Bond-CDS Basis Handbook

Measuring, trading and analysing basis trades

Basis trades exploit the different pricing of bonds and CDS on the same underlying company: by taking opposite positions in a bond and CDS, investors can profit from changes in the Bond-CDS basis. On aggregate, bond spreads are currently trading very wide to CDS spreads, generating very attractive negative basis trades (i.e. buy the bond and buy CDS protection). **This handbook reviews the definition, measurement, construction, risks and sensitivities of Bond-CDS basis trades**.

Section 1: Introduction
Section 1 introduces the concept of the Bond-CDS basis, what it encapsulates, its definition, measurement, main drivers and how it is generally traded.

Section 2: Bond and CDS: Credit Spread Measures
Section 2 tackles the measurement of the basis by analysing different spread measures for bonds (e.g. asset swap spreads, Z-spreads) and how well suited they are for comparisons with CDS spreads. We present a bond spread measure (par equivalent CDS spread or PECS) which we consider better suited for measuring the basis.

Section 3: Trading the Basis
Section 3 focuses on the trading aspects of basis trades. We start with a simple stylised basis trade example which we use to illustrate the structural features of bonds and CDS. These features affect the mechanics and economics of basis trades, and investors should be aware of all of them and their potential impact on the profitability of basis trades. This section also reviews the most popular motives for entering into basis trades: locking-in a “risk-free” spread over the life of the trade, expressing the view that the basis will revert back to zero and profiting from a default of the company. We analyse hedging ratios as well as default and spread sensitivities.

Section 4: Historical Evolution, Outlook & Current Opportunities
In Section 4 we review the historical evolution of the basis and present our outlook for 2009. This section also provides an overview of the current state of the European and US basis. We analyse the basis breakdown by sector, rating and maturity, as well as the most attractive basis trades. We outline J.P. Morgan’s new daily *European Bond-CDS Basis Report*, which will highlight the best trading opportunities and the evolution of the basis by rating, maturity and sector. It complements our existing *US Corporate High Grade Basis Report* and *US Corporate High Yield Basis Report* for the US market. All of them are available on *Morgan Markets* and provide an efficient way to track the Bond-CDS basis.

In the appendices, we include a brief reminder of CDS pricing as well as a comprehensive review of bond spread measures.

European Credit Derivatives & Quantitative Credit Research

Abel Elizalde[AC]
(44-20) 7742-7829
abel.elizalde@jpmorgan.com

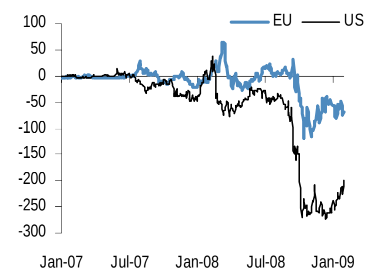
Saul Doctor
(44-20) 7325-3699
saul.doctor@jpmorgan.com

Yasemin Saltuk
(44-20) 7777-1261
yasemin.x.saltuk@jpmorgan.com

J.P. Morgan Securities Ltd.

Historical IG Aggregate Bond-CDS Basis

Basis (bp).



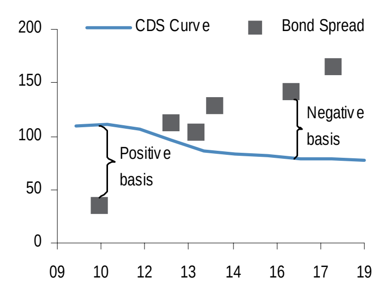
Source: J.P. Morgan.

Bond-CDS Basis = CDS Spread – Bond Spread

CDS vs. Bond Spreads

Electricite de France

X-axis: Maturity. Y-axis: Spread (bp).



Source: J.P. Morgan. Data as of 29 January 2009. Bond spread measured as the PECS.

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1. Introduction

Basis trades exploit the different pricing of bond and CDS on the same underlying company.

They represent one of the closest trading techniques in the credit market to an "arbitrage free" trade. If the bond is trading less expensive than the CDS: buy the bond and buy CDS protection to "lock in" a risk-free profit. Although potentially very attractive, basis trades are not usually straightforward and almost never arbitrage free trades. Fortunately, the current levels of the basis are high enough to make basis trades more attractive than ever.

Bond-CDS basis:

CDS spread *minus* Bond spread

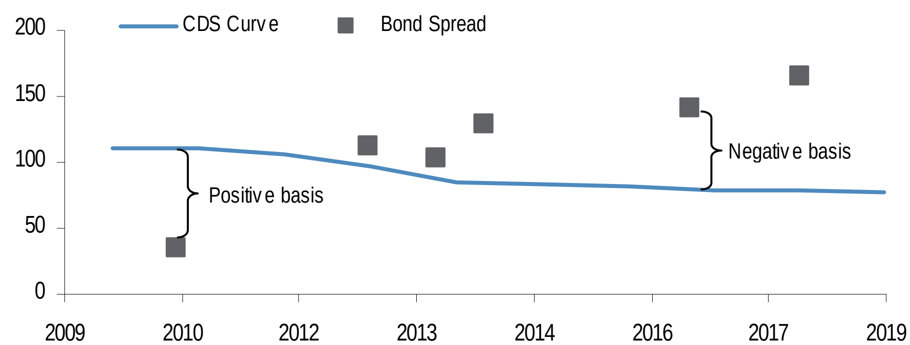
The basis between a bond and a CDS measures the pricing differential between the two, expressed on a running spread per year. In particular, it is computed as the **CDS spread minus the bond spread** with a similar maturity. Throughout this report, we will use the term "basis" to mean Bond-CDS basis, also referred to as basis-to-cash.

Investors frequently seek to exploit discrepancies in the Bond-CDS basis. The rationale is that bond and CDS positions should offset each other in case of default, allowing the investor to take a view on the relative pricing of bonds and CDS without taking on credit risk.

Being different instruments, bond and CDS might have different exposures to movements in the underlying company's credit risk. For example, higher liquidity in the CDS market might cause CDS spreads to lead bond spreads after a negative piece of information about a company reaches the market. Investors can set up basis trades to profit from this, and related, phenomena.

Figure 1: *Electricite de France* – CDS Spreads vs. Bond Spreads

X-axis: Maturity. Y-axis: Spread (in bp). Bond spread measured as the PECS.



Source: J.P. Morgan. Data as of 29 January 2009.

Figure 1 shows, for *Electricite de France*, the CDS spread curve together with the spread on several bonds. The difference between the bond spread and the CDS spread (with the same maturity) will give us the Bond-CDS basis.

Abel Elizalde
(44-20) 7742-7829
abel.elizalde@jpmorgan.com

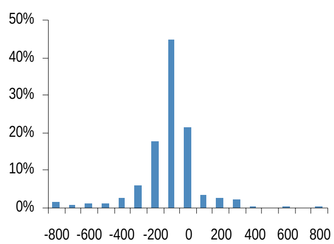
Basis trades aim to take advantage of two separate but related factors:

- **Hedging bonds with CDS should theoretically produce a risk-free trade**. An investor can buy a bond and matched CDS protection in order to be neutral to a default event. If the income from the bond is larger than the cost of protection, an investor should receive a risk-free income.
- **The basis should be mean reverting**. The basis can be negative, positive or zero. If it is close to zero, bonds and CDS trade in line and there might be no relative value opportunities. However, if the basis is too positive or too negative, the relative value between bond and CDS should attract investors to do trades that could cause the absolute value of the basis to decrease. Thus, the basis is mean-reverting, implying that investors with shorter trade horizons can also take advantage of large positive or negative basis.

If the basis is **negative**, then the CDS spread is lower (tighter) than the bond spread. To capture the pricing discrepancy when a negative basis arises, an investor could buy the bond (long risk) and buy CDS protection (short risk) with the same maturity as the bond. If the basis is **positive**, then the CDS spread is higher (wider) than the bond spread. An investor could borrow and short the bond (if possible) and sell CDS protection (long risk) with the same maturity (or as near as possible) as the bond. Thus the investor is not exposed to default risk but still receive a spread equal to the Bond-CDS basis.

Figure 2: Current Basis Distribution in Europe

X-axis: Basis bucket; Y-axis: % of bonds with basis within each bucket.



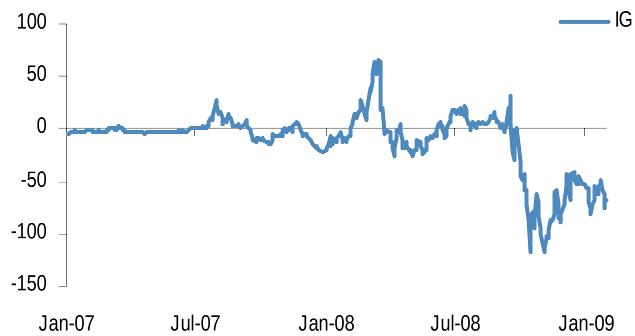
Source: J.P. Morgan.

We typically find that negative basis trades are more attractive than positive basis trades. In a negative basis trade an investor will buy the bond and buy CDS protection. For a positive basis trade however, an investor needs to repo the bond and sell CDS protection. The difficulty with repo of corporate bonds and the cheapest-to-deliver option that protection buyers own makes positive basis packages more difficult to analyse and execute.

Negative basis trades have been in the spotlight recently (and still are) due to the historical levels reached in the Bond-CDS basis since October 2008. Figure 2 shows the current distribution of basis in the European market. Figure 3 and Figure 4 show the average historical basis for the European and US bond market. Since October 2008, the basis has reached historical (negative) levels as credit investors have shunned cash bonds due to their lower liquidity and higher funding requirements compared to CDS.

Figure 3: Historical Aggregate Bond-CDS Basis: Europe

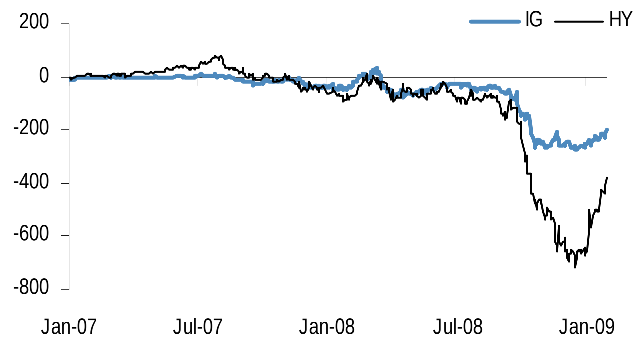
In bp.



Source: J.P. Morgan.

Figure 4: Historical Aggregate Bond-CDS Basis: US

In bp.



Source: J.P. Morgan.

Negative basis trades have been a popular investment strategy during the last years. Since the risk on these trades is partially hedged, compared to long risk positions in bonds or CDS, they were used extensively. The sudden and extreme widening of the basis to negative territory during the last months caused significant negative MtM losses to negative basis investors. The combination of low liquidity in the cash market and tightening funding conditions contributed to unwinds of previously established negative basis trades.

The current market conditions are very attractive to set up negative basis packages. However, investors should be fully aware of all the issues affecting basis trades construction, risks and sensitivities. In this research note, we will provide a comprehensive analysis of the most important aspects relating basis trades such as their measurement, their trading, their risks as well as their historical patterns and future outlook.

Abel Elizalde
(44-20) 7742-7829
abel.elizalde@jpmorgan.com

The Bond-CDS basis measures the extra compensation CDS investors receive relative to bond investors. It is expressed as a "running" spread measure.

Trading the Bond-CDS basis requires investors to:

1. **Identify an attractive negative basis** using a basis spread measure.
2. **Choose the notionals in the bond and CDS positions**, which will determine the trade sensitivity to spread movements and to a default, as well as the carry.
3. **Understand the trade mechanics: cash flow structure, funding, secondary risks ...** Whether the bond trades with a low price and coupon, or a high price and coupon; whether the CDS trades on a full running, full upfront or upfront plus running basis; whether the CDS spread curve is upward sloping or inverted ... All these factors affect the economics of basis trades.

The different sections of this report cover all the above considerations in detail. In Section 1 we take a closer look at what exactly the Bond-CDS basis encapsulates, how we define it, how we measure it, its main drivers and how it is generally traded.

Section 2 tackles the measurement of the basis by analyzing different spread measures for bonds (e.g. asset swap spread, Z-spread) and how well suited they are to be compared with CDS spreads. We present a bond spread measure (par equivalent CDS spread or PECS) which we consider better suited for measuring the basis.

Section 3 focuses on the trading aspects of basis trades. We start with a very simple stylised basis trade example which we use to illustrate all the structural features of bonds and CDS which affect the mechanics and economics of basis trades. The section also reviews the most popular motivations to enter into basis trades: lock-in a "risk-free" spread over the life of the trade, bet that the basis will revert back to zero and profit from a default of the company.

In Section 4 we review the historical evolution of the basis and present our outlook for 2009. Finally, Section 4 provides an overview of the current picture in the European basis space. We analyse the basis breakdown by sector, rating and maturity, as well as the most attractive basis trades. We also outline J.P. Morgan's new *European Bond-CDS Basis Report*, which will highlight on a daily basis the best trading opportunities and the evolution of the basis per rating, maturity and sector. It complements our existing *US Corporate High Grade Basis Report* and *US Corporate High Yield Basis Report* for the US market. All of them are available on *Morgan Markets* and provide an efficient way to track the Bond-CDS basis on a daily basis.

In the appendices, we include a brief remainder of CDS pricing as well as a comprehensive review of bond spread measures.

Although we cover the most relevant aspects of basis trading extensively, we do not analyse with all the detail that they might deserve some other important issues such as the treatment of basis in the high yield space (where bonds generally have some embedded optionality), the practical implementation of funding issues surrounding basis trades, and the hedging of the interest rate and FX risks in basis trades. We plan to tackle them in future research.

Basis Definition

CDS and corporate bonds are both affected by the credit risk of a company. As the perceived credit risk of a company increases, CDS spreads rise and corporate bond prices fall. "*If*" *CDS and bonds contain the same credit risk, do they price the same credit risk?*[1] The Bond-CDS basis aims to be a measure of the discrepancy between the risks priced into bonds and CDS.

Bond yield components:

In order to isolate the effect of the increased credit risk on a bond, we decompose the bond's yield into four components:

- **Risk-Free rate:** The bond holder could earn this yield in a default/risk-free investment (for example, the US Treasury rate).
- **Swap Spread:** The swap spread is the difference between the funding cost of a AA rated company and the risk-free rate. The swap rate (swap spread + risk-free rate) is the cost of capital for many investors since they can borrow or lend at this rate rather than the risk-free rate.
- **Credit Spread:** The spread to compensate for the risk that the company defaults and investors lose future interest and principal payments. When investors refer to bond spreads, they usually have some measure of this credit spread in mind.
- **Bond Liquidity Premium:** The spread to compensate investors for the illiquidity of the bond.[2]

Credit and liquidity risks are measured by traditional "bond spread measures" such as Z-spread and asset swap spread.

CDS spread components:

CDS spreads are meant to be a clean measure of credit risk, although liquidity risks can also be priced in.

Leaving aside liquidity considerations, CDS and bond spreads both compensate investors for the same risk – the risk that a company might default. As such, they should be approximately equal. The **Bond-CDS** basis measures the extent to which these spreads differ from each other. We thus define it as the difference, in basis points, between the CDS spread and the bond spread *with the same maturity dates*:

Definition of Bond-CDS Basis

Bond-CDS Basis = CDS spread – Bond spread measure

The Bond-CDS basis is also referred to as **Basis-to-Cash**.

As we make clear later in the report, the basis is measured on a "running" format, i.e. using a CDS running spread and a bond spread measure (also expressed on a running format). For very wide credits, CDS might trade on an upfront plus running basis. In that case, we will compute the equivalent full running CDS spread and use it in our basis definition. We expand on these topics in Section 2.

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[1] In fact, do they actually contain the same risk? Throughout this report, we will dissect the structural differences between bonds and CDS, which should contribute towards answering this question.

[2] Our credit strategists estimate that the current liquidity premium in investment grade bond spreads could potentially range from 100to 200bp. See *How big is the liquidity or illiquidity premium?*, P Malhotra et al, 30 January 2009.

Abel Elizalde
(44-20) 7742-7829
abel.elizalde@jpmorgan.com

Our measure of the basis will still provide a measure of the different credit risk priced in both instruments if we assume the liquidity premium is the same. If that was not the case the basis will be a combination of credit and liquidity risks. This can be particularly relevant in situations where the liquidity on each market is very different.

Whereas CDS spreads are determined by market participants and are readily observable in the market, bond spreads are a theoretical measure backed out from bond prices. There are different bond spreads measures which can be used to compute the Bond-CDS basis.

For the purposes of the Bond-CDS basis, we are concerned with the comparability of different bond spread measures with CDS spreads. In later sections we analyse in detail different bond spread measures (e.g. Z-spread and asset swap spread) and judge their comparability with CDS spreads. In particular, we highlight the problems of comparing traditional bond spread measures with CDS spreads since, unlike CDS spreads, their calculation does not explicitly take into account expected recovery rates and the term structure of default probabilities (although their prices should do so).

We also propose a bond spread measure which tackles those problems and represents, in our view, a more appropriate spread measure to be compared to CDS spreads. We call such measure the bond's par equivalent CDS spread (PECS). Like the CDS spread, the PECS is a function of the assumed bond recovery rate and the term structure of default probabilities. J.P. Morgan introduced the PECS in 2005[3] and we use it extensively in our research and analytics.

[3] See *Credit Derivatives: A Primer*, E Beinstein et al, January 2005, and *US High Yield Spread Curve Report: A Guide*, E Beinstein et al, 29 April 2005.

Main Drivers of the Bond-CDS Basis

We next highlight some of the most important drivers of the Bond-CDS basis. The direction of the basis will be a function of which of these drivers is more important at each point in time.

Though the investor communities on bond and CDS markets are converging over time, market segmentation still exists, which manifests in different demand/supply dynamics in either market.

Table 1: Main Drivers of the Bond-CDS Basis

Drivers	Effect on Basis
Bond issuance (in illiquid and deteriorating credit conditions)	Negative Basis
Bond issuer call options	Negative Basis
Bond repo costs	Negative Basis
Funding costs	Negative Basis
Higher CDS relative liquidity (tightening spreads)	Negative Basis
Issuance of synthetic structured products	Negative Basis
Risk on Non-deliverables	Negative Basis
Bond covenants protecting bond holders	Positive Basis
Cheapest-to-deliver option	Positive Basis
Higher CDS relative liquidity (widening spreads)	Positive Basis
Soft Credit Events	Positive Basis
Unwind of synthetic structured products	Positive Basis

Source: J.P. Morgan

Liquidity Premium

Credit instruments do price a liquidity risk premium on top of the credit risk premium. The Bond-CDS basis captures all those premiums. Even though liquidity premiums for bonds and CDS might be similar during normal times, periods of financial stress can have very different consequences in the liquidity of bonds and CDS respectively.

A significantly lower liquidity in bonds than in CDS will tend to make the basis positive in spread widening scenarios, as investors find it easier to buy CDS protection than to sell their bonds. In a spread tightening environment, the opposite should be true. **Therefore, the different liquidity of bonds and CDS can give basis trades significant market directionality.**

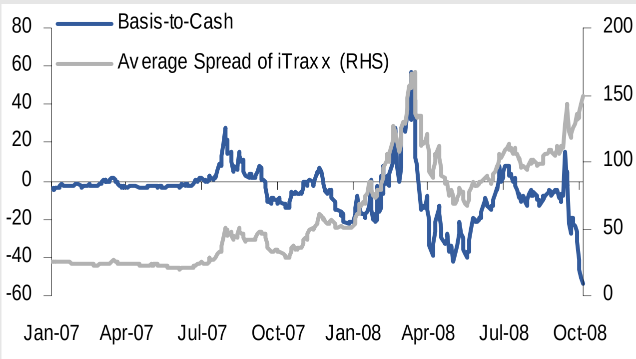
The grey box in the following page contains an extract of our *CD Player* published on 8 October 2008, where we reviewed the situation of the Bond-CDS basis at the time, highlighting the importance of liquidity on the basis.

Extract from CD Player - 8 October 2008: The Basis-to-Cash is at its historical negative levels of the last 2 years. For all practical purposes, CDS continues to be the only way to short the credit market or to hedge cash positions. The lower liquidity and funding issues in bonds means investors are asking for a substantial risk premium over CDS, taking the basis to the 53bp area (Figure 1 and Figure 2).

Liquidity has taken over new issuance concerns, which now look less relevant for the basis. It all points out that this situation should persist until the bond market recovers in terms of liquidity. Some of the negative basis packages established during the last months run the risk of unwinding, which will not help the basis to trend to positive territory. We expect investors with liquidity reserves to monitor the existing negative basis opportunities, but not to deploy enough capital to meaningfully move the aggregate market basis as long as liquidity and funding in the bond market do not improve.

Figure 5: Historical iTraxx Basis vs. Spread

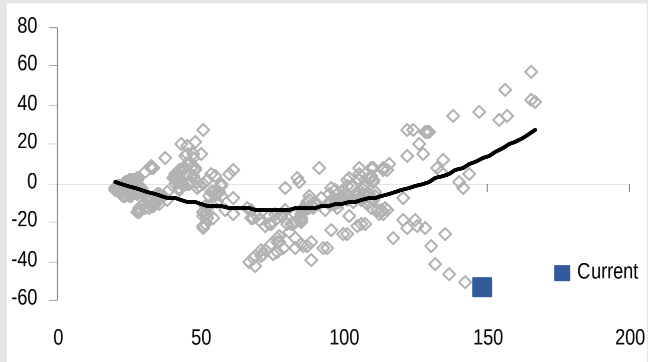
Spread (bp)



Source: J.P. Morgan.

Figure 6: iTraxx Basis vs. Spread: Historical Scatter Plot

X-axis: iTraxx 5y spread (bp); Y-axis: Basis-to-cash (bp)



Source: J.P. Morgan. Historical data since August 2006.

Synthetic Structured Products

The massive issuance of synthetic products in past years was one of the major drivers of credit spread tightening. Effectively, such issuance implies initial protection selling pressure through CDS, driving the basis towards negative territory until bond spreads catch up with CDS. This phenomenon was more significant in investment grade credit.

In the current environment, the risk of unwinds of synthetic products issued in previous years can trigger the opposite mechanism. As investors unwind those products, dealers will unwind their hedges by buying CDS protection and pulling the basis to positive territory.[4]

Bond Issuance

Bond issuance, especially in environments of low liquidity and deteriorating credit conditions, should push the basis to negative territory as companies need to incentivise investors by offering wider bond spreads.

Bond Repo

Positive basis trades involve selling CDS protection and shorting a bond, which requires borrowing it through the repo market. Unlike in CDS, shorting bonds is more complex than buying them. As a consequence, positive basis can be less attractive than negative basis trades, especially for "hard to borrow" bonds.

However, bond repo considerations can work the other way around. Investors can establish negative basis trades by borrowing (rather than buying) bonds and buying CDS protection in order to obtain leverage. Recently, bond lenders have pulled back on this product, forcing the unwind of some negative basis trades if the investor did not have the borrowed bond locked up.

[4] For an analysis of the impact of synthetic structured products on the Bond-CDS basis, see *Impact of Structured Product Activity on the Credit Markets*, D Toublan et al, 23 January 2009.

Abel Elizalde
(44-20) 7742-7829
abel.elizalde@jpmorgan.com

Unfunded vs. Funded

For investors who borrow above Libor, i.e. most of them, selling CDS protection might be more economical than borrowing money to buy bonds in order to go long the credit risk of a company. This can pull the basis negative. In fact, the substantial increase in funding costs during the last months can be seen as a structural factor which has contributed to the basis becoming significantly negative.

Cheapest-to-deliver Option

CDS protection buyers have the so-called "cheapest-to-deliver" option: in case of default, they are contractually allowed to choose which bond to deliver[5] in exchange for the notional amount. Thus, investors will generally deliver the cheapest bond in the market.[6] When there is a credit event, bonds at the same level of the capital structure generally trade at or near 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.

The cheapest-to-deliver option, other things equal, should increase CDS spreads relative to equivalent bonds: protection sellers need an extra compensation for the cheapest-to-deliver option they are selling. This would lead to CDS spreads trading wider than bond spreads and therefore contribute to positive basis.

Soft Credit Events

A CDS contract might be triggered by a broader set of events than a "real" default, e.g. restructurings such as maturity extension. In these cases, if there are deliverable bonds trading below par, the CDS protection buyer will deliver them and earn the difference between par and price. Soft credit events have the same impact on the basis as the cheapest-to-deliver option: they are advantageous for protection buyers, pushing CDS spreads up compared to comparable bond spreads.

Freddie Mae and Fannie Mac credit events in 2008 can be seen as a recent example of "soft" credit events. The auction recovery rates were set above $91 for both senior and subordinated CDS contracts.[7]

Risk of non-deliverables

In cases of restructuring associated with M&A activity, bonds may sometimes be transferred to a different entity, which may leave the CDS contract without any deliverable bonds (i.e., without a Succession event[8]). In cases such as this (or where investors feel there is a risk of this event), CDS will tighten, often leading to a negative basis.

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[5] The bond must satisfy the characteristics of the deliverable obligations.

[6] For a detailed case study on the impact and importance of the "cheapest-to-deliver" option we refer investors to two research reports covering the settlement of Fannie Mae and Freddie Mac (October 2008). *Fannie and Freddie CDS Settlement Auctions*, E Beinstein et al, 2 October 2008. *Fannie Mae and Freddie Mac CDS Settlement*, E Beinstein et al, 6 October 2008.

[7] See *Fannie Mae and Freddie Mac CDS Settlement*, E Beinstein et al, 6 October 2008.

[8] See *J.P. Morgan Credit Derivatives Handbook* for more information on succession events (December 2006, p. 34).

High Yield Structural Features

Multiple call dates and bond covenants give lenders and bond holders rights which CDS protection buyers and sellers do not enjoy. Therefore they are a potential source of spread differential between bonds and CDS. Covenants, protecting bond holders, will contribute to a positive basis, while lenders' options to call bonds at specific dates will have the opposite effect. The impact of these features on basis measurement and basis trading is relevant as well as complex. We do not analyse them in this report, and aim at doing more work on it in the future.

Why Do Investors Enter Negative Basis Trades?

Although we shall go in detail through the practical considerations of constructing and sizing basis trades in a later section, we mention here the most popular motivations for establishing negative basis trades:

1. **Lock-In "Risk-free" Spread**. If bond and CDS share the same credit risk but they are pricing it differently, it might be possible to construct something akin to an "arbitrage-free" trade to profit from it. As we show later, this is not generally possible due to the trading conventions of bonds and CDS. However, the more negative the basis the more attractive the basis trade.

2. **Trade the Basis**. A negative basis trade (buy bond and buy CDS protection) can be used to bet that an already negative basis will disappear, or to bet that the basis will become positive.

   For example, CDS spreads might react faster to negative news regarding corporate events.[9] In those cases, the basis can become positive until bond spreads catch up. A negative basis trade established prior to the negative news should profit from it.

3. **Profit from Default**. If the bond and CDS legs of a basis trade are done in the same notional, the investor can, after a default, deliver the bond to the CDS counterparty and both legs of the trade will terminate with no further payment. In that case, the investor's gain will be the net cash flows the trade generated up to that point. If the investor expects the default to happen soon, a short maturity CDS can be more economical if the CDS spread curve is steep enough.

The sizing of the basis trades will be key in determining their performance.

In the next section we tackle the measurement of the basis by analyzing different spread measures for bonds (e.g. asset swap spread, Z-spread, PECS) and how well suited they are to be compared with CDS spreads.

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[9] The issue of whether CDS spreads react faster than bond spreads is not entirely clear cut, and it depends on the relative liquidity of bonds and CDS on each particular market. For example, the lower liquidity of the European bond market vs. the US one will affect such relationship. There are some empirical academic papers which analyse this issue. See R Blanco, S Brennan and W Marsh, 2005, "*An Empirical Analysis of the Dynamic Relation between Investment Grade Bonds and Credit Default Swaps*", Journal of Finance 60 (5). See also S Alvarez, 2004, "*Credit default swaps versus corporate bonds: Do they measure credit risk equally?*", unpublished manuscript.

Abel Elizalde
(44-20) 7742-7829
abel.elizalde@jpmorgan.com

2. Bond and CDS: Credit Spread Measures

Bond-CDS Basis

CDS Spread

minus

Comparable Cash Bond Spread

We start this section by reviewing CDS spreads and alternative formats of trading CDS. Then we analyse the variety of metrics that exist for calculating the bond spread. The most commonly referenced bond spreads are:

1. *Z-spread*
2. *Par Asset swap spread (ASW)*
3. *Par Equivalent CDS Spread (PECS)*

Others include *spread to benchmark*, *I-spread* and *True ASW*. **ASW** and **Z-spreads** have traditionally been the most widely used bond spread measures when dealing with basis trades. However, these spread measures have features which make it difficult to have a like-for-like comparison with CDS spreads. In particular, their calculation does not explicitly account for expected recovery rates or the term structure of default probabilities, which are key determinants of CDS spreads. **PECS** can be thought of as a bond credit spread measure consistent with the recovery rate and term structure of default probabilities priced into the CDS market.

