CREDIT 101

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Credit 101

Broadly speaking a trading floor can be thought of as being composed of desks that focus on either equity, FX, rates, commodities, or credit.

Credit is one of the broadest categories as what we mean by credit is essentially any form of debt instrument not issued by a government (or guaranteed by the government in some way, as is the case for many MBS products).

The major forms of credit-based products traded on a floor will be investment grade debt, high yield debt, distressed debt, and CLOs. Each of these areas will have their own desk. Further, you'll often have a few "cross-market" desks that will deal with more esoteric forms of credit that don't neatly fit into any one of the categories above.

This report will focus on getting you up to speed on the basics of credit that are applicable and essential to understand regardless of which desk you end up on with credit. We'll in particular focus in on bonds given that I've put together a separate report on CLOs.

When it comes to credit desks it's all about knowing the fundamentals as those are the building blocks every kind of credit asset is built on.

Desk Structure

I would categorize credit desks into two categories: investment grade and everything below investment grade.

The investment grade desk – which focuses on trading investment grade bonds in the secondary market – is a bit more flow based as the issuance sizes are large, bonds are liquid, and a wider set of clients will be interested in them (given that they have high credit ratings so a wider swath of clients will be able to hold them).

On investment grade desks you'll often have distinct traders and sales people, however you may also have some salestraders who focus on the most liquid names. As with every other area of credit there is significant warehousing risk; meaning traders do carry quite large books, that can fluctuate significantly, in order to facilitate client flow.

Everything below investment grade includes desks such as high yield, distressed, and CLO trading (although some tranches of CLOs will be AAA, of course).

These desks all have a "traditional" structure where you have dedicated traders and sales people operating side-by-side, but with distinct roles and responsibilities. With that being said, sales people will often not be solely "distressed sales people", but rather will deal with both distressed, high yield, and even investment grade traders.

It is more common for sales people in credit roles to be tied less to the specific product, and more to specific clients and work with them on trades across the credit spectrum.

Further, you will have "desk analysts" who do more fundamental credit research as opposed to trading or sales (similar to what you'd imagine an equity research analyst to do, but desk analysts sit on the trading floor usually).

Future of the Desks

Everyone agrees – whether you're bullish on automation on the trading floor or believe we've hit a bit of a status quo – that areas of credit will be one of the last places to be automated in any meaningful way (if at all).

This is because – in particular as you get into more distressed areas of credit – spreads become wide and markets become illiquid. Further, one has to make a lot of judgement calls on where to price trades, what securities to hold in inventory, and how to hedge your overall exposure.

Even in investment grade credit – where things are most liquid – the pace is much slower than in rates trading, for example. More discretion is needed, one has to keep abreast to what is happening with specific credits (meaning specific companies), and clients often want more contact (or what some sales people might call hand holding).

The main issue with credit trading after the great financial crisis has not been automation, but rather regulation. Because post-crisis regulations have made it more costly to hold "riskier", illiquid debt (due to enhanced risk-weighted-asset requirements), banks have to make decisions about how much balance sheet to give to credit desks.

This has resulted in traders not being able to have as large of books in areas like distressed debt as they previously had, which has constrained their profitability to a certain degree. Credit traders – broadly speaking – who have a high-risk tolerance have often left sell-side S&T in order to take on buy-side roles where they can act in a purely discretionary manner.

The future of credit trading on the sell-side, in my view, is as bright as any area of the trading floor. It allows for you to gain a practical skillset – by understanding the underlying credit in either a sales or trading role – and opens up a broader set of exit opportunities than many other areas of S&T.

Further Reading

There are three books that are circulated on almost all rates desks for new analysts joining:

- The Bond Book – Annette Thau
  - The broadest coverage of all bonds in both the corporate and government space
- Leveraged Financial Markets – William Maxwell
  - Good, broad introduction to the high yield space
- Distressed Debt Analysis – Stephen Moyer
  - The Bible of distressed debt; from a buy-side investing perspective
- Leveraged Finance – Stephen Antczak
  - Good coverage of leveraged finance with a focus in on derivatives that isn't found in the books above

Primers

Credit in the S&T context can really be thought of as having two components:

- Trading simple corporate bonds – whether they are investment grade, high yield, or distressed – that have embedded credit risk
- Trading credit derivatives that more closely isolate, splice up, amplify, or diminish credit risk in some way

As a result, the two primers attached cover each of these elements of credit. The first is a primer from Lehman Brothers on trading credit spreads. The second is a primer from JP Morgan on credit derivatives.

Both are from the 2004-05, but because these are primers the fundamentals haven't changed at all. These primers are the best way to get a rundown on everything done in the credit space in the shortest amount of time.

If you're looking for a deeper dive, then the books I mentioned in "Further Reading" will get you a more technical understanding of credit (but that's entirely unnecessary for an internship or even your first few months on the job).

Q&A

What are corporate bonds?

Bonds issued by corporations (as the name would imply!) that generally have maturities between 1-20 years (rarely sometimes longer) that have *fixed* coupons. Coupons are paid semi-annually on a 30/360 day-count convention.

What drives the pricing of corporate bonds?

Ultimately, as with everything in finance, it's the market clearing price (what a marginal individual is willing to pay). However, what makes those investing in corporate bonds feel comfortable receiving a certain coupon amount is a mix of:

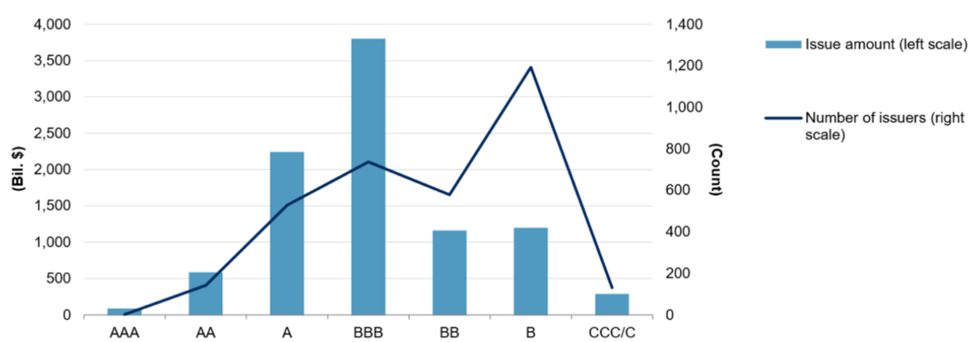
- The credit rating given to the bond (from Moody's or S&P)
- The historical performance and credit worthiness of the corporation in question
- Where the bond resides in the capital structure
    - Is it secured? Unsecured? How much debt (bonds, loans, revolvers) are ahead of the bond in question
- What comparable bonds are trading at (or were issued at)

How large is the corporate debt market? What kind of credit worthiness do most of these securities have?

The total corporate debt market – including bonds, loans, and revolvers – is approximately $10 trillion in 2020. S&P has compiled the distribution of ratings below:

Chart 2 | Download Chart Data

Distribution Of U.S. Corporate Debt By Rating Category



Issue amount includes bonds, loans, and revolving credit facilities that are rated by S&P Global Ratings from financial and nonfinancial issuers. Issuer count is based on the total number of issuer credit ratings for U.S. corporates. Data as of Jan. 1, 2019. Sources: S&P Global Fixed Income Research.

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You can see the full S&P report here: https://www.spglobal.com/en/research-insights/articles/u-s-corporate-debt-market-the-state-of-play-in-2019

What industries are the biggest issuers of corporate debt?

Financials are by far. For the non-financials industry, it is led by utilities, telecom, and tech.

How are corporate bonds brought to market?

Debt Capital Markets (DCM) divisions of an investment bank – that are not part of S&T due to their access to private, confidential information – bring bonds to market. These bonds are underwritten by a Lead Manager and a syndicate that will determine the best price the company can get (the lowest coupon they'll have to offer) and build up a book of investors who will buy the bonds at issuance.

Investment grade, high yield, and distressed debt desks on the trading floor deal with trading these bonds – once issued – in the *secondary* market. In other words, they provide liquidity to the market so those who buy a bond at issuance do not need to hold them indefinitely and those who weren't able to buy at issuance can now buy them.

Why do companies issue bonds to begin with?

This is a simple question that can sometimes trip people up. Bonds are issued primarily due to funding needs surrounding expansions, acquisitions, or a re-balancing of their existing balance sheet.

Who buys corporate bonds (either at issuance or in the secondary market)?

- Hedge funds
- Banks (trading desks or internal funds)
- (Very) High net worth individuals
- Pension fund managers
- Endowment funds
- Mutual funds

Corporate bond markets – after equities – have the broadest scope of investors who will participate in the market.

Is everyone who buys investment grade debt as likely to buy high yield debt?

No. Almost all market participants who have raised money from outside investors have mandates that constrain them on what they can and cannot do. For example, pension funds have a mandate – in their founding documents – that outlines the amount of risk they are allowed to take on given that funds must be routinely available to pay pension holders.

Therefore, most pension funds will have very little or no interest in distressed debt – given how risky it can be – but will routinely buy AAA-rated CLO tranches, investment grade debt, etc.

Likewise, distressed debt hedge funds have a mandate – from those who have put money into them – to buy high yield and distressed assets. However, investors would likely look unfavorably on a distressed fund having lots of their assets in investment grade bonds.

What's the credit spread?

The credit spread is the difference between the yield of a corporate bond and the yield of the underlying government bond (treasury, in the U.S.) of the same duration.

For example, T+250 on a 10-year corporate bond would mean it trades at the ten-year treasury note, plus 2.5% (250 basis points).

What makes credit spreads move?

Credit spreads will widen due to general economic downturns, the company performing poorly, or general pessimism in the credit markets. Credit spreads will tighten if the economy is healthy, the company is doing well, or credit markets are very active (lots of new issuance, new issuance pricing tight to treasuries, etc.)

What credit ratings correspond to investment grade or high yield?

Bond Rating		Grade	Risk
Moody's	Standard & Poor's		
Aaa	AAA	Investment	Lowest Risk
Aa	AA	Investment	Low Risk
A	A	Investment	Low Risk
Baa	BBB	Investment	Medium Risk
Ba, B	BB, B	Junk	High Risk
Caa/Ca/C	CCC/CC/C	Junk	Highest Risk
C	D	Junk	In Default

What goes into the credit rating process?

The credit rating process is quite extensive and is a substantial cost (that the company must pay the rating agency directly). The credit rating agency seeks to study both the business risk – how likely the company is to continue to expand, grow, and be profitable – along with its unique financial risks surrounding its capital structure, current debt payments, likely default rate, etc.

Credit rating agencies also look to the "comparable universe" of similar companies and how they're performing and where their debt is rated.

What are the differences in how investment grade and high yield bonds trade?

As previously mentioned, investment grade bonds tend to be originated in larger size, by large companies (that are obviously healthier). This makes the market much more liquid; not only because of larger issuance size, but also because banks hold more of these bonds in inventory (because they are safer, thus require less balance sheet to be reserved to warehouse them).

Investment grade bonds are often – but not always – quoted as a spread against treasuries of the same duration. However, high yield and distressed bonds are almost always quoted outright with much wider spreads (e.g. the bid ask will be often many times wider than that of an investment grade bond).

Note: It's important to know the paragraph above; that'd be very impressive to hear in an interview.

What's the default probability depending on rating?

Fitch U.S. Public Finance Average Cumulative Default Rates: 1999–2013

(%)	One-Year	Two-Year	Three-Year	Four-Year	Five-Year	10-Year
AAA	0.00	0.00	0.00	0.00	0.00	0.00
AA	0.00	0.00	0.00	0.00	0.00	0.00
A	0.00	0.01	0.02	0.04	0.05	0.05
BBB	0.05	0.10	0.18	0.28	0.47	1.28
BB	0.39	2.01	3.38	4.31	4.43	5.26
B	2.78	4.48	4.07	3.54	3.74	5.71
CCC to C	11.76	13.79	19.61	24.00	27.91	44.00
Investment Grade	0.01	0.01	0.03	0.05	0.08	0.19
Speculative Grade	1.92	3.59	5.01	6.15	6.65	11.61
All U.S. Public Finance	0.04	0.08	0.11	0.15	0.18	0.35

Source: Fitch

What are Fallen Angles?

Fallen Angles are bonds that were issued as investment grade but have now fallen below investment grade. In 2020 Fallen Angles became a talking point given the rapid rise in them: https://www.bloomberg.com/news/articles/2020-03-13/why-billions-in-bonds-now-trade-like-fallen-angels-quicktake

What happens to credit spreads as credit ratings decline?

As credit ratings decline, credit spreads increase (denoting the greater risk of default potentially occurring). Note that credit spreads will compress when credit markets are hot (meaning when yields are falling and lots of new issuance is occurring, usually because of strong economic conditions).

Credit Spreads by Rating

Moody's Rating	Spread (bp)	S&P Rating	Spread (bp)
Aaa	67	AAA	66
Aa1	69	AA+	84
Aa2	82	AA	81
Aa3	74	AA-	72
A1	91	A+	87
A2	95	A	103
A3	121	A-	120
Baa1	136	BBB+	144
Baa2	151	BBB	165
Baa3	189	BBB-	190
Total	125	Total	125

What kinds of debt are most common in capital structures by seniority?

- Revolver (Revolving Credit Facility)
  - Like a credit card; can be drawn and paid down over the maturity period with some restrictions
- Term Loans
  - Can have Term Loan A or Term Loan B (TLBs are often syndicated and traded by a "bank loan desk" on the floor)
- Senior Notes
  - Either secured or unsecured
- Subordinated Notes
- Mezzanine Debt
- Preferred Equity
- Common Equity

How are corporate bonds often hedged (if you want to minimize exposure)?

Any trader will have to maintain an inventory and he or she may not like the direction of the markets or the kind of inventory being held. A common way to hedge is by taking an offsetting position in the underlying treasury (the treasury with the same maturity).

What are convertible bonds?

Convertible bonds are often traded separately from high yield, distressed, or investment grade bonds. Often, it'll be just one or two traders (who also operate as sales people) who deal with these bonds and they will often sit near equity teams, as opposed to credit teams.

Convertible bonds provide the capacity for the owner to convert into equity at a pre-set rate. For the issuer of convertible bonds, they have the benefit of allowing them to raise debt at favorable terms and potentially get rid of future interest payments (if their stock appreciates above the pre-set conversion rate).

For the investor, buying provides a position higher in the capital structure than equity if the company ends up defaulting (so could have some level of recovery), but if the company does well it allows for the investor to have higher upside (compared to just getting the pre-set coupon payments of the bond) via converting to equity.

What are callable bonds?

While convertible bonds are wholly distinct from traditional corporate bonds, given that they can convert into equity, callable bonds are just like traditional corporate bonds, but have the feature of being callable.

Callable bonds have gone from being a rarity to being the majority of corporate bonds issued. All callable bonds do is allow for the company to recall part or the entire issuance of bonds after a certain amount of time. The reason why the company likes to have this feature is that in a declining rates environment, if the company is healthy, they may be able to call the bonds and reissue bonds with a lower coupon (thus saving money).

Why would investors ever want a bond that is callable?

This is an obvious next question. If corporations can just call bonds when rates decline, then won't investors get none of the benefits of yields going down (and thus prices on the bonds going up)? The answer is that the callable price – the price that corporations must pay to recall the bonds – is above the issuance price.

So, for example, a bond may have an issuance size of $10m and be issued at par (100) with a coupon of 4%. Interest rates may decline, and the company may believe they can go and issue the same amount of bonds ($10m), but at an interest rate of 3% instead of 4%. If the original bond is past the "non-call" period the company can retire the original bonds early but must do so at a higher than par (higher than 100) price per bond (for example, 103).

So, the corporation needs to make the determination if the price to retire the bonds early (paying the callable amount above par) is worthwhile given the lower interest rate they can get on a new bond issuance.

What are puttable bonds?

Puttable bonds just allow for the holder of a bond to redeem it early (get their principal back). They would obviously do this if they feel like new bonds being issued have higher coupons that are more favorable.

However, corporate bonds being puttable is much less common than them being callable. Partly because of the low rates environment we have been in for the past few decades and partly because it creates quite a bit of cash flow uncertainty for a company (as rates rise they suddenly need to have lots of cash to pay back bond holders early).

What are Eurobonds?

Eurobonds are a rather confusing name for a simple kind of bond: one issued outside the country that the company is based in and the currency most utilized by the company.

When we think about a bond, what do we mean by "expected loss"?

Expected loss is the probability of the company defaulting multiplied by the loss that will be incurred as a result of defaulting. This sets an initial downside case for what to expect in terms of a loss.

Why is EBITDA so important to thinking about bonds?

Because EBITDA represents the amount of cash available for debt servicing (paying coupons) if we assume no capex or working capital changes. Most covenants in debt documents will have EBITDA within them.

What are the two most common types of ratios used in credit?

- Coverage ratios
  - EBITDA / Interest Expense
- Leverage ratios
  - Debt / EBITDA
  - Net debt / EBITDA
  - Debt / (EBITDA – capex)

What qualities would an investment grade issuer (company) have financially?

- Strong EBITDA margin
- Low current interest expenses
- Predictable revenue
- High current coverage ratio
- Low current leverage ratio

- Simple capital structure

What types of covenants will you likely find in corporate debt (in particular, corporate bonds)?

Debt docs are the documents at issuance that govern the terms of the debt being issued. These debt docs will contain covenants that specify the things that can't be done (negative covenants); if the company does break any of the covenants then the holders have a right to force the company (broadly speaking) into a technical default unless a resolution can be found.

- Coverage ratio (min EBITDA / interest expense)
- Leverage ratio (max debt / EBITDA)
- Restricted cash (min amount of cash that must be kept aside at all times)
- Negative pledge provisions (inability to pledge certain assets for new debt)
- Restrictions on guarantees that can be offered to subsidiaries without prior consent
- Payment priority in the event of asset sales
- Additional covenants to protect priority of the debt (meaning the place in the capital structure) and under what conditions additional debt can be placed ahead of this debt

Do investment grade or high yield bonds tend to have more covenants? What about bonds vs loans?

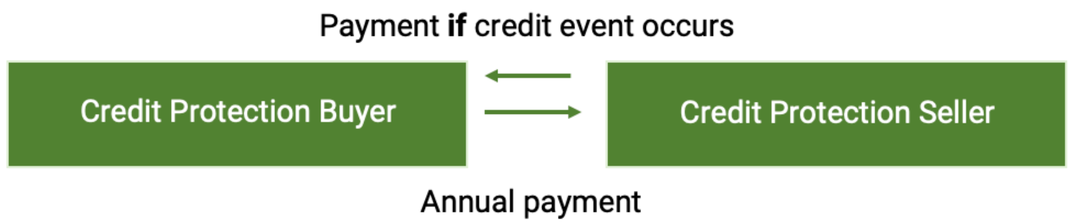
High yield bonds tend to have more covenants than investment grade debt given the slightly precarious nature of most high yield issuers (all ratios and restrictions will be tighter at issuance). Loans tend to have more covenants than bonds as well although loans are frequently renegotiated if the borrower gets into trouble (to get around a technical default that may not be in the best interest of any party, including the loan holder).

What are credit default swaps?

When we think of derivatives and structured products, much of the rationale really boils down to chopping up and disbursing risk to those who actually want to hold it.

For example, in the credit markets there will sometimes be those who want to mitigate credit risk and can do so via a credit default swap. In a credit default swap, there will be two sides: a credit protection buyer and a credit protection seller.

