JPMorgan

**Corporate Quantitative Research**
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# Credit Derivatives Handbook

## Detailing credit default swap products, markets and trading strategies

## About this handbook

This handbook reviews both the basic concepts and more advanced trading strategies made possible by the credit derivatives market. Readers seeking an overview should consider Sections 1.1 - 1.3, and 8.1.

There are four parts to this handbook:



Part I introduces the CDS market, its participants, and the mechanics of the credit default swap. This section provides intuition about the CDS valuation theory and reviews how CDS is valued in practice. Nuances of the standard ISDA documentation are discussed, as are developments in documentation to facilitate settlement following credit events.



Part II provides a comparison of bonds and credit default swaps and discusses why CDS to bond basis exists. The theory behind CDS curve trading is analyzed, and equal-notional, duration-weighted, and carry-neutral trading strategies are reviewed. Credit versus equity trading strategies, including stock and CDS, and equity derivatives and CDS, are analyzed.



The CDX and iTraxx products are introduced, valued and analyzed. Options on these products are explained, as well as trading strategies. Tranche products, including CDOs, CDX and iTraxx tranches, Tranchlets, options on Tranches, and Zero Coupon equity are reviewed.



Part IV covers loan CDS, preferred CDS, Recovery Locks, Digital default swaps, credit-linked notes, constant maturity CDS, and first to default baskets.

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

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# Part I: Credit default swap fundamentals

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# 1. Introduction

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

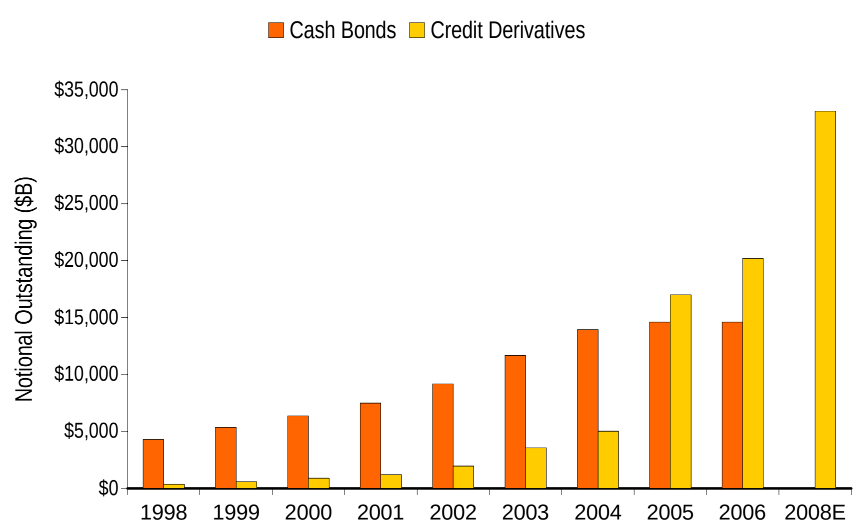
1) express a positive or negative credit view on a single entity or a portfolio of entities, independent of any other exposures to the entity one might have.

2) reduce risk arising from ownership of bonds or loans

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

- The notional amount of credit derivative contracts outstanding in 2006 is $20.2 trillion, up 302% from 2004[1]. This amount is greater than the face value of corporate and sovereign bonds globally.
- The tremendous growth in the credit derivatives market has been driven by the standardization of documentation, the growth of product applications, and diversification of participants.
- Credit derivatives have become mainstream and are integrated with credit trading and risk management at many firms.

Exhibit 1.1: The notional amount of credit derivatives globally is larger than the global amount of debt outstanding




*Sources: British Bankers' Association Credit Derivatives Report 2006, Bank for International Settlements and ISDA.*
Note: Cash bonds through June 2006.

[1] British Bankers' Association estimates.

A driver of the growth in credit derivatives is the ability to use them to express credit views not as easily done in cash bonds, for example:

- Relative value, or long and short views between credits
- Capital structure views, i.e., senior versus subordinated trading
- Views about the shape of a company's credit curve
- Macro strategy views, i.e. investment grade versus high yield portfolio trading using index products
- Views on credit volatility
- Views on the timing and pattern of defaults, or correlation trading

Single name credit default swaps are the most widely used product, accounting for 33% of volume. Index products account for 30% of volume, and structured credit, including tranched index trading and synthetic collateralized debt obligations, account for another 24%. In this handbook, single name CDS is addressed in Part I and II, and index and structured credit in Part III. Part IV introduces other CDS products.

Exhibit 1.2: Credit derivative volumes by product

| Type | 2004 | 2006 |
|---|---|---|
| Single-name credit default swaps | 51.0% | 32.9% |
| Full index trades | 9.0% | 30.1% |
| Synthetic CDOs | 16.0% | 16.3% |
| Tranched index trades | 2.0% | 7.6% |
| Credit linked notes | 6.0% | 3.1% |
| Others | 16.0% | 10.0% |

Sources: *British Bankers' Association Credit Derivatives Report 2006*

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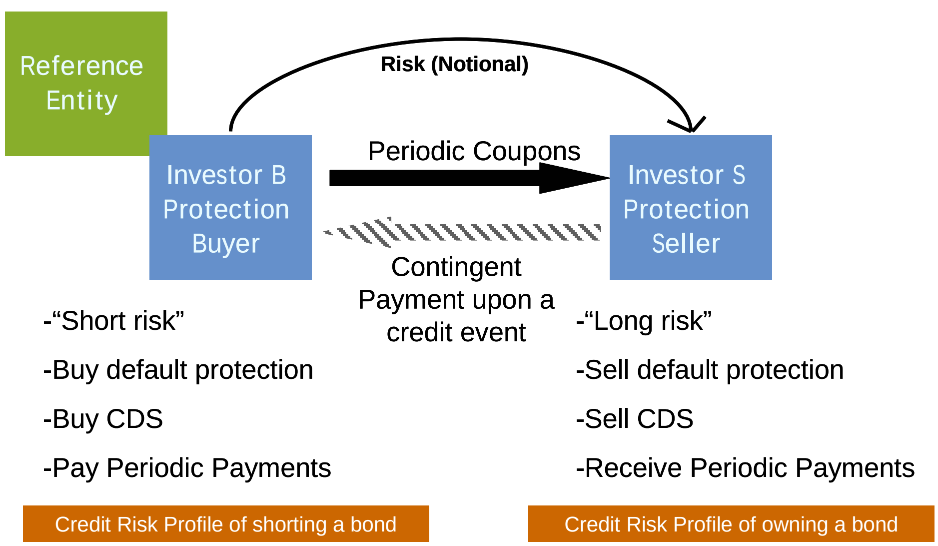
# 2. The credit default swap

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

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

As shown in Exhibit 2.1, Investor B, the buyer of protection, pays Investor S, the seller of protection, a periodic fee (usually on the 20th of March, June, September, and December) for a specified time frame. To calculate this fee on an annualized basis, the two parties multiply the notional amount of the swap, or the dollar amount of risk being exchanged, by the market price of the credit default swap (the market price of a CDS is also called the spread or fixed rate). CDS market prices are quoted in basis points (bp) paid annually, and are a measure of the reference entity's credit risk (the higher the spread the greater the credit risk). (Section 3 and 4 discuss how credit default swaps are valued.)

Exhibit 2.1: Single name credit default swaps




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

Source: JPMorgan.

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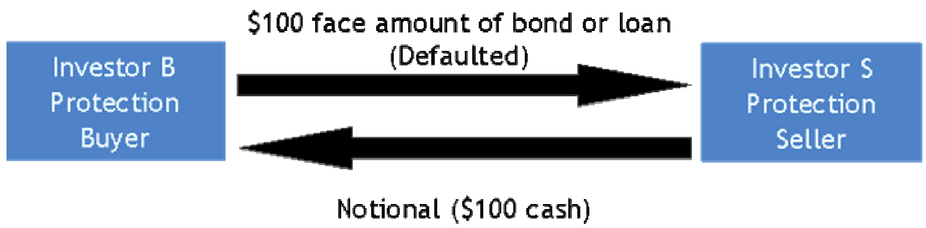
Exhibit 2.2: If the Reference Entity has a credit event, the CDS Buyer delivers a bond or loan issued by the reference entity to the Seller. The Seller then delivers the Notional value of the CDS contract to the Buyer.




Source: JPMorgan.

**There are 4 parameters that uniquely define a credit default swap**

1. Which credit (note: not which bond, but which issuer)
    - Credit default swap contracts specify a reference obligation (a specific bond or loan) which defines the issuing entity through the bond prospectus. Following a credit event, bonds or loans pari passu with the reference entity bond or loan are deliverable into the contract. Typically a senior unsecured bond is the reference entity, but bonds at other levels of the capital structure may be referenced.
2. Notional amount
    - The amount of credit risk being transferred. Agreed between the buyer and seller of CDS protection.
3. Spread
    - The annual payments, quoted in basis points paid annually. Payments are paid quarterly, and accrue on an actual/360 day basis. The spread is also called the fixed rate, coupon, or price.
4. Maturity
    - The expiration of the contract, usually on the 20th of March, June, September or December. The five year contract is usually the most liquid.

## Credit events

A credit event triggers a contingent payment on a credit default swap. Credit events are defined in the 2003 ISDA Credit Derivatives Definitions and include the following:

1. **Bankruptcy**: includes insolvency, appointment of administrators/liquidators, and creditor arrangements.

2. **Failure to pay**: payment failure on one or more obligations after expiration of any applicable grace period; typically subject to a materiality threshold (e.g., US$1million for North American CDS contracts).

3. **Restructuring**: refers to a change in the agreement between the reference entity and the holders of an obligation (such agreement was not previously provided for under the terms of that obligation) due to the deterioration in creditworthiness or financial condition to the reference entity with respect to:

    - reduction of interest or principal
    - postponement of payment of interest or principal
    - change of currency (other than to a "Permitted Currency")

- contractual subordination

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

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

For US high grade markets, bankruptcy, failure to pay, and modified restructuring are the standard credit events. Modified Restructuring is a version of the Restructuring credit event where the instruments eligible for delivery are restricted. European CDS contracts generally use Modified Modified Restructuring (MMR), which is similar to Modified Restructuring, except that it allows a slightly larger range of deliverable obligations in the case of a restructuring event[2]. In the US high yield markets, only bankruptcy and failure to pay are standard. Of the above credit events, bankruptcy does not apply to sovereign reference entities. In addition, repudiation/moratorium and obligation acceleration are generally only used for emerging market reference entities.

## Settlement following credit events

Following a credit event, the buyer of protection (short risk) delivers to the seller of protection defaulted bonds and/or loans with a face amount equal to the notional amount of the credit default swap contract. The seller of protection (long risk) then delivers the notional amount on the CDS contract in cash to the buyer of protection. Note that the buyer of protection pays the accrued spread from the last coupon payment date up to the day of the credit event, then the coupon payments stop. The buyer can deliver any bond issued by the reference entity meeting certain criteria that is pari passu, or of the same level of seniority, as the specific bond referenced in the contract. Thus the protection buyer has a "cheapest to deliver option," as she can deliver the lowest dollar price bond to settle the contract. The value of the bond delivered is called the recovery rate. Note that the recovery rate in CDS terminology is different from the eventual workout value of the bonds post bankruptcy proceedings. The recovery rate is the price at which bonds or loans ar trading when CDS contracts are settled. This CDS settlement process is called "physical settlement," as the "physical" bonds are delivered as per the 2003 ISDA Credit Derivative Definitions[3]. Specifically, there is a three step physical settlement procedure in which:

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[2] For more information, refer to "The 2003 ISDA Credit Derivatives Definitions" by Jonathan Adams and Thomas Benison, published in June 2003.

[3] Copies of the 2003 ISDA Credit Derivatives Definitions can be obtained by visiting the International Swaps and Derivatives Association website at http://www.isda.org

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**At default, Notification of a credit event**: The buyer or seller of protection may deliver a notice of a credit event to the counterparty. This notice may be legally delivered up to 14 days after the maturity of the contract, which may be years after the credit event.

**Default + 30 days, Notice of physical settlement**: Once the "Notification of a credit event" is delivered, the buyer of protection has 30 calendar days to deliver a "Notice of physical settlement." In this notice, the buyer of protection must specify which bonds or loans they will deliver.

**Default + 33 days, Delivery of bonds**: The buyer of protection typically delivers bonds to the seller within three days after the "Notice of physical settlement" is submitted.

Alternatively, because the CDS contract is a bilateral agreement, the buyer and seller can agree to unwind the trade based on the market price of the defaulted bond, for example $40 per $100. The seller then pays the net amount owed to the protection buyer, or $100 - $40 = $60. This is called "cash settlement." It is important to note that the recovery rate ($40 in this example) is not fixed and is determined only after the credit event.

Currently, and importantly, the market has drafted an addendum to the 2003 ISDA definitions that defines an auction process meant to be a fair, logistically convenient method of settling CDS contracts following a credit event. This CDS Settlement protocol is discussed in Section 5.

## Monetizing CDS contracts

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

Investor B could monetize her unrealized profits using two methods. First, she could enter into the opposite trade, selling four-year protection (long risk) at 75bp. She continues to pay 50bp annually on the first contract, thus nets 25bp per year until the two contracts mature, effectively locking in her profits. The risk to Investor B is that if the credit defaults, the 50bp and 75bp payments stop, and she no longer enjoys the 25bp difference. Otherwise, she is default neutral since she has no additional gain or loss if a default occurs, in which case she just stops benefiting from the 25bp per year income.

The second, more common method to monetize trades is to unwind them. Investor B can unwind the 50bp short risk trade with Investor S or another dealer, presumably for a better price. Investor B would receive the present value of the expected future payments. Namely, 75 – 50 = 25bp for the remaining four years on her contract, multiplied by the notional amount of the swap, and multiplied by the probability that the credit does not default. After unwinding the trade, investors B has no outstanding positions. The JPMorgan "CDSW" calculator on Bloomberg is the industry standard method of calculating unwind prices, and is explained in Section 3.

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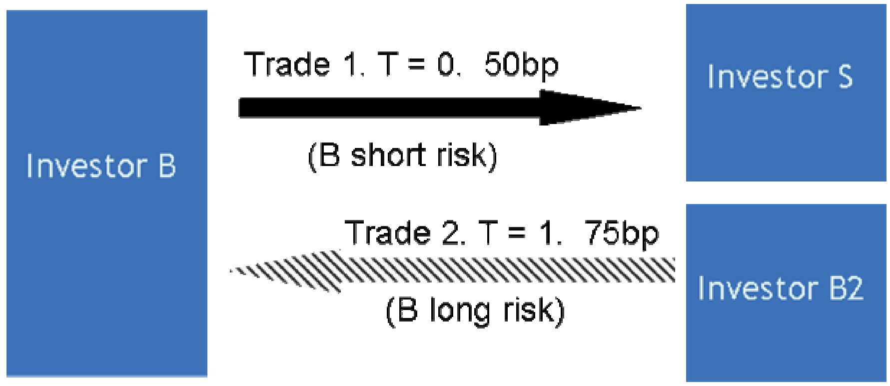
Exhibit 2.3: CDS investors can capture gains and losses before a CDS contract matures.




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

Source: JPMorgan.

**Other notes about credit default swaps**

The most commonly traded and therefore the most liquid tenors, or maturity lengths, for credit default swap contracts are five, seven, and ten years, though liquidity across the maturity curve continues to develop. JPMorgan traders regularly quote 1, 2, 3, 4, 5, 7, 10 year tenors for hundreds of credits globally.

Standard trading sizes vary depending on the reference entity. For example, in the US, $10 - 20 million notional is typical for investment grade credits and $2-5 million notional is typical for high yield credits. In Europe, €10 million notional is typical for investment grade credits and €2 - 5 million notional is typical for high yield credits.

## Counterparty considerations

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

## Accounting for CDS

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

# 3. Marking CDS to market: CDSW

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

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

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

The calculation for the probability of default (and survival) is detailed in Section 4. In summary, the default probability is approximately equal to spread / (1 - Recovery Rate). If we assume that recovery rate is zero, then the spread equals the default probability. If the recovery rate is greater than zero, then the default probability is greater than the spread. To calculate the mark-to-market on a CDS contract (or the profit or loss of an unwind), we discount the net cash flows by both the risk free rate and the survival probability.

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

From the position of a protection buyer:

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

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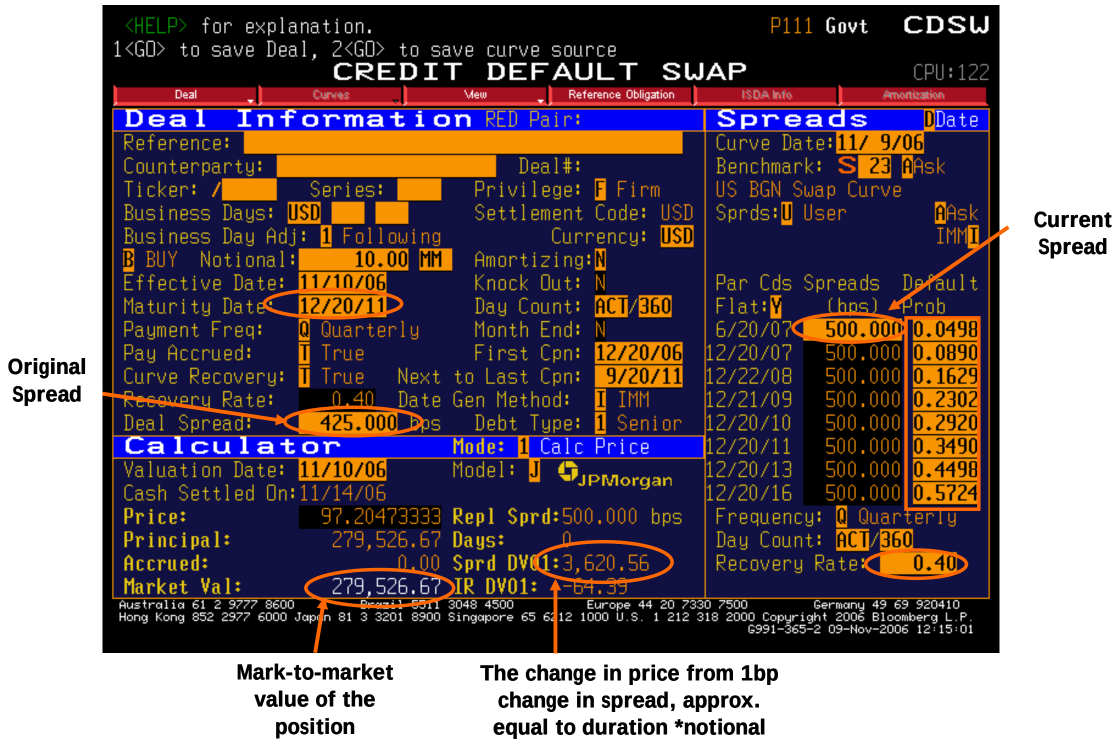
- Negative clean mark-to-market value means that spreads have tightened (buyer pays seller to unwind)

To access this model type "CDSW<Go>" in Bloomberg.

Exhibit 3.1: The CDSW model on Bloomberg calculates mark-to-market values for CDS contracts




Source: Bloomberg.

Please see Appendix I for a simplified excel example.

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# 4. Valuation theory and credit curves

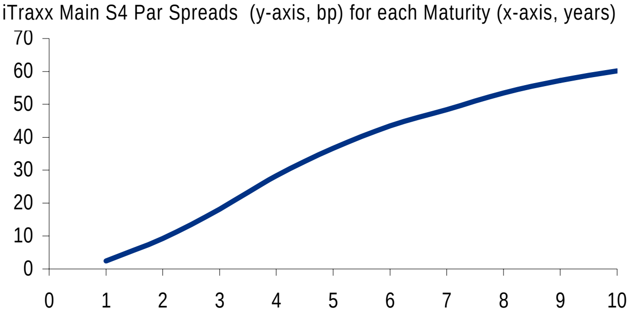
As discussed in Sections 2 and 3, the valuation of credit default swaps is similar to other securities, namely future cash flows are discounted to the present. What is different in CDS is that the cash flows are further discounted by the probably that they will occur. As discussed in Section 2, if there is a credit event the CDS contract is settled and the cash flows then stop. The valuation of CDS can be thought of as a scenario analysis where the credit survives or defaults. The protection seller (long risk) hopes the credit survives, and discounts the expected annual payments by the probability of this scenario (called the fee leg). The protection buyer (short risk) hopes the credit defaults, and discounts the expected contingent payment (Notional – Recovery Rate) by the probability of this scenario (called the contingent leg). At inception of the CDS contract, the value of the expected payments in each scenario are equal; thus the swap's value equals zero. As CDS spreads move with the market and as time passes, the value of the contract may change. Section 4 reviews, among other things, how these probabilities are calculated using CDS spreads quoted in the market.

## Default probabilities and CDS pricing

**Survival probabilities, default probabilities and hazard rates.**
We talk about credit *curves* because the spread demanded for buying or selling protection generally varies with the length of that protection. In other words, buying protection for 10 years usually means paying a higher period fee (spread per year) than buying protection for 5 years (making an upward sloping curve). We plot each spread against the time the protection covers (1Y, 2Y,..., 10Y) to give us a credit curve, as in Exhibit 4.1.

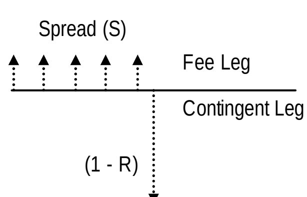
Exhibit 4.1: The Shape of the Credit Curve

iTraxx Main S4 Par Spreads (y-axis, bp) for each Maturity (x-axis, years)




Source: JPMorgan

Exhibit 4.2: CDS Fee and Contingent Leg




Source: JPMorgan

Each point along this credit curve represents a spread that ensures the present value of the expected spread payments (Fee Leg) equals the present value of the payment on default (Contingent Leg), i.e. for any CDS contract:

$$PV(\text{Fee Leg}) = PV(\text{Contingent Leg})$$

Given that the spread will be paid as long as the credit (reference entity) has not defaulted and the contingent leg payment (1—Recovery Rate) occurs only if there is a default in a period, we can write for a Par CDS contract (with a Notional of 1):

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$$\underbrace{S_n.\sum_{i=1}^{n}\Delta_i.Ps_i.DF_i + Accrual\ on\ Default}_{\text{PV(Fee Leg)}} = \underbrace{(1-R).\sum_{i=1}^{n}(Ps_{(i-1)} - Ps_i).DF_i}_{\text{PV(Contingent Leg)}} \quad [1]$$

Where,
$S_n$ = Spread for protection to period $n$
$\Delta_i$ = Length of time period $i$ in years
$Ps_i$ = Probability of Survival to time $i$
$DF_i$ = Risk-free Discount Factor to time $i$
$R$ = Recovery Rate on default

$$Accrual\ on\ Default = S_n.\sum_{i=1}^{n}\frac{\Delta_i}{2}.(Ps_{(i-1)} - Ps_i).DF_i$$

**Three Default Probabilities**
There are actually three measures commonly referred to as 'default probabilities':

1. The Cumulative Probability of Default – This is the probability of there having been any default up to a particular period. This increases over time.

2. Conditional Probabilities of Default or Hazard Rates – This is the probability of there being a default in a given period, conditional on there not having been a default up to that period. I.e. Assuming that we haven't defaulted up to the start of Period 3, this is the probability of then defaulting in Period 3.

3. Unconditional Default Probabilities – This is the probability of there being a default in a particular period as seen at the current time. In our current view, to default in Period 3 we need to survive until the start of Period 3 and then default in that period. This is also the probability of surviving to the start of the period minus the probability of surviving to the end of the period.

*Building Survival Probabilities from Hazard Rates*
We typically model Survival Probabilities by making them a function of a Hazard Rate. The Hazard Rate (denoted as λ) is the conditional probability of default in a period or in plain language "the probability of the company defaulting over the period given that it has not defaulted up to the start of the period." For the first period, *i*=1, the Probability of Survival (*Ps*) is the probability of not having defaulted in the period, or (1 – Hazard Rate). So, we can write:

For *i*=1, $Ps_1 = (1- \lambda_1)$

Where, $\lambda_1$ is the hazard rate (conditional default probability) in period 1.

For the next period, *i*=2, the Probability of Survival is the probability of surviving (not defaulting in) period 1 **and** the probability of surviving (not defaulting in) period 2, i.e.:

For *i*=2, $Ps_2 = (1- \lambda_1) . (1- \lambda_2)$

(See Footnote [4] for a formal treatment of hazard rates.)

The probability of default (*Pd*) (as seen at time 0) in a given period is then just the probability of surviving to the start of the period minus the probability of surviving to the end of it, i.e.:

For *i*=2, $Pd_2 = Ps_1 - Ps_2 = (1- \lambda_1) . \lambda_2$

This shows how we can build up the Probabilities of Survival ($PS_i$) we used for CDS pricing in Equation [1].

In theory, that means we could calculate a CDS Spread *from* Probabilities of Survival (which really means from the period hazard rates). In practice, the Spread is readily observable in the market and instead we can back out the Probability of Survival to any time period implied by the market spread, which means we can back out the Hazard Rates (conditional probabilities of default) for each period using market spreads.

[4] Formal treatment of Survival Probabilities is to model using continuous time, such that the probability of survival over period $\delta t$, $Ps_{(t,\ t+\delta t)} = 1-\lambda_t \delta t \approx e^{-\lambda_t \delta t}$. So, for any time *t*, $Ps_t = e^{-\int_0^t \lambda u du}$.

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*Bootstrapping Credit Curves*

We call the hazard rate we derive from market spreads the 'Clean Spread'[5]. In terms of pricing a CDS contract, we could in theory solve Equation [1] using a single hazard rate. However, we can also *bootstrap* a hazard rate implied for each period from the market-observed credit curve. To do this we use the Period 1 Spread to imply the hazard rate for Period 1. For Period 2 we use the Period 1 hazard rate to calculate the survival probability for Period 1 and use the Spread observed for Period 2 to calculate the hazard rate for Period 2. In that way, we are using the market pricing of default risk in Period 1 when we price our Period 2 CDS contract (i.e. when we back out the survival probability for Period 2). Continuing this process, we can *bootstrap* the hazard rates (a.k.a 'clean spreads') implied for each period.

We use these bootstrapped hazard rates whenever we Mark-to-Market a CDS position as we use our hazard rates to build the Survival Probabilities used in calculating our Risky Annuity (see Grey Box), where:

The MTM of a CDS contract is (for a seller of protection) therefore:

Risky Annuity = PV(Fee Payments + Accruals on Default )

$$RiskyAnnuity \approx 1.\sum_{i=1}^{n} \Delta_i . Ps_i . DF_i + 1.\sum_{i=1}^{n} \frac{\Delta_i}{2} (Ps_{(i-1)} - PS_i) . DF_i \qquad [2]$$

The MTM of a CDS contract is (for a seller of protection) therefore:

$$MTM = (S_{Initial} - S_{Current}) \,.\, Risky\ Annuity_{Current} \,.\, Notional \qquad [3]$$

In practice, CDS unwinds are sometimes calculated with flat curves for convenience.

*Risky Annuities and Risky Durations (DV01)*

Many market participants use the terms Risky Duration (DV01) and Risky Annuity interchangeably. In reality they are not the same but for CDS contracts trading at Par they are very close, which is why Risky Duration is sometimes (inaccurately) used instead of Risky Annuity. At the end of this section, we formally shows how to equate Risky Duration (DV01) and Risky Annuity and why the approximation is fair for small spread movements when looking at a Par CDS contract.

We define the terms as follows:

Risky Annuity is the present value of a 1bp risky annuity as defined in Equation [2] above. We use the Risky Annuity to Mark-to-Market a CDS contract as shown in Equation [3].

Risky Duration (DV01) relates to a trade and is the change in mark-to-market of a CDS trade for a 1bp parallel shift in spreads. We mainly use Risky Duration for risk analysis of a trade for a 1bp shift in spreads and therefore it is used to Duration-Weight curve trades.

We will show that for a Par CDS trade and a small change in spreads Risky Annuity ≈ Risky Duration (DV01). However for a contract trading away from Par and for larger spread movements this approximation becomes increasingly inaccurate. We will mostly be talking about Risky Annuities when we discuss Marking-to-Market a CDS position and when we move on to discuss Convexity.

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[5] Clean Spreads are analogous to zero rates that we derive from bootstrapping risk-free interest rates in the sense that we derive a rate from the market curve that we use in pricing other instruments.

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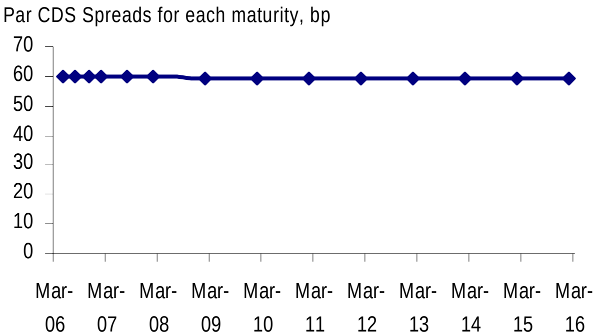
## The Shape of Credit Curves

The concepts of Survival Probability, Default Probability and Hazard Rates that we have seen so far help us to price a CDS contract and also to explain the shape of credit curves.

**Why do many CDS curves slope upwards?**
The answer many would give to this is that investors demand greater compensation, or Spread, for giving protection for longer periods as the probability of defaulting increases over time. However, whilst it's true that the cumulative probability of default does increase over time, this by itself does not imply an upward sloping credit curve – flat or even downward sloping curves also imply the (cumulative) probability of default increasing over time. To understand why curves usually slope upwards, we will first look at what flat spread curves imply.

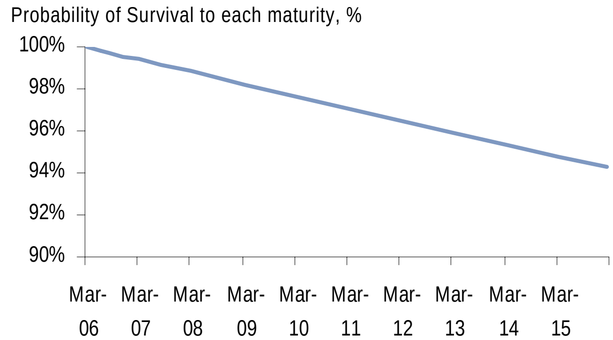
**What do flat curves imply?**
A flat spread curve, as in Exhibit 4.3, does imply a declining Probability of Survival over time (and therefore an increasing Probability of Default), as shown in Exhibit 4.4. So, in order to justify our thought that the probability of default increases with time, we don't need an upward sloping spread curve.

Exhibit 4.3: Flat Spread Curve




Source: JPMorgan

Exhibit 4.4: Probability of Survival for Flat Spread Curve




Source: JPMorgan

The key to understanding why we have *upward sloping* curves is to look at the hazard rate implied by the shape of the curve: *flat curves imply* ***constant*** *hazard rates* (the conditional probability of default is the same in each period). In other words, if the hazard rate is constant, spreads should be constant over time and credit curves should be flat[6].

If the hazard rate ($\lambda$) is constant, then we can show that:

For $i$=n, $$Ps_n = (1-\lambda)^n$$

This formula shows that to move from the Probability of Survival (in Exhibit 4.5) in one period to the next we just multiply by (1- Hazard Rate).

---

[6] For flat curves we can also calculate the hazard rate as: $\lambda = \dfrac{S}{(1-R)}$

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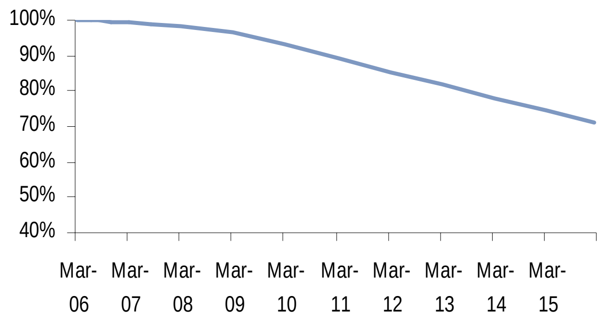
**So what does an upward-sloping curve imply?**

For curves to slope upwards, we need the hazard rate to be *increasing over time*. Intuitively, this means that the probability of defaulting in any period (conditional on not having defaulted until then) increases as time goes on. Upward sloping curves mean that the market is implying not only that companies are more likely to default with every year that goes by, but also that the likelihood in each year is ever increasing. Credit risk is therefore getting increasingly worse for every year into the future[7].

An upward sloping curve, such as in Exhibit 4.1, implies a survival probability as shown in Exhibit 4.5, which declines at an increasing rate over time. This means that we have an increasing hazard rate for each period as shown in Exhibit 4.6.

Exhibit 4.5: Probability of Survival for Upward Sloping Spread Curve

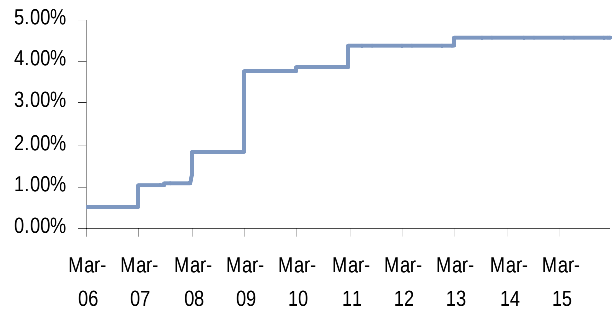
Probability of Survival to each maturity, %




Source: JPMorgan

Exhibit 4.6: Hazard Rates for Upward Sloping Spread Curve

Conditional probability of default in each period, %




Source: JPMorgan

As Exhibit 4.6 illustrates, we tend to model hazard rates as a step function, meaning we hold them constant between changes in spreads. This means that we will have constant hazard rates between every period, which will mean Flat Forwards, or constant Forward Spreads between spread changes. This can make a difference in terms of how we look at Forwards and Slide.

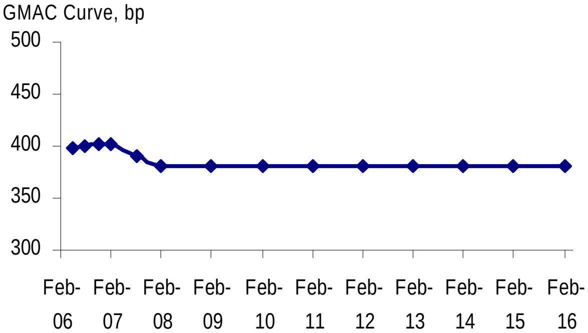
**Downward sloping credit curves**

Companies with downward sloping curves have decreasing hazard rates, as can be seen when looking at GMAC (see Exhibit 4.7). This does not mean that the cumulative probability of default decreases, rather it implies a higher conditional probability of default (hazard rate) in earlier years with a lower conditional probability of default in later periods (see Exhibit 4.8). This is typically seen in lower rated companies where there is a higher probability of default in each of the immediate years.  But if the company survives this initial period, then it will be in better shape and less likely to (conditionally) default over subsequent periods.

---

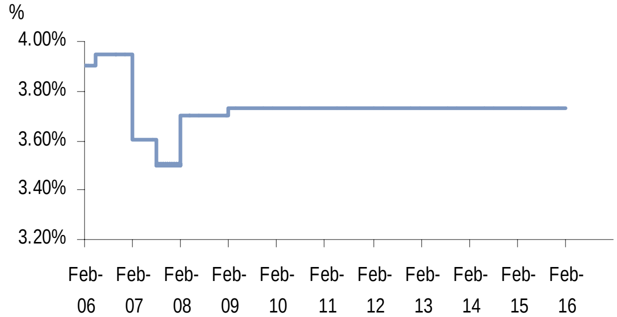
[7] One explanation justifying this can be seen by looking at annual company transition matrices. Given that default is an 'absorbing state' in these matrices, companies will tend to deteriorate in credit quality over time. The annual probability of default increases for each rating state the lower we move, and so the annual probability of default increases over time.

Exhibit 4.7: Downward Sloping Par CDS Spreads




Source: JPMorgan

Exhibit 4.8: Bootstrapped Hazard Rates




Source: JPMorgan

Having seen what the shape of credit curves tells us, we now move on to look at how we calculate Forward Spreads using the curve.

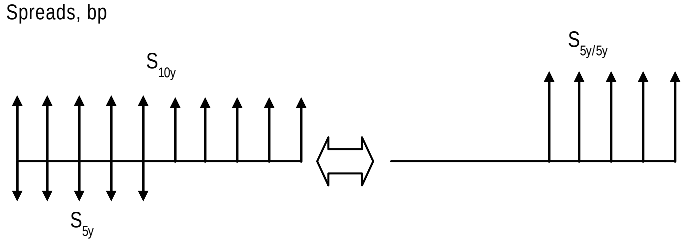
## Forwards in credit

**Forward rates and their meaning**

In CDS, a Forward is a CDS contract where protection starts at a point in the future ('forward starting'). For example, a 5y/5y Forward is a 5y CDS contract starting in five years[8]. The Forward Spread is then the fair spread agreed upon today for entering into the CDS contract at a future date.

The Forward is priced so that the present value of a long risk 5y/5y Forward trade is equivalent to the present value of selling protection for 10y and buying protection for 5y, where the position is default neutral for the first five years and long credit risk for the second five years, as illustrated in Exhibit 4.9.

Exhibit 4.9: Forward Cashflows For Long Risk 5y/5y Forward




Source: JPMorgan

*Deriving the forward equation*

The Forward Spread is struck so that the present value of the forward starting protection is equal to the present value of the 10y minus 5y protection.

Given that the default protection of these positions is the same (i.e. no default risk for the first 5 years and long default risk on the notional for the last 5y), the present value of the fee legs must be equal as well. We can think of the Forward as having sold protection for 10y at the Forward Spread and bought protection for 5y at the

[8] See also, *Credit Curves and Forward Spreads* (J. Due, May 2004).

Forward Spread. The fee legs on the first five years net out, meaning we are left with a forward-starting annuity.

Given that the present value of a 10y annuity (notional of 1) = $S_{10y} \,.\, A_{10y}$

Where,
$S_{10y}$ = The Spread for a 10 year CDS contract
$A_{10y}$ = The Risky Annuity for a 10 year CDS contract

We can write:

$$S_{10y} \,.\, A_{10y} - S_{5y} \,.\, A_{5y} = S_{5y/5y} \,.\, A_{10y} - S_{5y/5y} \,.\, A_{5y}$$

Where,
$S_{t1,t2}$ = Spread on $t_2$-$t_1$ protection starting in $t_1$ years' time

Solving for the Forward Spread:

$$S_{5y/5y} = \frac{S_{10y}.A_{10y} - S_{5y}.A_{5y}}{A_{10y} - A_{5y}}$$

For example, Exhibit 4.10 shows a 5y CDS contract at 75bp (5y Risky Annuity is 4.50) and a 10y CDS contract at 100bp (10y Risky Annuity is 8.50).

$$\text{The Forward Spread} = \frac{(100 \times 8.5) - (75 \times 4.5)}{8.5 - 4.5} = 128bp$$

Exhibit 4.10: 5y/5y Forward Calculations

| | 5y | 10y |
|---|---|---|
| Spread (bp) | 75 | 100 |
| Risky Annuity | 4.5 | 8.5 |
| | | 5y/5y |
| Forward Spread (bp) | | 128 |

Source: JPMorgan

For a flat curve, Forward Spread = Par Spread, as the hazard rate over any period is constant meaning the cost of forward starting protection for a given horizon length (i.e. five years) is the same as protection starting now for that horizon length. We can show that this is the case for flat curves, since $S_{t2} = S_{t1} = S$:

$$S_{t1,t2} = \frac{S_{t2}.A_{t2} - S_{t1}.A_{t1}}{A_{t2} - A_{t1}} = \frac{S.(A_{t2} - A_{t1})}{A_{t2} - A_{t1}} = S$$

We refer to an equal-notional curve trade as a Forward, as the position is present value equivalent to having entered a forward-starting CDS contract. To more closely replicate the true Forward we must strike both legs at the Forward Spread. In practice, an equal-notional curve trade for an upward-sloping curve (e.g. sell 10y protection, buy 5y protection on equal notionals) will have a residual annuity cashflow as the 10y spread will be higher than the 5y. Market practice can be to strike both legs with a spread equal to one of the legs and to have an upfront payment (the risky present value of the residual spread) so that there are no fee payments in the first 5 years. In that sense, replicating the Forward with 5y and 10y protection is

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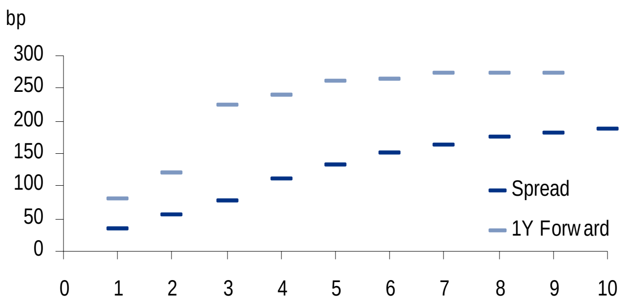
not truly 'forward starting' as there needs to be some payment before five years and protection on both legs starts immediately.

**What do forward rates actually look like?**
When we model forward rates in credit we use Flat Forwards meaning we keep the forward rate constant between spread changes (see Exhibit 4.11). This is a result of the decision to use constant (flat) hazard rates between each spread change.

This can be important when we look at the Slide in our CDS positions (and curve trades) which we discuss in Section 10.

Exhibit 4.11: Par CDS Spreads and 1y Forward Spreads




Source: JPMorgan

## Summary

We have seen how we can understand the shape of the credit curve and how this relates to the building blocks of default probabilities and hazard rates. These concepts will form the theoretical background as we discuss our framework for analyzing curve trades using Slide, Duration-Weighting and Convexity in Section 10.

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## Risky Annuities and Risky Durations (DV01)

We show how to accurately treat Risky Annuity and Risky Duration (DV01) and the relationship between the two. We define Risky Annuity and Risky Duration (DV01) as follows:

*Risky Annuity* is the present value of a 1bp risky annuity stream:

$$RiskyAnnuity = A_S \approx 1.\sum_{i=1}^{n} \Delta_i . PS_i . DF_i + 1.\sum_{i=1}^{n} \frac{\Delta_i}{2} (PS_{i-1} - PS_i) . DF_i$$

where $A_s$ = Risky Annuity for an annuity lasting n periods, given spread level S

*Risky Duration (DV01)* relates to a trade and is the change in mark-to-market of a CDS trade for a 1bp parallel shift in spreads.

The Mark-to-Market for a long risk CDS trade using Equation [3], (Notional = 1) is:

$$MTM_{S_{current}} = (S_{Initial} - S_{Current}) \; . \; A_{S_{current}}$$

$$MTM_{1bp\ shift} = (S_{Initial} - S_{Current+1bp}) \; . \; A_{S_{current+1bp}}$$

Given, $DV01\ (Risky\ Duration) = MTM_{1bp\ shift} - MTM_{S_{current}}$

$$DV01 = [\,(S_{Initial} - S_{Current+1bp}) \; . \; A_{S_{current+1bp}}\,] - [(S_{Initial} - S_{Current}) \; . \; A_{S_{current}}\,]$$

Using,

$$S_{Current+1bp} \; . \; A_{S_{current+1bp}} = S_{Current} \; . \; A_{S_{current+1bp}} + 1bp \; . \; A_{S_{current+1bp}}$$

We can show that:

$$DV01 = -A_{S_{current+1bp}} + (S_{Initial} - S_{Current}) \, . (A_{S_{current+1bp}} - A_{S_{current}})$$

For a par trade $S_{Initial} = S_{Current}$, and since Risky Annuities do not change by a large amount for a 1bp change in Spread, we get:

$DV01 = -A_{S_{current+1bp}} \approx -A_{S_{current}}$ I.e. Risky Duration ≈ Risky Annuity

This approximation can become inaccurate if we are looking at a trade that is far off-market, where $S_{Initial} - S_{Current}$ becomes significant, causing the Risky Duration to move away from the Risky Annuity.

Also, as we start looking at spread shifts larger than 1bp, the shifted Risky Annuity will begin to vary more from the current Risky Annuity (a Convexity effect) and therefore we need to make sure we are using the correct Risky Annuity to Mark-to-Market and not the Risky Duration (DV01) approximation.

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# 5. The ISDA Agreement

## Standardized documentation

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

ISDA produced its first version of a standardized CDS contract in 1999. Today, CDS is usually transacted under a standardized short-form letter confirmation, which incorporates the 2003 ISDA Credit Derivatives Definitions, and is transacted under the umbrella of an ISDA Master Agreement[9]. Combined, these agreements address:

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

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

ISDA's standard contract has been put to the test and proven effective in the face of significant credit market stress. With WorldCom and Parmalat filing for bankruptcy in 2002 and 2003, respectively, and more recently Delphi Corp, Dana Corp, Calpine Corp, Northwest and Delta airlines filing in 2005 and 2006, the market has seen thousands of CDS contracts and over $50 billion of notional outstanding settle post default. In all situations of which we are aware, contracts were settled without operational settlement problems, disputes or litigation.

## The new CDS settlement protocol

The current CDS contract is based on the 2003 ISDA definitions and calls for physical settlement following a credit event, as described in Section 2. An alternative settlement mechanism known as the CDS protocol has been developed by ISDA in conjunction with the dealer community, however. The new settlement protocol allows investors to cash or physically settle contracts at a recovery rate determined in an auction process. A protocol was first introduced after Collins & Aikman defaulted then refined for the Delphi Corp. and Calpine Corp. credit events. The settlement protocol can be used to settle:

- Single name CDS contracts

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

- Credit derivative indices and tranched indices, including the CDX, TRAC-X, and HYDI
- Bespoke portfolio transactions
- Other CDS transactions, including Constant Maturity Swaps, Principal Only Transactions, Interest Only Transactions, Nth to Default Transactions, Recovery Lock Transactions, and Portfolio Swaptions

Note that the Protocol is optional and not part of the 2003 ISDA definitions.

**Summary of CDS Protocol**

- The protocol effectively allows investors to cash or physically settle their CDS contracts using a Recovery Rate determined in an auction process.
- The **timing** of the settlement of contracts using the Protocol mirrors the timing of settlement without using the Protocol. Namely, a bond auction will occur approximately 30 days after the credit event, and contracts will settle shortly thereafter.
- Following a credit event, ISDA will publish a Settlement Protocol for the defaulted credit. The Protocol will have a timeline of events and list of obligations that can be delivered into the contract. **Once the Protocol is published, investors decide whether to opt-in**. Note that after opting in, investors retain the ability to unwind their trade and pay/receive 100% - recovery, where recovery is the price of the defaulted bond in the open market. This is common practice as credit default swaps are bilateral agreements between two parties. Investors can unwind their positions up until the day before the auction.
- By the day of the auction, **investors must decide if they want to [1] cash or [2] physically settle their net positions** through the auction. Namely, investors have the option to [1] cash settle and pay/receive 100 – Recovery Rate, or [2] physically settle, trading bonds at the final Recovery Rate determined in the auction. Investors may trade a bond position as large as their net CDS position. To physically settle, investors must alert their dealers. We suggest calling the day before the auction, and re-confirming on the morning of the auction.
- **The CDS protocol auction has two parts**. In part one, two numbers are calculated.
- **Part 1a)** Dealers submit bid/ask prices for bonds to the auction Administrator and a midpoint is calculated. This midpoint can be thought of as the **preliminary Recovery Rate**.
- **Part 1b)** Second, the Administrator calculates the **Open Interest**. Open Interest is created when a protection buyer wishes to physically settle but the protection seller does not, or visa-versa. If all CDS contract holders cash settle or if all holders physically settle, as there is a protection buyer for every seller (assuming all investors opt into the Protocol), Open Interest must be zero, by definition. It is only created when, for example, a protection seller (long risk) wishes to physically settle a $10 million contract at the market clearing price, but the protection buyer does not. Open Interest of $10 million to buy bonds would be created. We explain the intuition behind the “buy” order in the Mechanics section.
- Limit orders submitted: After **the Administrator calculates and posts the results of Part 1 on its website**, dealers and **clients** working through their dealers have approximately two hours to **submit limit orders** to buy or sell bonds, depending on the Open Interest direction. **This is a new feature not**

**included in previous protocols**. In our example, only limit orders to sell bonds would be submitted in order to satisfy the $10 million Open Interest to buy bonds calculated in Part 1. Note that any investor can submit limit orders (working through their dealers), whether they are involved in CDS or not. **In our opinion, this is the best opportunity for investors to express their views on Recovery Rate.**

- **Part 2** of the auction is a Dutch Auction where the Open Interest is filled using limit orders. **The price of the final limit order used to fill the Open Interest will be the final Recovery Rate. This Recovery Rate is used to cash and physically settle contracts, and is the price at which all limit orders transact**. The transactions will occur shortly after the auction.

Ultimately, we expect a future iteration of the settlement Protocol to be incorporated into the standard ISDA credit default swap documentation. If and when this occurs, the new documentation would likely require adherence to these settlement terms. Furthermore, outstanding CDS contracts may be able to opt into a Protocol as well, so that all outstanding CDS contracts would settle in the same manner. The market will address these issues in turn.

### Exhibit 5.1: Summary of the CDS Protocol. Note, timeline is hypothetical and will be determined after a credit event

| Hypothetical Timeline | Protocol mechanic | Client decisions |
|---|---|---|
| Default | | |
| | CDS Protocol taken off "shelf" and published for defaulted credit with list of Deliverable Obligations. | |
| | | Do I opt-into the protocol? |
| | | Do I unwind my CDS trade pre-auction? |
| Default +27 | | Final day to unwind CDS trades, if opted in. |
| Default +28 | Auction Part 1A: initial Recovery Rate determined through dealer fixing and published | |
| | Auction Part 1B: Market Orders collected and Open Interest calculated and published | Do I want to physically settle my CDS contract? If yes, submit Market Order, potentially creating Open Interest. If not, will cash settle. |
| | For 2 hours, limit bids or offers collected, as appropriate based on Open Interest | Do I want to submit limit orders for bonds? |
| | Auction Part 2: Dutch auction, determination of final Recovery Rate | |
| Default +30 | Delivery of Notice of Physical Settlement for clients who elected to trade bonds in auction. | If I sold bonds in auction, what bonds will I deliver? |
| Default +33 | Settlement of bonds traded in auction | |
| Default +40 | Settlement of all trades, cash and physical | |

Source: JPMorgan

**CDS Protocol auction example**

*Part 1.A: initial recovery rate calculation*

Dealers submit bids/offers to the Administrator which are sorted (Exhibit 2). Orders that are tradable are set aside, meaning bids and offers are set aside when bids match offers or if bids are greater than offers. The best 50% of remaining bids and offers are averaged. The initial recovery rate is 65.75%.

**Exhibit 5.2: Part 1.A of auction. Dealers submit bids/offers for bonds based on market trading levels.**

Bids/Offers are sorted, and tradable markets and initial Recovery Rate are determined.

| Initial submissions | | |
|---|---|---|
| Dealer | Bid | Offer |
| 1 | $65.00 | $67.00 |
| 2 | $64.00 | $66.00 |
| 3 | $63.00 | $65.00 |
| 4 | $67.00 | $69.00 |
| 5 | $62.00 | $64.00 |
| 6 | $65.00 | $67.00 |
| 7 | $64.00 | $66.00 |
| 8 | $66.00 | $68.00 |
| 9 | $65.00 | $67.00 |
| 10 | $64.00 | $66.00 |
| 11 | $67.00 | $69.00 |
| 12 | $68.00 | $70.00 |

Source: JPMorgan

| Sorted submissions | | |
|---|---|---|
| Bid | Offer | |
| $68.00 | $64.00 | Tradeable markets |
| $67.00 | $65.00 | |
| $67.00 | $66.00 | |
| $66.00 | $66.00 | |
| $65.00 | $66.00 | Best half of non-tradable markets |
| $65.00 | $67.00 | Average, initial Recovery Rate = $65.75 |
| $65.00 | $67.00 | |
| $64.00 | $67.00 | |
| $64.00 | $68.00 | |
| $64.00 | $69.00 | |
| $63.00 | $69.00 | |
| $62.00 | $70.00 | |

Source: JPMorgan

*Part 1.B: Open Interest calculation*

The orders to physically settle bonds at the market clearing price are aggregated by the Administrator. In our example, there is a $100 million face value net demand to buy bonds at the market clearing price (Exhibit 3).

**Exhibit 5.3 Part 1.B of auction: Open Interest is calculated**

| | Buy Market Orders (bond face value MM) | Sell Market Orders (bond face value MM) |
|---|---|---|
| | $500 | $400 |
| Open Interest: | $100 | |

Source: JPMorgan

*Part 2: Dutch Auction and determination of final Recovery Rate*

The Recovery Rate and Open Interest calculated in Part 1 are published to the market. Investors have two hours to submit limit orders to their dealers. The limit orders to sell bonds are aggregated by the Administrator. The $100 million of market orders are filled by all of the limit orders, starting with $64, and finishing at $68 (Exhibit 4). Thus, $900 million of market orders for bonds, and $100 million of limit orders used to fill the market orders will trade at $68. These bonds will actually trade. Furthermore, all credit default swap contracts signed up for the protocol will cash settle with a recovery rate of 68%. Thus, buyers of protection (short risk) will receive $32 (100-68) per $100 of notional risk, paid by the sellers of protection (long risk).

**Exhibit 5.4: Part 2 of auction. Open Interest is filled with limit orders. Recovery rate determined.**

| | Bond price | Dealer sell limit orders from Part 1A (assume $5mm offer from each dealer) (bond face value MM) | New sell limit orders (bond face value MM) |
|---|---|---|---|
| | $70.00 | $5 | $30 |
| | $69.00 | $10 | $25 |
| Final Recovery Rate | $68.00 | $5 | $15 |
| | $67.00 | $15 | $15 |
| | $66.00 | $15 | $10 |
| Initial Recovery Rate | $65.75 | $0 | $20 |
| | $65.00 | $5 | |
| | $64.00 | $5 | |
| | $63.00 | | |

Source: JPMorgan

### Our recommendations

In our opinion, investors should:

1. opt-into the protocol
2. cash settle their CDS positions through the protocol
3. place limit orders for bonds in Part 2 of the auction to express their views on the recovery rate.
4. or pre-auction (after opting-in), unwind their CDS positions if they can do so at attractive recovery rates

Consider the following example. An investor has a long risk CDS position, thus she will pay $100 and receive bonds if she physically settles. She opts into the protocol, and has a $10 target Recovery Rate in mind. Pre-auction, if bonds are trading above $10, she can choose to unwind her trade and pay 100% - Recovery Rate. This is nothing new, as CDS contracts can be unwound at any time if a price can be agreed upon. If bonds are trading below $10, she will not unwind and will participate in the Protocol auction.

She has further choices. She can choose to physically settle through the auction process, and thus will receive bonds. There is pricing risk in this strategy, as the final Recovery Rate may be above or below the market price of bonds before the auction or her target price, depending on the Open Interest direction.

Alternatively, she can choose to cash settle her contract through the Protocol. After Part 1 of the auction she will know the initial Recovery Rate – assume $5 – and the Open Interest amount.

If there is Open Interest to buy bonds, the final Recovery Rate should move towards her $10 target. Furthermore, she can now place a limit order to sell bonds in Part 2 of the auction, say at $12. If the final Recovery Rate is $7, she cash settles her CDS paying $93 (her $12 limit offer was not lifted). She can attempt to buy bonds in the open market, anticipating they will rise to $10.

If the final Recovery Rate is $15, she cash settles her CDS paying $85, and also sells bonds at $15 (not $12, but the final RR), perhaps selling short. She anticipates covering her short in the open market closer to $10.

The opposite situation holds for a short risk CDS investor. Thus, the Protocol helps separate the investment decisions of unwinding the CDS contract and taking a view on Recovery Rates. This could help to minimize the volatility of bond prices, as the bonds should trade to the market consensus Recovery Rate. This Rate should reflect the fundament value of the defaulted bonds.

**Protocol goals**

At the beginning of 2006, ISDA discussed multiple goals for the Protocol:

1. Reduce the price volatility of defaulted bonds caused by the settlement of CDS contracts.
2. Ensure that, if CDS contracts were used to hedge bond positions, bonds can be traded at the same price as the Recovery Rate determined in an auction.
3. Simplify CDS settlement logistics.
4. Use one recovery rate for all CDS contracts. This allows index positions hedged with single name CDS to settle using the same recovery rate, for example, and tranche contracts to remain fungible.

Unfortunately, goals [1] and [2] are conflicting. A cash settlement process can solve issue [1]. Specifically, the credit default swap market is a closed system, as there is a buyer of protection for every seller. If the market agreed on a recovery rate, all CDS contracts could be settled using this rate, and artificial demand for bonds caused by CDS contract settlement would be avoided. However, issue [2] would remain unsolved. Namely, investors who purchased bonds (long risk) and CDS protection (short risk) would cash settle their CDS position and receive (1 – recovery rate percentage) through the auction. They might not be able to sell the bond they own at this rate in the open market, however. Thus, these bond and protection owners could be exposed to discrepancies in recovery rate.