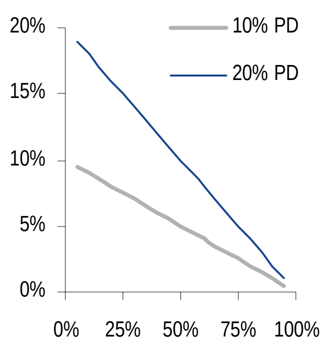
Appendix I includes a reminder of CDS pricing, and Appendix II provides a detailed analysis of each of the above bond spreads measures. Here, we summarise the differences between CDS spread, Z-spread, ASW and PECS.

CDS Spreads: Recovery Rates and Term Structure

When trading and quoting CDS spreads, market participants do so under a recovery rate assumption. As we outline in Appendix I, CDS spreads are a function of recovery rates and default probabilities. In a simple one-step time period example, Equation 1 shows that the CDS spread (S) equals the default probability (PD) times the loss in case of default, given by one minus the expected recovery rate (R).[10]

Figure 7: CDS Spread & Recovery

X-axis: recovery rate assumption (%); Y-axis: CDS spread (%).



Source: J.P. Morgan.

Equation 1: CDS Spread as a Function of Default Probability and Recovery Rate

Simple one-step time period example.

$$S = PD \times (1 - R)$$

Keeping default probabilities constant, changes in expected recovery rates will affect CDS credit spreads. This effect is larger for high default probabilities (Figure 7). When the likelihood of default is high enough, estimates of recovery rates are more important and the cheapest-to-deliver optionality in CDS contracts is priced in more accurately. Thus, expected recovery rates affect CDS spreads. For a better comparison with CDS spreads, bond spread measures should explicitly take into account assumed recovery rates.

[10] See Equation 10.

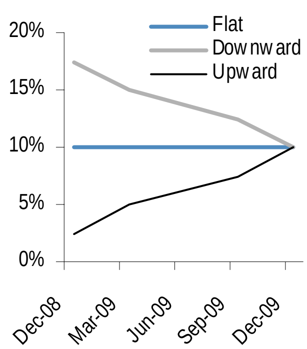
Abel Elizalde
(44-20) 7742-7829
abel.elizalde@jpmorgan.com

In an equal notional basis trade where the investor plans to deliver the bond into the CDS contract in case of default, the *assumed* recovery rate should not play such a big role (except for cheapest-to-deliver considerations and assuming the bond is deliverable into the CDS contract). Movements on the assumed recovery rate should therefore not affect our measure of the basis. Since recovery rate changes do affect CDS spreads, in order to compute the basis we would prefer a bond spread measure which is also sensitive to the assumed recovery rate.

Additionally, CDS spreads for a given tenor can not be considered in isolation from the full CDS curve, especially when analyzing trades where there is a regular stream of risky running payments; which is the case in basis trades. The shape of the term structure of CDS spreads determines default probabilities over time, i.e. the likelihood of those future running payments being realised. For example, Figure 9 shows the cumulative default probabilities implied from the three CDS curves in Figure 8. The three CDS curves have a similar 1y spread but different shapes.

Figure 8: CDS Curves

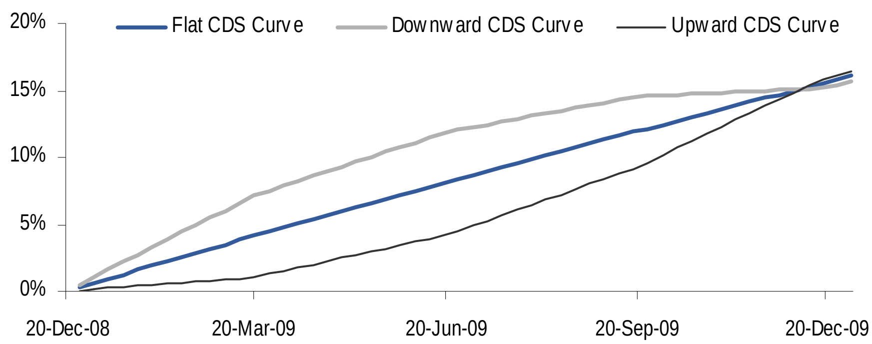
CDS Spread (%)



Source: J.P. Morgan.

Figure 9: Implied Cumulative Default Probabilities

Using the CDS curves in Figure 8 and 40% recovery rate.



Source: J.P. Morgan.

Therefore, looking at a CDS spread for a particular tenor in isolation will not give us the full information regarding default probabilities and therefore regarding credit risk.

As we review in the next section, the shape of the term structure of default probabilities will impact the economics of the basis trade as long as the timing of default has an impact on the trade's performance.

The difficulty here lies in which term structure of default probabilities to use: the one implied by bond spreads of different maturities or by CDS spreads. Either one would add value versus not using it. The PECS measure we introduce later uses the term structure of default probabilities implied by the CDS curve; this is generally more convenient as CDS curves are more readily available.

Abel Elizalde
(44-20) 7742-7829
abel.elizalde@jpmorgan.com

What is the basis when CDS trade with upfront?

In our report *Understanding CDS Upfronts, Unwinds and Annuity Risk* (S Doctor, 11 March 2008) we dealt at length with the issues around the different ways to trade CDS: running, upfront and upfront plus running.

The recent return to a high spread environment has seen an increased number of CDS trading in upfront plus running, or points upfront, format. This is not a new phenomenon and is frequently employed when trading high spread names.

Having defined the basis as the difference between the CDS spread and a bond spread, the question that arises is which spread we should use when CDS trades on an full upfront or upfront plus running basis.

In the case of bonds, which trade on an upfront (price) plus a running (coupon) spread, we compute an equivalent full running credit spread measure which we then use in our basis calculation.

For consistency, we should do the same for the CDS, i.e. **use the equivalent full running spread for the maturity we are considering**. When the CDS is not trading on a full running format, we would have to compute it.

As we describe in Appendix I, we can compute the full running equivalent spread of a CDS contract using the risky annuity and the accrued interest. Equation 2 shows how to compute the full running equivalent spread on a contract trading with upfront plus a running coupon (*Fixed Coupon*), using the CDS risky annuity (*RA*) and accrued interest (*AI*).

Equation 2: CDS Pricing Equation – From upfront plus running to full running

$$Full\ Running = \frac{Upfront\ \text{-}\ AI}{RA} + Fixed\ Coupon$$

As we explain in the next section, the CDS trading format does have an impact on the economics of basis trades. Thus, the trading format matters even if it implies the same full running spread. This illustrates the fact that basis measures, expressed in a full running format, are useful to judge the attractiveness of basis trades, but they are not enough.

Next, we look at three alternative measures of bond credit risk to asses the best comparison to CDS.

Abel Elizalde
(44-20) 7742-7829
abel.elizalde@jpmorgan.com

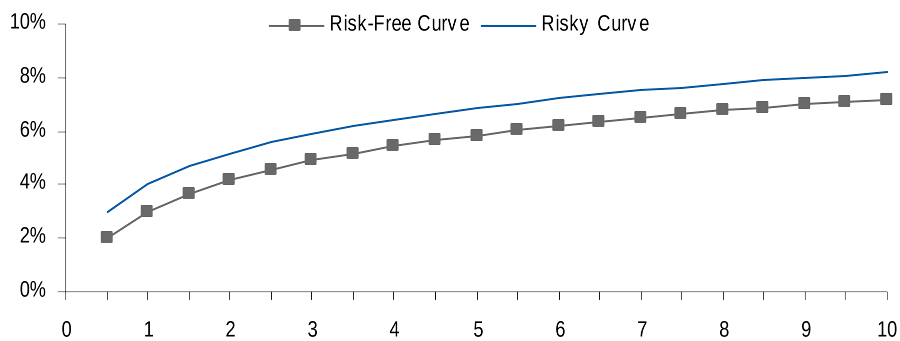
Z-spread

The Z-spread is the parallel shift applied to the zero curve in order to equate the bond price to the present value of the cash flows.[11]

We take the zero curve as an input and add a "flat" credit risk premium (the Z-spread) for which the bond's discounted cash flows match its market price. Effectively, the Z-spread can be thought of as the flat spread that can be added to the risk-free curve to capture the risks of the bond apart from interest rate risk.

The Z-spread accounts for the term structure of interest rates, but assumes a flat term structure of credit spreads (assuming credit is the only additional risk priced in by the bond). Thus, it does not explicitly take into account the term structure of default probabilities.

Figure 10: Z-spread as a Set of Risky Discount Factors



Source: J.P. Morgan.

When computing the Z-spread, we do not take into account the possibility of the bond defaulting (i.e. we assume zero default probabilities) or, if we do take such possibility into account, we assume a zero recovery rate. In any case, the expected recovery rate is not explicitly taken into account in the Z-spread calculation.

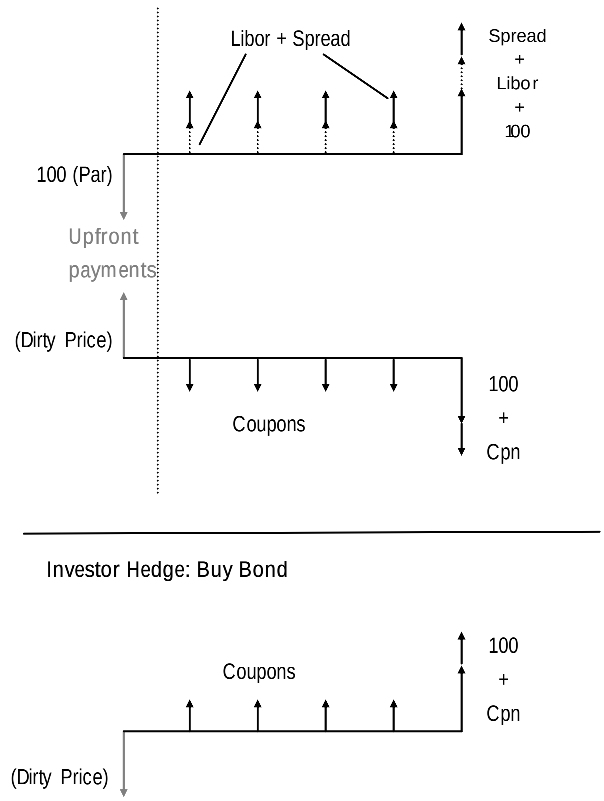
Z-spreads are useful for comparing the relative value of bonds as they take into account the full term structure of the risk-free rates. However, Z-spreads are not traded in the market.

[11] As the Z-spread is just a spread above a given risk-free rate, we can reference it either to LIBOR/Swap zero rates or to government zero rates.

Asset Swap Spread

An asset swap is a way of trading a bond in which its fixed coupons are exchanged for floating payments that fluctuate in line with Libor (or some other agreed rate). Essentially, this transforms a fixed coupon bond into something analogous to a floating rate note. In doing this, the investor is able to hedge out the interest rate risk inherent in owning a bond. **The spread over Libor received on the floating side is called the asset swap spread, and can be considered to give some measure of the bond's credit risk**.

Figure 11: Asset Swap Package + Hedge: Cash flows from the Investor's Perspective



Source: J.P. Morgan.

Let us consider an investor who is entering into an asset swap package and buying the bond at the same time. In the asset swap package, the investor pays €100 and receives the bond price €P, which is used to buy the bond. Therefore the investor's payment at inception is €100.

We assume the bond and asset swap package have the same maturity and payment dates. The bond pays an annual coupon c on the €100 notional, which the investor transfers through the asset swap package in exchange for Libor l plus the asset swap spread s on a €100 notional. Therefore he receives a net amount of €100 x $(l + s - c)$ per year in the asset swap and receives €100 x c on the bond as long as there has been no default. At maturity, the investor receives the notional from the bond.[12]

[12] An asset swap package is an interest rate swap with €100 notional with an initial cost of €$(100 – P)$ where the investor pays fixed coupons (c) and receives floating coupons ($l + s$).

Abel Elizalde
(44-20) 7742-7829
abel.elizalde@jpmorgan.com

On a net basis, the investor has paid €100 to buy the bond and the asset swap package, and receives an annual coupon of €100 x ($l + s$). Effectively, it has transformed the fixed coupon bond into a floating one, hedging the interest rate risk. The asset swap spread s is the extra-compensation above the (Libor) risk-free rate, and therefore it can be interpreted as a measure of the bond's credit risk. However, notice that such spread is being paid on the bond's notional value, not on its price P.

Par asset swap spreads are useful as they can be traded. An investor can find a dealer who will pay him the annual par asset swap spread. In Appendix II, we show that the asset swap spread can be computed as:

Equation 3: Par Asset Swap Spread Calculation

$$\text{Asset swap spread} = \frac{PV\left[\text{Coupon} + \text{Principal}\right] - \text{Bond Price}}{\text{Risk free annuity}}$$

where the annuity used here is the risk-free annuity (present value of a 1bp annuity stream) and PV represents the present value of the bond's future cash flows using the risk-free discount curve.

The asset swap package does not go away in case of default. In the extreme case that the bond defaults immediately after entering the asset swap package, the interest rate swap part of the package remains in place with the same value, but the bond's value goes down from €P to €R (its recovery price). Therefore, the loss for the investor upon an instantaneous default is €($P – R$). Although the loss is a function of the bond's recovery rate, the asset swap spread does not explicitly take it into account. The loss in case of default in a CDS position with a €100 notional would be €(100 – R), i.e. it is a function of the recovery rate. Unlike the ASW, the CDS spread is affected by the assumed recovery rate.

The asset swap spread is an equivalent measure for the credit risk of a bond and, unlike the Z-spread, it is a traded measure. However, like the Z-spread, its computation does not explicitly take into account the expected recovery rate and the term structure of default probabilities. As the Z-spread, the asset swap spread represents a "flat" credit spread measure.

Abel Elizalde
(44-20) 7742-7829
abel.elizalde@jpmorgan.com

In this section, we have argued that bond spread measures that explicitly take into account the term structure of default probabilities and the assumed recovery rates are more appropriate for measuring the Bond-CDS basis than other measures, such as Z-spreads or asset swap spreads, which do not. In the next grey box, we expand our argument regarding the recovery rate issue.

Recovery Rates in Bond and CDS Pricing

Both traded CDS spreads and bond prices do factor in some assumption not only about the expected recovery rate, but also about its distribution function and its relationship with default and interest rates risk. However, when modeling bond and CDS prices, those recovery rate assumptions can not generally be disentangled from the assumptions regarding default risk.

The market convention for CDS pricing is to assume an expected recovery rate (independent of default and interest rate risks) and derive, from traded levels, information regarding default probabilities. Traders and investors will change their recovery rate assumptions to reflect changing market conditions, especially in distressed environments like the current one where recovery rates become very important for pricing credit risk.

These changes in CDS recovery rates assumptions do not necessarily come with changes in spreads. If, for example, a trading desk or an investor decides to mark down their recovery rate assumption on one particular credit from 40% to 20%, their pricing models will use this new assumption to calibrate default probabilities to the same CDS spread. The new calibrated default probabilities (with a 20% recovery rate) will be lower than before.

When changing the recovery rate assumptions the credit risk priced into the CDS has not changed (it has the same spread), but the allocation of that risk between default and recovery risks has changed. Using the simple one-step time period example Equation 1 and a spread level of 1000bp, changing the recovery rate from 40% to 20% “moves” the calibrated default probability from 17% to 13%.

Bond-CDS basis trades can be viewed as risky annuity trades. Let us take a simplistic example for illustration purposes. Imagine a negative basis trade where the investor buys a 5% coupon bond and buys CDS protection trading at 2% running spread on the same notional and with the same maturity. Let us not worry now about funding costs, interest rate risk…The trade involves an initial payment equal to the bond price plus a *risky annuity* of 3% per annum.

As we show later, this trade is not exposed to the realised recovery rate on default: the investor delivers the bond into the CDS contract and gets par, irrespective of the realised recovery rate. However, the risky annuity is very sensitive to default probabilities and, as we argued above, default probabilities are very sensitive to the assumed recovery rate.

Thus, changes in the assumed recovery rate will affect the value of the risky annuity and therefore the MtM of a basis trade. Since the assumed recovery rate is an important element for basis trades, we would prefer to use spread measures (both for CDS and bonds) which do explicitly incorporate the assumed recovery rate.

Bond measures like Z-spread or asset swap spread do not incorporate such assumption explicitly, even though they are indirectly affected by it (because it will affect the bond price). But if the assumed recovery rate changes, the distribution of credit risk between default and recovery rates will change, and those spread measures will not necessarily capture it.

The bond spread measure that does explicitly take into account both the term structure of default probabilities and the assumed recovery rates is the PECS, which we turn to next.

Abel Elizalde
(44-20) 7742-7829
abel.elizalde@jpmorgan.com

Par Equivalent CDS Spread (PECS)

To compute the PECS of a bond, we start from the term structure of CDS spreads and the market assumed recovery rate. We derive the term structure of default probabilities from the CDS curve and compute an implied price for the bond based on its future cash flows, their likelihood (given by the default probabilities), the payment in case of default (given by the recovery rate) and the risk-free interest rates.

We are pricing the bond using information about credit risk (recovery and term structure of default probabilities) extracted from the CDS market. If the bond market price and the bond implied price are not the same (and generally they are not the same), then bond and CDS markets are not pricing the same risks. The difference between these two prices represents a measure of such discrepancy, i.e. it is the Bond-CDS "basis" expressed in upfront terms.

To express the basis in a running spread measure we compute the PECS of the bond using the following procedure:

1. Using the full CDS curve traded in the market and a recovery rate assumption, we calculate the implied default probabilities for the company.
2. Using an iterative process, we identify the parallel shift to the default probability curve which will make the bond implied price equal to its market price.[13]
3. Once we have matched the bond price, we convert these default probabilities back into spreads.

The PECS is the CDS spread which would match the bond market price respecting the recovery rate and term structure of default probabilities implied by the CDS market.

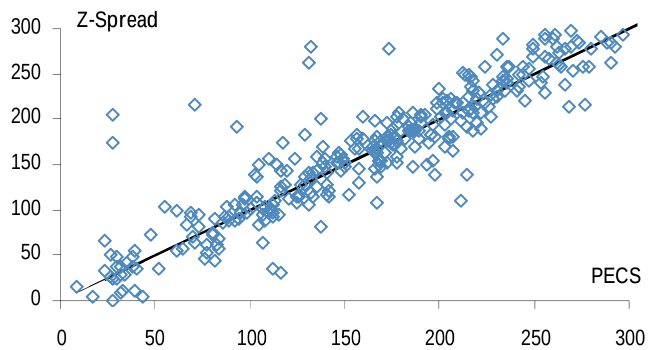
Appendix II contains more details on the precise way PECS is computed.

* * *

[13] In particular, we additively shift the hazard rates which characterise the term structure of default probabilities.

Figure 12: Z-spread vs. PECS: Spreads Below 300bp

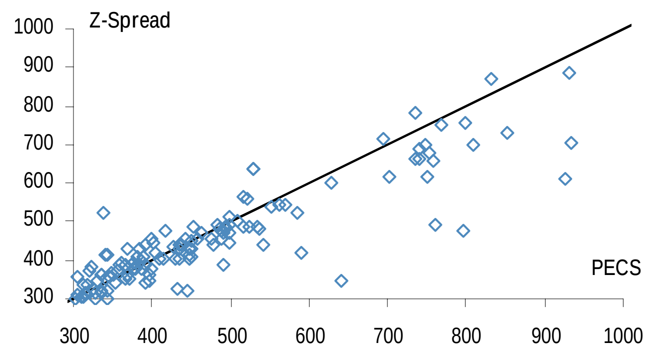
In bp.



Source: J.P. Morgan. Sample of over 500 European bonds. Data as of 6 Jan 09.

Figure 13: Z-spread vs. PECS: Spreads Above 300bp

In bp.



Source: J.P. Morgan. Sample of over 500 European bonds. Data as of 6 Jan 09.

Figure 12 and Figure 13 compare Z-spreads and PECS for a sample of European bonds. They show how the observations are spread around the 45% degree line (in black), meaning that there is a clear correlation between both spread measures. However, the deviations from the 45% degree line are widespread and can be significant, independently of the spread levels. A similar picture emerges when comparing ASW and PECS. Different spread measures aim at measuring the credit risk of the bond, but the way they are constructed implies they do not measure exactly the same thing. We will also see discrepancies between these different bond spread measures in the next section.

As long as different bond spread measures exist, there will be different ways to measure the Bond-CDS basis. We have reviewed the most common ones and their advantages and disadvantages. Although the basis is a good indicator of the different risks priced in bonds and CDS, we show in the next section that the structural features of bonds and CDS are a relevant factor for the risk exposures of basis trades.

3. Trading the Basis

In this section, we focus on the trading aspects of basis trades. We start with a very simple stylised basis trade example which we use to illustrate all the structural features of bonds and CDS which affect the mechanics and economics of basis trades. The section also reviews the most popular motivations to enter into basis trades: lock-in a “risk-free” spread over the life of the trade, bet that the basis will revert back to zero and profit from a default of the company.

Base Case: Stylised Negative Basis Trade

The real difficulty of basis trades lies in understanding the technicalities and cash flow dynamics of bond and CDS instruments. We think it appropriate to start with a stylised example of a basis trade, and build upon it.

The set of assumptions we make for this stylised example provides an idea of the potential complexity of these trades:

1. Zero-coupon bond with 1y maturity and no optionality attached. We assume, for illustration purposes, that the investor can deliver the zero-coupon bond into the CDS contract for the full notional of the bond. Generally, only the accreted amount of the zero-coupon bond will be taken into account.
2. Full upfront CDS with the same maturity as the bond. Zero running spread and no CDS margin requirements.
3. Equal notional trade: the bond and CDS notional are the same.
4. Flat 0% interest rate, which we assume remains fixed. This removes any interest rate risk on the trade and allows the investor to borrow money to pay for the bond, CDS upfront (and any CDS margin) without affecting the economics of the trade.
5. The bond we are considering will be the cheapest-to-deliver if there is a default (or will have a similar recovery rate).
6. No FX risk: bond and CDS trade on the same currency.

Under the above assumptions, we can compare the bond price and the CDS upfront directly without the need to transform them to spread levels. For example, if the bond price is €94 and the CDS upfront premium is €5, an investor can: borrow €99 at no cost, buy the bond and buy CDS protection to lock a €1 risk-free profit:

a. In case of no default the investor receives, at maturity, par (€100) on the bond, pays back the borrowed €99 and keeps €1.

b. If there is default before maturity, the investor delivers the bond into the CDS contract and gets paid the contracted CDS notional (€100). The investor pays back the borrowed €99 and keeps €1.

In either circumstance the investor has locked €1 of risk-free profit; there are no initial or interim payments in the transaction until maturity or default.

Arbitrage?

In this simple example the focus has been on “arbitrage”, which would involve trading the same notional on each product. In what follows, we continue with this example and introduce different issues which increase the complexity of the trade and eliminate the arbitrage opportunity.

There is no arbitrage anymore …

Things to Consider in Basis Trades

In this section, we build upon the previous stylised case example and consider the different aspects which affect the economics of basis trades and which investors should take into account.

Table 2: Things to Consider in Negative Basis Trades

To Consider	Effect on Basis Trades
CDS Running Spread vs. Bond Coupon at Default	Treatment upon default: while bond coupons are usually lost, the CDS protection buyer has to pay for the accrued coupon since the last coupon date.
Cheapest-to-deliver: Different Recovery Rates	The investor benefits if the bond in the basis trade recovers more than the cheapest-to-deliver.
Maturity Mismatch	Very rarely investors will be able to exactly match bond and CDS maturities in a basis trade. This introduces a residual naked long or short protection position for the last period of the basis trade, which will affect its economics.
Funding Costs	Funding costs increase the exposure of a basis trade to the timing of default, and reduce the attractiveness of negative basis trades.
CDS Upfront vs. Running Premium: Carry vs. Jump-to-Default (JtD)	A higher CDS running spread generates a negative basis trade with a worse carry profile (more negative or less positive) but a better (less positive or more negative) JtD sensitivity during the first part of the trade.
Bond Price vs. Coupon: Carry vs. Jump-to-Default (JtD)	Bonds with higher price and coupon generate a negative basis trade with a better carry profile (less negative or less positive) but a worse (less positive or more negative) JtD sensitivity during the first part of the trade.
Interest Rate, FX Risks	Basis trades are subject to interest rate risks in several dimensions such as funding or bond and CDS sensitivity to interest rates. If bond and CDS do not refer to the same currency, the basis trade will be subject to movements in the exchange rate.
Bondholders' rights & Bond embedded options	Bond holders might have actual or potential rights, and bonds may have embedded options such as callable, puttable, poison puts, etc. These features can affect the economics of basis trades.
Bond deliverability into CDS contract	If the bond in the basis trade is not deliverable into the CDS contract, the investor is exposed to the different recovery rate of their bond and the cheapest-to-deliver (or to the result of CDS cash auction if they decide to cash settles their CDS position).
CDS Restructuring Credit Events	If a restructuring event occurs, CDS contracts specify restrictions regarding which obligations can be delivered into the contract by CDS protection buyers. These restrictions (e.g. on the maturity of the deliverable obligations) can affect the bond in the basis trade.
Bond Covenant Breaching vs. CDS Credit Events	Breaching a bond covenant does not necessarily trigger a CDS credit event.

Source: J.P. Morgan.

1. CDS Running Spread vs. Bond Coupon at Default

We assume that the above bond and CDS have a 5% annual coupon and running spread respectively, maintaining the same price and upfront premiums above. Moreover, we also assume that both bond and CDS have similar quarterly coupon payment dates (20 March, 20 June, 20 September, 20 December) and that we enter into the trade on 20 December 2008, i.e. there are no accrued components on the bond coupon or CDS running spread.

The key difference between bond and CDS running coupons is their treatment upon default: *while bond coupons are lost, the CDS protection buyer has to pay for the accrued coupon since the last coupon date*. Other things equal, the lower and the more frequent the bond coupons the better for the investor in a negative basis trade.

Figure 14 shows the total cash flows of our negative basis trade for different default dates. We draw readers' attention to the grey box on page 25, where we explain carefully how to read figures which, like Figure 14, show the default exposure of negative basis trades over time. We will use these figures throughout the rest of the report.

Abel Elizalde
(44-20) 7742-7829
abel.elizalde@jpmorgan.com

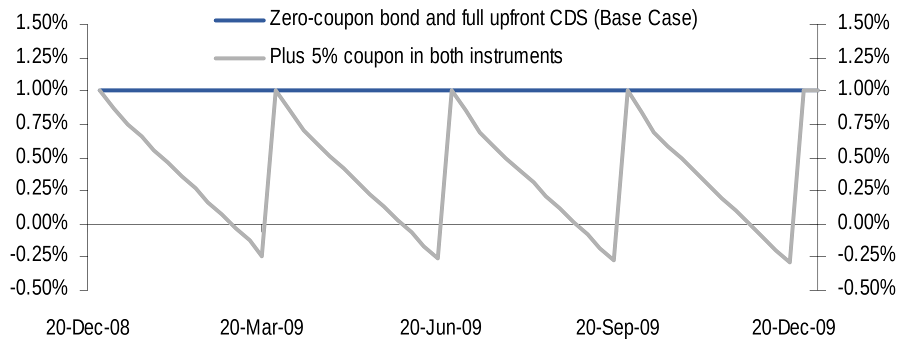
If the default happens right after a coupon payment date or after maturity, the investor makes a similar amount of money, €1, as in the previous case (where there were no coupons). However, if the default happens within coupon dates, the investor losses the bond accrued coupon but has to pay the CDS accrued coupon. Thus, the worst case is one where the default happens the day before a coupon payment date. The €1 that the investor makes upon default is not enough to compensate for the full €1.25 quarterly bond coupon lost.

Treatment upon default: while bond coupons are usually lost, the CDS protection buyer has to pay for the accrued coupon since the last coupon date.

Bond coupons are lost upon default; however CDS protection buyers pay for the accrued coupon since the last coupon date

Figure 14: Bond Coupons and CDS Running Spreads: Impact on Basis Trades (JtD Exposure)

Y-axis: Sum of total cash flows on the negative basis trade until default; X-axis: Assumed default dates.



Source: J.P. Morgan.

Finally, two additional issues should be considered. The frequency and payment dates on bond and CDS can be different. Bond coupons have different accrual day conventions (e.g. 30/360, Act/Act…), whereas CDS coupons (running spread) accrue on an actual/360 convention.

Jump-to-Default (JtD) Exposure

Negative Basis Trades Cash Flow Profile upon Default

Throughout the report, we will rely on figures similar to Figure 3 in order to show **JtD sensitivity of negative basis trades through time**. These figures should be read as follows. The x-axis, which will generally run from the trade inception date to its maturity, shows the different dates in which the underlying company can default. For each of the dates in the x-axis, the y-axis will show the total cash flow of the trade that the investor would earn (or pay) in case of a default at each point in time.