The protection buyer pays a fixed annual fee and will receive payment if a "credit event" occurs on the "reference entity". The protection seller on the other hand gets paid annually to provide this "insurance" and may never have to pay out anything, if a credit event occurs, or may have to pay much more than they've received in annual payments.



Do credit default swaps trade in the secondary market? Does their value change?

Absolutely! Credit default swaps change in price due to the increasing or decreasing credit value of the underlying entity being referenced by the CDS. For instance, Goldman bought billions worth of CDS on AIG when they were healthy in 2005-2007 as a hedge – because they had a lot of exposure to AIG – and then were paid out billions when a credit event (technical default) occurred in 2008.

The CDS contracts were very cheap in 2005-2007, but became incredibly valuable as folks noticed trouble at AIG and desperately tried to hedge their exposure to the insurance giant.

What are the two ways that CDS contracts can settle?

If a credit event occurs, then CDS contracts can be settled either physically or on a cash basis.

If the contact is settled physically, then the CDS buyer will deliver the reference asset (for example, certain eligible corporate bonds, which will obviously have a very low value) to the seller. Then the CDS seller will pay the par value in cash.

To be clear, when the CDS buyer purchases the reference asset it will be at a very steep discount to par (given that a credit event has occurred, so the company is distressed), but once they deliver the assets to the CDS seller then the seller will pay par.

If a contact is cash settled, then the physical delivery does not occur. Instead the CDS seller pays the difference between the par value of the reference asset and the auction settlement price. Learn more about the auction process here: https://www.investopedia.com/articles/bonds/09/what-happens-to-single-name-cds.asp#credit-default-auctions

Why would a client buy credit default swaps?

- Speculate on a credit that they think will become distressed and have a credit event
    - These kinds of clients are generally distressed hedge funds
- Protect yourself from credit exposure to the company

    - If you deal frequently with a company – perhaps they are a large customer of yours or you've extended them some kind of credit – you can mitigate your exposure to the company by buying CDS
    - This way if the company ends up having a credit event you can hedge your exposure (potential losses) by just paying the CDS premium
    - Clients who buy CDS for this purpose are large corporations and banks
- Reduce exposure to a sector
    - If you are a large fund you may have lots of exposure to a certain sector – like oil and gas – that you want to hedge
    - However, you don't want to sell your current oil and gas holdings (perhaps because they're illiquid or you like the particular asset)
    - In order to gain downside exposure to the industry, you can pick certain companies (in this example, oil and gas companies) and buy CDS against them
    - This rationale will often be that of large funds – like endowments or sovereign wealth funds – who want to buy downside exposure, but can't entirely shift their portfolio around because it's so large

Stay Up-To-Date with Markets via The Market Making Newsletter

As you can hopefully tell from going through these guides, I love writing about markets and trying to break down complex topics as simply as possible.

So, I've thought quite a bit about how I could write more regularly about markets and keep you updated on how those on the buy-side and sell-side are thinking about things.

In the end, I decided to create a weekly newsletter – delivered to your inbox every Sunday evening – that dives deep into what themes and stories are currently moving markets.

My aim with the newsletter is to share the institutional sales and trading perspective and walk you through some of the sell-side research that has been most discussed on trading desks across asset classes over the past week.

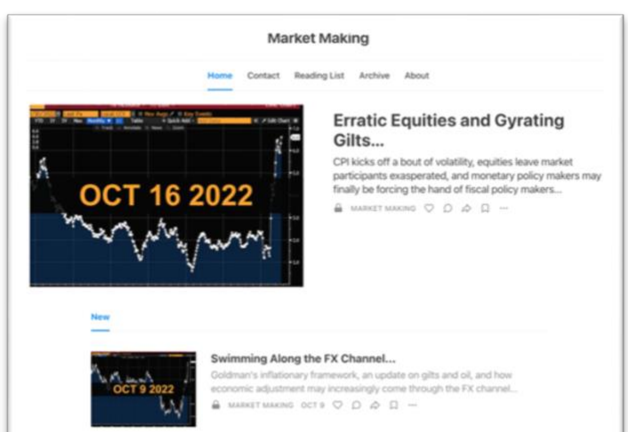
Each Sunday's newsletter is around 5,000-7,000 words and will probably take you 25-35 minutes to read. So, the newsletters aren't exactly short (brevity isn't my strong suit!).

But if you're deeply interested in markets and enjoy my writing style, then I'm sure you'll love reading the Market Making newsletter each week.

Given how much time and effort goes into creating the newsletter each week, I do charge a small amount for full access to it. However, the first part of each week's newsletter will always be completely free as I want everyone to be able to enjoy and benefit from it.

You can read past newsletter editions and subscribe here: MarketMaking.Substack.com

Creating the newsletter each week has been a lot of fun and I hope reading it becomes something you look forward to doing every Sunday evening!



Fixed Income
Quantitative Credit Research

March 2004

Credit Spreads Explained

Dominic O'Kane and Saurav Sen

Credit investors need a measure to determine how much they are being paid to compensate them for assuming the credit risk embedded within a security. A number of such measures exist, and are commonly known as credit spreads since they attempt to measure the return of the credit asset relative to some higher credit quality benchmark. Each has its own strengths and weaknesses. In this article, we define, describe and analyse the main credit spreads for fixed rate bonds , floating rate notes and the credit default swap.

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1. INTRODUCTION

It is useful for credit investors to have a measure to determine how much they are being paid to compensate them for assuming the credit risk embedded within a security. This credit risk may be embedded within a bond issued by some corporate or sovereign or may be synthesized through some credit derivative. Such a measure of credit quality should enable comparison between securities issued by a company, which may differ in terms of maturity, coupon or seniority. It should also facilitate comparisons with the securities of other issuers. Ultimately it should enable the credit investor to identify relative value opportunities within the bonds of a single issuer, and across different issuers.

When we enlarge our universe of credit instruments to include not just fixed rate bonds, but also floating rate bonds, asset swaps and default swaps, it is only natural to try to define a credit risk metric which also allows a comparison across instruments. For example, we would like to know when a credit default swap is priced fairly relative to a cash bond when both are linked to the same issuer. This is especially important for determining the relative value of a default swap basis trade.

While we would like one simple credit measure, there is in fact a multiplicity of such measures. Most are called "credit spreads" since they attempt to capture the difference in credit quality by measuring the return of the credit risk security as a spread to some higher credit quality benchmark, typically either the government (assumed credit risk free) curve or the same maturity Libor swap rate (linked to the funding rate of the AA-rated commercial banking sector).

Well-known credit measures include the yield spread, the asset swap spread, the option adjusted spread (OAS), the zero volatility spread, the discount margin, the default swap spread and the hazard rate. Each is defined in its own particular way and so has its own corresponding strengths and weaknesses. However, since they play such a fundamental role in the trading, analysis and valuation of credit securities, it is essential that there exist a clear picture as to the information contained in each of these different credit spreads.

The purpose of this report is to define, explain and examine these different credit spreads. We would also like to understand the relationship between different credit spread measures. To do this we have to set up a unifying credit risk modelling framework through which we can express each of these credit-spread measures. Such a model will enable us to understand how different measures behave with changing credit quality and asset indicatives. A comparison of the various credit spread measures is left to a forthcoming Quantitative Credit Research Quarterly article.

[1] *An analysis of spread measures within the context of agency bonds has been published in Tuckman (2003).*

The remainder of this paper is organised as follows: We describe a number of credit spread measures in turn, starting with those for fixed coupon cash bonds, followed by those for floating rate bonds. We focus mainly on the spread measures quoted by Bloomberg on its YAS, YAF and ASW pages and also those used by Lehman Brothers on Lehman Live. Additionally, we define and explain the credit default swap spread.

2. CREDIT SPREAD MEASURES FOR FIXED RATE BONDS

We start by discussing the most common credit spread measures for fixed rate bonds.

THE YIELD SPREAD

The yield spread, also known as the yield-yield spread, is probably the most widely used credit spread measure used by traders of corporate bonds. Its advantage is that it is simply the difference between two yields – that of the credit bond and that of the associated treasury benchmark and so is easy to compute and sufficiently transparent that it is often used as the basis to price in the closing of a crossing trade of credit bond versus treasury bond.

Definition

The yield spread is the difference between the yield-to-maturity of the credit risky bond and the yield-to-maturity of an on-the-run treasury benchmark bond with similar but not necessarily identical maturity.

The mathematical definition of the yield-to-maturity is well known and has been discussed at length elsewhere (Fabozzi 2003). However we repeat it here for the sake of completeness. It is the constant discounting rate which, when applied to the bond's cashflows, reprices the bond. If we denote the full (including accrued) price of the defaultable bond by P^{full}, the annualised coupon by C_D, the coupon frequency by f_D, and the time to each of the cash flow payments in years by T_1, …, T_N, then the yield y_D of the defaultable bond is the solution to the following equation.

$$P^{full} = \frac{C_D / f_D}{(1 + y_D / f_D)^{f_D T_1}} + \frac{C_D / f_D}{(1 + y_D / f_D)^{f_D T_2}} + \ldots + \frac{100 + C_D / f_D}{(1 + y_D / f_D)^{f_D T_N}}$$

Note that the full coupon is used for the first period, consistent with using the full price. The times to the payments are calculated using the appropriate day count convention, such as 30/360 (bond) or ACT.

A 1-dimensional root-searching algorithm is typically used to find the value of y_D which satisfies this equation.

Before we can consider the information content of the yield spread, let us consider for a moment the assumptions behind the yield to maturity measure. These are:

1. An investor who buys this asset can only achieve a return equal to the yield measure if the bond is held to maturity and if all coupons can be reinvested at the same rate as the yield. In practice, this is not possible since changes in the credit quality of the issuer may cause yields to change through time. As many investors may re-invest coupons at rates closer to LIBOR, at least temporarily, the realised return will usually be lower than the yield to maturity.

2. It assumes that the yield curve is flat which is not generally true. In practice, we would expect different reinvestment rates for different maturities. In the yield to maturity, these reinvestment rates are the same for all maturities.

To calculate the yield spread we also need to calculate the yield of the benchmark government bond y_B as above. The yield spread is then given by the following relationship:

$$\text{Yield Spread} = y_D - y_B \,.$$

Example

As an example, consider the following bond: Ford Motor Credit 7.25% 25 Oct 2011 which priced at 107.964 on the 9th February 2004, and settles on the 12th February 2004. This bond has semi-annual coupons which accrue on 30/360 (Bond) basis. With 107 days[2] of accrued interest worth 2.1549, the full price of the bond is 110.1189. A simple price-yield calculation, summarised in Table 1 below, gives a yield of 5.94%.

The benchmark for this corporate bond at issuance was the 10-yr on-the-run treasury, with 5% coupon and maturity date 15 August 2011. As the bond has rolled down the curve, the current benchmark is the 5-yr on-the-run treasury, which has 3% coupon and matures on 15 February 2009. It has a yield to maturity of 3.037%. As the yield of the Ford bond is 5.94% and that of the benchmark is 3.04%, so the yield spread is 290bp.

In this case, therefore, there is a maturity mismatch between the bond and its benchmark where the Ford bond matures almost 3 years after the benchmark. The benchmark has also changed since the bond was issued.

Table 1. Yield to maturity calculation summary

Date	Cashflow on \$100 Notional	Yield	Time in Years (30/360 Basis)	Yield Discount Factor	Cashflow PV
12-Feb-04			0.008	0.9995	
25-Apr-04	3.625	5.94%	0.211	0.9877	3.5805
25-Oct-04	3.625	5.94%	0.711	0.9593	3.4773
25-Apr-05	3.625	5.94%	1.211	0.9316	3.3771
25-Oct-05	3.625	5.94%	1.711	0.9048	3.2797
25-Apr-06	3.625	5.94%	2.211	0.8787	3.1852
25-Oct-06	3.625	5.94%	2.711	0.8533	3.0934
25-Apr-07	3.625	5.94%	3.211	0.8288	3.0042
25-Oct-07	3.625	5.94%	3.711	0.8049	2.9176
25-Apr-08	3.625	5.94%	4.211	0.7817	2.8335
25-Oct-08	3.625	5.94%	4.711	0.7591	2.7519
25-Apr-09	3.625	5.94%	5.211	0.7373	2.6725
25-Oct-09	3.625	5.94%	5.711	0.7160	2.5955
25-Apr-10	3.625	5.94%	6.211	0.6954	2.5207
25-Oct-10	3.625	5.94%	6.711	0.6753	2.4480
25-Apr-11	3.625	5.94%	7.211	0.6559	2.3775
25-Oct-11	103.625	5.94%	7.711	0.6370	66.0041
Yield-Implied Full Price of the Bond:				**110.1189**	

Interpretation

We can make a number of observations about the yield spread as a credit risk measure:

- It shares all of the weaknesses of the yield to maturity measure in terms of constant reinvestment rate and hold to maturity.

[2] *The 110 calendar days between the previous coupon date (25 Oct 2003) and settlement (12 Feb 2004) correspond to 107 interest accrual days in the 30/360 basis.*

- Another disadvantage of being based on yield to maturity is that it is not a measure of return of a long defaultable bond, short treasury position.
- As a relative value measure, it can only be used with confidence to compare different bonds with the same maturity which may have different coupons.
- The benchmark security is chosen to have a maturity close to but not usually coincident with that of the defaultable bond. This mismatch means that the measure is biased if the underlying benchmark curve is sloped.
- The benchmark security can change over time, as the bond rolls down the curve. This is illustrated in the example above, where the bond switches from being benchmarked against a 10-yr on-the-run treasury security to a 5-yr on-the-run. As a result, yield spread is not a consistent measure through time.

The bottomline is that the yield and yield-spread measures are only rough measures of return. In no way do they actually measure the realised yield of holding the asset. For these reasons, the yield spread should only be used strictly as a way to express the price of a bond relative to the benchmark, rather than a measure of credit risk.

The only time when it may become useful is if the asset and Treasury are both trading at or very close to par. In this case, the yield to maturity of the defaultable bond and treasury are close to their coupon values and the yield spread is a measure of the annualised carry from buying the defaultable bond and shorting the Treasury. However this information is already known, so even then the yield spread does not add any value.

INTERPOLATED SPREAD

To overcome the issue of the maturity mismatch, it is possible to use a benchmark yield where the correct maturity yield has been interpolated off the appropriate reference curve. Rather than choose a specific reference benchmark bond, the idea is to use a reference yield curve which can be interpolated.

Definition

The Interpolated Spread or I-spread is the difference between the yield to maturity of the bond and the *linearly interpolated yield to the same maturity* on an appropriate reference curve.

The simplest way to interpolate the yield off the treasury curve is to find two treasury bonds which straddle the maturity of the defaultable bond. It is then simple to linearly interpolate the yield to maturity of these two treasury bonds to find the yield corresponding to the maturity of the credit-risky bond. If the maturities of the two government bonds are T_{G1} and T_{G2} and the yields to maturity are y_{G1} and y_{G2}, then the interpolated spread is given by

$$ISpread = y_D - \left[y_{G1} + \left(\frac{y_{G2} - y_{G1}}{T_{G2} - T_{G1}} \right) (T_D - T_{G1}) \right].$$

Other choices of reference curves include a Constant Maturity Treasury (CMT) rates curve, or the LIBOR swap rate curve. The reference curve is always specified when quoting I-spread.

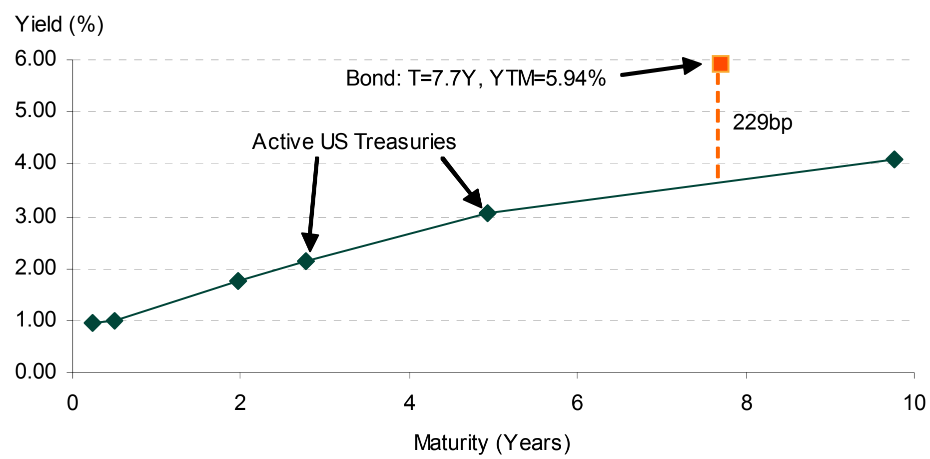
Example

Consider the following bond: Ford Motor Credit 7¼ 25 Oct 2011 which priced at 107.964 on the 9th February 2004, and settles on the 12th February 2004.

If we consider the other benchmark bonds on the US Treasury curve (shown in Figure below), we see that the two which straddle the maturity of our defaultable bond are the 3¼ Jan-09 with a yield of 3.0742% and the 4¼ Nov-13 with a yield of 4.0791%. Linearly interpolating these in maturity time gives an interpolated yield of 3.65%.

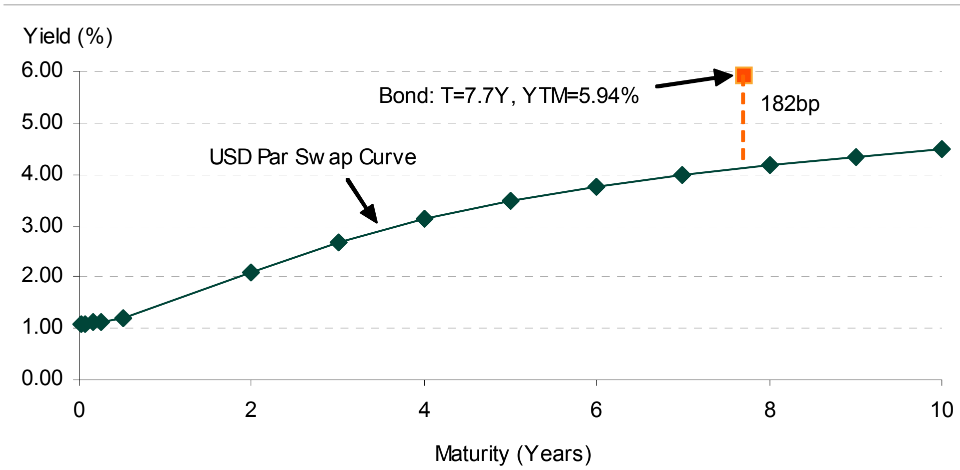
The resulting interpolated spread becomes 5.94% minus 3.65% which is 229bp. Note that this is less than the yield spread to the treasury benchmark, as the benchmark has shorter maturity than the credit bond and the treasury curve is upward-sloping.

Figure 1. I-spread against US Treasury yield curve (active)



Alternately, we may choose the LIBOR swap curve, shown in Figure 2 below, as the reference. The interpolated swap rate to this maturity is therefore a linear mixture of the 7 year swap rate which is 3.99% and the 8 year swap rate which is 4.175%. We calculate the linearly interpolated swap rate to be 4.121%. Given that defaultable bond yield is 5.94%, the interpolated spread equals the difference which is 182bp.

Figure 2. I-spread relative to US Swap Curve



Interpretation

If the reference curve is upward sloping and the benchmark has a shorter maturity then the I-spread will be less than the yield spread. If the reference curve is downward sloping and the maturity is shorter than that of the benchmark then the I-spread will be greater than the yield spread.