Issue [2] is addressed through physical settlement, for in this process, the price paid for the bond is the recovery rate, by definition. However, if the notional value of outstanding CDS contracts is larger than the face value of deliverable bonds, bond prices may be volatile during the months after default. Buyers of protection could cause bond prices to rise as they purchase bonds needed to settle their contracts, amplifying issue [1].

The ISDA proposal attempts to optimize a solution given the competing priorities. In our opinion, the two step auction process does this. This could help to minimize the volatility of bond prices, as the bonds should trade to the market consensus Recovery Rate. This Rate should reflect the fundamental value of the defaulted bonds.

**Exhibit 5.5: History of open interest in auctions. In the three Dutch Auctions, protection buyers have physically settled, creating Open Interest to sell bonds**

| Credit | Date of auction | Open Interest ($mm) | Open Interest direction | Recovery Rate |
|---|---|---|---|---|
| Dana Corp | 03/31/2006 | 41 | Sell bonds | 75.0% |
| Calpine Corp | 01/17/2006 | 45 | Sell bonds | 19.125% |
| Delphi Corp | 11/04/2005 | 99 | Sell bonds | 63.375% |

Source: JPMorgan

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### Protocol Mechanics

Investors choose to participate in the protocol by emailing a signed adherence letter to ISDA. Even after opted in, investors can continue to unwind or settle trades up to the day before the auction. After this date, investors must settle using the mechanics described by the Protocol.

Under the 2003 ISDA definitions, CDS investors were required to fax individual notices to each of their counterparties. No notices need to be delivered under the Protocol for trades covered by the Protocol. If notices happened to be delivered before investors sign up for a Protocol, the notices are revoked. By adopting the Protocol investors agree that the credit event occurred on the date specified in the Protocol, and that CDS coupons accrue up to and including the credit event date (called the Event Determination Date). The date of the credit event is typically recorded as the day of the event if the credit event occurs before noon, and the day after if not.

There are two parts to the auction.

*Part 1: Initial Recovery Rate and Open Interest calculation*

There are two goals in the Initial Bidding process. First, to determine an initial recovery rate through a dealer fixing process and second, to determine the net demand/supply of bonds created by investors wishing to physically settle their net CDS positions.

*1.A) Initial Market Midpoint, or the preliminary Recovery Rate calculation*

Dealers submit bid/ask markets to the Administrator, with a maximum bid/ask spread of 2% of par. ISDA will define the size of the bid/ask markets, based on discussions with market participants and the amount of deliverable obligations outstanding. As a point of reference, $10 million markets were used in previous CDX Protocols. The Administrator sorts the best bids and offers. Orders that are tradable effectively trade, meaning bids and offers trade when bids match offers or if bids are greater than offers (Exhibit 6).

**Exhibit 5.6: Part 1A of auction – dealers submit bids/offers to Administrator**

| Contributed | |
|---|---|
| IM Bids | IM Offers |
| 39.50% | 41.00% |
| 40.00% | 42.00% |
| 41.00% | 43.00% |
| 45.00% | 47.00% |
| 32.00% | 34.00% |
| 38.75% | 40.00% |
| 38.00% | 39.50% |
| 41.00% | 42.75% |

| | Sorted | | |
|---|---|---|---|
| | IM Bids | IM Offers | |
| | 45.00% | 34.00% | Tradable Markets |
| | 41.00% | 39.50% | Tradable Markets |
| | 41.00% | 40.00% | Tradable Markets |
| Best half of non-Tradable Markets | 40.00% | 41.00% | |
| Best half of non-Tradable Markets | 39.50% | 42.00% | |
| Best half of non-Tradable Markets | 38.75% | 42.75% | |
| | 38.00% | 43.00% | |
| | 32.00% | 47.00% | |

Source: ISDA CDS Protocol

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### Exhibit 5.7: Part 1A of auction, continued – initial Recovery Rate is calculated

| Best Half | |
|---|---|
| IM Bids | IM Offers |
| 40.00% | 41.00% |
| 39.50% | 42.00% |
| 38.75% | 42.75% |

Inside Market Midpoint = Average (40, 41, 39.5, 42, 38.75, 42.75) = 40.667%, rounded to 40.625%

Source: ISDA CDS Protocol

As an aside, if there are tradable markets, the dealers are in essence penalized for submitting off-market bids or offers. Details of the payment calculation are found in the Protocol. Payments are made to ISDA to defray costs associated with the Protocol process.

*1.B) Net market orders submitted – calculation of Open Interest:*
Each investor has the option to physically settle his or her net CDS position, and may submit an order to physically settle bonds at the final Recovery Rate, called a Market Order. If an investor was net long risk $10mm, for example, she would be allowed to submit through her dealer an order to purchase up to $10 million bonds in the auction at the final Recovery Rate, or market clearing price. As discussed previously, Open Interest is created when a protection buyer wishes to physically settle but the protection seller does not, or vice versa. The Administrator tallies the physical settlement requests to buy and sell bonds and calculates the imbalance, the Open Interest amount.

Investors who wish to cash settle their CDS positions do not participate in Part 1 of the auction in any way.

Note an investor with a long risk CDS position submits an order to buy, not sell bonds. This Market Order attempts to replicate the risk position our investor would have had if the auction did not take place. If there was not an auction, our long risk CDS investor would have physically settled, effectively buying a bond from the short risk investor for $100. Thus she would be the owner of a bond after the CDS contract was settled. In order to replicate this risk position through the Market Order, she must purchase bonds.

For example, if our investor physically settled her $10mm CDS contract, she would pay $10mm and receive $10mm face value of bonds. If she places a Market Order to buy $10mm bonds in the Protocol, she will pay $10mm x (1 – RR) to settle her CDS contract and then settle her Market Order, paying $10mm x RR and receiving bonds. She is left in the same risk position through the auction as if she physically settled; namely, she paid $10mm and owns $10mm face of bonds.

The Administrator collects the physical settlement requests and calculates an Open Interest amount. At the end of Part 1, the Administrator will post on the web:

1. the size and direction of the open interest
2. the initial market midpoint

Note that clients do not submit orders directly into the auction process but do so through their dealers. To increase transparency, the auction administrator will publish which dealer is associated with each market order. The client orders behind the dealer orders will not be disclosed, however.

If an investor has positions with multiple dealers, she may attempt to submit her total net position through one dealer. Per the protocol, the dealer is only required to accept an order that matches the dealer's position with the client. The dealer may accept the client's complete order if they choose, or alternatively ask the client to make submissions through multiple dealers.

*Part 2: Dutch auction and final Recovery Rate calculation*
The goal of Part 2 is to fill the Open Interest calculated in Part 1B with limit orders. Dealers and clients working through their dealers can place limit orders to buy or sell bonds, depending on the Open Interest calculated. Dealers will have approximately two hours from the announcement of the Part 1 results to submit limit orders to the administrator.

The Administrator will use the dealer markets from Part 1A of the process and additional limit orders submitted to fill this demand. The price of the last limit order used to fill the net market orders is the Recovery Rate. It is the price at which the filled limit orders trade, the price at which market orders for bonds will trade, and it is the rate used in cash settlement of trades.

If there are not enough limit orders to fill the open interest, the recovery rate will be 100% or 0%, if the Open Interests is to buy or sell bonds, respectively. All Market Orders will then be matched on a pro-rata basis. This situation can only occur if the Open Interest amount posted in Part 1 does not source enough limit offers. In our opinion, the opportunity to trade distressed bonds in potentially large size at a named price will likely source buyers or sellers during the two hour submission window.

We note a minor detail. If the net market order is to buy bonds, for example, the final price determined in the auction cannot be 1% below the midpoint calculated in part [1] of the auction. This unusual situation -- where a buy imbalance settles below the midpoint – could only occur if there was small Open Interest that was filled with sell orders originally submitted in Part 1A by the dealers, sell orders that were at prices below the initial Recovery Rate. This 1% rule prevents an artificially high or low bid/ask submitted in Part 1A from being the final auction price. Conversely, if the net market order is to sell bonds, the final price cannot be 1% above the midpoint.

**Other comments**
The Protocol does not currently include Loan Only CDS or Preferred CDS. We expect these contracts to adopt the Protocol technology after adjusting it for the specifics of the contracts.

## CDX Note settlement procedures

The settlement procedures for the notes are outlined in the offering memorandum. Note holders do not need to take any action in order for the default to be settled. The settlement process is as follows:

The CDX dealers will hold the three bond auctions. The CDX dealers deliver bonds to the auction agent over the course of the three auctions. The auction agent then sells the bonds to the marketplace through an auction process. The average price paid by the marketplace during the three auctions will be the recovery price. Note holders in affected indices then receive a payment of this recovery price.

**Coupon payments**
For current investors in the swap indices, the coupon on the index will include the defaulted credit and will accrue until the settlement procedure is triggered. Once triggered, the defaulted credit will not be included. This will be reflected through a

change in the notional value of the trade, not in a change in the coupon rate of the index. For example, the coupon on the DJ CDX.NA.HY.6 is 345bp. If an investor originally purchased $100 of the index, the new notional value of the trade will be $100 * (99/100), or $99, and their coupon payments will be based on this new notional value.

The coupon on the note index is similar to the swap indices in that the coupon rate does not change, but the notional value does. The treatment of the current coupon, however, differs from the swaps. For the note, the next coupon payment will be based on a reduced notional of (99/100) for the entire coupon period.

## "Old-fashioned" CDS settlement procedures

Credit default swap contracts have a three-step physical settlement procedure, as per the 2003 ISDA definitions:

**1. Notification of a credit event**
The buyer or seller of protection may deliver a notice of a credit event to the counterparty. Certain public source news articles or a company press release qualify as official documentation of a credit event. This notice may be legally delivered up to 14 days after the maturity of the contract, which may be years after the credit event.

**2. Notice of physical settlement**
Once the "Notification of a credit event" is delivered, the buyer of protection has 30 calendar days to deliver a "Notice of physical settlement." In this notice, the buyer of protection must specify what bonds or loans they will deliver.

**3. Delivery of bonds**
The buyer of protection typically delivers bonds to the seller within three days after the "Notice of physical settlement" is submitted. In order to receive full payment, the buyer of protection must deliver bonds with an aggregate face amount equal to the notional value of the credit exposure that the buyer has. The buyer of protection may deliver fewer bonds and receive less cash, if they choose.

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## Succession events

A corporate action can cause a Succession Event, or a change in the Reference Obligation of a CDS contract. Corporate actions can impact bondholders and CDS investors differently, depending on how the company transaction is structured. In a merger, spin-off or asset sale, for example, companies will often manage their bonds and loans in a manner that maximizes the company's economics under the constraints of debt indentures. While the indentures protect bondholders, they do not consider CDS investors. CDS are derivatives that do not affect the economics of companies, thus management teams are not forced to consider the corporate event's impact on the contracts. They may consider the contracts, however, as their bondholders may also use CDS. Thus, the instrument used by the investor, whether it be bonds or CDS, can make all the difference in whether a corporate action improves or damages the investor's profit/loss.

Each CDS has a Reference Obligation that defines the issuing entity, or what company the contract "points" to. In order for the reference obligation of a credit default swap contract to change, there must be an event that satisfies qualitative and quantitative criteria. The provisions for determining a successor are detailed in the 2003 International Swaps and Derivatives Association (ISDA) Credit Derivatives Definitions (see www.isda.org for more information).

This note is our interpretation of the ISDA documentation and is not part of the 2003 Definitions. Every corporate action is different, and the facts of the case must be analyzed. Investors should consult their legal advisors, as appropriate. This report does not provide legal advice.

**Qualitative criteria**

The qualitative criteria determines if there is a "Succession Event," or a corporate action. Section 2.2(b) of the ISDA definitions describes the event:

> "Succession Event" means an event such as a merger, consolidation, amalgamation, transfer of assets or liabilities, demerger, spin-off or other similar event in which one entity succeeds to the obligations of another entity, whether by operation of law or pursuant to any agreement.

This definition should encompass most corporate actions that could affect the debt of the reference entity. Note that an exchange offer on its own will not constitute a Succession Event, but must be associated with a corporate action. The definitions continue:

> Notwithstanding the foregoing, "Succession Event " shall not include an event in which the holders of obligations of the Reference Entity exchange such obligations for the obligations of another entity, unless such exchange occurs in connection with a merger, consolidation, amalgamation, transfer of assets or liabilities, demerger, spin-off or other similar event.

For a corporate event to be a Succession Event, the original entity that was responsible for servicing the bonds and loans (or Relevant Obligations, to be defined shortly) must no longer be an obligor or guarantor. Furthermore, a new entity must assume responsibility for the bonds, either by assuming the liability for the old bonds, or exchanging the old bonds for new bonds. The new entity is said to "succeed" to the bonds.

Finally, note that a corporate name change, redemption or repurchase of debt without another corporate action, and a change in ownership of stock without a merging of entities, are not Succession Events.

**Quantitative criteria**

Once it is determined that there is a Succession Event using the qualitative criteria, a Successor(s) may be determined if the quantitative criteria are met. The criteria reviews how many of the bonds and loans, or Relevant Obligations, are assumed by another entity. Relevant Obligations include all bonds and loans issued by the original company, excluding inter-company debt. Note that, in an exchange offer, the bonds being tendered for may be a subset of the Relevant Obligations. The percentage calculations use the Relevant Obligations in the denominator, not just the bonds and loans defined in the exchange. The following rules are used to determine a Successor:

- If one new entity succeeds to 25% or more of the Relevant Obligations, and the old company retains less than 25%, the new entity is the sole Successor. All CDS contracts will reference the new company.
- In the situation described above, if there are multiple new entities that succeed to 25% or more of the Relevant Obligations, the CDS contracts will be split equally amongst these new entities. For example, if three new entities succeeded to 25%, 35% and 40% of the Reference Obligations, a $9 million notional CDS position would be split into three, $3 million positions.
- If the original company retains 25% of the Relevant Obligations, and there are new entities that succeed to 25% of more of the Obligations, both the new and original company become Reference Entities. Like in the previous example, a CDS contract is divided equally between the new Reference Entities.
- If no entity succeeds to 25% of the Relevant Obligations, and the original company still exists, there is no Successor and no change to the CDS contract. If the original company does not exist, the entity that succeeds to the greatest percentage of the Relevant Obligations becomes the sole successor.

The Calculation Agent is tasked with making the determination if the qualitative and quantitative criteria are met. The Calculation Agent is specified in the CDS contract.

**Other issues**

In a corporate action, the fate of specific bond issues may be different from the fate of bonds overall and of the credit default swap contracts. For example, if a company tenders for one bond, perhaps because of its pricing or covenants, and leaves another outstanding, the two bonds may yield different returns. The same holds true for CDS, which generally follows the aggregate movement of the Relevant Obligations in a Successor Event, but could yield different profits or losses than the bonds depending on how the CDS is ultimately divided and the credit quality of the final Reference Obligations.

Bond guarantees can affect CDS trading levels as well. First, recall that for a corporate action to be a Succession Event, the original company may no longer be an obligor or guarantor of the Relevant Obligations. Thus, a guarantee or lack thereof may determine how many Relevant Obligations succeed, and if an outstanding CDS contract will refer to a new entity. Second, for situations with Parent and Subsidiary companies, guarantees determine which bonds are deliverable to settle CDS contracts after a credit event. If a Parent guarantees a Subsidiary's debt, then a CDS contract with the Parent as the Reference Entity can be settled with debt from the Parent or Subsidiary, under the standard CDS contracts. The CDS should trade based on the quality of the weaker credit, Parent or Sub. A CDS contract with the Subsidiary as the Reference Obligation, however, can only be settled with a Subsidiary bond or loan. Furthermore, upstream guarantees, when a Subsidiary guarantees a Parent's bonds, are not considered under the 2003 ISDA definitions. Parent bonds cannot be used to settle a CDS contract with the Subsidiary as the Reference Obligation.

If all the bonds and loans of a Reference Entity are tendered for, the CDS contract is not canceled nor does the spread reach zero. The spread should tighten, of course, as there is less debt and a reduced likelihood that the company defaults. Because the company retains the option of issuing debt in the future, the CDS should reflect this likelihood, and the level at which bonds might be issued.

There is a situation in which a CDS contract can be terminated in a Succession event. If there is a merger between a Reference Entity and the Seller of protection (long credit risk), the buyer of protection may choose to unwind the trade.

**Post-succession, CDS trading logistics**

In December 2005, the wireline and wireless telecom company ALLTEL announced it intention to spin off its wireless business. We use this as an example of the post-succession trading logistics.

- The spin off was effective on July 17, which is also the effective date of the succession event.
- CDS contracts referencing ALLTEL split evenly into two contracts each with half of the original notional amount, one referencing ALLTEL and the other referencing Windstream, the spin off company. Thus, a $10 million CDS ALLTEL contract entered into on or before Friday, July 14 became a $5 million contract referencing ALLTEL and a $5 million contract referencing Windstream on Monday, July 17.
- Legally, CDS contract holders do not need to take any action. A succession event does not require confirmation or acknowledgement from the two contract holders. Thus, CDS contracts do not need to be re-issued.
- The CDS confirmation, 2003 ISDA Credit Derivatives Definitions, and the public filings by ALLTEL that allow you to perform the succession event calculations, are the documents that "prove" the occurrence of the succession event.
- Operationally, clients may choose to adjust internal records, replacing the original contract with two new contracts each with half of the original notional amount. This should more accurately reflect the risk of the contract, as ALLTEL 5-year CDS will likely trade in the 25-30bp range and Windstream in the 150-175bp range. Dealers will likely make this adjustment in their internal records.
- The majority of ALLTEL CDS contracts are MR, or include modified restructuring as a credit event. When the contract is split, both the new ALLTEL and Windstream contracts will be MR. The only differences between the old and new contracts will be the notional amount and the reference obligation.
- Windstream is a "crossover" credit. Many crossover credits trade NR, with only bankruptcy and failure to pay as credit events. New Windstream CDS contracts

will likely be NR, thus may trade 4-6% tighter than the MR Windstream contracts created by the succession event.

- The ALLTEL spin-off is not a succession event under the 1999 ISDA definitions, in our opinion.

**ALLTEL's impact on the CDX indices**

ALLTEL is an underlying credit in six credit default swap indices. The language for CDX is similar to single name contracts, in that no action is required by contract holders to acknowledge a succession event. Rather, the number of credits underlying the Series 6 IG CDX will increase from 125 to 126, for example, with the new ALLTEL and Windstream entities replacing the old ALLTEL contract. The weight of the 124 credits will remain 1/125 of the index, while the ALLTEL and Windstream credits will have a 0.5 / 125 weight. This should have minimal impact on the theoretical value of the CDX indices, as the division of the ALLTEL contract is currently priced in.

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# 6. The importance of credit derivatives

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

**Credit derivatives provide an efficient way to take credit risk.**
Credit default swaps represent the cost to assume "pure" credit risk. A corporate bond represents a bundle of risks including interest rate, currency (potentially), and credit risk (constituting both the risk of default and the risk of volatility in credit spreads). Before the advent of credit default swaps, the primary way for a bond investor to adjust his credit risk position was to buy or sell that bond, consequently affecting his positions across the entire bundle of risks. Credit derivatives provide the ability to independently manage default and interest rate risks.

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

**Credit derivatives provide ways to tailor credit investments and hedges.**
Credit derivatives provide users with various options to customize their risk profiles. First, investors may customize tenor or maturity, and use different maturities to express views about the shape of the credit curve (further discussed in Part II). Second, while CDS often refer to a senior unsecured bond, CDS that reference senior secured, syndicated secured loans (LCDS, Part IV), and preferred stock (PCDS, Part IV) commonly trade, allowing investors to express views on different parts of a company's capital structure.

Through the CDS market, investors may customize currency exposure, increase risk to credits they cannot source in the cash market, or benefit from relative value transactions between credit derivatives and other asset classes. Additionally, investors have access to a variety of structures, such as baskets and tranches that can be used to tailor investments to suit the investor's desired risk/return profile.

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

**Credit derivatives provide liquidity in times of turbulence in the credit markets.**
The credit derivative market is able to provide liquidity during periods of market distress (high default rates). Before the credit default swap market, a holder of a

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

**Credit derivative transactions are confidential.**
As with the trading of a bond in the secondary market, the reference entity whose credit risk is being transferred is neither a party to a credit derivative transaction, nor is even aware of it. This confidentiality enables risk managers to isolate and transfer credit risk discreetly, without affecting business relationships. In contrast, a loan assignment through the secondary loan market may require borrower notification, and may require the participating bank to assume as much credit risk to the selling bank as to the borrower itself. Since the reference entity is not a party to the negotiation, the terms of the credit derivative transaction (tenor, seniority, and compensation structure) can be customized to meet the needs of the buyer and seller, rather than the particular liquidity or term needs of a borrower.

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# 7. Market participants

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

Exhibit 7.1: Participants in the credit derivatives market. Some favor one direction over the other.


Source: *British Bankers' Association Credit Derivatives Report 2006.*

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

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

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

**Hedge funds**
Since their early participation in the credit derivatives market, hedge funds have continued to increase their presence and have helped to increase the variety of

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

**Asset managers**

Asset managers are typically end users of risk that use the CDS market as a relative value tool, or to provide a structural feature they cannot find in the bond market, such as a particular maturity. Also, the ability to use the CDS market to express a bearish view is an attractive proposition for many. For example, an asset manager might purchase three-year protection to hedge a ten-year bond position on an entity where the credit is under stress but is expected to perform well if it survives the next three years. Finally, the emergence of a liquid CDS index market has provided asset managers with a vehicle to efficiently express macro views on the credit markets.

**Insurance companies**

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

**Corporations**

Corporations use credit derivatives to manage credit exposure to third parties. In some cases, the greater liquidity, transparency of pricing and structural flexibility of the CDS market make it an appealing alternative to credit insurance or factoring arrangements. Some corporations invest in CDS indices and structured credit products as a way to increase returns on pension assets or balance sheet cash positions. Finally, corporations are focused on managing funding costs; to this end, many corporate treasurers monitor their own CDS spreads as a benchmark for pricing new bank and bond deals.

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# Part II: Valuation and trading strategies

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# 8. Comparing bonds to credit default swaps

Credit default swaps and bonds of the same credit will usually trade similarly, as both reflect the market's view of default risk. As discussed, CDS is a measure of credit risk of an entity. Credit default swaps are not measured as a spread over a benchmark, rather, the spread is the annual coupon the buyer of protection (short risk) will pay and the seller of protection will receive. Quite simply, the higher the perceived credit risk, the higher the CDS spread. In order to compare credit default swaps with bonds, one needs to isolate the spread of the bond that compensates the holder for assuming the credit risk of the issuer.

## Decomposing risk in a bond

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

**Risk-Free Rate:** the bond holder could earn this yield in a default/risk-free investment (for example, the US Treasury rate).

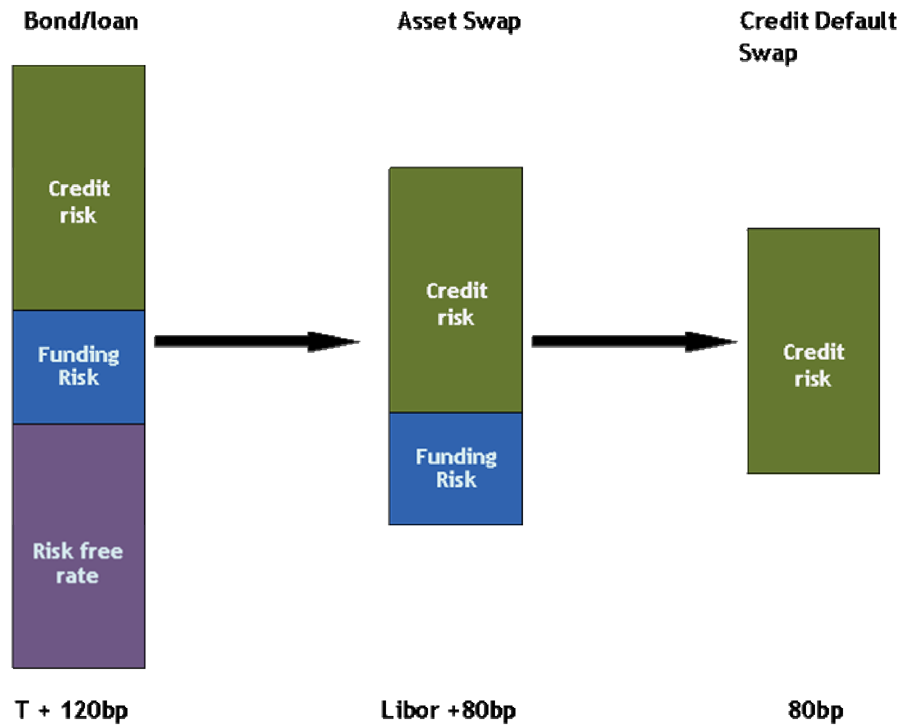
**Funding Risk:** This is the swap spread. While this is a type of credit risk, it is not specific to the issuer. The swap yield (swap spread plus the risk-free rate) is the hurdle rate for many investors' investment opportunities.

**Credit Risk:** the risk that the investor might suffer a loss if the issuer defaults.

For example, assume that a bond is paying a yield of Treasury rates plus 120bp (Exhibit 8.1). To remove interest-rate risk from owning this bond, an investor can swap the fixed payments received from the bond for floating rate payments through an asset swap. In a fixed-to-floating asset swap, Investor B (Exhibit 8.2) agrees to make a series of fixed payments to Investor S, and Investor S makes floating payments to Investor B. Swaps are typically constructed so that the present value of the fixed payments equals the present value of the floating payments. In our example, the fixed rate is the bond's coupon, and we solve for the floating rate equivalent, Libor[10] + 80bp. As a result of the fixed-to-floating rate swap, Investor B will receive floating payments equal to Libor + 80bp. Thus, the value of Investor B's position is no longer very sensitive to changes in risk-free rates, as she will receive a higher coupon as rates increase and a lower coupon as rates decrease.

[10] London interbank offer rate

Exhibit 8.1: Spreads of Credit Default Swaps can be compared to bond yields.




Source: JPMorgan.

Exhibit 8.2: Fixed to floating asset swap, or a "Vanilla" swap


Source: JPMorgan.

To isolate the credit risk, our investor must account for her funding costs, or the rate at which she borrows money needed to purchase the bonds. In our example, we assume that an investor can borrow money at a rate of Libor. Thus, if an investor purchased this bond, she would receive the yield on the bond less her borrowing costs, or (Libor + 80bp) – Libor = 80bp. The difference between the bond's yield and the swap yield curve (Libor) is called the Z-spread[11]. For bonds trading with low Z-spreads and market prices close to par, or $100, it is usually valid to directly

[11] More specifically, the Z-spread is the value that solves the following equation (assuming a three period bond): $Bond\ Price = \frac{c_1}{(1+s_1+Z)^1} + \frac{c_2}{(1+s_2+Z)^2} + \frac{c_3+Face}{(1+s_3+Z)^3}$

Where Bond Price = current market price, $c_i$ = coupon at time i, $s_i$ = zero-coupon rate to maturity *i* based on the swap rate curve, Face = face value of bond.

The I-spread is also used in the valuation of bonds. It solves the equation (assuming a three period bond): $Bond\ Price = \frac{c_1}{(1+YTM)^1} + \frac{c_2}{(1+YTM)^2} + \frac{c_3+Face}{(1+YTM)^3}$

I-spread = YTM - $s_t$

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

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

## Par-equivalent credit default swap spread

For investment grade bonds, the Z-spread is often compared to a CDS spread. For bonds that trade close to par and with low Z-spreads, this comparison is usually a fair one. If the bond's Z-spread is wide or the bond's price is not close to $100, however, the subtle differences between the Z-spread and the credit default swap spread become more important. This is often the case for high yield bonds. The par equivalent CDS spread adjusts the bond's Z-spread for these differences so it is directly comparable to the CDS market. For most investment grade bonds, it is less important to adjust the Z-spread as it is usually within a few basis points of the par equivalent CDS spread.

**Differences in cash prices between bonds and credit default swaps**

There are two primary differences and three secondary differences between a Z-spread and a CDS spread. These five differences are as follows:

Exhibit 8.3: Adjustments should be made to the Z-spread to make it comparable to credit default swap spreads.

| | Issue | Bond | Credit Default Swap |
|---|---|---|---|
| Major differences | Par vs. Non-par securities: | Dollar price can be above or below par | Spread "price" is par by definition |
| | Options: | Bond issuer may have option to call (buy back) outstanding bonds, and/or bond holder may have option to put (sell) bonds back to the company | No such options in typical CDS contracts |
| Minor differences | Coupon conventions: | Semi-annual payments; 30 / 360 day count convention | Quarterly payments; actual / 360 convention |
| | Coupons in default: | Missed accrued payments are not paid | Accrued payments made up to the date of default |
| | Given default, the potential cost to unwind a swap: | Swap portion and credit portion of coupon payments stop. | Credit portion of coupon payments stop, but swap portion must be unwound |

Source: JPMorgan.

*1. Bonds usually trade above or below par, while CDS effectively trade at par*

For a given issuer, if a bond's Z-spread and the CDS spread are the same, and the investor has the same amount of money at risk in each investment, and the issuer does not default, the return on the bond and CDS may be different. For example, assume an investor is considering purchasing a five year bond with a price of $90, and a Z-spread of 3.5%. If we assume that the recovery value on this bond is $40, an investor who buys one bond for $90 will be taking the risk of losing $50, or $90 - $40. If there is no default, the investor will earn the spread of 3.5% per year for assuming credit risk, multiplied by the cash invested of $90, for an annual return of $3.15 (Exhibit 8.4a).

If this investor had the alternative of taking risk in a CDS, but still wanted to limit her loss to a maximum of $50, she could sell (go long risk) $50/(1- 40%) = $83.33 of default protection. This investment has equal risk as the bond investment because, in default, the investor will suffer a loss of (the notional of the investment) • (1-recovery rate), or $83.33 x (1- 40%) = $50. If the CDS position also had a spread of 3.5%, the investor will earn $83.33 x 3.5%, or $2.92 annually. Therefore, an investor willing to risk $50 is better off doing so in cash bonds, as the return is better in the event of no default and it is the same in the event of default.

In the par-equivalent CDS spread calculation, we address this issue by making an upward adjustment to the bond's Z-spread. In other words, we widen the bond Z-spread because a bond priced below par can be thought of as "cheaper" than the unadjusted Z-spread implies, for there will be more return per dollar risked than for an asset priced at par (such as a credit default swap). A downward adjustment to the Z-spread is made if the bonds are priced above par.

Exhibit 8.4a: The par equivalent CDS spread adjusts for the issue that bonds trade at a discount or premium to par and CDS are par instruments...

| Bond | | Credit Default Swap | |
|---|---|---|---|
| Bond price (cash invested) | $90 | Notional[1] | $83.33 |
| Assumed recovery value in default | $40 | Assumed recovery rate | 40% |
| Money at risk | $50 | Money at risk | $50 |
| (bond price - recovery value) | | (notional * (1 - recovery rate)) | |
| Z-spread | 3.50% | CDS spread | 3.50% |
| Profit on credit risk if no default (per yr) | $3.15 | Profit on credit risk if no default (per yr) | $2.92 |
| (bond price * Z-spread) | | (notional * CDS spread) | |

1. Notional of the credit default swap contract is calculated such that, in the case of default, the "money at risk" on the CDS investment equals the "money at risk" for the bond investment.

Source: JPMorgan.

Exhibit 8.4b: ...and for cash versus non-cash spread in bonds and CDS

| Bond | | Credit Default Swap | |
|---|---|---|---|
| Bond price | $90.00 | CDS Notional | $83.33 |
| Face | $100.00 | CDS spread | 350bp |
| Cash coupon | 5.50% | | |
| Swap fixed rate | 4.50% | | |

| Row | | Year: | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|---|
| A | Bond: | Coupon | | $5.50 | $5.50 | $5.50 | $5.50 | $5.50 |
| B | | Principal | ($90.00) | | | | | 100.00 |
| C | | Funding | $90.00 | ($4.05) | ($4.05) | ($4.05) | ($4.05) | ($94.05) |
| D | | | $0.00 | $1.45 | $1.45 | $1.45 | $1.45 | $11.45 |
| E | CDS: | CDS spread | | $2.92 | $2.92 | $2.92 | $2.92 | $2.92 |
| F | Bond – CDS, no default: | | | ($1.47) | ($1.47) | ($1.47) | ($1.47) | $8.53 |

Notes:
Row A: bond notional x fixed coupon = $100 x 5.5%
Row B: discount bond price of $90, maturing at $100
Row C: Cost to fund bond's $90 price, (borrowed funds x fixed Libor) = $90 x 4.5%
Row D: Bond's cash flow after funding, sum of row A + B + C
Row E: CDS coupon payments, notional x fixed rate = $83.33 x 350bp
Row F: Difference in bond and CDS cash flow, Row E - D

Source: JPMorgan

There is another factor, however, that makes the CDS more attractive than the bond. The 350bp CDS coupon is paid in cash. Part of the bond's 350bp Z-spread is paid in cash and part is the "pull to par" as the bond price converges towards its face value at maturity.

Continuing with our example, the five year bond has a fixed coupon of 5.5% and the five year swap rate is 4.5% (assume a flat swap curve for simplicity), thus the Z-spread is 350bp. Observing the cash flows, the bond will pay the cash coupon of 5.5% per year if there is no default, and return $100 at maturity. To compare the bond and the unfunded CDS cash flows fairly, we subtract the cost to fund the bond position. We fund the $90 bond at Libor and subtract this cost from the bond's coupon flows. The net cash flow coming from the bond after funding is $1.47 less each year than the CDS cash flows. Thus, if there is a default in years 1 – 5, an investor is better off investing in CDS because of the larger cash coupon. By design, the investor will lose $50 in either the CDS or bond investment. Thus, the adjustments made to account for a bond not trading at par are often partially offset by the adjustments made to compensate for cash versus non-cash yields. We continue this discussion in "Calculating the par equivalent CDS spread."

*2. Options in cash bonds*
The standard Z-spread does not adjust for options embedded in the bond. The par equivalent CDS spread incorporates an adjustment as described later in this section.

*3. Convention with coupon payments*
The coupons for US corporate bonds are usually paid semi-annually and accrue using a 30/360 day count convention (30-day month and 360-day year). The coupon, or fee payments, for a CDS are paid quarterly and accrue using an actual/360 convention. The par equivalent CDS spread adjusts for this by converting the bond's coupon payments to the CDS convention. All else being equal, a CDS with a quoted spread of 100bp is more valuable than a bond with Z-spread of 100bp, as the CDS will actually pay 100 x (365/360) = 101.39bp per year compared to the bond, which will pay exactly 100bp.

*4. Treatment of coupons in the event of default*
If an issuer defaults in between scheduled coupon payments, the bond investor does not receive money for the coupon payment. Rather, the missed accrued payment is a claim on the issuer's assets. On the other hand, if an issuer defaults in between scheduled CDS coupon payments, the seller of protection (long risk) receives the accrued coupon payment up to the date of default. This payment will be settled when the buyer and seller of protection close the transaction. As in the case above, this makes a CDS more valuable than a bond with the same spread, all else being equal. For European corporations that often pay coupons annually, this issue is more valuable than in the US with semi-annual coupons.

*5. The potential cost to unwind a swap*
The yield on a bond can be divided into the swap yield plus a credit yield. For CDS investors to replicate a long bond position, they would sell protection (long risk) and invest in swaps (paying floating, receiving fixed). When an issuer defaults, both the swap part of the bond coupon payments and the credit part of the coupon payments stop. But for the CDS investor, the swap transaction will continue to maturity. To make the swap plus credit default swap investment equivalent to a bond, we must adjust for the potential cost to unwind the swap position before maturity. This cost, multiplied by the probability of default, discounted to present value terms, is another adjustment made to calculate the par equivalent CDS spread. When the swap curve is upward sloping, this factor implies that a bond has more value than a credit default swap with the same spread.

**Calculating the par-equivalent CDS spread**

The par equivalent CDS spread is calculated using an iterative process. Each iteration consists of the following two steps.

1. For a given par equivalent CDS spread and assumed recovery rate, we calculate a curve of default probabilities. The actual calculation involves numeric integration (using the same model that underlies the CDSW calculation on Bloomberg), however a useful approximation is: Probability of default = CDS Spread / (1 – Recovery)
2. We use the risk-free curve and the default probabilities found in step 1 to calculate the value of the bond

We repeat these steps until the bond price found in step 2 matches the market price. Note that a par equivalent CDS spread calculator is available on the Credit Derivatives homepage found in www.morganmarkets.com.

We return to our five year, 5.5% coupon $90 bond, introduced in Exhibit 8.4, to illustrate how we calculate the par equivalent CDS spread.

We start with an initial guess of the par equivalent CDS spread and, along with a recovery assumption, use it to calculate a curve of default probabilities. Suppose we guess that a bond's par equivalent CDS spread is 341bp (a rather educated guess) and assume its recovery rate is 40%. This implies an annual default probability of approximately 5.7% = 3.41%/(1-40%). (We do not use this approximation in our model, however, but use the same calculation as in the CDSW calculator).

We calculate the value of the bond using the default probabilities, risk-free discount factors from the Libor/Swap curve, and the recovery rate assumption. We value the bond by separating the bond into two payment streams: 1) the coupon payments, and 2) the principal payment, and value each stream under the default and no default scenarios. The value of the payment streams are summed to find the value of the bond.

In the scenario where the company survives, we receive the coupon and principal payments (Exhibit 8.5, row F). We find the risky present value of the cash flows by multiplying them by the discount factor (row A) and the probability of survival (row B). In other words, this is the present value of the bond's cash flows discounted by the likelihood of the cash flows being paid. The sum of the flows is $81.47.

In the scenario where the company defaults, the coupon payments stop and we are left with a bond that is worth $40, as per our assumptions. We assume that the default can happen at the end of the year, immediately before a coupon payment. As a default can happen only once, we discount $40 not by the cumulative probability of default, but by the probability of default in a particular year. This conditional probability of default can be calculated by subtracting the cumulative probabilities of survival in adjacent years (refer to Section 4 for more discussion on probabilities). The expected value of the bond in the default scenario is $8.53 (row J).

The sum of the two scenarios is $90, the price of the bond. Thus, a CDS spread of 341bp produces a probability curve that makes the expected value of the bond's cash flow equal to the price of the bond. If we had not guessed this spread initially, we would iterate until the $90 expected cash flow was calculated. In our simplified example, 341bp is the par equivalent CDS spread.

Note that in our exact model, default can occur at any point in time and we assume that the principal recovery is paid at the actual time of default. Additionally, we adjust for the factors described in Exhibit 8.3.

Exhibit 8.5: A bond's par-equivalent CDS spread makes the expected value of the cash flows equal to the current market price.

| Bond | | Credit Default Swap | |
|---|---|---|---|
| Bond price | $90.00 | CDS Notional | $83.33 |
| Face | $100.00 | CDS spread | 341bp |
| Cash coupon | 5.5% | Recovery rate | 40% |
| Swap fixed rate | 4.5% | Clean spread | 5.7%= (341 / (1-40%) |

| Row | Year: | 0 | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|---|---|
| A | Discount factors | | 0.96 | 0.92 | 0.88 | 0.84 | 0.80 | |
| B | Probability of survival | | 94.6% | 89.5% | 84.7% | 80.2% | 75.8% | |
| C | Probability of default | | 5.4% | 5.1% | 4.8% | 4.6% | 4.3% | |
| | *Scenario 1: no default* | | | | | | | |
| D | Coupon | | $5.50 | $5.50 | $5.50 | $5.50 | $5.50 | |
| E | Principal | | | | | | $100.00 | |
| F | | | $5.50 | $5.50 | $5.50 | $5.50 | $105.50 | |
| G | Probability weighted PV, no default | | $4.98 | $4.51 | $4.08 | $3.70 | $64.21 | $81.48 |
| | *Scenario 2: default* | | | | | | | |
| H | Value of bond principal | | $40.00 | $40.00 | $40.00 | $40.00 | $40.00 | |
| J | Probability weighted PV, default | | $2.06 | $1.86 | $1.69 | $1.53 | $1.38 | $8.53 |
| K | | | | | | | | $90.00 |

Notes:
Row A: Discount factors based on the flat swap curve, = 1 / (1+4.5%) ^ t
Row B: Probability of survival approximation based on the clean spread = 1 / (1+5.7%)^t. See Section 4 for more information.
Row C: Probability of default = 1 – probability of survival in year 1, and the difference between cumulative probabilities of survival in years 2-5
Row D: Bond's coupon
Row E: Bond's principal payment of $100 at maturity
Row F: Row D + E
Row G: Risky present value of scenario 1 = (row F) x (row A) x (row B)
Row H: Recovery value of bond after default
Row J: Risky present value of scenario 2 = (row H) x (row A) x (Row C)
Row K: Sum of risky PV of scenario 1 and 2 = expected present value of bond's cash flows
Source: JPMorgan.

We can also consider our bond and the funded component described in Exhibit 8.4b and apply the same methodologies. Assume we have a long bond and short risk CDS position. Recall we have sized the CDS position so the bond and CDS both have $50 at risk. We analyze the cash flows in two scenarios, if the bond survives or if it defaults, and use the probabilities calculated from the CDS spread to evaluate the scenarios.

Exhibit 8.6: In our simplified example, a CDS spread of 341bp is equivalent to a Z-spread of 350bp adjusted for the discount bond

| Bond | | Credit Default Swap | | |
|---|---|---|---|---|
| Bond price | $90.00 | CDS Notional | $83.33 | |
| Face | $100.00 | CDS spread | 341 | bp |
| Cash coupon | 5.50% | Recovery Rate | 40% | |
| Z-spread | 3.50% | Clean spread | 5.7% | |
| Swap fixed rate | 4.50% | | | |

| Row | | Year: | 0 | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|---|---|---|
| A | Bond: | Coupon | | $5.50 | $5.50 | $5.50 | $5.50 | $5.50 | |
| B | | Principal | ($90.00) | | | | | 100.00 | |
| C | | Funding | $90.00 | ($4.05) | ($4.05) | ($4.05) | ($4.05) | ($94.05) | |
| D | | | $0.00 | $1.45 | $1.45 | $1.45 | $1.45 | $11.45 | |
| E | CDS: | CDS spread | | $2.84 | $2.84 | $2.84 | $2.84 | $2.84 | |
| F | Bond - CDS, no default: | | | ($1.39) | ($1.39) | ($1.39) | ($1.39) | $8.61 | |
| | Scenario 1: No default | | | | | | | | |
| G | | Discount factors | | 0.96 | 0.92 | 0.88 | 0.84 | 0.80 | |
| H | | Probability of survival | | 94.6% | 89.5% | 84.7% | 80.2% | 75.8% | Sum of PV |
| J | | Present value, no default | | ($1.26) | ($1.14) | ($1.03) | ($0.94) | $5.24 | $0.86 |
| | Scenario 2: Default | | | | | | | | |
| K | | CDS payment | | $50.00 | $50.00 | $50.00 | $50.00 | $50.00 | |
| L | | Value of bond principal | | $40.00 | $40.00 | $40.00 | $40.00 | $40.00 | |
| M | | Funding payment, including coupon | | ($94.05) | ($94.05) | ($94.05) | ($94.05) | ($94.05) | |
| N | | | | ($4.05) | ($4.05) | ($4.05) | ($4.05) | ($4.05) | |
| O | | Probability of default | | 5.4% | 5.1% | 4.8% | 4.6% | 4.3% | Sum of PV |
| P | | Present value, default | | ($0.21) | ($0.19) | ($0.17) | ($0.15) | ($0.14) | ($0.86) |
| Q | | | | | | | | | $0.00 |

Row A - F: Refer to exhibit 8.4b
Row G - Discount factors based on the flat swap curve, = 1 / (1+4.5) ^ t
Row H: Probability of survival approximation based on the clean spread = 1 / (1+5.7%)^t. See Section 4 for more information.
Row J: Risky present value of scenario 1 = (row F) x (row G) x (row H)
Row K: CDS payment in default = (1 – RR) x notional
Row L: Recovery value of bond after default
Row M: Unwind value of the funding = borrowed money + accrued interest paid in final year
Row N: Row K + L + M
Row O: Risky Probability of default = 1 – probability of survival in year 1, and the difference between probabilities of survival in years 2-5
Row P: Risky present value of scenario 2 = (row N) x (row G) x (Row O)
Row Q: Sum of risky PV of scenario 1 and 2 = expected present value of bond + funding + CDS cash flows
Source: JPMorgan.

If the bond survives, we will realize the cash flows in row F. The risky present value of these cash flows is $0.86.

If the company defaults (again, we assume default on the last day of the year), the CDS position will receive (1- recovery) x notional, or (1-40%) x (83.33) = $50. The value of our long bond position is $40, by assumption. Furthermore, we must pay back our funding principal amount, plus accrued interest for the year. If there is a

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default, we will lose $4.05 in any one year, given our assumptions. The risky present value our position in this scenario is -$0.86 (row J).

The value of our two scenarios is +$0.86 - $0.86 = $0. Again, a CDS spread of 341bp provides a probability curve that makes the expected value of our cash flows zero, analogous to a fairly priced swap, or a par security.

## Methodology for isolating credit risk in bonds with embedded options

Many high-yield bonds have embedded options, usually call options. A call option gives the issuer the right, but not the obligation, to buy the bond back from the holder at a predetermined price at a future date. Often there is more than one call date and call price in a single bond. The call schedule of a typical bond is shown in Exhibit 8.7.

Exhibit 8.7: Example of typical call schedule

| Call Date | Call Price |
|---|---|
| 07/15/2007 | 104.250 |
| 07/15/2008 | 102.125 |
| 07/25/2009 | 100.000 |

The company has the right to buy the bond at a price of $104.25 from 7/15/2007 – 7/14/2008. It then has the right to buy the bond at $102.125 from 7/15/2008 – 7/25/2009. 7/25/2009 is the maturity date of the bond.
Source: JPMorgan

Our valuation framework is to observe a bond's market price and calculate a spread (the par equivalent CDS spread) that reflects the credit risk of the bond. Difficulties arise because we must separate the value of the embedded option from the market price of the bond.

For example, suppose an issuer has the following two bonds outstanding:

A. A standard bullet bond (no embedded option) with an 8% coupon and 1-Jun-2010 maturity.

B. A callable bond with an 8% coupon and 1-Jun-2010 maturity. The bond is callable on 1-Jun-2008.

If bond B did not have the embedded call option, the two bonds would be identical. Suppose the market price of bond A is $110 and the market price of bond B is $103. In this case, we could precisely determine the value of the option at $110 - $103 = $7.

Consider a different issuer that has a standard bullet bond outstanding with a 9% coupon and 1-Nov-2013 maturity. Assume the market price of the bond is $102. Suppose the issuer wants to issue another 9% 1-Nov-2013 bond—with the twist that this new bond is callable on 1-Nov-2008 at a price of $102. What is the value of this new bond? The new bond should be worth less than $102 (the price of the non-callable bond), but how much less? The value of the new bond depends on the value of the embedded call option. Suppose a dealer was willing to quote a 1-Nov-2008 $102 strike call option on the old bond at a price of $3. In this case, an investor could replicate the risk in the new bond by buying the old bond and selling the call option. We would therefore estimate the value of the new bond to be no less than $102 - $3 = $99. Where does the $3 value of the come from? The value of this option depends on the volatility of the underlying, i.e., it depends on the volatility of the old bond.

Now suppose the new bond is issued and a year later the older bond becomes illiquid with no observable market price. Suppose the callable bond is now being quoted at $101. We want to calculate a par equivalent CDS spread for the bond based on this market quote. To do so we need to estimate the value of the option and we need a bond option valuation model.

We think of the value of the callable bond as consisting of two parts:

$$\textit{Value of Callable Bond} = \textit{Value of Underlying Non-Callable Bond} - \textit{Value of Call Option}$$

The underlying non-callable bond is the bond stripped of the embedded option.

The par equivalent CDS spread for a callable bond is found by the same iterative process that we use for a non-callable bond. For a given guess at the par equivalent CDS spread, we use a model to value the callable bond. We adjust the guess until our model value of the callable bond is equal to the price quoted in the market.

To value the call option, we use a separate model set up to value options on credit-risky bonds. This approach to the option valuation assumes that the issuer calls the bond when it is economically rational, without taking into account the issuer's finance costs. In reality, there may be significant costs for an issuer when calling a bond, especially if the issuer must issue a new bond to finance the call. For this reason, an issuer may postpone a call to a later date or not call the bond at all. If our model is otherwise correct, our approach is more likely to overestimate the value of the option. For a given par equivalent CDS spread, this may lead us to underestimate the value of the callable bond, which will lead us to solve for a par equivalent CDS spread that is too low.

**How does our option valuation model work?**
The value of the option is determined primarily by the value and volatility of the underlying. When choosing an option valuation model we are also choosing how to specify the volatility of the underlying. Our methodology is based on the observation that the value of the underlying is driven by changes in

- the term structure of default-free interest rates, and
- the credit risk of the issuer.

In our model, we use the Libor/swap rates as the default-free interest rates and the par equivalent CDS spread of the bond as the measure of credit risk.

Prices of interest rate swaptions provide market information about volatility in the Libor/swap curve. Our model is calibrated to fit the prices of swaptions where the swap matures on the same date as the bond. For most bonds, especially in less credit risky bonds, the volatility in interest rates is the most important determinant of the volatility of the value of the bond. The less credit-risky bonds are also the bonds with the most valuable call option and, thus, the bonds for which it is most important that we value the option correctly. Indeed, the call option in the most credit-risky bonds is usually far out of the money since such bonds are priced significantly below par and the call prices are usually above par.

We must also specify the volatility of the bond's par equivalent CDS spread and the correlation between interest rates and the spread. While it can be argued that for some issuers the correlation should be negative and for others it should be positive, we find it most reasonable to set the correlation to zero for all bonds. Finally, spread volatility can be estimated by the historical volatility of historical CDS spreads for the bond's issuer. In our High Yield Spread Curve Report, we calculate the par equivalent CDS spread for three different spread volatilities to show the sensitivities. We also report six-month historical spread volatility in order to see how our assumption on future volatility fits the recently observed credit volatility.

**How does the par equivalent CDS spread differ from a standard OAS?**
For an investment grade bond, an embedded option is often dealt with by calculating an OAS (option adjusted spread) instead of the Z-spread. On Bloomberg this can be done using the OAS1 calculator. An OAS is directly comparable to a Z-spread and

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has the same drawbacks compared to the par equivalent CDS spread (see previous section).

The par equivalent CDS spread is not directly comparable to a standard OAS as its volatility assumptions are different. The bond price volatility implicit in the par equivalent CDS spread calculation is determined by: 1) the interest rate volatility, 2) the spread volatility, 3) the correlation between interest rate and spread, and 4) the probability of jump to default. In comparison, the standard OAS calculation ignores the jump to default and collects the interest rate, spread, and correlation into a single volatility input that can be loosely thought of as the volatility of the issuer's yield curve. The par equivalent CDS spread calculation is most comparable to the OAS calculation when the interest rate and spread volatility are the same and the correlation between the two is one. However, even in this special case, the par equivalent CDS spread is different because it specifically takes into account the risk of default.

**A brief note on the technical details**

The term structure model we use in our option valuation methodology is a standard one-factor model for the instantaneous spot rate with time-dependent volatility and mean reversion. The distribution of the spot rate is set to lognormal and the mean version to 0.05.

The model's second factor is the hazard rate, or the default intensity, which we assume is lognormally distributed without mean reversion and with constant volatility. The hazard rate volatility is set equal to the number that is labeled "Spread Vol" in the US bond versus CDS daily analytic reports. The recovery rate is fixed and constant for all bonds of the same issuer.

# 9. Basis Trading

## Understanding the difference between bonds and credit default swap spreads

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

**Negative basis**
If the basis is negative, then the credit default swap spread is lower (tighter) than the bond's spread. This occurs when there is excess protection selling (investors looking to go long risk and receive periodic payments), reducing the CDS spread.

*Structured credit activity:* Excess protection selling may come from structured credit issuers, for example, who sell protection in order to fund coupon payments to the buyers of structured credit products.

*Borrowing costs:* Protection selling may also come from investors who lend or borrow at rates above Libor. For these investors, it may be more economical to sell protection (long risk) and invest at spreads above Libor, rather than borrow money and purchase a bond.

*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, described in Part I). 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.

*Bond new issuance:* When bond issuance increases, the laws of supply and demand dictate that prices must drop, forcing credit spreads higher. This usually widens bond spreads more than CDS spreads.

An investor could buy the bond (long risk), then buy protection (short risk), to capture this pricing discrepancy. In this trade, an investor is not exposed to default risk, yet still receives a spread. This is, therefore, a potential arbitrage opportunity[12]. Trading desks at investment banks and other investors who can fund long bond positions cheaply (borrowing at or near Libor) will typically enter into this position when the negative basis exceeds 10–25bp.

[12] The trade does have mark-to-market and counterparty risk and may have a gain or loss in default as the cash flows received on the two legs of the trade prior to default may differ.

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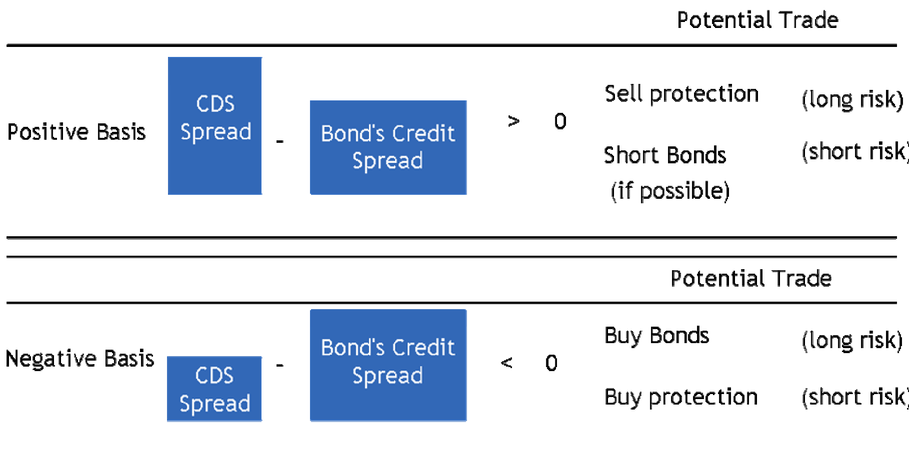
Exhibit 9.1: Basis is the basis point difference between a credit default swap spread and a bond's par equivalent credit default swap spread with the same maturity dates. Basis is either positive or negative.




Source: JPMorgan.

**Positive basis**
If the basis is positive, then the credit default spread is greater than the bond's credit spread. Positive basis occurs for technical and fundamental reasons.

*Imperfections in repo markets:* The technical reasons are primarily due to imperfections in the repo[13] market for borrowing bonds. Specifically, if cash bonds could be borrowed for extended periods of time at no cost, then there would not be a reason for bonds to trade "expensive" relative to credit default swaps. If a positive basis situation arose, investors would borrow the bonds and sell them short, eliminating the spread discrepancy. In practice, there are significant costs and uncertainties in borrowing bonds. Therefore, if the market becomes more bearish on a credit, rather than selling bonds short, investors may buy default protection (short risk). This may cause credit default swap spreads to widen compared with bond spreads.

*Segmented markets:* Another technical factor that causes positive basis is that there is, to some degree, a segmented market between bonds and credit default swaps. Regulatory, legal and other factors prevent some holders of bonds from switching between the bond and credit default swap markets. These investors are unable to sell a bond and then sell protection (long risk) when the credit default swap market offers better value. Along this vein of segmented markets, sometimes there are market participants, particularly coming from the convertible bond market, who wish to short a credit (buy default swap protection) because it makes another transaction profitable. For example, investors may purchase convertible bonds and purchase default protection in the CDS market, thus isolating the equity option embedded in the convertible. These investors may pay more for the protection than investors who are comparing the bonds and credit default swap markets. This is another manifestation of the undeveloped repo market.

[13] 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.

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*Cheapest-to-deliver option:* A fundamental factor that creates positive basis is the cheapest-to-deliver option. A long risk CDS position is short the cheapest-to-deliver option. If there is a credit event, the protection buyer (short risk) is contractually allowed to choose which bond to deliver in exchange for the notional amount. This investor will generally deliver the cheapest bond in the market. When there is a credit event, bonds at the same level of the capital structure generally trade at 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. Thus, protection sellers (long risk) may expect to receive additional spread compared to bonds for bearing this risk. This would lead to CDS spreads trading wider than bond spreads and therefore contribute to positive basis.

*Bond covenants:* In addition, bond holders have actual or potential rights that sellers of CDS protection do not have. These may include bonds being called with a change in control of the company. Also, bond holders may receive contingent payments if a company wishes to change a term of a bond. Bond holders may benefit from a tender offer, or may be treated better in a succession event. These issues are difficult to quantify but can cause bonds to perform significantly better than CDS in certain circumstances.

*Non-default credit events*: Finally, a CDS contract may payout in a variety of events, such as restructuring, that are not actual defaults. The CDS premium will therefore be higher than the bond spread to account for this.