The total cash flow will include all of the cash flows from inception up to, and including, the default date: upfront payments on bond and CDS, bond coupons and CDS running spread, funding costs, CDS margin, and payments on default. When the date shown in the x-axis is past the trade maturity, the figure will effectively show the total net cash flows of the trade if there is no default during the life of the trade.

In case of default, and obviating any risk-free discounting, the profit (or loss) for the investor in a basis trade is given by Equation 4.

Equation 4: Basis Trade Profit on Default

$$\begin{gathered}\text{CDS Notional x } (100 - \text{Recovery } - \text{CDS Upfront} - \text{CDS Coupons Paid} - \text{CDS Funding Costs Paid}) \\ + \text{ Bond Notional x } (\text{Recovery} + \text{Bond Coupons Received} - \text{Bond Price} - \text{Bond Funding Costs Paid})\end{gathered}$$

Note: Bond Price refers to the dirty bond price.

If both legs are done on the same notional, the final profit is independent on the recovery rate of the bond.

Negative Basis Trades Total Cash Flow at Maturity

If there is no default during the life of the trade, and again ignoring any risk-free discounting, Equation 5 shows the total cash flows of a negative basis trade at maturity (i.e. after both the bond and CDS legs have expired).

Equation 5: Basis Trade Profit on Maturity

$$\begin{gathered}\text{Bond Notional x } (100 + \text{Bond Coupons Received} - \text{Bond Price} - \text{Bond Funding Costs Paid}) \\ - \text{ CDS Notional x } (\text{ CDS Upfront} + \text{CDS Coupons Paid} + \text{CDS Funding Costs Paid})\end{gathered}$$

Note: Bond Price refers to the dirty bond price.

It can be shown that Equation 4 and Equation 5 generate the same results for equal notional basis trades. Notice that the amount of bond coupons received, CDS coupons paid and funding costs paid will be different in both cases (since they depend on the timing of default in Equation 4).

2. Cheapest-to-deliver: Different Recovery Rates

The assumption of a similar recovery rate in bonds and CDS can be challenged. As we explained before, the "cheapest-to-deliver" option that CDS protection buyers enjoy represents a potential extra-benefit in a negative basis trade in case of default.

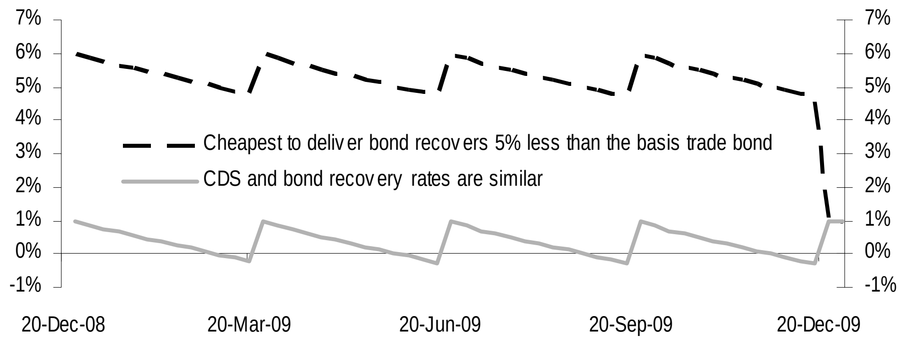
Figure 15 shows the total cash flows of our negative basis trade for different default dates. We compare two scenarios under the previous case (bond and CDS with 5% coupon). These scenarios are: (i) bond and CDS recovery rates are similar, and (ii) the cheapest-to-deliver bond has a recovery rate 5% lower than the bond in the negative basis trade. As Figure 15 shows, the lower the recovery rate of the bond in the basis trade compared to the cheapest-to-deliver bond, the better for the negative basis investor.

Negative basis trades benefit if the bond is not the cheapest-to-deliver

Benefit: bond recovery – cheapest-to-deliver recovery

Figure 15: Cheapest-to-delivery Option: Impact on Basis Trades (JtD Exposure)

Y-axis: Sum of total cash flows on the negative basis trade until default; X-axis: Assumed default dates.



Source: J.P. Morgan.

Valuing the cheapest-to-deliver option on a CDS contract is very difficult since, among other things, the full universe of deliverable instruments might not be known until default. CDS spreads will generally start pricing the cheapest-to-deliver option when the likelihood of default becomes large enough.

Other things being equal, **investors will prefer bonds which are not likely to be the cheapest-to-deliver**.

For a detailed case study on the impact and importance of the "cheapest-to-deliver" option we refer investors to two research reports covering the settlement of Fannie Mae and Freddie Mac (October 2008).[14]

[14] *Fannie and Freddie CDS Settlement Auctions*, E Beinstein et al, 2 October 2008. *Fannie Mae and Freddie Mac CDS Settlement*, E Beinstein et al, 6 October 2008.

3. Maturity Mismatch

Very rarely will investors be able to exactly match bond and CDS maturities in a basis trade. If the bond maturity does not coincide with a standard CDS maturity, investors will have to decide either to buy CDS protection in the previous or next maturity around the bond maturity. **This introduces a residual naked long or short protection position for the last period of the basis trade, which will affect its economics.**

Investors might prefer to pair long dated bonds with short dated CDS in some cases (e.g. to play a positive jump-to-default "JtD" negative basis trade with a short term trading horizon). In that case, the investor is effectively entering a negative basis trade and a curve flattener trade on the name. Whether the investor wants to profit from an early default or just a correction of a negative basis dislocation will determine the notional used in both legs (e.g. equal notional vs. duration neutral).

4. Funding Costs

When interest rates are positive, funding (i) the bond purchase (or bond margin), (ii) the CDS upfront cost (and/or running spreads) and (iii) the CDS margin will affect the economics of a negative basis trade.

The margin that the investor posts for the CDS trade will depend on its credit quality and the credit risk of the reference company. The margin is generally applied to the CDS notional at risk: difference between notional and upfront premium (€95 in our example). The margin will differ if the investor is buying or selling protection.

In our stylised example, assuming a 5% CDS margin the investor would need to fund €103.75 (bond price €94 + CDS upfront €5 + CDS margin €4.75)[15]. Assuming a flat and fixed 5% interest rate swap curve at which the investor can fund, the total cost of funding the trade if there is no default, i.e. for one year, is €5.1875 (= 103.75 * 5%). Such cost will completely outweigh the €1 risk-free profit of our original stylised example.

Generally, the sooner the default happens, the lower the funding costs ultimately paid. If the default occurs immediately after the trade is entered into, funding costs will be pretty much zero and the investor will make €1, i.e. the same as in our stylised example.

shows the total (not discounted) cash flows of our negative basis trade for different default dates for our stylised example (i.e. no funding costs) and for the case where the investor has funding costs. The sooner the default occurs, the better for the investor.

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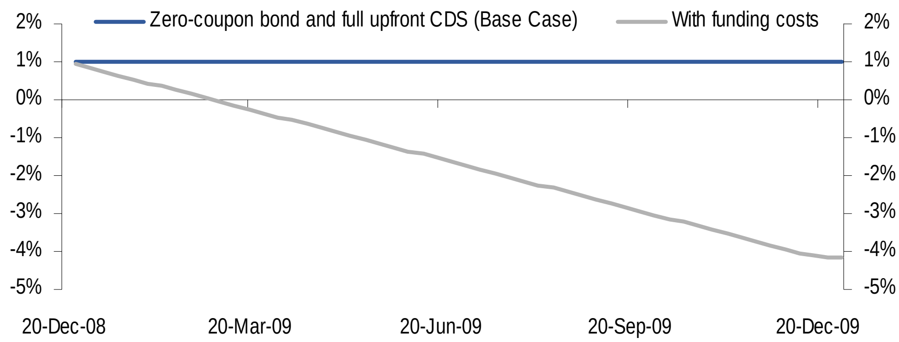
[15] CDS margin in this example (€4.75) is calculated as 5% of the CDS notional at risk (€95), which is the difference between the CDS notional (€100) and the upfront premium (€5).

Abel Elizalde
(44-20) 7742-7829
abel.elizalde@jpmorgan.com

Negative basis trade becomes a "timing of default" trade

Figure 16: Funding Costs: Impact on Basis Trades (JtD Exposure)

Y-axis: Sum of total cash flows on the negative basis trade until default; X-axis: Assumed default dates.



Source: J.P. Morgan.

The "risk-free" negative basis trade of our stylised example has effectively turned into a "timing of default" trade: the investor makes money only if a default happens soon enough. For a very high funding cost the negative basis trade might be completely unattractive.

Repo. 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.

An alternative way of funding all or part of the bond purchase is through a bond repo agreement.

The repo counterparty will take the bond as collateral and lend to the investor the bond price minus a given haircut the investor has to pay. Effectively, the investor will be funding part of the bond price at the repo rate and the rest at his standard funding rate. The repo rate will be a function of the investor's credit quality, the credit quality of the bond and the length of the loan. Repo financing is generally done on short terms (e.g. one week) and rolled over. If the investor can not secure funding for a long enough period of time, he runs the risk of running out of funding and having to sell the bond.

Funding costs increase the exposure of a basis trade to the timing of default.

For fully funded investors with capital to put at work, the **cost of funding** effectively becomes an **opportunity cost** for the capital invested in the basis trade. This will probably be lower than the cost of funding, but it can be significant anyway.

The following box contains an extract of *CMOS* (Credit Markets Outlook and Strategy, E Beinstein et al) published on 31 October 2008, where the impact of funding conditions on the basis is analysed.

Extract from CMOS - 31 October 2008:[16] The financing of the bond has changed significantly. Last year, investors could effectively get 20x leverage (a 5% haircut) with a financing cost of Libor. Now, investors may get 4x leverage (25% haircut) with a financing costs of Libor + 125bp. With 5Y Libor rallying about 125bp over the year (effectively offsetting the increase in cost over Libor), financing costs have increased.

Exhibit 1: Repo is not available in most situations. When it is, it is more expensive than even one month ago

	07-Jun	07-Dec	08-Jun	08-Sep	Current
Approx Haircut	5%	8%	10%	12-15%	20-25%
Approx Spread	LIBOR Flat	L+10bp	L+15-20bp	L+35-50bp	L+100-125bp

Source: J.P. Morgan

CDS trading requires more cash as well. Last year, an investor buying protection was often not required to post an initial margin. Now, short risk positions may require collateral posting of 2-10% or more of the notional amount of the trade. Thus, costs have increased for CDS as well.

Given these assumptions, we calculate that basis must be about -155bp for investors to earn returns similar to those earned basis of -30bp when financing conditions were easier. We calculate this by estimating the amount of capital required to establish the bond, interest rate swap, and CDS position in January 2007 and currently. The amount of capital required is about 5x higher – if it is available at all. In other words, basis must be about -155bp for investors to earn returns similar to those earned basis of -30bp when financing conditions were easier. This should be viewed as boundary for basis (basis should be more negative), in our view, if the currently tight funding conditions persist.

Exhibit 2: The capital required to establish a negative basis trade (bond + interest rate swap + CDS) has increased almost 5x

	Jan-07	Oct-08
Bond		
Price of bond	$100	$100
Capital required	$5	$25
Leverage	20x	4x
Interest rate swap		
notional amount	$100	$100
Capital required (%)	0%	1%
CDS		
notional amount	$100	$100
Capital required (%)	1%	5%
Capital required for package	$6	$31
Negative basis (bp) (now to match Jan '07 return on capital)	-30	-155
Returns on capital (bp/$)	5.0	5.0

Source: J.P. Morgan

[16] Updated with *High Grade Bond and CDS 2009 Outlook*, E Beinstein et al, 5 December 2008; pp. 21-23.

5. CDS Upfront vs. Running Premium: Carry vs. Jump-to-Default (JtD)

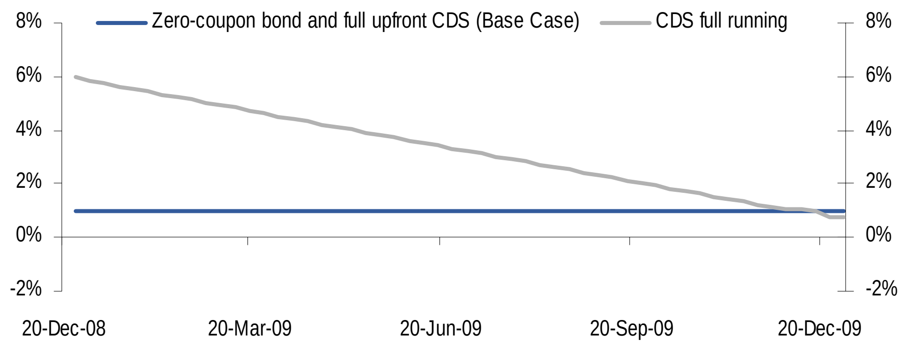
The cash flow structure of both legs in a negative basis trade (bond and CDS) will have a significant impact on the attractiveness of the basis trade. Our initial stylised example represented the extreme case where there are no running payments during the trade, i.e. the trade carry is zero.

Here we look at the difference between the CDS trading on a full upfront (5%) or a full running basis (e.g. with a 5.13% coupon). Both positions would be equivalent in terms of their expected losses. Figure 17 shows the total cash flows of our negative basis trade for both cases.

CDS Running Spread: Higher initial JtD and less attractive carry profile

Figure 17: CDS Upfront vs. Running: Impact on Basis Trades (JtD Exposure)

Y-axis: Sum of total cash flows on the negative basis trade until default; X-axis: Assumed default dates.



Source: J.P. Morgan.

In the case of a full running CDS spread, an instantaneous default will make the investor earn the difference between par and the bond price (€6). If no default occurs, the investor still receives €6 at maturity but he will have paid €5.13 for the CDS protection, i.e. a €0.87 gain.

In the full running case, the sooner the default the better, as the investor stops paying for the CDS protection. A basis trade with a full running CDS introduces an exposure to the timing of defaults. In general, swapping upfront payments into running payments (both in the bond and CDS leg) will expose the investor to default timing.

If there is no default, the investor will generally end up paying more for the CDS protection in a full running contract than in the full upfront case. Therefore, there will be a cut-off date such that: if the default happens before it, the full running CDS will be more attractive, but if the default happens afterwards, the full upfront CDS will be preferred. Such date will actually be given by the duration of the CDS, which in our example was 0.97 (i.e. almost one year). The higher the CDS spread the lower its risky duration.

Compared to a CDS trading on an upfront (or upfront plus running) format, an equivalent full running CDS spread generates a negative basis trade with a worse carry profile (more negative or less positive) **but a better** (less positive or more negative) **JtD sensitivity during the first part of the trade.**

6. Bond Price vs. Coupon: Carry vs. Jump-to-Default (JtD)

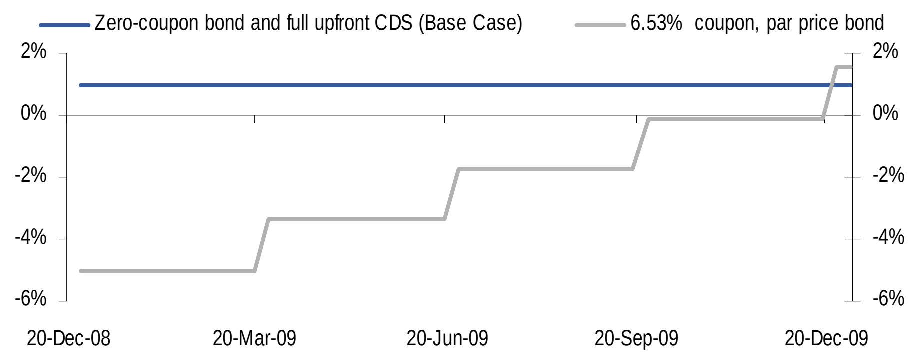
In the previous example, we analysed the trade-off between JtD and carry when CDS trades on an upfront or running basis. There is a similar trade-off for bonds depending on the relationship between price and coupon.

There are many variations of the price-coupon relationship which would involve the same "credit risk" as measured, for example, by the bond Z-spread or PECS. In our stylised example, a €94 zero-coupon bond corresponds to a Z-spread of 7% and a PECS of 6.4% (assuming all CDS maturities trade at 5% full upfront). A par bond with a 6.53% quarterly coupon would have a similar PECS of 6.4%.[17] Figure 18 shows the total cash flows of our negative basis trade for the two cases (assuming a full upfront 5% CDS).

Higher bond coupon and price: Lower initial JtD and more attractive carry profile

Figure 18: Bond Price-Coupon: Impact on Basis Trades (JtD Exposure)

Y-axis: Sum of total cash flows on the negative basis trade until default; X-axis: Assumed default dates.



Source: J.P. Morgan.

In the case of a par bond with a 6.25% coupon, an instantaneous default will lose the investor the €5 paid for the CDS protection. If no default occurs during the life of the trade, the investors will pocket the €6.25 bond coupon minus the €5 CDS protection.

Bonds with higher price and coupon generate a negative basis trade with a better carry profile (less negative or less positive) **but a worse** (less positive or more negative) **JtD sensitivity during the first part of the trade.**

As before, there will be a cut-off date such that, if default happens before it the investor would prefer the zero-coupon bond relative to the coupon bond, and vice versa.

Basis trades tend to be measured, analysed and ranked in terms of the "credit risk" priced in each leg (bond and CDS) through a credit risk spread measure. However, this might not be enough: different combinations of price and coupon in bonds, and upfront and running in CDS generate material differences in a basis trade, in particular regarding carry and JtD exposure.

[17] And a Z-spread of 7.36%.

7. Interest Rate, FX Risks

Basis trades are subject to interest rate risks in several dimensions such as funding or bond and CDS sensitivity to interest rates (which in the case of the CDS will be minimal and in the case of the bond will be a function of whether the bond has a fixed or floating coupon). If bond and CDS are not denominated in the same currency, the basis trade will be subject to movements in the exchange rate.

Through this report we assume these risks are being hedged. In case of default, the investor will have to unwind the hedge, which will likely have a MtM impact.

8. Bondholders' rights & Bond embedded options

Bond holders have actual or potential rights, e.g. negotiating rights after bankruptcy, contingent payments if the company changes the debt terms, tender offers, etc. CDS protection sellers do not have any such rights.

Bonds may have embedded options such as callable, puttable, poison puts, etc. They may also have step-up coupons if the company ratings are downgraded. CDS contracts do not have such features.

In this report, we do not consider the impact of bond optionality in basis trades. The standard bond spread measures that we consider to characterise Bond-CDS basis (e.g. Z-spread, asset swap spread, PECS) do not take into account options embedded in the bond.

9. Bond deliverability into CDS contract

When analyzing basis trades, investors implicitly assume that in case of default they will be able to deliver the bond into the CDS contract. This will be the case if the bond is "deliverable" upon default. CDS contracts specify a list of characteristics that bonds must satisfy to be deliverable into the CDS contract upon default.

Among others, CDS contracts generally specify the following deliverable obligation characteristics: Not subordinated, standard specified currency, transferable, 30 years maximum maturity, not bearer and not contingent.

Investors should check whether the bond they are buying satisfies these deliverability conditions, otherwise the economics of the basis trade can change dramatically on default. In particular, the investor is exposed to the different recovery rate of their bond and the cheapest-to-deliver (or to the result of CDS cash auction if they decide to cash settle their CDS position).

10. CDS Restructuring Credit Events

CDS contracts generally include "restructuring" within the different credit events that trigger the contract. Without going in detail into the legal fine print relating a restructuring event, it refers to a change (or changes) in the terms of one or more obligations which negatively affect the holders of such obligation and it is not expressly provided for under the terms of such obligation. These changes relate to, for example, reduction in the obligation coupon payments, reduction in the obligation principal payable at maturity, postponement or deferral of payments, changes in subordination and currency of the obligation. Investors should check the complete legal implications of the CDS contract clauses and definitions relating to restructuring. For example, the type of restructuring specified in the contract might affect the type of obligations which can trigger a restructuring credit event.

If a restructuring event occurs, CDS contracts specify restrictions regarding which obligations can be delivered into the contract by CDS protection buyers. These restrictions vary with the type of restructuring the contract specifies (e.g. old-restructuring, modified-restructuring, modified-modified-restructuring, no-restructuring). They generally limit the maximum maturity of deliverable obligations and their transferability.

European contracts generally include the so-called “Mod-Mod” restructuring, which applies to all the obligations and specifies that deliverable obligations cannot mature after the later of the scheduled termination date of the contract and 60 months after the Restructuring Date (in the case of the restructured obligation) or 30 months (in the case of other deliverable obligations). Deliverable obligations must also be conditionally transferable.

The relevance, for basis trades, of the restructuring clause in CDS contracts has to do with the potential of the bond bought in the basis package not being deliverable after a restructuring credit event for maturity or transferability reasons. In that case, as in the previous point, the investor would be exposed to the different recovery rate of their bond and the cheapest-to-deliver (or on the CDS cash auction if they decide to cash settles their CDS position).

Basis trades where the CDS maturity is close to (or lower than) the bond maturity will generally minimise the impact of restructuring credit events (unless the restructuring involves a maturity extension on the bond).

11. Bond Covenant Breaching vs. CDS Credit Events

Investors should be aware of the possibility of bond covenants being breached without triggering a credit event under the CDS contract. Remember that the standard credit events included in corporate CDS contracts are bankruptcy, failure to pay and restructuring. Breaching a bond covenant does not necessarily trigger any of the previous credit events.

For example, breaching a bond covenant might give bond holders the option to force the company to accelerate some payments. However, it might be in the interest of bondholders not to accelerate those payments (particularly if it forces the company into a formal bankruptcy in a jurisdiction unfriendly to bondholders). In some circumstances the lack of acceleration means that there is no failure to pay and therefore no trigger of a CDS credit event.

Abel Elizalde
(44-20) 7742-7829
abel.elizalde@jpmorgan.com

As we hinted in the examples included in this section, looking at basis trades through a single "basis" number is a simplification which potentially leaves important characteristics un-accounted for. Basis trades generate a distribution of future risky cash flows.

In the rest of this section, we review the three main ways of trading and structuring basis trades, each with a different rationale:

1. **Lock-In Risk-free Spread**

2. **Trade the Basis**

3. **Profit from Default**

In what follows, we shall be using the following assumptions:

1. 5y bond with a quarterly fixed coupon and no optionality attached.
2. Flat 5% interest rate, which we assume remains fixed.
3. 5% CDS margin.
4. 5% cost of funding available on a daily basis throughout the life of the trade. The investor funds all upfront payments: bond price, CDS margin and upfront (if any).
5. The bond we are considering will be the cheapest-to-deliver if there is a default (or has a similar recovery rate).
6. Both bond and CDS have the same quarterly coupon payment dates (20 March, 20 June, 20 September, 20 December) and the same maturity (20 December 2013). We enter into the trade on 20 December 2008, i.e. there is no bond accrued coupon or CDS running spread.
7. No FX risk: bond and CDS are denominated on the same currency.

Trading the Basis I: Hold-To-Maturity Basis Trades

Objective: Lock-in the negative basis (not concerned about basis movements). **Trade notional**: Equal notional. **CDS maturity**: Match the bond maturity (as closely as possible).

As we showed in the grey box at the beginning of this section (*Jump-to-Default Exposure*), default and maturity allows the investor to "cash in" the Bond-CDS basis in equal notional basis trades. If bond and CDS notionals are equal, the payoff in the event of default is independent of the realised recovery rate.

Our aim in this sub-section is threefold. First, we want to illustrate the impact, on the JtD exposure of a negative basis trade, of the relationship between the price and coupon of a bond (e.g. whether it trades at a discount with a low coupon or above par with a high coupon). Second, we want to illustrate that the shape of the term structure of CDS spreads can have a large impact on the attractiveness of basis trades, in particular in those with a significant (positive or negative) JtD exposure. Finally, we want to analyse which bond spread measure (Z-spread, asset swap spread or PECS) better captures the two previous points when compared with the CDS spread.

For our purposes, we will use two different 5 year bonds with a different price-coupon relationship but with the same Z-spread, as well as two CDS curves with the same 5 year CDS spread but different CDS curve shapes. This way, we will have the same Bond-CDS basis, as measured by the Z-spread, and we will analyse the basis generated by using the asset swap spread or PECS. We could have used a different example with two bonds which share the same asset swap spread or PECS (rather than Z-spread). The results would point in the same direction: the PECS is a more reliable measure to use in Bond-CDS basis calculations.

Bond Price & Coupon: High or Low?

Assume the 5y CDS is trading at 5% running spread (with no upfront payment). Figure 19 and Figure 20 show the cash flows of a basis trade for two different bonds: one with a low price and coupon (62.31 and 2% respectively), and another with a high price and coupon (110.27 and 15%, respectively). Both bonds have a similar Z-spread of 7%, which generates a basis of -2%.

Figure 19 and Figure 20 show the total cash flows of the trades assuming there is no default during the life of the trade, and including carry, margin and funding costs.[18] Since we assume the investor is funding the whole trade without committing any money upfront, the payment due to the difference between the bond price and notional occurs at maturity (or at default time if before maturity).[19]

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[18] In Figure 19, for example, the trade involves a quarterly negative carry or around -1.6%, which is the sum of the CDS quarterly coupon (-1.25% = 5% annual spread * ¼ year), the bond quarterly coupon (+0.5% = 2% annual coupon * ¼ year), the CDS margin (-0.0625% = 5% margin * 5% funding cost * ¼ year) and the bond funding (-0.78% = 62.31% price * 5% funding cost * ¼ year).

[19] In Figure 19, for example, the trade involves a payment at maturity equal to 36.1%, which is the sum of the CDS quarterly coupon (-1.25%), the bond notional plus the quarterly coupon (+100.5%), the CDS margin (-0.0625%), the bond margin (-0.78%) and the bond price which settles the bond funding (-62.31%).

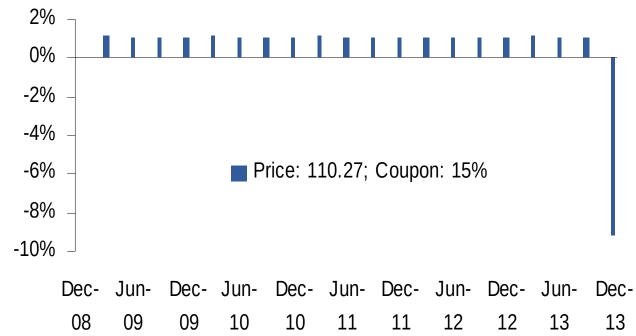
Figure 19: Low Price & Coupon: Basis Trade Cash Flows

Assuming no default during the trade. Bond Z-spread: 7%.

Source: J.P. Morgan.

Figure 20: High Price & Coupon: Basis Trade Cash Flows

Assuming no default during the trade. Bond Z-spread: 7%.



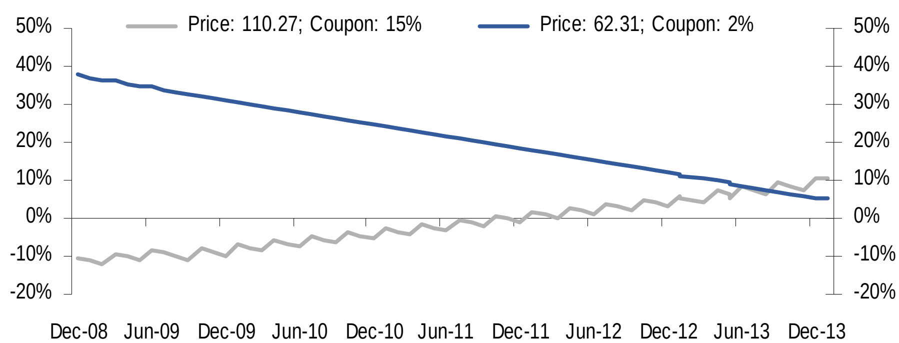
Source: J.P. Morgan.

Bonds with high price and coupons will generate a better carry profile over the life of the trade, but a worse exposure to default.

Figure 21 shows the total (not discounted) cash flows of our negative basis trade for the two different bonds.[20] If there is no default, both trades generate positive total cash flows. However, the exposure of each trade to the timing of defaults is completely different. Basis trades with low price-coupon bonds will benefit from an early default; basis trades with high price-coupon bonds will suffer from it.

Figure 21: Bond Price & Coupon Relationship: Constant Z-spread (JtD Exposure)

Y-axis: Sum of total cash flows on the negative basis trade until default; X-axis: Assumed default dates.



Source: J.P. Morgan.

The cash flows and JtD exposure of both trades are significantly different, even though they share the same Z-spread. *Timing of default is paramount, and the shape of the CDS curve gives us information about it.*

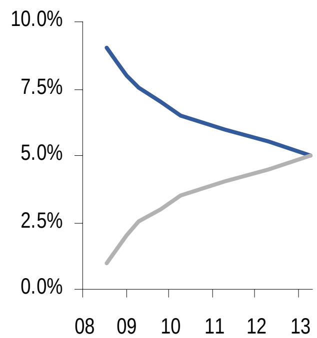
[20] Figure 18 and Figure 19 refer to the case where there is no default during the life of the trade, and show the cash flows that are received / paid at each point in time. Figure 20 shows the jump-to-default exposure of the trade. For dates higher than the trade maturity (20-Dec-13), i.e. if there is no default during the life of the trade, the value of each line in Figure 21 is just the sum of the cash flows in Figure 18 and Figure 19 respectively.