Viewed purely as a yield comparison, I-spread gets around the problem of mismatched maturity which affects yield spread, but it does not necessarily correspond to the yield to maturity of a traded reference bond. In addition, it inherits all the drawbacks of the yield to maturity measure, and so should be interpreted as a way to express the price of the defaultable bond relative to a curve.

I-spread does take into account the shape of the term structure of interest rates, but only in a very crude way. The option adjusted spread, which we describe next, does so in a more robust manner.

OPTION-ADJUSTED SPREAD (OAS)

The Option Adjusted Spread (OAS) was originally conceived as a measure of the amount of optionality priced into a callable or puttable bond. However, the definition of the OAS is not option specific. Indeed it can also be used to measure the credit risk embedded in a bond.

Definition

The Option Adjusted Spread is the parallel shift to the LIBOR zero rate curve required in order that the adjusted curve reprices the bond.

The OAS is sometimes referred to as the Zero-Volatility Spread (ZVS) or Z-Spread. In the latter case, semi-annual compounding is always assumed (e.g. on Bloomberg).

If we choose discrete compounding for the OAS with a frequency equal to that of the bond f, then the OAS, denoted by Ω, satisfies the following relationship:

$$P^{full} = \frac{C}{f}\sum_{j=1}^{n}\frac{1}{\left(1+\frac{(r_{T(j)}+\Omega)}{f}\right)^{f\times T(j)}} + \frac{100}{\left(1+\frac{(r_{T(n)}+\Omega)}{f}\right)^{f\times T(n)}}\,.$$

where C is the annual coupon of the bond and the LIBOR zero rates are related to LIBOR discount factors Z_T as follows:

$$r_T = [(Z_T)^{-1/(f\times T)} - 1]\times f\,.$$

In OAS calculations, time is measured as calendar time in years, rather than being dependent on the basis of the bond, as is the case with the yield to maturity calculation. A one-dimensional root-searching algorithm is used to solve this equation.

The Lehman Brothers convention, used on LehmanLive, is to use continuous compounding for the OAS, so that the above equation becomes

$$P^{full} = \frac{C}{f}\sum_{j=1}^{n} Z_{T(j)}e^{-\Omega T(j)} + 100 Z_{T(n)}e^{-\Omega T(n)}\,.$$

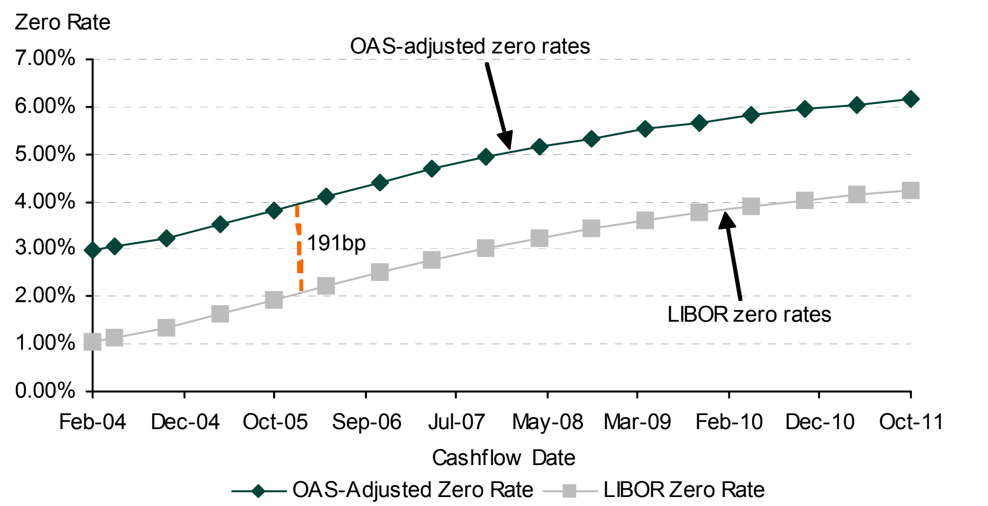
As a spread measure the OAS has a number of important differences from the yield spread. They are

1. The OAS is typically measured against LIBOR, although the reference curve is always specified and can be taken as the treasury curve as well.
2. The OAS reflects a parallel shift of the spread against LIBOR. Only the spreads are bumped rather than the whole yield. As a consequence, the OAS takes into account the shape of the term structure of LIBOR rates.
3. The OAS assumes that cashflows can be reinvested at LIBOR+OAS. As a result, future expectations about interest rates are taken into account. However there still remains reinvestment risk as it is not possible to lock in this forward rate today.

Example

Consider again the Ford Motor Credit 7.25% 25 Oct 2011 which priced at 107.964 on the 9th February 2004, and settles on the 12th February 2004. The full price of the bond, including accrued interest to the settlement date, is 110.1189. The observed US swap rates are shown in Figure 2. With semi-annual compounding, the resulting value of the OAS computed is 191bp. Figure 3 illustrates the concept of OAS as a parallel shift to the LIBOR zero rates curve.

Figure 3. Option-adjusted spread



The calculation of OAS is summarised in Table 2 below.

Table 2. Calculation of Option-Adjusted-Spread (6M-Frequency)

Date	Cashflow on $100 Notional	Calendar Time (Y)	LIBOR Discount Factor	LIBOR Zero Rate	OAS-Adjusted Zero Rate	Adjusted Discount Factor
12-Feb-04		0.008	0.9999	1.06%	2.97%	0.9998
25-Apr-04	3.625	0.208	0.9976	1.14%	3.05%	0.9937
25-Oct-04	3.625	0.708	0.9906	1.33%	3.24%	0.9775
25-Apr-05	3.625	1.207	0.9807	1.62%	3.53%	0.9587
25-Oct-05	3.625	1.707	0.9680	1.92%	3.83%	0.9374
25-Apr-06	3.625	2.206	0.9527	2.21%	4.12%	0.9140
25-Oct-06	3.625	2.707	0.9348	2.51%	4.42%	0.8885
25-Apr-07	3.625	3.206	0.9153	2.78%	4.69%	0.8620
25-Oct-07	3.625	3.707	0.8949	3.02%	4.93%	0.8349
25-Apr-08	3.625	4.206	0.8737	3.24%	5.15%	0.8076
25-Oct-08	3.625	4.707	0.8521	3.43%	5.34%	0.7804
25-Apr-09	3.625	5.206	0.8303	3.60%	5.51%	0.7534
25-Oct-09	3.625	5.707	0.8086	3.76%	5.67%	0.7269
25-Apr-10	3.625	6.206	0.7869	3.90%	5.81%	0.7009
25-Oct-10	3.625	6.707	0.7654	4.03%	5.94%	0.6755
25-Apr-11	3.625	7.206	0.7442	4.14%	6.05%	0.6508
25-Oct-11	103.625	7.707	0.7234	4.25%	6.16%	0.6267
OAS-Implied full price of the bond (OAS = 191bp):					**110.1189**	

Interpretation

The OAS is higher than the 182bp calculated for the interpolated yield spread. This difference is mainly due to the fact that the reference curve is upward sloping. The OAS is lower than the interpolated yield when the reference curve is inverted. When the reference curve is flat, both the OAS and the interpolated yield are equal, except for minor differences due to the slightly different compounding conventions. In this sense, the relationship between OAS and I-spread is similar to the relationship between zero-coupon rates and current swap rates.

The magnitude of the OAS also depends on the compounding frequency used. The relationship is analogous to discretely or continuously compounded interest rates, and is shown below in Table 3 for the Ford bond considered earlier.

Table 3. Dependence of OAS on compounding frequency

Frequency	Continuous	3M	6M	1Y
OAS (bp)	186	189	191	196

While the OAS takes into account the term structure of interest rates, it is essentially a relative value measure and should be viewed, along with yield spread and I-spread, as a way to express the price of a bond relative to a reference curve.

ASSET SWAP SPREAD (ASW)

Unlike the spread measures described so far, the asset swap spread is a traded spread rather than an artificial measure of credit spread.

Definition

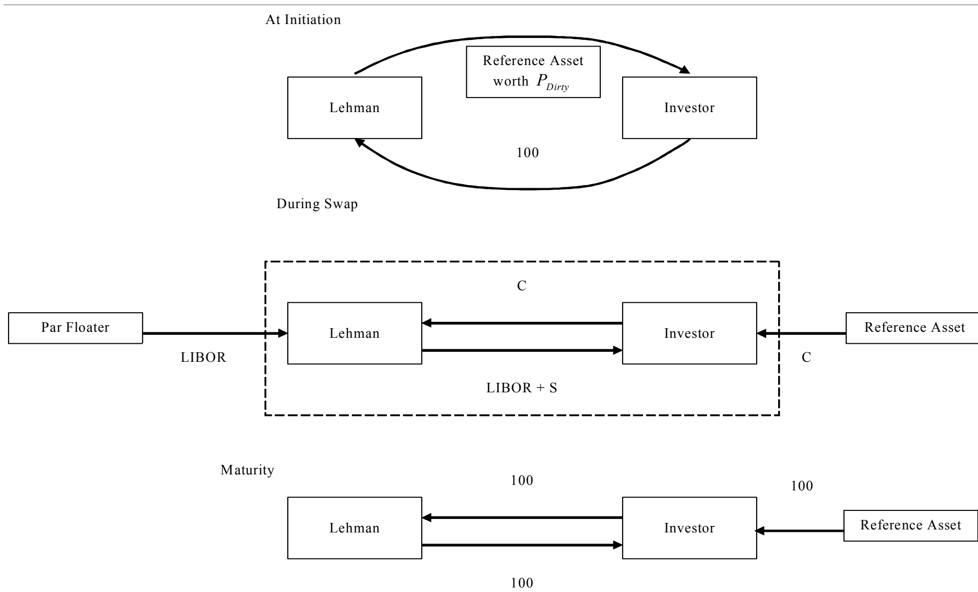
The Asset swap spread is the spread over LIBOR paid on the floating leg in a par asset swap package.

In a par asset swap package, a credit investor combines a fixed rate asset with a fixed-floating interest rate swap in order to remove the interest rate risk of the fixed rate asset. The mechanics of an asset swap spread are shown in Figure 4 below. There are two components to the package

1. At initiation the investor pays par, and in return, receives the bond which is worth its full price.
2. The investor simultaneously enters into an interest rate swap, paying fixed, where the fixed leg cashflows are identical in size and timing to the coupon schedule of the bond. On the floating side of the swap, the investor receives a fixed spread over LIBOR – the asset swap spread. The floating leg of the swap is specified with its own frequency, basis and settlement conventions.

If the asset in the asset swap package defaults, the interest rate swap continues or can be closed out at market and the associated unwind cost is taken by the asset swap buyer. The asset swap buyer also loses the remaining coupons and principal payment of the bond, recovering just some percentage of the face value.

Figure 4. Mechanics of a Par Asset Swap



More details on the mechanics of asset swaps, including pricing considerations and variations on the theme of par asset swaps, can be found in *Credit Derivatives Explained*

(March 2001), and Tuckman (2003), where we show that the par asset swap spread is given by the formula:

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

Equation 1

Here, P^{LIBOR} is the value of the bond's cashflows discounted at LIBOR, P^{full} is the market price of the bond, and $PV01$ is the LIBOR discounted present value of a 1bp coupon stream, paid according to the frequency, basis and stub conventions of the floating leg of the interest rate swap.

Example

To illustrate the calculation of asset swap spread, consider the Ford Motor Credit 6.75% 15 Nov 2006 which priced at 105.594 on the 12th February 2004, and settles on the 17th February 2004. The full price, including accrued interest, is 107.3193. Assume that the floating leg of the swap pays quarterly and is computed using the ACT360 basis. We calculate the asset swap spread to be 214bp. Cashflows from this par asset swap spread are shown in Table 4 below.

The first two columns of Table 4 show the cashflow schedule of the bond. LIBOR discount factors are shown in the third column. Using these, we have:

$$P^{LIBOR} = 113.0877$$

$$P^{full} = 107.3193$$

The floating leg of the swap has 3M frequency and accrues interest on ACT360 basis. These accrual factors for each period are shown in column 4. Note that the first cashflow on the floating leg is adjusted for the stub period to the first cashflow date. The PV01 of the floating leg is to:

$$PV01 = 2.7017$$

Using these figures, the Asset Swap Spread works out to 214bp.

Table 4. Cashflows in an Asset Swap Spread

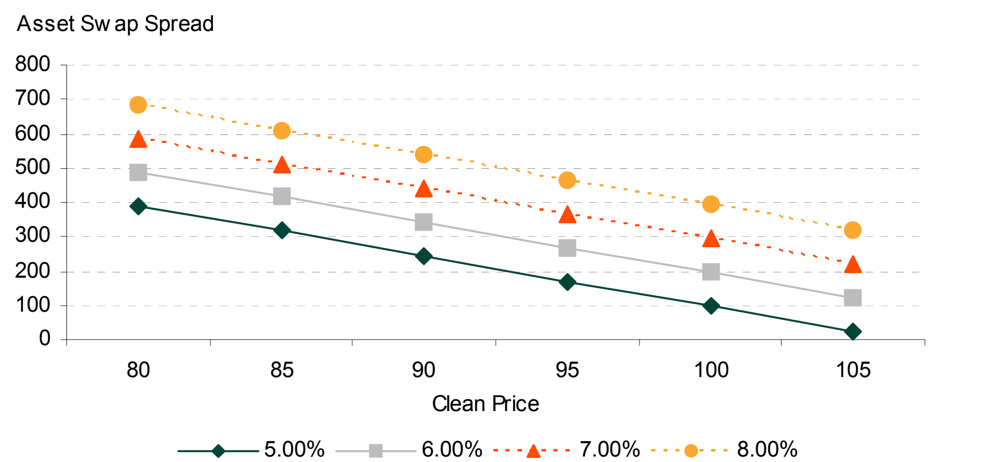
Date	Cashflow on $100 Notional	LIBOR Discount Factor	Accrual Factor (ACT360)	Forward LIBOR	ASW Fixed Leg	ASW Floating Leg
17-Feb-04		1.0000				
15-May-04	3.375	0.9971	0.244	1.19%	-3.375	0.813
15-Aug-04		0.9939	0.256	1.26%		0.869
15-Nov-04	3.375	0.9899	0.256	1.59%	-3.375	0.951
15-Feb-05		0.9852	0.256	1.85%		1.018
15-May-05	3.375	0.9800	0.247	2.15%	-3.375	1.060
15-Aug-05		0.9740	0.256	2.43%		1.166
15-Nov-05	3.375	0.9674	0.256	2.66%	-3.375	1.227
15-Feb-06		0.9602	0.256	2.93%		1.295
15-May-06	3.375	0.9524	0.247	3.32%	-3.375	1.350
15-Aug-06		0.9436	0.256	3.62%		1.471
15-Nov-06	103.375	0.9344	0.256	3.86%	-3.375	1.533

Interpretation

One thing to understand about the asset swap spread is that if the asset in the asset swap defaults immediately after initiation, the investor, who has paid 100 for the asset swap, is left with an asset which can be sold for a recovery price R, and an interest rate swap worth 100-P where P is the full price of the bond at initiation. The loss to the investor is -100-R-(100-P) = P-R, the difference between the full price of the bond and the recovery price of the defaulted bond. If the price of the asset is par, i.e. P = 100, then the loss on immediate default is 100-R, similar as we shall see to a default swap.

The point here is that if we hold the credit quality of the asset constant and increase its price, by, say, considering another bond of the same issuer with the same maturity but with a higher coupon, the loss on default is greater and the asset swap spread should increase.

Figure 5. Dependence of asset swap spread on bond coupon



What is more relevant is what happens if we keep the details of the bond constant but allow the credit quality to change. Suppose we fix the LIBOR curve and coupon and the price of the bond changes. As any change in the bond price can only be due to a change in the perceived credit quality of the issuer, as the bond price falls this can only be because the implied credit risk of the issuer is increasing and vice versa. This is clear from Equation 1. An increase in the bond price results in a fall in the asset swap spread. This supports the idea of the asset swap spread as a measure of credit quality.

Table 5 below summarises the various credit spread measures for fixed rate bonds.

Table 5. Summary of credit spread measures for fixed rate bonds

Spread Measure	Summary	Comments
Yield Spread or Yield-Yield Spread	Difference between YTM of the bond and YTM of the benchmark treasury bond.	Assumes reinvestment at same rate as the yield, and assumes the bond is held to maturity. Can be biased as maturities may not be the same and the benchmark bond changes over time.
I-Spread	Difference between YTM of the bond and corresponding rate for the same maturity on a benchmark curve (swaps or treasuries).	Reference curve rates are linearly interpolated. Gets around the maturity mismatch problem of yield spread, but suffers drawbacks from being based on the yield to maturity measure.
OAS or Z-Spread	Parallel shift to treasury or LIBOR zero rates required to reprice the bond.	Relative value measure for the bond against a reference curve. A rough measure of credit quality. Expect a difference in the computed OAS based on compounding frequency: Bloomberg uses discrete compounding, while Lehman uses continuous.
Asset Swap Spread or Gross Spread	Investor pays par and receives LIBOR+ASW instead of paying full price and receiving fixed coupons.	This is a tradable spread – not a spread “measure” – it corresponds to a real cashflow. A better measure of compensation for assuming credit risk as the cashflows are real and the interest rate exposure is residual.
CDS Spread[3]	Compensation for expected loss due to a credit event. A “real” spread.	Cleanest measure of credit risk. Similar to OAS if recovery rates are zero, but a pricing rather than a yield measure. Better than ASW since the contract terminates following a credit event (no residual interest rate swap MTM).

[3] *The CDS spread is defined in a later section but included here for completeness.*

3. CREDIT SPREAD MEASURES FOR FLOATING RATE NOTES

We now turn to Floating Rate Notes (FRNs). In contrast to fixed rate bonds, there are fewer commonly quoted measures of spread for FRNs. These are the quoted margin which determines contractual cashflows, discount margin which is similar to yield-to-maturity, and zero-discount margin which is similar to OAS. We now describe each in turn.

QUOTED MARGIN (QM)

The quoted margin is not strictly a spread measure; it is simply the spread over the LIBOR index paid by a floating rate note.

Definition

The quoted margin is the fixed, contractual spread over the floating rate index, usually LIBOR, paid by a floating rate note.

Once issued, the quoted margin of the bond is contractually fixed. In certain cases, defined within the bond prospectus, it may step up or down. It is therefore not a dynamic measure of ongoing credit quality. At most it only reflects the credit quality of the issuer *on the issue date of the bond* since this was the spread over LIBOR at which the bond could be issued at par

Example

To illustrate credit spread measures for FRN's, we consider a Ford Motor Credit bond with maturity 6 January 2006. This bond pays quarterly coupons indexed to the 3M-Euribor with accrued interest computed on an ACT360 basis. It is currently trading at a clean price of 101.09.

The quoted margin for this bond is 175bp. The floating rate is set at the start of each period, so that the coupon is known 3 months in advance. In this case, the size of the coupon due on 6 April 2004 is 3.87% (annualised), which means that the floating rate was fixed at 2.12% on 6 January 2004.

DISCOUNT MARGIN (DM)

Unlike the quoted margin, the discount margin is a dynamic spread measure which reflects the ongoing perceived credit quality of the note issuer. It is a simple measure of spread which assumes that the underlying reference curve is flat.