## Trading the basis

Investors frequently seek to exploit discrepancies in the bond-CDS basis at a single-name level by trading basis packages. A positive basis package consists of a short position in the bond coupled with short CDS protection position. A negative basis package consists of a long bond position and a long CDS protection position. In both cases, the principle is that the bond and CDS position offset each other in the case of default, allowing the investor to take a view on the relative pricing of bonds and CDS without taking on credit risk. Basis trades are normally hedged against interest rate risk.

Trading a positive basis is more complex than a negative basis for two main reasons:

- rather than buying the bond outright, the investor must short the bond via reverse repo
- the CDS contract contains a degree of optionality in terms of deliverable bonds in default. Therefore, if the bond defaults, it is possible that the bond delivered into the CDS contract would not match the investor’s short position.

Negative basis packages are easier to implement as it is easy to take a short risk position in CDS with the same maturity date of the bond. Exhibit 9.2 is a stylized example of a negative basis trade. A three year, 8% bond is trading at par. Assuming our investor funds the bond at a fixed rate of 5%, she will net 3% annually. She pays 280bp annually for CDS protection, thus nets \$0.20 per year (column A+B+C), or \$0.60 over three years. The present value of \$0.60 is \$0.55 (assuming a flat Libor curve of 5%), and the risky present value is \$0.51. Note that we are ignoring day count conventions, which would increase the cost of CDS protection given it is paid on the actual/360 convention. Furthermore, we are not bootstrapping the probability of default curve, but using a rough approximation (default probability = spread / (1-RR) = 0.028/(1-.04) = 4.67%. The two year default adjustment is calculated 1 / $(1+4.67\%)^2$). Thus, we expect to earn $0.51 without exposure to credit risk. This methodology is the same as the par equivalent CDS spread calculation, discussed in Section 8.

Exhibit 9.3 is a stylized example of a negative basis trade with a discount bond. The three year 6.86% coupon bond is trading at $97, but as in Exhibit 9.2, has a yield to maturity of 8%.

With a discount bond, our investor does not buy $100 of CDS protection. Rather, she buys enough protection to be neutral in default. Assuming a 40% recovery rate for the bond, she expects to lose (initial bond price – recovery price) = $97 - $40 = $57 on the defaulted bond. Thus she buys $95 of CDS protection, as notional x (1-recovery rate) = payment in default, $95 x (1-40%) = $57.

She will lose $0.66 each year, before earning $3 as the $97 priced bond matures at par in year three. She nets $1.05, or $0.80 after discounting, or $0.61, after adjusting for the probability of default.

Exhibit 9.2: Negative basis trade using a par bond.

| | |
|---|---|
| Bond Price | $100.00 |
| Bond Coupon | 8.00% |
| YTM = | 8.00% |
| Swap Rate | 5.00% |
| CDS spread | 280bp |

| Bond payment type | Years | (A) Bond cash flow | (B) Funding at fixed Libor | (A)+(B) Net bond cash flow | (C) CDS cost | A+B+C Net Cash Flow | Discounted at risk free rate (Libor) | Default adjusted |
|---|---|---|---|---|---|---|---|---|
| Principal | 0.0 | -$100.00 | $100.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| | 0.5 | $4.00 | -$2.50 | $1.50 | -$1.40 | $0.10 | $0.10 | $0.10 |
| | 1.0 | $4.00 | -$2.50 | $1.50 | -$1.40 | $0.10 | $0.10 | $0.09 |
| Coupons | 1.5 | $4.00 | -$2.50 | $1.50 | -$1.40 | $0.10 | $0.09 | $0.09 |
| | 2.0 | $4.00 | -$2.50 | $1.50 | -$1.40 | $0.10 | $0.09 | $0.08 |
| | 2.5 | $4.00 | -$2.50 | $1.50 | -$1.40 | $0.10 | $0.09 | $0.08 |
| | 3.0 | $4.00 | -$2.50 | $1.50 | -$1.40 | $0.10 | $0.09 | $0.08 |
| Principal | 3.0 | $100.00 | -$100.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| Total | | | | $9.00 | -$8.40 | $0.60 | $0.55 | $0.51 |

Source: JPMorgan.

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Exhibit 9.2: Negative basis trade using a discount bond.

| | |
|---|---|
| Bond Price | $97.00 |
| Bond Coupon | 6.86% |
| YTM = | 8.00% |
| Swap Rate | 5.00% |
| CDS Spread | 280bp |

| Default analysis | |
|---|---|
| Recovery Rate | 40% |
| Bond's loss in default | $57 |
| CDS notional for equal loss | $95 |

| Bond payment type | Years | (A) Bond cash flow | (B) Funding at fixed Libor | (A)+(B) Net bond cash flow | (C) CDS cost | A+B+C Net Cash Flow | Discounted at risk free rate (Libor) | Default adjusted |
|---|---|---|---|---|---|---|---|---|
| Principal | 0.0 | -$97.00 | $97.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| | 0.5 | $3.43 | -$2.43 | $1.01 | -$1.33 | -$0.33 | -$0.32 | -$0.31 |
| | 1.0 | $3.43 | -$2.43 | $1.01 | -$1.33 | -$0.33 | -$0.31 | -$0.30 |
| Coupons | 1.5 | $3.43 | -$2.43 | $1.01 | -$1.33 | -$0.33 | -$0.30 | -$0.28 |
| | 2.0 | $3.43 | -$2.43 | $1.01 | -$1.33 | -$0.33 | -$0.29 | -$0.27 |
| | 2.5 | $3.43 | -$2.43 | $1.01 | -$1.33 | -$0.33 | -$0.29 | -$0.26 |
| | 3.0 | $3.43 | -$2.43 | $1.01 | -$1.33 | -$0.33 | -$0.28 | -$0.25 |
| Principal | 3.0 | $100.00 | -$97.00 | $3.00 | $0.00 | $3.00 | $2.59 | $2.27 |
| Total | | | | $9.03 | -$7.98 | $1.05 | $0.80 | $0.61 |

Source: JPMorgan.

*Logistics in default*

A negative basis package is usually considered to be perfectly hedged in the case of default, but as the three separate components of the package (bond, swap/bond funding and CDS) all behave differently, the behaviour of the package in default is more complex. The effects of default on different parts of the package are as follows:

**CDS contract and defaulted bond:** The bond, by definition, is deliverable into the CDS contract (as the bond is issued by the reference entity). So, if a default were to occur, we can deliver the bond into the CDS contract, and receive par (the price we initially paid for the bond) in return.

**Coupon payments:** Bondholders are not entitled to any accrued coupon payments on default. However, buyers of CDS protection must still pay any interest accrued up to the default date to the seller of protection. For bonds that pay coupons annually, in the worst case scenario (the bond defaults the day before a coupon payment is due), an investor could lose a full year's worth of accrued interest on the notional invested, while still paying for a full year of CDS protection.

**Funding:** The interest rate component of a bond must be hedged in the negative basis trade. There can be a cost of unwinding this hedge early, whether it was created using a fixed for floating swap, through funding the bond, or an asset swap. An asset swap (detailed next), for example, does not knock out in the case of default of the associated bond meaning the investor is left with a residual swap position. Whether or not this position is in the favour of the investor depends on two factors:

- Movement of rates: If swap rates (and forward swap rates) are lower than predicted at the inception of the swap then the investor will be receiving payments of a lower value than they are making to the swap counterparty. Falling rates will result in a negative mark-to-market for the residual swap position in the case of default (all else equal).
- Dirty price of the bond: The bond is worth its dirty price at inception, but the investor pays par for the (par) asset swap package. The value of the asset

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swap at inception must be equivalent to the difference between par and the bond dirty price. If the bond was trading at a discount to par, this effect will be in the favor of the investor. The value will amortise over the life of the swap, as the price approaches par as the contract approaches maturity.

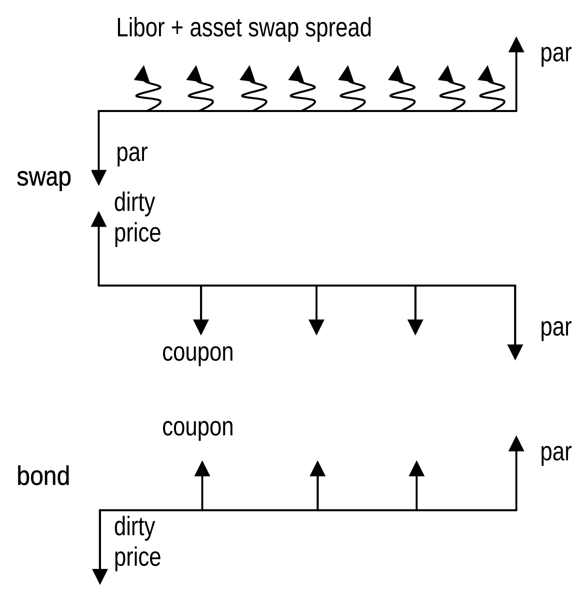
When using an asset swap, the behaviour in default outlined above implies that lower priced bonds with low coupons are the most attractive for negative basis trades, as these are the least likely to cost the investor on default.

## Asset Swap Spread

Commonly used in Europe, an asset swap is a way of trading a bond in which the fixed coupons on the bond are exchanged for floating payments that fluctuate in line with Libor (or some other agreed rate). Essentially, this transforms the 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.

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 cashflows: 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.

Exhibit 9.3: The Asset Swap




Source: JPMorgan

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 investors 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.

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.

**Calculating the asset swap spread**

The asset swap spread can be computed using a simple equation of cashflows argument on the swap portion of the package. As the package as a whole costs par, the purchaser must pay an additional par - dirty price to the swap counterparty at inception (or, equivalently, receive dirty price - par if the bond is at a premium). The investor then pays the coupon and receives the asset swap spread over Libor for the life of the swap. By equating the fixed and floating payment streams, we have:

$$par - DP + c\sum_i DF_i = \sum_j \left(L_j + a\right) DF_j$$

where:
$DP$ = dirty price of bond
$c$ = bond coupon
$a$ = Asset swap spread
$L_j$ = Libor rates
$DF_i$ = risk-free discount factors.
The asset swap spread is the value of a that solves this equation.

Notice that there are no risky discount factors involved in this calculation. This is because the swap does not knock out on default of the bond.

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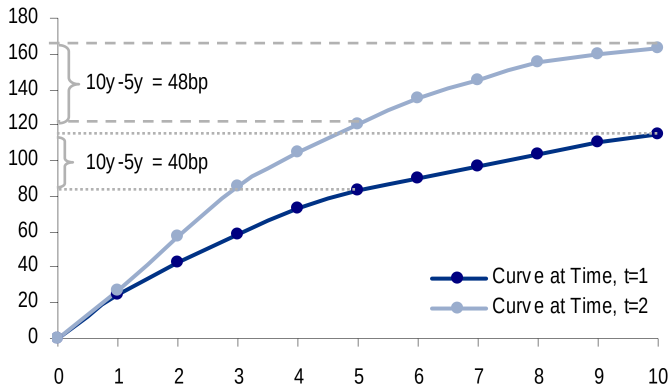
# 10. Trading Credit Curves

Curve trading in credit involves taking a view on the relative steepness of points on the credit curve and trading the view that the curve will either steepen or flatten. For example, an investor may believe that the curve of Company ABC will steepen over time (10y - 5y spread will increase). To position for this an investor could sell protection in the 5y point and buy protection in the 10y point. If the curve moves as the investor predicts, as in Exhibit 10.1, then the investor will benefit. Trading the curve as opposed to a single point can be useful where an investor is not sure which point will move but has a view on the relative steepness of the curve. Additionally, curve trading can mean an investor avoids an outright credit (default) exposure while positioning for points in the curve moving (as opposed to trading a single point where an investor must take outright default exposure).

Exhibit 10.1: Example Curve Trade for Company ABC

x-axis = Time in Years, y-axis = Spread, bp




Source: JPMorgan

Exhibit 10.2: iTraxx Curve Over Time

iTraxx Europe Main 10y - 5y Spread, bp


Source: JPMorgan

Credit curve movements can be significant and investors can look to position for curve trades both on a company specific basis or on the market as a whole (see Exhibit 10.2 the curve of iTraxx Europe Main over time).

Structuring curve trades involves trying to isolate the view on the curve. This makes it important to understand the drivers of P+L on these trades so traders or investors can assess whether their core view of curve steepening / flattening can be turned into a profitable strategy. Understanding these drivers of P+L in curve trades should more accurately allow for more profitable curve trading strategies. We structure this as follows:

We first outline our framework for analyzing the P+L in curve trades.

We then apply this to common curve trades and highlight the common characteristics of these.

Future notes in this series will examine Barbells and other curve themes.

## Drivers of P+L in curve trades

**A Framework For Analysing Curve Trades**

When we look at trading credit curves there are four dimensions we need to look across to analyse the expected profitability of any trading strategy:

**Time**: We need to understand how our curve trade will be affected by the passage of time. This breaks down into the fee we earn, our 'Carry', and the way our position moves along the credit curve over time, our 'Slide'.

**Sensitivity to spread changes**: We need to understand how our trade will be affected by parallel spread changes. As a first order effect we need to look at the P+L sensitivity to spread movements (Duration effect), but we also need to understand the second order P+L impact as our Durations change when spreads move giving us a *Convexity* effect. There is also a third order effect which models the way our curve shape changes as a function of our 5y point. Analysing the sensitivity to spread changes at the trade horizon needs special care due to the *Horizon Effect* which shows how our position changes over the horizon.

**Default risk**: We need to understand the trade's exposure to underlying credit risk, as our curve trade positions may leave us with default risk.

**Breakevens and expected curve movements**: Once we have understood all of the other' risks to our curve trade, we need to put this together with our expectation of curve moves and look at our 'Breakeven' levels. I.e. given the other risk factors that can affect the trade, how much of a curve move do we need for our trade to breakeven over the horizon we are considering.

We tackle these dimensions in turn in this section and then turn to common curve trading strategies to see how our framework for analysis can be applied to each strategy to give more profitable trades.

- **Time: Carry**

The Carry of a curve trade is the income earned from holding the position over time. For example, if we constructed a simple curve flattening trade buying protection on $10mm notional for 5 years at 50bp and selling protection on $5mm notional for 10 years at 90bp (we will discuss trade structuring further on), we would end up with net payments, or Carry, of -$5,000 over the first year as shown in Exhibit 10.3[14].

Exhibit 10.3: Carry Example

| | Buy Protection | Sell Protection | Total 1y Carry |
|---|---|---|---|
| Maturity | 5y | 10y | |
| Notional ($) | 10,000,000 | 5,000,000 | |
| Spread | 50bp | 90bp | |
| 1y Carry ($) | -50,000 | +45,000 | -5,000 |

Source: JPMorgan

To generalize, the Carry on a curve trade is calculated as:

$$Carry_{Horizon} = (Ntnl_{Leg1} \times S_{Leg1} \times Horizon) + (Ntnl_{Leg2} \times S_{Leg2} \times Horizon) \qquad [1]$$

Where,

$Ntnl_{Leg\ n}$ : Notional of protection bought or sold on Leg n of the trade. This will be positive if selling protection and negative if buying protection.

$S_{Leg\ n}$ : Annual Spread on leg n of the trade, expressed in % terms (Spread in bp / 10000).

*Horizon*: Length of time in which trade is being evaluated, in years.

[14] We usually look at Carry without any present value discounting.

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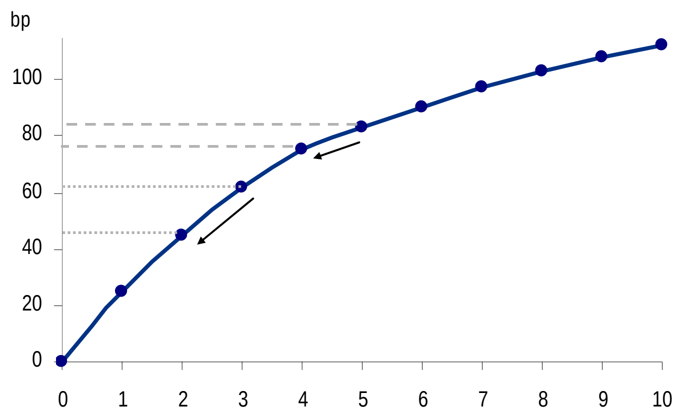
- **Time: Slide**

Slide is the change in value of a position due to the passage of time, assuming that *our credit curve is unchanged*. Intuitively, as we usually observe an upward sloping credit curve (see Exhibit 10.4) as time passes we will 'slide' down the curve. So, using the example in Exhibit 10.4, a 3y position slides down to become a 2y position and a 5y position slides down to become a 4y position over a year horizon. If I had sold protection in 5y and bought protection in 3y (a 3y/5y flattener), the 3y leg would slide more than the 5y, as the 3y part of the curve is steeper than 5y in this example.

Exhibit 10.4: Slide Intuition




Source: JPMorgan

At the end of this section we discuss two different ways to calculate Slide, depending on what we assume is *unchanged* over time: i) hazard rates for each maturity tenor (5y point), or ii) hazard rates for each calendar point (year 2010). In our analysis we will use i) and keep hazard rates constant for each maturity tenor, which is the equivalent of keeping the spread curve constant (e.g. so that the 5y spread at 100bp remains at 100bp) and sliding down these spreads due to time passing.

*Horizon Effect*

Slide also leads to another effect which we will call the *Horizon Effect.* The effect of the change in Spreads and lessening of maturities over the horizon both imply a change in Risky Annuities, which we call the Horizon Effect. This will have the impact of changing the Duration-Weighting of trade over time, meaning the trade essentially gets longer or shorter risk over the horizon. This can have a significant impact when we look at sensitivity analysis at the horizon. We discuss these issues later in this section.

*Slide and Flat Forwards*

The way we model our hazard rates and Forward curves also affects how we calculate Slide. As we have seen in *Trading Credit Curves I*, we model the Forward curve as a Flat Forward curve. This means that the Forward spread (and hazard rates) are taken as constant between points on the curve where spreads change. In terms of our Slide, this could mean that we have no Slide over a given one month horizon if we are on a flat part of the curve and larger Slide over a given one month horizon if we are on a part of the curve where there is a step down. In order to account for this we tend to have a method of interpolating between our step points, so that this is not just a 'jump' down. The method of interpolation may lead to some of the Slide calculations requiring a little thought as they can be as much to do with the way we model the curves as they are to do with the intuition or reality we are trying to capture.

*Time Summary*
Putting our Carry and Slide together we get the Time (=Carry + Slide) effect, which is the expected P+L of our curve trade from just time passing. Time is somewhat of a bottom line for curve trades in that it is the number you need to compare your likely P+L from curve movements against. For upward-sloping curves, Carry can dominate Slide in Equal-Notional strategies, but Slide tends to dominate Carry in Duration-Weighted trades. We will see more of this later.

Time analysis of our curve trade assumes nothing changes, so we now need to understand our likely profit if the spread environment does change as we turn to sensitivity analysis looking at Duration and Convexity.

**Risky Duration (DV01) & Risky Annuity**
We define Risky Duration (DV01) as the change in MTM of a CDS position for a 1bp change in Spreads. We define the Risky Annuity as the present value of a 1bp annuity given a Spread curve.

These are discussed in detail in *Credit Curves I*, where we show that for a par CDS contract we can approximately say that: Risky Duration ≈ Risky Annuity.

To accurately Mark-to-Market a CDS contract we need to use the Risky Annuity.

- **Sensitivity to Spread Changes**

*First Order Effects: Duration*
A curve trade positions for a credit curve to flatten or steepen. But what happens if the curve moves in a parallel fashion? Practically, we might think that the curve on Deutsche Telecom (for example) looks too steep, but are concerned that new M&A events occur in the telecoms sector could cause all telecom curves to shift wider in a parallel movement. We may want to immunize our curve trade for this movement as our core view is that the curve is too steep in Deutsche Telecom.

The first order effect that we need to consider is that of spread moves, which is captured by our (Risky) Duration / Risky Annuity (see grey box). Longer dated CDS contracts have higher Risky Annuities than shorter dated contracts. This means that the impact on P+L of a 1bp move in spreads is larger for longer dated CDS contracts as Exhibit 10.5 shows for a +1bp move in iTraxx Main 5y and 10y contracts.

Exhibit 10.5: iTraxx Main Europe Long Risk (Sell Protection) Sensitivities to Parallel Curve Shift

| | iTraxx Main 5y | iTraxx Main 10y |
|---|---|---|
| Spread (bp) | 34.25 | 58.5 |
| Risky Annuity | 4.38 | 7.91 |
| Notional ($) | 10,000,000 | 10,000,000 |
| Approx P+L for 1bp widening ($) | -4,380 | -7,910 |

Source: JPMorgan

This is because the Mark-to-Market of a CDS contract struck at par is given by:

$$MTM_{t,t+1} = (S_{t+1} - S_t) \,.\, Risky\ Annuity_{t+1} \,.\, Ntnl \qquad [2]$$

Where: $S_t$ = Par CDS Spread at time $t$

If we have a parallel move wider in spreads ($(S_{t+1} - S_t)$ is same for both legs) the MTM of a curve trade buying protection in 10y and selling protection in 5y in equal notionals of $10mm will be negative as the Risky Annuity is larger in the 10y leg than the 5y leg. **To immunize a curve trade against parallel moves in the curve we need to look at Duration-Weighting the legs of our curve trade**, i.e. sizing both legs so that the MTM on a parallel spread move is zero. We will discuss structuring these trades in the *Curve Trading Strategies* section.

Duration analysis is intended to immunize our curve trade for market spread moves. However, looking at this first order Duration effects is not the full story and we need to consider second order effects by looking at Convexity.

*Second Order Effects: Convexity*
We define Convexity as the change in MTM of a curve trade coming from changes in Risky Annuity due to spreads moving. It measures the second order effect of how our curve trade is affected due to Durations (or Risky Annuities) changing when spreads change.

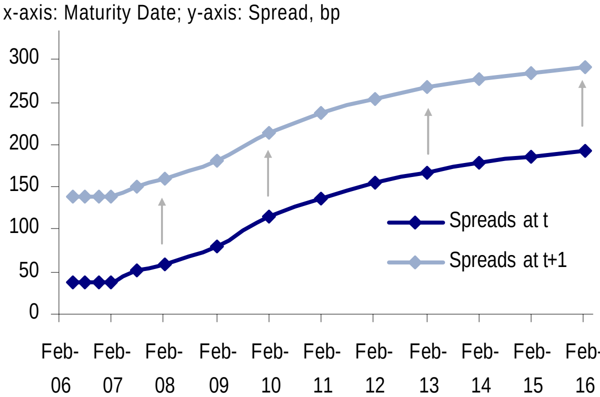
Why is there convexity in CDS positions?
We have seen that the Mark-to-Market of a CDS contract (in Equation [2]) is the Change in Spread × The Risky Annuity, and:

$$RiskyAnnuity \approx 1.\sum_{i=1}^{n} \Delta_i . Ps_i . DF_i \qquad [3]$$

Where,
$Ps_i$, is the Survival Probability to period *i*.[15]
$DF_i$ is the risk-free discount factor for period *i*
$\Delta_i$ is the length of period *i*
*n* is the number of periods.

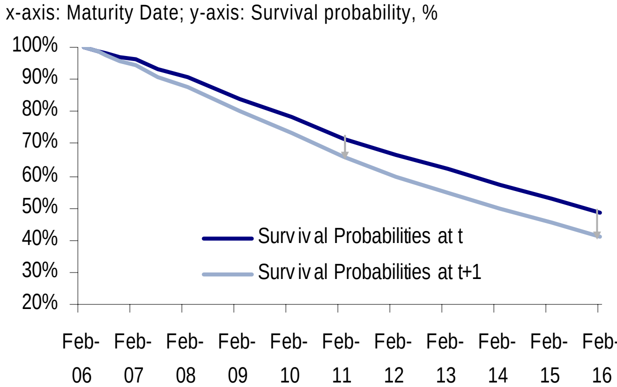
If the spread curve parallel shifts (widens) by 100bp, this means that credit risk has risen and survival probabilities have fallen. For a given spread widening, *survival probabilities decrease more for longer time periods* as the impact of higher hazard rates is compounded. This is illustrated in Exhibit 10.6 and Exhibit 10.7 where we can see that the Probability of Survival decreases proportionately more at longer maturities for a 100bp spread change.

Exhibit 10.6: Parallel Shift in Par Spread Curve
x-axis: Maturity Date; y-axis: Spread, bp




Source: JPMorgan

Exhibit 10.7: Survival Probabilities for Parallel Shift in Spreads
x-axis: Maturity Date; y-axis: Survival probability, %




Source: JPMorgan

Looking at Equation [3], we can see this has the effect of making our Risky Annuities decrease more for longer maturity CDS contracts as Exhibit 10.8 illustrates.

[15] See *Trading Credit Curves I* for a more complete explanation of Survival Probabilities and Risky Annuities.

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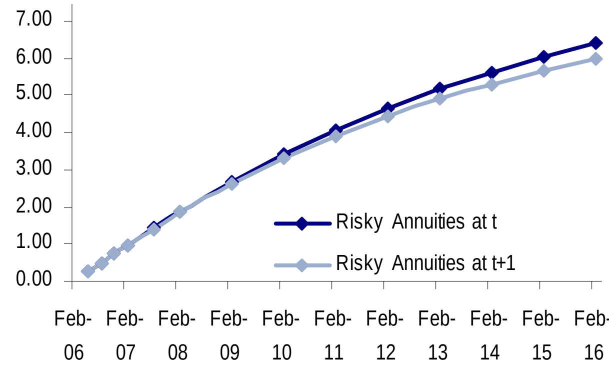
Exhibit 10.8: Risky Annuity Changes for Parallel Shift in Spreads

x-axis: Maturity Date; y-axis: Duration



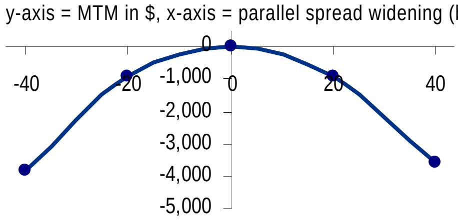

Source: JPMorgan

| | |
|---|---|
| Spreads ↑ | Risky Annuities ↓ |
| Spreads ↓ | Risky Annuities ↑ |

The upshot of this is that if we have weighted a curve steepener (sell protection in shorter maturity, buy protection in longer maturity, for an upward sloping curve) so that the curve trade is Duration-Neutral, if spreads widen our Risky Annuity in the 10y will fall **more** that that of the 5y meaning we will have a negative Mark-to-Market (our positive MTM in the 10y declines as the Risky Annuity is lower). We call this Negative Convexity, meaning that the Duration-Weighted position loses value for a given parallel shift in spreads due to the impact of Risky Annuities changing. Exhibit 10.9 illustrates the impact of this convexity in a curve steepener. The trade was Duration-Weighted, i.e. the P+L should be zero for a 1bp parallel move in spreads. We can see for changes larger than 1bp we have a Convexity effect as Risky Annuities change.

Exhibit 10.9: Convexity in a Duration-Weighted Curve Steepener

y-axis = MTM in $, x-axis = parallel spread widening (bp)




Source: JPMorgan

When looking at the risks to any curve trade over a particular scenario, we will need to analyze the P+L impact from Convexity as it can have an impact on the likely profitability of a trade.

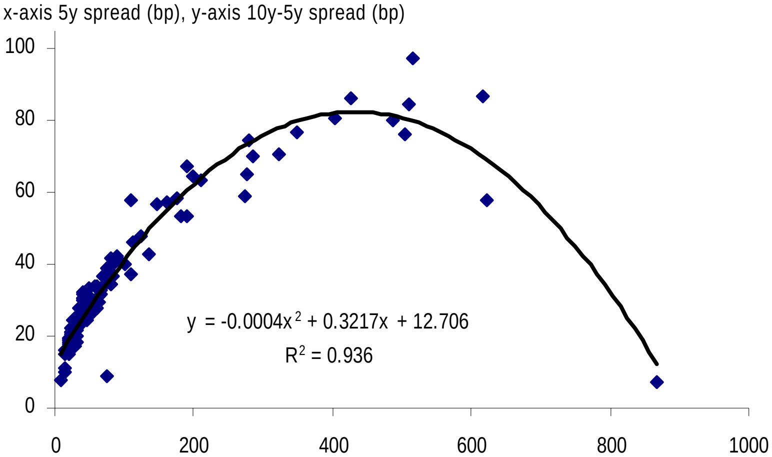
*Sensitivity Analysis at Horizon*

The sensitivity analysis we have been looking at is for instantaneous parallel moves in spreads. When we look at sensitivity analysis at the horizon of our trade we will also have to consider what we call the Horizon Effect. **This Effect means that our curve position can get longer or shorter risk over the life of the trade** and so our sensitivity analysis will reflect this. We discuss this in more detail later in the Section where we show that it can mean we get a negative MTM for spread widening and a positive MTM for spread tightening at the trade horizon.

*Third Order Effects: Including a Curve Model*
We have shown in previous work (see *The Curve of DJ Trac-x Europe,* Due, McGinty, Jan 2004 and *Revisiting Credit Maturity Curves*, Due, McGinty, Nov 2004) that the shape of the credit curve for single names can be modeled as a function of the 5y point (see Exhibit 10.10). Given this, the assumptions that we have made when looking at the risks to our curve trades 'if the curve parallel shifts by xbp' should be unrealistic of what we would expect to see in the market. More specifically, our model shows that if the 5y point is at xbp the 10y point will be at ybp, where this 10y Spread is a function of the 5yr Spread. This function should tell us how much the 10y point will shift for a given move in the 5y point.

Exhibit 10.10: iTraxx Constituents 10y-5y Slope as a Function of 5y Spread - JPMorgan Model

x-axis 5y spread (bp), y-axis 10y-5y spread (bp)




Source: JPMorgan

The impact on our risk analysis of curve trades could be significant. Instead of looking at scenario analysis for a *parallel* curve movement, we should look at scenario analysis for a given move in our 5y point and then use our model to show how the 10y point will move for this 5y move. We could then look at Duration and Convexity analysis including this expected curve shift. We have not included this analysis in this curve trade analysis framework and hope to develop it further in future notes.

So far we have seen how to analyze the likely P+L of our curve trade for no change in Spreads (Time) and for a given parallel shift in Spreads (Duration, Convexity and the Horizon Effect). We now move on to consider the Default Risk we take on in our curve trades.

- **Default risk**

Default risk is the company default exposure that we take when putting on our curve trade. This is relatively simple to analyze for curve trades and will have one of two consequences:

For Equal-Notional strategies, economically there is no default exposure initially as you have a long default risk and a short default risk position in each leg of the curve trade in equal notional size. However, the curve trade will have a time element to the default risk; there will be a residual CDS contract remaining once the first leg matures. Typically this is not of large concern as curve trade horizons are often of lengths below one year.

For strategies with differing notional weights in each leg (e.g. Duration-Weighted trades) there will be default risk for the life of the curve trade which forms part of the risks to the trade being profitable. Depending on their view on the underlying credit, investors may not wish to put on a curve view if it results in a default exposure they are uncomfortable with.

- **Breakevens and curve steepening / flattening**

The point of our framework for understanding the drivers of P+L in a curve trade is to understand the likely profitability of curve trades given our view of future curve moves. We therefore need to look at the *breakeven* curve movements that are needed for our curve trade to be profitable.

**Bid-Offer Costs**
In our analysis we simplify our Breakevens by ignoring bid-offer costs. In practice these trading costs also need to be considered when accessing likely profitability and Breakevens.

In general, the Breakeven on a trade tells us what market move we need to ensure that it makes zero profit. In that sense the Breakeven is the bottom line or our minimum condition for putting on a trade. For example, if the 10y point is trading at 100bp and the 5y point is trading at 75bp, the ‘curve steepness’ (10y minus 5y spread) is 25bp. An investor putting on a curve flattener trade, buying protection in the 5y point and selling protection in the 10y point is working on the assumption that the curve steepness will fall lower than 25bp. So, how much does the curve need to flatten in order to breakeven on the trade over the trade horizon? If we calculate that given all the other drivers of P+L in the trade, if the curve flattens 5bp the trade will breakeven over three months, then 5bp is our bottom line flattening. An investor can then assess whether this 5bp is really reasonable given their view of the company and the market, or whether 5bp is too much of a move to expect and therefore the trade will most likely lose money even if the curve does flatten a little.

We have two Breakevens we may want to look at for our trade:

*Breakeven from Time*
This is the breakeven curve change needed to ensure our curve trade MTM is zero over the horizon given the Time (=Carry + Slide) P+L.

The Breakeven from Time is the curve change needed so that:

$$MTM_{Time,\ t\ to\ t+1} + MTM_{Curve,\ t\ to\ t+1} = 0 \qquad [4]$$

Or in long hand (for a curve flattener):

$$Carry_{\ t\ to\ t+1} + Slide_{\ t\ to\ t+1} + \Delta S_{5y}.A_{5y,t+1}.Ntnl_{5y} - \Delta S_{10y}.A_{10y,t+1}.Ntnl_{10y} = 0 \qquad [5]$$

*Breakeven for a given spread change*
The Breakeven for a given spread change gives the curve change needed to breakeven from both the Time element **and** from the P+L effect of a given Spread change.

Exhibit 10.11: Breakeven Curve Movements Analysis – Where Current 10y-5y Curve = 77.4bp, Slide Implied 10y-5y = 99.3bp
5y / 10y Curve Movement (in bp) Needed to Breakeven With a Duration-Weighted Flattener Over 3 Months

| Chg in 5y (vs Slide Implied) bp | 5Y (Slide Implied) bp | 10Y Breakeven bp | Breakeven Curve (10Y-5Y) bp | Breakeven Curve Chg (vs current curve) bp | Breakeven Curve Chg (vs Slide implied) bp |
|---|---|---|---|---|---|
| -10 | 228 | 303 | 74.8 | -2.7 | -24.6 |
| 0 | 238 | 312 | 73.8 | -3.6 | -25.5 |
| 10 | 248 | 321 | 73.0 | -4.5 | -26.4 |

Source: JPMorgan

**Curve Trade Analysis Framework Summary:**

**1. Time:** P+L from just time passing.
- a) Carry
- b) Slide

**2. Spread Changes:** P+L if spreads change
- a) Duration
- b) Convexity
- c) Horizon Effect

**Default Risk**

**Breakevens**

In our "Calculating Breakevens" discussion at the end of this section, we show that we cannot find a *single* Breakeven number due to Convexity effects. Rather we analyse Breakevens by setting the Spread at horizon of *one leg* of our trade and calculating the curve move needed in *the other leg* to breakeven over the horizon. Typically we set the shorter leg, for example we will set our 5y Spread and calculate how the 10y point needs to move (and hence curve moves) to breakeven. This is illustrated in Exhibit 10.11, for a 5y/10y trade where the 5y is currently at 200bp and the Slide implied spread at horizon is 238bp. The grey row is our Breakeven from Time, i.e. 5y is constant over the horizon and we therefore need 3.6bp of flattening of our current curve to breakeven (column 5), which is really 25.5bp of flattening given the implied curve due to Slide. The other rows are our Breakevens for a Given Spread Change, for example if the 5y widens 10bp (to 248bp at horizon) then the 10y needs to flatten 26.4pp for the trade to breakeven. This incorporates the Convexity effects of a change in Spread.

"The Horizon Effect" discussion explains how we understand sensitivity analysis at trade horizon where the Horizon Effect will mean we can have more or less market exposure over the life of the trade – as we will see, this will help us understand our Breakeven analysis at horizon.

*Summary*

In this section we have outlined our framework for properly analysing P+L in curve trades looking at Time (Carry & Slide), Sensitivity Analysis (Duration, Convexity and Horizon Effects), Default Risk and Breakevens. We now move on to common curve trading strategies to see how we apply this in practice.

## Curve trading strategies

*Two-Legged Curve Trades*

In the first part of this Section we outlined a framework for analyzing the drivers of P+L in trades. We now turn to common curve trading strategies to understand what typically are the largest factors that influence profitability in these trades. We concentrate our analysis here on two-legged trades involving buying protection at one point in the curve and selling protection at the second to express a view on the way the shape of the curve will change. To express a view on the shape of the curve with a two-legged trade, an investor can choose from: Equal-Notional Strategies (Forwards), Duration-Weighted Strategies or Carry-Neutral Strategies.

### 1. Equal-Notional Strategies: Forwards

Equal-Notional curve trades involve buying and selling protection on equal notional at two different maturities (i.e. points on the curve). For example, an investor can buy protection on a notional of $10mm for 5 years and sell protection on a notional of $10mm for 10 years (an equal-notional flattener). This trade is effectively Default Neutral for the life of the first (earlier maturity) leg of the trade – if a default happens within the first 5 years, the investor will pay out on default for the 10y contract and will receive back equal to this on the 5y contract.

We refer to a two-legged equal notional strategy as a Forward, as the position is economically equivalent to having entered a forward-starting CDS contract (see *Trading Credit Curves I* for a full explanation of this and the derivation of the Forward equation). The 5y/5y Forward Spread ($S_{5y/5y}$) is calculated as:

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$$S_{5y/5y} = \frac{S_{10y}.A_{10y} - S_{5y}.A_{5y}}{A_{10y} - A_{5y}}$$

Market Exposure

**Equal-notional strategies are default-neutral for the life of the first leg, however they do have a significant market exposure**, since the Mark-to-Market for a 1bp spread move on each leg is:

**10y:** $MTM_{10y} = 1bp \,.\, Risky\ Annuity_{10y} \,.\, Notional_{10y}$

**5y:** $MTM_{5y} = 1bp \,.\, Risky\ Annuity_{5y} \,.\, Notional_{5y}$ where the Notionals are equal.

**Equal-Notionals are Forwards and are Therefore Market Directional**

Given that *Risky Annuity 10y* will be greater than *Risky Annuity 5y*, for any parallel spread widening the 10y leg will gain / lose much more than the 5y leg. For this reason equal-notional curve trades leave a significant market exposure. This is important for investors looking to position a curve view with an equal-notional trade. A 5y/10y equal-notional flattener is long forward-starting risk or long (risk in) the Forward. This Forward is a directional position and given that *market moves tend to be larger than moves in curves* (Average Absolute 5y 3m Change = 5.6bp, Average Absolute 10y-5y Curve 3m Change = 2.4bp, over the last 2 years on iTraxx Main), investors should be aware they are taking on this market exposure with an equal-notional curve trade, or Forward.

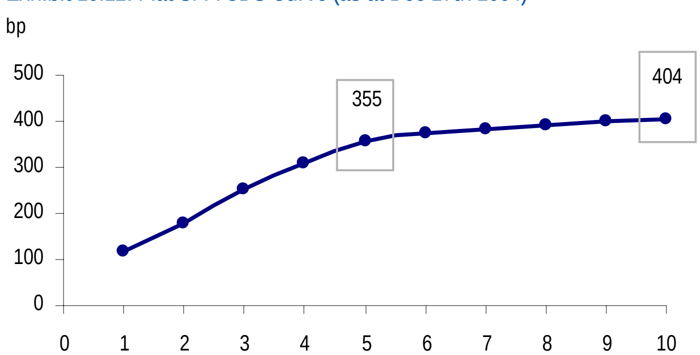
Carry

As an equal-notional strategy will pay or receive spread payments on equal notional in each leg, the Carry earned or paid by the longer dated leg will be greater than that for the shorter dated leg for upward sloping curves. That means we can say **for upward sloping curves, equal-notional Flatteners will be Positive Carry and Steepeners will be Negative Carry.**

*Equal Notional Strategies Analysed*

We will use as an example of a typical upward-sloping curve Fiat SPA, the Italian car manufacturer, to show how we apply our curve trading analysis framework. We will take the curve as of December 17th 2004 for illustration, which is shown in Exhibit 10.12.

Exhibit 10.12: Fiat SPA CDS Curve (as at Dec 17th 2004)




Source: JPMorgan

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Using a trade horizon of 6 months and putting on a 5y/10y curve flattener (buy protection in 5y, sell protection in 10y), with an equal notional of $10mm in each leg, we can illustrate the characteristics of an equal-notional strategy in Exhibit 10.13:

Exhibit 10.13: Equal Notional 5y / 10y Flattener

6 month trade horizon

| Tenor | Position | Spread bp | Notional ($) (Default Exposure) | Carry ($) Over Horizon | Slide ($) Over Horizon | Time ($) Over Horizon |
|---|---|---|---|---|---|---|
| 5Y | Buy Protection | 355 | -10,000,000 | -177,972 | -75,419 | -253,390 |
| 10Y | Sell Protection | 404 | +10,000,000 | 202,687 | 14,660 | 217,347 |
| Flattener | | | 0 | 24,715 | -60,759 | -36,043 |

Source: JPMorgan

*Time (Carry + Slide)*

The Carry on the equal-notional flattener is positive ($24,715) as we are receiving 404bp (10y spread) and paying 355bp (5y spread) on an equal notional (Exhibit 10.13). The Slide on our equal-notional flattener is negative (-$60,759) which can be characteristic of higher spread names.

Equal-notional Flatteners on lower spread names mostly have Positive Slide since lower Spread curves are often fairly linear in shape (meaning the roll down in the 5y is around the same as that in the 10y). Given that the Slide for a 6 month horizon is calculated as:

$$Slide_{5y} = (S_{5y} - S_{4.5y}) \,.\, A_{4.5y} \,.\, Ntnl_{5y} \quad and$$

$$Slide_{10y} = (S_{10y} - S_{9.5y}) \,.\, A_{9.5y} \,.\, Ntnl_{10y}$$

and since the Risky Annuity of the 9.5y will be much higher than the 4.5y Risky Annuity, the P+L from Slide on the 10y will be greater than that from the 5y in lower spread names, as the change in spread can be roughly equal in both legs. **Lower Spread equal-notional Flatteners are therefore generally Positive Slide** (see Grey Box.)

For higher spread names, the curve can often be much steeper in the short end than the long end, which makes **equal-notional Flatteners generally Negative Slide for higher spread names**. This is the case in our example (see Exhibit 10.12), since we have a steep curve in the short end of the curve compared to a flat long end we get a Negative Slide (as in Exhibit 10.13).

For this curve trade Slide dominates Carry in the Time (Carry + Slide) part of the analysis, showing that just looking at the Carry on this trade may make it look attractive, but adding in the Slide shows it will have Negative Time. **Generally for equal-notional trades, with low Spread names Carry is larger than Slide, but for higher Spread names Slide can dominate the Carry component.**

**Positive Slide in Equal Notional Flatteners:**

The positive Slide condition can be shown to be:

$$\frac{(S_{10y} - S_{9.5y})}{(S_{5y} - S_{4.5y})} > \frac{A_{4.5y}}{A_{9.5y}}$$

Since the 9.5y Annuity is usually around 2 × larger that the 4.5y Annuity, we need the ($S_{5y}$ - $S_{4.5y}$) to be less than twice ($S_{10y}$ - $S_{9.5y}$) to be Positive Slide for a Flattener. Where we have a steep curve in the short-end and a flat curve in the long end we can therefore get Negative Slide for equal-notional Flatteners.

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*Sensitivity to Spread Changes (Duration & Convexity)*
Having understood the Time component if nothing else changes, we now need to understand how our trade will perform should spreads change – we first look at the sensitivity to immediate or instantaneous changes in spreads.

Exhibit 10.14: Sensitivity to Instantaneous Spread Changes

| | -40bp Spread Chg | -20bp Spread Chg | 0bp Spread Chg | 20bp Spread Chg | 40bp Spread Chg |
|---|---|---|---|---|---|
| 1) MTM 5Y (Buy) | -172,604 | -85,614 | 0 | 84,262 | 167,192 |
| 2) MTM 10Y (Sell) | 271,344 | 133,728 | 0 | -129,958 | -256,260 |
| 3) Curve Trade | 98,740 | 48,113 | 0 | -45,696 | -89,068 |
| 4) Spread Chg × Current Annuity 5Y | -169,869 | -84,934 | 0 | 84,934 | 169,869 |
| 5) Spread Chg × Current Annuity 10Y | 263,646 | 131,823 | 0 | -131,823 | -263,646 |
| 6) Curve Trade | 93,778 | 46,889 | 0 | -46,889 | -93,778 |
| 7) Convexity Effect (Row 3 – Row 6) | 4,962 | 1,224 | 0 | 1,193 | 4,709 |

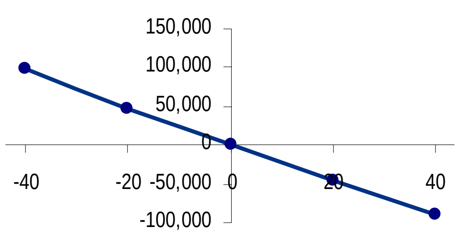
Source: JPMorgan

Exhibit 10.14 shows the MTM of our trade to parallel spread changes. We first look at the actual MTM of the trade in rows 1-3, where we can see that this trade has a large directionality to it. Exhibit 10.15 shows this graphically and we have a negative MTM for spread widening and positive MTM for spread tightening. Given the 5y/10y equal-notional Flattener is long Forward-starting risk, we should imagine a market-directionality to this position. **Investors looking to position for curve moves using an equal-notional strategy, should be aware they are taking this market risk position by trading the Forward.**

Rows 4-7 of Exhibit 10.14 show the Convexity effect in the trade, which is much smaller compared to the first order effect of spreads moving. In order to illustrate Convexity, we keep the Risky Annuities constant and look at the predicted MTM from the spread change and compare that to the actual MTM to get the MTM gain / loss from changes in Risky Annuity, i.e. the Convexity. This trade has Positive Convexity as it has a relative MTM gain for spreads tightening or widening due to changes in the Risky Annuities (Durations). **Equal-Notional Flatteners have Positive Convexity and Steepeners have Negative Convexity.**

Exhibit 10.15: Sensitivity to Instantaneous Spread Changes

x-axis: bp spread changes, y-axis: MTM ($)




Source: JPMorgan

*Sensitivity Analysis at Horizon*
We can also analyse our trade's sensitivity to spread changes at horizon. This is a more complex analysis as the Horizon Effect on the trade affects our market exposure over the life of the trade, discussed later. Exhibit 10.16 shows us the sensitivity of the position to a 20bp move in spreads wider or tighter at horizon (Carry not included). The large Negative Slide (-$60,759) means that we have a negative MTM for a spread widening and 20bp tightening at horizon, although we have a positive MTM if spreads tighten 40bp at horizon (row 3). If we look at the MTM net of Slide (row 4) we can see the market position that we have in the curve trade. In order to look at just the market position we gain over time, we finally look

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at the MTM effect less the Instantaneous MTM, in order to get just our Horizon Effect.

Exhibit 10.16: Sensitivity Analysis AT HORIZON for Equal Notional Flattener (Carry Not Included)

| | -40bp Spread Chg | -20bp Spread Chg | 0bp Spread Chg | 20bp Spread Chg | 40bp Spread Chg |
|---|---|---|---|---|---|
| 1) MTM 5Y (Buy) | -233,428 | -153,783 | -75,419 | 2,103 | 78,377 |
| 2) MTM 10Y (Sell) | 275,938 | 143,497 | 14,660 | -110,704 | -232,672 |
| 3) Curve Trade MTM at Horizon | 42,509 | -10,286 | -60,759 | -108,601 | -154,295 |
| 4) Curve Trade MTM at Horizon minus Slide | 103,268 | 50,473 | 0 | -47,842 | -93,536 |
| 5) Instantaneous MTM | 98,740 | 48,113 | 0 | -45,696 | -89,068 |
| 6) Horizon Effect (Row 4 - Row 5) | 4,528 | 2,360 | 0 | -2,146 | -4,468 |

Source: JPMorgan

In this case, we have a larger risk position due to the Horizon Effect and so lose more for spread widening and gain for spread tightening at horizon (as shown in the last row of Exhibit 10.16).

<u>Equal Notional 5y/10y Flatteners generally have increasing risk over the life of the trade due to the Horizon Effect and Steepeners have decreasing risk due to the Horizon Effect.</u>

*Default Risk*

This trade has equal notional exposure in each leg so is effectively Default-Neutral over the trade horizon.

*Breakeven Analysis*

Putting all this analysis together, the bottom line is whether our curve will flatten enough to at least breakeven. Exhibit 10.17 shows this Breakeven analysis. Given we have a flattener on, if the spread curve is constant (i.e. the 5y leg rolls down the current spread curve to its Slide-implied level) we need the 10y point to move to 397bp, as in Row 3. This looks like a *steepening* of 11.7bp vs the current 10y-5y Spread, but is really a 5.4bp curve *flattening* versus the Slide-implied curve steepness (as shown in the final column). The shaded row shows this *Breakeven for Time*. This intuitively makes sense as we need some curve flattening to counterbalance the negative Time (Slide –Carry). If Spreads do widen in the 5y point by 20bp then we need curves to flatten 13.4bp to breakeven on the trade over the 6 month horizon as we have greater negative MTM for spread widening due to the Horizon Effect making the trade longer risk. Therefore, we need a larger flattening to breakeven. The key decision in putting on this trade is therefore whether we can expect -5.4bp if spreads are unchanged or if we think spreads are widening 20bp do we think curves will flatten 13.4bp.

Exhibit 10.17: Breakevens for Equal-Notional Flattener

Current 10y-5y curve = 49bp, Slide Implied 10y-5y curve = 66bp.

| Chg in 5y (vs Slide Implied) bp | 5Y (Slide Implied) bp | 10Y Breakeven bp | Breakeven Curve (10Y-5Y) bp | Breakeven Curve Chg (vs current curve) bp | Breakeven Curve Chg (vs Slide implied) bp |
|---|---|---|---|---|---|
| -40 | 296 | 373 | 77.2 | 27.9 | 10.7 |
| -20 | 316 | 385 | 69.1 | 19.8 | 2.6 |
| 0 | 336 | 397 | 61.0 | 11.7 | -5.4 |
| 20 | 356 | 409 | 53.0 | 3.7 | -13.4 |
| 40 | 376 | 421 | 45.1 | -4.2 | -21.3 |

Source: JPMorgan

*Trade Performance Analysis*

We can finally look at the likely trade performance for different spread levels in our 5y and 10y legs over the horizon in Exhibit 10.18.

### Exhibit 10.18: Trade Performance Analysis

Vertical spreads are centered around Slide Implied 5y Spreads (bp) at horizon, Horizontal are centered around 10y Spreads at horizon (bp). Data is trade MTM ($) incl. Carry at horizon

| | | Current 10y at Horizon** | | | | |
|---|---|---|---|---|---|---|
| | | 362 | 382 | 402 | 422 | 442 |
| | 296 | 70,765 | -60,563 | -190,330 | -318,544 | -445,212 |
| | 316 | 147,036 | 16,917 | -111,651 | -238,676 | -364,166 |
| Current 5y at Horizon* | 336 | 221,867 | 92,929 | -36,043 | -160,337 | -284,679 |
| | 356 | 295,295 | 167,511 | 41,254 | -83,484 | -206,707 |
| | 376 | 367,359 | 240,703 | 115,560 | -8,074 | -130,208 |

Source: JPMorgan. * Slide Implied spread of current 5y at Horizon, ** Slide Implied spread of current 10y at Horizon.

We can see that this trade performs well for curve flattening (10y spread decreases or 5y spread increases) and due to the Negative Time, if spreads are unchanged it loses money over the horizon. This is what we would expect from a flattener trade – it profits as the curve flattens and will lose money increasingly as the curve steepens. Importantly we now have a way to accurately assess this P+L and so can take a view on whether we think the curve will flatten enough to make the trade profitable.

## Summary of Equal Notional Characteristics

The P+L and Sensitivity characteristics for equal-notional curve trades (for 5y/10y trades on typical upward sloping curves) are summarised in Exhibit 10.19 and Exhibit 10.20.

### Exhibit 10.19: P+L Characteristics for Equal Notional Curve Trades

| | Carry | Slide | Dominant Time Effect (Carry or Slide) | 1bp Instantaneous Widening | Default |
|---|---|---|---|---|---|
| Flattener | Positive | Low Spread = Positive<br>High Spread = Negative | Low Spread = Carry<br>High Spread = Slide | MTM Loss | Neutral |
| Steepener | Negative | Low Spread = Negative<br>High Spread = Positive | Low Spread = Carry<br>High Spread = Slide | MTM Gain | Neutral |

Source: JPMorgan

### Exhibit 10.20: Sensitivity Summary for Equal Notional Curve Trades

| | 1bp Instantaneous Widening | Convexity from Spread Chg | Horizon Impact for 5y/10y Trade |
|---|---|---|---|
| Flattener | MTM Loss | Positive | Longer risk over horizon |
| Steepener | MTM Gain | Negative | Shorter risk over horizon |

Source: JPMorgan

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## 2. Duration-weighted strategies

We have seen that a major feature of equal-notional trades is the large MTM effect from parallel curve moves which may not be particularly desirable for an investor who is just trying to express a view on the relative movement of points in the curve. In order to immunize curve trades for parallel curve moves we can look to weight the two legs of the trade so that for a 1bp parallel move in spreads, the Mark-to-Market on each leg is equal – we call this Duration-Weighting the trade. We can do this by fixing the Notional of one leg of the trade, for example set the 10y Notional to $10mm, and can then solve to find the Notional of the 5y leg so that the trade is MTM neutral for a 1bp move in Spreads.

For a curve trade at Par, the Mark-to-Market of each leg for a 1bp shift in Spreads is given by[16]:

$MTM_{10y} = 1bp.Duration_{10y}.Ntnl_{10y}$, and equivalent for the 5y

The Duration-Weighted trade adjusts the Notionals so that:

$MTM_{10y} = MTM_{5y}$ for a 1bp parallel move in spreads,

i.e. $\cancel{1bp} \,.\, Duration_{10y} \,.\, Ntnl_{10y} = \cancel{1bp} \,.\, Duration_{5y} \,.\, Ntnl_{5y}$

$$Ntnl_{5y} = \frac{Duration_{10y}}{Duration_{5y}}.Ntnl_{10y}$$

*Default Exposure*

As we have adjusted the 5y notional exposure to be larger than the 10y, we now have default exposure over the life of the trade as a default in the first 5 years will mean paying out or receiving (1-Recovery) on a larger notional.

**Duration-weighted strategies analysed**

We continue with our Fiat SPA example to see how we should analyse our Duration-Weighted trade whose structure is shown in Exhibit 10.21.

**Time (Carry & Slide)**

Looking first at our Carry in Exhibit 10.21, we can see that we have Negative Carry (-$73,535) over the trade horizon. **Duration-weighted flatteners are typically Negative Carry unless for very steep curves** (see the Grey Box for an explanation of this)**.**

Exhibit 10.21: Duration-Weighted 5y / 10y Flattener

6 month trade horizon

| Tenor | Position | Spread bp | Notional ($) (Default Exposure) | Carry ($) Over Horizon | Slide ($) Over Horizon | Time ($) Over Horizon |
|---|---|---|---|---|---|---|
| 5Y | Buy Protection | 355 | -15,520,593 | -276,223 | -117,054 | -393,277 |
| 10Y | Sell Protection | 404 | +10,000,000 | 202,687 | 14,660 | 217,347 |
| Flattener | | | -5,520,593 | -73,535 | -102,394 | -175,930 |

Source: JPMorgan

[16] See *Trading Credit Curves I* for a discussion of Risky Duration and Risky Annuity. For a curve trade at Par and for a 1bp change in spreads only the MTM can be expressed using the Risky Duration, for other moves we need to use the Risky Annuity.

**Positive Carry Duration-Weighted Flatteners**

To Duration-Weight a trade we set: $Ntnl_{5y} = \frac{Duration_{10y}}{Duration_{5y}}.Ntnl_{10y}$

Given that the Carry in each leg is given by (e.g. for the 5y): $Carry_{5y} = S_{5y} \,.\, Ntnl_{5y} \,.\, Horizon$

We can see that: $Carry_{5y} = S_{5y}.\frac{Duration_{10y}}{Duration_{5y}}.Ntnl_{10y}.Horizon$

For a Duration-Weighted Flattener to be Positive Carry, we need: $S_{10y} > S_{5y}.\frac{Duration_{10y}}{Duration_{5y}}$

which is generally not the case unless curves are very steep.

We also have significant Negative Slide over the horizon as the 5y part of the curve is much steeper than the 10y part and therefore there is larger Negative Slide here, as Exhibit 10.12 shows.

**Generally for Duration-Weighted Flatteners Slide is Negative and for Steepeners Slide is Positive**. This is because the Risky Annuity × Notional is approximately equal in both legs (the Duration-Weighting condition), so the MTM due to Slide is largely about whether the spread change is greater in the shorter leg or the longer leg. As most curves are steeper in the short end, this means the short end has a greater MTM from Slide, hence flatteners have negative Slide and steepeners have positive Slide.

**For Duration-Weighted trades Slide dominates Carry in the Time consideration** meaning Carry alone is not sufficient to assess likely profitability of a trade in an unchanged spread environment. The Duration-Weighted 'holy grail' of the *Positive Carry Flattener* will most likely be P+L negative if curves remain unchanged as Slide will be negative and will dominate the Carry effect.