CDS Curve: Upward or Downward Slopping?

Figure 22 shows two CDS curves with the same spread for the 5y tenor, one upward sloping and an inverted one. Figure 23 shows their implied hazard rates.

Figure 22: CDS Curves

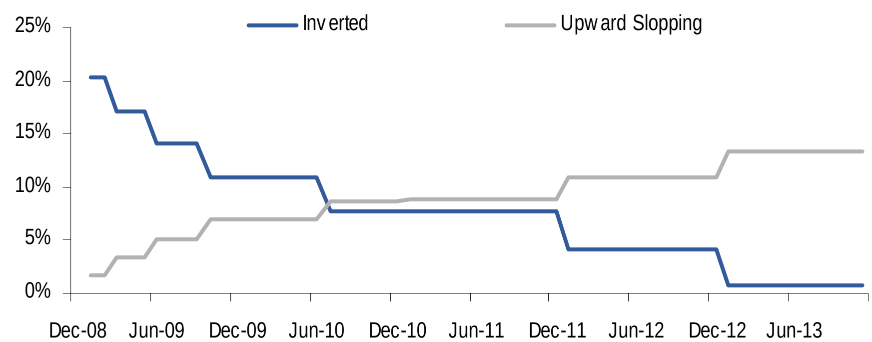
Y-axis: CDS Spread (%); X-axis: Maturity (year).



Source: J.P. Morgan.

Figure 23: Hazard Rates

Hazard (default intensity) rates for the two CDS spread curves in Figure 22.



Source: J.P. Morgan.

The hazard rate at any point in time represents the instantaneous default probability at the time assuming there has been no prior default. Inverted curves have higher default hazard rates for short maturities: as time goes by, if the company does not default, its credit quality should improve. Upward slopping ("normal") curves assume that the credit quality of the company will deteriorate as time goes by.

Table 3 shows the expected value of the basis trade for the four possible scenarios we have considered. We take the trade cash flows assuming a default at different points in time (every month) and weight them by the probability of defaulting in that period.

Table 3: Basis Trades: Expected Cash Flows

As a % of the bond notional.

	CDS Curve: Inverted	CDS Curve: Upward Slopping
Bond: Low Price-Coupon	8.77%	6.88%
Bond: High Price-Coupon	-1.92%	-0.16%

Source: J.P. Morgan.

Usually, inverted CDS curves coincide with low priced bonds, and upward slopping curves with bonds trading above par. However, the four combinations in Table 3 represent a good sample of possibilities. Bonds with low price and coupon generally offer a better alternative for negative basis trades since they involve less funding costs and benefit from a default more than bonds with higher coupons (as these are lost after a default).

Low price-coupon bonds benefit from front-loaded defaults and therefore from inverted CDS curves. On the contrary, high price-coupon bonds benefit from back-loaded defaults and therefore from upward slopping CDS curves.

A measure to judge the attractiveness of the above basis trades should generate a more negative basis for the case of a low price-coupon bond and inverted CDS curve than for the case of a high price-coupon bond and upward slopping CDS curve. Table 4 shows the difference between the CDS spread (5% in all cases) and (i) PECS, (ii) ASW and (iii) Z-spread.

Table 4: Basis

	CDS Curve: Inverted Bond: Low Price-Coupon	CDS Curve: Upward Slopping Bond: High Price-Coupon
CDS - PECS Basis	-4.78%	-3.39%
CDS - ASW Basis	-0.56%	-2.66%
CDS - Z-spread Basis	-2.02%	-2.02%

Source: J.P. Morgan.

The PECS comes up as the best measure for the basis, as it is sensitive to both the shape of the CDS curve and the cash flow structure of the bond.

Example: Telecom Italia €12s and €55s

A good, although probably extreme, example of the above considerations can be found looking at two Telecom Italia (TITIM) bonds, one of them maturing in 2055. Table 5 shows the coupon, price, ASW, Z-spread and PECS of both bonds on 18-Dec-08. As Figure 24 shows, the Z-spread on both bonds was similar around that date. Table 5 shows that the ASW was lower for the €55s but the PECS was higher. Obviously, depending on which spread measure we use for the basis, the basis will be different.

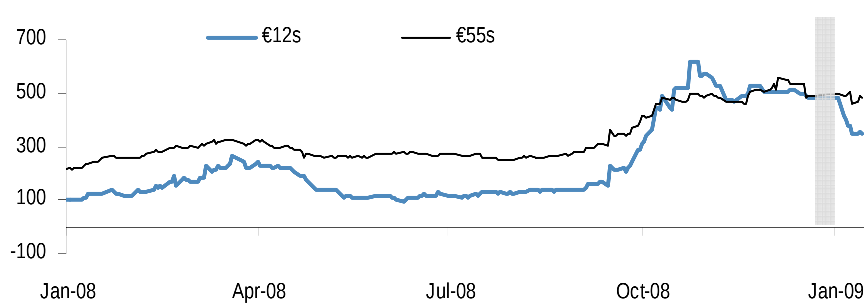
Table 5: TITIM Bonds

Maturity	Coupon	Clean Price	Par ASW	Z-spread	PECS
01-Feb-12	6.250%	96.0	463	488	475
17-Mar-55	5.250%	63.5	345	486	722

Source: J.P. Morgan. As of 18 December 2008.

Figure 24: Historical Z-spread of TITIM Bonds

In bp.

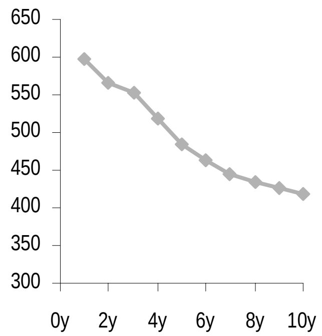


Source: J.P. Morgan.

Using these two TITIM bonds and buying CDS protection with Dec-11 maturity (trading at around 552bp) and with a notional equal to the bond notional, Figure 26 shows the total cash flows of our two basis trades for different default dates. The lower price of the €55s gives its basis trade a very positive default exposure compared to the one for the €12s.

Figure 25: TITIM CDS Spreads

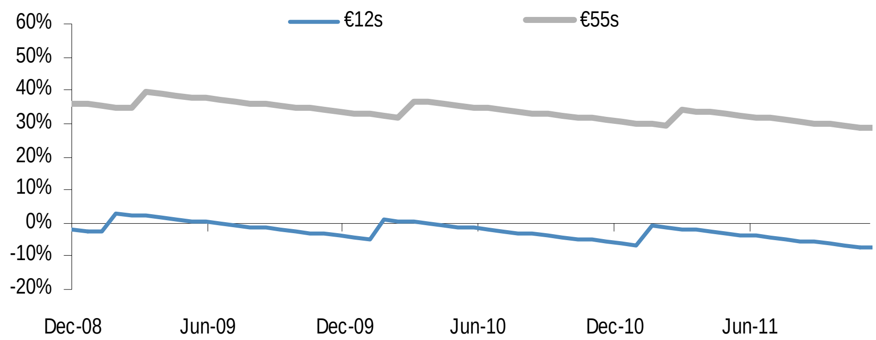
In bp. As of 28-Dec-08.



Source: J.P. Morgan.

Figure 26: TITIM Equal Notional Basis Trades: Buying Dec-11 CDS Protection (JtD Exposure)

Y-axis: Sum of total cash flows on the negative basis trade until default; X-axis: Assumed default dates.



Source: J.P. Morgan.

We next include an extract of a basis trade idea we published on 13 January 2009 using a Ford Motor Credit Company (FMCC) bond maturing in 2010. It will serve to illustrate the concepts that we have dealt with so far, as well as to compare the different ways of trading the basis.

Case Study: Ford Motor Credit Co.

- **Buy FMCC €4.875% 2010s and buy March 2010 CDS protection**: Take advantage of a Bond-CDS basis below -1000bp and one year of maturity.
- **An equal notional trade generates positive Jump-to-Default exposure during the life of the trade**, especially in the first month of the trade (with a pick up of around 10% in case of default) and during the last two months of the trade (where the investor holds a naked short credit position via the CDS protection bought).
- **Short credit risk exposure:** The trade benefits if spreads widen in both bond and CDS, since the duration of the CDS is slightly higher than the bond duration. We estimate that an instantaneous 500bp spread widening would generate 1.25% of MtM.
- **Although the basis has retraced from its historical (negative) wides, it still stands around -1100bp according to our calculations**. If the basis tightens the trade makes around 0.75% for each 100bp of (spread) basis tightening, according to our calculations.

Table 6: FMCC Basis Trade: Buy EUR 4.875% 2010 and Buy March 2010 CDS Protection

Instrument	Maturity	Currency	Price / Upfront	Coupon	Notional
Bond	15-Jan-10	EUR	75.5	4.875%	10,000,000
CDS	20-Mar-10	USD	13%	5.000%	10,000,000

Source: J.P. Morgan. Indicative mid prices shown. COB 12 Jan. Check with the trading desk for updated levels. CDS trades with a full upfront price plus a fixed 500bp running coupon.

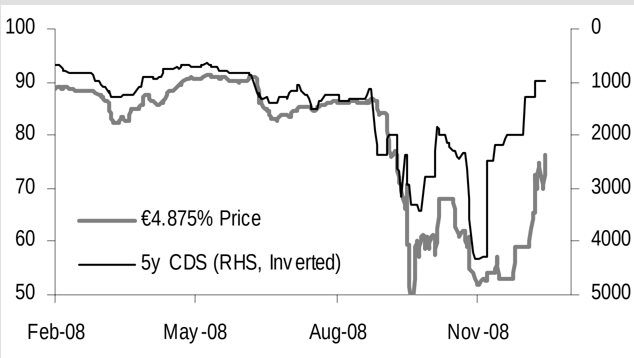
- According to the latest market pricing, we estimate a mid-to-ask bond cost of 1.5% and a mid-to-ask CDS cost of 2%, both upfront. Please check with the trading desk for updated levels.

Figure 27 shows how FMCC €4.875% 2010 bonds and FMCC 5y CDS have evolved over the last year. Figure 28 shows that the €10s Bond-CDS basis has ranged between +1000 and -2000bp during that time. Although the basis has retraced from its historical (negative) wides, it still stands around -1100bp according to our calculations.

Abel Elizalde
(44-20) 7742-7829
abel.elizalde@jpmorgan.com

Figure 27: FMCC: €4.875% Bond Price and 5y CDS

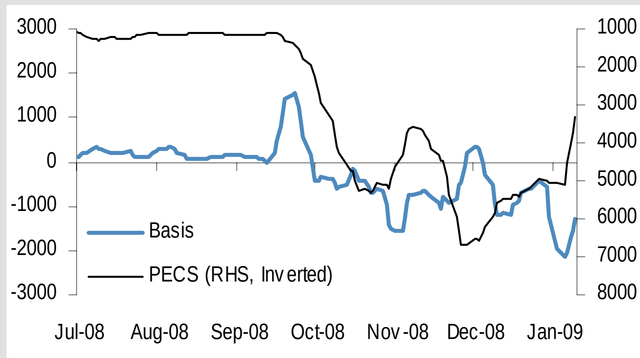
LHS: Bond price (€); RHS: 5y full running CDS (bp), inverted.



Source: J.P. Morgan, Bloomberg.

Figure 28: FMCC €4.875%: PECS and Basis

LHS: Bond price (€); RHS: 5y full running CDS (bp), inverted.



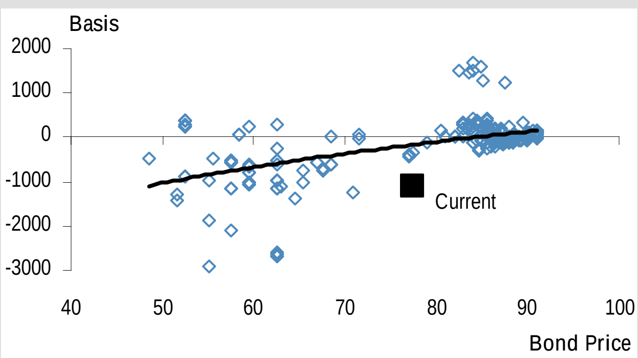
Source: J.P. Morgan, Bloomberg. 5 days moving average.

Figure 29 and Figure 18 show how the basis has, roughly, moved in line with FMCC's credit quality (as measured by the bond price and PECS).

As we wrote in our 2009 *CD Player* Outlook, we think we have seen the widest levels on the CDS-cash basis. Basis trades have attracted investors' attention as one of the most attractive type of trade for 2009, and we think that as liquidity conditions normalise so will the basis (on average).

Figure 29: FMCC €4.875% Basis vs. Bond Price

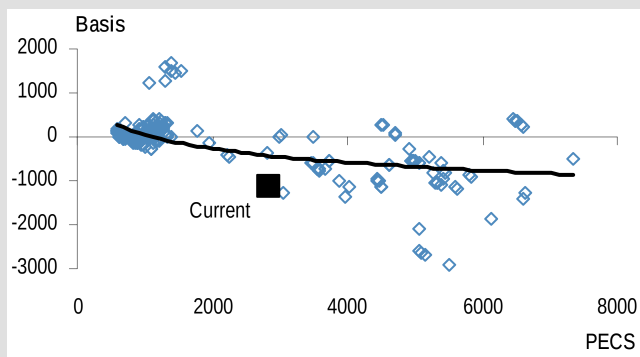
X-axis: Bond price (€); Y-axis: Basis (bp). One year historical data.



Source: J.P. Morgan.

Figure 30: FMCC €4.875% Basis vs. PECS

X-axis: Bond PECS (bp); Y-axis: Basis (bp). One year historical data.



Source: J.P. Morgan.

With average high yield basis around -550bp for the US corporate high yield market, we think **FMCC's €4.875% bonds represent an attractive basis trade opportunity**.

Table 7: FMCC €10s

	€4.875%
Currency	EUR
Maturity	15-Jan-10
Coupon	4.875%
Frequency	Annual
Mid Price	75.50
Dirty Price	80.43
Mod. Duration	0.70
Z-spread	3315
PECS	2854
Basis	-1118

Source: J.P. Morgan. Calculations using mid prices. Indicative mid prices shown. COB 12 Jan. Check with the trading desk for updated levels.

Table 8: FMCC CDS

Upfront plus 500bp. In $.

Maturity	Upfront
20-Dec-09	12.5%
20-Mar-10	13%

Source: J.P. Morgan. Indicative mid prices shown. COB 12 Jan. Check with the trading desk for updated levels.

Buying March 2010 CDS Protection
In FMCC's €4.875% bonds case, we can either buy CDS protection with Dec-09 or March-10 maturity, both of them trading on upfront levels (plus a 500bp running coupon). Table 8 shows indicative CDS mid levels: 12.5% for Dec-09 and 13% for March-10 respectively.

If we construct the basis trade with the longer dated CDS (March-10), the negative basis trade has a positive jump-to-default during all the trade life (especially if the default happens after the bond matures). If we construct the basis trade with the Dec-09 CDS, we end up with a naked long bond exposure from the CDS maturity until the bond maturity (1 month approximately).

We recommend use of the March-10 CDS contract rather than the Dec-09 one given the small difference in cost. It does not expose the investor to a month of outright long credit exposure to FMCC (event risk remains high during all the trade life) and it is slightly more bearish with respect to spread movements.

Sizing the Trade: Equal Notional
An **equal notional basis trade** would involve:

- **Buying the bond** at a current mid-dirty price of around 80.43€ (see Table 7). The bond pays an annual coupon on January 15th (i.e. this Thursday).
- **Buying CDS protection**, which requires an upfront payment plus a 500bp running premium. We assume the investor buys the same USD CDS protection as the EUR notional bought on the bond, and make our calculations assuming the EUR/USD exchange rate stays constant. Investors can hedge the FX risk by locking in a forward FX rate. With a current FX rate of around 1.3375, the investor would have to buy USD 133.75 CDS protection for each EUR 100 of bond notional bought.
- **Funding the bond purchase, the CDS upfront cost and the CDS margin**. We assume a 5% funding cost and a 5% margin on the CDS.

We recommend an equal notional trade. However, investors who want to trade movements in the basis but do not want to be exposed to general movements in spreads (keeping the basis constant) would need to duration-hedge the trade.

Trade Default Scenarios
In Figure 31 we show what would be the total (undiscounted) cash flows of the basis trade if FMCC was to default anytime from here to the end of the trade. Figure 32 contains the same information as Figure 31, but it only shows dates from today to December 2009. We have assumed a 20% recovery rate for both bond and CDS in case of default.

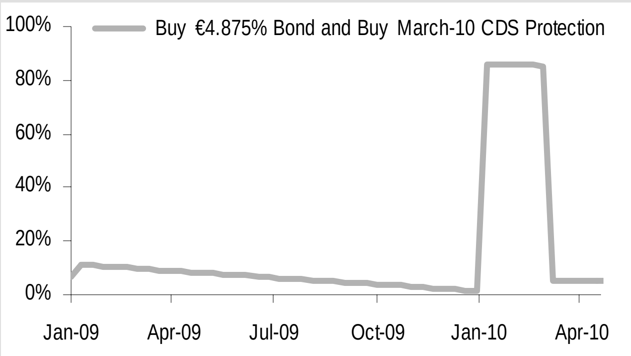
In case of no default during the trade life, the bond coupon (4.875%) would be almost enough to cover for the 500bp running payment on the CDS, and the investor would earn around EUR 5.21 for each EUR 100 of bond notional on the trade, net of funding and margin costs: Around EUR 29.3 on the bond (coupons plus pull to par), minus EUR 19 from the CDS protection (upfront plus coupons), minus EUR 5.1 on funding costs.

In case of a default after the bond maturity, but before the March-10 CDS maturity, the investor would earn a total EUR 86.2 (approximately): Around EUR 61.8 from the CDS (EUR 80 on default minus the upfront and running premiums paid), plus EUR 29.3 on the bond (coupons plus pull to par), minus EUR 5 on funding costs.

Abel Elizalde
(44-20) 7742-7829
abel.elizalde@jpmorgan.com

Figure 31: FMCC €4.875% Basis Trade: Default Scenario Analysis

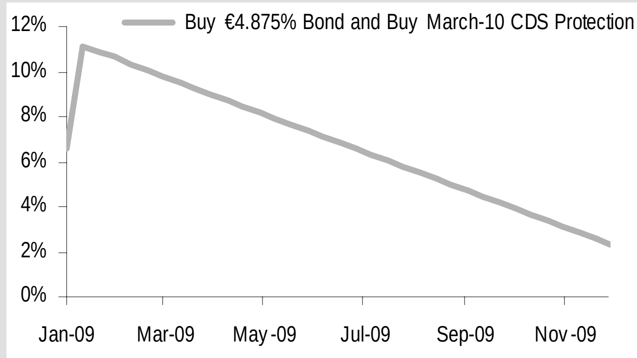
Y-axis: Sum of total cash flows on the negative basis trade until default; X-axis: Assumed default dates.



Source: J.P. Morgan. Expressed as % of the bond notional. Using Mids.

Figure 32: FMCC €4.875% Basis Trade: Default Scenario Analysis

Y-axis: Sum of total cash flows on the negative basis trade until default; X-axis: Assumed default dates.



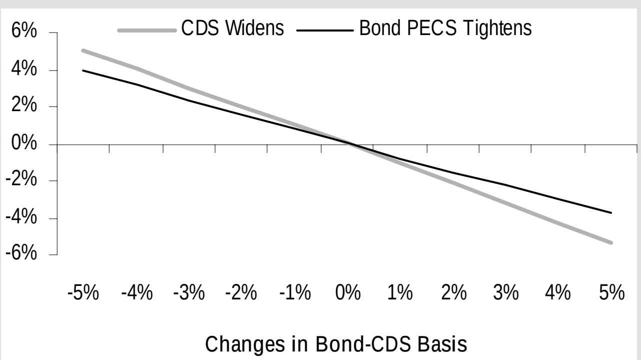
Source: J.P. Morgan. Expressed as % of the bond notional. Using Mids.

Spread Scenarios

Using the March-10 CDS contract, Figure 33 and Figure 34 show the trade MtM for changes in the Bond-CDS basis and on spread levels (with the same basis), respectively. The trade would make money as the basis goes down (less negative) and also as spreads increase (since the duration of the CDS is slightly higher than the bond duration).

Figure 33: FMCC €10s Basis Trade: Basis Scenario Analysis

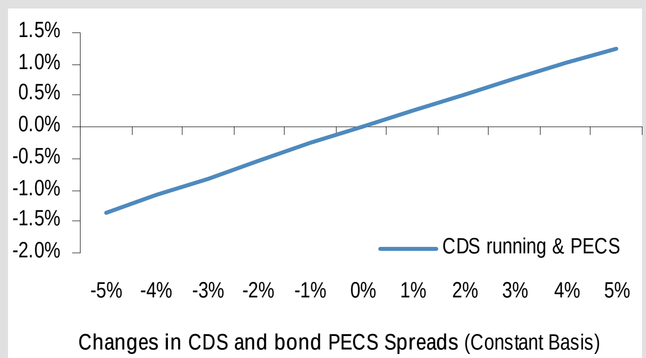
Y-axis: Trade MtM; X-axis: Changes in the Bond-CDS basis.



Source: J.P. Morgan. Additive spread changes. MtM expressed as % of the bond notional. Using mids.

Figure 34: FMCC €10s Basis Trade: Spread Scenario Analysis

Y-axis: Trade MtM; X-axis: Changes in both CDS and bond PECS spreads.



Source: J.P. Morgan. Additive spread changes. MtM expressed as % of the bond notional. Using mids.

Recovery Rate Risk: The impact of the realised recovery rate on the trade PnL would be negligible (since we are using the same notional in both bonds and CDS) unless the default happens between 15-Jan-10 and 20-March-10. In that case, the investor would be benefit from a low recovery rate since the trade is outright short credit.

"Capital-at-Risk" Hedging

In the previous examples, we assumed that the amount of CDS protection bought is similar to the bond notional. In that case, the investor is not exposed to the realised recovery rate in the event of default. On default, the investor delivers the bond into the CDS contract and receives par.

Equation 4 showed the profit for the investor in a basis trade upon default:

$$\begin{aligned}&\text{CDS Notional } x\ (100 - \text{Recovery } - \text{CDS Upfront} - \text{CDS Coupons Paid} - \text{CDS Funding Costs Paid})\\&+ \text{Bond Notional } x\ (\text{Recovery} + \text{Bond Coupons Received} - \text{Bond Price} - \text{Bond Funding Costs Paid})\end{aligned}$$

Assuming an instantaneous default (or not considering the coupons and funding costs on both legs), the loss on the bond is given by *Bond Notional x (Recovery – Bond Price)*, and the profit on the CDS is given by *CDS Notional x (100 – Recovery – CDS Upfront)*. If both legs are done on the same notional, the final profit is independent on the recovery rate of the bond.

Equation 6 splits the trade cash flows into running and one-off payments.

Equation 6: Basis Trade Profit on Default

$$\begin{aligned}&\underline{\text{From one - off payments:}}\\&\text{CDS Notional } x\ (100 - \text{Recovery} - \text{CDS Upfront}) + \text{Bond Notional } x\ (\text{Recovery} - \text{Bond Price})\\&\underline{\text{From running payments:}}\\&\text{Bond Notional } x\ (\text{Bond Coupons Received} - \text{Bond Funding Costs Paid})\\&- \text{CDS Notional } x\ (\text{CDS Coupons Paid} + \text{CDS Funding Costs Paid})\end{aligned}$$

Some investors prefer to structure basis trades in such a way that the amount of CDS protection bought is the amount needed to neutralise the losses in the bond position upon default (without considering running payments). We call it "capital-at-risk" basis trade. From Equation 6, the CDS protection would be given by:

Equation 7: CDS Notional in a "Capital-at-Risk" Basis Trade

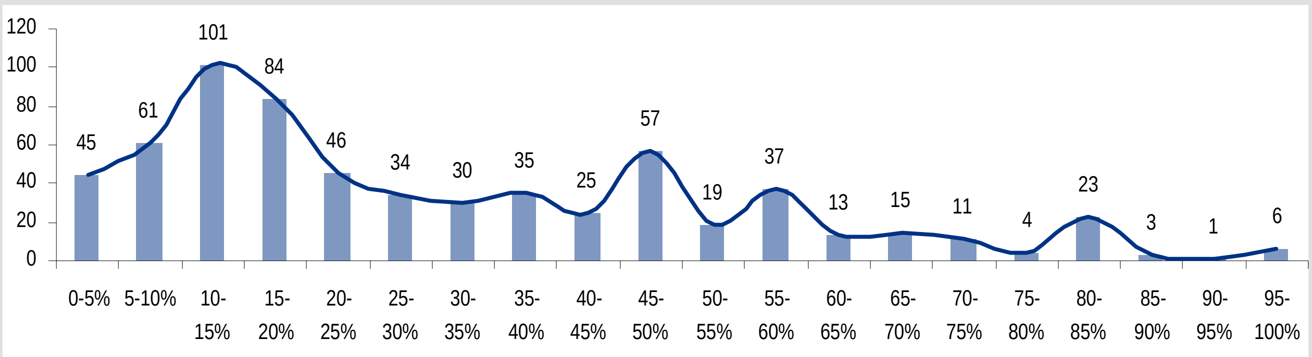
$$\text{CDS Notional} = \frac{\text{Bond Price} - \text{Recovery}}{100 - \text{Recovery} - \text{CDS Upfront}}\ x \text{ Bond Notional}$$

The first and most important problem with the above hedging alternative is that the recovery rate is not known in advance. Thus, the hedging ratio will only achieve its purpose if the realised recovery is similar to the one the investor assumed in the first place. Figure 35 shows the distribution of recovery rates for the period 1998-2007. The figure shows the high variability of recovery rates, which makes challenging the success of the above hedging strategy. The mean recovery rate is 27%, and the mode (most common) recovery rate in our data sample since 1998 is 10-15%.

Abel Elizalde
(44-20) 7742-7829
abel.elizalde@jpmorgan.com

Figure 35: Distribution of Recovery Rates

Histogram of recovery rates. x-axis: Recovery amount bucket (of face value 100); y-axis: Count of defaulted instruments in bucket.



Source: S&P CreditPro, JPMorgan.

Table 9 shows the CDS notional in a "capital-at-risk" basis trade for different bond prices as a % of the bond notional, assuming the CDS trades on a full running basis (i.e. no upfront). When the bond trades at par, the CDS notional is similar to the bond notional. For bonds trading below par, the CDS notional is lower than the bond notional, and vice versa.

Table 9: CDS Notional in a "Capital-at-Risk" Basis Trade (as a % of the bond notional)

		Recovery Rate								
		10%	20%	30%	40%	50%	60%	70%	80 %	90%
Bond Price	60	56%	50%	43%	33%	20%				
	70	67%	63%	57%	50%	40%	25%			
	80	78%	75%	71%	67%	60%	50%	33%		
	90	89%	88%	86%	83%	80%	75%	67%	50%	
	100	100%	100%	100%	100%	100%	100%	100%	100%	100%
	110	111%	113%	114%	117%	120%	125%	133%	150%	200%
	120	122%	125%	129%	133%	140%	150%	167%	200%	300%

Source: J.P. Morgan. Assuming no CDS upfront.

Compared to an equal notional basis trade, a "capital-at-risk" trade tries to eliminate the jump-to-default (JtD) exposure of the trade at the expense of the carry profile. For discount bonds, where the JtD exposure is positive in an equal notional trade,[21] a "capital-at-risk" would imply buying a lower CDS notional, which reduces the JtD to zero and also improves the carry of the trade. For bonds trading above par, the opposite holds.

Again, we should notice that a "capital-at-risk" trade leaves the investor with exposure to realised recovery rates. Effectively, the JtD exposure will only zero if the realised recovery rate is similar to the one assumed to construct the hedging notional.

[21] Assuming the CDS trades on a full running basis.

Abel Elizalde
(44-20) 7742-7829
abel.elizalde@jpmorgan.com

Trading the Basis II: Basis Trading

Objective: Profit from the basis becoming more positive / less negative in the short / medium term. **Trade notional**: Duration weighed. **CDS maturity**: Higher CDS maturities will imply higher CDS durations, better carry profile and worse JtD profile for the basis trade.

Investors who want to trade movements in the basis but do not want to be exposed to general movements in spreads (keeping the basis constant) need to duration-hedge the trade.

Durations on bonds and CDS need to be computed in a consistent way. CDS durations represent the instrument's mark-to-market (MtM) sensitivity to small changes in spreads, and take into account the shape of the full term structure of spreads and the assumed recovery rate. Using the PECS methodology, we can compute a comparable duration measure for the bond. The bond modified duration can also be a good measure to compare with the CDS duration.

If the notional of the bond is €100 and the durations for CDS and bond are D_{CDS} and D_B respectively, the CDS notional will be the ratio D_B / D_{CDS}.