Definition

The discount margin is the fixed add-on to the current LIBOR rate that is required to reprice the bond.

Discount margin measures yield relative to the current LIBOR level and does not take into account the term structure of interest rates. In this sense, it is analogous to the YTM of a fixed rate bond.

The expected cashflows of an FRN are usually based on forward LIBOR rates. In the discount margin calculation, however, the assumption is that all future realised LIBOR rates will be equal to the current LIBOR rate. Cashflows are therefore projected as the current LIBOR plus quoted margin (except for the first cashflow, which is known for sure). Discount factors are also based on the current level of LIBOR, adjusted by a margin. The size of the margin is chosen to reprice the FRN, in which case it is called the discount margin.

The discount margin δ satisfies the following relationship:

$$P^{full} = \frac{L_{fix} + q}{1 + \Delta_1 (L_{stub} + \delta)} + \sum_{j=2}^{n} Z_\delta(T_j)\Delta_j (L + q) + 100 Z_\delta(T_n)$$

where

$$Z_\delta(T_j) = \frac{Z_\delta(T_{j-1})}{1 + \Delta_j (L + \delta)}; Z_\delta(T_1) = \frac{1}{1 + \Delta_1 (L_{stub} + \delta)}$$

and we have used the following notation:

P^{full}	=	Full price of the FRN
q	=	Quoted margin on the FRN
L_{fix}	=	Known LIBOR rate for the current coupon period
L_{stub}	=	LIBOR between the valuation date and the next coupon date
L	=	Current LIBOR for the term of the FRN coupons (e.g. 3M)
$\Delta_1,\ldots,\Delta_n$	=	Coupon accrual periods in the appropriate basis (e.g. ACT360)
$T_1,\ldots,T_n$	=	Cashflow dates for the FRN

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.

Example

The concept of discount margin is best illustrated using an example. Consider the same bond as before, i.e. Ford €+175bp 6 Jan 2006. The previous Euribor fixing, which together with the quoted margin determines the cashflow at the next coupon date, is 2.12%. The stub Euribor to the next coupon date, used to determine the discount factor, is 2.057%.

The bond pays quarterly coupons. The current level of 3M-Euribor is 2.064%. For all cashflows beyond the next coupon date to maturity, the discount margin calculation assumes that the realised Euribor rate is equal to 2.064%. This is also used in discounting.

The calculation of discount margin is illustrated in Table 6. Since the Euribor fixing for the current period is known, we can compute accrued interest. The full price of the FRN is 101.50. The discount margin comes out to 116.3bp.

As with most spread calculations for fixed rate bonds, we typically need to use a 1-dimensional root-searching algorithm to solve for the discount margin.

Table 6. Discount margin calculation

Date	Accrual Factor (ACT360)	Projected LIBOR	LIBOR + Discount Margin	Adjusted Discount Factor	Projected Cashflows
06-Jan-04				1.0000	
06-Apr-04	0.253	2.057%	3.220%	0.9952	0.978
06-Jul-04	0.253	2.064%	3.227%	0.9871	0.964
06-Oct-04	0.256	2.064%	3.227%	0.9791	0.975
06-Jan-05	0.256	2.064%	3.227%	0.9711	0.975
06-Apr-05	0.250	2.064%	3.227%	0.9633	0.954
06-Jul-05	0.253	2.064%	3.227%	0.9555	0.964
06-Oct-05	0.256	2.064%	3.227%	0.9477	0.975
06-Jan-06	0.256	2.064%	3.227%	0.9399	100.975
Implied full price from Discount Margin (116.3bp):				**101.498**	

Interpretation

Discount margin is similar to the yield-to-maturity measure for fixed rate bonds. It expresses the price of an FRN relative to the current LIBOR level, and as such does not take into account the shape of the yield curve.

ZERO DISCOUNT MARGIN

The zero discount margin is the analogous spread measure to the zero volatility spread used for fixed rate bonds.

Definition

The Zero Discount Margin (Z-DM) is the parallel shift to the forward LIBOR curve that is required to reprice the FRN.

Forward LIBOR rates are used to project cashflows, and adjusted by the Z-DM to calculate discount rates. Z-DM therefore takes into account the term structure of interest rates. The calculation of Z-DM is similar to that for discount margin, except that forward LIBOR rates are used rather than current rates. It is determined using the equation:

$$P^{full} = \frac{L_{fix} + q}{1 + \Delta_1 (L_{stub} + \zeta)} + \sum_{j=2}^{n} Z_\zeta (T_j) \Delta_j (L(T_{j-1}, T_j) + q) + 100 Z_\zeta (T_n)$$

where

$$Z_\zeta (T_j) = \frac{Z_\zeta (T_{j-1})}{1 + \Delta_j (L(T_{j-1}, T_j) + \zeta)}; Z_\zeta (T_1) = \frac{1}{1 + \Delta_1 (L_{stub} + \zeta)} .$$

Here, $L(T_{j-1}, T_j)$ is the forward LIBOR rate between the two cashflow dates T_{j-1} and T_j, ζ is the Z-DM, and the rest of the notation is the same as for the discount margin calculation.

Example

Table 7 below illustrates the calculation of the zero discount margin for the bond in the previous example. The calculated Z-DM is 116.2bp, which is close to the discount margin since the FRN has short maturity. In general for upward-sloping yield curves, the Z-DM is less than the discount margin.

Table 7. Calculation of Z-DM

Date	Accrual Factor (ACT360)	Projected LIBOR	LIBOR + Zero-DM	Adjusted Discount Factor	Projected Cashflows
06-Jan-04				1.0000	
06-Apr-04	0.253	2.057%	3.219%	0.9952	0.978
06-Jul-04	0.253	2.077%	3.239%	0.9871	0.967
06-Oct-04	0.256	2.107%	3.269%	0.9789	0.986
06-Jan-05	0.256	2.191%	3.353%	0.9706	1.007
06-Apr-05	0.250	2.416%	3.578%	0.9620	1.042
06-Jul-05	0.253	2.678%	3.839%	0.9528	1.119
06-Oct-05	0.256	2.829%	3.991%	0.9431	1.170
06-Jan-06	0.256	2.976%	4.137%	0.9333	101.208
Implied full price from Z-DM (116.2bp):					**101.498**

Interpretation

The Z-DM is similar to a par floater spread; in fact they are 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 $\zeta = q$ and we are on a coupon refix date, the price of the bond equals par.

Both DM and Z-DM are yield measures, and as such should be viewed as ways to express the price of an FRN relative to some curve. Only the quoted margin is a real cashflow measure.

4. CREDIT DEFAULT SWAP SPREAD

The CDS spread is the contractual premium paid to a protection seller in a credit default swap contract. As such it measures the compensation to an investor for taking on the risk of losing par minus the expected recovery rate of a bond if a credit event occurs before the maturity of the CDS contract. It is termed a "spread" even though it does not explicitly reference any interest rate curve. However, implicitly, the reference curve is Libor.

Definition

The CDS spread is the contractual spread which determines the cashflows paid on the premium leg of a credit default swap.

It is the spread which makes the expected present value of the protection and premium legs the same. The valuation of CDS is described fully in the references and reviewed in the next section, but we can consider a simple example to explain the basic concepts.

Example

Suppose an investor sells protection on $10mm notional to a 5-year horizon on a credit risky issuer at a default swap spread of 200bp. The investor is paid for protection in the form of fixed quarterly instalments of approximately $50,000. The payments stop if the issuer defaults prior to maturity, in which case the value of protection delivered by the seller is par minus the recovery rate. Assuming a recovery rate of 40%, the investor would lose $6mm.

It has been shown that the valuation of a CDS position requires a model. The reader is referred to O'Kane and Turnbull (2003) for a more detailed discussion.

Interpretation

The CDS spread is arguably the best measure of credit risk for several reasons. First, a CDS contract is almost a pure credit play, with low interest rate risk. Second, it corresponds to a realisable stream of cashflows, which compensates an investor for a loss of par minus the recovery rate of the issuer following a credit event. All cashflows cease and the contract is settled following a credit event. Third, an investor can trade CDS to a number of fixed terms, so we should be able to observe a term structure. Finally, the CDS market is relatively liquid, so that CDS spreads accurately reflect the market price of credit risk.

5. CONCLUSIONS

In this article, we have tried to explain the precise definition and significance of the plethora of market terms used to express the credit risk embedded in a bond. There is an important distinction between measures of yield and tradable measures of spread. The former should be viewed as convenient ways to express the price of a bond or FRN relative to some benchmark instrument (bond, rate or curve). The latter can be translated into physical cashflows. There remains the important issue of how these spreads compare with each other, particularly in regard to their relative magnitudes and sensitivities to changes in the credit quality of the underlying bond. This analysis is left to a forthcoming paper in the Quantitative Credit Research Quarterly series.

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LEHMAN BROTHERS

Credit Derivatives and Quantitative Research
New York, London
January 2005

JPMorgan

Credit Derivatives:
A Primer

About this primer

This primer introduces credit derivatives to new users and explains how to value and trade them. The supporting graphs, exhibits, footnotes, and appendices further aid the reader in learning about credit derivatives.

JPMorgan publishes daily reports that analyze the credit derivative markets. To receive electronic copies of these reports, please contact a Credit Derivatives research professional or your salesperson. These reports are also available on www.morganmarkets.com.

1. Introduction

A credit derivative is a financial contract that allows one to take or reduce default exposure, generally on bonds or loans, of a sovereign or corporate entity. The contract is between two parties and does not directly involve the issuer itself. Credit derivatives are primarily used to:

1) reduce risk arising from ownership of bonds or loans

2) take exposure to an entity, as one would do by buying a bond or loan, and

3) express a positive or negative credit view on a single entity or a group of entities, independent of any other exposures to the entity one might have.

Since its introduction in the mid-1990s, the growth of the credit derivative market has been dramatic:

- The notional amount of credit derivative contracts outstanding at the end of 2003 stood at $3.5 trillion, up 82% from 2002[1]. At the end of 2004, outstanding contracts are estimated to be $5 trillion.
- The tremendous growth in the credit derivatives market has been driven by the diversification of participants, the standardization of documentation, and the growth of product applications.
- Credit derivatives have become mainstream and are integrated with credit trading and risk management at many firms.
- We estimate that single-name credit default swaps represent about 60% of the total volume of credit derivatives traded, while credit derivative index products (see Section 6) represent about 25%. Options, first-to-default baskets, synthetic CDOs, and tranched credit products (see Section 7)

1. British Bankers' Association estimates.

The certifying analyst(s) is indicated by a superscript AC. See last page of the report for analyst certification and important legal and regulatory disclosures.

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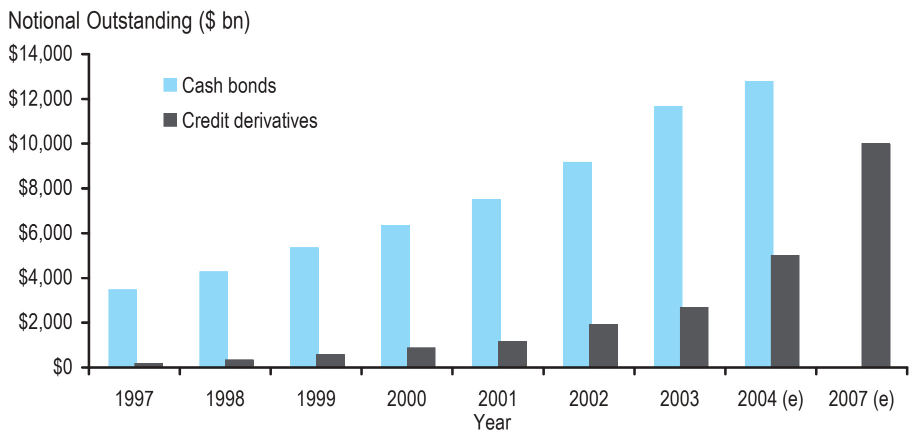
account for the remaining 15% of the credit derivatives market. We expect this segment to grow.

- The variety of products is growing along with the sophistication of users. Recent additions to the credit derivatives product suite allow for the trading of spread volatility, correlation, and spread curves, as well as specific components of credit risk such as recovery rates.

Exhibit 1: Credit derivative volumes continue to grow rapidly and are an increasing portion of total debt outstanding.



Sources: British Bankers' Association, Bank for International Settlements.

2. The credit default swap

The credit default swap (CDS) is the cornerstone of the credit derivatives market. A credit default swap is an agreement between two parties to exchange the credit risk of an issuer (reference entity). The buyer of the credit default swap is said to buy protection. The buyer usually pays a periodic fee and profits if the reference entity has a credit event, or if the credit worsens while the swap is outstanding. A credit event includes bankruptcy, failing to pay outstanding debt obligations, or in some CDS contracts, a restructuring of a bond or loan[2]. Buying protection has a similar credit risk position to selling a bond short, or "going short risk."

The seller of the credit default swap is said to sell protection. The seller collects the periodic fee and profits if the credit of the reference entity remains stable or improves while the swap is outstanding. Selling protection has a similar credit risk position to owning a bond or loan, or "going long risk."

As shown in exhibit 2, Investor B, the buyer of protection, pays Investor S, the seller of protection, a periodic fee (usually on the 20th of March, June, September, and December) for a specified time frame. To calculate this fee on an annualized basis, the two parties multiply the notional amount of the swap, or the dollar amount of risk being exchanged, by the market price of the credit default swap (the market price of a CDS is also called the spread or fixed rate). CDS market prices are quoted in basis points (bp), and are a measure of the reference entity's credit risk. (Section 3 discusses how credit default swaps are valued.)

2. See the appendix for an in-depth description of credit events

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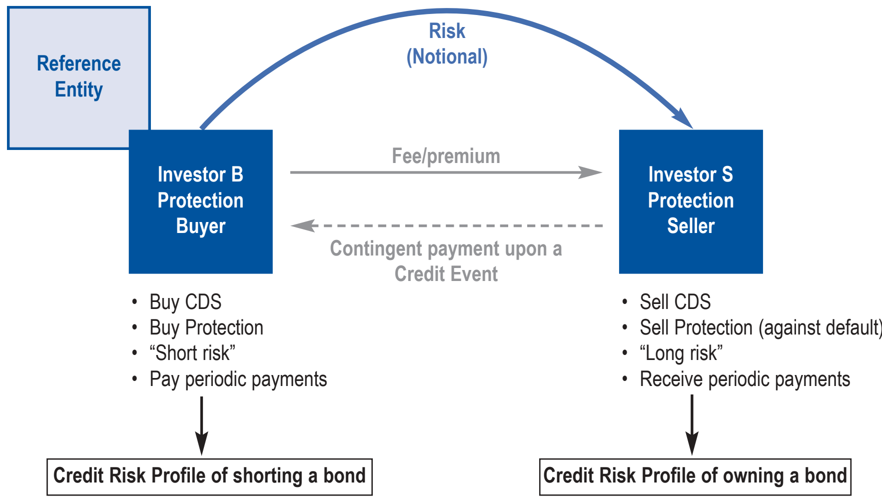
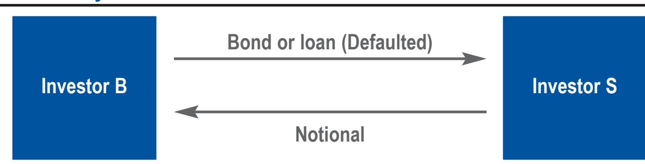
Exhibit 2: Single name credit default swaps



Definition: A credit default swap is an agreement in which one party buys protection against losses occurring due to a credit event of a reference entity up to the maturity date of the swap. The protection buyer pays a periodic fee for this protection up to the maturity date, unless a credit event triggers the contingent payment. If such trigger happens, the buyer of protection only needs to pay the accrued fee up to the day of the credit event (standard credit default swap), and deliver an obligation of the reference credit in exchange for the protection payout.
Source: JPMorgan.

Exhibit 3: If the Reference Entity has a credit event, the CDS Buyer delivers a bond or loan issued by the reference entity to the Seller. The Seller then delivers the Notional value of the CDS contract to the Buyer.



Source: JPMorgan.

Following a credit event, the buyer of protection delivers to the seller of protection defaulted bonds and/or loans with a face amount equal to the notional amount of the credit default swap contract. The seller of protection then delivers the notional amount on the CDS contract in cash to the buyer of protection. The buyer can deliver any bond meeting certain criteria issued by the reference entity that is pari passu, or of the same level of seniority, as the specific bond referenced in the contract. This is called "physical settlement," as the "physical" bonds are delivered. Alternatively, because the CDS contract is a bilateral agreement, the buyer and seller can agree to unwind the trade based on the market price of the defaulted bond, for example $40 per $100. The seller then pays the net amount owed to the protection buyer, or $100 - $40 = $60. This is called "cash settlement." It is important to note that the recovery rate ($40 in this example) is not fixed and is determined only after the credit event.

There does not need to be a credit event for credit default swap investors to capture gains or losses, however. Like bonds, credit default swap spreads widen when the market perceives credit risk has increased and tightens when the market perceives credit risk has improved. For example, if Investor B bought five years of protection (short risk) paying 50bp per year, the CDS spread could widen to 75bp after one year.

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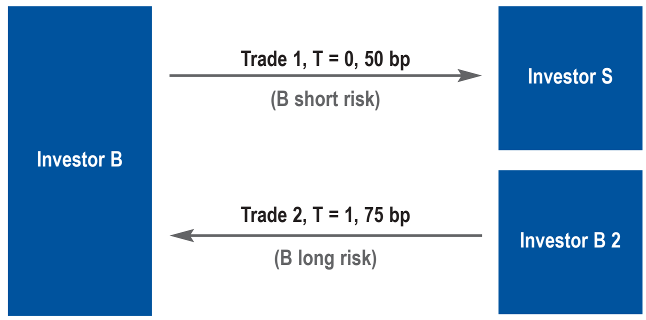
Investor B could collect profits and unwind the swap by selling four-year protection (long risk) at 75bp. Investor B would receive the present value of 75 – 50 = 25bp for the remaining four years on her contract multiplied by the notional amount of the swap (this is an approximation; Section 8 details the profit calculation).
Other notes about credit default swaps:

Exhibit 4: CDS investors can capture gains and losses before the contract matures.



Note that Investor B may directly unwind Trade 1 with Investor S, or instead with Investor B2 (presumably for a better price). If she chooses to do the unwind trade with Investor B2, she tells Investor B2 that she is assigning her original trade with S to Investor B2. Investor S and Investor B2 then have offsetting trades with each other. In either case her profit is the same. She would receive the present value of (75 - 50 = 25 bp) * (4, approximate duration of contract) * (notional amount of the swap). Thus, Investor B finishes with cash equal to the profit on the trade and no outstanding positions.
Source: JPMorgan.

- The most commonly traded and therefore the most liquid tenors, or maturity lengths, for credit default swap contracts are five and ten years, though liquidity across the maturity curve continues to develop.
- Standard trading sizes vary depending on the reference entity. For example, in the US, $10 - 20 million notional is typical for investment grade credits and $2-5 million notional is typical for high yield credits. In Europe, €10 million notional is typical for investment grade credits and €2 - 5 million notional is typical for high yield credits.