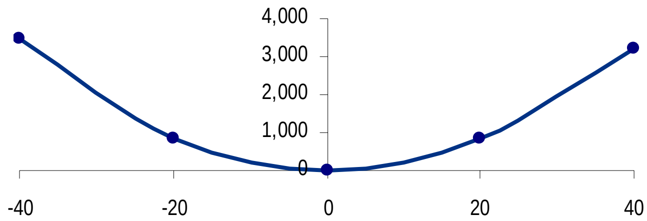
**Sensitivity to Spread Changes (Duration & Convexity)**

In terms of parallel curve movements (Duration effect) we have structured the trade so that it should be MTM neutral for a 1bp parallel change in spreads of the curve. However, there is also a Convexity impact from Spread widening to understand.

Exhibit 10.22 shows this Convexity impact for larger spread changes on our Duration-Weighted Flattener. We can see that for large spread widening or tightening the position has a positive MTM. We call this Positive Convexity and **Duration-Weighted Flatteners usually have Positive Convexity and Steepeners have Negative Convexity** (see the first section of this note, *The Drivers of P+L in Curve Trades*, for an explanation of this)

Exhibit 10.22: Convexity for Duration-Weighted Flattener

x-axis: parallel chg (bp), y-axis: P+L at horizon from curve position




Source: JPMorgan

Exhibit 10.23 shows this analysis in more detail, where Row 3 has the *actual* MTM from (instantaneous) spread moves and Row 6 shows the *expected* MTM from spread moves using the current Risky Annuities – given we are Duration-Weighted this is zero. The Convexity effect (Row 7) is then just the actual MTM minus the expected MTM using the current Risky Annuities.

Exhibit 10.23: Sensitivity Analysis for Spread Changes

| | -40bp Spread Chg | -20bp Spread Chg | 0bp Spread Chg | 20bp Spread Chg | 40bp Spread Chg |
|---|---|---|---|---|---|
| 1) MTM 5Y (Buy) | -267,892 | -132,879 | 0 | 130,779 | 259,492 |
| 2) MTM 10Y (Sell) | 271,344 | 133,728 | 0 | -129,958 | -256,260 |
| 3) Curve Trade | 3,452 | 849 | 0 | 821 | 3,232 |
| 4) Spread Chg × Current Annuity 5Y | -263,646 | -131,823 | 0 | 131,823 | 263,646 |
| 5) Spread Chg × Current Annuity 10Y | 263,646 | 131,823 | 0 | -131,823 | -263,646 |
| 6) Curve Trade | 0 | 0 | 0 | 0 | 0 |
| 7) Convexity Effect (Row 3 – Row 6) | 3,452 | 849 | 0 | 821 | 3,232 |

Source: JPMorgan

**Sensitivity Analysis at Horizon**

Having seen our sensitivity to instantaneous spread changes, we can now look at our sensitivities to spread changes at the horizon of the trade. Exhibit 10.24 shows the MTM (without Carry) from the trade in both a Parallel Widening and Tightening at horizon. The trade has negative MTM in both, which is mostly due to the large negative Slide that we saw in this trade. However, the sensitivity to spread widening and tightening at the trade horizon also contains a Horizon Effect. As we discuss in "The Horizon Effect", our Duration-Weighted trade will become market directional over its life due to this Effect. We can see this in Exhibit 10.24 as we get a market directional position where we have relative positive MTM for spreads tightening and negative for spreads widening (row 7 of Exhibit 10.24).

Exhibit 10.24: P+L Sensitivity Analysis for Duration-Weighted Flattener

| | -40bp Spread Chg | -20bp Spread Chg | 0bp Spread Chg | 20bp Spread Chg | 40bp Spread Chg |
|---|---|---|---|---|---|
| 1) MTM 5Y (Buy) | -362,295 | -238,680 | -117,054 | 3,264 | 121,645 |
| 2) MTM 10Y (Sell) | 275,938 | 143,497 | 14,660 | -110,704 | -232,672 |
| 3) Curve Trade MTM at Horizon | -86,357 | -95,183 | -102,394 | -107,440 | -111,026 |
| 4) Curve Trade MTM at Horizon minus Slide | 16,037 | 7,211 | 0 | -5,045 | -8,632 |
| 5) Instantaneous MTM | 3,452 | 849 | 0 | 821 | 3,232 |
| 6) Horizon Effect (Row 4 – Row 5) | 12,585 | 6,363 | 0 | -5,867 | -11,864 |

Source: JPMorgan

Exhibit 10.25 illustrates the Horizon Effect graphically – the full workthrough of this is detailed later in our discussion.

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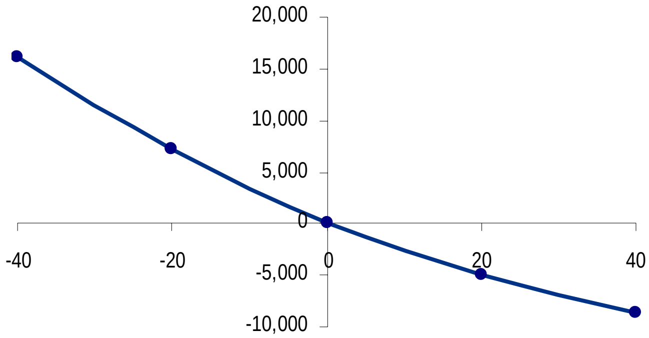
Exhibit 10.25: Sensitivity Analysis at Horizon (less Slide)

x-axis: parallel chg (bp), y-axis: P+L at horizon from curve position at horizon less Slide




Source: JPMorgan

<u>5y/10y Duration-Weighted Flatteners generally get longer risk over the horizon of the trade and steepeners get shorter risk over the horizon.</u>

**Default Risk**

We can see from Exhibit 10.21 that we are short default risk for the trade horizon, as we have bought protection on a larger notional than we sold protection on, meaning we benefit if there is a default in the first 5 years. **Duration-Weighted Flatteners will always be short default risk as they will always have a larger notional in the shorter leg in order to balance the Duration effects; Steepeners will be long default risk.**

**Breakevens**

Once we have done all of our analysis, we can finally look at the Breakevens for our Duration-Weighted Flattener in Exhibit 10.26. The shaded row shows the Breakeven curve move needed to compensate for the unchanged spread scenario, i.e. to compensate for the Time effect. Due to the large Slide effect in Time, we need 27.2bp of curve flattening to Breakeven from Time in this trade (shaded row, column 6). We can also see the Breakeven curve moves needed for spread widening or tightening at the 5y point (more on how we analyse Breakevens at the end of the Section). As our Horizon Effect makes us longer risk over the life of the trade, we need increasing flattening if spreads widen at horizon, as Exhibit 10.26 shows.

Exhibit 10.26: Breakeven for Duration-Weighted Flattener

Current 10y-5y curve = 49bp, Slide Implied 10y-5y curve = 66bp.

| Chg in 5y (vs Slide Implied) bp | 5Y (Slide Implied) bp | 10Y Breakeven bp | Breakeven Curve (10Y-5Y) bp | Breakeven Curve Chg (vs current curve) bp | Breakeven Curve Chg (vs Slide implied) bp |
|---|---|---|---|---|---|
| -40 | 296 | 339 | 43.4 | -5.9 | -23.1 |
| -20 | 316 | 357 | 41.2 | -8.1 | -25.2 |
| 0 | 336 | 375 | 39.3 | -10.0 | -27.2 |
| 20 | 356 | 393 | 37.6 | -11.7 | -28.9 |
| 40 | 376 | 412 | 36.0 | -13.3 | -30.4 |

Source: JPMorgan

Exhibit 10.27 analyses the trade performance at horizon, where we can see that our Duration-Weighted flattener will only perform if we have larger curve flattening due to the large negative Time for this trade. For example, if the 5y point is unchanged (and we therefore move to the Slide Implied 5y of 336bp over the horizon, shaded row), the 10y point needs to flatten 40bp for the trade to breakeven. A trader or investor looking to put on this flattener would need to decide whether they think that this magnitude of flattening is likely in order to want to put on this trade.

Exhibit 10.27: Trade Performance Analysis

Vertical spreads are centered around Slide Implied 5y Spreads (bp)at horizon, Horizontal are centered around 10y Spreads at horizon (bp). Data is trade MTM ($) incl. Carry at horizon

| | | Current 10y at Horizon** | | | | |
|---|---|---|---|---|---|---|
| | | 362 | 382 | 402** | 422 | 442 |
| | 296 | -153,750 | -285,390 | -415,478 | -544,025 | -671,040 |
| | 316 | -34,210 | -164,528 | -293,301 | -420,538 | -546,249 |
| Current 5y at Horizon* | 336* | 83,078 | -45,954 | -175,930 | -299,418 | -423,864 |
| | 356 | 198,174 | 70,393 | -55,862 | -180,596 | -303,817 |
| | 376 | 311,138 | 184,574 | 59,526 | -64,010 | -186,042 |

Source: JPMorgan. * Slide Implied spread of current 5y at Horizon, ** Slide Implied spread of current 10y at Horizon.

## *Summary of Duration-Weighted Characteristics*

The P+L and Sensitivity characteristics for Duration-Weighted curve trades (for 5y/10y trades on typical upward sloping curves) are summarised in Exhibit 10.28 and Exhibit 10.29.

Exhibit 10.28: P+L Characteristics for Duration-Weighted Trades

| | Carry | Slide | Dominant Time Effect (Carry or Slide) | 1bp Instantaneous Widening | Default |
|---|---|---|---|---|---|
| Flattener | Generally Negative | Generally Negative | Generally Slide | MTM Neutral | Short Risk |
| Steepener | Generally Positive | Generally Positive | Generally Slide | MTM Neutral | Long Risk |

Source: JPMorgan

Exhibit 10.29: Sensitivity Summary for Duration-Weighted Curve Trades

| | 1bp Instantaneous Widening | Convexity from Spread Chg | Horizon Impact for 5y/10y Trade |
|---|---|---|---|
| Flattener | MTM Neutral | Positive | Longer risk over horizon |
| Steepener | MTM Neutral | Negative | Shorter risk over horizon |

Source: JPMorgan

## 3. Carry-neutral strategies

A third way of looking to structure two-legged curve trades in credit is to look at putting on these trades Carry Neutral. By 'Carry Neutral' we mean that the income earned on both legs is the same over the trade horizon.

We define the Carry on a 5y CDS contract as: $Carry_{5y} = S_{5y} \,.\, Horizon \,.\, Ntnl_{5y}$

Where,
$S_{5y}$ = Par Spread on 5y maturity CDS contract
$Horizon$ = Year fraction of trade horizon
$Ntnl_{5y}$ = Notional of 5y CDS contract

The Carry-Neutral condition is that: $Carry_{Legx} = Carry_{Legy}$

For a 5y / 10y flattener (buy protection 5y, sell protection 10y):

$$S_{5y}.\cancel{Horizon}.Ntnl_{5y} = S_{10y}.\cancel{Horizon}.Ntnl_{10y}$$

Therefore, to be Carry-Neutral where we want to buy $10m of notional protection in the 10y, we need to sell protection on the following notional in the 5y leg:

$$Ntnl_{5y} = \frac{S_{10y}}{S_{5y}}.Ntnl_{10y}$$

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Carry-Neutral strategies can be useful for investors who want to avoid P+L from interim cashflows and would like pure P+L from curve movements.

**Carry-neutral strategies with our analysis framework**

Without going through all of the features of Carry-Neutral strategies, we can see that the Carry-Neutral trade can have some of the characteristics to Duration-Weighted strategies. We use our Fiat SPA trade as before to briefly show the characteristics of Carry-Neutral Flattener trades.

**Time (Carry & Slide)**

Looking at Exhibit 10.30, we can see that we have zero Carry over the horizon (by definition) and negative Slide of -$71,232, which will be the Time (as Carry is zero).

Exhibit 10.30: Time Analysis for Carry-Neutral Trade

| Tenor | Position | Spread bp | Notional ($) (Default Exposure) | Carry ($) Over Horizon | Slide ($) Over Horizon | Time ($) Over Horizon |
|---|---|---|---|---|---|---|
| 5Y | Buy Protection | 355 | -11,388,732 | -202,687 | -85,892 | -288,580 |
| 10Y | Sell Protection | 404 | +10,000,000 | 202,687 | 14,660 | 217,347 |
| Flattener | | | -1,388,732 | 0 | -71,232 | -71,232 |

Source: JPMorgan

**Sensitivity to spread changes (Duration & Convexity)**

We can see that our Carry-Neutral strategy is long risk for spread moves (see Row 3 of Exhibit 10.31) and has negative MTM for spread widening and positive MTM for spread tightening. If $S_{10y}/S_{5y}$ is less than $Duration_{10y} / Duration_{5y}$ then a Carry-Neutral flattener will be long spread risk as it will have bought less notional protection in the 5y leg than it needs to be Duration-Weighted so it will have negative MTM for spread widening. **Carry-Neutral trades on low spread names tend to be mixed in terms of being long or short spread risk**; **higher spread names tend to be long risk.** Additionally, this has Positive Convexity and therefore loses relatively less for spread widening and makes relatively more for spread tightening (Row 7).

The Horizon Effect for Carry-Neutral flatteners also makes the position longer risk, meaning at horizon we have a negative MTM for spreads widening (relative to the start) and positive MTM for spreads tightening (relative to the start).

Exhibit 10.31: P+L Analysis for Carry-Neutral Flattener

| | -40bp Spread Chg | -20bp Spread Chg | 0bp Spread Chg | 20bp Spread Chg | 40bp Spread Chg |
|---|---|---|---|---|---|
| 1) MTM 5Y (Buy) | -196,574 | -97,504 | 0 | 95,963 | 190,411 |
| 2) MTM 10Y (Sell) | 271,344 | 133,728 | 0 | -129,958 | -256,260 |
| 3) Curve Trade | 74,770 | 36,224 | 0 | -33,994 | -65,850 |
| 4) Spread Chg × Current Annuity 5Y | -193,459 | -96,729 | 0 | 96,729 | 193,459 |
| 5) Spread Chg × Current Annuity 10Y | 263,646 | 131,823 | 0 | -131,823 | -263,646 |
| 6) Curve Trade | 70,187 | 35,094 | 0 | -35,094 | -70,187 |
| 7) Convexity Effect (Row 3 – Row 6) | 4,582 | 1,130 | 0 | 1,099 | 4,338 |

Source: JPMorgan

**Default risk**

**For upward sloping curves, Carry-Neutral Flatteners will be short default risk and Steepeners will be long default risk.** We tend to see lower Spread names having a larger short default risk position than higher Spread names, as the ratio of spreads between 10y and 5y is generally higher for lower Spread names as curves are more linear.

## *Summary of Carry-Neutral Characteristics*

The P+L and Sensitivity characteristics for Carry-Neutral curve trades (for 5y/10y trades on typical upward sloping curves) are summarised in Exhibit 10.32 and Exhibit 10.33.

Exhibit 10.32: P+L Characteristics for Carry-Neutral Trades

| | Carry | Slide | Dominant Time Effect (Carry or Slide) | 1bp Instantaneous Widening | Default |
|---|---|---|---|---|---|
| Flattener | Zero (by definition) | Negative | Slide (by definition) | Lower Spread: Mixed<br>Higher Spread: Generally Negative | Short Risk |
| Steepener | Zero (by definition) | Positive | Slide (by definition) | Lower Spread: Mixed<br>Higher Spread: Generally Positive | Long Risk |

Source: JPMorgan

Exhibit 10.33 : Sensitivity Summary for Carry-Neutral Curve Trades

| | 1bp Instantaneous Widening | Convexity from Spread Chg | Horizon Impact for 5y/10y Trade |
|---|---|---|---|
| Flattener | Lower Spread: Mixed<br>Higher Spread: Generally Negative | Positive | Longer risk over horizon |
| Steepener | Lower Spread: Mixed<br>Higher Spread: Generally Positive | Negative | Shorter risk over horizon |

Source: JPMorgan

## Different ways of calculating slide

We talk of Slide as the effect from moving down the credit curve over time *assuming that the credit curve is unchanged*. However, there are two ways that we could understand that the *credit curve is unchanged* which would give rise to two ways of calculating Slide:

i) Hazard Rates / Spreads for a given tenor are kept constant[17]

ii) Hazard Rates for a given calendar point are kept constant

**i) Hazard rates / spreads for a given tenor constant**

Keeping spreads constant for each tenor means that if the 5y point is currently at 100bp (for maturity in March 2011), the 5y point will still be at 100bp at horizon. If our trade horizon is 1 year and we have a 5y contract, our March 2011 maturity will become a 4y over the horizon and therefore rolls down the spread curve to be at 90bp (e.g.). This will mean that the survival probability is higher for this shorter maturity and a long risk CDS position will have a positive MTM equal to: - (Spread 5y – Spread 4y) × Risky Annuity 4y × Notional.

We can illustrate what this Slide means in terms of default probabilities and hazard rates in Exhibit 10.34 and Exhibit 10.35.

[17] See *Trading Credit Curves I* for a full discussion of the role of hazard rates in CDS pricing.

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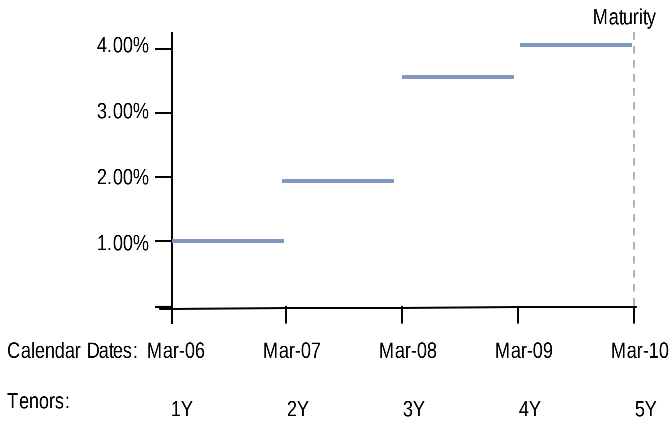
Exhibit 10.34: Initial Hazard Rates at Inception of CDS Contract

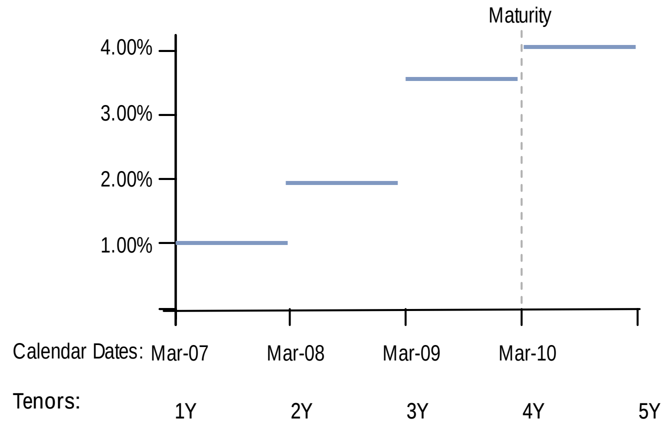
Hazard Rates, %




Source: JPMorgan

Exhibit 10.35: 1 Year Slide - Hazard Rates Constant at Tenors

Hazard Rates, %




Source: JPMorgan

Keeping hazard rates constant at each tenor means keeping the hazard rate for the 1y period constant even though we move on in time. This is the equivalent of keeping your spreads curve constant. As you have 1 year less until maturity, there will be lower default probability which gives you a Slide effect as you move down the spread curve.

We could therefore look at our Slide as the P+L if the spreads for each future given tenor stay constant.

**ii) Hazard rates constant for each calendar point**

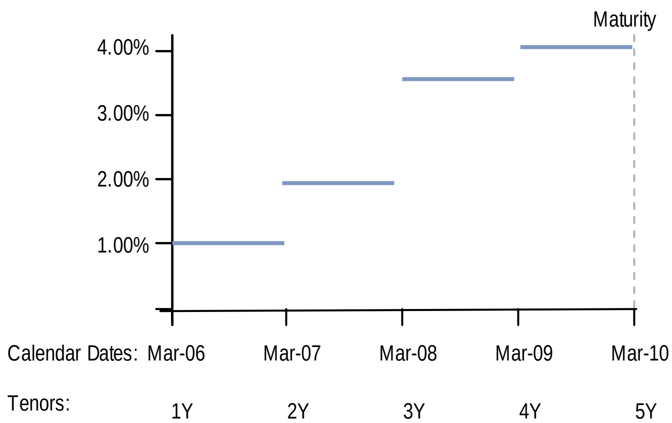
The other '*assuming no change*' scenario that we could mean when we look at our Slide is the hazard rates staying constant **for each calendar point** (e.g. between March 2007 and March 2008). We have seen that the current spread curve implies a hazard rate for each period. For example, it may imply that the conditional probability of default between March 2007 and March 2008 is 2.00% and likewise we have an implied hazard rate for each maturity point (as in Exhibit 10.36). These hazard rates could be founded on company fundamentals – for example, Company ABC has a large amount of outstanding debt needing refinancing around March 2007 and therefore it may have a higher probability of default at that calendar period due to risks around refinancing this debt.

We may therefore want to keep our hazard rates constant for each calendar point so that between March 2007 and March 2008 the hazard rate stays at 2.00% when we slide over time, as shown in Exhibit 10.37. We could re-price our CDS contract after our 1 year horizon assuming that these hazard rates are constant for each calendar date.

This would result in a lower positive MTM than method i) for upward sloping curves.

Exhibit 10.36: Initial Hazard Rates at Inception of CDS Contract

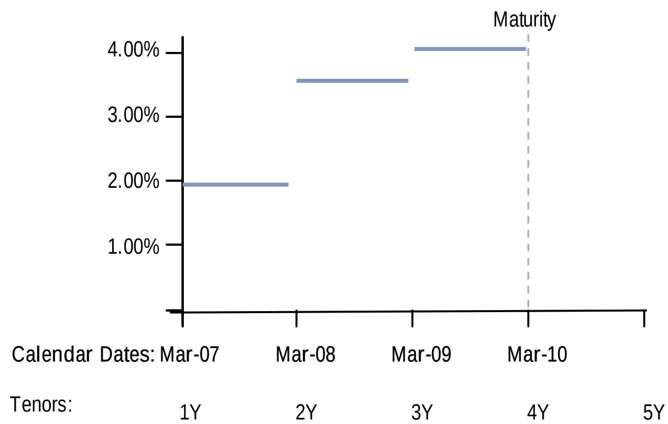
Hazard Rates, %




Source: JPMorgan

Exhibit 10.37: 1 Year Slide - Hazard Rates Constant at Calendar Dates

Hazard Rates, %




Source: JPMorgan

In practice, we would expect the view from the trading desk to be more i), i.e. keep spreads constant for each tenor (e.g. 5y). The view from analysts however may be more inclined towards ii), i.e. keep the conditional probabilities of default constant for each future date. In our calculations we use the Slide calculated using i), keeping spreads constant for each maturity length.

## Calculating breakevens

We can see that the MTM (Mark to Market) on a 5y/10y curve flattener (bought 5y protection, sold 10y protection) is:

$$MTM_{Curve\ Trade,\ t\ to\ t+1} = (\Delta S_{5y,\ t\ to\ t+1} \,.\, A_{5y,t+1} \,.\, Ntnl_{5y}) \ + \ (-\Delta S_{10y,\ t\ to\ t+1} \,.\, A_{10y,t+1} . Ntnl_{10y})$$

*Where,*

$S_{5y,\ t+1}$ = Spread for a 5y maturity as at time $t+1$

$\Delta S_{5y} = S_{5y,\ t+1} - S_{5y,\ t}$

$\Delta S_{10y} = S_{10y,\ t+1} - S_{10y,\ t}$

$A_{5y,t+1}$ = Risky Annuity for 5y maturity at time $t+1$

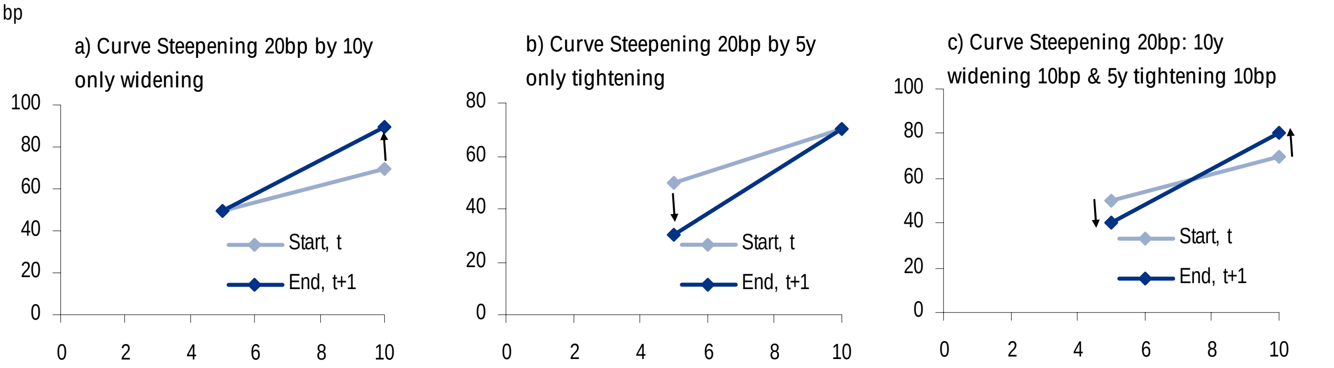
$Ntnl_{5y}$ = Notional of 5y contract.

We would like to think of finding a single breakeven curve change such that this equation gives us MTM = 0, in other words it breaks even. However, given there is Convexity in our curve trades we cannot solve for a single number as the Risky Annuities will change for each different change in spreads.

We can illustrate this by looking at three ways in which curves could steepen 20bp. In scenario a) only the 10y point widens 20bp, in b) only the 5y point tightens 20bp and in c) the curve pivots with the 10y widening 10bp and the 5y tightening 10bp. The Mark-to-Market in all these will be different as the Risky Annuities will be different in each scenario, so we cannot find a single number that will give us a Exhibit 10.38 breakeven.

Exhibit 10.38: Illustration of a 20bp Curve Steepening Causing Different Mark to Markets

bp




Source: JPMorgan

In practice, we therefore analyse Breakevens by looking at discrete changes in a given point (say the shorter maturity leg for ease sake) and then calculate at how much the longer maturity leg needs to move such that our trade MTM = 0.

We can therefore define $Breakeven\ Curve_{t+1} \mid S_{n,\,t+1} = S'$ as the breakeven Curve at time $t+1$ conditional on the Spread at the $n$ year point at $t+1$ being $S'$. For example, if the 5y point ($S_{5,\,t+1,}$) is at 50bp ($S'$) at the trade horizon $t+1$, where does the Curve need to be so that the 10y point ensures that the MTM = 0 for a 5y / 10y curve trade. We can show these Breakevens as a range around the current spread as in Exhibit 10.39. The Breakeven for Time is the highlighted row where the 5y point is unchanged over the horizon. The other rows represent Breakevens for a Given 5y Spread Change. We change the 5y spread to see how far the curve has to steepen or flatten at the 10y point for the trade to breakeven given the 5y Spread change and the effect of Time. The real Breakeven needs to show how much the curve needs to flatten or steepen versus the Slide Implied Curve (this is shown in the final column) as the Slide will imply a natural curve move over the life of the trade.

Exhibit 10.39: Breakeven Curve Movements Analysis

5y/10y Curve Movement (in bp) Needed to Breakeven With a Duration-Weighted Flattener Over 3 Months

| Chg in 5y (vs Slide Implied) bp | 5Y (Slide Implied) bp | 10Y Breakeven bp | Breakeven Curve (10Y-5Y) bp | Breakeven Curve Chg (vs current curve) bp | Breakeven Curve Chg (vs Slide implied) bp |
|---|---|---|---|---|---|
| -40 | 296 | 339 | 43.4 | -5.9 | -23.1 |
| -20 | 316 | 357 | 41.2 | -8.1 | -25.2 |
| 0 | 336 | 375 | 39.3 | -10.0 | -27.2 |
| 20 | 356 | 393 | 37.6 | -11.7 | -28.9 |
| 40 | 376 | 412 | 36.0 | -13.3 | -30.4 |

Source: JPMorgan

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## The Horizon Effect

Sensitivity analysis of curve trades at their horizon can be a complex issue. Here we examine the Horizon Effect on curve trades, which we define as the impact of the trade horizon on a trade's sensitivity to parallel spread changes.

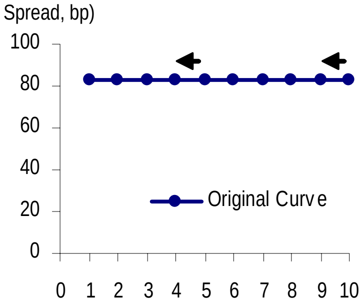
The Horizon Effect can be most easily seen by the difference in our sensitivity analysis for a Duration-Weighted trade between *instantaneous* changes in spread and changes in spread *at horizon*. The reason we have a Horizon Effect is because our Risky Annuities change over the life of a trade. This causes a Duration-Weighted trade – which is intended to be neutral to directional (parallel) spread moves – to become longer or shorter spread risk over the life of the trade. In other words, the change in Risky Annuities (and Durations) causes the trade to be un-Duration-Weighted over the trade horizon. So why do Risky Annuities change over the life of a curve trade?

## Changing Risky Annuities over the Trade Horizon

There are two effects that cause Risky Annuities change over a trade horizon, if the curve itself is unchanged:

Exhibit 10.40: Maturity Effect

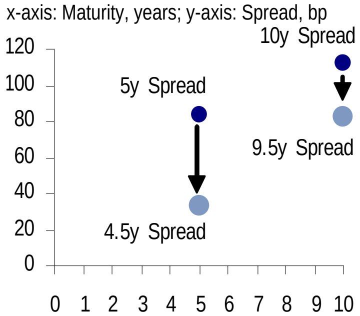
Flat Spread Curve (x-axis: Maturity, years; y-axis: Spread, bp)




Source: JPMorgan

Exhibit 10.41: Roll / Slide Effect (bp)

x-axis: Maturity, years; y-axis: Spread, bp




Source: JPMorgan

**a) Impact of maturity decreasing**

*As the length of time to maturity decreases, Risky Annuities fall and shorter-dated Risky Annuities fall* **more** *than longer-dated Risky Annuities*. For example, the effect of 6 months of time passing could make the 10y Risky Annuity decrease from 8.50 to 8.25 and the 5y decrease from 4.50 to 4.00. This is easiest to illustrate by picturing a flat curve as shown in Exhibit 10.40, where only the effect of time passing changes the Risky Annuities.

As our shorter leg Risky Annuity declines faster, we will no longer be Duration-Weighted. Essentially we will be getting longer risk in a Flattener, as we will not have enough protection in our short risk leg of the trade at horizon to be Duration-Weighted.

**b) Roll Down / slide effect**

Given that credit curves are typically upward sloping and often steeper at the short end than at the long end, the roll-down or Slide effect typically has the effect of a non-parallel tightening of a curve trade, as shown in Exhibit 10.41.

*Spread tightening will mean that Risky Annuities rise in both legs.*

We call the net effect of both of these factors on Risky Annuities changing over time the Horizon Effect. The net effect will depend on the shape of the particular curve and time horizon, but for normal shaped curves (e.g. our previous example of Fiat SPA) and for 5y/10y trades, maturity effect will tend to dominate the roll down effect.

## A worked example

A real-life example will help to show how the Horizon Effect of changing Risky Annuities affects the directional position of a trade. We will look at a our example from the main body of the note, a Duration-Weighted curve flattener on Fiat SPA where we buy protection in 5y and sell protection in 10y Duration-Weighted (as shown in Exhibi VII.3). We analyse this curve trade for a 6 month horizon. The curve for Fiat SPA is shown in Exhibit 10.43.

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Exhibit 10.42: Worked Convexity Example – Duration-Weighted Flattener on Fiat SPA

| Tenor | Position | Spread bp | Notional ($) (Default Exposure) | Risky Annuity |
|---|---|---|---|---|
| 5Y | Buy Protection | 355 | -15,520,593 | 4.25 |
| 10Y | Sell Protection | 404 | +10,000,000 | 6.59 |

Source: JPMorgan

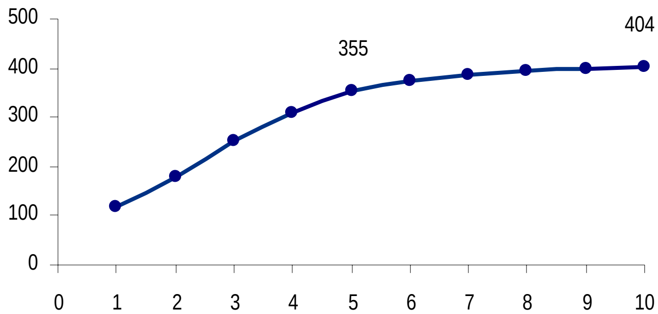
**Positive Convexity from Parallel Spread Moves in Isolation**

## Instantaneous parallel spread moves

If the curve moves parallel wider or tighter, Risky Annuities change in our Duration-Weighted trade giving us a Convexity impact (as shown in Exhibit 10.44). As we have seen, a Flattener has a Positive Convexity meaning it has a positive MTM effect from both a tightening and widening of spreads.

Exhibit 10.43: Fiat SPA Credit Curve

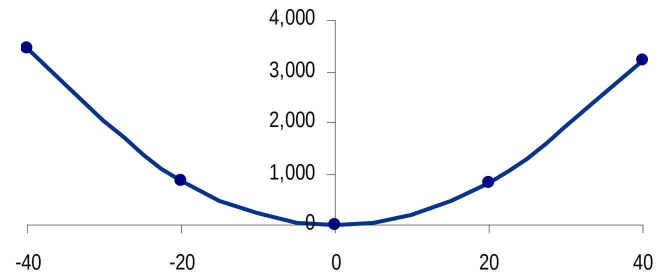
x-axis: Maturity in years; y-axis: Spread, bp




Source: JPMorgan

Exhibit 10.44: Convexity Effect for (Instantaneous) 20bp Parallel Curve Shifts

x-axis: parallel curve move in bp; y-axis: MTM ($)



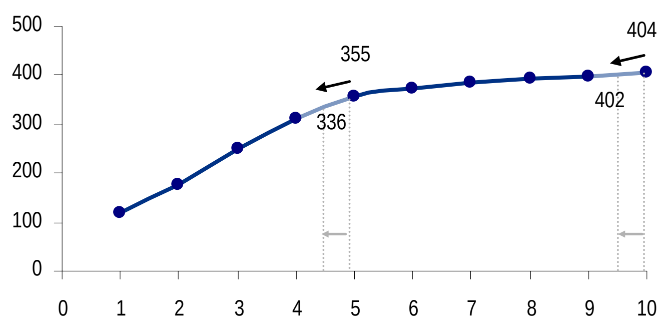

Source: JPMorgan

## Horizon Effect on Risky Annuities

As the trade Slides over the trade horizon we will get both a shortening of maturity and a non-parallel tightening of spreads. We can see this effect in Exhibit 10.45 where we have the maturity declining 6 months and the spreads tightening from 355bp to 336bp in the 5y leg of the trade and from 404bp to 402bp in the 10y leg of the trade.

Exhibit 10.45: Slide Impact on Spread and Maturity

bp




Source: JPMorgan

The roll (tightening) effect should make Risky Annuities rise and the Maturity effect will mean that Risky Annuities will fall, with the 5y Risky Annuity falling more than the 10y. The net results of these different Slide effects will differ case by case.

In our example, where the trade horizon is 6 months, the 5y Risky Annuity ends up moving from 4.25 to 3.92 (-0.33) and the 10y Risky Annuity ends up moving from 6.59 to 6.42 (-0.17), i.e. our 5y Risky Annuity falls more than our 10y. This makes our trade longer risk over the horizon. Exhibit 10.46 shows how we work through this. We look at the current Duration-Weighting (column 6) and then using our Slide Implied horizon Risky Annuities look at how we should be Duration-Weighting at horizon, assuming the curve is unchanged. The difference can be seen in the final column, the Horizon Effect. We can see that as our 5y Risky Annuity falls more, we should be buying more protection (shorter risk) at horizon. I.e. to be Duration-Weighted at horizon we need to have bought protection on $16,373,090 but we have only bought protection on $15,520,593. Essentially, we are less short than we should be in the 5y leg (+$852,498), so we have become longer risk over the life of the trade.

Exhibit 10.46: Change in Annuities and Horizon Effect

| | Current Spread (bp) | Slide Implied Spread (bp) | Current Annuity | Slide Implied Annuity | Current Duration-Weighting | Horizon Duration-Weighting | Horizon Effect |
|---|---|---|---|---|---|---|---|
| Buy 5Y | 355 | 336 | 4.25 | 3.92 | -15,520,593 | -16,373,090 | +852,498 |
| Sell 10Y | 404 | 402 | 6.59 | 6.42 | +10,000,000 | +10,000,000 | 0 |
| Curve | 49 | 66 | | | | | |

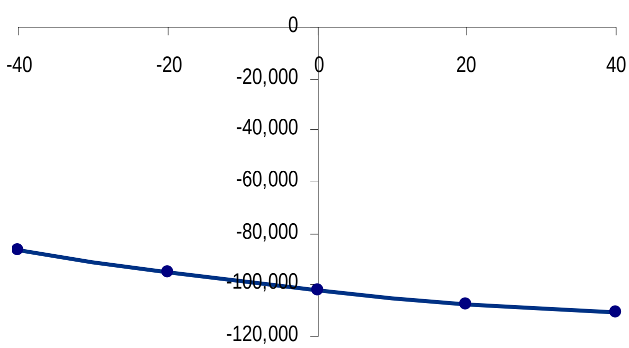
Source: JPMorgan

### Isolating the Horizon Effect

We can see the impact of this Horizon Effect when we look at sensitivity analysis at horizon. Exhibit 10.47 shows the MTM of the trade at horizon including the Slide, which shows the large negative Slide effect (-$102,394) in this trade dominates horizon P+L if curves are unchanged. When we take out the Slide effect in Exhibit 10.48 we can see the Horizon Effect as we are now long risk, so that a widening of spreads has a MTM loss and a tightening of spreads has a MTM gain. Compare Exhibit 10.48 to Exhibit 10.44 to see how we get a very different pattern for a change in spreads at the start of the trade and at its horizon.

Exhibit 10.47: Sensitivity Analysis at Horizon Including Slide

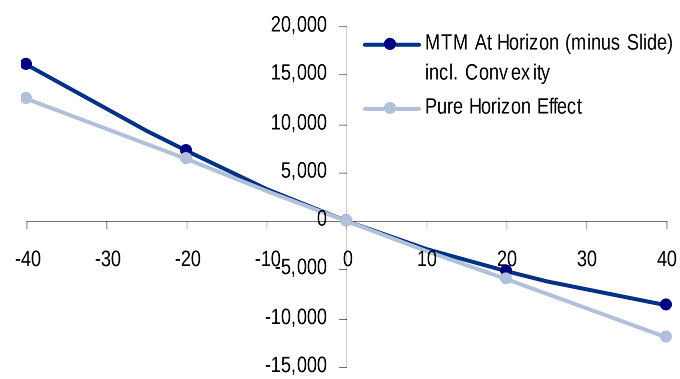
x-axis: Spread Change at Horizon (bp), y-axis: Trade MTM ($)




Source: JPMorgan

Exhibit 10.48: Sensitivity Analysis at Horizon minus Slide

x-axis: Spread Change at Horizon (bp), y-axis: MTM ($)




Source: JPMorgan

We summarize this horizon effect by looking at how the trade MTM at horizon (less Slide) differs from the instantaneous MTM for changes in spread, as we see in the final row of Exhibit 10.49. The trade is now longer risk and so has a more negative MTM as spread widen and a less negative MTM as spreads tighten.

Exhibit 10.49: Sensitivity Analysis at Horizon

MTM from Given Spread Changes ($)

| | -40bp Spread Chg | -20bp Spread Chg | 0bp Spread Chg | 20bp Spread Chg | 40bp Spread Chg |
|---|---|---|---|---|---|
| 1) MTM 5Y (Buy) | -362,295 | -238,680 | -117,054 | 3,264 | 121,645 |
| 2) MTM 10Y (Sell) | 275,938 | 143,497 | 14,660 | -110,704 | -232,672 |
| 3) Curve Trade MTM at Horizon | -86,357 | -95,183 | -102,394 | -107,440 | -111,026 |
| 4) Curve Trade MTM at Horizon minus Slide | 16,037 | 7,211 | 0 | -5,045 | -8,632 |
| 5) Instantaneous MTM | 3,452 | 849 | 0 | 821 | 3,232 |
| 6) Horizon Effect (Row 4 – Row 5) | 12,585 | 6,363 | 0 | -5,867 | -11,864 |

Source: JPMorgan

## Horizon Effect Conclusion

The Horizon Effect gives us a market directional position over the life of the trade due to our changing Risky Annuities. This can affect our sensitivity analysis for spread changes at the horizon. The net risk position we pick-up in a trade is difficult to predict with certainty and will depend on:

The shape of the underlying curve

The time between the maturities of the trade

The length of the horizon we are considering

We can remove the Horizon Effect in a curve trade by Forward Duration-Weighting the trade so that it is weighted to be market-neutral *at horizon*, given the Slide-implied Risky Durations. This weighting would need to be continually adjusted as any curve movements would change our Forward Durations. Practically, many traders will Duration-Weight their curve trades for the *current* Durations, but should be aware of how the Horizon Effect will give them a longer or shorter risk position over the life of the trade.

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# 11. Recovery rate and curve shape impact on CDS valuation

The value of an existing CDS position or unwind depends on the recovery rate and curve shape assumptions used in the calculation. Often, flat CDS curves and 40% recovery rates are used. However, as the result of increased liquidity in the recovery rate lock market as well as greater transparency of spreads across the CDS curve tenors, some dealers unwind certain single-name credit default swaps using non-standard conventions. We review the impact of the shape of the CDS curve and the recovery rate on CDS valuation. We show how investors can do similar analysis on their own using the CDSW screen in Bloomberg.

## Intuition

We present a simplified example below. Assume an investor bought protection (short risk) at 200bp and spreads instantaneously widen to 600bp. Also assume the five year trade was entered on 12/20/05, a standard coupon payment date, thus there is no accrual. Below we show the cash flows expected from the original trade and the cash flows from a second trade that locks in the 400bp spread widening, namely a long risk position receiving 600bp.

Exhibit 11.1: A $1mm short risk CDS position at 200bp and long risk position at 600bp generates a cash flow stream of approx $10k per quarter

| Trade Size | $1,000,000 | | |
|---|---|---|---|
| | Trade 1: Buy protection at 200bp (outflow) | Trade 2: Sell protection at 600bp (inflow) | Expected Net Cash Flow |
| 03/20/2006 | -$5,000 | $15,000 | $10,000 |
| 06/20/2006 | -$5,111 | $15,333 | $10,222 |
| 09/20/2006 | -$5,111 | $15,333 | $10,222 |
| 12/20/2006 | -$5,056 | $15,167 | $10,111 |
| 03/20/2007 | -$5,000 | $15,000 | $10,000 |
| 06/20/2007 | -$5,111 | $15,333 | $10,222 |
| 09/20/2007 | -$5,111 | $15,333 | $10,222 |
| 12/20/2007 | -$5,056 | $15,167 | $10,111 |
| 03/20/2008 | -$5,056 | $15,167 | $10,111 |
| 06/20/2008 | -$5,111 | $15,333 | $10,222 |
| 09/20/2008 | -$5,111 | $15,333 | $10,222 |
| 12/20/2008 | -$5,056 | $15,167 | $10,111 |
| 03/20/2009 | -$5,000 | $15,000 | $10,000 |
| 06/20/2009 | -$5,111 | $15,333 | $10,222 |
| 09/20/2009 | -$5,111 | $15,333 | $10,222 |
| 12/20/2009 | -$5,056 | $15,167 | $10,111 |
| 03/20/2010 | -$5,000 | $15,000 | $10,000 |
| 06/20/2010 | -$5,111 | $15,333 | $10,222 |
| 09/20/2010 | -$5,111 | $15,333 | $10,222 |
| 12/20/2010 | -$5,111 | $15,333 | $10,222 |

Source: JPMorgan

The investor expects to net about $10,000 a quarter for the five-year term of the trades (the 4th column in the table above). She is exposed to the *timing* of a potential default, as she will no longer receive the quarterly cash flows once a default occurs (both trades terminate upon a credit event). The investor clearly hopes there is no default at all; or, if there is one, that it is as far in the future as possible so that she continues to receive the positive cash flow stream.

In the event of default, the investor is insensitive to recovery rate as the two trades are offsetting. Specifically, on the short protection position she will receive a bond which she can deliver to settle the long protection position. Furthermore, she may be able to use a CDS settlement protocol, detailed in Part I, and settle both trades at the same recovery rate.

Alternatively, and more commonly, the investor will seek to *unwind* the first trade, receiving the present value of the quarterly cash flows as a single payment today. As discussed in Part I, to value CDS we discount cash flows using swap curve based discount factors, and probability of default discount factors. In essence, we find the present value of the $10k quarterly cash flows, multiplied by the probability that the cash flows are paid, or one minus the probability the credit defaults. The CDS spreads and recovery rates used to calculate these probabilities effect the value of the CDS contract.

## CDS curve shape impact

The curve shape assumption affects the assumed timing of default, or the probability of default in a given year. Consider scenarios A and B. In scenario A, there is a 50% chance of a default tomorrow and a 50% chance the credit does not default during the five year life of the contract. In scenario B, there is a 50% chance of a default in 4.75 years (thus receiving all but one quarterly payment), and a 50% chance the credit does not default. The risky present value of the cash flows is higher in scenario B than in A. Scenario A is more like a flat curve, with large probabilities of default in the early years of the contract. Scenario B is more like a steep curve, with small probabilities of default in the early years and larger probabilities in the later years.

Another way to think about the curve shape impact on the mark-to-market of CDS is using the concept of duration. Duration is often thought of as the weighted average term to maturity of cash flows. Steeper curves exhibit higher duration than flatter curves as lower spreads at the front end imply lower probability of default early in the life of the trade and higher spreads at the backend imply higher default probability later in the life of the trade. A higher duration therefore implies that we receive cash flows for a longer period of time, thus the value of our CDS contract should be higher.

Below we show two curves, each with 5Y CDS equal to 500bp. The steeper curve has a longer duration. The present value of a CDS contract is equal to the change in spread multiplied by the risky duration. Thus, the greater the duration the larger the present value.

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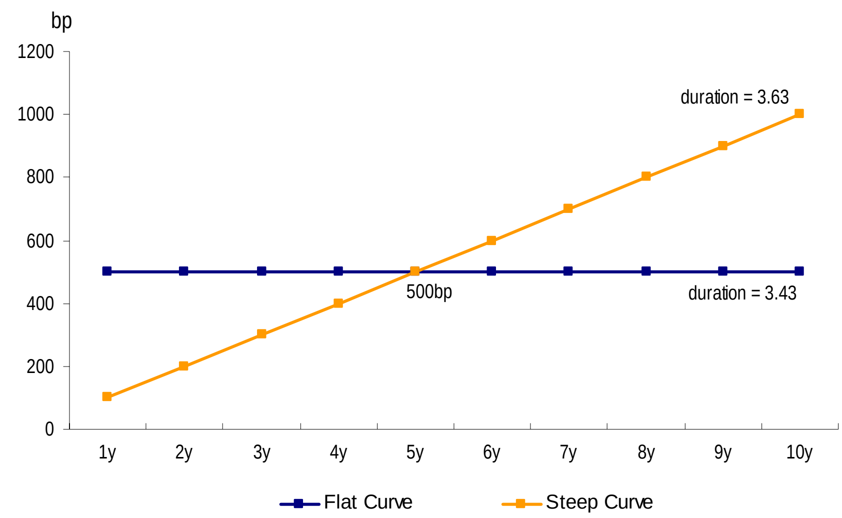
Exhibit 11.2:Flat and Steep Curve with same 5Y Spread




Source: JPMorgan

## Recovery rate impact

The recovery rate's impact on CDS valuation is more subtle. Recovery rates effect default probabilities, and thus effect the valuation of cash flows. Consider the following equation:

$$\text{CDS spread} \approx (1\text{-Recovery}) \, x \text{ Probability of default}$$

In other words, CDS spreads are equal to the potential loss in default multiplied by the probability of default. Re-arranging the terms gives

$$\text{Probability of default} \approx \text{CDS spread} / (1 - \text{Recovery})$$

Therefore, for a given CDS spread, the higher the recovery rate assumption the higher the default probability assumed. The investor in our example wants a low default probability so that the present value of the cash flow stream is higher. Thus, she wants a low assumed recovery rate.

In this table we show the MTM (in $000's) of a 5Y CDS entered at 300bp and unwound at a flat spread specified in the column using different recovery assumptions.

Exhibit 11.3: CDS MTM for unwind of $10MM 5Y short risk position on 12/9/2005, entered at 300bp

| | Unwind Spread ($000s) | | |
|---|---|---|---|
| Unwind Recovery | 100bp | 300bp | 500bp |
| 50% | -$858 | $0 | $714 |
| 40% | -$865 | $0 | $741 |
| 30% | -$870 | $0 | $761 |

Source: JPMorgan.

Note that the difference in MTM of the unwind between the 30% and 50% recovery assumptions is greater when unwinding at 500bps ($761 - $714 = $47) than when unwinding at 100bps ($870 - $858 = $12). This is logical as CDS MTM is more sensitive to recovery rate at wider spread levels since the credit is closer to default and recovery rates are closer to being realized. We can see this graphically in the slope of the curve below. It plots P/L on the unwind (Y-Axis) against recovery rate (X-Axis). As recovery rates increase the curve becomes steeper. Intuitively, a higher recovery leads to higher default probability, which means that one is more

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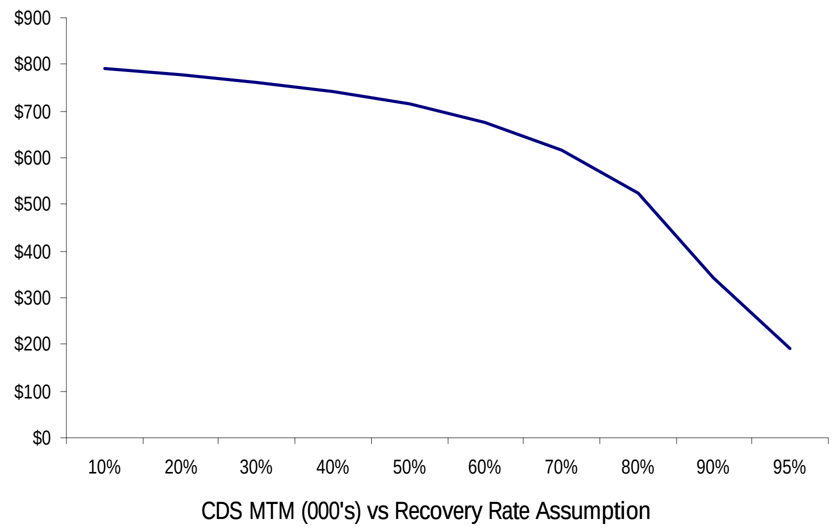
likely to experience and settle at that recovery. CDS MTM is also more sensitive to recovery at higher spreads for the same reason.

Exhibit 11.4: MTM of long protection 5y CDS entered at 300bp unwound at 500bp.




Note: in $000's
Source: JPMorgan

## Assumptions at contract inception

When one enters a standard CDS trade (as opposed to a fixed recovery CDS trade) there is no explicit or implied recovery rate or curve shape assumption. Two parties are simply agreeing on a spread to exchange. When one party agrees to buy protection from another at 200bps, for example, she may have very different views from the seller on the recovery rate that will prevail should there be a default in the future. This is irrelevant in the trade, thus, there is no concept of recovery rate "changing" between the original trade and the unwind.

Since different dealers may use different conventions, investors must know the unwind assumptions (curve shape and recovery) corresponding to a spread to understand the economic impact. For example, an investor who bought protection and wants to unwind the contract may typically look for the highest bid. This is reasonable if the conventions used in the quotes are the same. If they are not, however, an investor may be better off unwinding at a lower bid if the conventions used are more in his favor (steeper curve and/or lower recovery / lower default probability).

To summarize, for an investor who bought protection at 200bps and is unwinding at 600bps:

**Higher** recovery (higher default probability) leads to **lower** absolute MTM on the unwind

**Steeper** CDS curve (default not likely to happen until later in the trade) leads to **higher** absolute MTM on a CDS contract

For an investor who sold protection and is unwinding at a higher spread (for a loss) the opposite is true.

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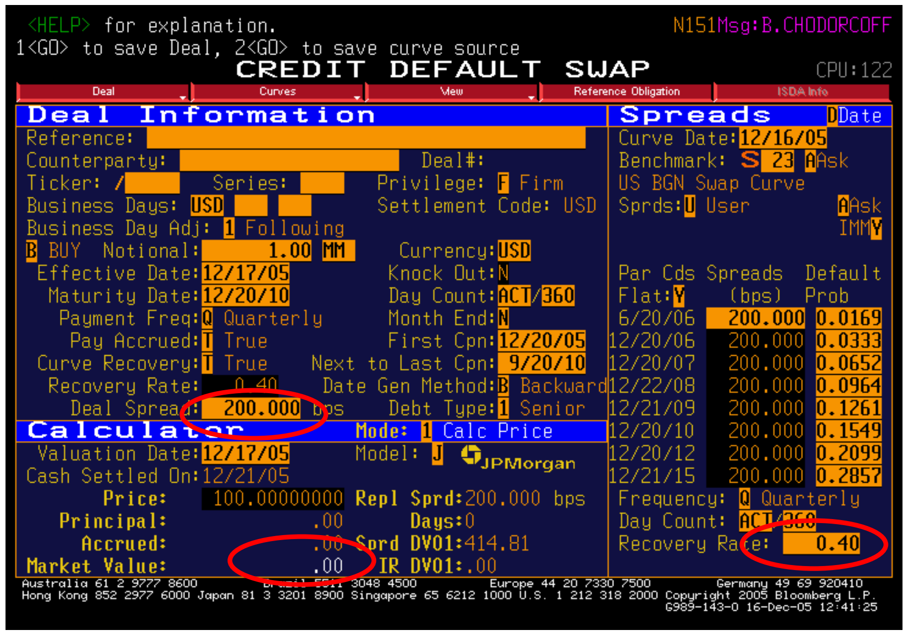
## Worked examples

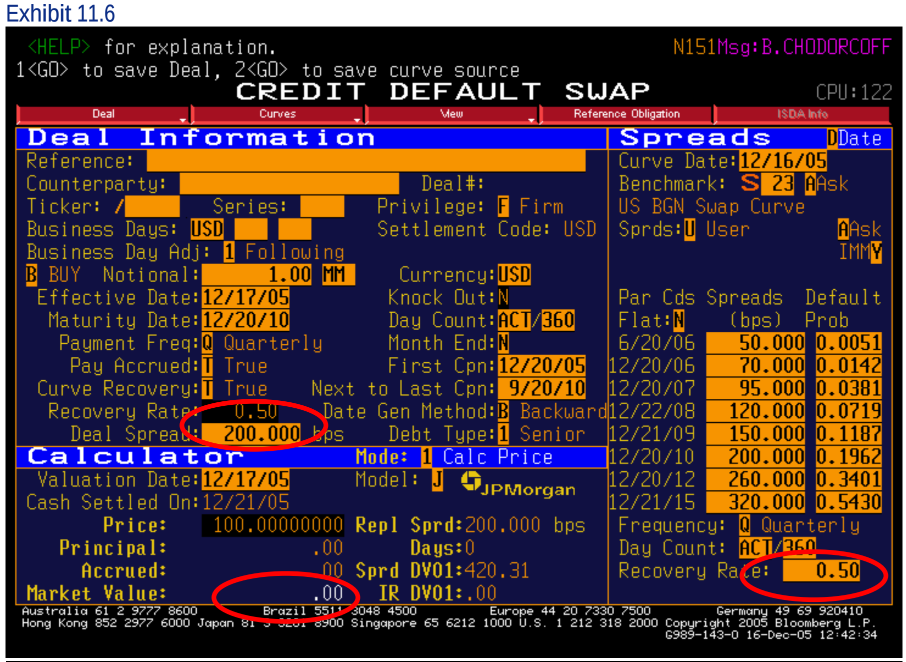
Assume an investor entered in a five-year contract buying protection at 200bps with a trade size of $1mm. If the current 5Y spread remains at 200bps, the CDS market value is zero regardless of the recovery rate (Exhibit 11.5) and the curve shape (Exhibit 11.6).