In order to have a cleaner exposure to the basis, the CDS maturity should match (or be as close as possible to) the bond maturity. However, there might be instances where playing with the CDS maturity can provide investors an attractive exposure to default and the spread curve.

Using the two CDS curves in Figure 22 (inverted and upward slopping), Table 10 shows the PECS duration of the bond and CDS (for 3, 4 and 5y tenors). We assume a 10% coupon bond with 5y maturity and a price of €92 (which implies a 7% Z-spread, as in our previous examples).

Table 10: Duration Weighted Basis Trade

Assuming a €100 notional bond with 10% coupon and a price of €92. Using the two CDS curves in Figure 21.

	CDS Curve: Inverted	CDS Curve: Upward Slopping
Bond Duration	3.38	3.49
3Y CDS Duration	2.34	2.59
4Y CDS Duration	2.94	3.25
5Y CDS Duration	3.50	3.80
	CDS Notional	
3Y CDS	€144.6	€134.5
4Y CDS	€114.9	€107.3
5Y CDS	€96.6	€91.7
	Trade Annual Carry	
3Y	0.24%	4.62%
4Y	3.25%	5.17%
5Y	5.17%	5.41%

Source: J.P. Morgan.

As Table 10 shows, the lower duration of short maturity CDS contracts involve a higher notional to make the basis trade duration weighted.

Using a shorter maturity CDS in a duration weighted basis trade involves a worse carry profile (less positive or more negative) but a better JtD exposure.

Using a shorter maturity CDS will effectively overlay a curve flattener on top of the basis trade (selling longer protection through the bond and buying shorter protection through the CDS). This can be particularly attractive when the investor has a bearish view on the credit since spread widening tends to flatten spread curves, or when the investor wants to have a positive JtD exposure.

When the notional on both legs of a basis trade is not the same, the investor takes on recovery rate risk.

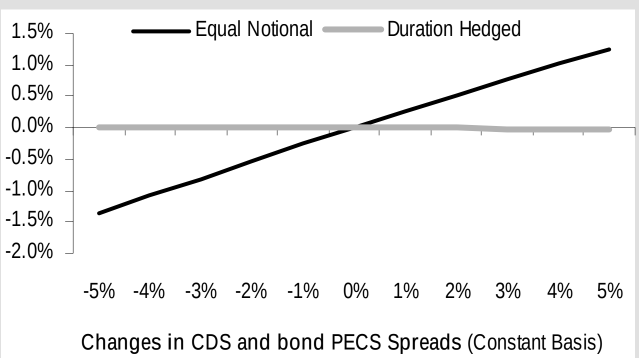
This recovery rate risk affects the difference between the bond and the CDS notional. If the bond notional is larger, the investor is long recovery rates, and vice versa.

FMCC Case Study (Cont.)

Coming back to the FMCC basis trade example we introduced previously, Figure 36 compares the trade sensitivity to movements in spreads (keeping the basis constant) in an equal notional basis trade and in a duration weighted basis trade (where we buy CDS protection on a notional equal to 75% of the bond notional bought). The lower CDS notional will also change the default exposure of the trade, as Figure 37 shows (assuming a 20% recovery rate): the trade is not positive jump-to-default any more. Since we have bought less CDS protection than bond notional bought, the realised recovery rate in case of default will also play an important role: the lower the recovery the higher the losses of the basis trade.

Figure 36: FMCC €10s Basis Trade: Spread Scenario Analysis

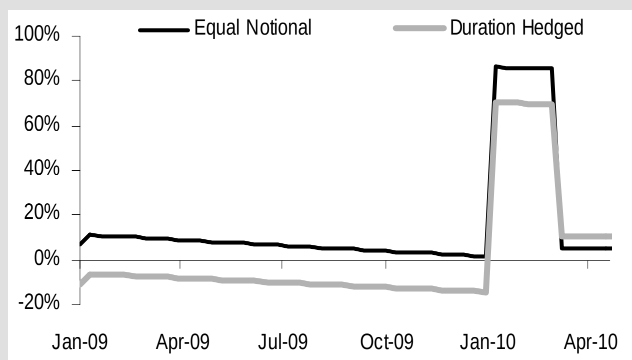
Y-axis: Trade MtM; X-axis: Changes in both CDS and bond PECS spreads.



Source: J.P. Morgan. Additive spread changes. MtM as % of the bond notional. Using Mids.

Figure 37: FMCC €10s Basis Trade: Default Scenario Analysis

Y-axis: Sum of total cash flows on the negative basis trade until default; X-axis: Assumed default dates.



Source: J.P. Morgan. Expressed as % of the bond notional. Using Mids. Assuming 20% recovery.

The above example illustrates clearly the **impact of the trade sizing on the economics of a basis trade**.

Trading the Basis III: Jump-to-Default Trading

Objective: Profit from a default. **Trade notional**: Equal notional. **CDS maturity**: Enough to include the period where the investor is expecting the default to happen.

Basis trades with different bond and CDS notional expose investors to recovery rate risks. An equal notional basis trade will eliminate that risk and provide a cleaner exposure to the pricing differential between bonds and CDS.

As we showed in the grey box at the beginning of this section (*Jump-to-Default Exposure*), in case of default, and ignoring any risk-free discounting and funding costs, the profit for the investor in an equal notional basis trade is given by Equation 8.

Equation 8: Equal Notional Basis Trade Profit on Default or Maturity (Ignoring risk-free discounting and funding costs)

$$(100 - \text{Bond Price} + \text{Bond Coupons Received} - \text{CDS Upfront} - \text{CDS Coupons Paid})$$

Note: Bond Price refers to the dirty bond price.

Other things being equal, it is clear from Equation 8 that in equal notional basis trades that look to benefit from a default:

- Bonds with low price-coupon are generally more attractive (see Figure 21) if the default is soon enough.
- Full running CDS are more attractive than full upfront CDS (again if the default is soon enough).

The more negative the basis the better for a JtD trade; however, we can also find positive JtD exposures in positive basis trades.

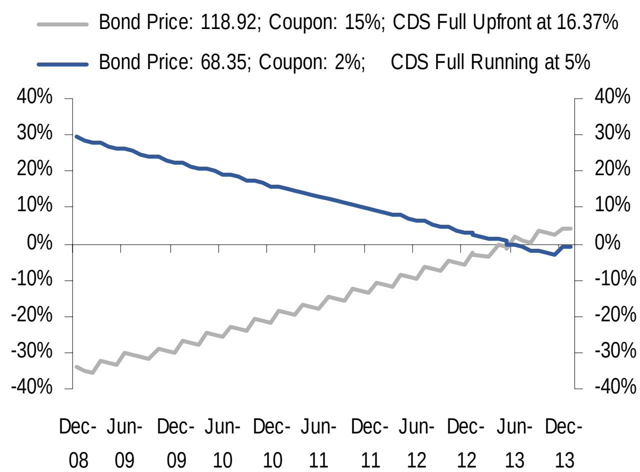
We can isolate two different aspects of negative basis trades with respect to their JtD exposure:

- **The different cash flow structure of bond (price vs. coupon) and CDS (upfront vs. running) generate a different JtD profile on each basis trade**. The lower the upfront payments on the bond (price) and CDS the better. Even in situations with positive basis, a long position in a low price-coupon bond and a short position in a full running CDS will provide a high initial positive JtD exposure (which will turn negative at some point during the trade).
- **Default (like maturity) allows the investor to cash in the Bond-CDS basis**. Therefore, the more negative the basis the better for the investor in any negative basis trade.

Figure 38 and Figure 39 illustrate the two points above. In Figure 38 we consider two extreme examples of bond and CDS, both with a zero basis (measured as equivalent full running CDS spread minus Z-spread). The figure shows the total (not discounted) cash flows of our negative basis trade for the two following combinations: (i) a low price-coupon bond paired with a full running CDS, in dark blue, and (ii) a high price-coupon bond paired with a full upfront CDS, in grey. Both trades generate similar basis, but the JtD exposure is completely different.

Figure 38: JtD Exposure

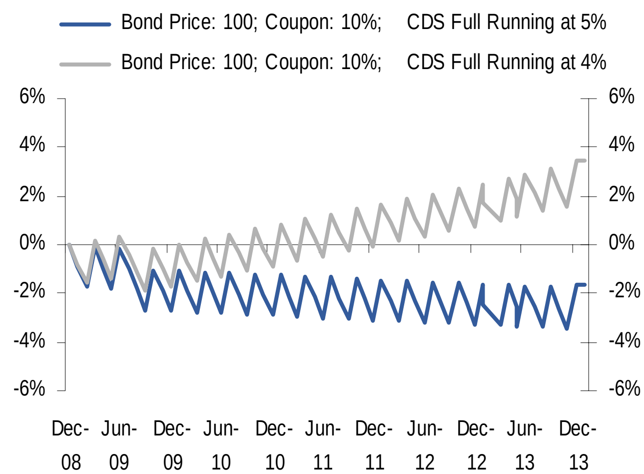
Y-axis: Sum of total cash flows on the negative basis trade until default; X-axis: Assumed default dates.



Source: J.P. Morgan.

Figure 39: JtD Exposure

Y-axis: Sum of total cash flows on the negative basis trade until default; X-axis: Assumed default dates.



Source: J.P. Morgan.

Figure 39 shows two basis trades sharing the same bond (5% Z-spread) paired with a full running CDS trading at 5% (in dark blue) and 4% (in grey) respectively. The more negative the basis the better for the JtD exposure of the trade.

JtD Exposure: Basis Trade vs. Fixed Recovery CDS

Assuming the sum of bond price and the CDS upfront is below par, which is necessary for an equal notional negative basis trade to have a positive payment from an instantaneous default, we can compare the profit from two alternatives:

- Equation 8 showed the profit from an instantaneous default in an equal notional basis trade is given by (100 – Bond Price – CDS Upfront), and the carry of the trade is given by the bond coupon minus the CDS spread.

- In a short CDS position, the profit from a default is given by (100 – Recovery – CDS Upfront), and the carry of the trade is given by the CDS running spread.

Compared with a short CDS position and assuming similar notional, a negative basis trade will earn more money from an instantaneous default as long as the bond price is lower than the realised recovery rate. Unlike in a short risk CDS position, in a negative basis trade the payment in case of default is known *a priori* and does not depend on the realised recovery rate. Thus, an equal notional basis trade resembles a fixed recovery CDS with the recovery struck at the bond price and with a spread equal to the difference between the CDS spread and the bond coupon.[22] However, there are very clear differences which difficult the comparison between the basis trade and the fixed recovery CDS: in the negative basis trade the investor receives the payment of (100 – Bond Price – CDS Upfront) even if there is not a default (he gets paid 100 and maturity and he has paid the bond price and CDS upfront at inception), and in the basis trade the investor has to fund the bond price.

[22] Notice the different treatment upon defaults for CDS spreads and bond coupons.

4. Historical Evolution, Outlook & Current Opportunities

In this section review the historical evolution of the basis and present our European outlook for 2009. We provide an overview of the current picture in the European basis space, analyzing basis breakdown by sector, rating and maturity, as well as the most attractive basis trades. We outline J.P. Morgan's new *European Bond-CDS basis Report*, which will highlight on a daily basis the best trading opportunities and the evolution of the basis per rating, maturity and sector. We include a snapshot of the current report, which highlights the most attractive basis opportunities. We also include a section covering the basis in the US market.

We focus on an aggregate measure of the Bond-CDS basis for the European market. Although the level of this type of measure will vary depending on the universe of bonds considered, its movements are a good representation of the overall market.

Historical Basis

- **Both during the first nine and last two months of 2008, the CDS-cash basis was remarkably market directional, i.e. driven by CDS spreads**.
- **September and October saw the basis moving significantly into negative territory due to the illiquidity in the cash market, at the same time spreads reached record wide levels**.
- **In December, jump-to-default hedging took the basis off its widest (negative) levels**. Investors bought CDS protection to hedge default risks, causing CDS spreads to underperform cash spreads.
- **The basis has continued to be market directional during the first weeks of 2009.** The rally during January has taken again basis levels closer to the (negative) levels seen during the last quarter of 2008.
- **Our base case scenario for the evolution of the CDS-cash basis during 2009 is a gradual transition to a new "normal" regime where the CDS becomes, again, the driver of the basis**.
- However, we can not rule out the possibility of a "sudden" transition to the previous normal regime: the basis collapsing to zero due to "jump-to-default" hedging by credit funds and correlation desks.

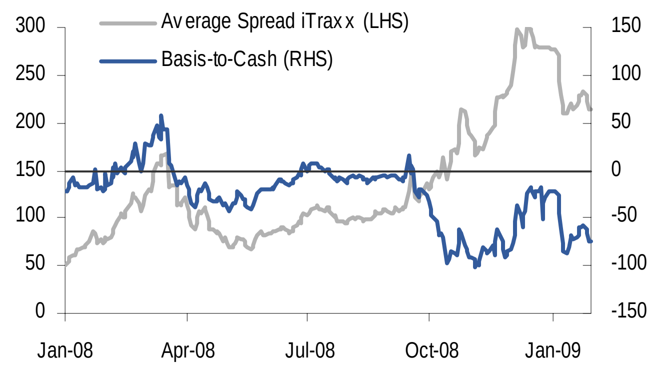
We think that taking a step back and looking at the drivers of the basis during "normal" and "non-normal" times can be helpful to understand its recent movements and to form an opinion on its future ones.

The Bond-CDS basis aims to be a measure of the discrepancy between the risks priced in bonds and CDS. Leaving aside liquidity considerations, CDS and bond spreads both compensate investors for the same risk – the risk that a company might default. As such, they should be approximately equal. The CDS-cash basis measures the extent to which these spreads differ from each other.

However, leaving aside liquidity considerations might be leaving aside too much. Notice that our measure of the basis-to-cash will still provide a measure of the different credit risk priced in both instruments if we assume the liquidity premium is the same. If that was not the case the basis-to-cash will be a combination of credit and liquidity risks. This can be particularly relevant in situations where the liquidity on each market is very different.

Figure 40: Historical iTraxx Basis vs. Spread

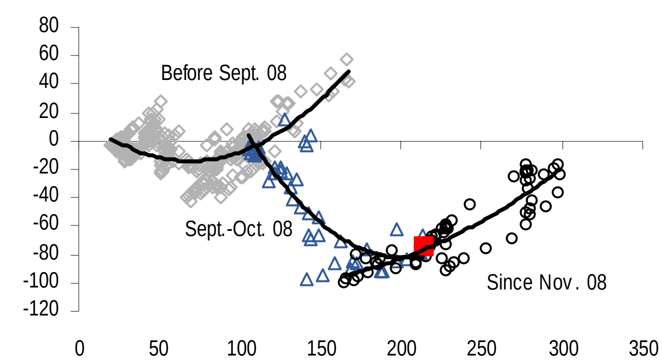
Spread (bp).



Source: J.P. Morgan.

Figure 41: iTraxx Basis vs. Spread: Historical Scatter Plot

X-axis: Average of iTraxx 5y CDS spread (bp); Y-axis: Basis-to-cash (bp)



Source: J.P. Morgan. Historical data since August 2006

CDS and bonds should price the same credit risk:[23] **on an aggregate level, the basis between them represents largely a combination of different "liquidity" factors affecting CDS and bond pricing**. These "liquidity" factors refer mainly to issuance/redemptions (synthetic and cash) and funding costs,[24] which tend to materialise in sudden shocks rather than gradual movements.

"Liquidity" is a very elusive concept which people tend to use for different purposes. We do think that "liquidity" can be interpreted simply as measure of the balance between supply and demand. When the demand for risk is high, any supply of risk is easily absorbed and liquidity is good; when the demand for risk is low, the supply of risk can not be absorbed and liquidity is poor. Generally, low demand for risk coincides with high supply of risk and vice versa; otherwise spreads would stay constant. Thus we call "liquidity" those factors that affect the demand and supply of risk.

"Normal" and "Sudden" Basis Regimes

Going back to the basis, we believe there are two different regimes which explain movements in the CDS-cash basis: a "normal" one and a "sudden" one.

[23] Leaving aside "soft" credit events, the "cheapest-to-deliver" option in CDS, the different treatment of bond and CDS coupons upon default, and any optionality embedded in bonds.
[24] Funding conditions affect funded instruments (bonds) more than it does unfunded ones (CDS).

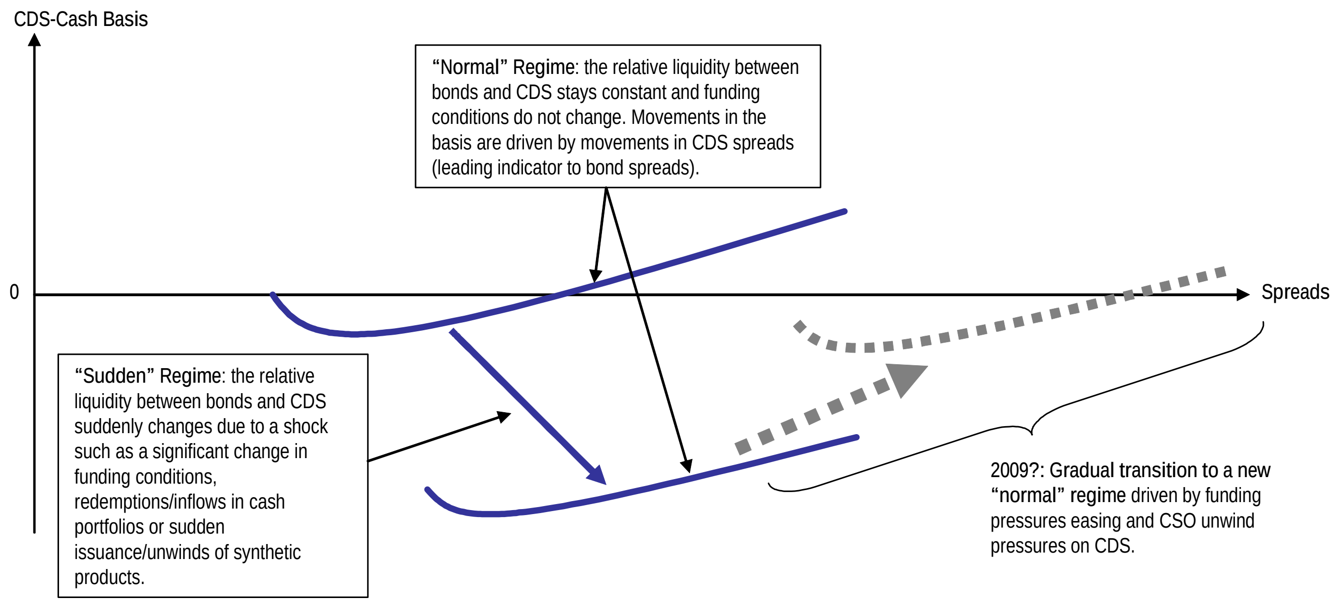
Abel Elizalde
(44-20) 7742-7829
abel.elizalde@jpmorgan.com

The "normal" CDS-cash basis regime is one where the relative liquidity between bonds and CDS stays constant or changes very slowly. In this regime, movements in the basis are driven by movements in CDS spreads since they tend to be a leading indicator to bond spreads due to their flexibility and unfunded nature (see grey box in the next page). We do realise that the issue of whether CDS spreads react faster than bond spreads is not entirely clear cut, and it depends on the relative liquidity of bonds and CDS on each particular market. However, we do believe that this is clearer in Europe, where the bond market is less liquid than in the US.

This "normal" regime is characterised by the relative liquidity between bonds and CDS staying more or less constant, <u>but not necessarily zero</u>. As we explained above, liquidity represents a very vague concept where we would generally include the net difference in protection selling pressure in the bond and CDS markets coming from factors such as issuance/redemptions and funding.

As Figure 41 shows, this "normal" regime was in place before September 2008 and it is also in place since November 2008. The relationship between the basis and underlying spreads tends to be a positive one (i.e. as spreads widen the basis becomes more positive/less negative).

Figure 42: Regimes in Cash-CDS Basis



Source: J.P. Morgan.

The "sudden" CDS-cash basis regime is one where the relative liquidity between bonds and CDS suddenly changes due to a shock such as a significant change in funding conditions, redemptions/inflows in cash portfolios or sudden issuance/unwinds of synthetic products. These "sudden" movements in liquidity significantly affect the basis (in either direction) and will likely be corrected gradually.

This is, for example, what happened during September and October this year (see Figure 41), where the "illiquidity" of cash bonds and funding pressures saw the basis moving 100-200bp negative in investment grade. Our European credit strategists estimate that the current liquidity premium in European investment grade bond spreads could potentially range from 100to 200bp.[25] Our US colleagues estimate that funding alone has made the basis around 125bp wider (i.e. more negative).[26]

These sudden shocks to the CDS-cash basis should generally be corrected gradually, taking the basis closer to zero and to a new "normal" regime. As we argue next, we believe 2009 will bring a gradual transition to a new "normal" basis regime (at wider spreads) driven by the easing of funding pressures and by the pressure on CDS spreads coming from a slow burning CSO unwind process.

"Price discovery takes place primarily in the CDS market" – Blanco, Brennan and Marsh (2005) [27]

Blanco, Brennan and Marsh (2005) represented one of the first academic papers to analyse the empirical relationship between CDS and bond spreads. The authors showed that "price discovery takes place primarily in the CDS market." The main conclusion of their empirical study is that "the pricing discrepancy between CDS prices and credit spreads is closed primarily through changes in the credit spread, reflecting the CDS market's lead in price discovery. It is through this error correction mechanism that both CDS and credit spreads price credit risk equally in the long run." The authors "speculate that price discovery occurs in the CDS market because of (micro)structural factors that make it the most convenient location for the trading of credit risk, and because there are different participants in the cash and derivative market who trade for different reasons."

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[25] Our credit strategists estimate that the current liquidity premium in investment grade bond spreads could potentially range from 100to 200bp. See *How big is the liquidity or illiquidity premium?*, P Malhotra et al, 30 January 2009.

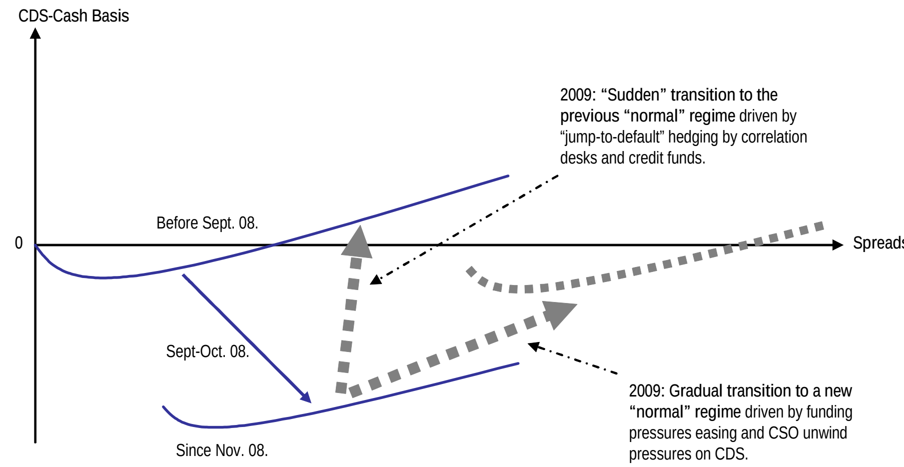
[26] See High *Grade Bond and CDS 2009 Outlook*, E Beinstein et al, 5 December 2008.

[27] R Blanco, S Brennan and W Marsh, 2005, "*An Empirical Analysis of the Dynamic Relation between Investment Grade Bonds and Credit Default Swaps*", Journal of Finance 60 (5). See also S Alvarez, 2004, "*Credit default swaps versus corporate bonds: Do they measure credit risk equally?*", unpublished manuscript.

2009 Outlook

Figure 42 sketched our base case scenario for the evolution of the CDS-cash basis during 2009: a gradual transition to a new "normal" regime where the CDS becomes, again, the driver of the basis. However, we do think the possibility of a "sudden" transition to the previous normal regime can not be ruled out, i.e. the basis collapsing to zero due to "jump-to-default" hedging by credit funds and correlation desks.

Figure 43: Cash-CDS Basis in 2009



Source: J.P. Morgan.

We think the current negative basis is mainly a reflection of the deleveraging process in cash portfolios.[28] Basis packages are one of the alternatives to sell cash bonds in the current market, and given the high funding costs, basis remain very negative. A negative basis trade in which investors lock-in, say, 100bp "default-free" spread during, say, 4 years, can be seen as a 400bp discount on cash bonds (before funding costs and taxes). Cash bonds are being sold at discounted prices versus instruments which provide similar risk profiles and require less funding.

In our view, this dynamic will persist going forward. The negative basis is slowly attracting the interest of credit investors, who are mainly cherry-picking among the existing opportunities. As this trend generalises the basis will gradually normalise, helped by easier funding and unwinds of synthetic structures.

Unwinds of CSOs should help this trend during 2009, as dealers buy synthetic protection to unwind their hedges. We have argued in recent reports that we think this unwind will be a gradual process during 2009.

The risk for our base case scenario is "jump-to-default" hedging through CDS. We have seen during December how spreads can pick-up very quickly in an environment of low trading volumes and deteriorating credit conditions. The auto sector led a wave of "jump-to-default" hedging by correlation desks and credit funds during the last weeks of 2008, which has quickly expanded to the overall market.

[28] Synthetic structures have suffered higher MtM losses than cash positions, and their "unwinding" dynamics are different. Many investors view these synthetic products (mainly CSOs) like options, due to their low prices, and do not have a lot of further downside from holding them forward. Thus, the pressure to unwind these synthetic structures might be lower.

In any case, we think we have seen the widest levels on the CDS-cash basis, but we also think the normalization of the CDS-cash basis will take time and will be a gradual process during the next months.

With bonds pricing at high discounts from par and wide spreads, negative basis packages generally have a significant negative carry component (or initial cost if the CDS is trading in upfront terms), but a positive jump-to-default exposure. Thus, they will be seen as "limited downside" trades going into 2009, attracting the interest and funds from investors.

Current Basis Opportunities

The rally during the first weeks of the year has taken the basis close to the (negative) highs that were reached during October and November 2008. We still think that the basis-to-cash will be very market directional going forward (widening as spreads tighten and vice versa) unless the liquidity in the cash market returns, funding conditions improve and cash investors' demand for secondary paper markedly pick up. The market directionality of the basis coupled with our general bearish stand on credit[29] suggests to us that the basis will most likely tighten going forward.

The current market conditions are very attractive to set up negative basis packages.

The current market conditions are very attractive to set up negative basis packages. The high "illiquidity" premium on cash bonds relative to CDS has taken the basis to (negative) levels never seen before. Additionally, the high credit risk environment has taken bond prices to very low prices, which give negative basis trades a positive jump-to-default exposure.

Drawing from the data of the *European Bond-CDS basis Report* we present an analysis of the current basis as well as the historical basis by rating, maturity and sector. The *European Bond-CDS basis Report* complements our existing *US Corporate High Grade Basis Report* and *US Corporate High Yield Basis Report* for the US market. All of them are available on *Morgan Markets* and provide an efficient way to track the Bond-CDS basis on a daily basis. Finally, we include a list of the **top 40 negative basis trades**.

Current Basis Breakdown: Maturity, Rating and Sector
Table 11 shows the current average basis for the bonds included in the *European Bond-CDS basis Report*. We should note that the universe of bonds used will imply different average basis and that, as we review next, the dispersion around the average basis can be significant.

It is clear from Table 11 that the basis is more negative the lower the rating. This is also clear from Figure 44 and Figure 45, which show the relationship between the basis and the bond spread. **The lower the credit quality of the bond, the more negative the basis-to-cash**.

Table 11 also shows that the **basis tends to be more negative for longer maturities**. This is reasonable in a distressed credit environment, where CDS curves tend to be inverted. The CDS market has higher "curve liquidity" than the bond market: investors use CDS, rather than bonds, to express curve views. Additionally, all the jump-to-default hedging coming from structured product desks tends to focus on short CDS maturities, which inverts CDS curves more than bond ones.

[29] See *First signs of a fade, or just a pause for thought?*, S Dulake, A Elizalde, 8 January 2009.

Abel Elizalde
(44-20) 7742-7829
abel.elizalde@jpmorgan.com

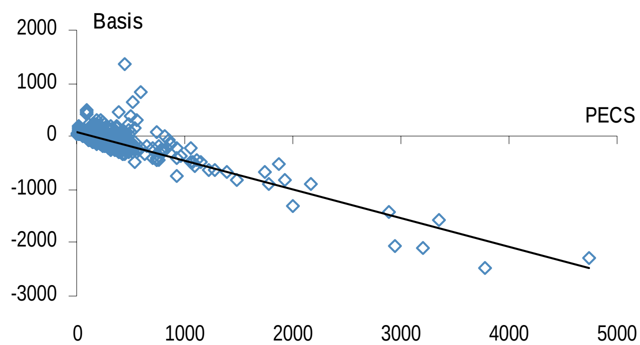
Table 11: Current European Basis Aggregate

		Basis	Count	PECS
Aggregate IG	IG All	-68	478	295
	IG with maturity above 3y	-101	341	324
	IG with maturity above 5y	-131	191	359
Rating	AAA	113	35	150
	AA	-78	97	244
	A	-49	198	228
	BBB	-129	148	452
	Crossover	-891	6	1940
Maturity IG	(1,3] years	15	137	224
	(3,5] years	-62	150	279
	(5,7] years	-112	82	343
	(7,10] years	-142	82	370
	(10,100] years	-160	27	371
Sector IG	Basic Industry	-8	51	450
	Capital Goods	55	30	272
	Consumer Cyclicals	-64	38	459
	Consumer Non-Cyclicals	-79	43	196
	Energy	51	9	226
	Financial Institutions	-96	146	290
	Technology	-147	2	310
	Telecom & Media	-144	87	301
	Transport	10	1	190
	Utilities	-18	71	178

Source: J.P. Morgan. Basis = PECS – Interpolated CDS Spread. Data as of 2 February 2009.