Credit default swaps and credit-linked notes
Credit default swaps are swap contracts where upfront cash is not exchanged at the time of the transaction but may be exchanged in the future based on market outcomes. The economics of the credit default swap can be captured in a funded security or a note. A credit linked note is a synthetic security, typically issued by a special purpose vehicle, that trades like a bond issued by the reference entity but with the economics of the credit default swap. For this security, the buyer of protection sells the note. As in the credit default swap, the protection buyer is still “going short risk.” The buyer of protection (note seller) will pay periodic payments and profit if the reference entity defaults. Unlike the swap, the buyer of protection in a credit-linked note will receive money at the time of transaction from the sale of the note, and will return this money at the contract’s maturity if no credit event occurs.

Conversely, the seller of protection purchases the note and is “long risk.” As with a credit default swap, the note purchaser (protection seller) receives periodic payments. Unlike the swap transaction, the protection seller must pay for the note at the time of the transaction and will collect this money at the contract’s maturity if no credit event occurs. Thus, the cash flows and risks of buying and selling credit-linked notes are similar to buying and selling bonds.

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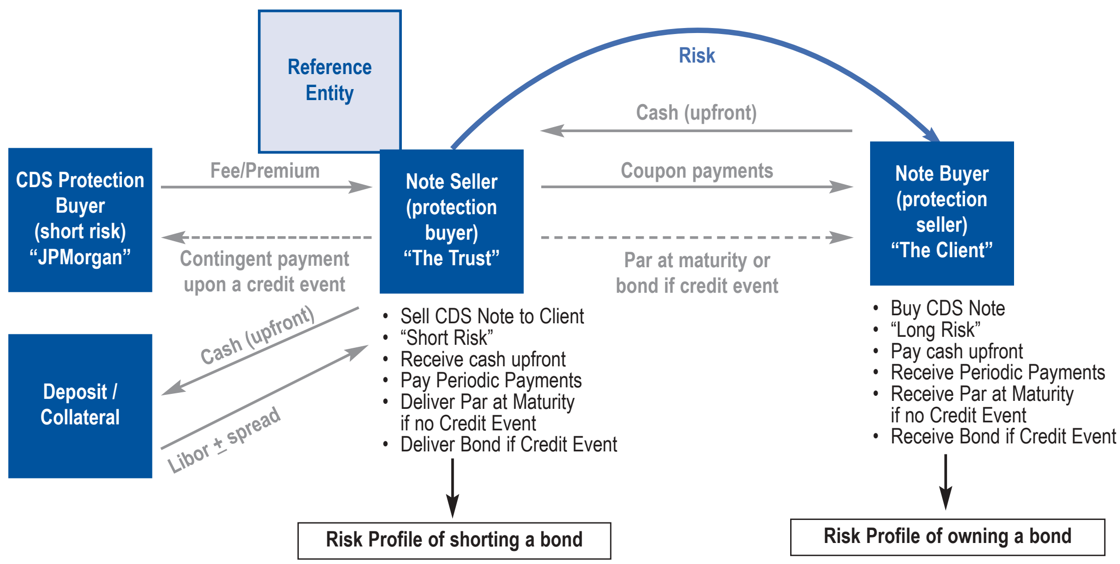
Recall that, in a credit default swap, if a reference entity has a credit event, the buyer of protection (short risk) delivers defaulted bonds or loans to the seller of protection (long risk), then receives the notional value of the credit default swap contract. In other words, the buyer of protection receives par minus the recovery value of the defaulted bond. When a reference entity of a credit linked note defaults, the economics are identical. In the case of default, the buyer of protection (short risk), or the investor who sold the note, delivers bonds and/or loans of the reference entity and keeps the cash she received at the trade's inception.

Exhibit 5: Credit-Linked Notes are a synthetic security that trades like a bond issued by the Reference Entity, but with the economics of a credit default swap.



Source: JPMorgan.

3. Valuation and relative value analysis of credit default swaps

Credit default swaps and bonds of the same credit will usually trade similarly, as both reflect the market's view of default risk. In order to compare credit default swaps with bonds, one needs to isolate the spread of the bond that compensates the holder for assuming the credit risk of the issuer.

Intuition behind credit default swap valuation

To make the comparison between credit default swaps and bonds, we assume that the yield on a typical fixed-rate corporate bond is intended to compensate the holder for the following:

- Risk-Free Rate: the bond holder could earn this yield in a default/risk-free investment (for example, the US Treasury rate).
- Funding Risk: This is the swap spread. The swap yield (swap spread plus the risk-free rate) is the hurdle rate for investment opportunities for many investors.
- Credit Risk: the risk that the investor might suffer a loss if the issuer defaults.

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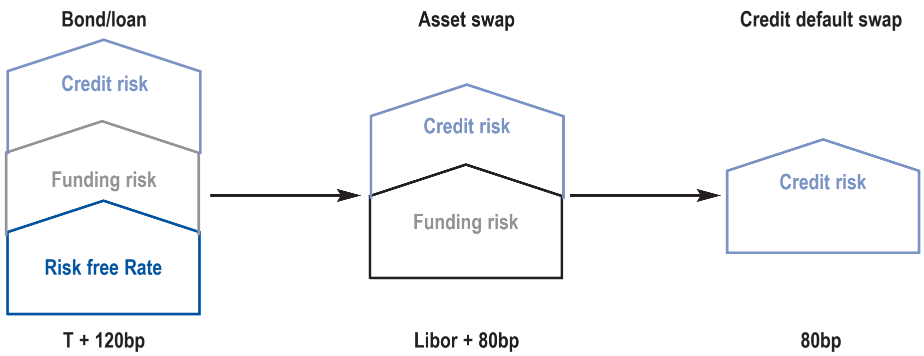
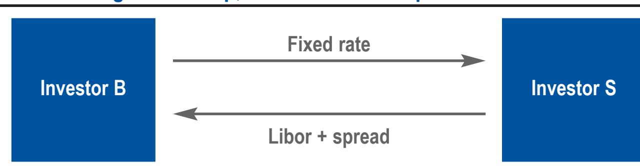
For example, assume that a bond is paying a yield of Treasury rates plus 120bp (Exhibit 6). To remove interest-rate risk from owning this bond, an investor can swap the fixed payments received from the bond for floating rate payments through an asset swap. In a fixed-to-floating asset swap, Investor B (Exhibit 7) agrees to make a series of fixed payments to Investor S, and Investor S makes floating payments to Investor B. Swaps are typically constructed so that the present value of the fixed payments equals the present value of the floating payments. In our example, the fixed rate is the bond's coupon, and we solve for the floating rate equivalent, Libor[3] + 80bp. As a result of the fixed-to-floating rate swap, Investor B will receive floating payments equal to Libor + 80bp. Thus, the value of Investor B's position is no longer very sensitive to changes in risk-free rates, as she will receive a higher coupon as rates increase and lower coupon as rates decrease.

Exhibit 6: Spreads of Credit Default Swaps can be compared to bond yields.



Source: JPMorgan.

Exhibit 7: Fixed to floating asset swap, or a "Vanilla" swap



Source: JPMorgan.

To isolate the credit risk, our investor must account for her funding costs, or the rate at which she borrows money needed to purchase the bonds. In our example, we assume that an investor can borrow money at a rate of Libor. Thus, if an investor purchased this bond, she would receive the yield on the bond less her borrowing costs, or (Libor + 80bp) – Libor = 80bp. The difference between the bond's yield and the swap yield curve (Libor) is called the Z-spread[4]. For bonds trading with

3. London interbank offer rate.

4. More specifically, the Z-spread is the value that solves the following equation (assuming a three period bond):

$$Bond\ Price = \frac{c_1}{(1+s_1+Z)^1} + \frac{c_2}{(1+s_2+Z)^2} + \frac{c_3 + Face}{(1+s_3+Z)^3}$$

Where Bond Price = current market price, c_i = coupon at time *i*, s_i = swap rate at time *i*, Face = face value of bond.

The I-spread is also used in the valuation of bonds. It solves the equations (assuming a three period bond):

$$Bond\ Price = \frac{c_1}{(1+YTM)^1} + \frac{c_2}{(1+YTM)^2} + \frac{c_3 + Face}{(1+YTM)^3}$$

I-spread = YTM - s_t

Where YTM = yield to maturity, s_t = swap rate to bond's maturity date.

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low Z-spreads and market prices close to par, or $100, it is usually valid to directly compare the Z-spread on a bond to the credit default swap spread. For example, if a bond has a Z-spread of 100bp and the CDS spread for the same credit and same maturity trades at 120bp, one could conclude that the CDS market was assigning a more bearish view compared to the bond market for this credit. In this case, there may be a relative value trading opportunity between the bonds and CDS. For bonds not trading close to par, investors should make adjustments to the Z-spread to more accurately compare it to the market-quoted credit default swap spread with the same maturity date.

Par equivalent credit default swap spread
If the bond's Z-spread is wide and/or the bond's price is not close to $100, the subtle differences between the Z-spread and the credit default swap spread become more important. We call the "perfect" bond spread to compare to a credit default swap spread a par equivalent credit default swap spread. In this calculation, we make adjustments to a bond's Z-spread so it is directly comparable to the CDS market. We emphasize, however, that for most investment-grade bonds, Z-spreads and par equivalent CDS spreads will be within a few basis points.

The reason that adjustments should be made to the bond's Z-spread, derived above, before comparing it to a credit default spread are:

Differences in cash prices between bonds and credit default swaps
For a given issuer, if a bond and a credit default swap have the same spread and the issuer does not default, the return on the bond and CDS will be the same. If a company defaults, however, the loss to the bond holder (long risk) and CDS seller (long risk) may not be the same.

For example, assume an investor is considering purchasing a bond with a price of $110.00, one year to maturity and a 3% spread over swaps. Assume that the one year CDS for this company also has a 3% spread. If the investor has $100 to spend (or to risk), she will buy $100 / $110 or 0.9091 bonds, or she will sell protection (take risk) for $100 notional in CDS. If there is no default, the investor will earn $3 in either case. If there is a credit event, however, the returns will not be the same. A bond investor will lose money equal to the price she paid for the bond less the recovery value she receives for selling the defaulted bond. In our example, if the defaulted bond's price falls to $40, the investor will have suffered a loss of: (price change) * (number of bonds), or ($110 - $40)*(.91) = $63.64. Alternatively, if the investor had sold $100 of default protection, her loss would be equal to the notional amount of CDS contract minus the recovery value of bonds delivered, or $100 – $40 = $60. A premium bond is thus more expensive, when compared to a credit default swap, than the Z-spread implies, because the bond has more risk in the case of default, while the same return on credit risk as a CDS if there is no default.

Exhibit 8: Although a bond and a CDS may have the same spread, they may have a different loss profile in the case of default.

Bond		Credit Default Swap	
Z-spread	3%	Market spread	3%
Cash at risk	$100	Cash at risk	$100
Bond price	$110		
No. of bonds purchased	0.9091		
Default recovery price	$40	Default recovery price	$40
Cash loss	(110-40)*0.909 = **$63.64**	Cash loss	100-40 = **$60**

Source: JPMorgan.

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In the par-equivalent CDS spread calculation, we adjust for the additional risk of default for bonds priced above par by making a downward adjustment to the Z-spread. In other words, we lower the bond Z-spread because a bond priced above par can be thought of as "more expensive" than the unadjusted Z-spread implies, for there will be a greater loss on default for a bond compared to a CDS. An upward adjustment to the Z-spread is made if the bonds are priced below par.

Convention with coupon payments
The coupon payments for US corporate bonds are paid semi-annually and accrue using a 30/360 day count convention (30-day month and 360-day year). The coupon, or fee payments, for a credit default swap are paid quarterly and accrue using an actual/360 convention. The par equivalent CDS spread adjusts for this by converting the bond's coupon payments to the credit default swap convention.

Treatment of coupons in the event of default
If an issuer defaults in between scheduled coupon payments, the bond investor does not receive money for the coupon payment. Rather, the missed accrued payment is a claim on the company's assets. On the other hand, if an issuer defaults in between scheduled credit default swap coupon payments, the seller of protection (long risk) receives the accrued coupon payment up to the date of default. This payment will be settled when the buyer and seller of protection close the transaction.

The potential cost to unwind a swap
As described in Exhibit 6, the yield on a bond can be divided into the swap yield plus a credit spread. When an issuer defaults, both the swap part of the bond coupon payments and the credit part of the coupon payments stop. For a credit default swap investor to replicate a long bond position, she would sell protection (long risk) and invest in swaps (paying floating, receiving fixed). But for the CDS investor, the swap coupon will continue to pay until maturity if the issuer defaults. To make the swap plus credit default swap investment equivalent to a bond, we must adjust for the potential cost to unwind the swap position before maturity. This cost, multiplied by the probability of default, discounted to present value terms, is another adjustment made to calculate the par equivalent CDS spread. (Please see the appendix for more detail on par equivalent CDS spread calculations.)

The difference between bonds and credit default swap spreads
Basis refers to the difference, in basis points, between a credit default swap spread and a bond's par equivalent CDS spread with the same maturity dates. Basis is either zero, positive or negative.

Negative basis
If the basis is negative, then the credit default swap spread is lower than the bond's spread. This occurs when there is excess protection selling (investors looking to go long risk and receive periodic payments), reducing the CDS coupon. Excess protection selling may come from structured credit issuers (or CDO issuers, discussed in Section 7), for example, who sell protection in order to fund coupon payments to the buyers of structured credit products. Protection selling may also come from investors who lend at rates above Libor. For these investors, it may be more economical to sell protection (long risk) and invest at spreads above Libor, rather than borrow money and purchase a bond.

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An investor could buy the bond (long risk) then buy protection (short risk), to capture this pricing discrepancy. In this trade, an investor is not exposed to default risk, yet still receives a spread. This is, therefore, a potential arbitrage opportunity[5]. Trading desks at investment banks and other investors who can fund long bond positions cheaply (borrowing at or near Libor) will typically enter into this position when the negative basis exceeds 10–25bp. Such arbitrage opportunities are increasingly rare.

Exhibit 9: Basis is the basis point difference between a credit default swap spread and a bond's par equivalent credit default swap spread with the same maturity dates. Basis is either positive or negative.

						Potential Trade	
Negative Basis	CDS Spread	—	**Bond's Par Equivalent Spread**	<	0	Buy bonds Buy protection	(long risk) (short risk)

						Potential Trade	
Positive Basis	**CDS Spread**	—	Bond's Par Equivalent Spread	>	0	Sell protection Short bonds (if possible)	(long risk) (short risk)

Source: JPMorgan.

Positive basis

If the basis is positive, then the credit default spread is greater than the bond's spread. Positive basis occurs for technical and fundemential reasons. The technical reasons are primarily due to imperfections in the repo[6] market for borrowing bonds. Specifically, if cash bonds could be borrowed for extended periods of time at fixed costs, then there would not be a reason for bonds to trade "expensive" relative to credit default swaps. If a positive basis situation arises, investors would borrow the bonds and sell them short, eliminating the spread discrepancy. In practice, there are significant costs and uncertainties in borrowing bonds. Therefore, if the market becomes more bearish on a credit, rather than selling bonds short, investors may buy default protection (short risk). This may cause credit default swap spreads to widen compared with bond spreads.

Another technical factor that causes positive basis is that there is, to some degree, a segmented market between bonds and credit default swaps. Regulatory, legal and other factors prevent some holders of bonds from switching between the bond and credit default swap markets. These investors are unable to sell a bond and then sell protection (long risk) when the credit default swap market offers better value. Along this vein of segmented markets, sometimes there are market participants, particularly coming from the convertible bond market, who wish to short a credit (buy default swap protection) because it makes another transaction profitable[7]. These investors may pay more for the protection than investors who

5. The trade does have mark-to-market and counterparty risk.
6. A repurchase (repo) trade is when an investor borrows money to purchase a bond, posts the bond as collateral to the lender, and pays an interest rate on the money borrowed. The interest rate is called the repo rate. Most repo transactions are done on an overnight basis or for a few weeks at most. To sell a bond short, an investor must find an owner of the bond, borrow the bond from the owner in return for a fee (repo rate), then sell the bond to another investor for cash. This is difficult to do at a fixed repo cost for extended periods of time.
7. Investors may purchase convertible bonds and purchase default protection in the CDS market, thus isolating the equity option embedded in the convertible.

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are comparing the bonds and credit default swap markets. This is another manifestation of the undeveloped repo market.

A fundemental factor that creates positive basis is the cheapest-to-deliver option. A short CDS position (long risk) is short the cheapest-to-deliver option. If there is a credit event, the protection buyer (short risk) is contractually allowed to choose which bond to deliver in exchange for the notional amount. This investor will generally deliver the cheapest bond in the market. When there is a credit event, bonds at the same level of the capital structure generally trade at the same price (except for potential differences in accrued interest) as they will be treated similarly in a restructuring. Still, there is the potential for price disparity. Thus, protection sellers (long risk) may expect to receive additional spread compared to bonds for bearing this risk. This would lead to CDS spreads trading wider than bond spreads and therefore contribute to positive basis.

4. The importance of credit derivatives

Credit derivatives have been widely adopted by credit market participants as a tool for managing exposure to, or investing in, credit. The rapid growth of this market is largely attributable to the following features of credit derivatives:

Credit derivatives allow the disaggregation of credit risk from other risks inherent in traditional credit instruments.
A corporate bond represents a bundle of risks including interest rate, currency (potentially), and credit risk (constituting both the risk of default and the risk of volatility in credit spreads). Before the advent of credit default swaps, the primary way for a bond investor to adjust his credit risk position was to buy or sell that bond, consequently affecting his positions across the entire bundle of risks. Credit derivatives provide the ability to independently manage default risk and interest rate risk.

Credit derivatives provide an efficient way to short a credit.
While it can be difficult to borrow corporate bonds on a term basis or enter into a short sale of a bank loan, a short position can be easily achieved by purchasing credit protection. Consequently, risk managers can short specific credits or a broad index of credits, either as a hedge of existing exposures or to profit from a negative credit view.

Credit derivatives create a market for “pure” credit risk that allows the market to transfer credit risk to the most efficient holder of risk.
Credit default swaps represent the cost to assume “pure” credit risk, as discussed in the Valuation section on page 5. Bond, loan, equity, and equity-linked market participants may transact in the credit default swap market. Because of this central position, the credit default swap market will often react faster than the bond or loan markets to news affecting credit prices. For example, investors buying newly issued convertible debt are exposed to the credit risk in the bond component of the convertible instrument, and may seek to hedge this risk using credit default swaps. As buyers of the convertible bond purchase protection, spreads in the CDS market widen. This spread change may occur before the pricing implications of the convertible debt are reflected in bond market spreads. However, the change in CDS spreads may cause bond spreads to widen as investors seek to maintain the value relationship between bonds and CDS. Thus, the CDS market can serve as a link between structurally separate markets. This has led to more awareness of and participation from different types of investors.