Exhibit 11.5




Source: Bloomberg

Exhibit 11.6




Source: Bloomberg

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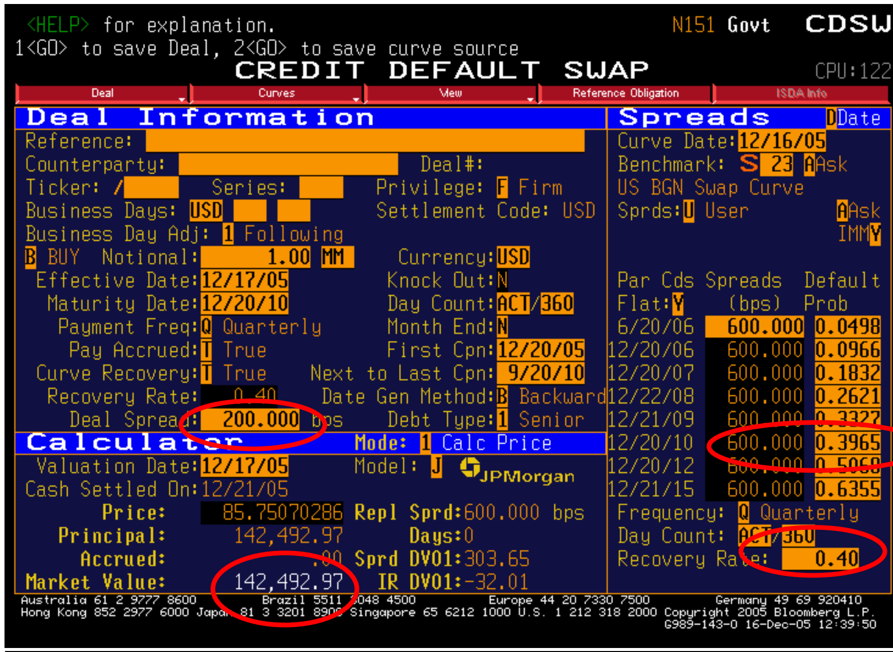
If the investor unwound at 600bps, she would receive cash payment of 142.5k, which is equivalent to the present value of expected payments, assuming that the recovery rate is 40% and the curve is flat.

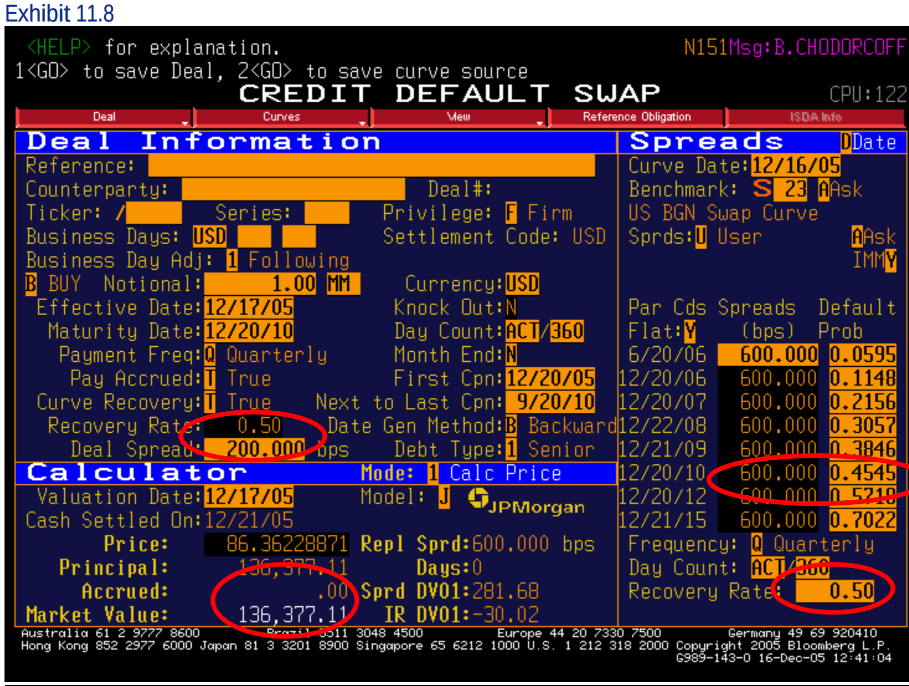
Exhibit 11.7




Source: Bloomberg

With 50% assumed recovery rate, the default probability would be higher. Therefore, the present value of cash flow stream received would be smaller.

Exhibit 11.8




Source: Bloomberg

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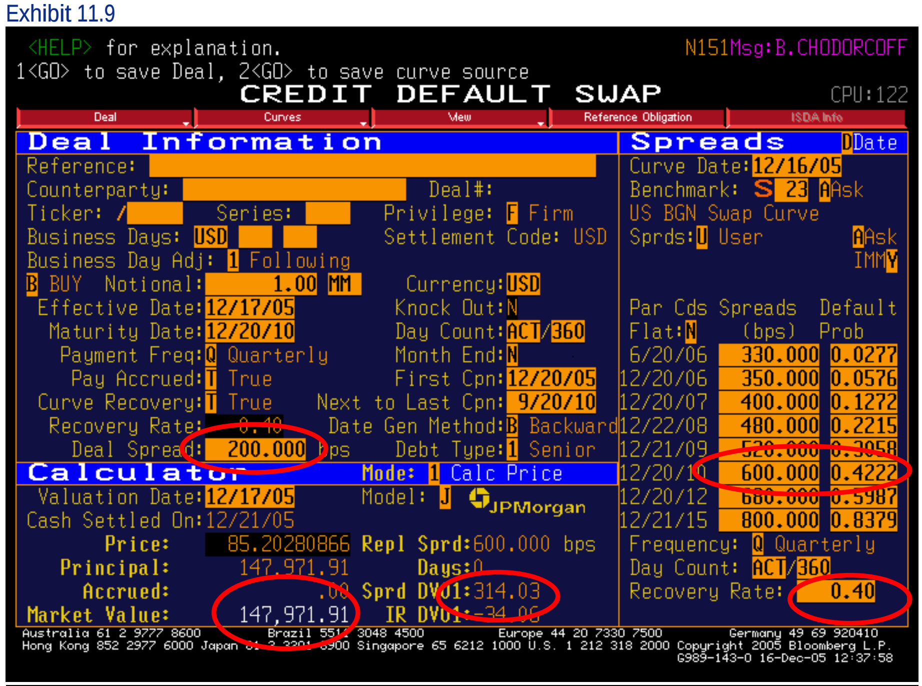
A steeper CDS curve, on the other hand, leads to a higher market value. Comparing Exhibit 11.7 and Exhibit 11.9, it can be seen that the default probability implied by a steeper CDS curve is lower in early years and higher in later years relative to a flat curve. This means a steeper CDS curve leads to a higher value of expected cash flows.

Exhibit 11.9




Source: Bloomberg

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# 12. Trading credit versus equity

Equity, Equity Option and Credit Derivative markets are all deep, liquid markets, where company news, macro events, and market flows are quickly reflected in prices and spreads. When bad news occurs, for example, equity prices usually fall, credit spreads rise, and equity option implied volatility usually increases. However, even when markets move in the expected direction, the extent of the moves may be very different. For example, if a stock price falls from $20 to $19, credit spreads rise from 100bp to 120bp, and equity volatility rises from 35% to 40%, it is not obvious whether each of these moves is “reasonable” relative to the others.

One approach is to use historical relationships between the markets to determine what is “reasonable.” This method does not determine if market pricing between assets is “correct,” as this is a subjective assessment requiring an understanding of the company and market environment. Rather, it simply identifies where relationships have changed. Investors can then determine whether the cross-asset relationship breakdown is justifiable or if there is a trade opportunity.

We discuss four market variables that can be used to track firm-specific performance and identify potential pricing discrepancies:

- Equity price
- Five-year credit default swap spread
- Implied volatility of six-month at-the-money equity options
- The 90-100% six-month equity volatility skew—this is the difference between implied volatility of options struck at 90% of the at-the-money strike and implied volatility of at-the-money options

## Relationships in equity and credit markets

We analyze four different relationships between market variables of the same firm.

*Equity price versus five-year CDS spread*
Typically, these two market variables are inversely related. That is, when a firm’s stock is increasing, CDS spreads are usually tightening. We say “usually” because occasionally there is justification for stock and CDS spreads to move in the same direction. A typical example is a leveraged buyout, which often leads to an increase in a firm’s stock price and widening of the CDS spreads.

The five-year CDS spread is used as the benchmark credit market price, rather than a bond spread. This is because five-year CDS spreads are standardized. In other words, if company A has a five-year CDS spread of 200bp and company B has a five-year CDS spread of 150bp, it is fair to conclude that company A is being priced by the market as 50bp wider. One could not do a similar comparison with bonds because companies issue bonds with different coupons and maturities. These characteristics have to be normalized before making comparisons.

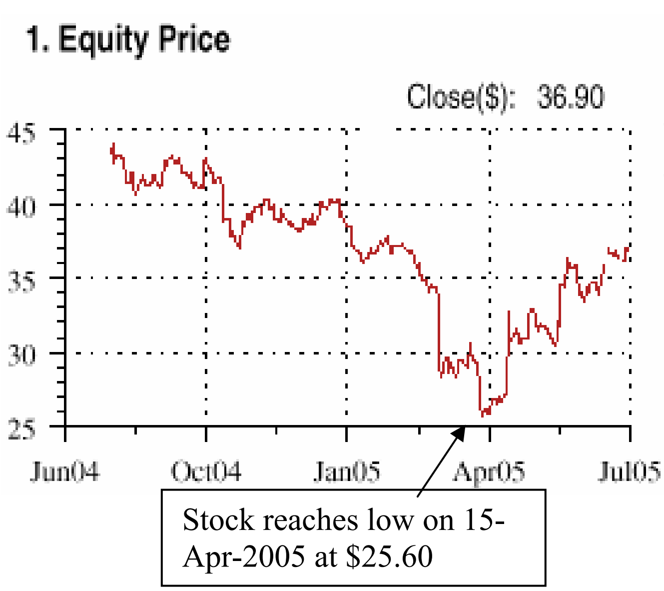
*Equity price versus six-month at-the-money implied volatility*
Stock price and implied volatility of options on the same stock tend to be inversely related. Volatility increases as the stock price falls and decreases as the stock price rises. The standard explanation for this relationship is the so-called "leverage effect." The fall in stock leads to an increase in the firm’s leverage, meaning the risk to both bondholders and stockholders increases. As equity risk increases, return volatility increases as well.

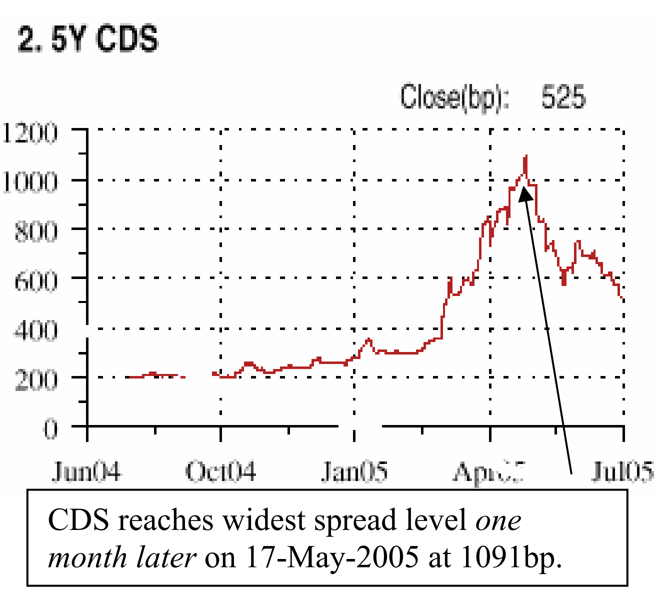
*Five-year CDS spread versus six-month at-the-money implied volatility*
Implied volatility of options on a firm's stock is the market's forecast of future volatility. Since volatility can be viewed as a measure of a firm's riskiness, it can be directly related to CDS spread, which is also a measure of risk. Therefore, as a firm's implied volatility increases, one would expect CDS spreads to widen. This is typically what is observed in the market.

*Five-year CDS spread versus 90-100% six-month at-the-money implied volatility skew*
Option prices are often expressed in terms of their implied volatilities. One might expect that all options on the same underlying would trade at the same level of implied volatility. This is almost never the case, however. A plot of implied volatilities of equity options across different strikes typically looks like a downward sloping line. This relationship implies that options at lower strikes (say, at 90% of the current stock price) are relatively more expensive than options at higher strikes (say, at 110% of the current stock price). This may suggest that the market believes there is greater chance of the stock price falling than is assumed by the lognormal distribution property of the Black-Scholes model. The skew, as it is defined in this report (implied volatility of options struck at 90% of the at-the-money strike less the implied volatility of option struck at-the-money) is a measure of the higher cost of out-of-the-money puts, which are often bought to protect against a large downward move in the stock. An increase in the skew suggests that the market considers a large downward move more likely. If the credit market shares this belief, the CDS spreads are likely to widen as well. This relationship suggests that there is a positive correlation between implied volatility skew and CDS spreads.

## Finding trade ideas

We can look for trade ideas by observing historical relationships and noting when relative pricing patterns change. In this example we consider the behavior of General Motors Corporation's stock and five-year CDS spreads in April through June 2005. Below are one-year charts of General Motors' stock price and five-year CDS.




Source: JPMorgan

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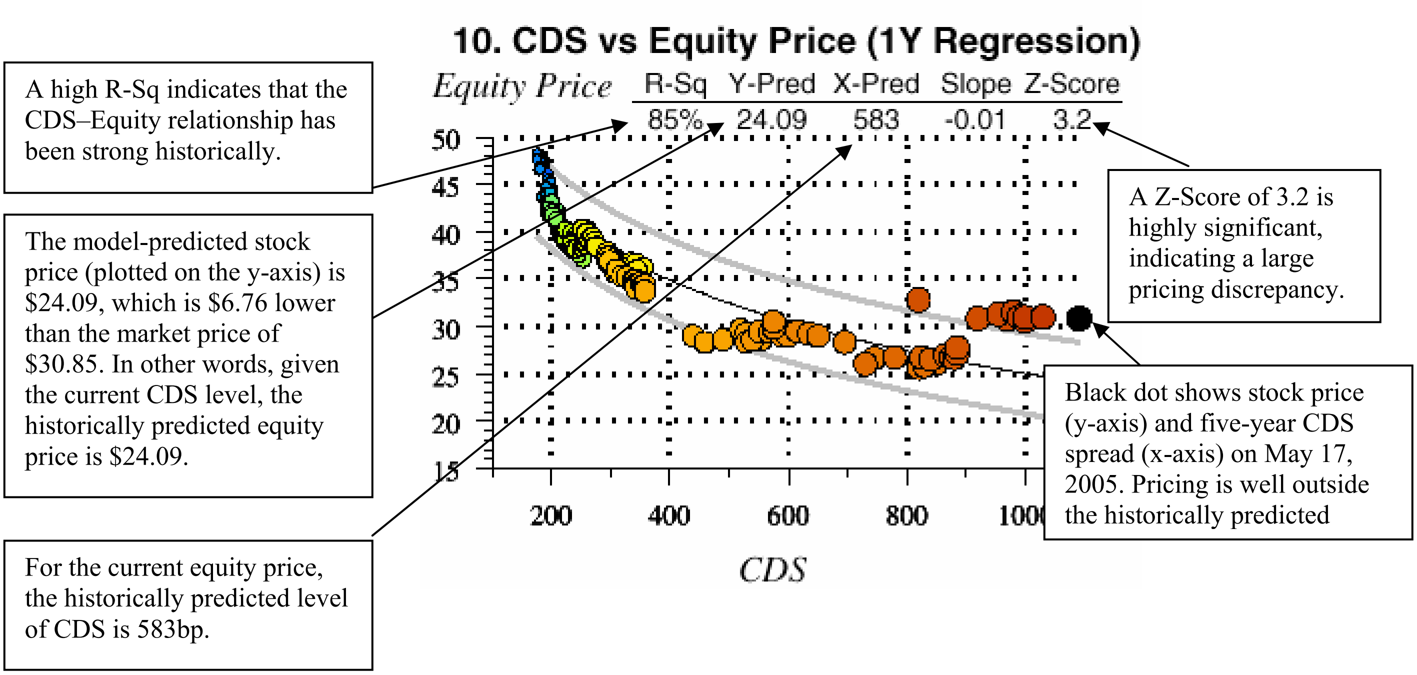
The fact that the widest CDS spread was observed a month after the lowest equity price suggests that during this highly volatile period for General Motors, the equity and CDS markets were not operating in sync. Whenever this happens (i.e., whenever the two markets diverge), a convergence trade may be attractive. This trade is essentially a view on a reestablishment of the historical relationship between the two markets. In this case, the position on May 17 would be that the CDS and equity price will converge, i.e. the CDS market is too bearish and spreads would tighten to come more in line with the stock price; OR, the equity market is too bullish and the stock price would drop to be more in line with the CDS spread. Given this view, a potential trade would be to sell CDS protection (go long credit risk) and short the stock.

Judging a potential mis-pricing between two markets is not very easy from the time series charts. This is why we include regression charts on the same page of our daily "Cross Asset Class Relative Performance" report. These charts quantify whether the current pricing in the two markets is out of line with the historical pattern.

Below is a chart of the one-year regression between the stock price and CDS on May 17, 2005. The larger circles correspond to more recent data on May 17, with the black dot representing the most recent observation. The Z-Score output of the regression model specifies how far out of line the most recent observation is with respect to the one-year historical relationship. A Z-Score of zero means the current observation is identical to the value predicted by the model. A Z-Score of less than -2 or greater than 2 means there is significant deviation from the historical relationship. The two grey curves are two-standard deviation confidence interval bands. Approximately 95% of variation lies between these bands. $R^2$ ranges from 0% to 100% and captures the strength of the relationship, with 100% being a perfectly correlated relationship. In our case, a relatively high $R^2$ of 85% between the stock and CDS means the two have moved very much in line in the past year. A Z-Score of 3.2 means there is a very significant deviation from this historically strong relationship. Below is an exhibit from our Cross Asset Class Relative Performance Report, which compares General Motors Corp (GM) stock prices (y-axis) to CDS spread (x-axis).




Source: JPMorgan

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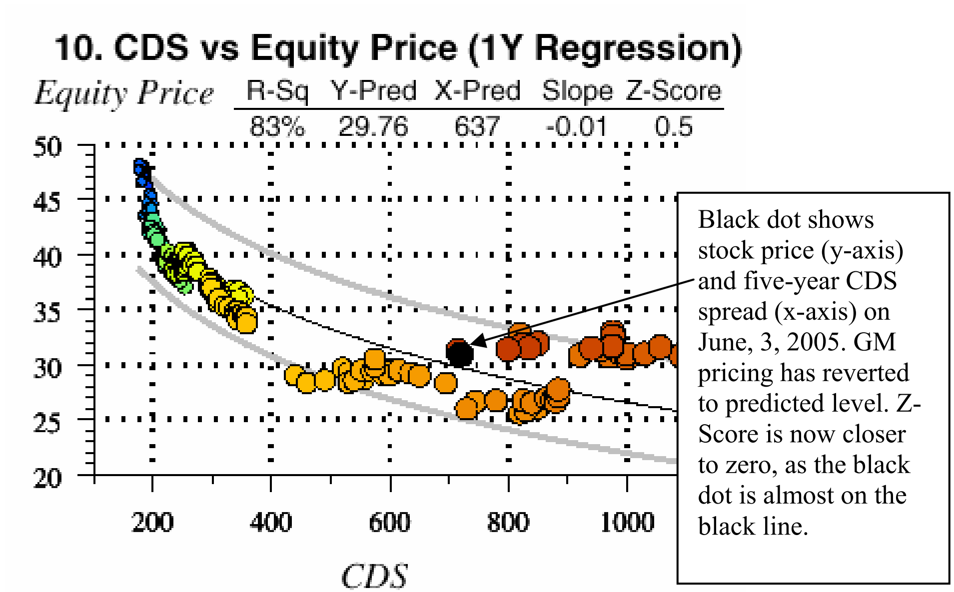
Below is the same chart plotted two weeks later, on June 3, 2005. In the two weeks following the observation above, the CDS tightened 370bp, while the stock went up \$0.08. The Z-Score fell to 0.5, indicating the relationship between the stock and CDS has been re-established. The black dot is closer to the black line, its predicted level. The convergence trade would have lost \$0.08 on the short stock position but gained 370bp on the CDS leg.

The slope in the regression output above tells us that for each 1bp increase in the CDS spread, the stock is expected to fall by approximately \$0.01. Given a notional on the CDS, we can use this relationship to find the number of shares to trade. Using the Bloomberg CDSW tool, for a given CDS contract, we can find the Spread DV01, or the P/L due to the 1bp move in CDS. Once we know this dollar amount, and given an expected \$0.01 drop in share, we can determine how many shares to trade to give us approximately the reverse P/L on the equity leg, assuming the historical relationship holds.




Source: JPMorgan

## A worked trade recommendation

When we recommend CDS versus stock strategies, we often combine quantitative analysis with our fundamental research analyst's views. The following is one such example.

*Trade recommendation from the Corporate Quantitative Weekly, published on January 18, 2006*

**Lear: Buy stock, buy 5Y CDS protection**[18]
Since mid December 05, LEA's stock is down 11.7%, implied volatility has increased 3.8 vols, and the volatility skew has increased 0.6 vols, all of which suggest an increasingly bearish outlook. Puzzlingly, CDS spreads are only 26bp wider over the same period. Over the last week, the CDS did soften 155bp, although this is less than would be expected given the 1 week movements in equity (-9.3%), equity volatility (+8.8 vols), and skew (+0.18 vols).

[18] For more information, refer to "Lear: Buy Stock, Buy 5Y CDS Protection", published in Corporate Quantitative Weekly, January 20, 2006.

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JPM Auto credit analysts expect LEA to report weak results over the coming quarters as the company shifts strategies and works through very difficult industry conditions. They see more downside than upside over the near-term, and rate the bonds Underweight. JPM Auto equity analysts think LEA could be an interesting long term value play, but see significant near term uncertainties, and rate the stock Neutral. LEA reports earnings on January 26th.

We recommend a relative value trade, buying CDS protection (short risk) versus a long stock position. We recommend a trade structure that is default neutral, profits if the relationship returns to its historical pattern, and is partially hedged against simultaneous bullish or bearish moves across equity and credit.

Exhibit 12.1: LEA Stock Price

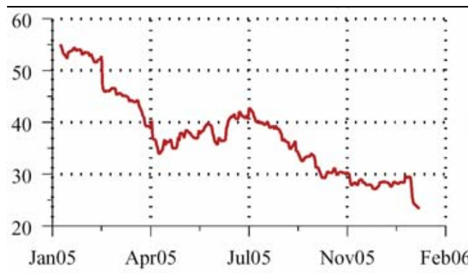
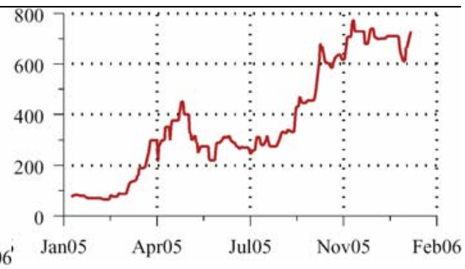



Exhibit 12.2: LEA 5yr CDS Spread (bp)




Source: JPMorgan, "Cross Asset Class Relative Performance Report", as of 18-Jan-06

Exhibit 12.3: LEA 6M ATM Implied Volatility (%)

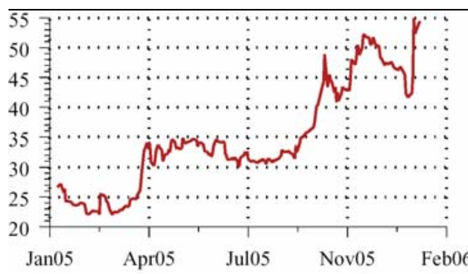
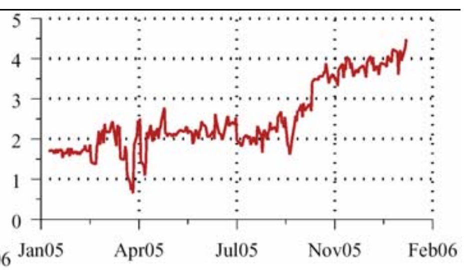



Exhibit 12.4: LEA 6M 90/100% Skew (%)




Source: JPMorgan, "Cross Asset Class Relative Performance Report", as of 18-Jan-06

**CDS appears out-of-line with equity and equity derivatives market**

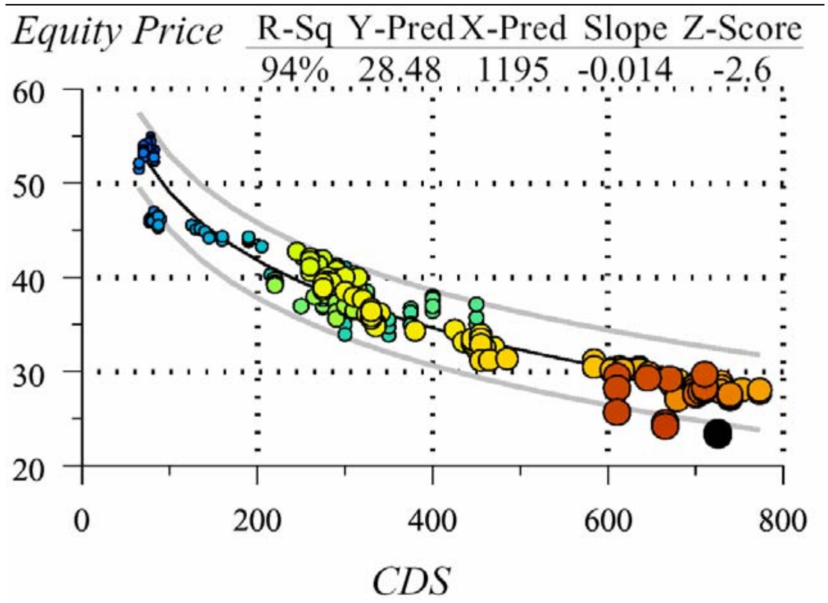
Below, we examine the relationship between LEA CDS and the equity and equity derivatives market. This relationship has been historically strong, but has recently broken down. Currently, equity price, equity volatility, and equity volatility skew all point toward wider CDS spreads.

*CDS is rich relative to equity: #2 most out-of-line across 250 companies as of Jan 18th*

LEA CDS and equity have been closely linked historically. Exhibit 12.5 visually depicts the close relationship between the two markets over the last year, with a high R-sq of 94%. Over the last few days, however, the decline in LEA equity price appears too steep relative to the limited widening in the CDS market. This divergence can be seen in the position of the large black dot (current point in time), which is 2.6 standard deviations away from the historically predicted value. The chart predicts that either the equity price should rally to $28.48 or the CDS spread should widen to 1195bp.

**Each dot on the chart represents one day, with the larger dots representing more recent points in time and the black dot representing the current day. The black line represents the regression "predicted" value, and the two grey lines represent two standard deviations from that value.**

Exhibit 12.5: LEA Debt vs. Equity Relationship, 1 yr regression




Source: JPMorgan, "Cross Asset Class Relative Performance Report", as of 18-Jan-06

*CDS is rich relative to equity volatility: #1 most out-of-line across 250 companies as of Jan 18th*

LEA CDS and equity volatility have also been closely linked historically. Exhibit 12.6 visually depicts the close relationship between the two markets over the last year, with an R-sq of 93%. Over the last few days, the increase in LEA equity volatility appears too high relative to the limited widening in the CDS market. This divergence can be seen in the position of the large black dot (current point in time), which is 2.8 standard deviations away from the historically predicted value. The chart predicts that either the equity volatility should fall to $48.31 or the CDS spread should widen to 885bp.

Exhibit 12.6: LEA Debt vs. Equity Vol Relationship, 1 yr regression

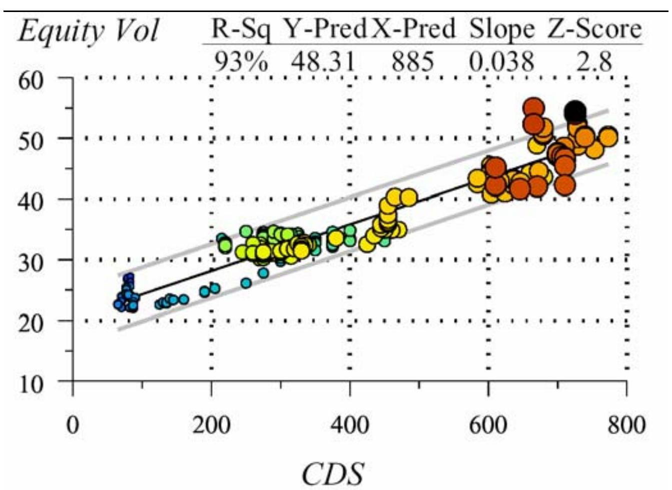
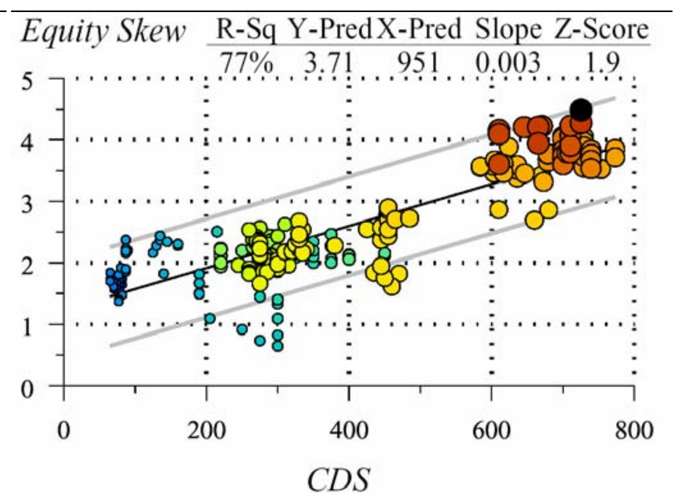



Exhibit 12.7: LEA Equity vs. Equity Skew Relationship, 1 yr regression




Source: JPMorgan, "Cross Asset Class Relative Performance Report", as of 18-Jan-06

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*CDS is rich relative to skew: #1 most out-of-line across 250 companies as of Jan 18th*

Finally, we note that CDS and the equity volatility skew have also been closely linked. In this case, equity skew has been increasing (indicating that OTM put volatility is being bid up by investors buying put protection, likely a bearish signal) in step with widening in the CDS market. Exhibit 12.7 depicts the close relationship between the two markets over the last year, with an R-sq of 77%. Over the last few days, the increase in LEA skew appears too high relative to the limited widening in the CDS market. This divergence can be seen in the position of the large black dot (current point in time), which is 1.9 standard deviations away from the historically predicted value. The chart predicts that either skew should fall to 3.71 vols or the CDS spread should widen to 951bp.

**Trade Structure Discussion**

We present our recommendation on how to structure this trade and the characteristics of the resulting pair of positions, with each column in Exhibit 12.8 discussed in more detail below.

Exhibit 12.8: Trade Recommendation and Sensitivities

| | (1) Buy/ Sell | (2) Size ($'000) | (3) Entry Level ($)/ Spread (bp) | (4) Regression Predicted Price/Spread | (5) P/L if Move to Predicted ($'000) | (6) 3month Carry ($'000) | (7) P/L in Default ($'000) |
|---|---|---|---|---|---|---|---|
| Long Stock | Buy | $5109 | $23.31 | $28.48 | $1,133 | $55 | -$5,000 |
| CDS 5Yr | Buy (short risk) | $10,000 | 725bp | 1195bp | $1,548 | -$181 | $5,000 |
| | | | | | | -$126 | $0 |

Source: JPMorgan, as of 18-Jan-06

1) We recommend buying the stock and buying CDS protection (short risk). We expect stock price to rise and/or the CDS spread to widen.
2) The two legs of the trade are sized to have equivalent P/L in default (i.e. we lose the same amount on the long stock position as we gain on the CDS position in the event of default). See column 7 for more detail. A $5109 position in the stock equates to 180,685 shares.
3) We show the current equity price and CDS spread. The CDS spread is the 5yr Credit Default Swap spread, or what one would pay annually in basis points to enter a short risk CDS position.
4) We show the predicted equity price, assuming no change in CDS and the equity price moves up to meet the regression line in Exhibit 12.5 above. The predicted CDS level is calculated similarly, but assuming the equity price is unchanged and CDS moves right to the predicted point in the regression. In the P/L grid below we illustrate the combined results of the positions across a range of stock price and CDS levels.
5) Stock P/L = change in stock price if move to predicted * number of shares. CDS P/L = change in spread / 10,000 * duration * notional
6) The carry on the equity leg is the dividend yield and on the CDS leg it is the spread - in both cases multiplied by the size of each position and shown as a quarterly figure. This position has a negative carry.

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7) We show the loss on each leg of the position assuming a jump to default. For the equity leg we assume $0.50 price in default and for the CDS leg we assume a recovery rate or value of bonds post a default of 50%. The 50% recovery is in the range of likely scenarios according to our credit analyst, and is in line with current pricing on recovery rate swaps (see "profiting from views on recovery rates" article in this publication). This combined position has zero P/L in default under these assumptions. In practice, if recovery on the credit is higher than 50%, P/L will be negative. If recovery on the credit is less than 50%, P/L will be positive.

**Profit/Loss on Position**

Below we present a grid of profit/loss on the position as recommended above. The figures in the grid are dollars, in thousands, assuming the sizes of the position discussed above. As there are different amounts at risk in the equity and CDS legs of the trade, showing P/L in dollars rather than as a percentage of risk is preferable. The result with the square is the P/L with unchanged stock price and CDS spread. It is negative reflecting the negative carry in the trade.

Note that the trade makes the most money if equity prices increase and CDS spreads widen. Although this scenario is possible, it is not the most likely. We believe scenarios where CDS spreads widen and equity prices are unchanged (move right on the grid) or equity price rallies and CDS is unchanged (move up on the grid) are more likely. Note that P/L volatility is relatively low for bullish or bearish moves across both equity and credit. For example, the P/L for CDS widening to 885bp combined with a $2.00 drop in the stock price is $102k, similar to the $126k in the unchanged scenario. In this way, the position isolates changes in the relationship between equity and CDS, while partially hedging against overall market direction.

Exhibit 12.9: Payout Diagram in 3 months: P/L ($thousand) on the combined positions

| Equity Price ($) | CDS Spread (bp) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 485 | 565 | 645 | 725 | 805 | 885 | 965 | 1045 | 1125 |
| 32.55 | 1,065 | 1,353 | 1,622 | 1,874 | 2,110 | 2,331 | 2,539 | 2,734 | 2,916 |
| 30.31 | 580 | 868 | 1,137 | 1,389 | 1,625 | 1,846 | 2,054 | 2,248 | 2,431 |
| 29.31 | 365 | 652 | 921 | 1,173 | 1,409 | 1,631 | 1,838 | 2,033 | 2,216 |
| 27.31 | (68) | 219 | 488 | 740 | 976 | 1,197 | 1,405 | 1,600 | 1,782 |
| 25.31 | (502) | (214) | 55 | 307 | 543 | 764 | 972 | 1,166 | 1,349 |
| 23.31 | (935) | (648) | (378) | **(126)** | 110 | 331 | 539 | 733 | 916 |
| 21.31 | (1,368) | (1,081) | (812) | (560) | (323) | (102) | 105 | 300 | 483 |
| 19.31 | (1,801) | (1,514) | (1,245) | (993) | (757) | (535) | (328) | (133) | 50 |
| 17.31 | (2,234) | (1,947) | (1,678) | (1,426) | (1,190) | (969) | (761) | (566) | (384) |
| 15.31 | (2,668) | (2,380) | (2,111) | (1,859) | (1,623) | (1,402) | (1,194) | (999) | (817) |
| 13.31 | (3,101) | (2,813) | (2,544) | (2,292) | (2,056) | (1,835) | (1,627) | (1,433) | (1,250) |

Source: JPMorgan

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### A successful debt/equity trade

On Jan 25, 2006, the stock had risen 8% while the CDS spread widened 30bp. We gained profits on both legs of the trade and therefore closed the position.

Exhibit 12.10: Closed Trade MTM P/L

| | (1) Buy / Sell | (2) Size ($'000) | (3) Entry Level($)/ Spread (bp) | (4) Closing Price/ Spread (bp) | (5) P/L Closing Price/ Spread |
|---|---|---|---|---|---|
| Long Stock | Buy | 5,109 | $23.31 | $25.12 | $395 |
| CDS 5Yr | Buy (short risk) | 10,000 | 725bp | 755bp | $100 |
| | | | | | $495 |

Source: JPMorgan, as of 25-Jan-06

# 13. Trading CDS against equity puts[19]

Credit default swaps offer investors protection in event of default. Equity options, specifically, deep out-of-the-money puts, offer similar protection: the options should profit in default, as the stock price should fall sharply. A popular debt/equity strategy has been to combine short-term CDS and equity puts into a single trade. To the extent that these two instruments imply different probabilities of default, investors can execute relative value trades by going long one instrument and short the other. Below we discuss the structure and associated risks of this trade strategy.

The intuition behind this strategy is as follows. Assume a stock price of $20 and a one year put with a strike of $2 that costs $0.25 today. If there is a default and the stock subsequently trades at $0.50, the investor will earn $1.25 on each put ($2 - $0.50 - $0.25). If the investor could sell CDS one year protection (long risk) such that the upfront premium received is also $0.25, but in default, the loss on the CDS is less than the gain on the put, this would be an attractive position. If there is not a default, the trade would be costless as the put cost is offset by the CDS premium earned. In default, however, the gain on the equity put more than offsets the loss on the CDS. Alternatively, one could structure the positions so that the two legs offset each other in default, but the premium earned on the CDS is greater than the cost of the put premium on the stock.

In summary these CDS/Equity Put relative value trades are attractive if they can be structured to have either the following properties:

- zero initial cost, with a positive payout in default, or
- zero risk in default and positive carry or payout up front

The zero initial cost/positive default payout trade typically provides a greater payout than the zero default risk/positive carry trade. However, the former trade has a smaller probability of occurring given that it involves a more extreme outcome. Investors, therefore, have to balance the likelihood of default versus the potentially greater payout on the trade.

### Structuring a CDS/Put trade

In this section, we provide an example of structuring a Sell Protection (long risk) versus buying puts trade (short risk) on Lear Corp, originally recommended on January 27, 2006. Specifically, we look at selling $5mm notional of Mar'07 CDS protection and buying Jan' 07 equity puts. Exhibit 13.1 below outlines current market pricing on both legs of the trade. We assume a 50% recovery rate on the CDS and a $0.50 stock price in default.

Exhibit 13.1

| Name | Stock | 1Y CDS Bid | CDS Mat | CDS Dur | CDS Notional | Recovery | Stock in Default |
|---|---|---|---|---|---|---|---|
| LEAR CORP | 24.74 | 785 | 20-Mar-07 | 1.04 | $5,000,000 | 50% | $0.50 |

Source: JPMorgan

[19] For more information, refer to "Monetize cross market views on default through CDS and equity puts", published in Corporate Quantitative Weekly, edition of January 27, 2006.

In Exhibit 13.2, we examine the P/L on this trade using different put strikes. In each scenario, we calculate the number of puts needed, such that, in default the positive P/L from the puts purchased is equivalent to the negative P/L from the long risk CDS position. For example, at a $10 put strike, 2,632 put contracts are needed to generate $2.5mm in default assuming the stock falls to $0.50, which is the amount lost on the long risk CDS position.

Continuing this example, at a cost of $0.95 per contract, the cost of buying 2,632 puts is $250k, which is $158k less than the premium received from the long risk CDS position. This $158k is the positive carry on the position. Since this carry is larger than the carry on higher strike puts, the $10 strike put appears most attractive.

Exhibit 13.2

Default-Neutral Structures: Sell Mar' 07 CDS Protection/Buy Jan' 07 Equity Puts

| Strike | Put Premium | CDS PV[1] | Loss in Default on CDS[2] | Gain in Default on Puts[3] | Put Contracts[4] | Put Hedge Cost[5] | Carry[6] |
|---|---|---|---|---|---|---|---|
| $10.00 | $0.95 | $408,200 | $2,500,000 | $2,500,000 | 2,632 | $250,000 | $158,200 |
| $12.50 | $1.35 | $408,200 | $2,500,000 | $2,500,000 | 2,083 | $281,250 | $126,950 |
| $15.00 | $1.90 | $408,200 | $2,500,000 | $2,500,000 | 1,724 | $327,586 | $80,614 |
| $17.50 | $2.50 | $408,200 | $2,500,000 | $2,500,000 | 1,471 | $367,647 | $40,553 |
| $20.00 | $3.30 | $408,200 | $2,500,000 | $2,500,000 | 1,282 | $423,077 | -$14,877 |
| $25.00 | $5.30 | $408,200 | $2,500,000 | $2,500,000 | 1,020 | $540,816 | -$132,616 |
| $30.00 | $8.10 | $408,200 | $2,500,000 | $2,500,000 | 847 | $686,441 | -$278,241 |

1. CDS PV is the present value of payments received for selling protection. For names trading in all running spread form (names trading at typically less than 1000bp), the calculation is Spread/10000 * Duration. $408,200 = 785/10000 * 1.04 * $5MM
2. Loss in Default is calculated as CDS Notional * (1 - Recovery). We assume recovery is 50%
3. Gain in Default is set to be the same as the loss on CDS so as to be default-neutral
4. Number of put contracts is set so as to achieve the required gain in default (column to the left). Number of contracts = Gain in Default on Puts / (100 * (K - Stock price in default))
5. Put hedge cost = Number of Put contracts * 100 * Put Premium
6. Carry = CDS PV - Put Hedge Cost
Source: Bloomberg, JPMorgan

Note, however, that the assumption of a 50% recovery affects the amount of puts we need to buy in order to offset the loss on the CDS in default. If the actual recovery rate was lower, then the CDS position would lose more money in default, and we would need to have bought more puts to have a default neutral trade. In other words, the trade in Exhibit 13.2 is left exposed to the actual recovery rate. This exposure can be significant. Exhibit 13.3 outlines the impact of recovery on the default exposure. Whereas our trade (at any strike) is default neutral, a realized recovery lower than 50% creates a negative default P/L and a realized recovery above 50% creates a positive default P/L.

Exhibit 13.3

Trade P/L for given Recovery

| 20% | 40% | 50% | 60% | 80% |
|---|---|---|---|---|
| -$1,500,000 | -$500,000 | $0 | $500,000 | $1,500,000 |

Note: P/L is calculated as the difference between CDS payout in event of default and gain on puts.
Source: JPMorgan

Recovery rate swaps can be used to hedge recovery exposure. Typically, only distressed companies are traded in the recovery rate market. Intuitively, this is because investors are more interested in taking views on recovery for names that may actually default. Currently, several auto and auto-parts companies trade in the recovery rate swap market. We list them and recovery rates below:

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| Company | Recovery Rate Swap |
|---|---|
| GM | 38 / 40 |
| DANA | 49 / 53 |
| LEAR | 47 / 57 |
| AXL | 53 / 63 |

Note: Indicative levels as of January 25, 2005
Source: JPMorgan

A level of 53/63, for instance, means that investors can sell protection at a fixed recovery of 53% (i.e. they will pay 47 in event of default) and buy protection on a vanilla CDS. Conversely, investors can buy protection at a fixed recovery of 63% (i.e. they receive 37% in event of default) and sell protection on a vanilla CDS. (Please see Part IV for more details on recovery rate swaps).

Incorporating a fixed recovery rate swap leg to our trade produces the following trade structure (Exhibit 13.4). Sell Mar' 07 Fixed Recovery CDS Protection @ 47% fixed recovery (current LEA recovery swap Bid) versus buying Jan '07 equity puts. In event of default, we lose 53% of the notional on the CDS.

Note that for each strike, the trade requires more put contracts since the recovery rate is lower (CDS loses 53% rather than 50% in default). Because of the need to buy more puts, the carry is reduced. In all other aspects the trade is the same, and is no longer sensitive to changes in actual realized recovery.

Exhibit 13.4

Default-Neutral Structures: Sell Mar' 07 Fixed Recovery CDS Protection/Buy Jan '07 Equity Puts

| Strike | Put Premium | CDS PV | CDS Default Exposure[1] | Gain in Default on Puts | Put Contracts | Put Hedge Cost | Carry |
|---|---|---|---|---|---|---|---|
| $10.00 | 0.95 | $392,500 | $2,650,000 | $2,650,000 | 2,789 | $265,000 | $127,500 |
| $12.50 | 1.35 | $392,500 | $2,650,000 | $2,650,000 | 2,208 | $298,125 | $94,375 |
| $15.00 | 1.90 | $392,500 | $2,650,000 | $2,650,000 | 1,828 | $347,241 | $45,259 |
| $17.50 | 2.50 | $392,500 | $2,650,000 | $2,650,000 | 1,559 | $389,706 | $2,794 |
| $20.00 | 3.30 | $392,500 | $2,650,000 | $2,650,000 | 1,359 | $448,462 | -$55,962 |
| $25.00 | 5.30 | $392,500 | $2,650,000 | $2,650,000 | 1,082 | $573,265 | -$180,765 |
| $30.00 | 8.10 | $392,500 | $2,650,000 | $2,650,000 | 898 | $727,627 | -$335,127 |

1. CDS Default Exposure is calculated as CDS Notional * (1 - 47%)
Source: Bloomberg, JPMorgan

**Risks to the strategy**
There are several risks inherent in this strategy:

- MTM volatility can be significant. CDS and puts have different risk profiles and, being different capital structure instruments, may react to company news in an unanticipated way. For example, a LBO announcement is likely to push spreads wider and the stock higher, hurting the investor in a sell CDS/buy Put trade on both legs.
- Recovery on CDS has a large impact on the trade payoff. Trading a fixed recovery CDS against the put hedges recovery rate risk. However, as we note below, the recovery rate market typically trades only distressed names, so the pool of potential trades is significantly smaller.
- Maturities between the CDS and equity puts may differ. CDS typically trade to the 20th of March, June, September and December, which often creates a mismatch with an exchange-traded puts. Tailoring a CDS or equity puts to a particular maturity may often be very difficult or prohibitively expensive. Another alternative may be to roll the option as maturity approaches, since there are more short-term than long-term option maturities available to an investor.

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- The final stock price will also affect the trade payoff

*Option Buyer.* Options are a decaying asset, and investors risk losing 100% of the premium paid.

*Put Sale.* Investors who sell put options will own the underlying stock if the stock price falls below the strike price of the put option. Investors, therefore, will be exposed to any decline in the stock price below the strike potentially to zero, and they will not participate in any stock appreciation if the option expires unexercised.

### Analyzing Fixed Recovery CDS/Put Trades

Below, we show a similar fixed recovery CDS/Put analysis for a number of companies that trade in the recovery rate market. We show both the zero carry as well as zero payoff in default scenarios.

Exhibit 13.5: Three names that trade in the recovery rate market

| Name | Stock | 1Y CDS Bid | Points | CDS Dur | CDS Not | CDS Recovery Bid | Stock in Def |
|---|---|---|---|---|---|---|---|
| General Motors | $22.58 | 500bp | 8.5 | 0.90 | $5,000,000 | 38 | $0.50 |
| American Axle | $18.37 | 555bp | 0 | 1.06 | $5,000,000 | 53 | $0.50 |
| Dana Corp | 4.44 | 500bp | 16 | 0.80 | $5,000,000 | 49 | $0.50 |

Source: JPMorgan, Bloomberg

Exhibit 13.6: Sell Fixed Recovery CDS/Buy Equity Puts Trades

| | | | | | Trade: Zero Carry, Positive Payoff in Default[1] | | | | Trade: Default-Neutral, Positive Carry[2] | |
|---|---|---|---|---|---|---|---|---|---|---|
| Name | Strike Price | Put Premium | CDS PV | Put Contracts | Loss in Default on CDS | Gain in Default on Puts | Total | # Contracts | Cost | Payoff |
| General Motors | $2.50 | $0.25 | $650,000 | 26000 | -$3,100,000 | $5,200,000 | $2,100,000 | 15,500 | $387,500 | $262,500 |
| American Axle | $12.50 | $1.25 | $294,150 | 2353 | -$2,350,000 | $2,823,840 | $473,840 | 1,958 | $244,792 | $49,358 |
| Dana Corp | $2.50 | $0.70 | $1,000,000 | 14286 | -$2,575,000 | $2,857,143 | $282,143 | 12,875 | $901,250 | $98,750 |

Source: JPMorgan
Note: Payoff in default assumes stock trades at $0.50

### Implications for put skew in the equity market

The potential to trade CDS against equity helps to anchor out-of-the-money put pricing in the equity derivatives market. Specifically, the CDS/Equity put relationship we describe above provides a lower bound to the put implied volatility skew. If the skew is insufficiently steep (i.e. deep out-of-the-money puts are cheap relative to CDS), investors can sell protection and buy puts. The upper bound for the skew is anchored by the ability to execute put spreads (buy one put, sell farther out-of-the-money puts). If the skew is too steep, investors can buy 1 put with strike K and sell two puts with strike K/2. The final payoff of this trade cannot be negative or an arbitrage is created.

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**JPMorgan Implied Recovery Report**

The JPMorgan daily Implied Recovery Rate Report analyzes pricing in equity derivatives compared to CDS spreads, and provides the following information:

- Equity option-implied recovery rates for the unsecured debt of over 100 companies.
- Top opportunities to sell CDS protection and buy equity put options with positive carry and expected neutrality in default.
- Fair value prices for deep out-of-the-money puts and short-dated CDS.

For further information, refer to "*Introducing the JPMorgan Implied Recovery Report*", published on November 3, 2006. Please contact us to be added to the distribution.

## Exhibit 13.7: Implied Recovery Rate Report

| | | | Equity Put Option | | | | | CDS | Sell CDS Protection, Buy Put Options | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sector / Industry | Ticker | Price ($) | Maturity | Strike[1] ($) | Open Interest (Contracts) | Bid ($) | Ask ($) | Mid Spread[2] (bp) | Upfront CDS Premium Received[3] ($) | Put Contracts Purchased[4] | Implied Recovery Rate[5] |
| Auto Manufacturers | F | 8.48 | Jan 08 | 5.00 | 261346 | 0.30 | 0.40 | 339 | 39,375 | 984 | 61% |
| Auto Manufacturers | F | 8.48 | Jan 09 | 5.00 | 34889 | 0.60 | 0.70 | 436 | 85,494 | 1221 | 51% |
| Auto Manufacturers | GM | 34.36 | Jan 08 | 10.00 | 154152 | 0.30 | 0.45 | 234 | 27,486 | 611 | 45% |
| Auto Manufacturers | GM | 34.36 | Jan 09 | 7.50 | 282 | 0.40 | 0.55 | 304 | 61,127 | 1111 | 28% |
| Auto Parts&Equipment | GT | 15.18 | Jan 08 | 10.00 | 50247 | 0.65 | 0.75 | 186 | 22,028 | 294 | 74% |
| Auto Parts&Equipment | GT | 15.18 | Jan 09 | 7.50 | 319 | 0.65 | 0.75 | 251 | 50,996 | 680 | 56% |
| Auto Parts&Equipment | LEA | 31.50 | Jan 08 | 10.00 | 57115 | 0.30 | 0.40 | 231 | 26,719 | 668 | 40% |
| Auto Parts&Equipment | LEA | 31.50 | Jan 09 | 10.00 | 28822 | 0.75 | 1.05 | 285 | 55,523 | 529 | 52% |

Source: JPMorgan

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# Part III: Index products

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# 14. Credit default swap index products

## Introduction

Credit default swap indices are tradable products that allow investors to establish long or short credit risk positions in specific credit markets or market segments. JPMorgan has worked with other dealers to create a global family of standardized CDS indices. The results of this effort are the Dow Jones CDX indices for North America and the Emerging Markets, and the iTraxx indices for Europe, Japan, and Asia (two collective ventures within the global credit derivatives dealer community).

Like the S&P 500 and other market benchmarks, the credit default swap indices reflect the performance of a basket of assets, namely, a basket of single-name credit default swaps (credit default swaps on individual credits). Unlike a perpetual index, such as the S&P 500, CDS indices have a fixed composition and fixed maturities. A new series of indices is established approximately every six months with a new underlying portfolio and maturity date, to reflect changes in the credit market and to help investors maintain a relatively constant duration if they wish. Equal weight is given to each underlying credit in the CDX and iTraxx portfolios. If there is a credit event in an underlying CDS, the credit is effectively removed from the indices in which it is included.

When a new index is launched, dubbed the "on-the-run index," the existing indices continue to trade (as "off-the-run"), until maturity. Investors have the option to close their positions in off-the-run series and enter into new positions in the on-the-run indices, but are not obligated to do so. The on-the-run indices tend to be more liquid than the off-the-run indices.

## Mechanics of the CDX and iTraxx indices

Each CDX index is a separate, standard credit default swap contract with a fixed portfolio of credits and a fixed annual coupon. Investors will pay or receive a quarterly payment of this fixed coupon on a desired notional. As with standard credit default swap contracts, payments are made on the 20th of March, June, September, and December. Accrued interest is calculated on an Actual/360 basis.

While CDX and iTraxx products pay or receive a fixed coupon, they also trade in the market. The traded level of the CDX or iTraxx is determined by supply and demand. To offset the difference between the fixed coupon and the market spread, investors must either pay or receive an upfront amount when a contract is created. If the market spread of the index is tighter than the fixed coupon, for example, an investor selling protection (long risk) will be required to pay an upfront amount, as they will be receiving a greater fixed spread (coupon) than the level at which they trade. The opposite is true if the spread on the index is wider than the fixed coupon; a buyer of protection (short risk) must pay an upfront fee, as the protection buyer is paying a fixed coupon that is lower than the spread determined by the market. The upfront fee is the risky present value of the spread difference, or (spread difference) x (duration) x (notional). It can be calculated using the CDSW page on Bloomberg. To access Series 6 information, for example, enter: CDX6 CDS Corp [go], select the index, then type CDSW [go]. Note that HY CDX indices are quoted in price terms, thus the upfront payment is the price difference from par.

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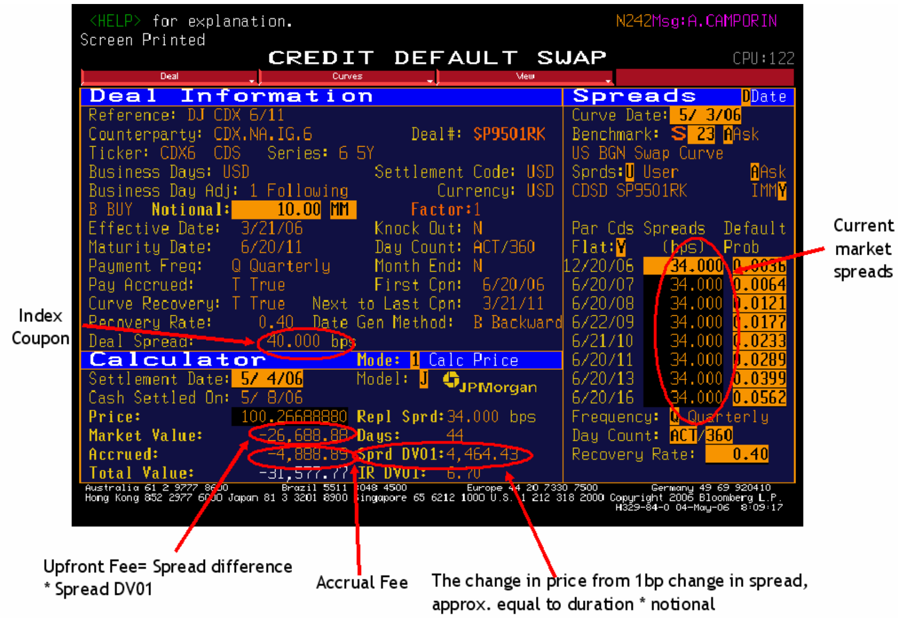
Exhibit 14.1: CDX CDSW model on Bloomberg




Source: Bloomberg

In addition to the market value upfront payment, investors must either pay or receive an accrued fee when entering into a new contract. An investor who has a long risk position on a coupon payment date will receive the full quarterly coupon payment, regardless of when she entered into the contract. If the contract was created in the middle of a payment period, for example, in order to offset the "extra" amount of coupon she will receive, the seller of protection (long risk) must pay an accrued fee upfront. This is similar to settling accrued interest on a bond

As mentioned in the Introduction, investors do not need to hold CDX or iTraxx contracts until maturity but can close-out, or unwind positions at any time. Investors can use the CDSW page on Bloomberg to calculate the value of unwinding an existing CDX or iTraxx contract, just as they calculate the value of the upfront payment when entering the contract. As the HY CDX is quoted in price terms, the value of the unwind is the difference from par.

## Basis to theoretical

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

Thus, the index spread is different from both the average spread of the underlying credit default swaps, and the theoretical value of the index. The theoretical value is the duration weighted average of the underlying CDS. We compute the theoretical value of the index using the following calculations:

- Observe the current market levels of the single-name CDS that have the same maturity date of the index. If the on-the-run single-name CDS has a different maturity date than the index, we interpolate between two points on the CDS curve.

- Convert the single-name CDS spreads into prices. We value each spread relative to the fixed coupon of the index. This is analogous to entering the fixed index coupon as the "deal spread," and the CDS spread as the "current spread" on the CDSW calculator on Bloomberg. For example, if the index has a coupon of 50bp and the market spread of an underlying CDS was 75bp, we approximate the price as par – (spread difference) x (duration). If we assume duration is 4, the result is 1 – (0.0075 - 0.0050) x 4 = $0.99.
- Once the prices for the underlying credits are calculated, we take a simple average. This is the theoretical value of the index in price terms. We convert this price into a spread using the same methodology used in the CDSW calculator.
- The market-quoted index spread less the theoretical spread is the basis to theoretical.