Figure 44: Current Basis vs. PECS: Sample of European Bonds

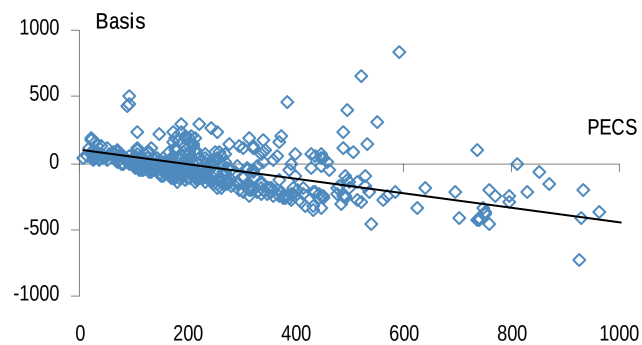
In bp. Each observation corresponds to one bond.



Source: J.P. Morgan. Basis = PECS – Interpolated CDS Spread.

Figure 45: Current Basis vs. PECS: Sample of European Bonds

In bp. Each observation corresponds to one bond.



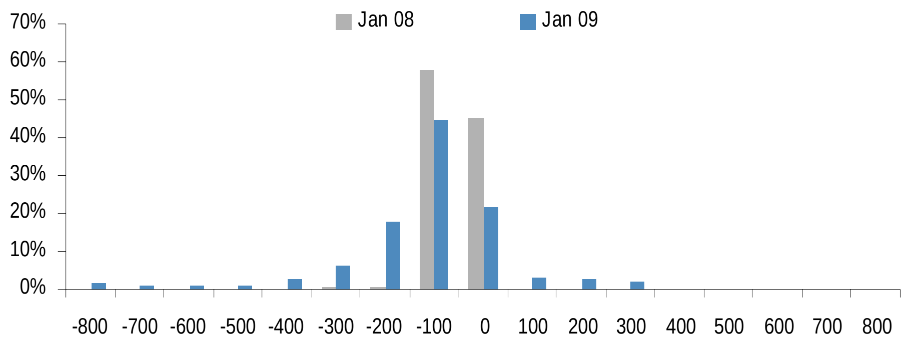
Source: J.P. Morgan. Basis = PECS – Interpolated CDS Spread.

Figure 46 shows the distribution of the current basis as well as the basis one year ago. It is clear how **the current basis is very disperse** compared to the one in January 2009. Moreover, it is **clearly skewed to negative levels**.

Thus, there are currently attractive opportunities in basis below -300bp which investors should look at very carefully. One of the sections of the European Bond-CDS basis Report highlights those opportunities daily (see also Table 12 in this report for the current top 40 most negative basis).

Figure 46: Basis Distribution – Current vs. January 2008

X-axis: Basis bucket; Y-axis: % of bonds with basis within each bucket.

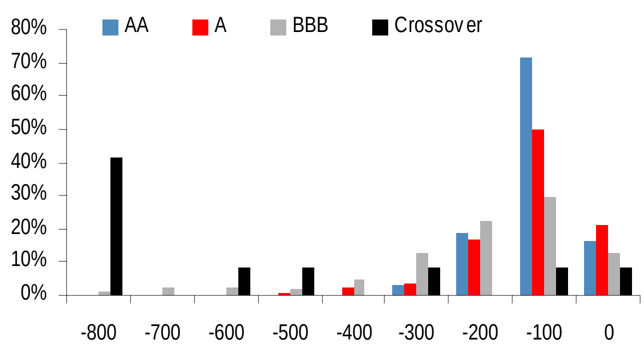


Source: J.P. Morgan.

Figure 47 shows the basis distribution by rating category. Although the number of crossover bonds the report covers is very small, it is clear how their basis tends to be a lot more negative. In Figure 48 we compare the basis distribution of the entire sample of bonds and the bonds within the consumer cyclical sector, which is one with the highest number of very negative basis.

Figure 47: Basis Distribution – By Rating

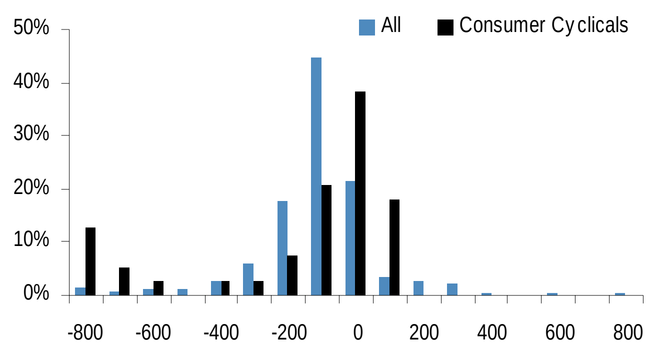
X-axis: Basis bucket; Y-axis: % of bonds with basis within each bucket.



Source: J.P. Morgan.

Figure 48: Basis Distribution – All Bonds vs. Cyclicals

X-axis: Basis bucket; Y-axis: % of bonds with basis within each bucket.



Source: J.P. Morgan.

North America Credit Derivatives Research

Eric Beinstein
(1-212) 834-4211
eric.beinstein@jpmorgan.com

Dominique D. Toublan
(1-212) 834-2370
dominique.d.toublan@jpmorgan.com

Andrew J Scott, CFA
(1-212) 834-3843
andrew.j.scott@jpmorgan.com

Miroslav Skovajsa
(1-212) 834-5154
miroslav.j.skovajsa@jpmorgan.com

Katy Le
(1-212) 834-4276
trang.t.le@jpmorgan.com

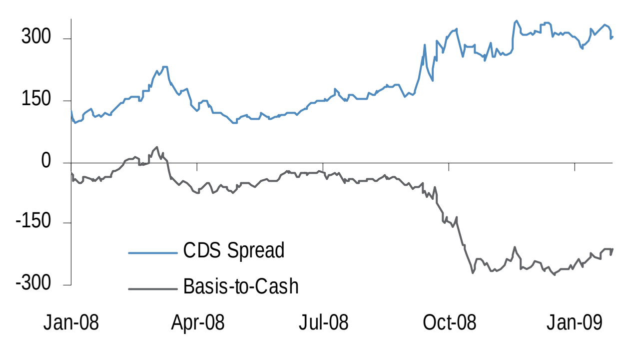
Basis in the US Market

- **In 2008 before Lehman's default, the basis for investment grade credit was relatively low and weakly directional. After the default it has traded in a range from 200-275bps.**
- **In the HY market, a similar transition took place, albeit slightly after the IG transition. Since mid-October, the HY basis has been in a -450bps to -750bps range. It has also been increasing as CDS spreads widened, but the relationship is relatively weak.**
- **The increase in funding costs has been an important driver of the significant widening of basis. IG basis has been somewhat contained by dealer correlation desks hedging their synthetic CDO positions. This is less important for HY basis.**

The US IG basis has behaved similarly to the EU IG basis in 2008. As shown in Figure 49 and Figure 50, the basis was mildly directional until September 2008, with the basis increasing (i.e. more positive) as CDS spreads increased. However, Lehman's default changed the trading pattern between CDS spreads and basis. After a couple of weeks, the basis was reset at around -250bps. Furthermore, in this new phase, the basis is not very directional.

Figure 49: US IG CDS spread and basis have diverged in mid Sep

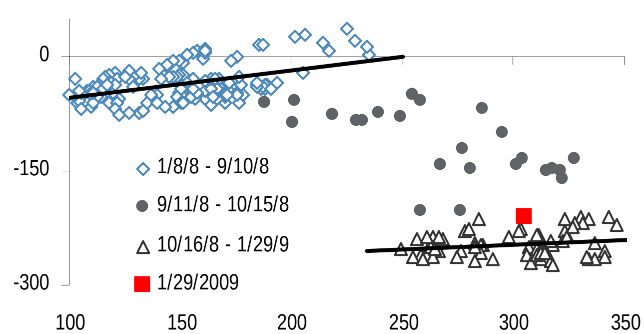
X-axis: Date; Y-axis: CDS spread and Basis-to-Cash.



Source: J.P. Morgan.

Figure 50: Spread vs. Basis: Two clearly different regimes

X-axis: CDS spread; Y-axis: Basis-to-Cash.



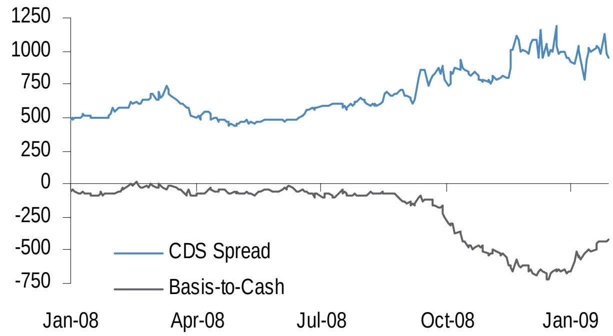
Source: J.P. Morgan.

The HY basis drastically changed last Fall. Early in 2008, the basis was small and changing almost independently of the CDS spreads (see Figure 52). Lehman's default did not immediately affect this pattern. However, things started to unravel near the end of September and, in a few days, a new relationship was established at much more negative basis levels. Since then, the HY basis has traded as negative as -720bps in mid December, but has somewhat recovered since then. Since this new trading pattern as been established, the basis has become more negative as spreads widened, which is the opposite of what has happened so far in either IG or HY.

Abel Elizalde
(44-20) 7742-7829
abel.elizalde@jpmorgan.com

Figure 51: US HY CDS spread and basis have diverged in late Sep

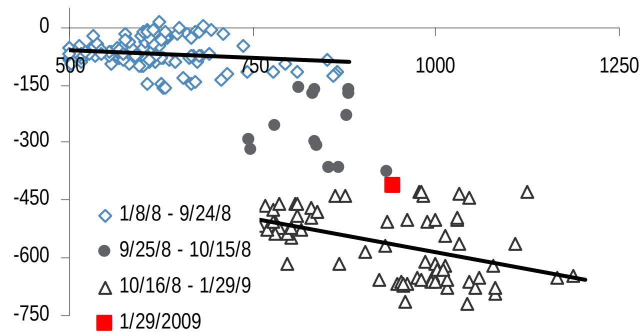
X-axis: Date; Y-axis: CDS spread and Basis-to-Cash.



Source: J.P. Morgan.

Figure 52: Spread vs basis: two clearly different regimes

X-axis: CDS spread; Y-axis: Basis-to-Cash.



Source: J.P. Morgan.

These resets are probably due to the abrupt increase in funding costs that took place at the same time as the perception of counterparty risk significantly increased. We believe that bond spreads and CDS will likely trade separately until financing becomes more readily available and the "arbitrage" trade becomes attractive. Finally, correlation desks activity to hedge their synthetic CDO positions should help reduce the size of the IG basis, especially if there is an increase in synthetic CDO unwinds. The HY basis is only slightly affected by this activity as few HY names were used in structured products.

European Bond-CDS basis Report

The current daily Bond-CDS report includes around 500 bonds, which we use to compute all the metrics in the report. In particular, the *European Bond-CDS basis Report* contains the following:

- Current basis aggregate data for the bonds in the report, split by rating, maturity and sector.
- Historical charts with average basis for IG and crossover bonds, as well as the historical relationship between average basis and average spread levels.
- Top 40 most negative and top 40 most positive basis trades opportunities.
- Historical basis charts for the current most negative basis trades.
- Historical average basis charts by rating, maturity and sector.
- Distribution of the current basis per rating, maturity and sector.

Composition of *European Bond-CDS basis Report*

We plan to restrict the universe of bonds covered in the report to liquid Euro denominated bonds. Currently, the list we use for our daily report consists of bonds has been selected according to the following filters:

- We start with the list of all MAGGIE Euro Credit bond index components, excluding bonds issued by entities belonging to the following categories: public sector, asset backed, miscellaneous, Pfandbriefe and EMU governments.
- We first eliminate bonds with low liquidity. The bonds with the following characteristics are eliminated:
  - Bonds with more than 5 days of stale prices during the month prior to the rebalancing date (which will generally correspond with month end).
  - Bonds which have not traded in the last 5 days prior to the rebalancing date.
  - Bonds with less than 3 dealers (as reported by ISDA).
  - Bonds with an average daily traded volume over the month lower than EUR 500,000.
  - Subordinated bonds.
- We then match up the remaining bonds with a CDS curve. Bonds for which such matching is not found are eliminated.
- We further eliminate those bonds for which the corresponding CDS spread has been stale more than 10 days during the month prior to the rebalancing date.

We plan to update the list of bonds in our report on a monthly basis.

Abel Elizalde
(44-20) 7742-7829
abel.elizalde@jpmorgan.com

Table 12: Most Attractive Negative Basis Trades in the European Bond Universe

	Company	Maturity	Basis (bp)	1 week change (bp)	1 month change (bp)	PECS (bp)	Interp. CDS* (bp)	Price (Clean)	Accr. Coupon	S&P Rating	Moody's Rating	ASW Par (bp)	Z-spread (bp)	Industry	Coupon	Ticker	ISIN
1	GMAC	Jun-11	-1655	-248	429	2800	1145	63.8	3.5	CC	C	1717	2320	Consumer Cyclicals	5.375%	GMAC	XS0187751150
2	GMAC	Sep-10	-1286	+653	+1,178	2565	1278	72.5	2.0	CC	C	1710	2122	Consumer Cyclicals	5.750%	GMAC	XS0177329603
3	FIAT FINANCE NTH AMER	Jun-17	-1244	-257	-342	2678	1434	48.6	3.6	BBB-	Baa3	866	1371	Consumer Cyclicals	5.625%	FIAT	XS0305093311
4	FCE BANK	Jan-12	-931	+130	-125	2052	1121	69.8	0.3	B-	B3	1462	1891	Financial Institutions	7.125%	F	XS0282593440
5	GLENCORE FINANCE EUROPE	Apr-15	-759	-114	+805	1946	1188	58.7	5.5	BBB	Baa2	1170	1771	Basic Industry	7.125%	GLEINT	XS0359781191
6	FCE BANK	Jan-13	-716	+110	-44	1820	1104	67.8	0.4	B-	B3	1242	1627	Consumer Cyclicals	7.125%	F	XS0299967413
7	GMAC INTL FINANCE	May-10	-708	-201	+704	2123	1416	80.5	4.0	CC	C	1499	1751	Consumer Cyclicals	5.750%	GMAC	XS0301812557
8	GIE PSA TRESORERIE	Sep-33	-698	-4	+33	949	252	60.5	2.2	BBB+	Baa2	464	709	Consumer Cyclicals	6.000%	PEUGOT	FR0010014845
9	CIT Group Inc	May-14	-696	-77	+116	1428	732	62.7	3.6	A-	Baa1	934	1286	Financial Institutions	5.000%	CIT	XS0192461837
10	WPP GROUP	May-16	-670	-15	-172	1126	456	67.9	4.8	BBB	Baa2	770	1003	Telecom & Media	6.625%	WPPLN	XS0362329517
11	WPP FINANCE	Jan-15	-669	-12	-37	1130	461	66.9	0.0	BBB	Baa2	740	959	Telecom & Media	5.250%	WPPLN	XS0329479728
12	RENTOKIL INITIAL	Mar-14	-589	+49	-38	1139	549	67.6	3.9	BBB-		742	948	Consumer Cyclicals	4.625%	RENTKL	XS0293496815
13	XSTRATA FINANCE (CANADA)	Jun-17	-566	+304	+1,502	1469	903	57.0	3.3	BBB+	Baa2	773	1173	Basic Industry	5.250%	XTALN	XS0305188533
14	CIT GROUP	Mar-15	-563	-5	+54	1270	707	60.6	3.7	A-	Baa1	754	1037	Financial Institutions	4.250%	CIT	XS0215269670
15	KINGFISHER	Nov-12	-531	-5	-38	979	449	75.5	0.8	BBB-	Baa3	723	871	Consumer Cyclicals	4.125%	KINGFI	XS0235984340
16	PORTUGAL TELECOM INTL	Jun-25	-510	-28	-47	619	110	62.1	2.8	BBB-	Baa2	326	458	Telecom & Media	4.500%	PORTEL	XS0221854200
17	VOLVO TREASURY	May-17	-497	-31	-62	890	393	66.8	3.3		A3	578	769	Capital Goods	5.000%	VLVY	XS0302948319
18	CIT GROUP	Sep-16	-494	-11	-37	1171	677	60.3	1.7	A-	Baa1	678	951	Financial Institutions	4.650%	CIT	XS0268133799
19	CIT GROUP	Nov-12	-452	-21	+867	1231	779	69.3	0.8	A-	Baa1	888	1133	Financial Institutions	3.800%	CIT	XS0234935434
20	XSTRATA FINANCE (CANADA)	May-11	-432	-20	+76	1582	1150	76.8	4.0	BBB+	Baa2	1499	1931	Basic Industry	5.875%	XTALN	XS0366203585
21	TELECOM ITALIA	Mar-55	-431	+17	-2	756	325	60.7	4.6	BBB	Baa2	349	504	Telecom & Media	5.250%	TITIM	XS0214965963
22	VALEO	Jun-13	-423	-46	-250	1018	595	71.6	2.3		Baa3	1607	6130	Consumer Cyclicals	3.750%	VLOF	FR0010206334
23	MORGAN STANLEY & CO INTL	Oct-16	-399	-5	+30	727	327	70.1	1.3	A+	A1	528	687	Financial Institutions	4.375%	MS	XS0270800815
24	MORGAN STANLEY	Oct-17	-389	-5	+45	706	317	73.5	1.8	A+	A1	515	644	Financial Institutions	5.500%	MS	XS0323657527
25	WOLTERS KLUWER	Apr-18	-376	-15	-28	452	76	88.4	5.2	BBB+	Baa1	411	467	Telecom & Media	6.375%	WKLNA	XS0357251726
26	KINGFISHER	Oct-10	-368	+16	+10	837	469	89.7	1.2	BBB-	Baa3	1127	1308	Consumer Cyclicals	4.500%	KINGFI	XS0178322128
27	MORGAN STANLEY	Dec-18	-356	+11	+56	662	306	77.4	4.4	A+	A1	531	650	Financial Institutions	6.500%	MS	XS0366102555
28	WPP GROUP	Dec-13	-344	-17	-105	811	467	75.6	0.7	BBB	Baa2	655	805	Telecom & Media	4.375%	WPPLN	XS0275759602
29	CLARIANT FINANCE	Apr-13	-344	+1	-150	883	539	77.4	3.6	BBB-	Baa3	754	926	Basic Industry	4.375%	CLAR	XS0249417014
30	MORGAN STANLEY	Nov-15	-339	+22	+77	680	341	72.0	0.8	A+	A1	502	633	Financial Institutions	4.000%	MS	XS0235620142
31	MORGAN STANLEY	May-19	-327	+5	+13	630	303	71.3	3.7	A+	A1	440	567	Financial Institutions	5.000%	MS	XS0298899534
32	ALTADIS EMISIONES	Dec-15	-326	-6	-4	416	91	81.9	0.5	BBB	Baa3	379	451	Consumer Non-Cycl.	4.000%	IMTLN	XS0236951207
33	PORTUGAL TELECOM INTL	Mar-17	-319	-6	+19	445	126	79.2	3.7	BBB-	Baa2	344	410	Telecom & Media	4.375%	PORTEL	XS0215828913
34	SAINT GOBAIN	Apr-17	-302	-28	-82	609	307	74.9	3.8	BBB+	Baa1	451	559	Basic Industry	4.750%	SGOFP	XS0294547285
35	GOLDMAN SACHS	Feb-15	-293	-2	+4	580	287	78.1	4.0	AA-	Aa3	454	545	Financial Institutions	4.000%	GS	XS0211034540
36	CASINO GUICHARD PERR	Apr-14	-291	-16	-9	500	209	86.3	3.9	BBB-		449	508	Consumer Non-Cycl.	4.875%	COFP	FR0010455626
37	ALTADIS FINANCE	Oct-13	-287	-9	-51	384	97	92.7	1.7	BBB	Baa3	400	437	Consumer Non-Cycl.	5.125%	IMTLN	XS0176838372
38	XSTRATA FINANCE (CANADA)	Jun-12	-284	+105	+612	1394	1110	71.8	3.1	BBB+	Baa2	1366	1943	Basic Industry	4.875%	XTALN	XS0305189002
39	OTE	May-16	-282	-12	-37	409	126	84.2	3.2	BBB+	Baa2	339	390	Telecom & Media	4.625%	OTE	XS0275776283
40	ERICSSON	Jun-17	-279	-25	-106	551	272	78.7	3.2	BBB+	Baa1	413	487	Technology	5.375%	LMETEL	XS0307504547

Source: J.P. Morgan, iBoxx, Standard and Poors, Modoy's. Data as of 2 February 2009.. *: Interp. CDS = From the CDS curve, we interpolate the CDS spread with a maturity equal to the bond maturity.

Abel Elizalde
(44-20) 7742-7829
abel.elizalde@jpmorgan.com

Appendix I: CDS Pricing – A Reminder

This section provides an overview of CDS pricing and marking to market.

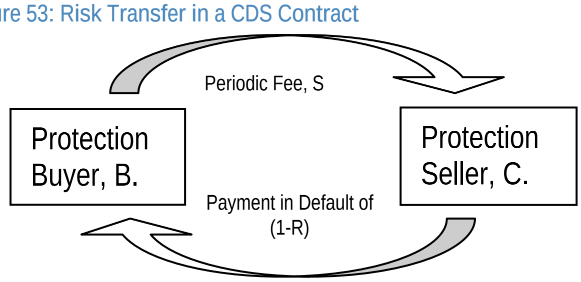
- The key to CDS pricing is that at inception of a CDS trade, the fee leg and the contingent leg of the contract are equal – neither the buyer nor the seller has an economic advantage.
- With this in mind, we look at how the usual *all running* CDS contracts are valued both at inception and at any subsequent time, leading to a mark-to-market on the trade.
- Finally we show that an *upfront plus running* contract can be seen as an *all running* contract with a mark-to-market.

CDS Pricing in a Nutshell

The basic setup of a CDS contract is shown in Figure 53. The buyer of protection B pays an annual fee or spread, S, to the seller of protection, C. Should a credit event occur, the buyer of protection will deliver defaulted bonds with a notional equal to that of the CDS contract and in return will receive 100% of the notional. We call the price of these defaulted bonds the recovery rate *R* (usually a % of the notional).

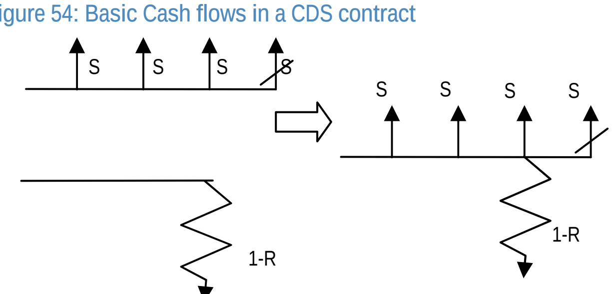
The net result is that the buyer pays S annually and receives (1-*R*) in the event of a credit event; these cash flows are shown in Figure 54. We remind readers of this process because it highlights an important concept – at inception of a CDS contract, the present value of the spread payments is equal to the present value of the expected default payments and the value of the contract to both buyer and the seller is equal.

Figure 53: Risk Transfer in a CDS Contract



Source: J.P. Morgan.

Figure 54: Basic Cash flows in a CDS contract



Source: J.P. Morgan.

This is not to say that the buyer and seller are indifferent to buying or selling protection. By entering the contract, they are clearly taking a view that one side of the contract will be more valuable in the future. The buyer thinks he will receive more from the default event than he pays in annual spreads and the seller thinks he will receive more from the spreads than he will have to pay out on default. The important point is that **at inception of the contract, the economic value to each party is equal** – the present value of the expected default payment (*contingent leg*) must equal the present value of the expected annual fees paid (*fee leg*).

Abel Elizalde
(44-20) 7742-7829
abel.elizalde@jpmorgan.com

Equation 9: The two legs of the CDS contract must balance

PV(Expected Spread Payments) = PV(Expected Payout from Default)
PV(E[Spread Payments]) = PV(E[Payout from Default])
or
PV(Fee Leg) = PV(Contingent Leg)

One Time Step Example
For a discrete 1-step time period, the *expected spread payment* is just a single payment of S, and *expected payout from default* is the probability weighted value of the payout from default i.e. (1- *R*) × probability of default (Equation 10).

Equation 10: Simple One-Step Time Period

PV(Expected Spread Payments) = PV(Expected Payout from Default)

which implies

$$S = PD \times (1 - R)$$

(The discounting factors on each side cancel.) Where:

S = Spread
PD = Probability of Default
R = Recovery-rate in %

The important point to note is that a change to any one of these three components must change at least one of the others for the equation to balance.

Simple Example
Suppose company XYZ is trading with a spread of 100bp and that recovery rate is expected to be 40% of the notional. The implied probability of default in this case can be backed out of Equation 10.

$$S = PD \times (1 - R)$$

$$100bp = PD \times (100\% - 40\%) \Rightarrow PD = \frac{100bp}{(100\% - 40\%)} = 1.7\%$$

Multi-Time Step Example
Expanding this to a multi-time step example, Equation 10 becomes that shown in Equation 11. The left hand side is just the expected present value of the spread payments, while the right hand side is the present value of the expected default payout. Note that the spread payments are also contingent since they stop in the event of default. A full derivation of this equation can be found in Section 4 of the *JPMorgan Credit Derivatives Handbook.*

Equation 11: CDS Pricing Equation

$$\underbrace{S_N \times \sum_{i=0}^{N} \Delta_i \cdot PS_i \cdot DF_i + AI}_{PV(Expected\ Spread)} = \underbrace{(1 - R) \times \sum_{i=0}^{N} PD_i \cdot DF_i}_{PV(Expected\ Default\ Payout)}$$

S_N = Spread for protection for N years, as at time t_0
Δ_i = Length of time period i in years
PS_i = Probability of Survival to time i, as at time t_0

PD_i = Probability of Default at time i.
DF_i = Risk-free discount factor to time i, as at time t_0
R = Recovery Rate on default
AI = Accrued Interest on default

Equation 11 shows two important characteristics of CDS spreads:

1. **CDS spreads take into account expected bond recovery rates**: Keeping default probabilities constant, a lower expected bond recovery rate increases the bond's credit risk.
2. **CDS spreads take into account the full term structure of default probabilities**: The shape of the default probability term structure conveys information about conditional default probabilities. For example, an inverted CDS curve means that if the company survives the next period of time (e.g. year), the probability of defaulting the subsequent period will be lower.

We now introduce the risky annuity to simplify our calculations.

We use cents, c, to denote an upfront payment and bp to denote a running payment. Both are equal to $\frac{1}{10{,}000}$.

Risky Annuities

We define the risky annuity as the present value of a 1bp risky cash flow or annuity stream. Suppose we are due to receive 1bp each year for 5 years. In a world with zero interest rates, the present value of this income stream is worth the sum of the 1bp payments (5c). However, in a world with non-zero interest rates, we can find the present value of this income stream by summing up the present value of each payment of 1bp. This present value calculation is called the Risk-Free Annuity and is given in Equation 12.

Equation 12: Risk-Free Annuity

$$RiskFreeAnnuity_N = \sum_{i=0}^{N} \Delta_i \cdot DF_i$$

where $DF_i = \dfrac{1}{(1 + RiskFreeRate_i)^i}$ = Discount Factor for maturity i

Suppose now that this income stream of 1bp is dependent on company XYZ surviving at each payment date. This is then a *risky annuity* and we add a probability term to realise the likelihood of receiving each cash flow (Equation 13). As the survival probabilities increase, the 1bp payments become more certain and the risky annuity increases. The risky annuity is therefore just a simple way of calculating the present value of a 1bp risky income stream.

Equation 13: Risky Annuity

$$RiskyAnnuity_N = \sum_{i=0}^{N} \Delta_i \cdot PS_i \cdot DF_i$$ [30]

where PS_i = Survival Probablility for maturity i

[30] We have simplified this by removing the Accrued Interest.

Abel Elizalde
(44-20) 7742-7829
abel.elizalde@jpmorgan.com

If the risky annuity for a 5-year CDS contract is 4.5, 1bp per year conditional on no default of company XYZ would be worth 4.5c paid today. If spreads rise, the survival probabilities decline and the risky annuity also declines resulting in a present value of less than 4.5c.