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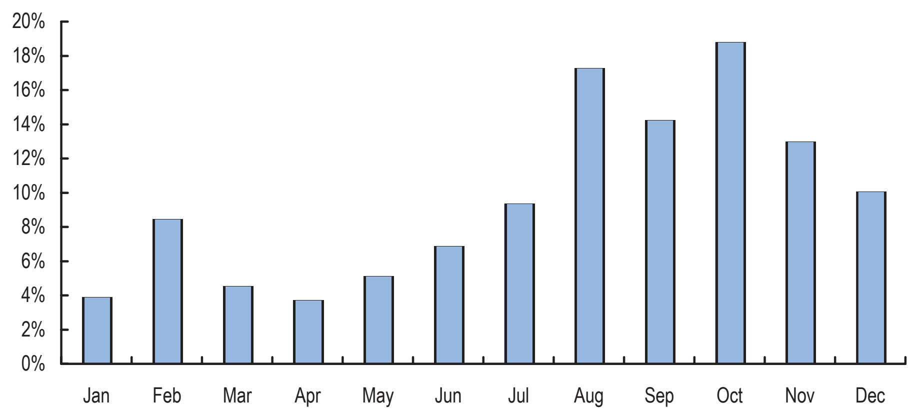
Credit derivatives provide liquidity in times of turbulence in the credit markets. The credit derivative market is able to provide liquidity during periods of market distress (high default rates). Before the credit default swap market, a holder of a distressed or defaulted bond often had difficulty selling the bond–even at reduced prices. This is because cash bond desks are typically long risk as they own an inventory of bonds. As a result, they are often unwilling to purchase bonds and assume more risk in times of market stress. In contrast, credit derivative desks typically hold an inventory of protection (short risk), having bought protection through credit default swaps. In distressed markets, investors can reduce long risk positions by purchasing protection from credit derivative desks, which may be better positioned to sell protection (long risk) and change their inventory position from short risk to neutral. Furthermore, the CDS market creates natural buyers of defaulted bonds, as protection holders (short risk) buy bonds to deliver to the protection sellers (long risk). CDS markets have, therefore, led to increased liquidity across many credit markets.

As the exhibit below illustrates, CDS volumes as a percentage of cash volumes increased steadily during the distressed spring and summer of 2002 in the face of credit-spread volatility and corporate defaults.

Exhibit 10: The CDS market remained liquid during the turbulent second half of 2002.

US High Yield CDS volumes as a % of High Yield cash volumes: 2002



Source: JPMorgan.

Credit derivatives provide ways to tailor credit investments and hedges. Credit derivatives provide users with various options to customize their risk profiles. Through the CDS market, investors may assume exposure to credits that do not actively trade in the cash market, customize tenor or currency exposure, or benefit from relative value transactions between credit derivatives and other asset classes. With credit derivatives, investors have access to a variety of structures, such as baskets and tranches that can be used to tailor investments to suit the investor's desired risk/return profile.

Credit derivative transactions are confidential.
As with the trading of a bond in the secondary market, the reference entity whose credit risk is being transferred is neither a party to a credit derivative transaction, nor is even aware of it. This confidentiality enables risk managers to isolate and transfer credit risk discreetly, without affecting business relationships. In contrast, a loan

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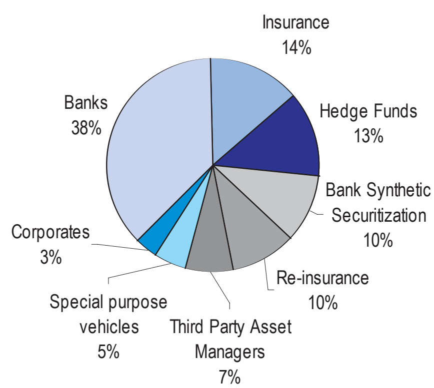
assignment through the secondary loan market may require borrower notification, and may require the participating bank to assume as much credit risk to the selling bank as to the borrower itself. Since the reference entity is not a party to the negotiation, the terms of the credit derivative transaction (tenor, seniority, and compensation structure) can be customized to meet the needs of the buyer and seller, rather than the particular liquidity or term needs of a borrower.

5. Market participants

Over the last 10 years, participants' profiles have evolved and diversified along with the credit derivatives market itself. While banks and hedge funds remain important players in the credit derivatives market, trends indicate that asset managers should be the principal drivers of future growth.

Exhibit 11: Diversity of CDS market participants



Source: Risk magazine: February 2003.

The following is a brief summary of strategies employed by the key players in the credit derivatives market:

Banks and loan portfolio managers
Banks were once the primary players in the credit derivatives market. They developed the CDS market in order to reduce their risk exposure to companies to whom they lent money, thus reducing the amount of capital needed to satisfy regulatory requirements. Banks continue to use credit derivatives for hedging both single-name and broad market credit exposure.

Market makers
In the past, market markers in the credit markets were constrained in their ability to provide liquidity because of limits on the amount of credit exposure they could have on one company or sector. The use of more efficient hedging strategies, including credit derivatives, has helped market makers trade more efficiently while employing less capital. Credit derivatives allow market makers to hold their inventory of bonds during a downturn in the credit cycle while remaining neutral in terms of credit risk. To this end, JPMorgan and some other dealers have integrated their CDS trading and cash trading businesses.

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Hedge funds

Since their early participation in the credit derivatives market, hedge funds have continued to increase their presence and have helped to increase the variety of trading strategies in the market. While hedge fund activity was once primarily driven by convertible bond arbitrage, many funds now use credit default swaps as the most effecient method to buy and sell credit risk. Additionally, hedge funds have been the primary users of relative value trading opportunities and new products that facilitate the trading of credit spread volatility, correlation, and recovery rates.

Asset managers

Asset managers have significantly increased their participation in the credit derivatives market in recent years. Asset managers are typically end users of risk that use the CDS market as a relative value tool, or to provide a structural feature they cannot find in the bond market, such as a particular maturity. Also, the ability to use the CDS market to express a bearish view is an attractive proposition for many asset managers. Prior to the availability of CDS, an asset manager would generally be flat or underweight in a credit they did not like, as most were unable to short bonds in their portfolios. Now, many asset managers may also buy credit protection as a way to take a short-term neutral stance on a credit while taking a bullish longer term view. For example, an asset manager might purchase three-year protection to hedge a ten-year bond position on an entity where the credit is under stress but is expected to perform well if it survives the next three years. Finally, the emergence of a liquid CDS index market has provided asset managers with a vehicle to efficiently express macro views on the credit markets.

Insurance companies

The participation of insurance companies in the credit default swap market can be separated into two distinct groups: 1) life insurance and property & casualty companies and 2) monolines and reinsurers. Life insurance and P&C companies typically use credit default swaps to sell protection (long risk) to enhance the return on their asset portfolio either through Replication (Synthetic Asset) Transactions ("RSATs", or the regulatory framework that allows some insurance companies to enter into credit default swaps) or credit-linked notes. Monolines and reinsurers often sell protection (long risk) as a source of additional premium and to diversify their portfolios to include credit risk.

Corporations

Corporations are recent entrants to the credit derivatives market and promise to be an area of growth. Most corporations focus on the use of credit derivatives for risk management purposes, though some invest in CDS indices and structured credit products as a way to increase returns on pension assets or balance sheet cash positions.

Recent default experiences have made corporate risk managers more aware of the amount of credit exposure they have to third parties and have caused many to explore alternatives for managing this risk. Many corporate treasury and credit officers find the use of CDS appealing as an alternative to credit insurance or factoring arrangements due to the greater liquidity, transparency of pricing and structural flexibility afforded by the CDS market. Corporations are also focused on managing funding costs; to this end, many corporate treasurers monitor their own CDS spreads as a benchmark for pricing new bank and bond deals and are exploring how the CDS market can be used to hedge future issuance.

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6. Credit default swap index products

Credit default swap indices provide investors with a single, liquid vehicle through which to take diversified long or short exposure to a specific credit market or market segment. The first index product was the High Yield Debt Index (HYDI), created by JPMorgan in 2001. Like the S&P 500 and other market benchmarks, the credit default indices reflect the performance of a basket of credits, namely, a basket of single-name credit default swaps (credit default swaps on individual credits). CDS indicies exist for the US investment-grade and high-yield markets, the European investment-grade and high-yield markets, the Asian markets, and global emerging markets.

Unlike a perpetual index like the S&P 500, CDS indices have a fixed composition and fixed maturities. New indices with an updated basket of underlying credits are launched periodically, usually twice a year. New indices are launched in order reflect changes in the credit market and to give the index more consistent duration and liquidity. When a new index is launched, dubbed the “on-the-run index,” the existing indices continue to trade (as “off-the-run”), and will continue to trade until maturity. The on-the-run indices tend to be more liquid than the off-the-run indices.

Mechanics of the indices
JPMorgan has worked with other dealers and the Dow Jones Company to create a global family of highly liquid, standardized CDS indices. The results of this effort are the Dow Jones CDX indices for North America, and the Emerging Markets and the Dow Jones iTraxx indices for Europe, Japan and Asia (two collective ventures within the global credit derivatives dealer community). There is a rules-based portfolio selection process used to create the indices. Credits that are prominent in the market and have liquid single-name credit default swaps are prime candidates for inclusion. Some of the indices have sub-indices based on ratings, industry groups, or geographic region.

The indices pay a fixed coupon that is determined by the consortium at the time of launch such that the market spread of the index will be near to its coupon. As the index trades, the market spread of the index changes while the coupon payment does not. For example, assume that an index has a coupon of 50bp (annual rate) that is paid quarterly. If the market spread of the index is different from the coupon, which is generally the case, there will be an upfront exchange of money to account for this difference. For example, if the market spread of the index is 60bp, the seller of protection (long risk, the investor who receives the coupon) will receive an upfront payment of (60bp minus 50bp)* duration*notional. The upfront payment plus the 50bp coupon is equivalent to receiving a 60bp coupon. Duration is used to calculate the present dollar value of the future spread payments, adjusting for default risk and time value. These calculations can computed using the credit default swap calculator on Bloomberg, discussed in Section 8. Details about duration are found in the appendix.

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Exhibit 12: The global credit derivative indices: DJ iTraxx and DJ CDX

Index	Tenors (yr)	No. of credits underlying index	Options traded?	Tranches traded?
European Investment Grade				
DJ iTraxx Europe Investment Grade	5, 10			
Europe		125	Yes	Yes
Non Financial		100	Yes	
HiVol		30	Yes	
TMT (Telecom, Media, Technology)		20	Yes	
Energy		20		
Auto		10		
Industrial		20		
Consumer		30		
Financial Senior		25		
Financial Sub		25		
European Crossover				
DJ iTraxx Europe Crossover	5, 10	30	Yes	
U.S. Investment Grade				
DJ CDX.NA.IG	1,2,3,4,5,7,10	125	Yes	Yes
High Vol		30	Yes	
U.S. High Yield				
DJ CDX.NA.HY (Swaps)	5			
100		100	Yes	Yes
BB		43		
B		44		
High Beta		30		
DJ CDX.NA.HY (Notes)	5			
100 (rated B3)		100	Yes	
BB (rated Ba3)		43		
B (rated B3)		44		
High Beta (not rated)		30		
Japan				
DJ iTraxx CJ	5, 10	50	Yes	Yes
Financials		10		
Technology		10		
Capital Goods and others		9		
HiVol		10		
Non-Japan Asia				
DJ iTraxx Asia ex Japan	5	30	Yes	Yes
Korea		8		
Greater China		9		
Rest of Asia		13		
Australia				
DJ iTraxx Australia	5	25	Yes	Yes
Emerging Markets				
DJ CDX.EM	5	14	Yes	

Source: JPMorgan.

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Exhibit 13: If the market price of the index is different from the coupon, there will be an upfront exchange of money to account for this difference.

If the market spread of the index =	**60bp**	**Payment to Seller of Protection: (60bp – 50bp) * Duration**
Index pays a fixed coupon of:	**50bp**	
If the market spread of the index =	**40bp**	**Payment to Buyer of Protection: (50bp – 40bp) * Duration**

Source: JPMorgan.

The credit default swaps in the index are equally weighted in terms of default protection; if there is a credit event in one credit, the notional value of an investor's CDS contract will fall by 1/100, if there are 100 credits in the index. After a credit event, in this example, the index will be comprised of 99 credits. Consider Investor B who buys $100 of protection (short risk) on an index with a coupon of 50 bp. Assume a credit event occurs in one credit whose bonds fall to $0.40 per $1 face. Investor B will deliver one bond, purchased for $0.40 in the marketplace, with a $1 face (notional * 1/100), to Investor S and receive $1 in cash. Investor B will continue paying 50 bp annually, but on the new notional value of $99.

The market spread of an index may change if there is a credit event in an underlying credit. Continuing our example, assume that, before the credit event, 99 of the credits underlying the index have a spread of 50 and one credit has a spread of 1,000. Also assume that the index is trading at its theoretical value (discussed next). The market spread of the index will be approximately 60 bp. If the credit with a spread of 1,000 defaults, the credit is removed from the index, and the market spread of the index will now be 50 bp, the average of the remaining 99 credits (Exhibit 14). An investor who is long protection (short risk) will therefore lose money when the index spread rallies, but receive money on the credit event ($0.60 in our example). If the credit event was widely anticipated, these two factors will likely offset one another for no significant net impact on her profit and loss statement.

Exhibit 14: After a credit event in an underlying credit, the credit drops out of the index, and the spread of the index should adjust to a tighter level.

	Number of underlying credits	Spread on each credit	Sum of spreads	Average spread	
	99	50	4,950	50	(market spread after credit event)
	1	1,000	1,000	1,000	
Total	**100**		**5,950**	**60**	(market spread before credit event)

Source: JPMorgan.

Theoretical value calculation

A credit default swap index spread is not directly based on the value of the underlying credit default swaps, but is set by the supply and demand of the market. This is analogous to the pricing of a closed-end mutual fund, where the traded price is based on the buying and selling of the index, not directly on the net asset value of the underlying securities.

To compute the theoretical value of the index, we perform the following calculations:

- Observe the current market levels of the single-name CDS that have the same maturity date as the index.

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- Convert the spreads into prices. Do this by assuming that each single-name CDS has a coupon equal to the index coupon and is being valued against its own CDS curve. For example, if the index has a coupon of 50 bp and the actual market spread of the first credit in the index was 75 bp, one would calculate its approximate price as par - (spread difference)* duration. If we assume duration is 4, the result is 1.00 - (0.0075 - 0.0050)*4 = $0.99.
- Mark-to-market: once the prices for all of the underlying credits are calculated, take a simple average. This is the theoretical value of the index in price terms. Then convert this price to a spread using the index duration.
- The market quoted index spread less the theoretical spread is the basis to theoretical.

If the quoted spread of the index is greater than this theoretical value, then basis to theoretical is positive. If the opposite is true, then basis to theoretical is negative. The terminology is different for the US High Yield CDX indices as they trade on price rather than spread terms. When the HY CDX indices trade at a higher price than the theoretical price implied by the underlying credits, we say the index is trading with a positive basis to theoretical value. For individual credits, investors attempt to arbitrage this relationship by buying the cheap security and selling the expensive security. This is also possible to do with the indices, however, the transaction costs involved with trading a basket of single name CDS against the index need to be considered.

In a rapidly changing market, the index tends to move more quickly than the underlying credits. This is because, in buying and selling the index, investors can express positive and negative views about the credit market in a single trade. This creates greater liquidity in the indices compared to the individual credits. As a result, the basis to theoretical for the indices tends to increase in magnitude in volatile markets.

Exhibit 15: The basis to theoretical of an index is the difference between the spread of the index and the theoretical spread of the index implied by the underlying CDS spreads.

Negative Basis to theoretical	Index Spread	—	**Theoretical Value of Underlying CDS**	<	0
Positive Basis to theoretical	**Index Spread**	—	Theoretical Value of Underlying CDS	>	0

Source: JPMorgan.

Comparing the CDS index to cash bonds

Comparing the credit default swap indices to cash bonds is a two-step process of first comparing the index to the levels of the individual credit default swaps that make up the index, and second, comparing the single names credit default swap levels to bonds. The second step is an average of the basis between a representative bond for each credit and the CDS curve for that credit. In order to do this calculation perfectly, one would need a liquid bond for each credit with the exact maturity date of each index. As such bonds do not exist, investors often choose the most liquid bond for each credit that is nearest to the maturity date of the index. If no such bond exists, credits are often excluded from the basis calculation. The result is therefore an approximation of the relative expensiveness or cheapness of the index to the cash bond market for a similar list of credits.

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Note that this calculation incorporates the comparison of the index to the underlying CDS. This is because, if the basis between each bond and its CDS curve averaged to zero but the index was trading 5bp expensive to the CDS market (i.e., expensive to theoretical), then the index would also be trading 5bp expensive to cash bonds.

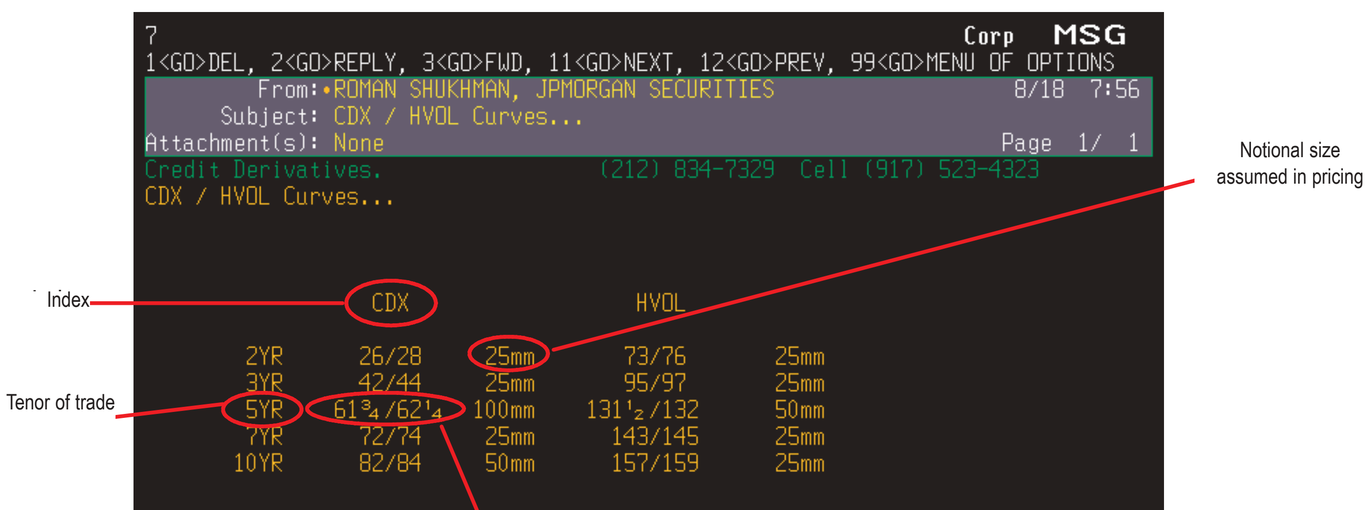
Other index points:

- The most liquid credit default swap maturity is the five-year tenor, followed by the ten-year tenor.
- Standard trade sizes are US$100-50 million, or its equivalent, for the main US and European indices, and US$10-25 million for subindices.
- Single-name North American high-grade credits typically include Modified Restructuring as a credit event, while single-name North American high-yield credits typically do not. Both the US high grade and high yield indices trade with no restructuring, however. Modified Restructuring is discussed in Section 8.
- European investment-grade credits and the indices typically trade with Modified Modified Restructuring as a credit event.

Notes versus swaps

The US high-yield indices have funded securities in addition to the swap indices. The funded index is similar to the swap index in that it tracks the returns of the same basket of single-name credit default swaps. It differs in that it is priced and trades like a bond, with transfers of cash at the time of purchase in addition to coupon payments. (Like the credit-linked note in exhibit 5.) If an underlying credit defaults, in percentage terms, the coupon level remains constant. However in dollar terms, it is lowered because the face value of the note is reduced by 1/100, assuming there are 100 credits in the index.