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

In a rapidly changing market, the index tends to move more quickly than the underlying credits. This is because, in buying and selling the index, investors can express positive and negative views about the broader credit market in a single trade. This creates greater liquidity in the indices compared with the individual credits. As a result, the basis to theoretical for the indices tends to increase in magnitude in volatile markets. In addition, CDX and iTraxx products are increasingly used to hedge and manage structured credit products. This may cause their spreads to be more or less volatile or to diverge from cash bond indices.

Single-name North American high-grade credits typically include Modified Restructuring as a credit event (MR spread curve), while single-name North American high-yield credits typically do not (NR spread curve). European credits generally use Modified Modified Restructuring (MMR), which is similar to Modified Restructuring, except that it allows a slightly larger range of deliverable obligations in the case of a restructuring event. However, across all indices, theoretical values are calculated using NR spread curves.

## Comparing on-the-run and off-the-run basis

Investors commonly use the CDX indices to gain broad market exposure and to take short risk positions to hedge a portfolio of bonds. Because of the latter, on-the-run CDX indices often trade at a wider spread relative to their theoretical value, or at a discount in dollar terms. For, if an investor wishes to enter into a short risk position, they usually do so in the on-the-run CDX, as opposed to the off-the-run CDX. As a result, in spread terms, on-the-run indices usually have a more positive basis to theoretical than off-the-run indices. Further supporting this trend is the tendency of long-risk CDX investors to hold off-the-run indices longer than short-risk investors. Long-risk investors enjoy the roll down the curve, while short-risk investors usually prefer not to "overpay" for a shorter maturity index. For example, assume an investor receives 100bp for taking a long-risk position in a 5-year CDX index. A year later, the same investor will still receive 100bp for a product that will now mature in only four years. In an upward sloping and constant CDS curve environment, this spread will be higher than the spread of a 4-year CDX index. An investor with a long risk position is more likely to hold an off-the-run index

Exhibit 14.2: CDX IG basis to theoretical tends to be more positive (CDX has wider spread than underlying) in the on-the-run index

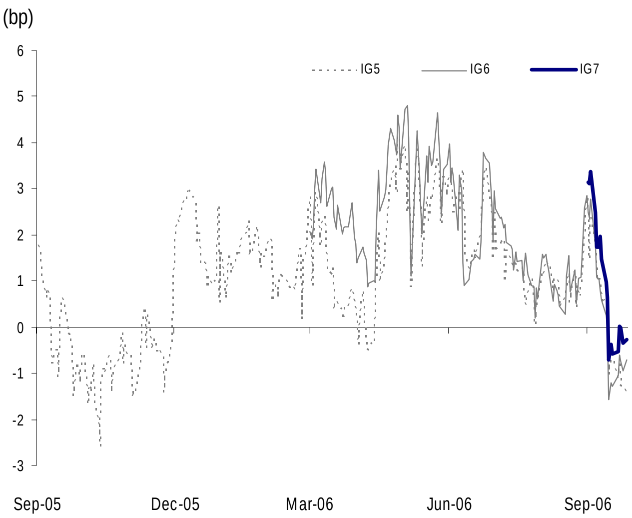
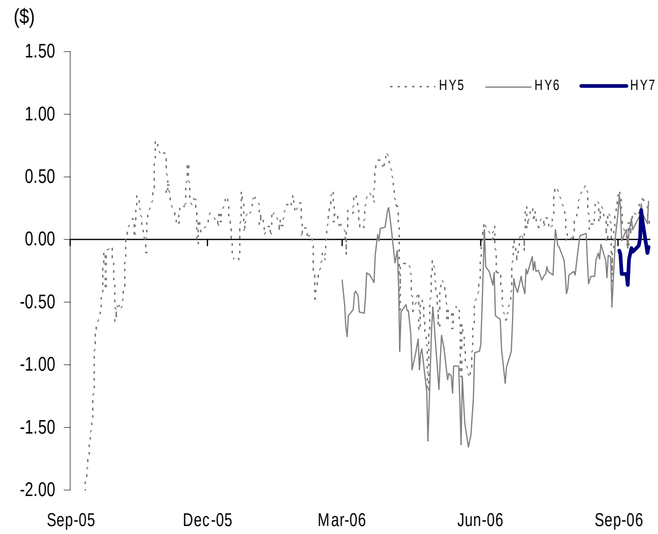



Exhibit 14.3: CDX HY basis to theoretical tends to be more negative (CDX has a lower dollar price than underlying) in the on-the-run index.




Source: JPMorgan

## Credit events

The credit default swaps in the index are equally weighted in terms of default protection; if there is a credit event in one credit, the notional value of an investor's CDS contract will fall by 1/100, if there are 100 credits in the index. After a credit event, in this example, the index will be comprised of 99 credits.

Consider an investor who buys $100 of protection (short risk) on an index with a coupon of 50bp. Assume a credit event occurs in one credit whose bonds fall to $0.40 per $1 face. If the position is physically settled, she will deliver one bond, purchased for $0.40 in the marketplace, with a $1 face (notional * 1/100), to the seller of protection (long risk) and receive $1 in cash. She will continue paying 50bp annually, but on the new notional value of $99.

The market spread of an index may change if there is a credit event in an underlying credit. Continuing our example, assume that, before the credit event, 99 of the credits underlying the index have a spread of 50 and one credit has a spread of 1,000. Also assume that the index is trading at its theoretical value. The market spread of the index will be approximately 60bp. If the credit with a spread of 1,000 defaults, the credit is removed from the index, and the market spread of the index will now be 50bp, the average of the remaining 99 credits (Exhibit 14.4). An investor who is long protection (short risk) will therefore lose money when the index spread rallies, but receive money on the credit event ($0.60 in our example). If the credit event was widely anticipated, these two factors will likely offset one another with no significant net impact on her profit and loss statement.

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Exhibit 14.4: After a credit event in an underlying credit, the credit drops out of the index, and the spread of the index should adjust to a tighter level.

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

Note: In practice, the market before the default will give a lower weight to the credit whose spread is at 1000, therefore the index spread will likely be below 60.

Source: JPMorgan.

In a credit event, CDX documentation calls for physically settlement. In 2005, however, a protocol was developed by the International Swaps and Derivatives Association (ISDA), working with the dealer community, to allow CDX investors to cash-settle a CDX position in a fair and convenient manner. The CDS protocol has been further developed to include single name CDS contracts as well as CDX contracts. The protocol is discussed in Part I.

## CDX and iTraxx indices

In North America there are investment grade, crossover, and high yield indices. In Europe, there are investment grade and crossover / high yield indices.

**Dow Jones CDX Investment Grade Indices**

The US Investment Grade main index, quoted in basis points per annum, is comprised of 125 underlying credits. To be eligible for inclusion in the index, a credit must have an investment grade rating from both Moody's and Standard and Poor's. The CDX dealer consortium, or the group of dealers who actively participate in the CDX market, choose the portfolio through a voting process. Before the launch of the new series, dealers submit a list of credits that are in the old series, but should be, in their opinion, excluded from the new series. Credits with low liquidity in the CDS market are often candidates for removal. Additionally, dealers who trade the CDX products cannot be included in the CDX portfolios. The final portfolio is determined through a voting process, detailed on http://djindexes.com.

The Dow Jones Investment Grade High Volatility Index is a 30-credit subset of the Investment Grade Main Index. During the launch of each new series, the dealer consortium votes on the credits to be included in the smaller portfolio. Generally, these 30 credits have the widest spreads among the 125 credits in the Main Index.

CDX.IG is liquid in 1 through 5, 7 and 10 year tenors. CDX.HiVol is primarily traded as a 5 year product. Standard trade sizes are up to $1 billion for the IG CDX, and up to $500 million for subindices.

**Dow Jones CDX Crossover Index**

The US crossover index is comprised of 35 credits with four- or five-B ratings. Namely, a four-B credit is rated BB by both S&P and Moody's and a five-B credit is rated BB by one agency and BBB by the other rating agency. The portfolio selection process is the same process used in the investment grade indices. This index was launched for the first time with the Series 5 Investment Grade and High Yield Indices on Sept 20, 2005, and was labelled with a "5" at the time of its introduction.

The maturity dates for this index are the same as the investment grade index. The five-year tenor is the most actively traded tenor. The index is quoted in basis points per annum and paid quarterly, as in the investment grade indices.

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**Dow Jones CDX High Yield Index**

The Dow Jones CDX.NA.HY 100 is comprised of 100 underlying North American credits. The CDX dealer consortium chooses the portfolio through a voting process similar to the Investment Grade indices. To be eligible for inclusion in the index, a credit must not have an investment grade rating from both Moody's and Standard and Poor's, but can have an investment grade rating from one of the two agencies. The most liquid credits are usually selected.

The High Yield index has three subindices, namely the DJ CDX.NA.HY BB, DJ CDX.NA.HY B and DJ CDX.NA.HY High Beta indices. The underlying credits of the BB and B sub-indices are based on the Moody's ratings at the time of the indices' launch. The High Beta index, like the investment grade High Volatility index, is a 30-credit index determined by the dealer consortium. Generally, the 30 credit default swaps with the highest spreads at the time of portfolio selection are included.

Unlike the investment grade indices, the high yield CDX is quoted in dollar prices. Furthermore, the 100, BB, and B indices are available in both swap (unfunded) and note (funded) form.

**Dow Jones CDX.NA.HY Notes:** Each Dow Jones CDX.NA.HY Note is a separate trust certificate with a fixed portfolio of credits and a fixed coupon. The notes have a prospectus and trade like bonds, with transfers of cash at the time of purchase. Like a bond, Dow Jones CDX.NA.HY Notes pay a fixed coupon on a semi-annual basis, with accrued interest calculated on a 30/360 day count convention. Payments are made on the 20th of June and December. The CDX notes can be thought of as a package of the CDX swaps plus a trust that pays Libor. A detailed diagram of the CDX.NA.HY Notes structure is provided below.

When a new index is launched, the CDX dealer consortium draws bonds from the trust. Dealers are able to draw from the trust, up to the amount specified in the prospectus, for up to 90 days after the CDX launch. After 90 days, dealers may be able to draw from the trust for up to one year if there has not been a credit event in an underlying CDS. Thus, bonds may trade rich or cheap compared to theoretical value depending on the number of bonds drawn from the trust and the overall supply and demand.

CDX HY Swaps settle physically or through auction after a default as described above in the CDX.IG discussion. CDX.HY Notes settle differently. If there is a credit event, note holders do not need to take any action in order for a default to be settled. The settlement procedures for the notes are outlined in the offering memorandum. In summary, the CDX dealers will hold the three auctions for bonds of the defaulted credit. The CDX dealers deliver bonds to the auction agent over the course of the three auctions. The auction agent then sells the bonds to the marketplace through an auction process. The weighted average price paid by the marketplace during the three auctions will be the recovery price. Note holders in affected indices then receive a payment of this recovery price. The entire process takes approximately four to six weeks.

The CDX.NA.HY Note will continue to pay the original coupon amount but on a reduced notional. For the 100 index, for example, each subsequent credit event will reduce the notional of a position by 1/100 of the original notional. The process is the same for the other Dow Jones CDX.NA.HY Notes except the ratios are different, as the original number of credits in each index is fewer than 100.

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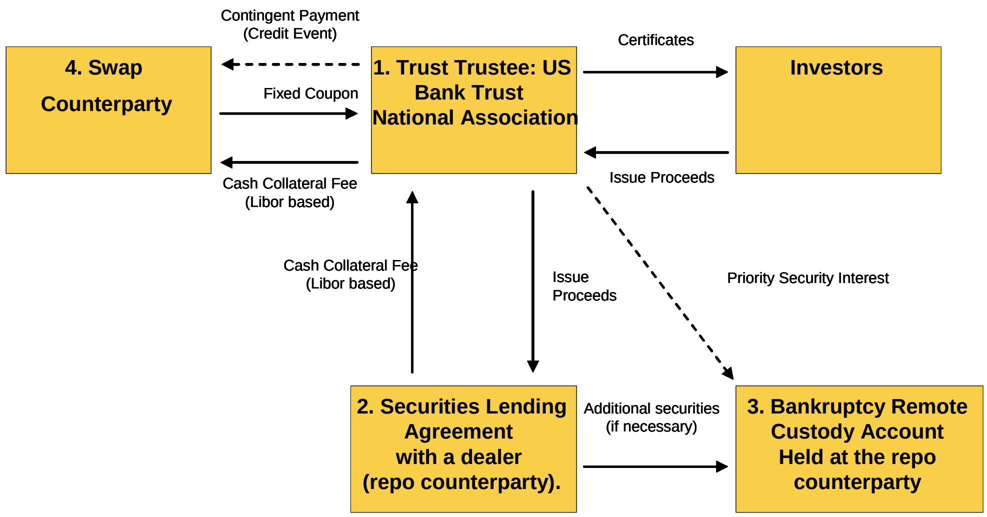
The Dow Jones CDX.NA.HY note is structured as follows:

1. A Delaware trust is established to issue certificates
2. Repo counterparty lends securities (the “Loaned Securities”) to the Trust in return for the issue proceeds
3. The Loaned Securities are deposited in a bankruptcy remote account
4. The Trust enters into a credit default swap with the Swap Counterparty, comprised of CDX dealers, referencing the DOW JONES CDX.NA.HY index

**Funded DOW JONES CDX Structure**




Source: JPMorgan

### iTraxx Investment Grade Indices

The iTraxx Europe series of indices (often referred to as “iTraxx Main”) is very similar in composition rules to the CDX Investment Grade indices. The index consists of 125 underlying CDS contracts on European names. All credits must have an investment grade rating (where non-investment grade is defined as being rated BBB-/Baa3 on negative outlook or below by either Moody's or Standard and Poor's).

Composition of the index is based on lists of most liquid credits supplied by participating dealers. Additionally, each sector has a constant number of credits in the index (e.g. the index always contains 10 names from the autos sector, 30 from the consumer sector, etc). Priority is given to credits that appeared in the previous series in order to minimize composition differences between consecutive series.

The iTraxx High Volatility index (or “iTraxx HiVol”) is a subset of iTraxx Europe consisting of the 30 names with the widest spreads in the index (based on spreads on the last trading day of the month prior to the series' launch). Both iTraxx Main and iTraxx HiVol trade in 3, 5, 7 and 10 year tenors. For further information on iTraxx Main and HiVol, see “Introducing iTraxx Europe Series 6” by Saul Doctor, September 19, 2006.

### iTraxx Crossover Index

Despite the name, iTraxx Crossover is arguably more representative of European High Yield rather than the Crossover market. It currently consists of 45 underlying credits.

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In order to be eligible for the Crossover index, a name must have a non-investment grade rating (rated BBB-/Baa3 on negative outlook or below by either Moody's or Standard and Poor's), and the spread must be at least twice the average spread of the names in iTraxx Main (excluding financials). Additionally, no credit with a spread greater than 1250bp or 35% upfront can be included in the index. Subject to these constraints, the index is composed of the most liquid credits, based on lists submitted by participating dealers. iTraxx Crossover trades in 5 and 10 year tenors. For further information on iTraxx Crossover, see "Introducing iTraxx Crossover Series 6" by Saul Doctor, September 19, 2006.

**iTraxx Asia**

The iTraxx Asia family is comprised of three main indices, the iTraxx Japan, iTraxx Asia ex Japan and iTraxx Australia. For iTraxx Japan, there are 50 names in the index, both high-grade and high-yield names, and liquidity as proxied by trading volume is the main criteria for index eligibility. It is the only Asian index to trade in the three, five and ten year tenors. Additionally, there is a 25 credit HiVol sub-index which is widely traded in the five year tenor.

iTraxx Asia ex Japan has a similar selection criteria and there are 50 names in the index. While there are no restrictions on the split between investment-grade and non-investment grade names, there are rules to ensure the index is broad-based and representative of the Pan-Asia sphere. Currently, the Series 6 and its sub-indices only trade in the 5-year tenor. In terms of liquidity, activity in the sub-indices is light.

Lastly, iTraxx Australia is the smallest index comprised of 25 underlying credits with Australia or New Zealand risks. Unlike the other two indices, there are sectoral restrictions to ensure its diversity. It trades only in the 5-year tenor. For more information, please refer to "Introducing to iTraxx Asia ex Japan Series 6" and "Introducing to iTraxx Australia Series 6" by Danny Soh, September 19, 2006 as well as "Introducing iTraxx Japan Series 6" by Mana Nakazora and Seiko Fujiwara.

**Dow Jones CDX Emerging Markets**

The CDX Emerging Markets index is currently comprised of 14 unequally-weighted sovereign credits. The construction of the portfolio, both the credit selection and weights, is determined via a voting process by the CDX dealer consortium. Before the launch of the new series, dealers submit a list of credits that they feel should be included in the new series, as well as a list of those they feel should be excluded. CDX.EM is issued in both a 5-year and 10-year tenor. Liquidity is currently concentrated in the 5-year. Like the High Yield index, CDX.EM is quoted in dollar prices; however, its coupon is paid out semi-annually, not quarterly.

The CDX.EM Diversified was launched in April 2005. It has 40 equal-weighted sovereign and corporate credit default swaps. This five year index is further divided into standard credit tranches.

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## History of US CDS Indices

Before DJ CDX.NA.IG.2 and DJ CDX.NA.HY.3, there were competing index products among dealers. In 2004, JPMorgan and other dealers worked with the Dow Jones Company to create and endorse a family of standardized CDS indices in both the Investment Grade and High Yield markets. This has increased the liquidity and innovation in credit derivative products, in our opinion.

The table below provides a brief history of current and predecessor indices.

| Investment Grade | | Maturity Date (5Y) | No. of Credits | 5Y Fixed Coupon(bp) |
|---|---|---|---|---|
| DJ TRAC-X NA Series 2 | | March-09 | 98 | 100 |
| | Hi Vol | | 40 | 100 |
| CDX.NA.IG.2 | Main | September-09 | 125 | 60 |
| | Hi Vol | | 30 | 115 |
| DJ CDX.NA.IG.3 | Main | March-10 | 125 | 50 |
| | Hi Vol | | 30 | 105 |
| DJ CDX.NA.IG.4 | Main | June-10 | 125 | 40 |
| | Hi Vol | | 30 | 90 |
| DJ CDX.NA.IG.5 | Main | December-10 | 125 | 45 |
| | Hi Vol | | 30 | 85 |
| DJ CDX.NA.IG.6 | Main | June-11 | 125 | 40 |
| | Hi Vol | | 30 | 75 |
| DJ CDX.NA.IG.7 | Main | December-11 | 125 | 40 |
| | Hi Vol | | 30 | 75 |

| Cross Over | Maturity Date (5Y) | No. of Credits | 5Y Fixed Coupon(bp) |
|---|---|---|---|
| DJ CDX.NA.XO.5 | December-10 | 35 | 200 |
| DJ CDX.NA.XO.6 | June-11 | 35 | 190 |
| DJ CDX.NA.XO.7 | December-11 | 35 | 165 |

| High Yield | | Maturity Date (5Y) | No. of Credits | 5Y Fixed Coupon(%) | Swaps Coupon(bp) |
|---|---|---|---|---|---|
| TRAC-X NA HY | 100 | June-09 | 99 | 8.00% | 450 |
| | BB | | 43 | 6.40% | 320 |
| | B | | 53 | 9.00% | 520 |
| | HB | | 32 | 10.00% | 750 |
| TRAC-X NA HY.2 | 100 | March-09 | 100 | 7.38% | 350 |
| | BB | | 38 | 6.05% | 220 |
| | B | | 59 | 8.00% | 410 |
| | HB | | 33 | 10.13% | 615 |
| DJ CDX .NA.HY.3 | 100 | December-09 | 100 | 7.75% | 375 |
| | BB | | 43 | 6.38% | 225 |
| | B | | 44 | 8.00% | 400 |
| | HB | | 30 | 10.50% | 625 |
| DJ CDX .NA.HY.4 | 100 | June-10 | 98 | 8.25% | 360 |
| | BB | | 42 | 6.75% | 210 |
| | B | | 40 | 8.00% | 340 |
| | HB | | 28 | -- | 500 |
| DJ CDX .NA.HY.5 | 100 | December-10 | 100 | 8.75% | 395 |
| | BB | | 43 | 7.25% | 250 |
| | B | | 44 | 8.25% | 340 |
| | HB | | 30 | -- | 500 |
| DJ CDX .NA.HY.6 | 100 | June-11 | 100 | 8.625% | 345 |
| | BB | | 38 | 7.375% | 210 |
| | B | | 48 | 8.125% | 300 |
| | HB | | 30 | -- | 500 |
| DJ CDX .NA.HY.7 | 100 | December-11 | 100 | 8.637% | 325 |
| | BB | | 38 | 7.125% | 205 |
| | B | | 48 | 8.000% | 300 |
| | HB | | 30 | -- | 500 |

Note: Coupons for HY are for fixed notes
Source: JPMorgan

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# 15. CDX and iTraxx options

## Product description

A CDS option is an option to buy or sell CDS protection on a specified reference entity at a fixed spread on a future date. Offered on both CDS indices and single-names, call options provide investors with the right to buy risk (receive spread) while put options provide investors with the right to sell risk (pay spread) at the strike spread. We therefore often refer to calls as receivers and puts as payers. Investors use options to trade credit volatility or tailor their directional spread views.

**We use cent to denote the upfront value of a running spread amount in units of 0.01%. So using a risky annuity of 4, 1bp would be equal to 4c (4×1bp).**

**CDS options have a European-style expiry and are quoted in cents upfront.**
CDX and iTraxx options have a fixed expiry that usually coincides with the index coupon dates (March 20, June 20, September 20 and December 20), although other maturities are available. All options are European-style in that an investor can only exercise them on the expiry date. At inception, the option buyer pays an upfront premium to the option seller (T+3 settlement).

**Most CDS options are quoted as spread options.**
In both Europe and North America, we usually quote the strike of an option as a basis point spreads amount. The notable exception is CDX.NA High Yield, which is quoted with a strike price, since the index trades on a price rather than spread basis.

### Exhibit 15.1: CDX and iTraxx Option Standard Terms

| | |
|---|---|
| Option Style: | European |
| Premium: | Quoted in cents upfront |
| Premium payment date: | Trade date + 3 business days |
| Expiration time: | 11am New York time, 4pm London time |
| Settlement: | Physical |
| Settlement terms | Expiry + 3 business days |
| Settlement amount | |
| a. if no credit events before expiry | Settlement by buying or selling the index at strike at expiry |
| b. if one or more credit events before expiry | Settlement by buying or selling the index at strike at expiry. Subsequently, protection buyer triggers the contract in regard to any defaulted credits under the standard procedures. |

Source: JPMorgan

**Standard CDS option contract calls for physical rather than cash settlement.**
If an option is In-the-Money at expiry, then the investor will enter the index contract at the strike spread. However, since the indices trade with an upfront fee, he will pay or receive this upfront and will then pay or receive the index coupon over the life of the CDS. An investor can immediately exit the contract and realise the difference between the strike and the prevailing market spread.

**Index options do not "Knockout" if there is a default on an underlying name.**
Standard CDS options do not roll onto the "on-the-run" index, but remain with the referenced series. If a name defaults, an investor's contract is on the original series that includes the defaulted name. An investor who bought a payer option would be able to exercise on the defaulted name, once they were entered into a long protection position on the index at the option expiry. Investors typically use the CDS settlement protocol (reviewed in Part I) to settle the defaulted name.

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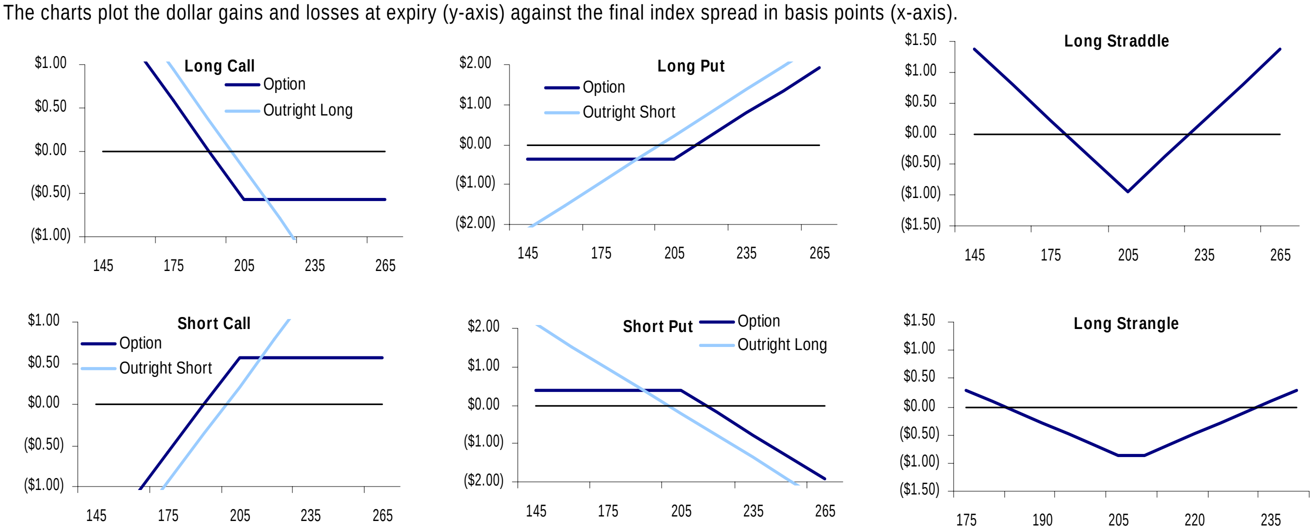
## Basic option strategy payoff diagrams

Below we show the payoff diagrams for six common option strategies. Note that the "hockey stick" diagrams are reversed compared to equity option graphs because spreads, not dollar prices, are plotted on the x-axis. The charts plot the dollar gains and losses at expiry (y-axis) against the final index spread quoted in basis points (x-axis).

In the following paragraphs, we look at how to use these payoffs to express a spread or volatility view.

### Exhibit 15.2: Payoff diagrams

The charts plot the dollar gains and losses at expiry (y-axis) against the final index spread in basis points (x-axis).




Source: JPMorgan.

## Using options to express a spread view

**Options can be used to express either a directional or range-bound market view.** An investor who is Bullish on credit and expects the index to tighten can sell index protection or buy a receiver option. If he chooses to buy the option, he cannot lose more than his initial outlay, but will only benefit if spreads tighten past the strike.

Alternatively, the same investor may wish to sell payer option, thereby receiving an upfront premium. So long as spreads remain below the option strike, the option seller will keep the full premium.

**Straddle and Strangle are used for range-bound views**

Investors can also express the view that spreads will remain range-bound by selling straddles or strangles (discussed in the next section). So long as spreads remain between the breakevens at expiry, an investor will keep all or part of the premium, irrespective of whether spreads move wider or tighter. However, an investor will lose on the trade if spreads widen past the breakevens at expiry.

## Using options to express a volatility view

**Expressing the view that realised volatility will exceed option-implied volatility.** Investors can also express a view that spreads will fluctuate without defining the direction of the move. The simplest way to buy volatility is to buy an At-the-Money

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(ATM) straddle. This position is initially spread neutral in that we would make an equal amount of money if spreads widened or tightened. We are therefore neutral to the direction of the spreads, but will benefit from a change in spreads.

However, in order to profit, we need spreads to move more than a breakeven amount. This breakeven is defined by the cost of the option, which in turn is defined by the implied volatility used to price the option. If the actual spread move (realised volatility) is greater than the breakeven (implied volatility) then the trade will be profitable. Equation 1 shows our daily Breakeven.

Equation 1: Daily basis point volatility assuming 252 business days in a year

$$DailyVol(bp) = \frac{ForwardSpread \times AnnualVol(\%)}{\sqrt{252}}$$

*where:*
*ForwardSpread = Adjusted Forward Spread on the index in basis points*[20]
*AnnualVol = Annualised percentage volatility*

## Combining spread and volatility views

**Investors with a view on volatility can optimize their spread view.**
The Delta of an option measures how much the value of an option should change if the underlying asset moves by one unit. Since ATM options have a delta of 50% (i.e. a 1% change in the index P&L equates to a 0.5% change in our option P&L) we could buy two options in order to have the same exposure as one index.

In Exhibit 15.3 we show the payoff at expiry from buying two ATM options. Here, we take a directional view, outperforming the index if volatility is high; the options outperform if the final spread of the index is very high or low. In Exhibit 15.4 we have sold two ATM payer options and outperform the index if volatility is low.

**Exhibit 15.3: Buying Two Payer Options Outperform if Volatility is High**

y-axis: P&L (cents); y-axis: Final Spread (bp)

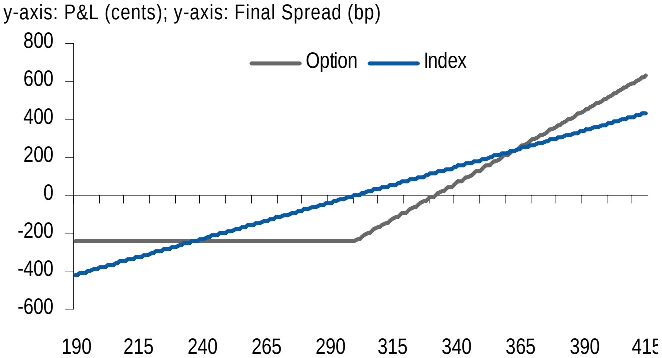
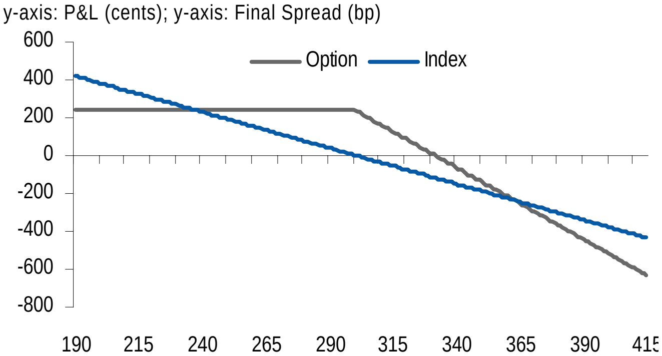



**Exhibit 15.4: Selling Two Payer Options Outperform if Volatility is Low**

y-axis: P&L (cents); y-axis: Final Spread (bp)




Source: JPMorgan.

[20] CDS index options are priced using the Black formula on the CDS forward. The forward is approximately equal to the spot plus the carry over the option term.

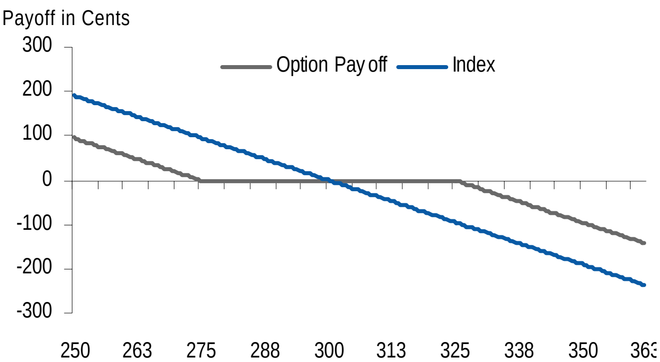
## Option trading strategies

Having looked at how we can express views using payers and receivers, we look at expressing views by combining payers and receivers.

*Bull Cylinders—spreads likely to move substantially tighter, but unlikely to widen.* We form these by selling a put/payer option and buying a call/receiver option. Between the two strikes of the trade, the cost is close to zero and the trade will perform if spreads tighten. On the downside, if spreads move much wider, the trade will lose money, although it outperforms an outright short protection position (Exhibit 15.5). Variations on this strategy involve increasing the notional on one or both legs of the trade versus the index. Bear Cylinders are formed by selling a call and buying a put.

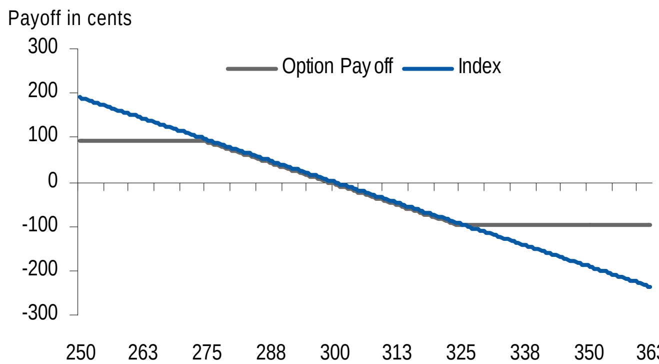
*Bull Spreads – spreads likely to drift tighter, protection against wider spreads.* We form these by selling a low strike call and buying a high strike call (we can also form these with puts) (Exhibit 15.6). Between the strikes of the trade, the position performs inline with the index while if spreads widen, the losses are capped above the upper strike. The downside is that we lose, inline with the index, if spreads widen, however, we can only lose up to the higher strike of the trade. At this point we cap our loss. Bear spreads are also formed using different strike puts or calls.

**Exhibit 15.5: Comparing a Cylinder to the Index**




Source: JPMorgan

**Exhibit 15.6: Comparing a Bull Spread to the Index**




Source: JPMorgan

**Market neutral strategies**

There are three common market neutral strategies available when using options:

*Straddles and Strangles – spreads to remain in a range.*
These are formed by selling a payer and receiver either at the same (Straddle) or at different (Strangles) strikes. Between the breakevens, the position will make money. The downside is that we lose if spreads widen or tighten past the breakevens (Exhibit 15.7).

*Butterfly– spreads likely to remain in a range.*
These are formed by selling a straddle and buying a higher strike payer option and a lower strike receiver option. Between the breakevens, the position will make money. Our loss is capped if we move above or below the extreme strikes, although we don't make as much as an outright straddle.

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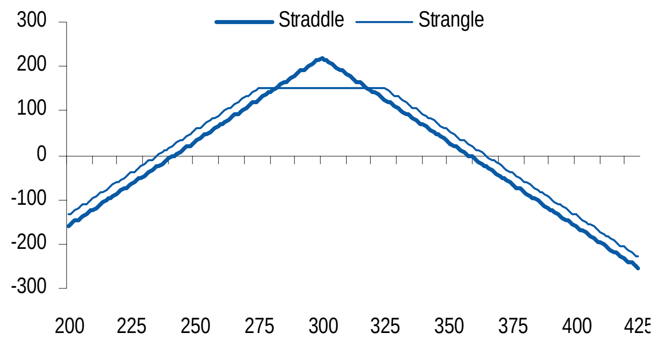
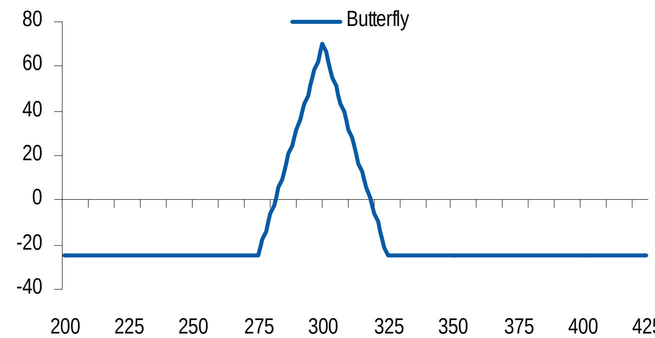
**Exhibit 15.7: Straddles and Strangles**




Source: JPMorgan

**Exhibit 15.8: Butterfly**




Source: JPMorgan

**Other option trading strategies**

*Calendar Spreads –trading the difference between volatility for different expiries.*
These are most commonly formed by trading straddles for different expiries. An investor who believes volatility will be low in the short term, but will pick up in the longer term may sell short-dated straddles and buy long-dated straddles. The notionals traded can be scaled to be Vega neutral, insensitive to changes in implied volatility, or Gamma-neutral, insensitive to changes in the index spread.

*Skew Trading- trading the difference between options at different strikes*
Skew measures the difference in implied volatility at different strikes. Although the index can have only one realized volatility, supply and demand dynamics often cause options at different strikes to trade with different levels of volatility. We tend to see options with higher strikes trade with higher implied volatility as investors buy cheap Out-of-the-Money payer options as portfolio protection. This causes positive skew.

Investors can trade options of different strikes to express the view that skew will increase or decline.

## The practical side to trading options

Having looked at the strategies we can use credit options for, we now look at the practical side of trading credit options. Exhibit 15.9 shows a typical Bloomberg screen we would see for iTraxx options (JITO <GO> on Bloomberg). Similar screens are available for CDX and runs are send out daily from option traders.

When using index options to express a spread view, there are three aspects we consider:

1. **Cost** – This is the upfront cost of an option and is the amount we pay if we buy an option, or receive if we sell an option. This amount is quoted in cents and is an upfront amount. Suppose an investor is concerned about spread widening and wants to buy the option to buy protection at 26bp out to 20 March 2007. From Exhibit 15.9 we can see that the cost of this option is 12c. On a notional trade of $10,000,000, an investor will pay $12,000.
2. **Breakeven** – the trade breakeven tells us the level spreads need to be at expiry in order to recoup the initial cost of buying the option. Continuing with our example above, if spreads are wider than 26bp at expiry, our option will be in-the-money. For each basis point above 26bp we will make approximately 1bp × duration. So

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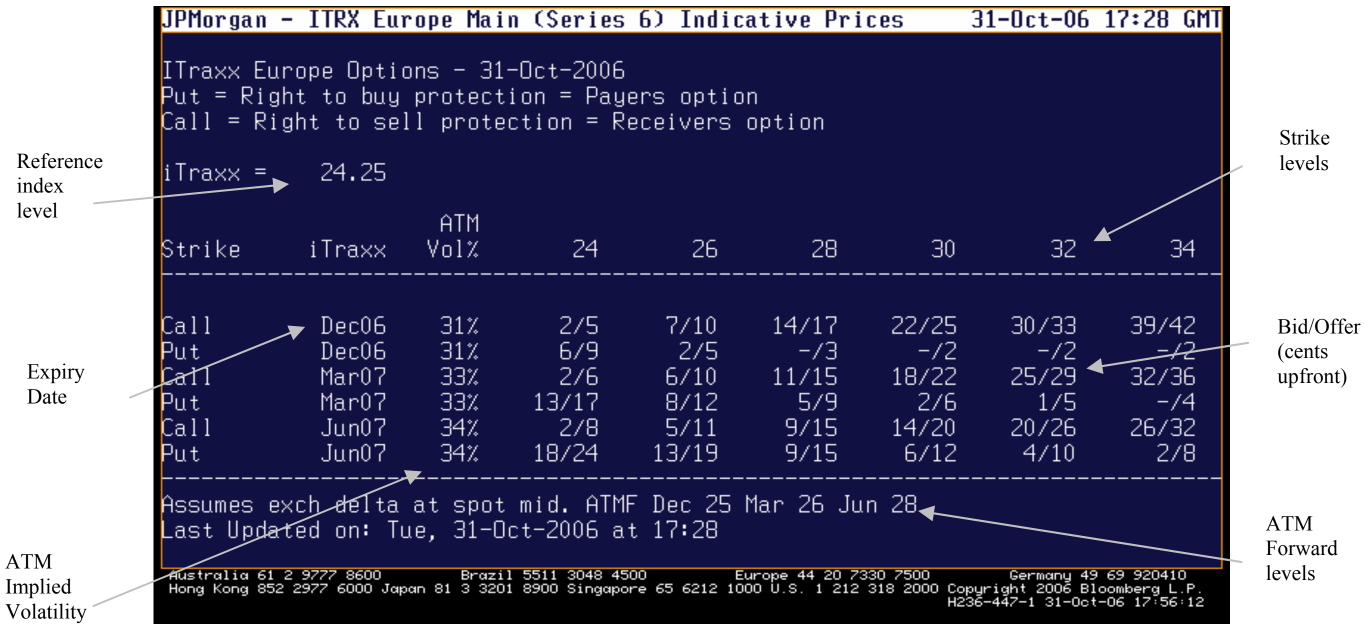
assuming a duration of 4, we will make 4c for each bp the index is wider than 26bp at expiry. Therefore if the index is above 29bp, we will recoup the full cost of the option. We call 29bp the breakeven.

### Exhibit 15.9: iTraxx Option Trading Run



JPMorgan - ITRX Europe Main (Series 6) Indicative Prices 31-Oct-06 17:28 GMT

ITraxx Europe Options - 31-Oct-2006
Put = Right to buy protection = Payers option
Call = Right to sell protection = Receivers option

iTraxx = 24.25

| Strike | iTraxx | ATM Vol% | 24 | 26 | 28 | 30 | 32 | 34 |
|---|---|---|---|---|---|---|---|---|
| Call | Dec06 | 31% | 2/5 | 7/10 | 14/17 | 22/25 | 30/33 | 39/42 |
| Put | Dec06 | 31% | 6/9 | 2/5 | -/3 | -/2 | -/2 | -/2 |
| Call | Mar07 | 33% | 2/6 | 6/10 | 11/15 | 18/22 | 25/29 | 32/36 |
| Put | Mar07 | 33% | 13/17 | 8/12 | 5/9 | 2/6 | 1/5 | -/4 |
| Call | Jun07 | 34% | 2/8 | 5/11 | 9/15 | 14/20 | 20/26 | 26/32 |
| Put | Jun07 | 34% | 18/24 | 13/19 | 9/15 | 6/12 | 4/10 | 2/8 |

Assumes exch delta at spot mid. ATMF Dec 25 Mar 26 Jun 28
Last Updated on: Tue, 31-Oct-2006 at 17:28

Australia 61 2 9777 8600 Brazil 5511 3048 4500 Europe 44 20 7330 7500 Germany 49 69 920410
Hong Kong 852 2977 6000 Japan 81 3 3201 8900 Singapore 65 6212 1000 U.S. 1 212 318 2000 Copyright 2006 Bloomberg L.P.
H236-447-1 31-Oct-06 17:56:12



Source: JPMorgan

Equation 2: Calculating the Breakeven of an Option

$$Breakeven = Strike + \frac{Upfront}{ForwardAnnuity}$$

*Forward Annuity = Annuity of for a forward trade*

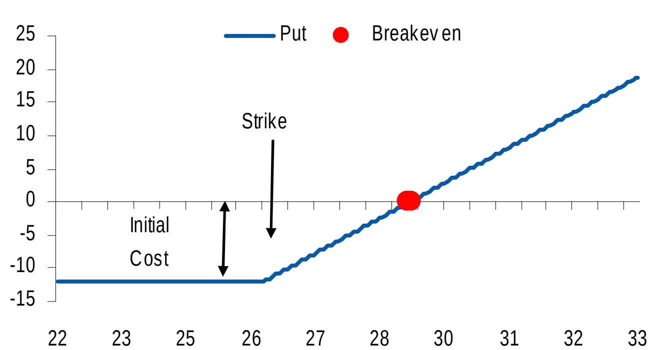
3. **Final P&L** – lastly, we look at our expected P&L in the case that spreads reach a certain level. If we buy a payer option and spreads remain below the strike at expiry, we will lose our upfront premium. For each basis point above our strike we will make 1bp × duration. Therefore, our P&L is shown in Equation 3.

Equation 3: Calculating the Final P&L of an Option

$$Final\ P\&L = \left[(FinalSpread - Strike) \times ForwardDuration - Upfront\right] \times Notional$$

### Exhibit 15.10: Trade Analysis

y-axis: Final P&L (cents); x-axis: Final Spread (bp)




Source: JPMorgan

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**Delta-Exchange – the cost of trading outright**

Another aspect to consider when trading options is that prices are usually quoted with delta-exchange. This means that an investor who purchases an option with a delta of 30% will also acquire an index position equal to 30% of the notional of the trade. This happens because option traders need to hedge their spread exposure. A trader who sells a $10,000,000 notional payer option with a delta of 30% and simultaneously buys index protection on $3,000,000 notional, will initially be neutral to spread changes in the index.

Therefore, investors who want to trade options outright and do not want this delta-exchange will need to exit their delta position. The cost of this is just the cost of exiting an index trade on the delta notional, Equation 4.

Equation 4: Cost of Exiting Delta

$$Cost = \frac{1}{2} \times (Bid, Offer) \times Annuity \times Notional$$

Source: JPMorgan

Suppose we want to buy the March payer option with a strike of 26, quoted in Exhibit 15.9, as an outright trade. The option is quoted as 8/12, so would cost us 12c to enter. If we assume that our delta is 50% and we wish to trade outright, then we would need to unwind our delta. If the bid/offer on the index is 0.25bp and the annuity is 4, then the cost of this unwind is 0.5c (= 1/2×0.25bp×4). Therefore, on a notional of $10,000,000 we would pay $12,000 for the options and $500 for the delta unwind giving a net cost of $12,500.

**The adjusted-forward – accounting for "no knockout"**

**We price CDS options using the forward rather than spot CDS spread**. This is because the model we use is a Black model that relies on lognormal distribution of spreads at maturity. This forward is calculated in the usual fashion (Equation 5).

Equation 5: Calculating the Forward between time s and t

$$F_{s,t} = \frac{S_t A_t - S_s A_s}{A_t - A_s}$$

*where*
$S_t$ = *Spreads for Maturity t*
$A_t$ = *Risky Annuity for Maturity t*

**However, we adjust the forward to account for the "No Knockout" feature of index options.** If a name in the index defaults before the expiry of the option, we will be entered into an index with a defaulted name at expiry of the option. If we had bought a payer option, we could trigger the contract and collect on the defaulted name. Therefore, we have received protection from today, even though the forward only offers protection from the option expiry.

We account for this additional protection by increasing the forward spread by the cost of protection. This makes payer options more expensive and receiver options cheaper because payer buyers receive protection on the spot and receiver buyers forgo this protection.

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Equation 6: Calculating the Adjustment

$$Adjustment = \frac{S_s A_s}{A_t - A_s}$$

Our adjusted-forward, which we use for pricing CDS options, is the sum of Equation 5 and Equation 6. It is roughly equal to our spot plus carry as a running spread.

Equation 7: Calculating the Adjusted Forward

$$\begin{aligned} AdjustedForward &= \frac{S_t A_t - S_s A_s}{A_t - A_s} + \frac{S_t A_s}{A_t - A_s} \\ &= S_t + \frac{S_t A_s}{A_t - A_s} \\ &\approx Spot + \frac{Carry}{ForwardAnnuity} \end{aligned}$$

**Exercising an option with a defaulted name in the portfolio**
We present below an example on expiry mechanics for options on the Dow Jones CDX.NA.HY Swaps. The expiry mechanics for options on CDX.IG and iTraxx work similarly.

**Expiry mechanics of options:** The option contract is not directly affected by credit events prior to the expiry date of the option. The option holder continues to have the right to buy or sell the "old" CDX.HY product (the product with the original reference entities) at the agreed strike price. After exercising the option, the buyer of protection can trigger the contract under the standard procedures if he chooses.

An example below demonstrates the expiry mechanics:

- Strike = $102
- Price at expiry of "new" CDX.HY Swap (with 99 underlying credits) = $101
- Price at expiry of bonds of the credit that defaulted (recovery rate) = $0.25

*Settlement process at expiry*

- Investor exercises the call: he buys the "old" contract for a price of $102 (the strike)
- The seller of the contract then triggers the defaulted name: investor pays $1.00
- Investor receives default bond worth $0.25

The net result suggests an equation that can be used to evaluate whether to exercise the option. Exercise a long call option if:

| | | |
|---|---|---|
| | Strike on "old" CDX.HY contract | $102.00 |
| + | Defaulted credit notional value | $1.00 |
| - | Recovery value of defaulted credits | ($0.25) |
| | Cash cost to buy "new" DJ CDX.NA.HY through the option | $102.75 |

Source: JPMorgan

In this example, the cash cost to buy new CDX.HY in the market is $101.00 * a factor of 0.99 = $99.99. The investor would not exercise the option, as it is $2.76 out of the money.

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In practice, the recovery rate of the defaulted bond is determined by the CDS Settlement protocol auction process, described in Part I.

**Accrued interest**

An outright position pays accrued interest on a defaulted credit up to the credit event date. At expiry, the settlement amount for an option on the index will be adjusted to reflect the same economics.

**Option pricing model**

We use option pricing models either to calculate option prices from volatility levels, or to calculate implied volatility levels from input prices.

Two such models are easily accessible to investors; JPMorgan's Excel based model and the CDSO Bloomberg screen. Both models use the Black pricing formula on the forward and return very similar results. The reader is referred to Bloomberg's own documentation on their model or to our previous note *Credit Option Pricing Model October 2004*.

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# 16. Trading credit volatility

Having seen the basics of option trading, we now look specifically at trading credit volatility. The reader is referred to Trading *Credit Volatility – August 2006* for more details.

## Defining volatility

**Volatility in credit is a measure of the standard deviation of spreads**
Volatility is defined as the annualized standard deviation of percent change in the underlying price or spread[21]. For example, a volatility of 30% can be interpreted as a 68% chance (1 standard deviation) that the asset will be +/- 30% of the current level a year from now.

We generally talk about two types of volatility:

**1. Historical** (also called actual, delivered or realised) volatility is the volatility of a particular asset as measured by its past price movements

**2. Implied** volatility is the volatility that is forecast by the pricing of options on the asset. This volatility is an output from the Black pricing formula for options.

**Our daily basis point volatility tells us how much spreads need to change in order to offset the cost of an option**
In Credit, it is often more convenient to talk in terms of daily volatility in basis points (basis point volatility) rather than annualised volatility in percentage terms. We can convert annualised volatility into daily volatility in basis points using the following formula:

Equation 8: Daily basis point volatility assuming 252 business days in a year

$$DailyVol(bp) = \frac{ForwardSpread \times AnnualVol}{\sqrt{252}}$$

*where:*
*ForwardSpread = Adjusted Forward Spread on the index in basis points*[22]
*AnnualVol = Annualised percentage volatility*

**If we think our daily spread move will exceed the breakeven then it is worthwhile buying volatility.** The breakeven, or daily volatility, therefore gives an intuitive feel for whether options are expensive or not.

---

[21] $Vol = \sum \sqrt{\frac{\left(x_i - \overline{x}\right)^2}{n}}$ , where $x_i = \ln\left(\frac{s_t}{s_{t-1}}\right)$ and $s_t =$ CDS spread on day t

[22] CDS index options are priced using the Black formula on the CDS forward. The forward is approximately equal to the spot plus the carry over the option term.

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## Delta-hedging

Delta-hedging involves buying an option and also an amount of the underlying index defined by the option delta. It is designed to be neutral to the direction of spread and benefits if spreads move more than the daily breakeven.

**The initial cost of an option is the cost of replication**

An investor can **replicate** the payoff from an option by establishing and regularly adjusting a position in the underlying index (CDX or iTraxx). The option delta tells us the amount of the index that an investor needs to own.

The delta of an option measures how much the theoretical value of an option should change if the underlying asset moves by 1 unit. **A positive delta means the option should rise in value if the underlying spread widens**. In credit, call deltas range between -1 and 0 while put deltas range between 0 and 1.

As the spread on the index changes, the delta of the option will change and the investor will need to adjust his position for the replication to work. In order to replicate the payoff from a long call/receiver (long risk) an investor will have to sell protection (long risk) when spreads tighten and buy protection (short risk) when spreads widen. He will therefore buy protection at a higher spread and sell it at a lower spread.

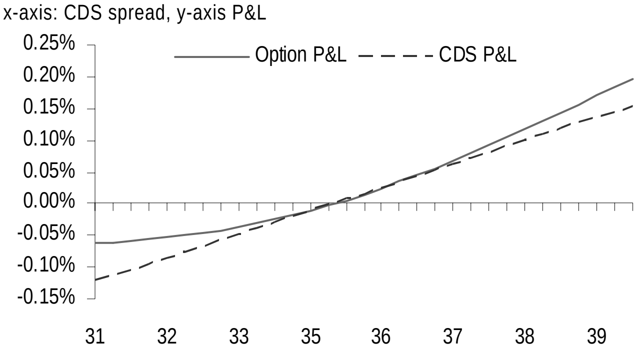
**Reminder:**
**Call = Receiver, Put = Payer**

**Essentially, the initial cost of an option should be equal to the cost of replicating it**. If the cost of replicating an option is more expensive than the initial cost, an investor should buy the option and delta-hedge it. This means that he should take the opposing position in the underlying index. An investor who buys a payer option (short risk) should therefore sell protection (long risk) on the index in the delta amount and adjust this hedge as the index spread moves.

Since the initial cost of an option is given by the implied volatility, and the cost of replicating the option is given by the realised volatility, an investor who buys a delta-hedged option will make money if realised volatility is higher than the initial implied volatility.

**Exhibit 16.1: Instantaneous P&L on Option and Delta Replication**

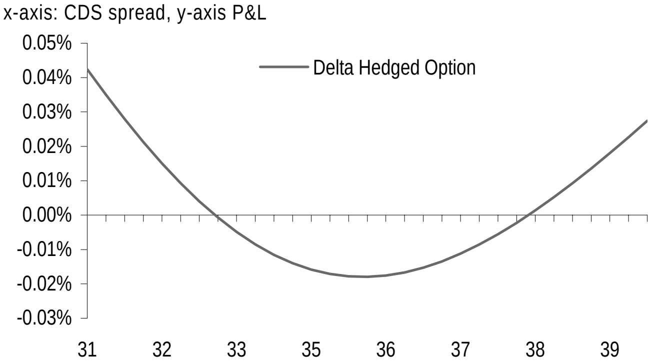
x-axis: CDS spread, y-axis P&L




Source: JPMorgan

**Exhibit 16.2: P&L on Delta-Hedged Option over a period of time**

x-axis: CDS spread, y-axis P&L




Source: JPMorgan

**We can trade credit volatility either with a delta hedged option or with a straddle.** Rather than buying a single option and delta-hedging this over the term of the option, a common strategy for trading volatility is to buy an ATM straddle (a call and put at the same strike) and delta-hedge this over the option term. The straddle has an initial delta of close to zero as the delta of the call and put net out.

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## The returns from delta-hedging in credit

**Volatility trades seek to benefit either from changes to implied volatility or from realised volatility differing from implied volatility**

This section looks at our expected return from trading volatility, which arises due to changes to implied volatility (Vega trading), or implied volatility differing from realised volatility (Gamma trading).

**Vega trading – changes in implied volatility:** an increase in implied volatility benefits a long option position as the options become more valuable.

Vega tells us our P&L for a change in implied volatility. A delta-hedged option is neutral to small spread changes in the underlying index. However, the P&L of such a position will change as implied volatility changes. Higher implied volatility will generally lead to higher option prices and an investor who is long volatility through buying a delta-hedged option will benefit from this. For an ATM option, we can show that:

Equation 9: Vega for an ATM Option

$$Vega \approx \frac{Price}{\sigma_{Implied}}$$

*where:*

$\sigma_{Implied}$ = *Implied Volatility of the Option*

Vega trading is best performed with longer dated options as these have higher price sensitivity to changes in implied volatility and have a lower gamma (and theta) since the delta of the option changes less with a spread change in the underlying.

**Gamma trading – differences between implied and realised volatility over the trade horizon**: realised volatility that is higher than implied should benefit a long volatility position

**Our expected P&L is dependent on the frequency of adjusting our delta-hedge** and is shown in Equation 10. In reality, a number of factors may mean that we do not actually realise this P&L. Primarily the Black pricing formula gives us a price for an option in a world where we can continuously buy and sell an asset in order to be delta-neutral. In reality, continuous hedging is not feasible and we must content ourselves with weekly, daily or inter-day hedging. The more frequently we hedge, the more likely we are to earn our expected return.

Equation 10: Linear approximation for expected P&L from Gamma Trading

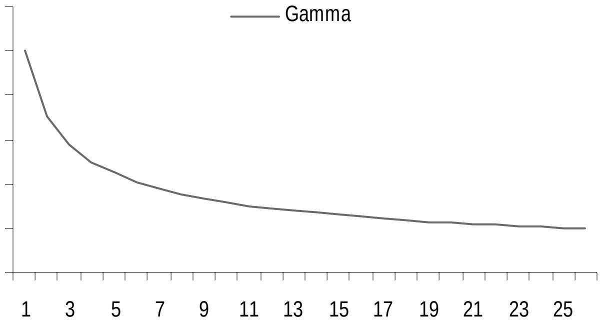
$$P\,\&\,L \approx \frac{1}{\sqrt{2\Pi}} \times \sqrt{time} \times Forward \times Annuity \times \left(\sigma_{Realised} - \sigma_{Implied}\right).$$

Option traders will likely use an alternative strategy to just hedging weekly or daily. Sometimes, they may wish to be underhedged in order to profit from changes in the option price and not pay this away through their delta-hedge. A volatility trader hopes not only to make his expected P&L, but to make more than this through expedient delta-hedging.

Gamma trading is best performed with shorter dated options since our P&L from gamma increases as we move closer to expiry (Exhibit 16.3). The higher the gamma of our option, the more frequently we will have to adjust our delta-hedge and the more we will be able to sell high and buy low. Higher gamma will be accompanied by higher theta as we move towards option expiry (Exhibit 16.4).

