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Trading Credit Curves II

Analysing the Drivers of P+L in Credit Curve Trading

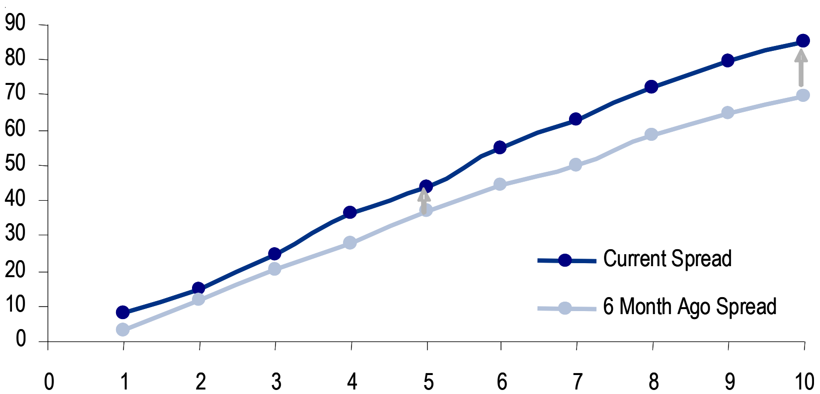
- Trading credit curves has become part of the standard repertoire for many credit investors.
- We introduce a framework to fully understand the factors impacting the P+L in curve trading.
- Slide and Convexity are often neglected and can be as important as Carry and Curve Moves in their impact on P+L.
- We apply our analysis to common curve trades to enable more profitable curve trading.

Introduction

Credit curve trading has become an important trading strategy for many credit investors. The changing shape of credit curves (see Figure 1) can mean P+L opportunities for those who successfully position for this. However, analyzing how to position for a view that 'the curve for Company A will steepen' has often ignored some of the drivers of P+L in these trades. In this note we continue our series *Trading Credit Curves* by outlining a framework for analyzing curves trades. We apply our analysis to common curve trading strategies, looking at Equal-Notional, Duration-Weighted and Carry- Neutral trades, which have very different P+L profiles.

Figure 1: France Telecom Curve Steepening

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



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Executive Summary

The Drivers of P+L in Curve Trades

In the first section of this note we outline our framework for analyzing the drivers of P+L in curve trades, where we look at:

- **Time**: The effect of the passage of time which breaks down into Carry and Slide.
- **Sensitivity to Spread Changes**: We breakout first-order effects of spreads changing and look at Duration, as well as analysing second-order effects of Convexity. We highlight the important *Horizon Effect* when looking at sensitivity to spread changes at the trade horizon.
- **Default Risk**: Our trade exposure to our underlying credit risk.
- **Breakevens & Expected Curve Movements**: We put our analysis together with our expectation of curve moves and look at our 'Breakeven' levels.

Common Curve Trades and Their Characteristics

In the second section we look at common curve trading strategies with this framework, with additional useful analysis in the Appendices.

1. Equal-Notional or Default-Neutral Strategies: These are like Forwards, where both legs of the curve trade have equal notional exposure.

Table 1: Equal-Notional Strategies - Summary of Characteristics for Standard 5y/10y Curves

	Carry	Slide	Dominant Time Effect	1bp Widening	Default
Flattener	Positive	Low Spread = Positive High Spread = Negative	Low Spread = Carry High Spread = Slide	MTM Loss	Neutral
Steepener	Negative	Low Spread = Negative High Spread = Positive	Low Spread = Carry High Spread = Slide	MTM Gain	Neutral

Source: JPMorgan

2. Duration-Weighted Strategies: Where the legs of the trade are weighted to be Mark-to-Market neutral for a 1bp parallel shift in spreads.