Exhibit 16: Sample CDX Index Run



The spread at which the index is trading. In this example, an investor can sell protection (long risk) in 5 year CDX and receive 61.75bp (accrues on an Act/360 basis). Alternatively, she can buy protection (short risk) and pay 62.25bp annually. Credit derivative indices such as the CDX have a fixed coupon; the 5 yr in this example has a 60bp coupon. The market spread is usually above or below that rate, just as a bond may trade at a different spread than its coupon. If an investor sold protection (long risk), she would receive the PV(61.75bp – 60bp) upfront.

Source: Bloomberg.

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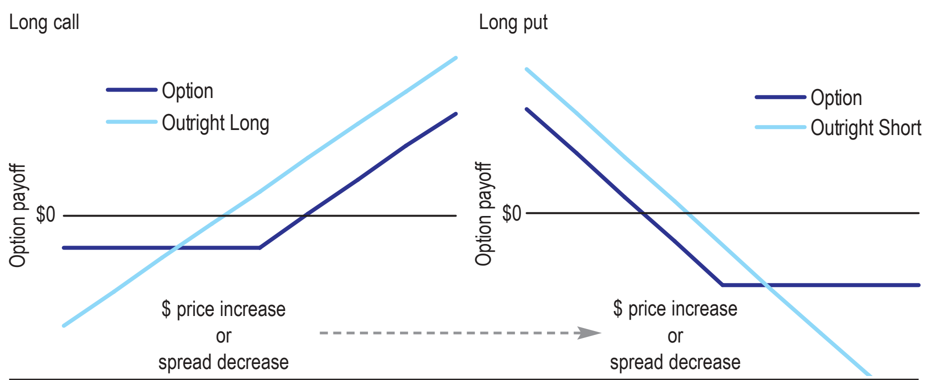
7. Other credit default swap products

Second generation credit derivative products are creating new economic opportunities. Below, we review several products based on single name credit default swaps that allow investors to express views on credit volatility, curve shape, and recovery rates. For each section, more extensive research is available.

Credit default swap options (CSO)[8]

A credit default swap option is an option to buy or sell CDS protection on a specified reference entity at a fixed spread on a future date. Offered on CDS indices and on many single-name CDS, the call option (receiver option) provides investors with the right to sell protection (the right to go long risk and receive the CDS coupon, i.e., the investor expects credit to strengthen), whereas the put option (payer option) provides investors with the right to buy protection (the right to go short risk and pay the CDS coupon, i.e., the investor expects credit to worsen). These options provide an instrument through which investors can trade credit market volatility or tailor their risk profile.

Exhibit 17: Call and Put Option payoffs



Source: JPMorgan.

Digital default swaps (DDS) and recovery swaps[9]

A digital default swap is a credit default swap where the payment to the buyer of protection following a credit event, normally 100% - recovery rate (the recovery rate is determined after the credit event), is instead fixed at the trade's inception. These structures are also known as fixed recovery CDS because the payout is based on a fixed assumption about recovery following default rather than on market recovery rates. This instrument may be used to hedge specific exposures where the loss upon default is a known amount.

A recovery swap is a combination of credit default swap and digital default swap contracts used to take isolated views on recovery rates. In a recovery swap, an investor goes long or short protection using a digital default swap and takes an offsetting default position using standard credit default swaps. The net of these two positions is typically structured to have zero carry, or in other words, cash inflows equal cash outflows except during a credit event. Following a credit event, the

8. For more information on options, see "Credit Volatility–A Primer," by Lee McGinty, published July 7, 2003.
9. For more information on DDS, see "Trading Recovery Rates-Digital Default Swaps and Recovery Swaps," by Jacob Due, published May 19, 2004.

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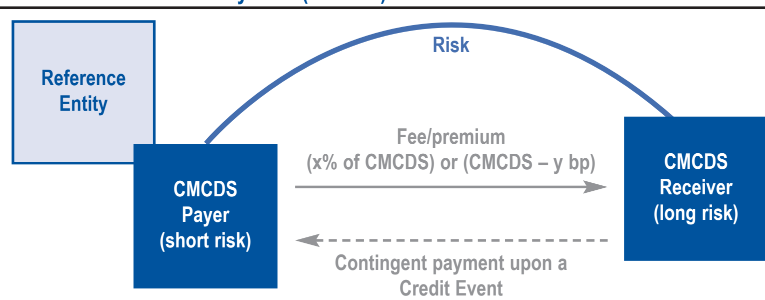
digital default swap protection buyer receives a fixed payout (1 - fixed recovery rate) from the seller, and the pays the seller an amount equal to the payout on a standard CDS contract (1 - market recovery rate). The DDS buyer benefits if market recovery rates are higher than the fixed recovery rate assumed in the DDS.

Constant maturity credit default swaps (CMCDS) and credit spread swaps (CSS)[10]
Constant maturity credit default swaps are CDS contracts where the spread is reset periodically, for example every six months, based on changes in the market spread for a benchmark CDS tenor. The benchmark CDS can be a single name or an index product. The buyer of protection (short risk) pays a fraction (called the participation rate, a rate negotiated at the initiation of the contract that remains constant) of the then current credit default swap spread of the relevant maturity (called the reference rate). For example, the buyer of protection could pay 70% of the current five-year credit default swap spread on Company X, which is 100bp initially, but expected to increase over time. If the five-year CDS spread on Company X six months later is 125bp, the buyer of the constant maturity credit default swap would now pay 70% * 125bp. This continues for the duration of the contract. If there is a credit event during the life of the contract, the contract terminates with a settlement procedure identical to the credit default swap procedure, namely, the buyer of protection (short risk) delivers the notional amount of defaulted bonds to the seller of protection (long risk), who then pays the notional amount to the buyer.

The buyer of protection in this example is taking the view that the spread on the credit will increase by less than the spread implied by existing forward rates. At the beginning of the contract, she is paying less for protection than if she had entered into a standard CDS contract. If the spread on the credit remains low, then she will continue to pay a low rate at each fixing, while if market spreads increase significantly, she will be obliged to pay much higher rates in the future. The initial participation rate reflects this risk - it will generally be a lower number for steep credit curves (i.e. perhaps 60%) and a higher number for flatter curves (i.e. 80%).

In a credit spread swap (CSS), an investor buys or sells protection using a CMCDS contract and enters into an offsetting default risk position using standard CDS. This structure allows investors to take curve and directional spread exposure to a reference entity without default risk.

Exhibit 18: Constant Maturity CDS (CMCDS)



Source: JPMorgan.

10. For more information CMCDS, see "Introduction to constant maturity CDS and CDO's" by Jacob Due and Rishad Ahluwalia, published October 21, 2004.

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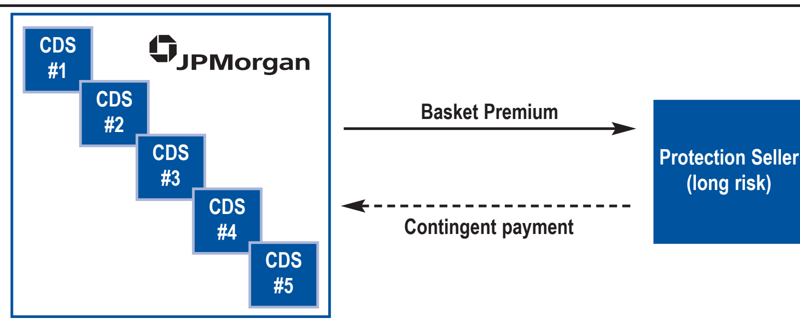
First-to-default baskets[11]

In a first-to-default (FTD) basket, an investor chooses a basket of credits, typically five names, instead of taking exposure to an individual credit default swap. If there are no credit events, the basket pays a fixed coupon throughout the life of the trade. Upon a credit event in one of the basket names, the swap terminates, and the protection buyer delivers the notional amount of the FTD basket in bonds or loans of the defaulted entity to the protection seller. The protection seller then pays the buyer the notional amount of the trade in cash. It is as if the protection seller (long risk) had written a contract on only the defaulted name.

A first-to-default basket is a leveraged position in a basket of credit default swaps. It is a leveraged position because an investor is exposed to the risk of default on the entire basket rather than on a single name. However, the investor's loss is limited to the notional value of the trade. Because the basket has a higher probability of default than an individual credit, the seller of protection receives a spread greater than the widest individual spread in the basket. Typically, the basket pays a spread of 60-80% of the sum of the spreads in the basket. For example, Exhibit 20 is an insurance company FTD basket that pays the seller of protection (long risk) 505 bp, which is 71% of the aggregate spread. The value drivers in this product are the number of basket components (the greater the number of names, the greater the likelihood of one name defaulting, the greater the premium paid), absolute spread levels (clustered spreads provide the greatest value), and correlation (or similarity of assumed default probability between credits, the less similar the correlation, the higher the default risk, therefore the greater the premium paid).

Exhibit 19: First-to-default baskets



Source: JPMorgan.

Exhibit 20: Sample High Yield FTD Basket

FTD Basket

Reference Credits	5yr Bid (bp)	S&P Industry
ACE LIMITED	125	Insurance
AIG CORP	27	Insurance
AON CORP	245	Insurance
MARSH & MCLENNAN	250	Insurance
HARTFORD FIN. GROUP	62	Insurance
AGGREGATE SPREAD	709	
5YR First to Default Spread over LIBOR	505	
5YR First to Default % of Aggregate Spread	71%	

Source: JPMorgan.

11. For more information on First-to-default baskets, see "First-to-Default Baskets: A Primer," by Rishad Ahluwalia, published October 24, 2003.

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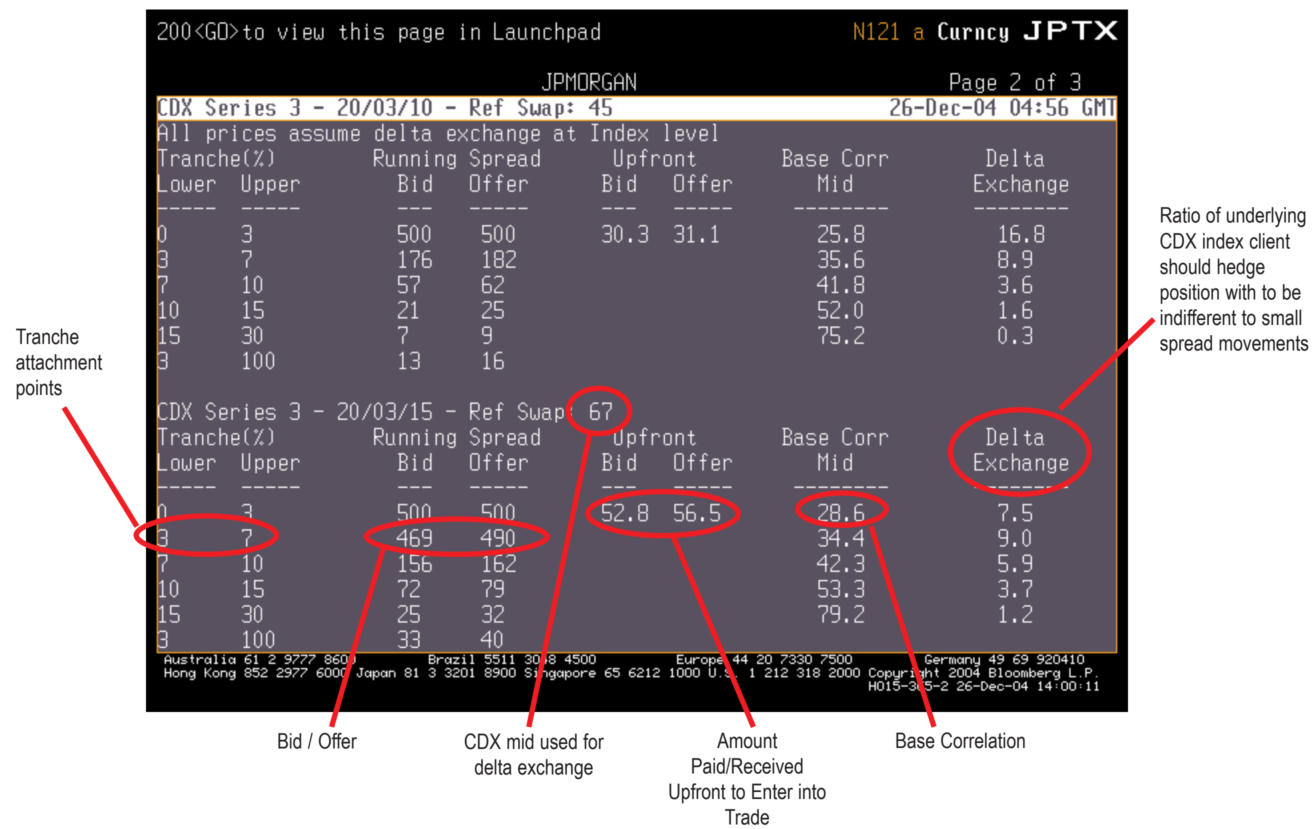
Synthetic collateralized debt obligations (CDO)[12] and tranched indices[13]
A synthetic collateralized debt obligation (also called a collateralized swap obligation, or CSO) is a transaction in which a basket of credit default swaps is created and the default risk of the basket of reference entities is pooled and divided into tranches. The most junior tranche (one that has no subordination) is often called the equity tranche. It will absorb the first credit losses on the portfolio, for example, it might absorb the first 3% of losses. When loss amounts exceed the notional of the most junior tranche, the next tranche absorbs losses. Investors are paid a coupon that reflects the risk of loss in their tranche. Tranched credit structures increase market efficiency by reallocating the risk of credit losses on an underlying portfolio into tailored investments that satisfy an investor's desired risk/return profile.

Synthetic CDOs have historically been bespoke or customized in nature, meaning that the end investor selects the underlying portfolio, amount of subordination, and tranche size. Currently, there are standardized synthetic collateralized debt obligations using the credits in the Dow Jones CDX and iTraxx indices. These tranched index products create a standardized, liquid, and transparent instrument to trade tranched credit risk. It also introduces the ability to hedge other CDO structures or take a view on market-implied correlation, a key value driver in the tranched credit market.

Exhibit 21: Sample Tranched Index Pricing Page



Source: Bloomberg.

12. For more information on synthetic CDOs, see "CDOs 101," published August 12, 2003, and "Innovations in the Synthetic CDO Market: Tranche-only CDOs," published January 22, 2003, by Chris Flanagan.
13. For more information on index tranches, see "Introducing Dow Jones Tranched TRAC-X," by Lee McGinty, published November 26, 2003.

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8. Logistics of trading credit default swaps

Accounting and marking to market

Under relevant US and international accounting standards, credit default swaps and related products are generally considered derivatives, though exceptions may apply. US and international accounting rules generally require derivatives to be reflected on the books and records of the parties at fair value (i.e., the mark-to-market value) with changes in fair value recorded in earnings at the end of each reporting period. Under certain circumstances, it is possible to designate derivatives as hedges of existing assets or liabilities. Investors should consult with their accounting advisors to determine the appropriate accounting treatment for any contemplated credit derivative transaction.

Marking a credit default swap contract to market

Investors mark credit default swaps to market, or calculate the current value of an existing contract, for two primary reasons: financial reporting and monetizing existing contracts. We find the value of a CDS contract using the same methodology as other securities; we discount future cash flows to the present. In summary, the mark-to-market on a CDS contract is approximately equal to the notional amount of the contract multiplied by the difference between the contract spread and the market spread (in basis points per annum) and the risk-adjusted duration of the contract.

To illustrate this concept, assume a 5-year CDS contract has a coupon of 500bp. If the market rallies to 400bp, the seller of the original contract will have a significant profit. If we assume a notional size of $10 million, the profit is the present value of (500bp - 400bp) * $10,000,000 or $100,000 per year for the 5 years. If there were no risk to the cash flows, one would discount these cash flows by the risk free rate to determine the present value today, which would be something slightly below $500,000. These contracts have credit risk, however, so the value is lower than the calculation described above.

Assume that, for example, the original seller of the contract at 500bp choose to enter into an offsetting contract at 400bp. This investor now has the original contract on which she is receiving $500,000 per year and another contract on which she is paying $400,000 per year. The net cash flow is $100,000 per year, assuming there is no default. If there is a default, however, the contracts cancel each other (so the investor has no immediate gain or loss) but she looses the remaining annual $100,000 income stream. The higher the likelihood of a credit event, the more likely that she stops receiving the $100,000 payments, so the value of the combined short plus long risk position is reduced. We therefore discount the $100,000 payments by the probability of survival (1 - probability of default) to recognize that the value is less than that of a risk-free cash flow stream.

The calculation for the probability of default (and survival) is detailed in the appendix. In summary, the default probability is equal to *spread / (1 - Recovery Rate)*. If we assume that recovery rate = 0, then the spread equals the default probability. If the recovery rate is greater than zero, then the default probability is greater than the spread. To calculate the market-to-market on a CDS contract (or the profit or loss of an unwind), we discount the net cash flows by both the risk free rate and the survival probability. See the appendix for a more complete example of the calculations described above.

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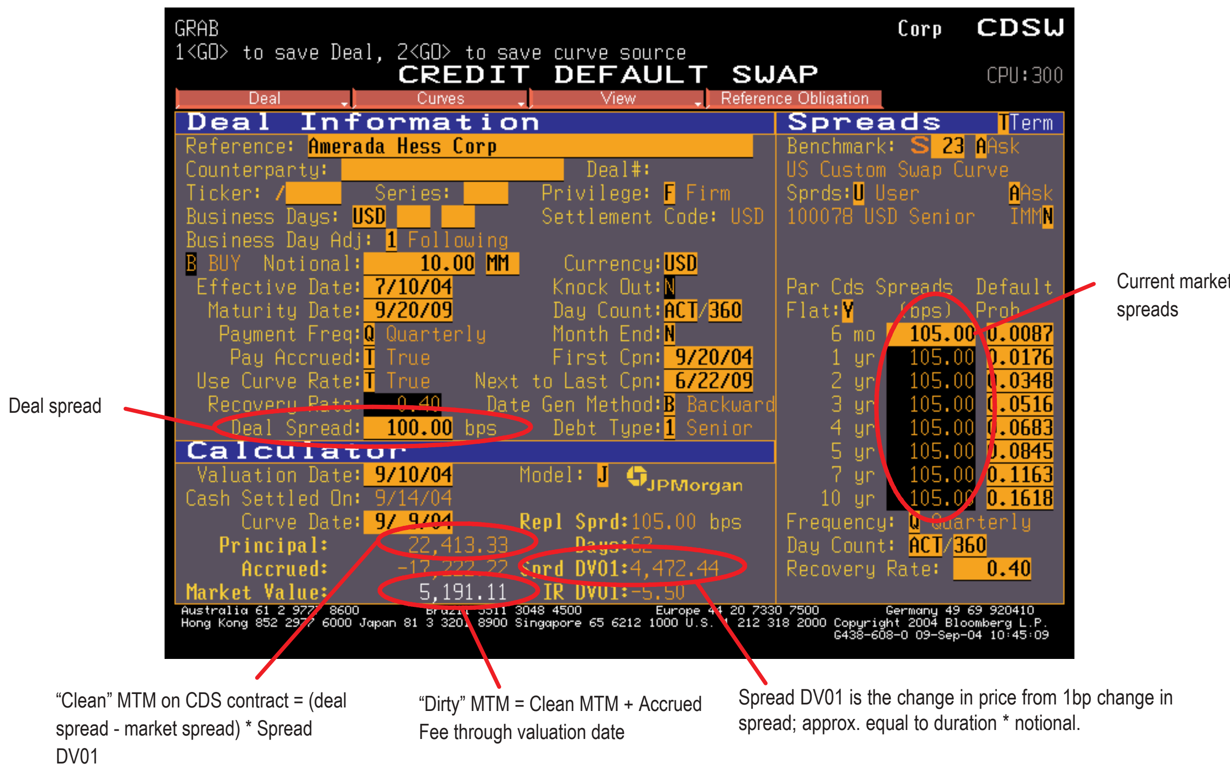
The JPMorgan CDSW model is a user friendly market standard tool on Bloomberg that calculates the mark-to-market on a credit default swap contract. Users enter the details of their trade in the Deal Information section, input credit spreads and a recovery rate assumption in the Spreads section, and the model calculates both a "dirty" (with accrued fee) and "clean" (without accrued fee) mark-to-market value on the CDS contract (set model in "Calculator" section to 'J'). Valuation is from the perspective of the buyer of protection:

- Positive clean mark-to-market value means that spreads have widened (seller pays buyer to unwind)
- Negative clean mark-to-market value means that spreads have tightened (buyer pays seller to unwind)

To access this model, select a bond of the issuer and type "CDSW<Go>."

