit risk is transferred by the sponsoring bank purchasing credit protection on the underlying collateral using a **portfolio default swap**.

Total Return Swap
A bilateral contract in which the total return receiver gets all of the benefits of owning an asset without actually holding the physical asset on balance sheet.

8 APPENDIX

8.1 Pricing a Floating-Rate Note

The full price of a floating-rate note on a coupon date is given by discounting the implied future coupons using the issuer discount curve as follows

$$P = \sum_{i=1}^{N} \left(L(i-1,i) + S \right) df(0,i) + df(0,N) \qquad \text{(Eqn 1)}$$

where *df(0,1)* is the issuer discount factor from today to the next coupon payment date, *df(0,i)* is the issuer discount factor from today to the subsequent coupon dates *i*, and *L(i-1,i)* represents the forward LIBOR rate, which sets at time *i-1* and pays at time *i*. For simplicity, we have assumed that the bond pays coupons annually.

If at time *t* the issuer has a *T*-maturity par floater spread of *F*, then the discount factors are given by the following iterative scheme

$$df(0,i) = \frac{df(0,i-1)}{1 + L(i-1,i) + F} \text{ where } df(0,0) = 1 \qquad \text{(Eqn 2)}$$

Clearly, *F* is a measure of the credit quality of the issuer since it is the fixed spread to LIBOR used to discount all cash flows. Note also that *F* changes over time as the credit quality of the issuer changes.

If we substitute $F=S$ into equations 1 and 2, then we find that P=100%; i.e., if the par floater spread, *F*, equals the fixed spread, *S*, on a coupon date, the floating rate note prices at par.

8.2 Calculating the Discount margin

The discount margin, *d*, is defined by the following relationship

$$P = \frac{\left[(L^{NEXT} + q) + \sum_{i=1}^{N} \frac{L+q}{(1+L+d)^i} + \frac{1}{(1+L+d)^N} \right]}{(1+L^* + d)}$$

where for simplicity we have ignored day count fractions and assumed that coupon dates are annual. The symbols are:

$P =$ full bond price
$L^* =$ stub LIBOR coupon to next coupon date
$L =$ current LIBOR fixing

L^{NEXT} = the next LIBOR payment (which was fixed on previous coupon date)
d = discount margin for which we solve
q = quoted margin

This calculation assumes that all future LIBOR cash flows are equal to the previous fixing. As a result, no account is taken of the shape of the LIBOR forward curve as in the par floater calculation.

The discount margin is similar to a par floater spread; in fact, it is numerically equivalent when the FRN is priced at par, which is certainly the case when the bond is issued. At other prices, the two measures differ since, as we have seen, they use a different method for implying the value of the future coupons. Also by convention, the fixed spread over LIBOR paid by a floating rate note is also called the quoted margin. If $q=d$ and we are on a coupon refix date, the price of the bond equals par. Just as with a standard yield-to-maturity calculation on a fixed coupon bond, the discount margin must be solved for using some root-finding method (e.g., Newton-Raphson).

8.3 Calculating the Asset Swap Spread

From the perspective of the asset swap sellers, they sell the bond for par plus accrued interest. The net up front payment, therefore, has a value of *100-P*, where *P* is the full price of the bond in the market. If we assume that both parties to the swap are of AA-bank or similar credit quality, these cash flows are priced off the LIBOR curve. We net off the principal payments of par at maturity. For simplicity, we assume that all payments are annual and are made on the same dates.

The breakeven asset swap spread *A* is computed by setting the net present value of all cash flows equal to zero. From the perspective of the asset swap seller, the present value is:

$$\underbrace{1-P}_{\text{Upfront payment to purchase asset in return for Par}} + \underbrace{\underbrace{C\sum_{i=1}^{N_{FIXED}} df(0,i)}_{\text{Fixed payments}} - \underbrace{\sum_{i=1}^{N_{FLOAT}} \Delta_i (L(i-1,i)+A) df(0,i)}_{\text{Floating payments}}}_{\text{Interest Rate Swap}} = 0$$

where C equals the annually paid coupon, $L(i-1,i)$ is the LIBOR rate set at the time of cash flow $i-1$ and paid at the time of cashflow i, and Δ_i is the accrual factor in the corresponding basis. The fixed and floating sides may have different frequencies. We solve for the asset swap spread A. This uses the result that a LIBOR flat floater priced off the LIBOR curve reprices to par:

$$1 = \sum_{i=1}^{N} \Delta_i L(i-1,i) df(0,i) + df(0,N),$$

to arrive at the result

$$A = \frac{P^{LIBOR} - P^{MKT}}{PV01},$$

where

$$P^{LIBOR} = c\sum_{i=1}^{N} df(0,i) + df(0,N)$$

is the price of the fixed rate bond priced off the LIBOR curve, and

$$PV01 = \sum_{i=1}^{N} \Delta_i df(0,i)$$

is the present value of 1 basis point paid on the floating side of the asset swap, priced off the LIBOR curve.

8.4 Calculating the Option-Adjusted/Zero-Volatility Spread

The OAS (or ZVS) is the continuously compounded constant spread to the LIBOR zero curve required to reprice a bond. If we denote the OAS by Θ, then we have:

$$P = C\sum_{i=1}^{N} df(0,i)\exp(-\Theta \cdot t_i) + df(0,N)\exp(-\Theta \cdot t_N)$$

where *df(0,i)* is the LIBOR discount factor from today to coupon payment date *i*. We solve for Θ using a root finding algorithm (e.g., Newton-Raphson).

9. BIBLIOGRAPHY

Related Lehman publications in reverse chronological order:

Modelling Credit: Theory and Practice, Lehman Brothers, February 2001, Dominic O'Kane and Lutz Schloegl

CDO Yearbook 2000, Lehman Brothers, January 15, 2001, Sunita Ganapati and Philip Ha

Introduction to Default Swaps, Lehman Brothers, January 2000, Dominic O'Kane

Introduction to Asset Swaps, Lehman Brothers, January 2000, Dominic O'Kane

Structured Credit Strategies: Credit Derivatives, Lehman Brothers, August 2000, February 2000, October 1999, Various Authors

New Opportunities in Cash Flow ABS CDOs, Lehman Brothers, May 2000, Alex Reyfman

Synthetic CLOs: A Product Description, ABS Quarterly, Lehman Brothers, April 1999, Sunita Ganapati

CLOs and Credit Derivatives: February 1999, Lehman Brothers, John Hunt, Mike Baek, and Mike Szymanski

Collateralized Debt Obligations: Market, Structure and Value, Lehman Brothers, June 1998, Sunita Ganapati and Alex Reyfman

Credit Derivatives, Lehman Brothers, May 1998, John Hunt, Michael Szymanski, Michael Baek, and Ren-Raw Chen

Publications—L. Pindyck, A. DiTizio, B. Davenport, W. Lee, D. Kramer, S. Bryant, J. Threadgill, R. Madison, A. Acevedo

Lehman Brothers
Structured Credit Trading

New York
Jim Ballentine
Phone: 212-526 -6570
Fax: 212 526 -1546
jballent@lehman.com

Tokyo
Brent Eastburg
Phone: 81-3-5571-7257
Fax: 81-3-5571-7920
eastburg@lehman.com

Europe
Mark Ames
Phone: 44-(0)-20-7260-2733
Fax: 44-(0)-20-7260-2201
mames@lehman.com

Latin America
Mohammed Grimeh
Phone: 212-526-9365
Fax: 212-526-6016
mgrimeh@lehman.com