**Exhibit 16.3: Gamma Exposure with Time to Expiry**

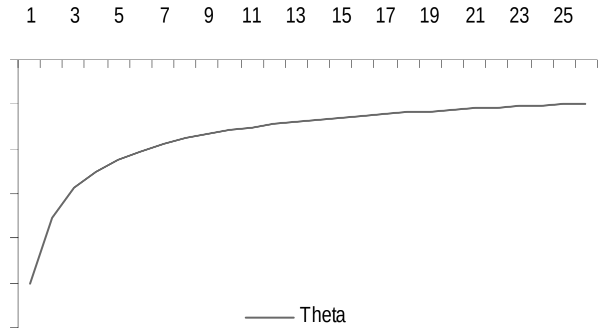
x-axis: months to exposure, y-axis: gamma




Source: JPMorgan

**Exhibit 16.4: Theta Exposure with Time to Expiry**

x-axis: months to exposure, y-axis theta




Source: JPMorgan

## Historical analysis

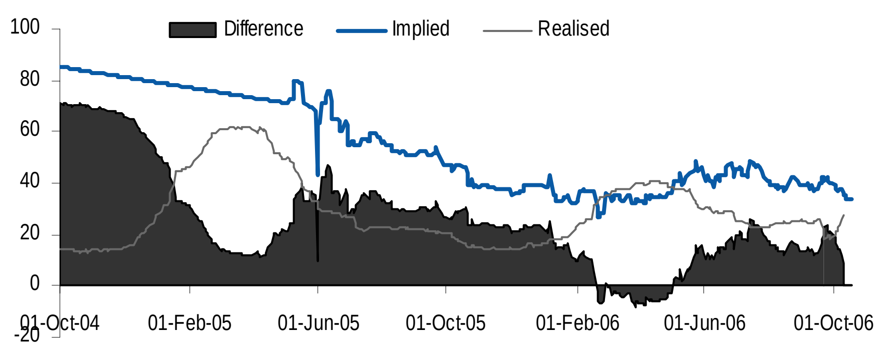
We have so far seen what credit volatility is, how to trade it, the profits we can expect. We now turn to the final chapter of the story and look at when it has been profitable to buy or sell volatility.

**Selling volatility has been a profitable strategy over the last two years**

Exhibit 16.5 shows the difference between implied and realised volatility over the last two years. The large difference indicates that selling options and delta-hedging them would have been a profitable strategy. Even when we include the bid/offer cost of selling the options and delta-hedging, which we estimate at around 3-4 Vegas, this difference is quite large.

**Exhibit 16.5: Three-Month Implied versus Realised Volatility**

Percent




Source: JPMorgan

**However, while over long periods selling volatility is profitable, there are a number of opportunities to buy volatility over short periods.**

In Exhibit 16.6 we look at the daily implied volatility versus the absolute change in spreads. As we saw earlier, if the daily moves are bigger than the daily implied volatility, then buying volatility would be a good trade.

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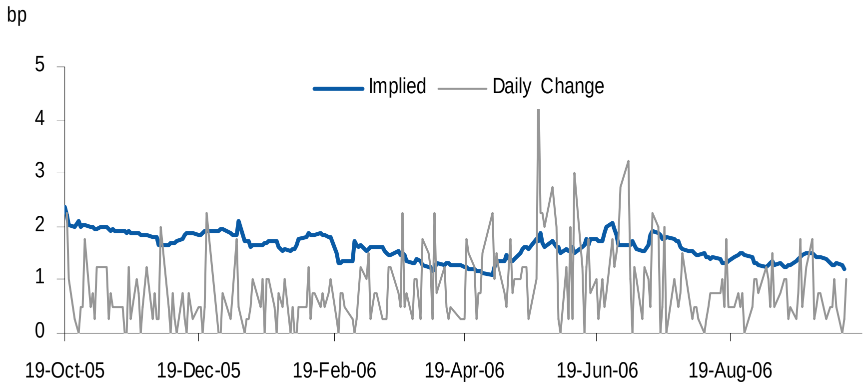
**Exhibit 16.6: Daily Implied Volatility versus Daily Move**




Source: JPMorgan

## Option glossary

**Call** – A call gives the holder the right, but not the obligation to enter into a long risk CDS index contract at a given spread, the strike. This is also called a receiver option.

**Put** – A put gives the holder the right, but not the obligation to enter into a short risk CDS index contract at a given spread, the strike. This is also called a payer option.

**Straddle** – A straddle is an option strategy where an investor purchases a call and a put option with the same strike. ATM straddles have a delta close to zero and are therefore often used to trade volatility.

**Strangle** – A strangle is an options strategy similar to the straddle, but with different strike levels for the call and put. Strangles are frequently sold by investors who believe the index will remain in a particular range.

**Strike** – The strike is the agreed spread at which CDS index contract will be struck at maturity of the option.

**Maturity** – There are two maturities in a CDS option contract. The maturity of the option and the maturity of the underlying CDS index contract. As traded indices have fixed maturities, the term of the index decreases as time passes.

**Adjusted Forward** – The forward is the fair spread, agreed today, at which we would enter into an index contract at a given date in the future. We use the forward at the option maturity to price the option. Since index options do not knock out if a name in the underlying index defaults, the forward spread is adjusted to account for the additional protection this affords. If a name in the index defaults before the maturity of the option, we will still be entered into an index, at the options maturity, that can be immediately triggered to collect on the defaulted name.

**At-The-Money (ATM)** - An option is ATM if its strike is equal to the forward spread on the underlying.

**In-The-Money (ITM)** - An option is ITM if its strike is above the forward spread for a call and vice versa for a put.

**Out-Of-The-Money (OTM)** - An option is OTM if its strike is below the forward spread for a call and vice versa for a put.

**Realized Volatility (also known as Historic or Delivered volatility)** – This is the standard deviation of the daily log returns of the index. This is annualized by multiplying by sqrt(252). Realized Volatility is a backward-looking measure and tells us how volatile the index has been over a given period.

**Implied Volatility** – This is the volatility implied from an option price, using the Black Equation. This is the equation used to price options and is detailed in "Option Pricing Model - March 2004, JPMorgan". Implied volatility is a forward-looking measure and reflects the expected volatility of the index to the maturity of the option.

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**Volatility Skew** – This describes the different levels of implied volatility for different strikes.

**Breakeven** – This is the spread level at which the profit from exercising the option equals the cost of the option. For example if we own a call and the spread ends up below the breakeven spread we will make money. If the spread ends up at any level above this we will lose part or all of our premium. The reverse holds for a put.

**Forward Duration** – This is the duration of the forward. It is the duration of the contract we can enter into at maturity of the option. We can convert option prices to breakevens by multiplying by the forward duration.

**The Greeks** – These are the sensitivities of the option price.

**Delta** – This describes how the option price changes with respect to the underlying index price. We calculate delta as the ratio of the change in option price to change in index upfront for a 1bp widening in index spread. An ATM option has a delta of around 50% meaning that for a 1bp spread widening the option price will change by around 50% of the upfront price change on the index. The delta tells us how much of the underlying we need to purchase or sell in order to hedge or replicate the option payoff.

**Gamma** – This describes how the delta changes for a 1bp shift in underlying index spread. Owning options results in a positive gamma position. This means that as the spread on the underlying moves our way, the option delta increases and the option becomes more likely to end up ITM. Effectively we get "longer in a rally and shorter in a sell-off."

**Vega** – This is the sensitivity of the option price to changes in implied volatility. Vega tells us how much the option price changes, in cents, for a 1% increase in implied volatility. Owning options (puts or calls) results in a positive vega position as the holder benefits from increasing implied volatility. Longer dated options have higher vega and therefore are more sensitive to changes in implied volatility.

**Theta** – Theta describes the time decay of the option. This is the change in the option price due to a 1 day passage of time assuming all else remains unchanged (index spread, implied volatility etc.). Owning options usually has a negative theta position as options become less valuable as time passes. Theta is often thought of as the "rent" paid for having a positive gamma position.

**Intrinsic Value** – This tells us how much the option is ITM. For a call, if the strike on the option is higher than the current adjusted forward, then the option is already ITM. If we were to take out a forward at the strike, we could effectively lock in this value. The premium paid for the option will therefore include an amount that is paid for being ITM. For ITM options we look at the difference between the forward and the strike and convert this to an upfront price by multiplying by the forward duration. OTM options have no intrinsic value.

**Time Value** – If an option is OTM, its value lies in time. It has no intrinsic value and the value it has is due to the fact that as time passes, we may end up ITM. We define the time value as the difference between the option price and its intrinsic value.

**Delta Exchange** - When trading an option, the convention is to hedge the delta of the option by buying or selling a delta amount of the underlying index. All prices in this report include the cost of the delta hedge. To take an outright option position, investors need to buy or sell their delta hedge back to the market.

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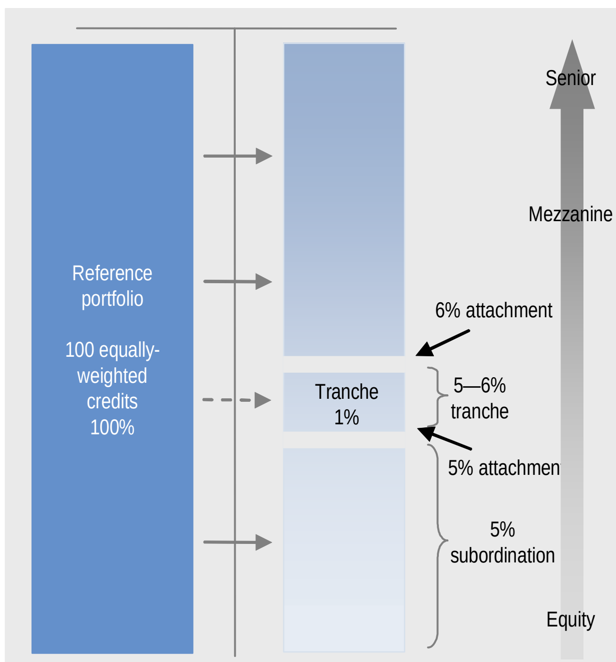
# 17. Tranche products

## What is a tranche?

A tranche provides access to customized risk by allocating the payouts on a pool of assets to a collection of investors. Each investor will be exposed to losses at different levels of subordination and will therefore receive different levels of compensation for this risk. Just as a CDS contract provides exposure to the credit risk of a reference company, and a CDS index provides exposure to the risk of a portfolio of credits, a ***tranche*** CDS provides exposure to the risk of a particular amount of loss on a portfolio of companies. As such, a tranche references a portfolio of companies and defines the amount of portfolio loss against which to sell or buy protection. Similar to a CDS contract, the cost of tranche protection is paid as a coupon and measured in spread.

**Exhibit 17.1: The capital structure**




Source: JPMorgan

We begin to illustrate the tranche technology with a specific example below. In general, a tranche is defined by

- The **reference portfolio** – the (bespoke or indexed) portfolio of companies against which the protection is being bought/sold
- **Subordination** – refers to the amount of losses a portfolio can suffer before the tranche investor's notional is eroded (more subordination means less exposure to losses on the portfolio, i.e. more senior in the capital structure).
- **Tranche width** – identifies the amount of leverage and the exposure to portfolio losses (smaller tranche width implies greater leverage)

- **Upper and lower attachment points** – the lower attachment point determines the amount of subordination, and the distance between the lower and upper attachment points is the tranche width
- **Maturity** – the length of time over which the protection contract is valid

The tranche instrument is a result of the capital structure framework, which translates a set of assets (the reference portfolio) into a set of liabilities (the tranche risk). Exhibit 17.1 shows an illustration of how this capital structure works, and highlights a hypothetical 5-6% tranche in the context of this capital structure. Equity tranches, which are attached at 0%, are exposed to the first losses on the portfolio. Mezzanine tranches, which have more subordination, are not exposed to portfolio losses until the portfolio losses exceed the lower attachment point of the tranche. Senior tranches have the most subordination and thus the least exposure to portfolio losses. The arrow in the figure indicates the increase in risk from the equity tranche, which provides exposure to the most risk, to the senior tranche, which provides the most protection.

The reference portfolio in this example is an equally-weighted basket of 100 credits. The lower and upper attachment points of the tranche are 5% and 6%, respectively, and the tranche width is 1%. In this case, the subordination means that the tranche protection will go into effect only after the portfolio has suffered losses of more than 5% of the notional amount. Since the lower attachment point of the tranche is greater than 0%, the tranche will not be affected by first losses in the portfolio, and hence can be called a mezzanine tranche.

**What is a synthetic tranche?**

What makes a tranche ***synthetic*** is that the reference portfolio of the underlying CDO is constructed as a basket of credit default swaps, rather than a basket of the cash bonds of the relevant companies. In contrast, a cash CDO, or collateralized debt obligation, tranches the risk from a basket of corporate bonds. A synthetic CDO can also be referred to as a collateralized swap obligation ("CSO") [23].

Synthetic CDOs can be bespoke (i.e. customized) in nature, meaning that the end investor can select the underlying portfolio, amount of subordination, and tranche widths. The portfolio of credit default swaps forming the collateral can be static or managed.

These products are an important influence on overall credit spreads. When investors enter into structured credit transactions they often need to quickly buy or sell CDS protection on a large number of credits. They do this by asking dealers to provide bids or offers on protection on a list of credits. These are known as BWICs (bids wanted in competition) when clients are taking long risk positions, and OWICs (offers wanted in competition) when clients are taking short risk positions. As these portfolios are can be 100 credits with $10 million notional each, or larger, absent other market trends, structured credit transactions can influence CDS spreads and the relative relationship between bond and CDS spreads. This is especially true in High Grade and Crossover credits, as activity is concentrated in BBB credits.

[23] For more information on synthetic CDOs, see "CDOs 101," published August 12, 2003, and "Innovation in the Synthetic CDO Market: Tranche-only CDOs," published January 22, 2003, by Chris Flanagan.

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Exhibit 17.2: BWIC and OWIC volumes

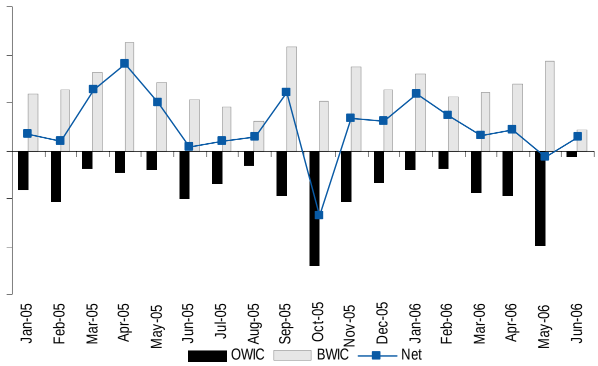
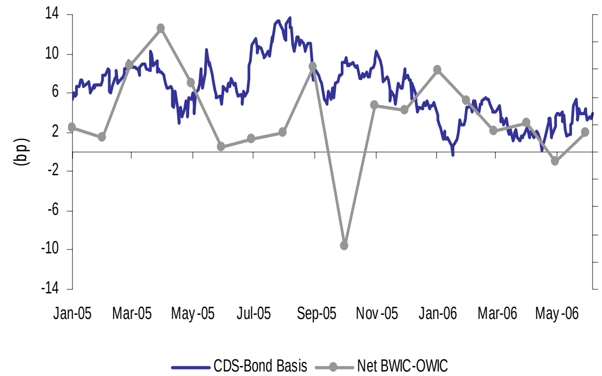



Exhibit 17.3: Net BWIC/OWIC volumes and CDS/bond basis




Source: JPMorgan

Standardized synthetic CDOs are traded as well. Standard tranches are traded on the US and European CDS indices, CDX and iTraxx, respectively. Here, we briefly describe the products traded on these indices, and Exhibit 17.4 shows a summary of the tranches available.

## Traded tranched indices

*US Credit: CDX tranches*[24]

Tranched CDX is a synthetic CDO on a static portfolio of the reference entities in the underlying CDX portfolio. CDX IG are broken into 0-3%, 3-7%, 7-10%, 10-15%, 15-30% and 30-100% tranches. CDX.HY is broken into 0-10%, 10-15%, 15-25%, 25-35% and 35-100% tranches. The IG 0-3% tranche and the HY 0-10% and 10-15% tranches are called the equity tranches. The IG equity tranche trades with an upfront payment and a running spread of 500bp, the HY trade with upfront payments only. The more senior tranches trade with running spreads only.

*European credit: iTraxx tranches*

Tranched iTraxx is very similar to the CDX structure. The main differences lie in the tranche widths, and the fact that the only tranched index is iTraxx Main (there are no iTraxx Crossover or High Yield tranches). The tranches traded on iTraxx Main are 0-3% (equity), 3-6%, 6-9%, 9-12%, 12-22%, and 22-100%.

Exhibit 17.4: Index tranches

| | High Grade (CDX.IG) | High Yield (CDX.HY) | iTraxx Main |
|---|---|---|---|
| Tenors | 3y, 5y, 7y, 10y | 3y, 5y, 7y, 10y | 3y, 5y, 7y, 10y |
| Tranches | 0—3%<br>3—7%<br>7—10%<br>10—15%<br>15—30%<br>30—100% | 0—10%<br>10—15%<br>15—25%<br>25—35%<br>35—100% | 0—3%<br>3—6%<br>6—9%<br>9—12%<br>12—22%<br>22—100% |

Source: JPMorgan

[24] For more information on index tranches, see "Introducing Dow Jones Tranched TRAC-X," by Lee McGinty, published November 26, 2003.

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## Why are synthetic tranches traded?

Tranches have developed into instruments that can provide investors with default protection, leveraged exposure, hedging tools, and relative value trading opportunities.

### Default protection

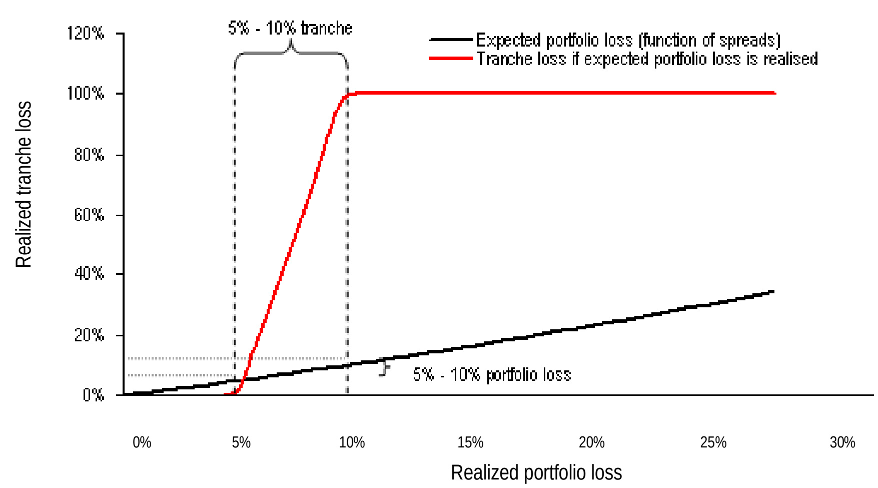
Buying protection on an equity tranche provides protection against defaults, up to a certain limit (as defined by the upper attachment point). This limitation means that buying default protection via equity tranches may be less expensive than hedging against defaults using indices.

### Leverage

Tranche technology introduces two types of leverage to the risk exposure an investor can take: leveraged exposure to the risk of portfolio losses, and leveraged exposure to moves in the spread of the underlying portfolio. In the examples above, we have seen what happens when portfolio losses exceed the lower attachment point of a tranche. The structure of a tranche, with subordination and a defined tranche width, means that tranche risk exposure *leverages the exposure to portfolio losses*. To illustrate this, consider the seller of protection of the CDX.IG index in comparison to the seller of the CDX.IG 0-3% equity tranche. If there are no defaults, both sellers of protection will not bear any losses and will receive spread paid by buyers. However, in case of one credit event, the seller of the 0-3% tranche will lose 16% of their notional, while the seller of CDX.IG protection will lose only 0.48% (the calculations are explained in the next section).

Exhibit 17.5 shows an example of a hypothetical mezzanine 5-10% tranche. As the illustration shows, the tranche is protected from portfolio losses of less than 5%, but will begin to experience losses once the portfolio losses exceed this value. Similar to the equity example above, as the portfolio losses approach the upper attachment point, the tranche loss will be much higher than the portfolio loss. The tranche will have lost 100% by the time the portfolio has lost only 10%.

**Exhibit 17.5: Illustration of tranche reaction to portfolio losses**




Source: JPMorgan

***Delta* refers to the sensitivity of a tranche to move in the spread of the underlying portfolio**

Tranche exposure will also provide *leverage to spread moves.* Since this leverage refers to a tranche's sensitivity to underlying spreads, we also use the term "***Delta***" to refer to this type of leverage, in line with its usage in options literature. This delta is often quoted with spreads on the relevant Bloomberg pages (see Exhibit 17.9 below).

With reference to spread moves, the equity tranche is generally the most leveraged of all the tranches, i.e., the equity tranche usually has the highest Delta. Since the equity tranche suffers from the first losses in the underlying portfolio, the buyer/seller of protection of this tranche would pay/receive the highest spread. The likelihood of other tranches experiencing losses drops as the level of subordination increases. Therefore, the spreads paid are lower for tranches with more subordination. The sensitivity to underlying spreads (or Delta) is also lower.

## Relative value

From a relative value point of view, tranches often provide higher spread for rating when compared with other credit investments. Exhibit 17.6 shows an indication of spread for rating across credit instruments. Tranches themselves are not rated by the rating agencies, but indicative ratings can be calculated based on the rating agency's methodologies. Exhibit 17.7 shows JPMorgan's calculations of the ratings that S&P might assign to the tranches in iTraxx Main Series 6.

Exhibit 17.6: Spread-for-rating comparison

| Ratings | Underlying | Indicative spread |
|---|---|---|
| AAA | RMBS | 11bp |
| AAA | CMBA | 19bp |
| AAA | iTraxx Series 6, 6-9% standard tranche[1] | 22bp |
| AAA | Managed synthetic CSO, higher levered[1] | 30bp |
| AAA | Corporate bonds | <5bp |

[1] Especially in structured synthetic corporate credit risk, spreads depend on factors such as leverage (tranche width) and spread for rating in the underlying asset pool. A wide range of spreads can therefore be achieved for the same rating.

Exhibit 17.7: Likely iTraxx Main Series 6 tranche ratings (using S&P's tranche evaluator 3.0)

| | 5y | 7y | 10y |
|---|---|---|---|
| 0—3% | - | - | - |
| 3—6% | BBB- | BB | B |
| 6—9% | AAA | AA | BBB |
| 9—12% | AAA | AAA | AAA |
| 12—22% | AAA | AAA | AAA |
| 22—100% | SS | SS | SS |

Sources: JPMorgan, S&P

## Hedging

The synthetic tranche has become useful as a hedge against portfolio losses or spread moves in the underlying portfolio, particularly on bespoke portfolios. From an outright trade perspective, investors with default risk against a portfolio of credits can now use tranches on bespoke portfolios to hedge against precisely the names in their portfolio. These hedges may be less expensive than using indices or options. And as tranches on the indices are more and more liquid, they have caught the attention of speculative traders, bank proprietary desks and hedge funds that may be interested in the risk on the other side of the hedge.

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## The mechanics of trading tranche protection

The tranched index products create a standardized, liquid, and transparent instrument to trade defined amounts of credit risk. Now, we show in more detail just how these instruments manage to access these specific slices of risk.

Assume the 0-3% tranche of the 5Y DJ NA.CDX.IG is trading at 500bp (for simplification, assume there is no upfront payment). The tranche exposes investors to the first 3% of losses on the CDX.IG portfolio. The buyer of protection will pay 500bp annually on the outstanding notional while the seller of protection will receive 500bp annually.

**In case of no defaults**
If there are no defaults on the portfolio of 125 names over the 5-year maturity, the buyer/seller of protection will pay/receive 500bp per annum on the full notional, over five years.

**In case of defaults**
Assume a credit event occurs after two years. This would trigger settlement cash-flows for buyers and sellers of protection of the 0-3% tranche. Assuming a recovery rate of 40%, this equates to a 60% loss on the credit, or a 0.48% loss on the 125-credit portfolio of the CDX.IG (1/125 x 60% = 0.48%). The seller of protection of the 0-3% tranche would pay the buyer of protection 16% (0.48%/3%) of the notional. After this point, the coupon would remain at 500bp, but on a reduced notional of 84% of the original value.

The credit event affects the attachment points of each tranche, as the subordination of each tranche is changed. The upper attachment point of the 0-3% tranche becomes 2.52%, in our example: 3% - (1/125 x 60%) = 3% - 0.48% = 2.52%. The lower and upper attachment points of the mezzanine and senior tranches are each reduced by 0.48%, while the width of the tranche and the notional remains the same. On the 30 - 100%, or super senior tranche, both the attachment points and notional are reduced. The notional is reduced because the “fate” of one of the credits has been decided and the recovered amount on the default name can no longer be "lost.” In our example, the notional is reduced by (1/125 x 40%). In essence, the credit event affects the “bookends” of the most junior and most senior tranches, reducing the notional on the junior tranche by (1/125) times (percent lost on the credit), and (1/125) times (percent recovered on the credit) for the senior tranche.

If there were seven defaults, all recovering at 40%, the total loss on the CDX.IG portfolio would be 3.36%. The first 3% of the 3.36% loss would cause the seller of protection of the 0-3% tranche to lose the entire notional they put at risk. They would have no more exposure to further credit events. Similarly, the buyer of protection on this tranche would earn the full notional at risk and would no longer have to pay the spread. The remaining 0.36% loss would trigger the settlement cash flows between the buyers and sellers of protection of the 3-7% tranche.

**Cashflow structures**
Tranche cashflows can be structured in three ways: all running spread, all upfront, or upfront + running spread. In an *all running spread* structure, which is typical for mezzanine tranches, the spread is fixed for the life of the trade. On an *all-upfront* basis, investors pay/receive an initial payment (the “upfront premium") and receive/pay for the loss contingent on defaults as the defaults occur. The upfront

premium is equal to the present value of the expected loss. Equity tranches are often traded as upfront + running spread, where the running spread is kept constant at 500bp, and the initial payment is calculated accordingly.

## The role of correlation

**What is the correlation measure?**
The correlation we speak of is the correlation as implied by market spreads. An implied correlation number describes the expected contagion of default among portfolio entities. In other words, when speaking of "correlation trading" or "implied correlations," we really speak about the *market's view* on how correlated the CDS portfolio is, as implied by the spreads traded in the market.

**The effect of correlation on tranche valuations**
As a tranche references the amount of losses in the underlying portfolio, the correlation of the behavior of the reference entities in the event of portfolio losses is central to the value of a tranche. *An increase in mezzanine and senior tranche spreads* means that buying protection on these tranches will be more expensive. This indicates the market expects defaults in the portfolio should affect the more senior tranches, or that defaults are likely to be correlated. As a result, *spreads in the equity tranches will respond by moving tighter*. We would see the opposite occur with a decrease in correlation.

The example above illustrates the relationship among tranche spreads, which can be thought of in analogy to the law of conservation of energy. In tranched portfolios, we see a "conservation of risk." The capital structure on a given portfolio has a certain amount of risk, which tranches divide into components. The possibility of arbitrage between the portfolio and the tranches will keep the "sum of tranche risk" balanced with the risk of the whole reference portfolio. Assuming the spread of the underlying portfolio or index remains constant (which means the overall risk in the underlying portfolio remains constant), supply and demand pressures may redistribute risk from one tranche into another, but the overall amount of risk can not change. In other words, given that portfolio spread remains constant, a change in the spread of one tranche must result in a respective change in the spread of another tranche somewhere else in the capital structure.

Exhibit 17.8 illustrates this concept. With correlation at 10%, the portfolio loss distribution shows that portfolio losses are likely to remain confined below the more senior tranches. In other words, not much subordination is required to provide protection from portfolio losses. But, when correlation increases to 40%, the portfolio loss distribution encroaches on the more senior tranches and more subordination would be required for the same amount of protection. The extreme case, correlation of 100% across the portfolio, would result in one default within the portfolio causing the entire portfolio to default. In this case, the spreads across the tranches would all be equal.

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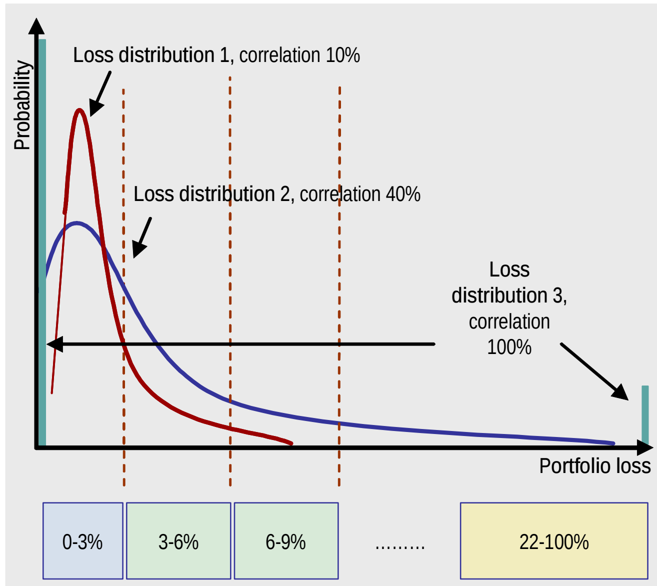
**Exhibit 17.8: Illustration: Impact of a change in base correlation**




Source: JPMorgan

**Correlation skew**

Although in theory there should be one number that describes the correlation across the single names in the portfolio, we can measure a unique "base correlation" at each attachment point. As demand will pull spreads in varying degrees for each tranche, there will be a "correlation skew" for the portfolio. Correlation skew also results from the fact that correlation is an implied number, based on models that translate spread moves into sentiment on correlation. Hence both the technical moves in relative tranche spreads, and the weaknesses of the models themselves, result in a range of implied correlations along the capital structure.

## Pricing tranches

Having looked at the mechanics and some of the drivers of tranche valuation, we turn now to the practicalities of pricing.

**Quoted prices**

Bloomberg screens like the one shown in Exhibit 17.9 show bid/offer spreads (or upfront cost for equity tranches) for the different tranches traded on the indices. JPTX <Go> will take Bloomberg users to the menu page to view JPMorgan prices on the various indices available.

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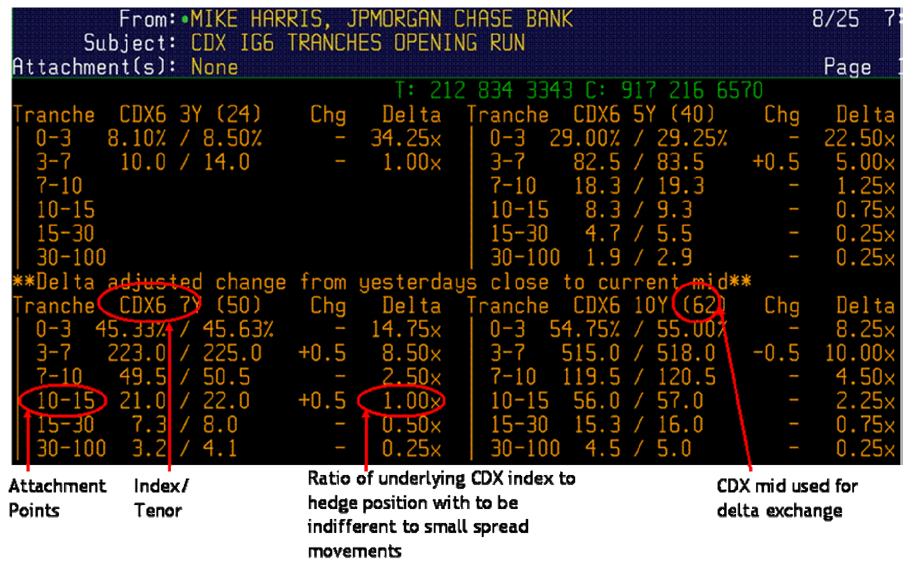
### Exhibit 17.9: Sample tranched index pricing page




Source: JPMorgan, Bloomberg

**Risky Duration (DV01) vs. Risky Annuity**
**These are often used interchangeably, but for the record, there is a difference.**

***Risky Duration (DV01)*** **is the change in mark-to-market of a tranche contract for a 1bp parallel shift in spreads**
***Risky Annuity*** **is the present value of a 1bp annuity as defined here**

### Marking-to-market

Similar to CDS contracts, tranches are marked to market using the risky present value of the change in spread. The **Risky Annuity** is the factor by which we can multiply the change in spreads to compute this present value. In essence, it represents the present value per basis point of spread paid over the life of the contract, assuming the relevant coupon dates and survival probabilities.

Hence, we define the mark-to-market (MtM) as

$$\text{MtM}_{(i-1,i)} = (S_{i-1} - S_i)\cdot \text{Risky Annuity}_i \cdot \text{Notional}$$

where $S_i$ represents the spread level at time i, and

$$\text{Risky Annuity}_i = \underbrace{\sum_{i=1}^{n} \Delta_i \cdot Ps_i \cdot DF_i}_{\text{fee contingent on survival}} + \underbrace{\sum_{i=1}^{n} \frac{\Delta_i}{2}\cdot\left(Ps_{i-1} - Ps_i\right)\cdot DF_i}_{\text{average accrual owed given a loss}}$$

### JPMorgan's Heterogeneous Gaussian Copula Model[25] ("HGC Model")

JPMorgan has developed this model for pricing tranche risk, which can be used to mark-to-market tranche positions, as well as to measure the sensitivities of tranche spreads. As we have seen, correlation is relevant to tranche valuations as it determines the main driver of a tranche spread: the expected loss of the tranche.

There are a number of ways of calculating the expected loss of a tranche. In our enhanced tranche pricer, we use a Gaussian copula pricing methodology that can

[25] For more information on the HGC Model and tranche sensitivities, see *Enhancing our Framework for index tranche analysis,* Dirk Muench, September 2005 and *Using JPMorgan's Framework for Tranche Analysis*, Dirk Muench, May 2006.

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price tranches on bespoke or indexed CDS portfolios using the full CDS curves for each of the underlying single names in the portfolio. This model also allows for the pricing of bespoke tranches, with attachment points as defined by the user. The HGC Model is especially useful in calculating sensitivities of a tranche, including Delta, Gamma and convexity.

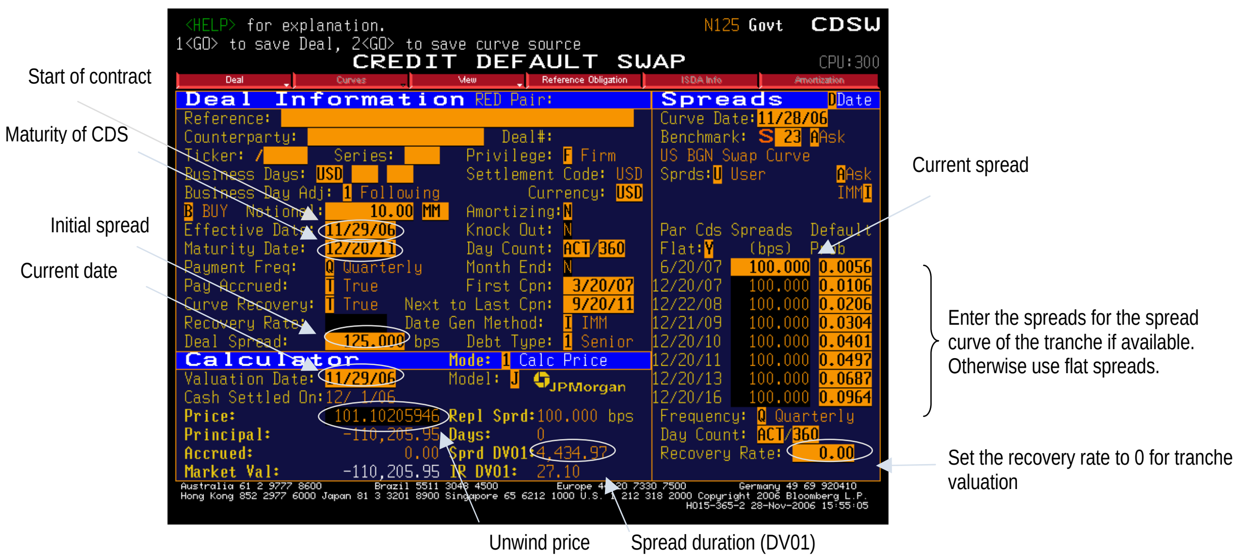
The model is flexibly designed to calculate the user's choice of: tranche spread/upfront premium, implied correlation at the upper attachment point, tranche risky annuity, or present value of expected loss. The model is available to clients and is described in detail in *Enhancing our Framework for index tranche analysis* (Muench, September 2005) and *Using JPMorgan's Framework for Tranche Analysis* (Muench, May 2006). For access to the model, clients should contact their JPMorgan salesperson.

**CDSW: Marking to market using Bloomberg**

The CDSW function on Bloomberg can be used to mark to market ("MtM") both credit default swaps and tranches. Using a bootstrapping technique, the pricer takes inputs of spread curves and recovery rates to return the price and the DV01. The MtM of a tranche is calculated in the same way as the MtM of a single-name CDS contract except that the tranche recovery rate is set to zero (since the tranche losses will be net of recovery, unlike the binary default situation of a single-name CDS).

Exhibit 17.10 below shows the CDSW page and highlights the relevant inputs and outputs for marking a tranche to market.

**Exhibit 17.10: Bloomberg's CDSW function can be used to price tranches by setting recovery rates to zero**




Source: JPMorgan

## Other products

As tranche technology continues to advance, we begin to see newer ways of accessing these slices of risk. Tranchelets, "tr-options", and zero coupon equity are three examples of this continued innovation.

**Tranchelets**[26]

Tranchelets are very thin tranches on a given portfolio. These products provide more granularity in constructing hedges or protection against default, and even higher leverage to portfolio losses. In particular, tranchelets with widths close to the expected loss point of the entire portfolio are most active. Note that the expected loss of the portfolio is equal to its coupon multiplied by its risky duration, or the present value of the coupon payments.

The obvious starting point for pricing a tranchelet is the tranche that includes it. In order to comply with no-arbitrage conditions the risk in all the tranchelets within the 0-3% tranche has to add up to the risk with in the 0-3% tranche itself. The distribution of risk among the tranchelets in turn depends on the implied correlation at the 1% and 2% attachment points, in a similar fashion as illustrated in Exhibit 17.8.

**Options on tranches**[27]

Tranche options are options on the spread of the tranche, and allow investors to trade the volatility of tranche spreads. We define a Put (Payer) as the right to buy protection (sell risk) and a Call (Receiver) as the right to sell protection (buy risk). This is consistent with other asset classes, where calls represent the right to buy risk. The typical option payoffs are shown in Exhibit 17.11 and Exhibit 17.12, where the x-axis shows the spread in basis points and the y-axis shows payoffs in percentage of notional.

**Exhibit 17.11: Long call (receiver) option payoff at maturity**

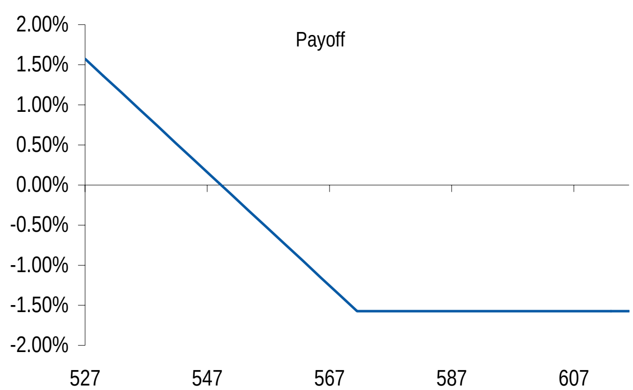
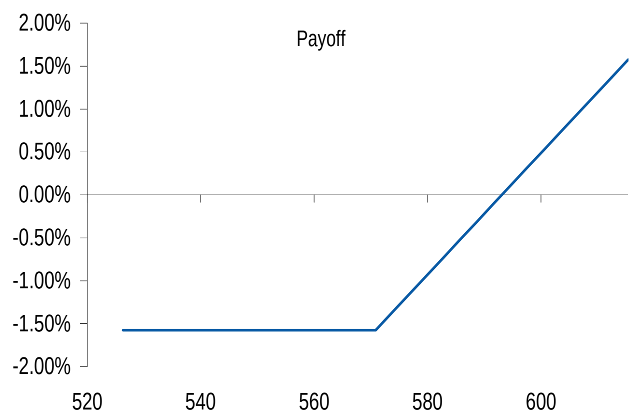



**Exhibit 17.12: Long put (payer) option payoff at maturity**




Source: JPMorgan

**Zero coupon equity**[28]

A zero coupon equity investment can be thought of as a zero coupon bond with the face value equal to par less the expected loss at maturity in the underlying equity

[26] For more information on tranchelets, refer to *An Introduction to Tranchelets* and *Tranche(let) Top Trumps*, Dirk Muench, January 2006.

[27] For more information on tranche options, refer to *Introducing Options on Tranches*, Saul Doctor, April 2006.

[28] For more information on zero coupon equity, refer to *All You Wanted to Know About: Zero Coupon Equity*, Dirk Muench, May 2006

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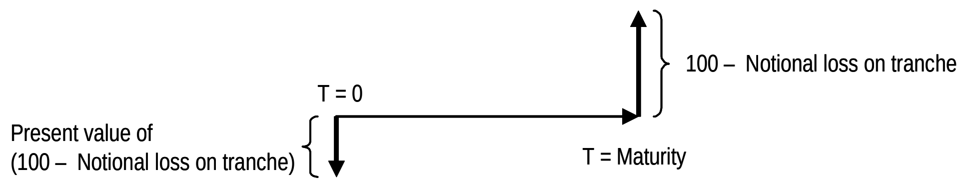
tranche. There are just two cash flows taking place for an investor in a zero coupon bond: one at trade inception, and one at maturity (or when the investment is unwound before maturity). The size of the cash flow at maturity depends only on the notional loss on the underlying tranche - it does not depend on when this loss occurred. The structure often provides a high internal rate of return with a payout on a certain date, which can be more attractive than a standard tranche contract where the date of cashflows is uncertain (i.e. occurs at the time of default). The high return comes from the fact that the initial payment assumes an expected loss, which is likely to be higher than the realized loss, thus lowering the initial cash flow.



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# Part IV: Other CDS products

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# 18. Loan CDS

## Overview

The emergence of a standardized secured loan CDS (LCDS[29]) market is a major development in the evolution of the loan market. Loans have historically been a long-only cash asset, with little or no ability for participants to go short risk or take on risk synthetically.

LCDS allows investors to take advantage of benefits and risks similar to those available to investors in standard CDS. These include:

- The ability to implement a bullish view (sell LCDS protection) without having to access the primary or secondary market for cash loans. The ability to create levered portfolios of secured risk.

- The ability to hedge or implement bearish views on loans (buy LCDS protection) and be short risk in what has traditionally been a long-only market.

- The ability to trade cross-asset views such as a view on the senior debt spread versus loan spread.

- The ability to implement curve shape positions and views once the market develops and a LCDS spread curve becomes available.

LCDS contracts are based on the standard corporate CDS contract, with several modifications to address the unique nature of the loan market. We discuss these differences, along with modifications made to LSTA documents, herein. Note that the actual terms of a LCDS transaction are defined by the confirmation of that transaction only, and this research note forms no part of that document.

## Comparing CDS contracts across asset classes

Exhibit 18.1 compares CDS contracts for standard corporate CDS, Loan CDS, Preferred CDS, and Asset Backed CDS.

[29] For more information on LCDS, refer to “Introducing Credit Default Swaps on Secured Loands (LCDS)” by Eric Beinstein and Ben Graves, published March 30, 2006.

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Exhibit 18.1: Comparison of CDS across different asset classes

| | Corporate CDS (CDS) | Loan CDS (LCDS) | Preferred CDS (PCDS) | Asset Backed CDS (ABCDS) |
|---|---|---|---|---|
| Reference Obligation | Obligation of the issuer | Syndicated secured loan of the issuer | Obligation of the issuer itself or a related preferred issuer | Specific security issued by the Reference Entity |
| Credit events | Bankruptcy, failure to pay, restructuring (for HG only) | Bankruptcy, failure to pay | Bankruptcy, failure to pay, restructuring, and deferral on the payment of a preferred stock dividend | Principal shortfall and writedown |
| Deliverable obligations | Bonds and loans | Syndicated Secured loans only | Preferred securities. Also bonds and loans in most cases. | Asset backed security, CUSIP specific |
| Notional amount | Par amount | Par amount | Par amount | Amortization mirrors the underlying bonds |
| Contract size | Typically $5-20 million | Typically $2-$5 million | Typically $5 million | Typically $5-10 million |
| Settlement | Physical (with cash option) | Physical or Partial Cash (with cash option) | Physical (with cash option) | Pay as you go (with physical settlement option) |
| Term | 5 - 10 years | 5 years currently | 5 years currently | Equal to the longest maturity asset in the pool. Roughly 30 years for mortgages. |
| Additional Information | "Credit Derivatives: A Primer," JPMorgan, January 2005. | "Introducing CDS on Secured Loans," JPMorgan, March 2006. | "Introducing CDS on Preferred Stock," JPMorgan, March 2006 | "Single Name CDS of ABS," JPMorgan, March 2005 |

Source: JPMorgan

## Similarities and differences between CDS and LCDS

Like standard corporate CDS, LCDS credit events include bankruptcy and failure to pay. Note that the failure to pay credit events applies to borrowed money, although the deliverables are syndicated secured loans only. This means that a failure to pay on the senior unsecured bonds, for example, would trigger a credit event even if the loans were paid as due (assuming they are the same borrower).

With regard to restructuring, LCDS contracts on US high yield issuers will follow the convention for standard corporate CDS. This will typically mean that the LCDS contract will *exclude* restructuring, since most US corporate HY CDS contracts exclude restructuring. For example, if a term loan is restructured with new covenants and a higher spread, the LCDS contract will remain outstanding with no change in coupon exchanged between existing counterparties.

**LCDS Reference Obligation: syndicated secured loan**

One difference between an LCDS and CDS contract is the level of the capital structure each contract "points" to. Namely, the reference obligation of most CDS contracts is a Senior Unsecured bond, while the reference obligation of a LCDS contract must be a syndicated secured loan. The loan may be a first, second or third lien note, but it must be secured.

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Exhibit 18.2: Structural considerations – loans versus bonds

| | Traditional syndicated loans | Second lien loans | High yield bonds |
|---|---|---|---|
| Size: | Any amount | Any amount; typically <$300mm | $100mm–125mm minimum |
| Security: | First-lien priority (assets and stock) | Second–lien priority (assets and stock) | Unsecured or subordinated, sometimes secured |
| Maturity: | Up to 5–7 years | Typically 5–7 years | Typically 7–10 years |
| Interest rates: | Floating | Floating | Fixed |
| Call flexibility: | Callable generally at par | Flexible, near–term call protection | Typically non–callable for 4–5 years |
| Amortization: | Yes, typically back–ended | Yes, typically back–ended | None |
| Covenants: | Maintenance–based, more restrictive than public or private notes | Bond–like with the exception of a total leverage maintenance covenant set wide of traditional bank covenant | Full, but unrestrictive, set of incurrence–based financial covenants |
| SEC filing: | None | None | Registration rights, generally within 180 days in a 144A offering |
| Disclosure: | Detailed (including projections); bifurcated between public and private investors | Detailed (including projections); bifurcated between public and private investors | Public disclosure; no projections Reg. FD |
| Ratings: | Moody's and S&P | Moody's and S&P | Moody's and S&P |
| Syndication/roadshow timing: | 4–6 Weeks Potential investor meetings/ conference call | 4–6 Weeks Investor meeting likely | 6–8 weeks Recommended 5–7 day roadshow |
| Investors | Commercial banks, mutual funds, insurance companies, prime funds, structure vehicles, CLOs | Hedge funds, prime rate funds, insurance companies, high yield crossover accounts, CLOs and CDOs | Mutual funds, insurance companies, money managers, bond funds, hedge funds |
| Ability to alter terms | High | Medium | Low |

Source: JPMorgan

Investment grade-rated companies generally have loans and bonds that are pari passu, or both having senior unsecured claims with equal rights to payment. Sub-investment grade companies, however, tend to have loans that are senior secured and bonds that are senior unsecured and senior subordinated. In the case of default, this means that the loans will have first priority on any recovery available to the debt-holders. As a result, the implied recovery rate on loans is much higher than for the bonds, and the risk to principal is therefore much lower for loans (Exhibit 18.3).

Because loans issued by investment grade-rated companies are generally senior unsecured claims, the vast majority of LCDS contracts will be limited to high yield issuers.

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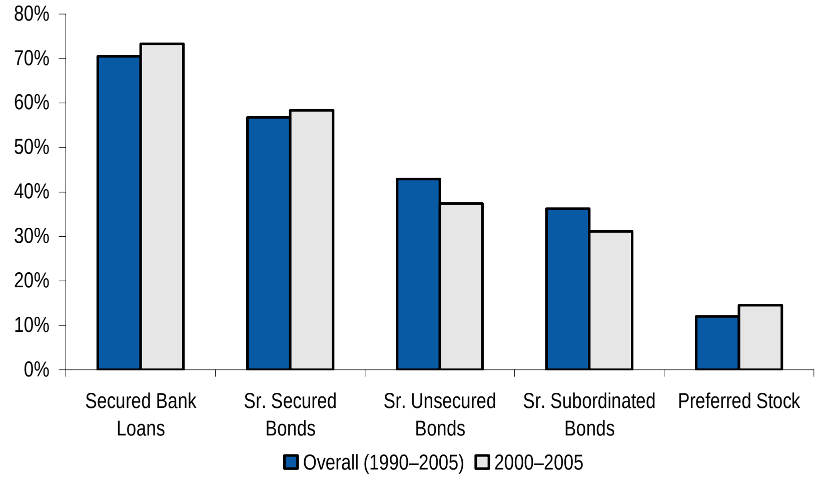
Exhibit 18.3: Recovery rates by priority




Source: Moody's Investors Service

A list of secured loan reference obligations and their priority will be published regularly by a third party. Contents of the list will be voted on by dealers on a regular basis.

**Cancel-ability - the termination of an LCDS contract**

A second difference between CDS and LCDS is that an LCDS contract is cancelled if there are no deliverable reference obligations outstanding, in other words, a senior secured loan must be outstanding. Recall that a CDS contract is not cancelled, even if the company tenders for all outstanding debt. The LCDS contract is different.

LCDS contracts remain outstanding if the reference loan is refinanced or replaced with another secured loan. If the original reference loan no longer exists for any reason, a replacement obligation can be selected. The replacement must be pari passu to the previous reference loan or, if none exists, higher in priority than the previous reference loan. For example, if an issuer refinances their existing loans and reissues new loans, the old LCDS contract will reference the new loans and the LCDS coupon will remain unchanged.

If a replacement cannot be found (i.e. no secured loans exist), or if the replacement is of a higher priority, either party has the option to terminate the contract. There is no unwind fee paid, the LCDS contract is simply terminated.

Either the buyer or seller can dispute the security of a loan and whether it is an acceptable reference, substitute, or deliverable obligation. The dispute is resolved via a poll of specified dealers as to whether the loan is "syndicated secured." To be syndicated secured, the loan must be issued under a syndicated loan agreement and trade as a loan of the designated priority in the secondary market. Note that this definition does not require a legal opinion as to the security and priority of the loan, but rather requires consensus among market participants as to how the loan trades in standard market practice.

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## Participants

As in standard CDS, banks and hedge funds are the most active users of LCDS. Participants include:

**Banks and other lenders**: LCDS provides an attractive opportunity for discrete hedging as an alternative to selling cash loans. LCDS also serves as an alternative to proxy hedging loan exposure in the bond or standard corporate CDS market – a hedge which introduces spread correlation, recovery, basis, and other risks.

**Total return funds:** Total return funds can use LCDS to effectively create levered portfolios of secured risk. We also anticipate selective positioning on spread widening or protective single-name hedging.

**Structured credit vehicles:** In the current market, where allocations to cash loans continue to be squeezed by excessive demand, we expect cash CLOs to sell protection (long risk) as an alternative means to access the loan market. LCDS also helps CLOs avoid high dollar prices in cash loans trading in the secondary market (high dollar prices decrease initial overcollateralization ratios), and some new structures are already incorporating synthetic buckets. LCDS also provides the potential for fully synthetic managed, bespoke, and index-tranched trades.

**Structured credit investors:** LCDS gives investors the ability to dynamically hedge single loans in cash CLOs or synthetic structured credit portfolios.

**Capital Structure investors:** Capital structure investors can express views on secured loans in relation to other securities including unsecured bonds, preferred stock, or common stock. Typical trades include selling LCDS protection (long risk) versus short a subordinate security (in cash or derivative form) or buying LCDS protection (short risk) vs. long a subordinate security (in cash or derivative form).

## Settlement following a credit event

### Settlement Timing

Like in traditional CDS contracts, the protection buyer has 30 days following a credit event notice to declare their intent to settle physically by delivering a notice of physical settlement (NOPS). The NOPS Fixing Date is set at 3 business days after the notice of physical settlement is delivered. As soon as practicable after the NOPS Fixing Date, the protection buyer must deliver all necessary documents to effect physical settlement. Upon receipt of these documents, the protection seller has 3 business days to execute and return the documents.

### What loans are deliverable if there is a credit event?

After a credit event, loans on the secured list, or other loans that trade as syndicated secured of equal or higher priority, are deliverable. Term loans, revolving loans, and multi-currency loans are all deliverable.

In the case of revolvers, a seller of protection who is delivered revolving loans is liable for any future draws on the revolver, although in nearly all cases[30] the ability to draw on a revolver is eliminated upon a default.

[30] One exception may be outstanding letters of credit, which may in some cases may be drawn. This is relatively rare.

**Loans trading above par after a credit event**
In some cases, cash loans may trade above par after a credit event. The protection buyer, however, will not be forced to realize a loss on the difference between par and the loan price.[31]

**Settlement Mechanics**
Like traditional CDS contracts, LCDS documents call for physical settlement, although (like corporate CDS) they do not preclude bilateral settlement agreements or participation in any cash settlement or netting protocols that may be developed, and we anticipate that a significant proportion of contracts will be cash settled. Physical settlement is governed by the documents customarily used by the Loan Syndications and Trading Association (LSTA) that are current at the notice of physical settlement fixing date, subject to the modifications discussed in the following section of this note. The physical settlement process calls for settlement by:

Assignment: In an assignment, the protection seller becomes a direct signatory to the loan agreement. Assignments typically require the consent of the borrower and agent.

Participation: If the loan cannot be transferred to the seller via assignment due to lack of necessary consent or other failure to meet requirements under the credit agreement, settlement may occur by participation. In a participation, the protection seller takes a participating interest in the existing lender's commitment, with the protection buyer remaining the title holder of, and lender under, the loan.

Settlement may also occur by subparticipation (the protection buyer does not own the loan, but holds a participation from another party). In this scenario, the protection seller will receive a participation, and will receive payments only to the extent the protection buyer receives payment from his upstream counterparty. A protection buyer is not stepping up if he does not receive payments from the grantor of the original participation. Accordingly, the protection seller is taking credit risk of more than just the protection buyer.

Cash Settlement: If settlement cannot be completed due to failure to meet requirements under the credit agreement (e.g. lack of necessary consent), or if the seller of protection elects to cash settle, settlement may occur by partial cash settlement. The cash settlement amount will be the difference between 100% and the loan price as determined from dealer quotations, and cannot be negative (i.e. the buyer does not pay the seller even if the loan trades above par following a credit event).

[31] In this situation, a protection buyer could determine not to deliver the notice of physical settlement and the transaction will terminate. In physical settlement, the protection buyer would not deliver the loan, not receive par, and would owe accrued up to the event date. There is also language in the LCDS docs that states that in partial cash settlement, the protection buyer does not pay the protection seller even if the loan trades above par following a credit event.

## Modifications to LSTA transfer documents

**Market Standard Indemnity**

Unlike standard cash loan settlement, loans delivered under LCDS contracts are physically transferred using the LSTA Purchase and Sale Agreement (PSA) template that is standard at the notice of physical settlement fixing date, without any credit-specific negotiation or amendments. The reason for using the template rather than a negotiated agreement is to expedite the settlement of a potentially large number of contracts after a credit event.

Although the template is used without negotiation, buyers and sellers recapture the economics of "standard market practice" documents with the Market Standard Indemnity. The protection buyer agrees to indemnify the protection seller for any loss suffered as a result of inconsistency between the documents actually used for physical transfer and the documents reflecting "standard market practice" for the specific loan at the time of transfer.

For example, consider a protection seller who is physically delivered a loan under the PSA template. If at some time in the future the protection seller realizes a loss (e.g. receives fewer payments or less favorable treatment) relative to lenders with market standard documents, the protection seller can recoup this loss from the protection buyer (including via litigation, if necessary) using the Market Standard Indemnity.

## Rating agency approach to LCDS in structured credit

Rating agency treatment of LCDS is critical to structured credit investors, as it influences the subordination required to achieve a desired tranche rating. Although the rating agency approach to LCDS has not yet been finalized, we briefly discuss the most relevant issues for both investors and the agencies.

Assumed default probability: It is possible for a company to default on its bonds but not its loans. For rating agencies that maintain separate secured and unsecured default probabilities, it is questionable which is the "correct" default probability for LCDS. Since the LCDS Failure to Pay credit event applies to all borrowed money (including both bonds and loans), some rating agencies may apply the relatively higher unsecured default rate to LCDS.