We can simplify Equation 11 by using the risky annuity. Since the risky annuity tells us the present value of 1bp, we can also use it to tell us the present value of S_N basis points. Equation 11 therefore becomes:

Equation 14: Simplifying the CDS Pricing Equation

$$S_N \times Annuity_N = (1-R) \times \sum_{i=0}^{N} PD_i \cdot DF_i = PV(E[1-R])$$

We have seen that pricing CDS relies on equating the expected spreads paid (*fee leg*) to the probability weighted default payout (*contingent leg*). This ensures that at inception neither the buyer nor the seller has an economic advantage. We now turn to an example of finding the present value of a Par CDS contract.

Example: Present Value of a Par CDS Contract
Suppose we have a 5-year CDS contract on company XYZ with a maturity of 20 March 2013 and a spread of 100bp. Initially, if the market trades at 100bp, then the MtM of the contract is zero. This is shown in the *Market Val* field of the Bloomberg CDSW calculator. For a Par CDS contract, the risky annuity and risky duration, Spread DV01, are very close. The PV of the *fee leg* is therefore equal to

$$\begin{aligned} PV(FeeLeg) &= S_{5,0} \times Annuity_{5,0} \\ &= 100bp \times 4.55 \\ &= 4.55\% \text{ of Notional} \\ &= \$455{,}000 \text{ on a notional of €10m} \end{aligned}$$

At inception, this is also the PV of the *contingent leg* or the *expected loss from default*.

We have seen how at inception of a CDS contract, the *fee leg* and *contingent leg* are equal and the value to both buyer and seller is the same. As the market perception of risk changes and spreads move away from their initial value, there will be a mark-to-market on the contract.

Marking-to-Market a CDS contract
As we will show, the mark-to-market on a CDS contract is the difference spread between the initial and final spread multiplied by the risky annuity. Let's consider the value of the CDS contract to the buyer of protection. They own the *contingent leg* and must pay the *fee leg*. Therefore the value of the contract is:

$$Value_t = [PV_t(E[1-R])] - \left[S_{N,t} \times \sum_{i=0}^{N} Annuity_{N,t} + AI \right]$$

At inception, as we have said, this value must be equal to zero. As the market perception of risk changes, the mark-to-market on the contract is the difference in the value of the contract at the start and at time *t*.

$$
\begin{aligned}
MtM &= Value_t - Value_0 \\
&= \left\{ [PV_t(E[1-R])] - \left[S_{N,0} \times \sum_{i=0}^{N} Annuity_{N,t} \right] \right\} - \left\{ [PV_0(E[1-R])] - \left[S_{N,0} \times \sum_{i=0}^{N} Annuity_{N,0} \right] \right\} \\
&= [PV_t(E[1-R])] - \left[S_{N,0} \times \sum_{i=0}^{N} Annuity_{N,t} \right] - 0 \\
&= \left[S_{N,t} \times \sum_{i=0}^{N} Annuity_{N,t} \right] - \left[S_{N,0} \times \sum_{i=0}^{N} Annuity_{N,t} \right] \\
&= \left[(S_{N,t} - S_{N,0}) \times \sum_{i=0}^{N} Annuity_{N,t} \right]
\end{aligned}
$$

So the mark-to-market on a CDS contract is the difference spread between the initial and final spread multiplied by the risky annuity.

So far we have seen how to value CDS contract that trade in *all running* format, where the full CDS spread is paid annually, we now to other format of trading CDS.

Full Upfront or Upfront Plus Running CDS

Another way to trade a CDS is to agree on a fixed spread that differs from the market spread and to pay the difference as an upfront amount. For example, suppose the fair spread for a CDS contract is 1,500bp but the protection buyer only wants to pay 500bp annually. In order to do so, he will have to compensate the protection seller by paying him an upfront amount equal to the risky present value of the 1,000bp that he is underpaying annually. We call this method of trading CDS trading in *points upfront* or trading *upfront plus running*, expressing that there is a points upfront payment plus running spread payments.

In this case, we get Equation 15.

Equation 15: CDS Pricing Equation

$$
\underbrace{Upfront + Running \times \sum_{i=0}^{N} \Delta_i \cdot PS_i \cdot DF_i + AI}_{PV(Expected\ Spread)} = \underbrace{(1-R) \times \sum_{i=0}^{N} PD_i \cdot DF_i}_{PV(Expected\ Default\ Payout)}
$$

where

Upfront = The upfront payment on the contract at inception

Running = The fixed *Running* spread for the contract

Combining Equation 14 and Equation 15 gives us Equation 16.

Equation 16: CDS Pricing Equation

$$
Upfront = (S_N - Running) \times \sum_{i=0}^{N} Annuity_N + AI
$$

This equation is the same as that used to Mark-to-Market a CDS contract**. So trading in *points upfront* is really no different to trading a CDS contract where the market spread has moved away from the initial deal spread**. For a par CDS contract, there is no upfront amount paid. However, as spreads move away from the initial spread, the contract will have a mark-to-market based on where the current market spreads are relative to the initial deal spreads. A contract with an initial spread of 500bp, with a market spread now at 1,500bp is simply an *upfront plus running* contract.

Appendix II: Bond Credit Spread Measures

The accurate calculation of the Bond-CDS basis depends on a suitable measure of bond spread. In this section, we highlight various measures for the credit spread of a bond. A variety of methods exist for calculating the bond spread, making it unclear which bond measure we should use to calculate the basis. The most commonly referenced bond spreads are:

3. Spread to benchmark
4. I-spreads
5. Asset swap spreads (Par and True)
6. Z-spreads
7. Par Equivalent CDS Spreads (PECS)

By considering each of these methods in turn, we will be able to better assess whether they are good measures for calculating the basis. Before we do so however, we will have a quick reminder of the terms we use in bond pricing.

Bond Pricing and Yields

Bond Price

The price of a bond is simply the present value of the expected future cash flows. Suppose we have a 5-year bond with a coupon C. Each year we will receive the annual coupon and additionally we will receive 1 after 5 years. If r_i is the annual discount rate, or zero-rate, for a payment at time i, then the present value of the cash flows is:

Equation 17: Present Value of Bond Cash flows

$$\begin{aligned} Present\,Value &= \frac{C}{(1+r_1)^1} + \frac{C}{(1+r_2)^2} + \frac{C}{(1+r_3)^3} + \frac{C}{(1+r_4)^4} + \frac{1+C}{(1+r_5)^5} \\ &= \sum_{i=1}^{5} \frac{C}{(1+r_i)^i} + \frac{1}{(1+r_5)^5} \end{aligned}$$

For an n-year bond with coupons paid with a frequency of f per year we get

Equation 18: Bond Pricing

$$Dirty\ price = \sum_{i=1}^{N=n\times f} \frac{C/f}{\left[1+r_{t_i}/f\right]^{f\times t_i}} + \frac{1}{\left[1+r_{t_N}/f\right]^{f\times t_N}}$$

where t_i is the time (in years from today) of each coupon payment and r_i is the annual zero-rate for a payment at time t_i.

Yield to Maturity (YTM)
The yield-to-maturity (YTM) for a bond can be thought of as the expected future income from a bond. Rather than using a different discount rate for each cash payment, we often use the single value, y.

Equation 19: Bond Pricing

$$Dirty\ price = \sum_{i=1}^{N=n\times f} \frac{C/f}{[1+y/f]^{f\times t_i}} + \frac{1}{[1+y/f]^{f\times t_N}}$$

where y = Bond Yield to Maturity.

Relationship between Bond Prices and Yields
Bond prices and yields are inversely proportional, as bond prices rise, yields fall and vice-versa. For a bond priced at par, *1*, the yield is equal to the coupon. If we buy a bond priced below par, we will still get the coupons on the full notional of *1*, but we pay less than this for the bonds; the yield will therefore be greater than the coupon.

Corporate bonds tend to have lower prices and higher yields than equivalent risk-free bonds. Investors who buy corporate bonds rather than risk-free bonds risk losing their notional investment should the company default. The cost of a corporate bond with the same coupons and maturity as a risk-free bond will therefore have a lower price or equivalently a higher yield.

Bonds of differing maturities will usually have different yields. Investors in long dated bonds usually demand a higher annual yield than investors in short dated bonds. One reason for this is that investors demand higher compensation for tying their money up for a longer period of time. This will lead to an upward sloping yield curve.

Risk-free Rates
The term risk-free can either refer to government rates or swap rates. For investors looking at an investment in corporate rather than government bonds, the additional yield of investing in credit is compared to the alternative of a risk-free government bond investment. The risk-free-rate is therefore the yield on equivalent government bonds. For investors who borrow in order to invest in credit however their risk-free rate is more likely to be the cost of borrowing. For investors able to borrow at Libor or swap rates, this is their risk-free rate.

We now turn to a detailed analysis of different spread measures. Each measure is slightly different from the other measures although they are closely related. Primarily, spreads are useful for three factors – indicating default probabilities, defining the excess yield of risky bonds over risk-free bonds and aiding trading and pricing of corporate bonds. In what follows, it is important to note that since the coupon and maturity of the bond are fixed, quoting the bond yield is equivalent to quoting the bond price as there is a direct correspondence.

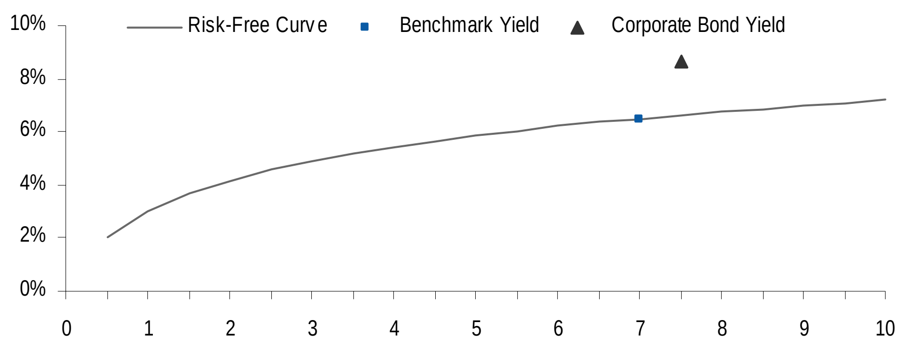
Abel Elizalde
(44-20) 7742-7829
abel.elizalde@jpmorgan.com

1. Spread to benchmark

Spread to benchmark (or benchmark spread) is the difference between the yield-to-maturity (YTM) on a corporate bond and the YTM of a benchmark bond. Investors buying a corporate rather than risk-free bond will receive an additional yield as compensation for holding the corporate bond rather than the risk-free bond. We call this additional yield on the corporate bond the benchmark spread: it is the compensation for the default risk and lower liquidity of the corporate bond. We usually quote benchmark spreads with reference to a relevant government bond; however we could also quote it with respect to a benchmark swap rate.

Figure 55: Example Benchmark Spread

x-axis: Years to Maturity; y-axis: Yield (%)



Source: J.P. Morgan.

In order to calculate the benchmark spread, we calculate the yield on the risky bond using Equation 19 and then calculate the yield on the reference government bond. The difference between these tells us the benchmark yield.

Equation 20: Spread to Benchmark

$$\text{Benchmark Spread} = \text{Bond Yield} - \text{Benchmark Bond Yield}$$

Substituting into the equation for yield calculation, Equation 19, we get:

Equation 21: Bond Pricing

$$\begin{aligned} Dirty\ price &= \sum_{i=1}^{N=n\times f} \frac{C/f}{\left[1+y/f\right]^{f\times t_i}} + \frac{1}{\left[1+y/f\right]^{f\times t_N}} \\ &= \sum_{i=1}^{N=n\times f} \frac{C/f}{\left[1+\left(y_B+S_B\right)/f\right]^{f\times t_i}} + \frac{1}{\left[1+\left(y_B+S_B\right)/f\right]^{f\times t_N}} \end{aligned}$$

where

y = *Bond Yield to Maturity*

y_B = *Benchmark Bond Yield to Maturity*

S_B = *Benchmark Spread*

Investors often refer to the benchmark spread as the ‘Govie’ spread as it is frequently used for quotation and trading purposes. The reason for this is that it provides an alternative to quoting bond prices. Since investors must ultimately pay the bond price when buying a bond, we need an unambiguous method for calculating this price. Given the relationship between bond prices and bond yields (Equation 19) quoting a yield is equivalent to quoting a price. Since the yield for the benchmark bond is well defined and easily available from a variety of pricing sources, we can add the 'Govie' spread to this in order to get the corporate bond yield. Using Equation 19 we can convert the corporate bond yield into a price.

The benchmark spread is a good alternative to quoting bond yields, it is however less useful as an indicator of excess return or default probabilities of investing in corporate rather than government bonds. While the maturity of the benchmark bond is usually chosen to be close to, it is not exactly the same as that of the corporate bond. The additional maturity of the corporate bond will result in additional yield, which is not related to credit risk.

The benefit of using benchmark spreads are ease of calculation and of quotation for trading purposes. The problems with using this spread measure are:

- The mismatch in maturity will tend to overestimate the credit risk
- As with all yields, the benchmark spread assumes that income is reinvested at the bond yield
- No account taken for the term structure of interest rates, since a single yield is assumed

The I-spread, which we discuss next, corrects for the maturity mismatch, although it also assumes that income is reinvested in the bond.

2. I-spread

The I-spreads is the difference in yield between a corporate bond and a maturity matched benchmark bond; it is similar to benchmark spreads but more accurately reflects the credit risk of a bond. Since the maturity of the benchmark bond usually differs from the maturity of the corporate bond, the benchmark spread will tend to overestimate the credit risk of a bond. Suppose we have a 7.5-year corporate bond and a 7-year benchmark bond. If the benchmark yield curve is upward sloping then the benchmark spread is the difference between the 7.5-year yield on the corporate bond and the 7-year yield on the government bond. Since the yield on a 7-year government bond is less than the yield on a 7.5-year government bond, some of the benchmark spread is simply compensation for the additional 0.5-years of maturity.

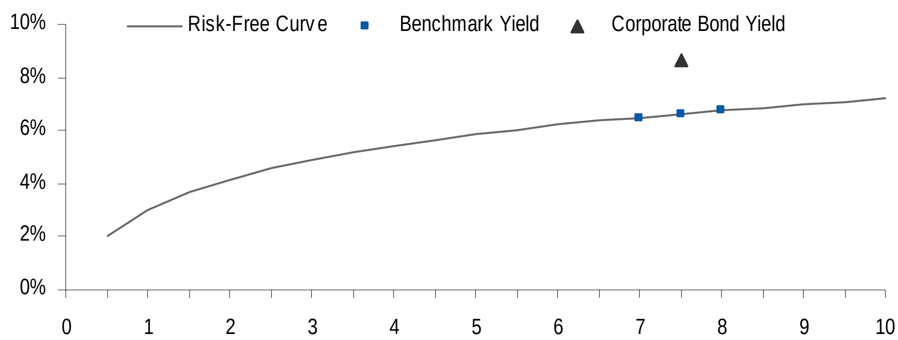
One way to adjust for this maturity mismatch is to calculate the yield of a theoretical 7.5-year benchmark bond. We do this by interpolating between the 7-year and the 8-year bond. Once we have the yield on the theoretical 7.5-year benchmark bond, we can compare it to the yield on the 7.5-year corporate bond. This will give a more accurate measure of the additional yield on the corporate bond relative to the benchmark bonds.

Abel Elizalde
(44-20) 7742-7829
abel.elizalde@jpmorgan.com

The I-spread is then the difference between the yield on a corporate bond and the yield on a theoretical maturity matched risk-free bond. As with benchmark bonds, the I-spread can be seen as the additional yield above government rates or swaps depending on what we use as the benchmark. The usual convention is to refer to I-spreads as spreads above swap.

Figure 56: Example I-spread

x-axis: Years to Maturity; y-axis: Yield (%)



Source: J.P. Morgan.

The I-spread is defined in Equation 22

Equation 22: I-spread

$$I\text{-}spread = Bond\ Yield - Interpolated\ Bond Yield$$

Substituting into the equation for yield calculation, Equation 19, we get something that looks very similar to our calculation of the benchmark spread. The difference here is that we use an interpolated benchmark bond yield, or the maturity matched swap rate.

Equation 23: Bond Pricing

$$\begin{aligned} Dirty\ price &= \sum_{i=1}^{N=n\times f} \frac{C/f}{[1+y/f]^{f\times t_i}} + \frac{1}{[1+y/f]^{f\times t_N}} \\ &= \sum_{i=1}^{N=n\times f} \frac{C/f}{[1+(y_I+S_I)/f]^{f\times t_i}} + \frac{1}{[1+(y_I+S_I)/f]^{f\times t_N}} \end{aligned}$$

where

y = *Bond Yield to Maturity*

y_I = *Interpolated Benchmark Bond Yield or Swap Rate to Maturity*

S_I =*I-spread*

While the I-spread adjusts for the maturity mismatch, and therefore better reflects the credit risk of a corporate bond, it is less suited for quoting purposes. Since market participants often construct the risk-free curve using different interpolation methods, the yield for a theoretical risk-free bond it is not as universally defined as the yield for a particular benchmark government bond. This could lead to different price calculations which would hamper trading.

Additionally, the I-spread looks at the spread above a single point, the yield. A further improvement could be to calculate the credit spread above the risk-free curve.

The benefits of the using the I-spread are:

- Account more precisely for the maturity of the bond
- Ease of calculation as swap rates are easily available

The problems with using this spread measure are

- As with all yields, the I-spread assumes that income is reinvested at the bond yield
- No account taken for the term structure of interest rates, since a single yield is assumed
- Different interpolation methods may lead to small differences in pricing

Comparing Benchmark Spread to I-spreads

We noted earlier that the spread to benchmark (or benchmark spread) is the difference between the yield-to-maturity (YTM) on a corporate bond and the YTM of a benchmark government bond:

$$\text{Benchmark Spread} = \text{Bond Yield} - \text{Benchmark Bond Yield}$$

And the I-spread is the difference in yield between a corporate bond and a maturity matched, or interpolated benchmark bond:

$$\textit{I-spread} = \textit{Bond Yield} - \textit{Interpolated Bond Yield}$$

Equating these leads to:

$$\begin{aligned}\textit{I-spread} &= \textit{Benchmark Spread} + \textit{Benchmark Bond Yield} - \textit{Interpolated Bond Yield}\\ &= \textit{Benchmark Spread} + (\textit{Benchmark Bond Yield} - \textit{Interpolated Bond Yield})\\ &< \textit{Benchmark Spread}\end{aligned}$$

The I-spread is therefore equal to the benchmark spread plus the difference between the benchmark bond yield and the interpolated bond yield. For an upward sloping yield curve, the interpolated bond spread will be higher than the benchmark bond yield, which usually has a shorter maturity, so the difference between these will always be negative. In an upward sloping yield environment, the I-spread is therefore always less than the benchmark spread. For a downward sloping yield curve, the reverse would hold.

- **Changing yield curves will impact the fixed difference between the I-spread and benchmark spread.** A parallel shift to the yield curve will preserve the difference between the benchmark yield and the interpolated benchmark yield and will therefore not affect the relationship between the I-spread and benchmark spread. A flattening or steepening yield curve however will decrease this difference (flatting) or increase the difference (steepening).
- **Recovery rates are not accounted for in either method and will therefore have no effect on the benchmark spread and I-spread.**

3. Z-spread

The Z-spread is the parallel shift applied to the zero curve in order to equate the bond price to the present value of the cash flows. We noted earlier that the price of a bond is equal to the present value of the expected cash flows. For a risk-free bond, each cash flow is discounted by the risk-free discount rate, r_{ti}, for that maturity t_i, (Equation 24).

Equation 24: Pricing a Risk-Free Bond

$$Dirty\ price = \sum_{i=1}^{N=n\times f} \frac{C/f}{\left[1 + r_{t_i}/f\right]^{f\times t_i}} + \frac{1}{\left[1 + r_{t_N}/f\right]^{f\times t_N}}$$

We also noted that the price of a risky corporate bond will be lower than the price of a risk-free bond. The price of the bond will therefore be less than the present value of the cash flows as we might not receive all these cash flows should the bond default. In order to equate the price of a risky corporate bond to the present value of the expected cash flows, we therefore increase each discount rate by an amount, z, the Z-spread (Equation 25). This has the effect of lowering the present value of each cash flow.

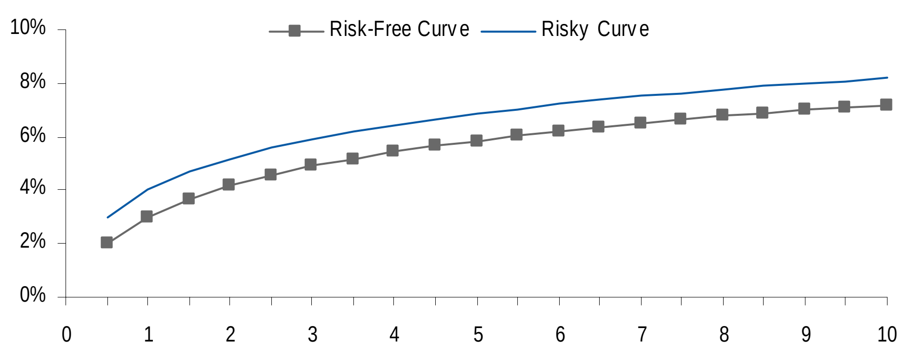
Equation 25: Pricing a Risky Bond

$$Dirty\ price = \sum_{i=1}^{N=n\times f} \frac{C/f}{\left[1 + \left(r_{t_i} + z\right)/f\right]^{f\times t_i}} + \frac{1}{\left[1 + \left(r_{t_N} + z\right)/f\right]^{f\times t_N}}$$

Formally, we move the risk-free discount curve by a constant amount (spread), in a parallel fashion.

As the Z-spread is just a spread above a given risk-free rate, we can reference it either to Libor/Swap zero rates or to government zero rates. Our convention is to look at Z-spreads as the spread above Libor zero-rates. While Z-spreads are not traded in the market, they are useful for comparing the relative value of bonds as they take into account the full term structure of the risk-free rates.

Figure 57: Z-spread as a Set of Risky Discount Factors



Source: J.P. Morgan.

Abel Elizalde
(44-20) 7742-7829
abel.elizalde@jpmorgan.com

The Z-spread therefore represents the credit risk in the bond. Z-spreads are useful values of the credit risk of a corporate bond as they take into account both the maturity and full term structure of interest rates. However, while Z-spreads indicate credit risk, they cannot be traded. Asset swap spreads however can be traded. We turn to these next.

The benefits of using the Z-spread are:

- Account more precisely for the term structure of interest rates
- Account for the maturity of the bond

The problems with using this spread measure are

- As with all yields, the Z-spread assumes that income is reinvested at the bond yield
- Calculations are not straight forward and the full discount curve needs to be used
- Z-spreads cannot be monetized simply
- Z-spreads assume a flat term structure of credit spreads
- Z-spreads do not account for recovery rates

The Z-spread is a good measure of credit risk; however, it cannot be traded directly. An investor cannot enter a trade and receive the Z-spread. Asset swaps, which we look at next, can be directly traded.

Comparing I-spreads to Z-spreads

We saw earlier that we calculate the I-spread as the difference in yield between the corporate bond yield and a maturity matched benchmark yield. We wrote this as:

$$Dirty\ price = \sum_{i=1}^{n} \frac{C}{\left[1+\left(y_I + S_I\right)\right]^i} + \frac{1}{\left[1+\left(y_I + S_I\right)\right]^n}$$

We also saw that the Z-spread is calculated through the equation:

$$Dirty\ price = \sum_{i=1}^{n} \frac{C}{\left[1+\left(r_i + z\right)\right]^i} + \frac{1}{\left[1+\left(r_i + z\right)\right]^i}$$

Combining these together gives:

$$\sum_{i=1}^{n} \frac{C}{\left[1+\left(r_i + z\right)\right]^i} + \frac{1}{\left[1+\left(r_i + z\right)\right]^i} = \sum_{i=1}^{n} \frac{C}{\left[1+\left(y_I + S_I\right)\right]^i} + \frac{1}{\left[1+\left(y_I + S_I\right)\right]^n}$$

So if we have a flat discount curve equal to the interpolated yield, then the I-spread and the Z-spread will be equal. If the curve is upward sloping then the Z-spread is greater than the I-spread. The converse holds if the curve is downward sloping.

- **Changing the zero curve will have an impact on the difference between the Z-spread and the I-spread.** With a flat curve, the I-spread and the Z-spread are equal. As the curve pivots into an upward sloping curve, Z-spread will increase above the I-spread. In a flattening scenario the reverse holds and the Z-spread decreases relative to the I-spread.
- **Recovery rate is not accounted for in either method and will therefore have no effect on the Z-spread and I-spread**

4. Asset Swaps in General

An asset swap is a package consisting of an asset of some sort combined with a swap. Typically, the swap will involve swapping the cash flows which are received from holding the asset for a floating stream of payments. For our purposes the 'asset' whose payments are swapped is a risky (fixed coupon) corporate bond.

Whereas a plain vanilla interest rate swap is costless (no upfront payment), the asset swap is not costless and there is typically a price to be paid related to the price of the asset.

A par asset swap package consists of a bond and an asset swap, with the total package priced at par. It can be considered as a combination of three sets of cash flows: one from owning a bond, a set of fixed payments made to the swap counterparty, and a set of floating payments received from the counterparty. These net out into a single stream of payments resembling a floating-rate note priced at par.

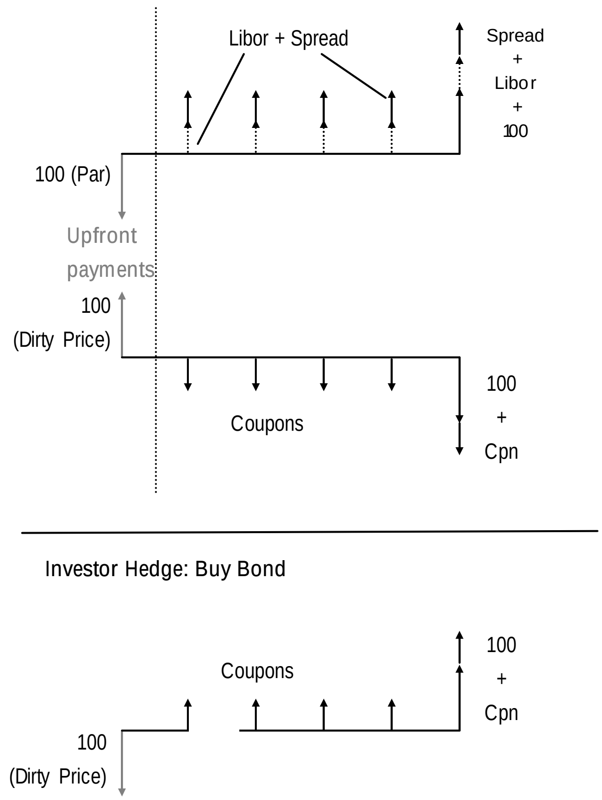
There are two main types of asset swaps:

- **Par asset swaps**: the price of the asset swap and notional swapped is par
- **True asset swaps**: the price of the asset swap and notional swapped is the market (dirty) price of the bond

Our aim here is to look at the cash flows and calculations of each to better understand what the *asset swap spread* represents.

Abel Elizalde
(44-20) 7742-7829
abel.elizalde@jpmorgan.com

Figure 58: Asset Swap Package + Hedge: Cash flows from the Investor's Perspective



Source: J.P. Morgan.

Although the bond and swap are traded as a package, the swap does not knock out in the case of default. This means that if the bond defaults, the investor will be exposed to interest rate risk, as well as any remaining MtM position resulting from the bond trading away from par at inception.

Par Asset Swaps

The par asset swap spread is equal to the difference between the risk-free present value of the bond coupons (plus principal) and the price paid for the bond. Since the spread is paid on a running basis, we divide this amount by the annuity to find the running spread amount. In the grey box below we will show that:

Equation 26: Par Asset Swap Spread Calculation

$$\text{Spread} = \frac{PV\left[Coupon + \text{Principal}\right] - \text{BondPrice}}{Annuity}$$

An intuitive way to think about this is as follows. Suppose an investor has a choice of two bonds, a risk-free bond and a risky bond, both with the same maturity and coupon. The risky bond will be cheaper than the risk-free bond because there is a chance that the risky bond defaults and the investor does not get back his money or coupons. The difference in value between these two bonds is the compensation for buying the risky bond over the corporate bond. Rather than paying this on an upfront basis, we can pay it as an annual spread by dividing by the annuity.

Abel Elizalde
(44-20) 7742-7829
abel.elizalde@jpmorgan.com

This spread is compensation because if the risky bond defaults, the investor will no longer receive the coupons nor will they receive the notional at maturity; they would still need to make the payments on the risk-free bond of both the coupons and principal at maturity.