Exhibit 22: The CDSW model on Bloomberg calculates mark-to-market values for CDS contracts



Source: Bloomberg.

Standardized documentation

The standardization of documentation from the International Swaps and Derivatives Association (ISDA) has been an enormous growth driver for the CDS market.

ISDA produced its first version of a standardized CDS contract in 1999. Today, CDS are usually transacted under a standardized short-form letter confirmation, which incorporates the 2003 ISDA Credit Derivatives Definitions, and is transacted

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under the umbrella of an ISDA Master Agreement[14]. Combined, these agreements address:

- Which issuers, if they default, trigger the CDS
- The universe of obligations that are covered under the contract
- The notional amount of the default protection
- What events trigger a credit event
- Procedures for settlement of a credit event

Standardized confirmation and market conventions mean that the parties involved need only to specify the terms of the transaction that inherently differ from trade to trade (e.g., reference entity, maturity date, spread, notional). Transactional ease is increased because CDS participants can unwind a trade or enter an equivalent offsetting contract with a different counterparty from whom they initially traded. As is true with other derivatives, CDS that are transacted with standard ISDA documentation may be easily assigned to other parties. In addition, single-name CDS contracts mature on standard quarterly end dates. These two features have helped promote liquidity and, thereby, stimulate growth in the CDS market.

ISDA's standard contract has been put to the test and proven effective in the face of significant credit market stress. When WorldCom filed for bankruptcy in July 2002, according to our estimates, there were 600 CDS contracts outstanding in the marketplace, accounting for over $7 billion in notional terms. More recently, when Parmalat SPA defaulted in December 2003, we estimate that there were approximately 4,000 CDS contracts and €10 billion outstanding in the marketplace. Additionally, Parmalat was a component of the original Trac-x Series 1 credit index. In December 2003, trading volumes in Trac-x increased 3 to 4 times after the Parmalat default, and over 550 Trac-x contracts settled. In all situations, contracts were settled without mechanical settlement problems, disputes or litigation.

Counterparty considerations

Recall that in a credit event, the buyer of protection (short risk) delivers bonds of the defaulted reference entity and receives par from the seller (long risk). Therefore, an additional risk to the protection buyer is that the protection seller may not be able to pay the full par amount upon default. This risk, referred to as counterparty credit risk, is a maximum of par less the recovery rate, in the event that both the reference entity and the counterparty default. While the likelihood of suffering this loss is remote, the magnitude of the loss given default can be material. When trading with JPMorgan, counterparty credit risk is typically mitigated through the posting of collateral (as defined in a collateral support annex (CSA) to the ISDA Master Agreement between the counterparty and JPMorgan), rather than through the adjustment of the price of protection.

14. For more information on the ISDA standard definitions, see 'The 2003 ISDA Credit Derivatives Definitions' note published on June 13, 2003 by Jonathan Adams and Tom Benison.

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Conclusion

The use of credit derivatives has grown exponentially since the beginning of the decade. Transaction volumes have picked up from the occasional tens of millions of dollars to regular weekly volumes measured in billions of dollars. The end-user base is broadening rapidly to include a wide range of banks, broker-dealers, institutional investors, asset managers, corporations, hedge funds, insurers, and reinsurers. Growth in participation and market volume is likely to continue at its current rapid pace based on the contribution that credit derivatives are making to efficient risk management, rational credit pricing, and systemic liquidity. At this stage, as a mainstream and integrated market, the focus within the credit derivatives market is on second generation products and further innovation.

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9. Appendix I

Credit events and settlement procedures

A credit event is the occurrence of a significant event with respect to a reference entity that triggers a contingent payment on a credit default swap. Credit events are defined in the 2003 ISDA Credit Derivatives Definitions[15] and include the following:

- Bankruptcy: insolvency, appointment of administrators/liquidators, creditor arrangements, etc.
- Failure to pay: payment failure on one or more obligations after expiration of any applicable grace period; typically subject to a materiality threshold (e.g., US$1million for North American CDS contracts).
- Restructuring: refers to an agreement between the reference entity and the holders of an obligation (and such agreement was not previously provided for under the terms of that obligation) with respect to:
  - reduction of interest or principal
  - postponement of payment of interest or principal
  - change of currency (other than to a "Permitted Currency")
  - contractual subordination

Note that there are several versions of the restructuring credit event that are used in different markets.

- Repudiation/moratorium: authorized government authority (or reference entity) repudiates or imposes moratorium and failure to pay or restructuring occurs.
- Obligation acceleration: one or more obligations due and payable as a result of the occurrence of a default or other condition or event described, other than a failure to make any required payment.

For US high grade markets, bankruptcy, failure to pay, and modified restructuring are the standard credit events. Modified Restructuring is a version of the Restructuring credit event where the instruments eligible for delivery are restricted. European CDS contracts are usually drafted with Modified Modified Restructuring, which has further modifications to account for the structural differences between the US and European debt markets[16]. In the US high yield markets, only bankruptcy and failure to pay are standard. Of the above credit events, bankruptcy does not apply to sovereign reference entities. In addition, repudiation/moratorium and obligation acceleration are generally only used for emerging market reference entities.

Credit default swap contracts call for physical settlement. After a credit event, the buyer of protection typically delivers to the seller of protection defaulted bonds or loans with a notional amount equal to the notional amount of the credit default swap. In return, the seller of protection delivers the notional amount of the CDS contract in cash to the buyer. The deliverables are selected from a predefined category of deliverable obligations, and typically consist of any bonds or loans of the reference entity that are pari passu with the reference obligation. The buyer of protection chooses which bonds or loans to deliver; she can typically deliver a bond or loan of any maturity (generally up to 30 years, however more maturity restrictions apply if the credit event is caused by Restructuring) and in several specified currencies. Often the buyer and seller of protection will agree on the value of defaulted bonds in the market and choose to cash settle rather than exchanging cash for bonds.

15. Copies of the 2003 ISDA Credit Derivatives Definitions can be obtained by visiting the International Swaps and Derivatives Association website at http://www.isda.org.
16. For more information, see "The 2003 ISDA Credit Derivatives Definitions," by Jonathan Adams and Thomas Benison, published in June 2003.

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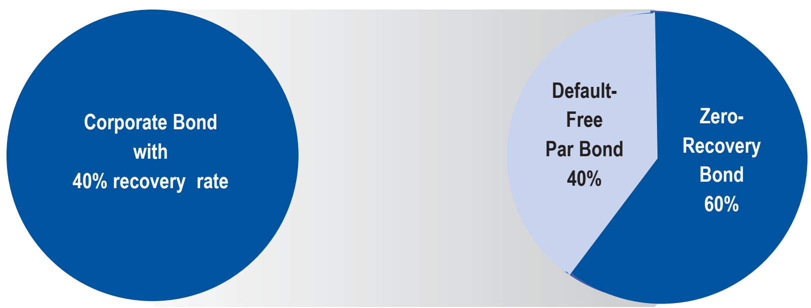
Appendix II

A five-step process to compare bonds to CDS[17]

Credit default swaps are par instruments whereas most bonds trade at a discount or a premium. The five-step valuation method presented here builds on the intuition provided earlier, and calculates an equivalent spread for a corporate bond so that like comparisons can be made with credit default swaps.

Step 1:

The first step is to estimate a recovery rate for the bond and then divide the bond into two parts based on that estimation. The recovery rate is the estimated price of a defaulted bond. It determines the default-free portion of the bond. As a default-free instrument, only the time value of money determines its value. A default-free bond is expected to recover the same amount at any point in time. We therefore price the default-free bond as a par instrument with a coupon of Libor to account for the time value of money.



Step 2:

Next we calculate the price and coupon for the zero recovery portion of the bond based on the actual corporate bond price and coupon, its recovery rate, and the price of the default-free bond of 100 and its coupon of Libor flat. The two formulas used are the following:

Bond Price = Default-Free Security + Risky Security

$$P_{corpbond} = [(R\% \text{ x } 100)] + [(1-R\%) \text{ x } P_{zero\ recovery}]$$

$$Cpn_{corpbond} = [(R\% \text{ x LIBOR})] + [(1-R\%) \text{ x } Cpn_{zero\ recovery}]$$

where,
R% is the recovery rate
$P_{\text{corp bond}}$ is corporate bond price
$P_{\text{zero recovery}}$ is zero recovery bond price

$Cpn_{\text{corp bond}}$ is corporate bond coupon
$Cpn_{\text{zero recovery}}$ is zero recovery bond coupon

17. For more information, see "A Simple and Robust Method to Compare Bonds to Credit Default Swaps" by Antonio Paras and Richard Stephenson, published in March 2003.

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Step 3:
The next step is to determine the yield to-maturity for the zero recovery bond based on the price and coupon derived from Step 2.

$$P_{zero\ recovery} = \sum \frac{Cpn_{zero\ recovery\ t} + Face_T}{(1+YTM)^t}$$

Step 4:
Most corporate bond coupons accrue on a semi-annual 30/360 basis whereas credit default swaps accrue quarterly actual/360, and upon a credit event, accrue up to the credit event determination date. After calculating the YTM for the zero recovery bond, we need to convert that semi-annual 30/360 rate to a continuously compounding rate to best capture the fact that credit default swaps pay accrued upon a credit event. This adjusted YTM from Step 3 minus Libor is the zero recovery bond's probability of default, also called the "clean spread."

Step 5:
The final step is to calculate the bond's par spread. It is this spread that is used to compare bonds to credit default swaps. The clean spread is the return paid to investors for assuming the risk that the issuer defaults. This spread is earned only on the zero recovery portion of the bond. By apportioning the clean spread calculated in Step 4 to the difference between one and the recovery rate, we are able to determine the par spread for the bond as a whole. The equation for this final step is the following:

$$\text{ParSpread} = \text{CleanSpread x (1 - RecoveryRate)}$$

When an investor purchases protection (short risk), she is protecting herself against the net loss on a bond, or (Par – Recovery Rate). Thus, the actual notional amount at risk on a credit default swap is the difference between par and the recovery rate. Intuitively, the par spread represents an expected payout whereby (1 – recovery rate) is the amount received and the clean spread is the likelihood of a credit event taking place. The end result is a bond equivalent par credit default swap spread that can be compared to credit default swaps[18].

See the following page for an example.

18. In reality, par bond spreads and par CDS spreads would differ slightly due to different coupon payment frequencies, day-count conventions, treatments of accruals, etc.

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Appendix II: A five-step process to compare bonds to CDS, an example

Bond information

Today's date	1-Jan-05	Bond price	$80
Maturity date	1-Jan-10	Coupon	6%
Years to bond maturity	5.00	Payments per year	2
Swap rate to bond maturity	3.50%	(the 5 yr swap rate)	

Step 1: Divide bond into a default free and a zero recovery bond

Estimated recovery rate 40%

Step 2: Calculate the implied price and coupon of the zero recovery bond

$P_{corp\ bond}$ = Default-free bond + Risky bond

$P_{corp\ bond} = (R\%*100) + [(1 - R\%)*P_{zero\ recovery}]$

$P_{zero\ recovery} = [P_{corp\ bond} - (R\%*100)] / (1 - R\%)$

$P_{zero\ recovery}$ = $66.67

$CPN_{corp\ bond}$ = Default-free coupon + Risky coupon

$CPN_{corp\ bond} = (R\%*Libor) + [(1-R\%)*CPN_{zero\ recovery}]$

$CPN_{zero\ recovery} = [CPN_{corp\ bond} - (R\%*Libor)] / (1-R\%)$

$CPN_{zero\ recovery}$ = 7.67%

Z-spread = $CPN_{zero\ recovery}$ - Libor

Z-spread = 4.17%

Step 3: Calculate the yield-to-maturity for the zero recovery bond

$P_{zero\ recovery}$ = $66.67

$CPN_{zero\ recovery}$ = 7.67%

Method 1 - use YTM excel function

YTM =yield() excel function 18.07%

Function inputs:

Settlement date	1-Jan-05
Maturity date	1-Jan-10
Percent coupon	7.67%
Price	$66.67
Redemption value	$100.00
Coupon frequency	2
Basis (30/360)	0

Method 2 - trial and error

YTM	**18.07%**
YTM / 2	9.04%

(calculate by trial and error, or use Solver in excel)

Period	Cash flows	Discount factor	PV
1	$3.83	0.9171	$3.52
2	$3.83	0.8411	$3.22
3	$3.83	0.7714	$2.96
4	$3.83	0.7075	$2.71
5	$3.83	0.6489	$2.49
6	$3.83	0.5951	$2.28
7	$3.83	0.5458	$2.09
8	$3.83	0.5006	$1.92
9	$3.83	0.4591	$1.76
10	$103.83	0.4210	$43.72
		Zero Recovery Bond Price:	**$66.67**

(adjust YTM so Price = $66.67)

Step 4: Calculate the Clean Spread

First, convert the YTM and swap rate from semi-annual 30/360 to continuous 30/360 rates

$e^{R_{continuous}} = (1 + R_m / m)^m$ where m is the number of times per year the rate compounds

$R_{continuous} = m*\ln(1 + R_m / m)$

In our case, m = 2, as the interest on the bond is compounded twice a year

$R_{continuous}$ = 2 * [ln (1 + Semi-annual rate / 2)]

Continuous $YTM_{zero\ recovery}$ =	17.30%
Continuous Swap rate to bond maturity =	3.47%
Continuous $Z\text{-}spread_{zero\ recovery}$ =	13.83%

Second, convert the Z-spread from continuous 30/360 to continuous actual/360

Clean Spread = Continuous $Z\text{-}spread_{zero\ recovery}$ * (360 / 365)

Clean Spread = 13.64%

The clean spread is the return paid to investors for assuming the risk the issuer defaults

Step 5: Calculate the Par Spread

Par Spread = Clean Spread * (1 - R%)

Par Spread = 8.18%

The par spread is the spread above Libor for a given bond assuming a $100 price.

Source: JPMorgan.

Appendix II: JPMorgan CDSW Example Calculations Model (for illustration of the general concepts only)

Notional value	10,000,000	Enter notional position amount
Initial contract sprea	5.00%	Enter the original contract coupon
Current at market S|	4.00%	Enter the current market spread
Recovery assumptic	40%	Enter the assumed Recovery Rate
Clean spread (probability of default)	6.667%	Equal to current market spread / (1 - Recovery Rate). It is the annual default probability. This is an approximation that is correct if one is doing the calculations assuming continuous possibility of default. It is slightly off when assuming default is only possible on the quarterly payment dates, as we do below.

Additional check of calculation

When a CDS is at par, it means that the expected value of the cash flows to be received (with no default) is equal to the expected value of the recovery value to be received (in case of default). These calculations are shown in columns 10 and 11 below. The columns generally will be a little off because the Clean Spread which is calculated as Current Market Spread / (1 - Recovery) is not quite right, because of continuous vs discrete compounding, as discussed.

Notional Value * Original Contract Spread / 4 (for quarterly payment)

Notional Value * Current Market Spread / 4 (for quarterly payments)

Difference between Column 2 and Column 3. This represents the cash flow which is being valued, i.e., the value of a CDS unwind is the discounted value of this cash flow stream.

Enter swap zero curve

Discount factors based on swap curve

1 Minus Column 8

Probability of no default. Calculated as 1/(1+ Clean Spread) ^ time in years. The concept is that the clean spread is the annual default probability. The probability of not having defaulted after two years (for example) is the probability of no default in year one time the probability of no default in year two.

Column 4 X Column 6 X Column 8.

The cash flows expected X the discount factor for time X the probability of receiving the cash flows.

Period	Cash Flow Earned on CDS	Premium Paid on offsetting CDS	Net Premium	Swap Curve	Discount Factor	Prob of Default	Survival Probability	PV of Expected Cash flows	Value of Current Coupon Flows	Value of loss if default
0.25	$125,000	$100,000	$25,000	2.000%	0.99502	0.0160	0.9840	$24,477	$97,910	$95,553
0.50	$125,000	$100,000	$25,000	2.000%	0.99007	0.0157	0.9682	$23,966	$95,864	$93,556
0.75	$125,000	$100,000	$25,000	2.000%	0.98515	0.0155	0.9527	$23,465	$93,860	$91,601
1.00	$125,000	$100,000	$25,000	2.000%	0.98025	0.0152	0.9375	$22,975	$91,898	$89,686
1.25	$125,000	$100,000	$25,000	2.000%	0.97537	0.0150	0.9225	$22,494	$89,977	$87,812
1.50	$125,000	$100,000	$25,000	2.000%	0.97052	0.0148	0.9077	$22,024	$88,097	$85,976
1.75	$125,000	$100,000	$25,000	2.000%	0.96569	0.0145	0.8932	$21,564	$86,256	$84,179
2.00	$125,000	$100,000	$25,000	2.000%	0.96089	0.0143	0.8789	$21,113	$84,453	$82,420
2.25	$125,000	$100,000	$25,000	2.000%	0.95610	0.0141	0.8648	$20,672	$82,688	$80,697
2.50	$125,000	$100,000	$25,000	2.000%	0.95135	0.0138	0.8510	$20,240	$80,959	$79,011
2.75	$125,000	$100,000	$25,000	2.000%	0.94661	0.0136	0.8374	$19,817	$79,267	$77,359
3.00	$125,000	$100,000	$25,000	2.000%	0.94191	0.0134	0.8240	$19,403	$77,611	$75,743
3.25	$125,000	$100,000	$25,000	2.000%	0.93722	0.0132	0.8108	$18,997	$75,988	$74,159
3.50	$125,000	$100,000	$25,000	2.000%	0.93722	0.0130	0.7978	$18,693	$74,772	$72,973
3.75	$125,000	$100,000	$25,000	2.000%	0.93722	0.0128	0.7850	$18,394	$73,576	$71,805
4.00	$125,000	$100,000	$25,000	2.000%	0.93722	0.0126	0.7725	$18,099	$72,398	$70,655
4.25	$125,000	$100,000	$25,000	2.000%	0.93722	0.0124	0.7601	$17,810	$71,239	$69,524
4.50	$125,000	$100,000	$25,000	2.000%	0.93722	0.0122	0.7479	$17,525	$70,099	$68,412
4.75	$125,000	$100,000	$25,000	2.000%	0.93722	0.0120	0.7360	$17,244	$68,977	$67,317
5.00	$125,000	$100,000	$25,000	2.000%	0.93722	0.0118	0.7242	$16,968	$67,873	$66,239
							Mark to market of CDS unwind	**$405,941**	**$1,623,762**	**$1,584,678**

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