Assumed recovery rate: Rating agencies will need to determine what recovery rate is most appropriate for LCDS. They will likely look to the soundness of the contract provisions for deliverable obligations and replacement obligations to determine whether the their first lien recovery rate is most appropriate versus using second lien recovery rates or a haircut to first lien recovery rates.

Cheapest to deliver haircut: Some rating agencies apply a "cheapest to deliver" haircut to recovery rates on standard corporate CDS to compensate for the protection seller's option to deliver the bond or loan trading at the lowest dollar price following a credit event. We would expect a similar haircut to be applied to LCDS, although the magnitude is not yet clear.

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## Spread relationship between loans and LCDS

The spread relationship between loans and LCDS is dynamic and depends on the interplay of both technical and structural factors. We discuss these factors below, including our rationale for why LCDS spreads are likely to be lower than loan spreads initially.

**Factors for LCDS spreads lower than loan spreads**
Supply/demand: A greater number of protection sellers (long risk) relative to buyers (short risk) would lead to lower LCDS spreads relative to cash loans.

Funding Advantages: Unfunded investors with borrowing costs greater than Libor cost can accept a LCDS spread of less than the cash loan spread due to the funding advantages of a long risk LCDS position.

Cash loan callability: Cash loans have limited call protection, and have seen frequent refinancing in the current spread tightening environment. While cash loan investors require a premium to compensate for the issuer option to refinance at lower spreads, no such premium exists for LCDS, which remains outstanding if a cash loan is refinanced. We expect this to be a significant factor for tighter LCDS spreads versus cash loans initially.

No extension: LCDS has a 5 year term and cannot extend. This is unlike cash loans, which typically have a weighted average life of 2-3 years, a maturity of 5-7 years, and may be amended or extended longer in some cases. In the event that a cash loan defaults sometime after 5 years, the LCDS contract would not realize a loss.

**Factors for LCDS spreads higher than loan spreads**
Supply/demand: High demand from hedgers to buy protection would cause CDS spreads to widen more than loan spreads.

Voting rights: Protection sellers receive no voting rights until they have taken assignment following a credit event. Sellers of protection may demand more spread to compensate for the lack of voting rights.

Coupon step-up: LCDS coupons don't step-up by way of amendment, as may occur in some cash loans. In other words, a seller of LCDS protection (long risk) will continue to receive the same coupon regardless of any step-up in the cash loans. Sellers of protection may demand additional spread to compensate for this. Of course, cash loan step-downs due to leverage based performance grids are also possible, and would have the opposite effect.

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# 19. Preferred CDS

## Overview

Trading preferred stock CDS (PCDS[32]) allows investors the benefits and risks similar to those available to investors in standard CDS. These include:

- The ability to implement a bullish view (sell preferred CDS protection) at potentially wider spreads than directly available in the preferred market.

- The ability to implement bearish views on preferred stock (buy PCDS protection) and be short risk in a clean structure without the risks of the repo market. The availability and cost uncertainty inherent in borrowing a preferred security to short are avoided.

- The ability to trade cross-asset views such as a view on the senior debt spread versus preferred stock spread. Implementing such positions in the CDS markets is usually more straightforward than in cash markets as maturities and cash flows can be aligned because the borrowing of bonds to short them is avoided.

- The ability to implement curve shape positions and views once the market develops and a PCDS spread curve becomes available.

## Preferred stock CDS contracts differ from the standard CDS contract

Although preferred stock CDS contracts are based on the standard CDS contract, they differ in several key ways. Below, we outline those differences. Note that the actual terms of a PCDS transaction are defined by the confirmation of that transaction only, and this research note forms no part of that document.

- **Reference Obligation:** Reference obligation is defined as an obligation of the reference entity itself or a related preferred issuer (e.g Trust Preferreds). Credit events include deferral of dividends (or interest, in the case of hybrids) on preferred stock, and are triggered if all or a portion of the required payment is not made at a scheduled payment date. Payments of preferred dividends in stock rather than cash will also trigger a credit event.

- **Deferral is an additional credit event:** Deferral on a preferred dividend is an *additional* credit event, not a replacement for the usual senior unsecured CDS contract credit events. A credit event in a bond or loan, even with no deferral of dividends on a preferred security, is a credit event for the preferred CDS.

- **Defining "preferred security":** Any security that represents a class of equity ownership which upon liquidation ranks prior to the claims of common stock holders. Reference Obligations can be senior preferred or subordinated preferred. The definition of preferred securities also includes Trust Preferred securities, where the issuer of the preferred is a trust or

[32] For more information on PCDS, refer to "Introducing Credit Default Swaps on Preferred Stock: New Market Standard Contract" by Eric Beinstein and Ben Graves, published March 16, 2006.

similar entity, and substantially all the assets of the trust are obligations of the related corporate entity. The deferral credit event will only apply to securities that rank either senior or *pari passu* to the Reference Obligation.

- **Deliverable obligations under standard corporate credit events:** Deliverables include all preferred securities in addition to the standard bond or loan deliverables in the event of bankruptcy or default. If the contract trades with restructuring (high grade names typically trade with restructuring, while high yield names typically trade without restructuring), the restructuring credit event applies only to the bonds and loans and does not apply to preferred securities.

- **Deliverable obligations under deferral credit event:** If the protection *buyer* (short risk) triggers a deferral credit event, the only deliverable is a preferred that is senior or *pari passu* to the Reference Obligation. If the protection *seller* (long risk) triggers a deferral credit event, deliverables may include bonds and loans, as well as preferreds that are Sr. or *pari passu* to the Reference Obligation.

  The difference in deliverable securities contingent upon the party that triggers a deferral credit event is designed to prevent exploitation of the contract in the event of a (rare) scenario where, for structural reasons, a bonds or loan is trading at a lower dollar price than the preferred following a deferral. For example, consider what might happen if the preferred security is trading at $50 a bond is trading at $40 after a deferral credit event, if the expansion of deliverables in a protection seller triggered deferral credit event were not in place.

  Protection seller viewpoint (long risk): If, at the time of a deferral credit event, the protection seller anticipates a default or failure to pay credit event in the future, he would have an incentive to trigger the contract right away so the protection buyer would be limited to delivering the preferred. In that case, the seller's losses would be only $50 ($100 - $50 price of preferred deliverable), whereas losses would have been $60 ($100 - $40 price of bond deliverable) if the bond were to become deliverable following a future default or failure to pay credit event. In this way, the protection seller could prevent the protection buyer from realizing the full value of his contract, which was intended to reflect the (subordinated, lower recovery) preferred security in a credit event.

  Protection buyer viewpoint (short risk): Under the same scenario, after a deferral credit event, if the protection buyer anticipates a default or failure to pay credit event in the future, he could wait to trigger the contract until that time. In such an event, the bonds and loans also become deliverable, and the protection buyer could deliver the bonds for a $60 payout ($100 - $40 price of bond deliverable), if the same prices hold. As such, the protection buyer has the potential to realize the full value of his protection irregardless of any abnormalities in preferred/bond price relationships following a deferral credit event.

  In order to prevent protection sellers from exploiting this (rare) scenario, deliverables securities include preferreds, bonds, and loans, if the protection seller triggers a deferral credit event. A parallel can be drawn to a similar restriction in standard corporate CDS for restructuring credit events (MR, MMR), whereby deliverable maturity limits apply if the event is triggered by a buyer of protection.

- **Succession:** Unlike standard corporate CDS, where the successor is determined by looking to the entity responsible for all relevant obligations (bonds, loans), PCDS successor is determined by looking to the entity responsible for the preferred securities only.

- **Settlement timing:** Following the credit event determination date, the buyer of protection has 60 days to deliver a notice of physical settlement, confirming his intent to settle the contract under the physical settlement method. The buyer has only 30 days under traditional corporate CDS.

- **Other conditions:** The usual conditions in standard CDS contracts that deliverable obligations be "Not Contingent" with "Maximum Maturity" of 30 years are not applicable to preferred securities as deliverable assets.

## PCDS versus CDS

Preferred stock is subordinate to bonds and loans so that PCDS spreads should generally be wider than CDS spreads. This is for two reasons. First, the likelihood of a deferral of preferred dividends is higher than that of default on a bond or loan. A company in a difficult cash flow situation is likely to first eliminate common stock dividends, then defer preferred stock dividends, and then if necessary miss coupon payments on debt securities or loans. Second, the recovery rate on preferred securities is likely to be lower than on a loan or bond given that they are subordinate. These are the main drivers of spreads on PCDS.

For example, if one believes there is a 10% probability of default on a bond, and that the bond will trade at $0.40 after a credit event (40% recovery rate, 60% loss), then the CDS spread should be approximately 6% (10%* 60%). This is because one receives or pays a spread to compensate for expected loss. In this example a 10% probability of default with a 60% loss results in a 6% expected loss. If the same issuer had preferred securities outstanding and one believed the probability of deferral was 20% and recovery was $0.30, than the PCDS spread would trade at approximately 14% (20%* [1.00 – 0.30]). This is the expected loss on the preferred security. In practice it is difficult to determine both default and deferral probabilities and to estimate recovery rates, however.

## Overview of preferred stock issuance and market

Preferred stocks are hybrid securities that combine equity and credit features. There are two main types of preferred securities: traditional perpetual preferreds and dated trust preferreds. Trust preferreds represent approximately 60% of the market currently outstanding. The total preferred stock market is about $200 billion in size.

Traditional preferred securities are perpetual securities with no stated maturity date, no mandatory redemption, and are callable (usually five or 10 years after issuance). They are subordinated to all other obligations except common stock. Dividends must be declared, usually on a quarterly basis, and an issuer can skip or defer a dividend without causing a default. Unpaid dividends can be cumulative or non-cumulative traditional preferreds.

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### Exhibit 19.1: Corporate CDS versus preferred CDS

| | Corporate CDS | PCDS |
|---|---|---|
| Reference obligation | Obligation of the issuer | Obligation of the issuer itself or a related preferred issuer |
| Credit events | Bankruptcy, failure to pay, restructuring (some contracts) | Bankruptcy, failure to pay, restructuring (some contracts), and deferral on the payment of a preferred stock dividend. |
| Deliverable obligations | Bonds and loans | Bonds, loans, or preferred securities that are Sr. or pari passu to reference entity. Preferred securities only in the event of a deferral event triggered by the protection buyer. |
| Notional amount | Par amount | Liquidation preference (i.e. aggregate par or stated value). |
| Contract size | Typically $10-20million for IG and $2-5 million for HY | Typically $5 million |
| Settlement | Physical | Physical |
| Term | Most liquid at 5 or 10 years | 5 years currently |
| Succession | Entity responsible for bonds and loans | Entity responsible for the preferred securities |

Source: JPMorgan.

### Exhibit 19.2: Sample pricing run for 5-year PCDS from selected issuers (bp)

| REITS | | INSURANCE | | UTILITIES | | AGENCY | | BROKERS | |
|---|---|---|---|---|---|---|---|---|---|
| ASN | 80/90 | ACE | 110/120 | EIX | 62/72 | FNM | 40/50 | BSC | 61/71 |
| AVB | 90/100 | AOC | 85/95 | NRU | 52/72 | FRE | 35/45 | GS | 60/70 |
| EOP | 105/115 | MET | 65/75 | | | | | MWD | 62/72 |
| EQR | 93/103 | SAFC | 50/60 | | | | | | |
| SPG | 110/120 | XL | 100/105 | | | | | | |
| VNO | 130/140 | | | | | | | | |

Buyer of protection (short risk) pays a spread of 72bp

Seller of protection (long risk) receives a spread of 52bp*

* Accrues on an actual/360 basis.
Source: JPMorgan.

Trust preferreds are primarily issued by financial institutions, insurance companies, and utilities. In Trust preferred securities, the issuer of the preferred is a trust or similar entity, and substantially all the assets of the trust are obligations of the related corporate entity. Their coupon payment must be declared (like dividends) but are considered interest payment for tax purposes. They have a maturity date (redemption) typically 30 to 40 years from issuance. They have a stated coupon, but the issuer is permitted to defer paying this coupon for up to five years without triggering an event of default. Trust preferreds are cumulative; therefore, the issuer must pay all missed coupons when it reinstates the dividend. Trust preferreds are, in most cases, senior to traditional preferreds.

In both traditional preferred securities and trust preferreds, credit events include deferral of dividends on preferred stock, and are triggered if all or a portion of the required payment is not made at a scheduled payment date.

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# 20. Profiting from views on recovery rates

## Recovery Rate Lock

The recovery rate market enables investors to take views on recovery, or "lock in" a recovery rate if there is a credit event. A standard contract was released in May 2006 by the International Swaps and Derivatives Association (ISDA) called the Recovery Lock. The Recovery Lock[33] is a modification of the standard credit default swap contract and can be used for recovery rate trading. Previously, two CDS contracts were used to isolate the trading of recovery rates, collectively know as the Recovery Rate Swap.

As the economics of the Lock and the Swap are essentially the same, the Lock may become the standard contract as the recovery rate market develops further. The primary difference between the investments is that, because the Recovery Swap is the combination of two CDS contracts (a standard CDS and a digital CDS), either contract can be priced, unwound, or settled, without effecting the other contract. The Lock is a single contract, however, and does not have this flexibility.

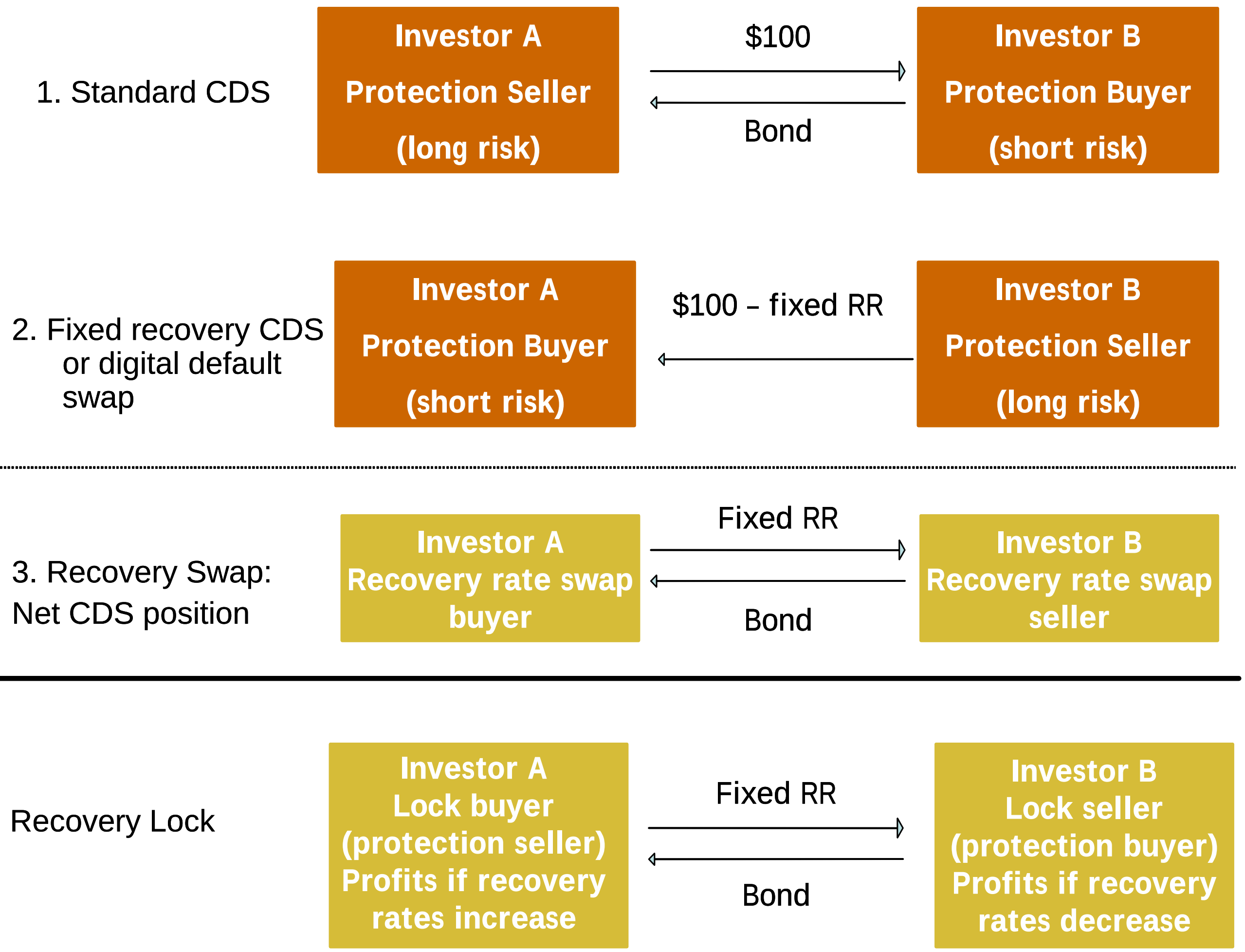
Note that the concept of recovery rates in the credit default swap (CDS) markets refers to the price at which bonds are expected to trade in the weeks after there is a credit event. This may differ from the workout value, or the eventual payout bond holders receive after a company emerges from bankruptcy or is restructured.

To date, investors have used the recovery rate market to

- express outright views on recovery rates,
- lock in recovery rates on single name CDS contracts,
- obtain the option to purchase bonds at a fixed price if there is a credit event. This is used by distressed investors as an alternative to outright purchases of bonds,
- facilitate debt/equity trading in distressed companies, by entering into long risk CDS contracts with fixed recovery, and purchasing out-of-the-money equity put options. See Part II for more information.

[33] For more information on Recovery Rate Lock, refer to "Locking in views on recovery: the Recovery Rate Lock", published in Corporate Quantitative Weekly, edition of June 2, 2006.

Exhibit 20.1: Comparison of the Recovery Swap and Recovery Lock. In default, the cash flows are essentially the same.




Source: JPMorgan

**Recovery Lock Contract**

We summarize the Recovery Lock contract:

- At the initiation of the contract, the buyer and seller of the Lock agree on a fixed recovery rate. There is no exchange of cash upfront, nor are their quarterly payments in the standard Lock contract.
- Investors who buy the Lock want recovery rates to increase, and sellers want recovery rates to fall.
- Payment after a credit event is the only cash flow called for in the Lock contract.
- If there is a credit event, the contract calls for physical settlement. The Lock seller delivers a Deliverable Obligation to the Lock buyer. As in a standard CDS contract, a bond or loan that is pari passu or better in seniority to the contract's Reference Obligation (typically a senior unsecured bond) can be delivered. The Lock buyer pays the seller the fixed recovery amount specified in the contract, or the Reference Price. This is different from the vanilla CDS contract, where par is paid for the bond. Thus, Lock buyers

will profit if they can sell the bond they receive for a price higher than the fixed recovery price they pay.

- Like in standard CDS, Lock investors may be able to use a CDS settlement protocol to cash or physically settle their contracts following a credit event. The CDS settlement protocol is discussed in Part I.
- Like in vanilla CDS contracts, Lock contracts may be unwound with the original or another counterparty. The unwind value is equal to the difference between the original and unwind recovery rate, multiplied by the probability of default implied by current spreads. The CDSW calculator is used to value the contract. Even after a credit event, the contract can be unwound and cash settled observing the traded price of defaulted bonds.
- The physical settlement process for the Lock differs in procedure from the vanilla CDS contract. In the vanilla CDS contract, the buyer of CDS protection has 30 days to deliver a notice of physical settlement (NOPS) after the notification of a credit event is delivered. The NOPS indicates what bonds or loans will be delivered. In the Lock contract, both parties have the option to deliver the NOPS. Specifically, the Lock seller has 30 days to deliver the NOPS, then the Lock buyer has 15 days to deliver. This is relevant because the Lock seller will not want to settle the contract if the defaulted bonds are trading above the recovery rate specified in the contract. For example, if the fixed recovery rate in the contract is 50%, and bonds are trading at $55, the Lock seller would prefer not to lose $5. But because the Lock buyer can deliver the NOPS, and thus decide what bond should be delivered, it is likely that the Lock seller will deliver the NOPS choosing the cheapest bond to deliver. The Lock seller would prefer to buy the $55 bond, as opposed to a $57 bond, for example.
- As a general rule, the exposure of the Lock seller is capped at par, as per the mechanisms of the Lock contract.
- We note that in the ISDA contract, the Lock buyer is called the seller of default protection, and the Lock seller is called the buyer of default protection. This naming convention is used because, after a credit event, the buyer of default protection (Lock seller) delivers bonds, as is done in vanilla CDS contracts.
- We anticipate that most Lock contracts will trade on a No Restructuring basis, namely bankruptcy and failure to pay will be the only two credit events.

Exhibit 20.2: Recovery Lock summary

| Lock Buyer | Lock Seller |
|---|---|
| Profits if recovery rates increase | Profits if recovery rates decrease |
| In default, pays fixed recovery amount and receives bond or loan | In default, receives fixed recovery amount and delivers bond or loan |
| In ISDA Lock contract, is said to be the seller of default protection | In ISDA Lock contract, is said to be the buyer of default protection |

Source: JPMorgan

### Valuation

There is one cash flow in the Lock contract. After a credit event, the Lock buyer purchases a defaulted bond from the Lock seller at the fixed recovery price. In default, the value of the Lock is the difference between the fixed recovery price and the floating recovery price, or the price of the defaulted bond. Prior to a credit event,

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the value of the Lock is this difference multiplied by the probability of default, or the probability that the cash flow is realized.

The CDSW calculator on Bloomberg can be used to find the mark-to-market value, but is used differently than in valuing standard CDS contracts. First, in the "Deal Information" section, three fields are adjusted compared to vanilla contracts:

Curve Recovery = False

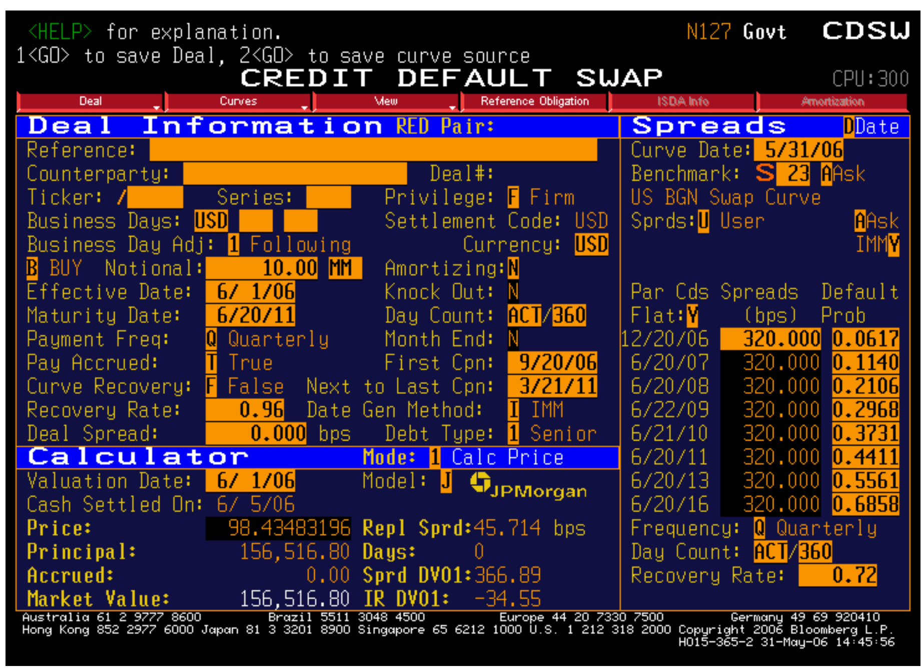
Recovery Rate = 1 minus the absolute value of the difference between the fixed rate percentage and the current recovery rate

Deal Spread = 0bp, as there is not a running spread in the Lock contract

Second, the "Spreads" section of the calculator is used in the same manner as in standard CDS contracts. Current CDS spread levels are inputted, using either a flat spread or the entire CDS curve. Importantly, the current recovery rate level should be entered into the "Recovery Rate" field. Based on the spreads and recovery rate inputted, the "Spreads" section calculates a default probability curve, or the likelihood the credit will default over time. By multiplying the default probabilities by the recovery rate inputted in the Deal Information section, and summing this product through the maturity date of the contract, the calculator determines the market value of the Lock.

Finally, the value of the Lock is displayed in the "Calculator" section in the "Market Value" field.

Exhibit 20.3: Valuation of our GMAC Recovery Lock example, where recovery rates changed by 4 percentage points.




Source: Bloomberg, JPMorgan

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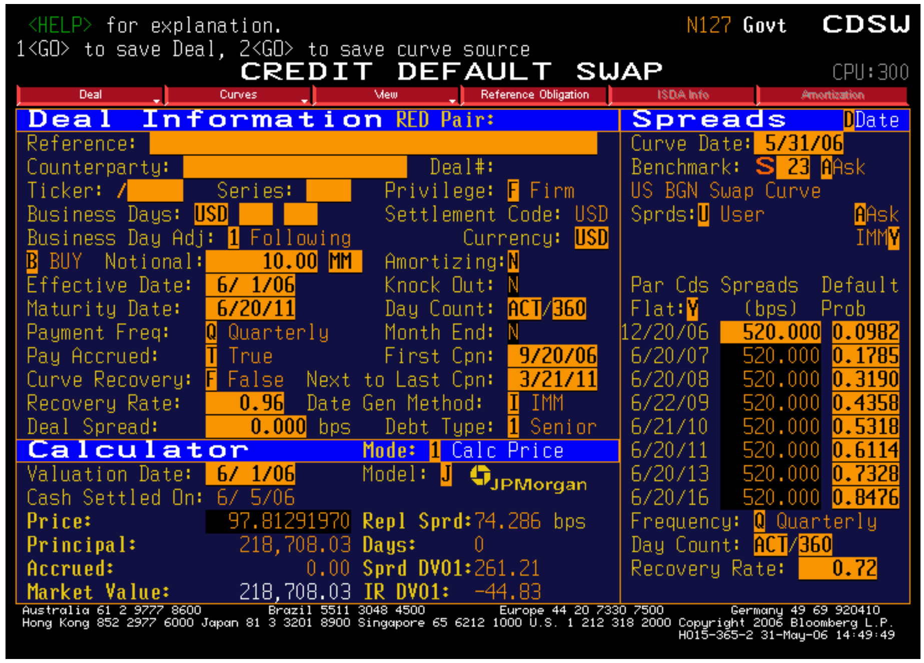
Exhibit 20.4: Valuation of our Ford Motor Credit Recovery Lock example, where recovery rates changed by 4 percentage points.




Source: Bloomberg, JPMorgan

As an example, assume we buy a Recovery Lock on GMAC at 68%, then unwind the Lock at 72%, with CDS spreads trading at 320bp. The value of the Lock is $157K, given a $10 million notional. Note in Exhibit 20.4, the "Recovery Rate" entered in the "Deal Information" section is .96, or 100% - |72% - 68%|, and the "Deal Spread" = 0. Furthermore, assume we buy a Recovery Lock on Ford Motor Credit at 68%, then unwind the Lock at 72%, but CDS spreads are trading at 520bp. The value of the Lock is $219K, given a $10 million notional. The FMC market value is higher than GMAC because the probability that Ford defaults is higher than the probability that GMAC defaults. Thus the Ford Recovery Lock unwind should be higher, because the cash flow - which only occurs if there is a default - is more likely.

**CDSW calculation intuition**

The CDSW calculator values the future cash flows specified in the "Deal Information" section. From the point of view of the vanilla CDS protection seller (long risk), it essentially calculates the present value of the "Deal Spread" multiplied by the probability the cash flows are realized, or one minus the probability of default. These probabilities are determined in the "Spreads" section, as the user inputs the current CDS levels and recovery rate, implying the probability of default. In the Lock, the "Deal Spread" is zero, thus the value of the vanilla CDS protection seller's cash flows is zero.

The CDSW calculator also values the future cash flows from the point of view of the vanilla CDS protection buyer (short risk). The protection buyer only receives cash if there is a credit event. In this case, the cash flow is equal to 1 minus the recovery rate. Thus, to value the protection buyer's cash flow, the CDSW calculator multiplies the cash payment following a credit event by the probability there is a credit event, then calculates the present value. Note, that if the recovery rate is 100%, then in default, the protection buyer would purchase a bond for $100, deliver the bond to the seller of protection, and receive par for a net gain of zero. If the

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recovery rate was 95%, then the protection buyer would purchase a bond at $95 and receive par, netting $5.

In the Recovery Lock, the goal is to find the value of the difference between the recovery rate specified in the contract and the current market recovery rate level. This cash flow is only realized if there is a credit event. Thus, we use the CDSW calculator as described above, valuing this difference given the probability the cash flow will be realized. The probability the cash flow will be realized is calculated in the "Spreads" section of the calculator, using the current CDS levels and recovery rate. In the "Deal Information" section, setting the "Deal Spread" to zero and the "Recovery Rate" to 100% less the difference between Lock contract and current market recovery rates, allows us to calculate the value based on current market pricing.

## Digital Default Swaps

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

A special DDS is a zero recovery swap. In this contract, an investor pays or receives a spread on a CDS that, in a credit event, will pay zero recovery. For example, assume a five year GMAC CDS quote of 405 / 410. An investor bullish on GMAC could sell protection (long credit risk) at 405bp. Alternatively, the investor could sell zero recovery protection at a spread above 405bp. The spread would be calculated by dividing the CDS spread of 405bp by (1 – Recovery Rate). If the recovery rate in the market is 60%, an investor could sell protection at 405 / 0.6 or 675bp. The investor would thereby earn a significantly higher spread than the normal GMAC CDS spread, but in a credit event, would suffer a greater loss. Namely, if the actual price of GMAC bonds after a credit event were above $50, the investor would have been better off taking a long credit risk position in the regular CDS than in the zero recovery CDS. If the actual recovery rate is below $50, the investor would have been better off with the zero recovery CDS.

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# 21. Other credit default swap products

## Credit linked notes

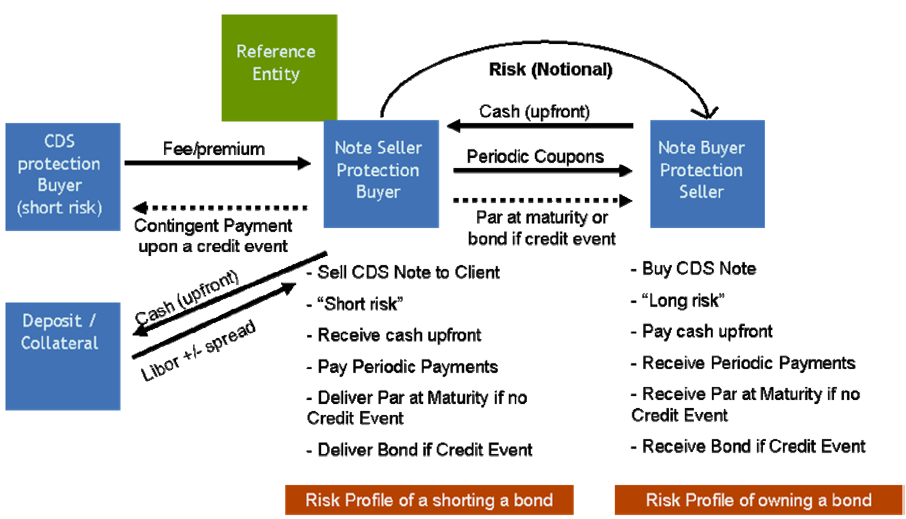
Credit linked notes may be created for investors who are not able to invest in swaps. These products are typically created if an investor wanted a $100 million or larger position to a particular credit, for example.

The economics of the credit default swap can be captured in a funded security or a note. A credit linked note is a synthetic security, typically issued by a special purpose vehicle that trades like a bond issued by the reference entity but with the economics of the credit default swap. For this security, the buyer of protection sells the note. As in the credit default swap, the protection buyer is still "going short risk." The buyer of protection (note seller) will pay periodic payments and profit if the reference entity defaults. Unlike the swap, the buyer of protection in a credit-linked note will receive money at the time of transaction from the sale of the note, and will return this money at the contract's maturity if no credit event occurs.

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

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

Exhibit 21.1: Credit-Linked Notes are a synthetic security that trades like a bond issued by the Reference Entity, but with the economics of a credit default swap.




*Source: JPMorgan.*

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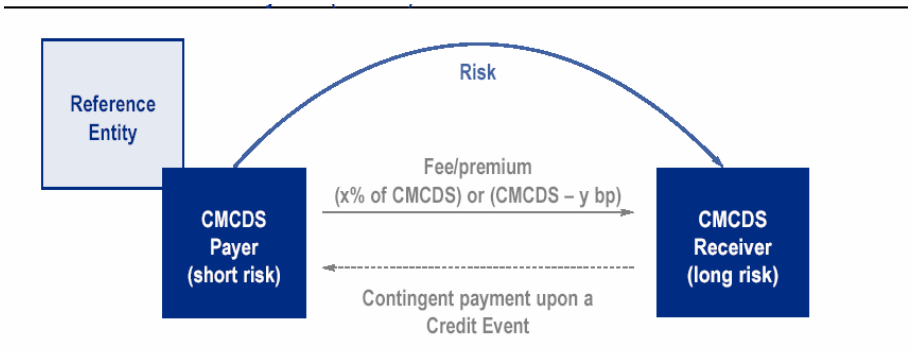
## Constant maturity credit default swaps (CMCDS)[34] and credit spread swaps (CSS)

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

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

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

Exhibit 21.2: Constant Maturity CDS (CMCDS)




Source: JPMorgan.

[34] For more information on CMCDS, refer to "Introduction to constant maturity CDS and CDOs" by Jacob Due and Rishad Hluwalia published October 21, 2004.

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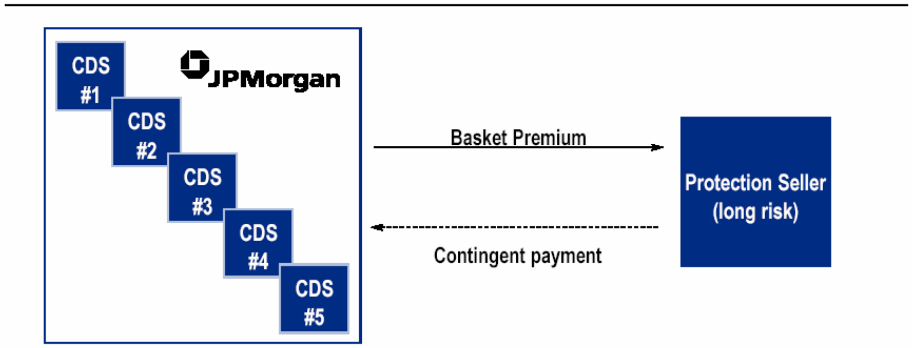
## First-to-default baskets[35]

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

A first-to-default basket is a leveraged position in a basket of credit default swaps. It is a leveraged position because an investor is exposed to the risk of default on the entire basket rather than on a single name. However, the investor's loss is limited to the notional value of the trade. Because the basket has a higher probability of default than an individual credit, the seller of protection receives a spread greater than the widest individual spread in the basket. Typically, the basket pays a spread of 60-80% of the sum of the spreads in the basket. For example, Exhibit 21.4 is an insurance company FTD basket that pays the seller of protection (long risk) 505 bp, which is 71% of the aggregate spread. The value drivers in this product are the number of basket components (the greater the number of names, the greater the likelihood of one name defaulting, the greater the premium paid), absolute spread levels (clustered spreads provide the greatest value), and correlation (or similarity of assumed default probability between credits, the less similar the correlation, the higher the default risk, therefore the greater the premium paid).

Exhibit 21.3: First-to-default baskets




Source: JPMorgan

Exhibit 21.4: Sample High Yield FTD Basket

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

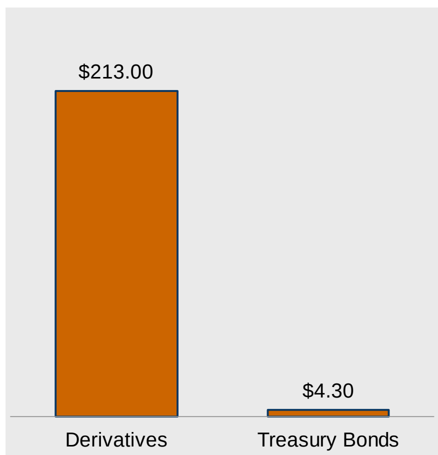
Source: JPMorgan

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

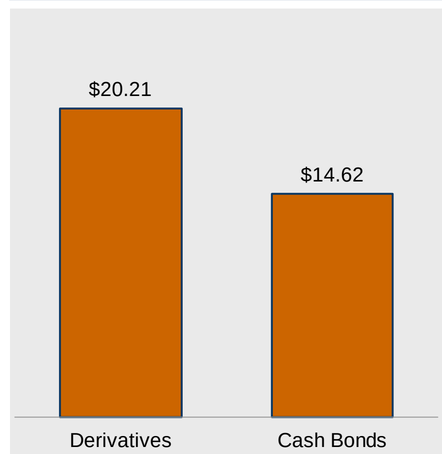
# Conclusion

The use of credit derivatives has grown exponentially since the beginning of the decade. Transaction volumes have picked up from the occasional tens of millions of dollars to regular weekly volumes measured in many billions of dollars. The end-user base is broadening rapidly to include a wide range of banks, broker-dealers, institutional investors, asset managers, corporations, hedge funds, insurers, and reinsurers. Growth in participation and market volume are likely to continue based on the investment opportunities created by the products. While we do not expect the credit derivatives market to reach the 50:1 derivative to cash ratio in the interest rate market anytime soon, we do expect growth to continue.

Interest rate market
$ trillion notional




Credit market
$ trillion notional




*Source: British Bankers' Association, Bank for International Settlements, Bureau of the Public Debt, and JPMorgan Estimates.*

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# Appendix I: JPMorgan CDSW Example Calculations Model

## (for illustration of the general concepts only)

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

Additional Check of calculation

Col 2: Notional Value * Original Contract Spread / 4 (for quarterly payment)

Col 3: Notional Value * Current Market Spread / 4 (for quarterly payments

Col 4: Difference between Column 2 and Column 3. This represents the cash flow which is being valued - I.e. the value of a CDS unwind is the discounted value of this cash flow stream

Col 7: 1 Minus Column 8

Col 8: Probability of no default. Calculated as 1/(1+ Clean Spread) ^ time in years. The concept is that the clean spread is the annual default probability. The probability of not having defaulted after two years (for example) is the probability of no default in year one multiplied by the probability of no default in year two.

Col 9: Column 4 X Column 6 X Column 8.

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

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

| Col 1 | Col 2 | Col 3 | Col 4 | Col 5 | Col 6 | Col 7 | Col 8 | Col 9 | Col 10 | Col 11 |
|---|---|---|---|---|---|---|---|---|---|---|
| Period | Cash Flow Earned on CDS | Premium Paid on offsetting CDS | Net Premium | Swap Curve | Discount Factor | Prob of Default | Survival Probability | PV of Expected Cash flows | Value of Current Coupon Flows | Value of loss if default |
| 0.25 | $125,000 | $100,000 | $25,000 | 2.000% | 0.99502 | 0.0160 | 0.9840 | $24,477 | $97,910 | $95,553 |
| 0.50 | $125,000 | $100,000 | $25,000 | 2.000% | 0.99007 | 0.0157 | 0.9682 | $23,966 | $95,864 | $93,556 |
| 0.75 | $125,000 | $100,000 | $25,000 | 2.000% | 0.98515 | 0.0155 | 0.9527 | $23,465 | $93,860 | $91,601 |
| 1.00 | $125,000 | $100,000 | $25,000 | 2.000% | 0.98025 | 0.0152 | 0.9375 | $22,975 | $91,898 | $89,686 |
| 1.25 | $125,000 | $100,000 | $25,000 | 2.000% | 0.97537 | 0.0150 | 0.9225 | $22,494 | $89,977 | $87,812 |
| 1.50 | $125,000 | $100,000 | $25,000 | 2.000% | 0.97052 | 0.0148 | 0.9077 | $22,024 | $88,097 | $85,976 |
| 1.75 | $125,000 | $100,000 | $25,000 | 2.000% | 0.96569 | 0.0145 | 0.8932 | $21,564 | $86,256 | $84,179 |
| 2.00 | $125,000 | $100,000 | $25,000 | 2.000% | 0.96089 | 0.0143 | 0.8789 | $21,113 | $84,453 | $82,420 |
| 2.25 | $125,000 | $100,000 | $25,000 | 2.000% | 0.95610 | 0.0141 | 0.8648 | $20,672 | $82,688 | $80,697 |
| 2.50 | $125,000 | $100,000 | $25,000 | 2.000% | 0.95135 | 0.0138 | 0.8510 | $20,240 | $80,959 | $79,011 |
| 2.75 | $125,000 | $100,000 | $25,000 | 2.000% | 0.94661 | 0.0136 | 0.8374 | $19,817 | $79,267 | $77,359 |
| 3.00 | $125,000 | $100,000 | $25,000 | 2.000% | 0.94191 | 0.0134 | 0.8240 | $19,403 | $77,611 | $75,743 |
| 3.25 | $125,000 | $100,000 | $25,000 | 2.000% | 0.93722 | 0.0132 | 0.8108 | $18,997 | $75,988 | $74,159 |
| 3.50 | $125,000 | $100,000 | $25,000 | 2.000% | 0.93256 | 0.0130 | 0.7978 | $18,600 | $74,400 | $72,609 |
| 3.75 | $125,000 | $100,000 | $25,000 | 2.000% | 0.92792 | 0.0128 | 0.7850 | $18,211 | $72,845 | $71,092 |
| 4.00 | $125,000 | $100,000 | $25,000 | 2.000% | 0.92330 | 0.0126 | 0.7725 | $17,831 | $71,323 | $69,606 |
| 4.25 | $125,000 | $100,000 | $25,000 | 2.000% | 0.91871 | 0.0124 | 0.7601 | $17,458 | $69,832 | $68,151 |
| 4.50 | $125,000 | $100,000 | $25,000 | 2.000% | 0.91414 | 0.0122 | 0.7479 | $17,093 | $68,373 | $66,727 |
| 4.75 | $125,000 | $100,000 | $25,000 | 2.000% | 0.90959 | 0.0120 | 0.7360 | $16,736 | $66,943 | $65,332 |
| 5.00 | $125,000 | $100,000 | $25,000 | 2.000% | 0.90506 | 0.0118 | 0.7242 | $16,386 | $65,544 | $63,967 |
| | | | | | | | Mark to market of CDS unwind | $403,522 | $1,614,089 | $1,575,237 |
| | | | | | | | | | Difference of sums: | -$38,851 |

*Source: JPMorgan*

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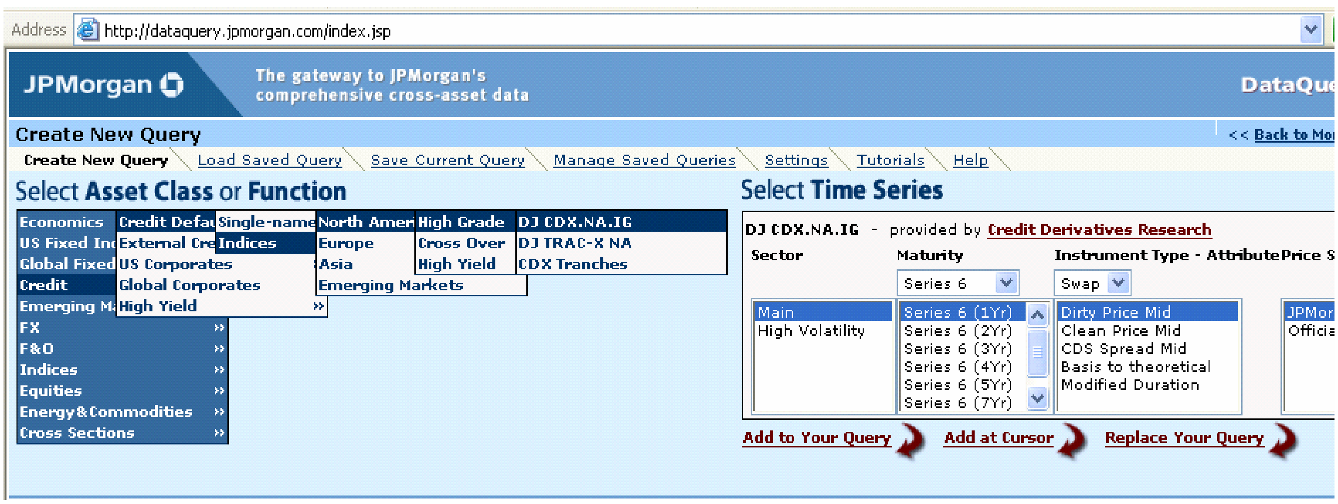
# Appendix II: How to get CDX and iTraxx data

Historical data on the CDX and iTraxx indices are available on the DataQuery tool (http://dataquery.jpmorgan.com/index.jsp) on MorganMarkets. Using this tool, prices, spreads, basis to theoretical value and duration for current and predecessor indices can be retrieved. The path to retrieve the CDX data, for example, is:

Credit → Credit Default Swaps → Indices → North America

iTraxx data for Europe and Asia, and EM CDX data is available through a similar path.




Source: JPMorgan

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**Companies Recommended in This Report (all prices in this report as of market close on 27 November 2006, unless otherwise indicated)**

Alltel (AT/$55.78/Overweight), American Axle & Manufacturing Holdings, Inc. (AXL/$18.06/Neutral), General Motors (GM/$30.36/Neutral), Lear Corporation (LEA/$30.67/Neutral), Windstream Communications (WIN/$13.62/Neutral)

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- **JP Morgan and/or its affiliates is advising General Motors Corp. on the sale of a 17.4% stake in Japan's Suzuki Motor Corp.**
- **JP Morgan and/or its affiliates is advising General Motors Corp. on the sale of a 17.4% stake in Japan's Suzuki Motor Corp.**
- **J.P. Morgan Securities Inc and/or its affiliates is acting as a financial advisor to Alltel Corporation ("AT") in connection with its proposed spinoff/sale of its Wireline business segment ("Alltel Wireline") to VALOR Communications Group, Inc. ("VCG") in a Reverse Morris Trust transaction announced on December 9, 2005. The proposed transaction is subject to regulatory and VALOR shareholder approvals. This research report and the information herein is not intended to provide voting advice, serve as an endorsement of the proposed transaction or result in procurement, withholding or revocation of a proxy or any other action by a security holder.**

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**Ratings System:** JPMorgan uses the following sector/issuer portfolio weightings: Overweight (over the next three months, the recommended risk position is expected to outperform the relevant index, sector, or benchmark), Neutral (over the next three months, the recommended risk position is expected to perform in line with the relevant index, sector, or benchmark), and Underweight (over the next three months, the recommended risk position is expected to underperform the relevant index, sector, or benchmark). JPMorgan's Emerging Market research uses a rating of Marketweight, which is equivalent to a Neutral rating.

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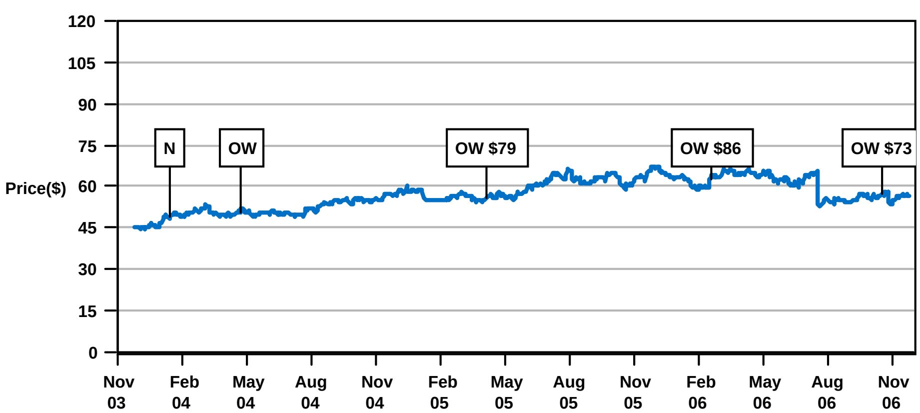
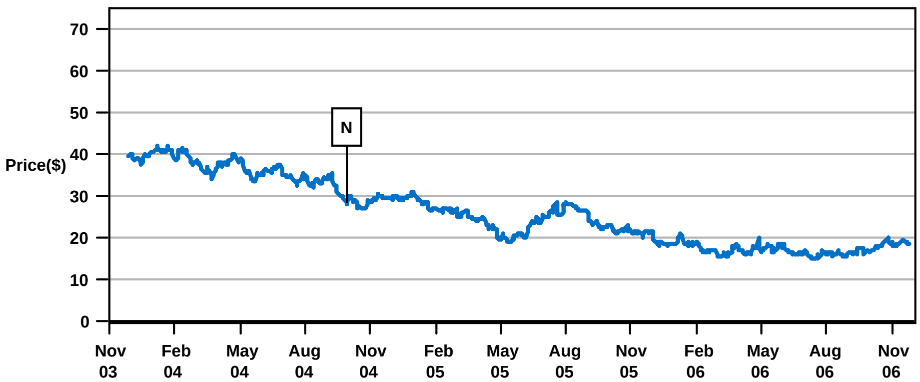
**Alltel (AT) Price Chart**




| Date | Rating | Share Price ($) | Price Target ($) |
|---|---|---|---|
| 13-Jan-04 | N | 48.97 | - |
| 23-Apr-04 | OW | 50.81 | - |

Source: Reuters and JPMorgan; price data adjusted for stock splits and dividends.
This chart shows JPMorgan's continuing coverage of this stock; the current analyst may or may not have covered it over the entire period. As of Aug. 30, 2002, the firm discontinued price targets in all markets where they were used. They were reinstated at JPMSI as of May 19th, 2003, for Focus List (FL) and selected Latin stocks. For non-JPMSI covered stocks, price targets are required for regional FL stocks and may be set for other stocks at analysts' discretion.
JPMorgan ratings: OW = Overweight, N = Neutral, UW = Underweight.

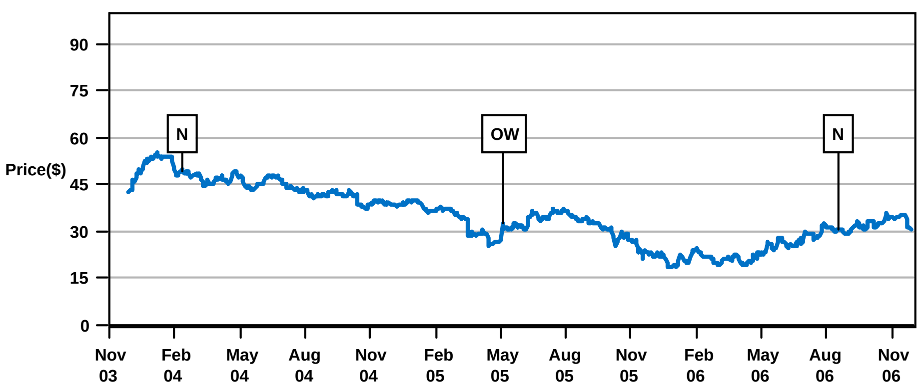
**American Axle & Manufacturing Holdings, Inc. (AXL) Price Chart**




| Date | Rating | Share Price ($) | Price Target ($) |
|---|---|---|---|
| 28-Sep-04 | N | 28.45 | - |

**Source: Reuters and JPMorgan; price data adjusted for stock splits and dividends.**
**Initiated coverage Sep 28, 2004. This chart shows JPMorgan's continuing coverage of this stock; the current analyst may or may not have covered it over the entire period. As of Aug. 30, 2002, the firm discontinued price targets in all markets where they were used. They were reinstated at JPMSI as of May 19th, 2003, for Focus List (FL) and selected Latin stocks. For non-JPMSI covered stocks, price targets are required for regional FL stocks and may be set for other stocks at analysts' discretion.**
**JPMorgan ratings: OW = Overweight, N = Neutral, UW = Underweight.**

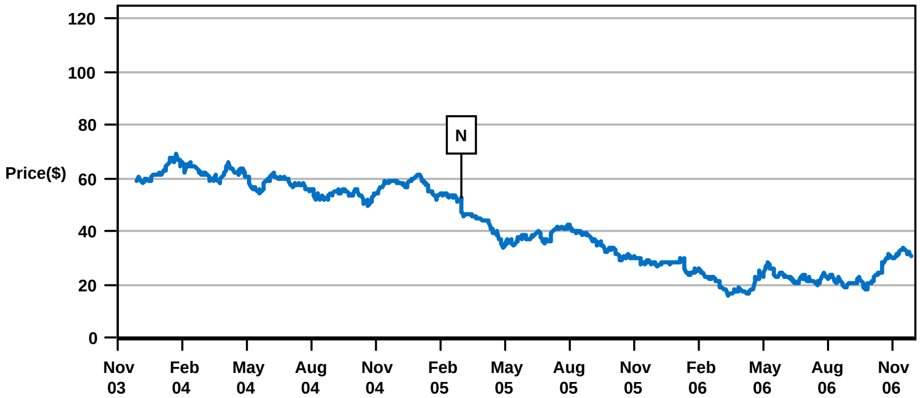
**General Motors (GM) Price Chart**




| Date | Rating | Share Price ($) | Price Target ($) |
|---|---|---|---|
| 10-Feb-04 | N | 49.11 | - |
| 05-May-05 | OW | 32.80 | - |
| 17-Aug-06 | N | 30.99 | - |

**Source: Reuters and JPMorgan; price data adjusted for stock splits and dividends.**
**Break in coverage Apr 16, 2003 - Jun 12, 2003. This chart shows JPMorgan's continuing coverage of this stock; the current analyst may or may not have covered it over the entire period. As of Aug. 30, 2002, the firm discontinued price targets in all markets where they were used. They were reinstated at JPMSI as of May 19th, 2003, for Focus List (FL) and selected Latin stocks. For non-JPMSI covered stocks, price targets are required for regional FL stocks and may be set for other stocks at analysts' discretion.**
**JPMorgan ratings: OW = Overweight, N = Neutral, UW = Underweight.**

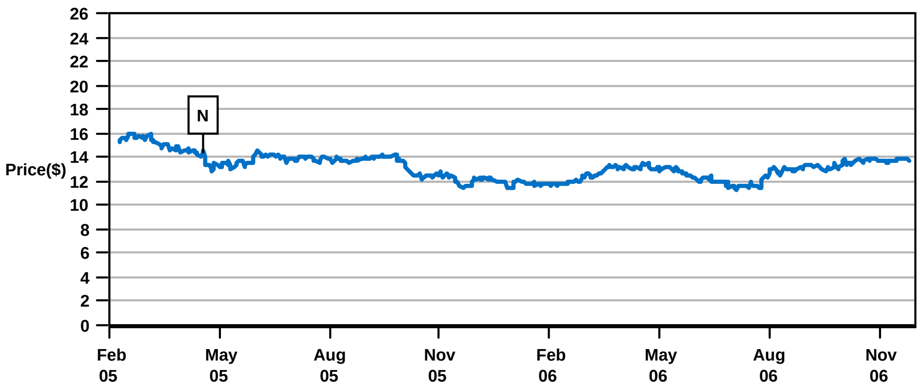
**Lear Corporation (LEA) Price Chart**




| Date | Rating | Share Price ($) | Price Target ($) |
|---|---|---|---|
| 02-Mar-05 | N | 52.76 | - |

**Source: Reuters and JPMorgan; price data adjusted for stock splits and dividends.**
**This chart shows JPMorgan's continuing coverage of this stock; the current analyst may or may not have covered it over the entire period. As of Aug. 30, 2002, the firm discontinued price targets in all markets where they were used. They were reinstated at JPMSI as of May 19th, 2003, for Focus List (FL) and selected Latin stocks. For non-JPMSI covered stocks, price targets are required for regional FL stocks and may be set for other stocks at analysts' discretion.**
**JPMorgan ratings: OW = Overweight, N = Neutral, UW = Underweight.**

**Windstream Communications (WIN) Price Chart**




| Date | Rating | Share Price ($) | Price Target ($) |
|---|---|---|---|
| 20-Apr-05 | N | 14.30 | - |

**Source: Reuters and JPMorgan; price data adjusted for stock splits and dividends.**
**Initiated coverage Apr 20, 2005. This chart shows JPMorgan's continuing coverage of this stock; the current analyst may or may not have covered it over the entire period. As of Aug. 30, 2002, the firm discontinued price targets in all markets where they were used. They were reinstated at JPMSI as of May 19th, 2003, for Focus List (FL) and selected Latin stocks. For non-JPMSI covered stocks, price targets are required for regional FL stocks and may be set for other stocks at analysts' discretion.**
**JPMorgan ratings: OW = Overweight, N = Neutral, UW = Underweight.**

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|---|---|---|---|
| JPM Global Equity Research Coverage | 42% | 41% | 17% |
| IB clients* | 44% | 46% | 35% |
| JPMSI Equity Research Coverage | 38% | 48% | 15% |
| IB clients* | 62% | 55% | 47% |

*Percentage of investment banking clients in each rating category.
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