First let's consider a simple asset swap where an investor buys a bond and swaps the fixed coupons into floating rate coupons through a swap (Figure 58). Ignoring the bond for the moment, let's consider the swap contract first. The swap contract essentially has two legs – a floating leg which we will assume the investor is receiving and a fixed leg, which we assume the investor is paying. The fixed leg is like shorting a fixed rate bond, the investor receives the upfront price and will pay the fixed coupon payments plus the notional at maturity. The floating leg is like being long a floating rate bond priced at par; the investor will pay out the notional amount and will receive a floating rate coupon plus the notional amount at expiry. The floating rate is set to be equal to *Libor + Spread*.

Now the value of a contract to pay fixed coupons is:

Equation 27: Value of Fixed Contract

$$FixedContractValue = Ntl \times \left(\mathrm{PV}\left[\mathrm{Coupon} + \mathrm{Principal}\right] - \mathrm{BondPrice}\right)$$

i.e. we receive the bond price but have to pay away the coupons plus the principal at maturity.

And the value of a contract to receive floating coupons is:

Equation 28: Value of Floating Contract

$$FloatingContractValue = Ntl \times \left(\mathrm{PV}\left[\mathrm{Floating} + \mathrm{Principal}\right] - 1\right)$$

i.e. we pay a 1 in order to receive the floating rate coupons plus the principal at maturity. Since the initial value of the floating rate leg must be equal to the initial value of the fixed rate leg, we get:

Equation 29: Equation the legs of the contract

$$Ntl \times \left(\mathrm{PV}\left[\mathrm{Floating} + \mathrm{Principal}\right] - 1\right) = Ntl \times \left(\mathrm{PV}\left[\mathrm{Coupon} + \mathrm{Principal}\right] - \mathrm{BondPrice}\right)$$

Now in a par asset swap, the notional of the swap is set to be equal to the notional of the bond, i.e. 1. We also set the Floating leg payments to be equal to *Libor + Spread*. Equation 29 then becomes:

$$\begin{aligned}
&1 \times \left(\mathrm{PV}\left[LIBOR + \mathrm{Spread} + \mathrm{Principal}\right] - 1\right) = 1 \times \left(P\mathrm{V}\left[Coupon + \mathrm{Principal}\right] - \mathrm{BondPrice}\right) \\
&\mathrm{PV}\left[LIBOR + \mathrm{Principal}\right] + \mathrm{PV}\left[\mathrm{Spread}\right] - 1 = P\mathrm{V}\left[Coupon + \mathrm{Principal}\right] - \mathrm{BondPrice} \\
&1 + \mathrm{PV}\left[\mathrm{Spread}\right] - 1 = P\mathrm{V}\left[Coupon + \mathrm{Principal}\right] - \mathrm{BondPrice}
\end{aligned}$$

Which we can rearrange to give us:

Equation 30: Par Asset Swap Spread Calculation

$$\Rightarrow \mathrm{Spread} = \frac{P\mathrm{V}\left[Coupon + \mathrm{Principal}\right] - \mathrm{BondPrice}}{Annuity}$$

We have used the following conventions in the above:

PV[Libor + Principal] = 1 as we are discounting along a Libor curve.

PV[Spread] = Spread × Annuity

The annuity used here is the risk-free annuity and is the present value of a 1bp annuity stream.

Par asset swap spreads are useful as they can be traded. An investor can find a dealer who will pay them the annual par asset swap spread. The dealer has bought the risk-free bond from the client and sold them the risky bond. In exchange, the dealer will benefit if the bond defaults as they still redeem their notional on the risk-free bond, but they will only have to pay out the recovery amount on the bond which they have gone short.

Note that, as the asset swap package is priced at par, if the bond is trading away from par then the value of the swap must account for the difference. So if the bond is trading at a discount to par, the swap will initially be in the investor's favour. Conversely, the swap will be against the investor if the bond is trading at a premium. Ignoring the effect of interest rates, the mark-to-market of the swap will gradually trend toward zero as the difference between the dirty price and par amortises over the life of the swap.

For discount bonds, par asset swap spreads tend to underestimate the credit risk in the bond since the annuity used to calculate the running spread is a risk-free annuity. The assumption here is that the spread payments will definitely be made. One way to adjust for this is through a true asset swap, which we now turn to.

True Asset Swap Spread

In a true asset swap rather than setting the swap notional to be equal to 1, we set it to equal the dirty price of the bond. This will increase the swap notional if the bond is trading above par and reduce it if it is below par.

We start from the same equation we had earlier:

Equation 31: Equation the legs of the contract

$$Ntl \times (PV[Floating + Principal] - 1) = Ntl \times (PV[Coupon + Principal] - BondPrice)$$

Here we set the notional in the swap to be equal to the bond price.

$$BondPrice \times (PV[LIBOR + Spread + Principal] - 1) = 1 \times (PV[Coupon + Principal] - BondPrice)$$
$$BondPrice \times (PV[LIBOR + Principal] + PV[Spread] - 1) = PV[Coupon + Principal] - BondPrice$$
$$PV[Spread] = \frac{PV[Coupon + Principal] - BondPrice}{BondPrice}$$

which we can rearrange to get

Abel Elizalde
(44-20) 7742-7829
abel.elizalde@jpmorgan.com

Equation 32: True Asset Swap Spread Calculation

$$\Rightarrow \text{Spread} = \frac{\text{PV}[Coupon + \text{Principal}] - \text{BondPrice}}{\text{BondPrice} \times Annuity}$$

Combining Equation 30 and Equation 32 we can see that

$$TrueASW = \frac{ParASW}{Bond\,Price}1$$

When bonds are trading above par, then the true ASW spread will be lower than the par ASW spread and vice-versa.

The benefits of using the asset swap spread are:

- Asset swap spreads can be traded and investors can receive the fixed spread for the life of the swap

The problems with using this spread measure are

- Assumes that spreads are paid with certainty which causes over/underestimation of credit risk for bonds trading above/under par
- Calculations are not straightforward

Comparing Asset Swap Spreads to Z-spreads
We showed earlier that the par ASW spread is given by Equation 33.

Equation 33: Par Asset Swap Spread Calculation

$$\Rightarrow ASW = \frac{\text{PV}[Coupon + \text{Principal}] - \text{BondPrice}}{Annuity}$$

Alternatively, we can write this as Equation 34 where *SwapRate* is the swap rate for the maturity of the bond with the same conventions. The *Annuity* here is the risk-free annuity and is the present value of 1bp.

Equation 34: Par Asset Swap Spread Calculation

$$\Rightarrow ASW = \frac{1 + (Coupon - SwapRate) \times Annuity - \text{BondPrice}}{Annuity}$$

We also saw that the Z-spread is given by Equation 35

Equation 35: Pricing a Risky Bond

$$Dirty\ price = \sum_{i=1}^{n} \frac{C}{\left[1 + \left(r_{t_i} + z\right)\right]^{t_i}} + \frac{1}{\left[1 + \left(r_{t_N} + z\right)\right]^{t_N}}$$

If we let Y be the yield on the bond, then the present value of a bond with a coupon of Y is 1. This gives:

Equation 36: Pricing a Risky Bond

$$1=\sum_{i=1}^{n}\frac{Y}{\left[1+\left(r_{t_i}+z\right)\right]^{t_i}}+\frac{1}{\left[1+\left(r_{t_N}+z\right)\right]^{t_N}}$$

The next step is to assume a **flat curve** such that $Y = r + z$, where the yield is equal to the risk-free rate plus the Z-spread. This gives us

$$1=\sum_{i=1}^{n}\frac{r+z}{\left[1+\left(r+z\right)\right]^{t_i}}+\frac{1}{\left[1+\left(r+z\right)\right]^{t_N}}$$

which we can combine with Equation 35 to give

$$\begin{aligned}DP-1&=\sum_{i=1}^{n}\frac{C}{\left[1+\left(r+z\right)\right]^{t_i}}+\frac{1}{\left[1+\left(r+z\right)\right]^{t_N}}-\sum_{i=1}^{n}\frac{r+z}{\left[1+\left(r+z\right)\right]^{t_i}}-\frac{1}{\left[1+\left(r+z\right)\right]^{t_N}}\\&=\sum_{i=1}^{n}\frac{C}{\left[1+\left(r+z\right)\right]^{t_i}}-\sum_{i=1}^{n}\frac{r+z}{\left[1+\left(r+z\right)\right]^{t_N}}\\&=(Coupon-SwapRate-zSpread)\times RiskyAnnuity\end{aligned}$$

this says that if we present value the coupon minus the swap rate minus the Z-spread we get the difference between the dirty price and 1. By substituting this into the asset swap calculation, we find that

$$\begin{aligned}ASW&=\frac{1+\left[\frac{\left(Bond\,Price-1\right)}{RiskyAnnuity}+Zspread\right]\times Annuity\text{-}Bond\,Price}{Annuity}\\&=\frac{\left(Bond\,Price-1\right)}{RiskyAnnuity}+Zspread+\frac{1\text{-}Bond\,Price}{Annuity}\\&=Zspread+\left(1-Bond\,Price\right)\times\left[\frac{1}{Annuity}-\frac{1}{RiskyAnnuity}\right]\end{aligned}$$

Therefore, for a **flat interest rate curve**, if the risky annuity is equal to the Annuity then both the Z-spread and the asset swap spread are zero. If the spreads are non-zero, then the risky annuity will be less than the risk-free annuity. We then get

If *BondPrice >1* then *ASW > Z-spread*

If *BondPrice <1* then *ASW < Z-spread*

When the riskless curve is upward slopping, the forward Libor rates will increase over time; therefore, in case of a future default the interest rate swap on the asset swap package will have a higher value than at inception. To compensate for this the asset swap spread will decrease.

Abel Elizalde
(44-20) 7742-7829
abel.elizalde@jpmorgan.com

Differences Between True Asset Swaps and Z-spreads
Both the true asset swap and Z-spread represent an addition or manipulation to the risk-free (swap) curve in order to compensate for credit risk in a bond. In practice, these spreads are close. The formal differences are:

a) Z-spread is a movement of the discount (zero) curve, but true asset swap spread represents a spread above the swap curve (from which the zero curve is bootstrapped).

b) The true asset swap payments are paid on swap conventions, so are paid quarterly on a 30/360 basis. The zero curve spread represents discount rates at each bond payment.

The final spread measure we look at is the Par Equivalent CDS Spread (PECS). This methodology explicitly accounts for recovery of a bond following default and is our preferred method of calculating the bond CDS basis.

5. Par Equivalent CDS Spread (PECS)

The PECS uses the market price of a bond to calculate a spread based on implied default probabilities. These default probabilities can then be transformed into implied CDS spread, which we call the Par Equivalent CDS Spread (PECS). The methodology used is similar to that used to imply default probabilities from CDS spreads.

Calculating the PECS has two steps:

8. **Calculate the implied survival probabilities from the market price of the bond**. The price of a risk-free bond is equal to the present value of the cash flows, including the bond coupons plus and notional amount paid back at maturity. For a corporate bond, where both the coupons and the notional amount are risky (i.e. contingent on the survival of the company), the price of the bond should be equal to the *expected* present value of the coupons plus notional. In case of default, we assume the bond recovers a fraction of notional *R*, which is the recovery rate assumed for pricing CDS contracts referencing the same company.

Equation 37: Bond Pricing

Bond Price = PV(Expected Coupon Payments) + PV(Expected Bond Value in Default)
Bond Price = PV(E[Coupon Payments]) + PV(E[Principal])

9. **Convert these implied probabilities into a CDS equivalent spread**. Given a set of survival probabilities we can use the traditional CDS pricing equation to calculate the implied Par CDS spread. This spread is the PECS.

Equation 38: CDS Pricing Equation

$$S_N \times \sum_{i=0}^{N} \Delta_i \cdot PS_i \cdot DF_i + AI = (1-R) \times \sum_{i=0}^{N} PD_i \cdot DF_i$$

One Time Step Example
Suppose we have a simple bond with a price, *P*, and a coupon, *C*. After the one time step, either the bond has survived and pays *1+C*, or it defaults and is worth a recovery value of *R*. If the survival probability for the one time step is *PS* then our first step is to calculate the survival probabilities from the bond.

Equation 39: Simple One-Step Time Period

$$P = PS \times (1+C) \times \frac{1}{1+r} + (1-PS) \times R \times \frac{1}{1+r}$$
$$= PS \times ((1+C) - R) \times \frac{1}{1+r} + R \times \frac{1}{1+r}$$

where
C = *Coupon*
PS = *Probability of Survival*
R = *Recovery-rate in %*

Once we have the implied probabilities, we can back out the spread using

$$S = (1-PS) \times (1-R)$$

Simple Example
Suppose a bond issued by company XYZ is trading with a price of 100% and that the bond coupon is 7% and the 1-year risk-free rate is 5%. Let us assume that the expected recovery on the bond is 0%. Using Equation 34 we get:

$$P = PS \times ((1+C) - R) \times \frac{1}{1+r} + R \times \frac{1}{1+r}$$
$$1 = PS \times ((1+7\%) - 0) \times \frac{1}{1+5\%} + 0\% \times \frac{1}{1+5\%}$$
$$1 = PS \times \frac{1.07}{1.05}$$
$$\Rightarrow PS = \frac{1.05}{1.07} \approx 98\%$$

Now from CDS pricing we know that

$$1bp = \frac{1}{10{,}000}$$

$$S = (PD) \times (1-R) = (1-PS) \times (1-R)$$
$$S = (1-98\%) \times (1-0\%)$$
$$\Rightarrow S = 2\% = 200bp$$

The PECS in this case would be 200bp.

Multiple Time Step
For a bond that is longer than one time step the calculations are more involved, but essentially the same. We start with Equation 37 and consider the expected coupon payments and principal separately

Now the present value of the expected coupons is

$$\text{PV(E[Coupon Payments])} = C \times \sum_{i=0}^{N} \Delta_i \cdot PS_i \cdot DF_i$$

and the present value of the principal leg is

$$\text{PV(E[Principal])} = 1 \times PS_N \cdot DF_{Ni} + R \times \sum_{i=0}^{N} PD_i \cdot DF_i$$

Equation 40: Bond Pricing Equation

$$\text{Bond Price} = C \times \sum_{i=0}^{N} \Delta_i \cdot PS_i \cdot DF_i + 1 \times PS_N \cdot DF_N + R \times \sum_{i=0}^{N} PD_i \cdot DF_i$$

C = Bond Coupon
Δ_i = Length of time period i in years
PS_i = Probability of survival to time i, as at time t_0
PD_i = Probability of default at time i,as at time t_0 = (1 - PS_i)
DF_i = Risk-free discount factor to time i, as at time t_0
R = Recovery rate on default

Readers familiar with CDS pricing will notice the similarity between Equation 40 and the standard CDS pricing equation (Equation 41).

Equation 41: CDS Pricing Equation

$$S_N \times \sum_{i=0}^{N} \Delta_i \cdot PS_i \cdot DF_i + AI = (1-R) \times \sum_{i=0}^{N} PD_i \cdot DF_i$$

S_N = CDS spread for maturity N
AI = Accrued interest on default

We now follow the two step procedure to calculate the PECS: (1) Using Equation 40 we calculate the implied survival probabilities from the bond, and (2) Use Equation 41, to back out the implied CDS spread.

In practice we reverse these steps. **Using the full CDS curve traded in the market, we calculate the implied survival probabilities for the company. By applying a parallel shift to the survival curve**, **we use Equation 40 to match the price of the bond to the expected value of the cash flows**.[31] In case of default, we assume the bond recovers a fraction of notional *R*, which is the recovery rate assumed for pricing CDS contracts referencing the same company. **Once we have matched the bond price, we convert these survival probabilities back into spreads**.

[31] In particular, we apply a parallel shift to all the hazard rates which characterise the term structure of default probabilities. Generally, we use a piece-wise constant hazard rate model calibrated to the available term structure of CDS.

The PECS calculation explicitly takes into account the term structure of default probabilities and the assumed recovery rate

Since the survival probabilities implied by the CDS are explicitly dependent on the assumed recovery rate *R*, using these probabilities to derive the PECS means it is also explicitly dependent on *R*. Moreover, as we explained in the previous paragraph, we first derive the default probabilities using the full CDS curve traded in the market, and then use them to compute the PECS. Thus the PECS explicitly takes into account the term structure of default probabilities.

The PECS therefore explicitly **accounts for the recovery of the bond** and is similar to the pricing methodology used for CDS. Moreover, the PECS **takes into account the term structure of default probabilities** implied by the CDS market in order to derive the credit risk (spread) of the bond.

Comparing PECS to CDS

Intuitively, as we explained above, PECS can be thought of as a shift in the term structure of CDS spreads in order to match the price of the bond. In particular, to compute the PECS:

10. We take as inputs the term structure of default probabilities and recovery rate derived from the CDS market.

    Using these inputs and Equation 40, one could derive the "CDS-implied bond price". In general, such price does not coincide with the bond market (dirty) price.

11. We find the shift we need to apply to those default probabilities in order to match the bond price. We maintain the recovery rate assumption and shape of the default probability term structure (we just shift it in parallel).

    When the "CDS-implied bond price" is higher than the bond market price, the PECS will be higher than the CDS spread: we need to add an extra component of default risk to the CDS spreads in order to match the bond price.

The result is a PECS which shares with the CDS spread the recovery rate assumption and the shape of the term structure of default probabilities.

Comparing PECS to Z-spread

PECS depends on the term structure of default probabilities and on the expected recovery rate, whereas Z-spreads are not affected by them.

We saw earlier that we can calculate the survival probabilities from the bond price.

Equation 42: Bond Pricing Equation

$$Bond\ Price = C \times \sum_{i=0}^{N} \Delta_i \cdot PS_i \cdot DF_i + 1 \times PS_N \cdot DF_N + R \times \sum_{i=0}^{N} PD_i \cdot DF_i$$

If we assume **flat** and continuous PECS (and CDS) spreads then

$$PS_i = exp(-st_i)$$

$$DF_i = exp(-r_i t_i)$$

We can then write

Abel Elizalde
(44-20) 7742-7829
abel.elizalde@jpmorgan.com

$$
\begin{aligned}
Bond\ Price &= C \times \sum_{i=0}^{N} e^{-r_i t_i} \cdot e^{-s t_i} + 1 \times e^{-r_N t_N} \cdot e^{-s t_i} + R \times \sum_{i=0}^{N} \left(e^{-s t_{i-1}} - e^{-s t_i} \right) \cdot e^{-r_i t_i} \\
&= C \times \sum_{i=0}^{N} e^{-(r_i + s) t_i} + 1 \times e^{-(r_N + s) t_N} + R \times \sum_{i=0}^{N} \left(e^{-s t_{i-1}} - e^{-s t_i} \right) \cdot e^{-r_i t_i}
\end{aligned}
$$

If we set the recovery to be zero, then this looks very similar to the calculation of the Z-spread in continuous time.

$$
Bond\ Price = C \times \sum_{i=0}^{N} e^{-(r_i + s) t_i} + 1 \times e^{-(r_N + s) t_N}
$$

Now since

$$
\begin{aligned}
e^{-x} &= 1 - x + \frac{x^2}{2} + O(x^3) \\
\frac{1}{1+x} &= 1 - x + x^2 + O(x^3)
\end{aligned}
$$

then

$$
e^{-x} < \frac{1}{1+x}
$$

so in order to equate the cash prices, the zero recovery PECS (in continuous time) needs to be lower than the Z-spread (in discrete time). In the case where the recovery rate is non zero, the PECS increases relative to the zero-recovery PECS.

In the following tables we provide a summary of the main features of the various spreads we have looked at.

Abel Elizalde
(44-20) 7742-7829
abel.elizalde@jpmorgan.com

	Benchmark Spread	I-Spread	Z-Spread
Definition	Benchmark Spread = Bond Yield –Benchmark Yield	I-Spread = Bond Yield –Interpolated Bond Yield	The Z-spread is the parallel shift applied to the zero curve that equates the bond price to the PV of the cash flows
Calculation	$Dirty\ price = \sum_{i=1}^{N=n\times f} \frac{C/f}{[1+y/f]^{f\times t_i}} + \frac{1}{[1+y/f]^{f\times t_N}}$ $= \sum_{i=1}^{N=n\times f} \frac{C/f}{[1+(y_B+S_B)/f]^{f\times t_i}} + \frac{1}{[1+(y_B+S_B)/f]^{f\times t_N}}$	$Dirty\ price = \sum_{i=1}^{N=n\times f} \frac{C/f}{[1+y/f]^{f\times t_i}} + \frac{1}{[1+y/f]^{f\times t_N}}$ $= \sum_{i=1}^{N=n\times f} \frac{C/f}{[1+(y_I+S_I)/f]^{f\times t_i}} + \frac{1}{[1+(y_I+S_I)/f]^{f\times t_N}}$	$Dirty\ price = \sum_{i=1}^{N=n\times f} \frac{C/f}{[1+(r_{t_i}+z)/f]^{f\times t_i}} + \frac{1}{[1+(r_{t_N}+z)/f]^{f\times t_N}}$
Benefit	Ease of calculation and of quotation for trading purposes.	Account more precisely for the maturity of the bond. Ease of calculation as swap rates are easily available.	Account more precisely for the term structure of interest rates. Account for the maturity of the bond.
Downside	The mismatch in maturity will tend to overestimate the credit risk. Assumes that income is reinvested at the bond yield. No account taken for the term structure of interest rates, since a single yield is assumed.	I-spread assumes that income is reinvested at the bond yield. No account taken for the term structure of interest rates, since a single yield is assumed. Different interpolation methods may lead to small differences in pricing.	Assumes that income is reinvested at the bond yield. Calculations are not straight forward and the full discount curve needs to be used. Cannot be monetized simply. Assume a flat term structure of credit spreads.
Comparison		Flat Discount Curve: I-Spreads = Benchmark Spreads Upward-sloping Discount Curve: I-Spreads < Benchmark Spreads	Flat Discount Curve: Z-Spreads = I-Spread Upward-sloping Discount Curve: Z-spread > I-spread.
Recovery	Recovery Rates and Credit Term Structure do not affect spread.	Recovery Rates and Credit Term Structure do not affect spread.	Recovery Rates and Credit Term Structure do not affect spread.

	Par Asset Swap Spread	True Asset Swap Spread	Par Equivalent CDS Spread
Definition	The par asset swap spread is a spread above swaps and is equal to the difference between the risk-free present value of the bond coupons (plus principal) and the price paid for the bond.	The true asset swap spread is a spread above swaps and is equal to the true asset swap spread on the bond price notional.	The PECS uses the market price of a bond to calculate a spread based on implied default probabilities
Calculation	$\text{Spread} = \frac{\text{PV}[Coupon + \text{Principal}] - \text{BondPrice}}{Annuity}$	$\text{Spread} = \frac{\text{PV}[Coupon + \text{Principal}] - \text{BondPrice}}{\text{BondPrice} \times Annuity}$	$\text{Bond Price} = C \times \sum_{i=0}^{N} \Delta_i \cdot PS_i \cdot DF_i + 1 \times PS_N \cdot DF_N + R \times \sum_{i=0}^{N} PD_i \cdot DF_i$
Benefit	Asset swap spreads can be traded and investors can receive the fixed spread for the life of the swap	Better account for risk of bonds trading away from par.	Uses CDS pricing methodology and accounts for recovery rates and credit curve
Downside	Assumes that spreads are paid with certainty which causes over/underestimation of credit risk for bonds trading above/under par. Calculations are not straightforward	Assumes that spreads are paid with certainty which causes over/underestimation of credit risk for bonds trading above/under par. Calculations are not straightforward	Calculations are not straightforward
Comparison	Flat Discount Curve: If BondPrice >1 then ASW > Z-spread If BondPrice <1 then ASW < Z-spread Upward-sloping Discount Curve: Asset swap spread will decrease.	$TrueASW = \frac{ParASW}{Bond\ Price}$	Zero-recovery PECS < Z-spread In the case where the recovery rate is non zero, the PECS increases relative to the zero-recovery PECS
Recovery	Recovery Rates and Credit Term Structure do not affect spread.	Recovery Rates and Credit Term Structure do not affect spread.	Explicitly accounts for the recovery of the bond and takes into account the term structure of default probabilities implied by the CDS market.

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J.P. Morgan European Credit Research

Head of European Credit Research & Strategy
Stephen Dulake
www.morganmarkets.com/analyst/stephendulake
125 London Wall
6th Floor
London EC2Y 5AJ

Team Assistant
Laura Hayes
(44 20) 7777-2280
laura.x.hayes@jpmorgan.com

High Grade and High Yield Research Groups

Autos & General Industrials
Stephanie Renegar
(44-20) 7325-3686
stephanie.a.renegar@jpmorgan.com
www.morganmarkets.com/analyst/stephanierenegar

Utilities & Energy
Olek Keenan, CFA
(44-20) 7777-0017
olek.keenan@jpmorgan.com
www.morganmarkets.com/analyst/olekkeenan

Tom Gibney, CFA
(44-20) 7325-1564
tom.j.gibney@jpmorgan.com
www.morganmarkets.com/analyst/tomgibney

Special & Legal Situations
Rachel Horsley
(44-20) 7325 9547
rachel.horsley@jpmorgan.com
www.morganmarkets.com/analyst/rachelhorsley

Consumer & Retail
Katie Ruci
(44-20) 7325-4075
alketa.ruci@jpmorgan.com
www.morganmarkets.com/analyst/katieruci

Raman Singla
(44-20) 7777-0350
raman.d.singla@jpmorgan.com
www.morganmarkets.com/analyst/ramansingla

Credit Derivatives & Quantitative Research
Saul Doctor
(44-20) 7325-3699
saul.doctor@jpmorgan.com
www.morganmarkets.com/analyst/sauldoctor

Yasemin Saltuk
(44-20) 7777-1261
yasemin.x.saltuk@jpmorgan.com
www.morganmarkets.com/analyst/yaseminsaltuk

Abel Elizalde
(44-20) 7742-7829
abel.elizalde@jpmorgan.com
www.morganmarkets.com/analyst/abelelizalde

Emerging Market Corporates
Victoria Miles
(44-20) 7777-3582
victoria.miles@jpmorgan.com
www.morganmarkets.com/analyst/victoriamiles

Allison Bellows Tiernan, CFA
(44 20) 7777-3843
allison.bellows@jpmorgan.com
www.morganmarkets.com/analyst/allisonbellowstiernan

Tatiana Tchembarova
(44-20) 7325-7278
tatiana.tchembarova@jpmorgan.com
www.morganmarkets.com/analyst/tatianatchembarova

Okan Akin, CFA
(44-20) 7777-4292
okan.akin@jpmorgan.com
www.morganmarkets.com/analyst/okanakin

Nikolay Zhukovsky, PhD
(44-20) 7777-3475
nikolay.x.zhukovsky@jpmorgan.com
www.morganmarkets.com/analyst/nikolayzhukovsky

Financials
Roberto Henriques, CFA
(44-20) 7777-4506
roberto.henriques@jpmorgan.com
www.morganmarkets.com/analyst/robertohenriques

Christian Leukers, CFA
(44 20) 7325-0949
christian.leukers@jpmorgan.com
www.morganmarkets.com/analyst/christianleukers

Alan Bowe
(44 20) 7325-6281
alan.x.bowe@jpmorgan.com
www.morganmarkets.com/analyst/alanbowe

General Industrials
Nachu Nachiappan, CFA
(44-20) 7325-6823
nachu.nachiappan@jpmorgan.com
www.morganmarkets.com/analyst/nachunachiappan

Nitin Dias, CFA
(44-20) 7325-4760
nitin.a.dias@jpmorgan.com
www.morganmarkets.com/analyst/nitindias

Ritasha Gupta
(44-20) 7777-1089
ritasha.x.gupta@jpmorgan.com
www.morganmarkets.com/analyst/ritashagupta

ABS & Structured Products
Rishad Ahluwalia
(44-20) 7777-1045
rishad.ahluwalia@jpmorgan.com
www.morganmarkets.com/analyst/rishadahluwalia

Gareth Davies, CFA
(44-20) 7325-7283
gareth.davies@jpmorgan.com
www.morganmarkets.com/analyst/garethdavies

Anh Dang
(44-20) 7777-4754
anh.l.dang@jpmorgan.com
www.morganmarkets.com/analyst/anhdang

TMT – Telecoms/Cable, Media & Technology
David Caldana, CFA
(44-20) 7777 1737
david.caldana@jpmorgan.com
www.morganmarkets.com/analyst/davidcaldana

Andrew Webb
(44-20) 7777 0450
andrew.x.webb@jpmorgan.com
www.morganmarkets.com/analyst/andrewwebb

Credit Strategy
Stephen Dulake
(44-20) 7325-5454
stephen.dulake@jpmorgan.com
www.morganmarkets.com/analyst/stephendulake

Daniel Lamy
(44-20) 7777-1875
daniel.lamy@jpmorgan.com
www.morganmarkets.com/analyst/daniellamy

Priyanka Malhotra
(44-20) 7325-7043
priyanka.x.malhotra@jpmorgan.com
www.morganmarkets.com/analyst/priyankamalhotra

Tina Zhang
(44-20) 7777-1260
tina.t.zhang@jpmorgan.com
www.morganmarkets.com/analyst/tinazhang

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