Table 2: Duration-Weighted Strategies - Summary of Characteristics for Standard 5y/10y Curves

	Carry	Slide	Dominant Time Effect	1bp 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

3. Carry-Neutral Strategies: Where the legs of the trade are weighted to be neutral from Carry over the trade horizon.

Table 3: Carry-Neutral Strategies - Summary of Characteristics for Standard 5y/10y Curves

	Carry	Slide	Dominant Time Effect	1bp Widening	Default
Flattener	Zero (by definition)	Negative	Slide (by definition)	Mixed	Short Risk
Steepener	Zero (by definition)	Positive	Slide (by definition)	Mixed	Long Risk

Source: JPMorgan

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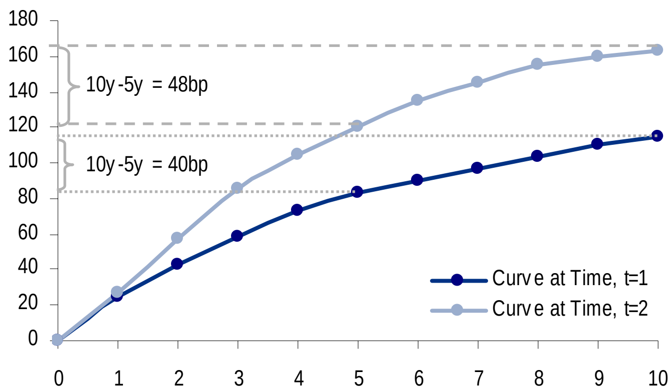
Introduction

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 Figure 2, then the investor will hope to make money as the curve steepens from 40bp to 48bp. 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 whilst positioning for points in the curve moving (as opposed to trading a single point where an investor must take outright default exposure).

Figure 2: Example Curve Trade for Company ABC

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



Source: JPMorgan

Figure 3: 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 Figure 3 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 more accurately should allow more profitable curve trading strategies. The first note in this series, *Trading Credit Curves I*, examined the concepts behind understanding the shape of credit curves. In this note we move on to the real analysis of the P+L drivers in curve trades. 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.

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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 & 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.

a) 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 Table 4[1].

Table 4: 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

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

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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.

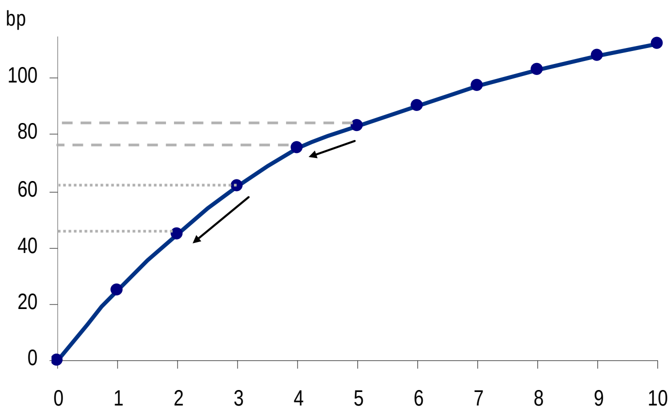
$S_{Leg\ n}$: Annual Spread on leg n of the trade, expressed in % terms (Spread in bp / 10000).

Horizon: Length of time horizon trade is being evaluated over, in years.

b) 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 Figure 4) as time passes we will 'slide' down the curve. So, using the example in Figure 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.

Figure 4: Slide Intuition



Source: JPMorgan

Appendix I discusses two different ways that we could 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

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impact when we look at sensitivity analysis at the horizon. We discuss these issues in Appendix III: The Horizon Effect.

Slide and Flat Forwards
The way we model our hazard rates and Forward curves also impacts 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 1 month horizon if we are on a flat part of the curve and larger Slide over a given 1 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.

c) 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 Table 5 shows for a +1bp move in iTraxx Main 5y and 10y contracts.

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.

Table 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

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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 immunise 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.[2]
DF_i is the risk-free discount factor for period i
Δ_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 Figure 5 and Figure 6 where we can see that the Probability of Survival decreases proportionately more at longer maturities for a 100bp spread change.

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

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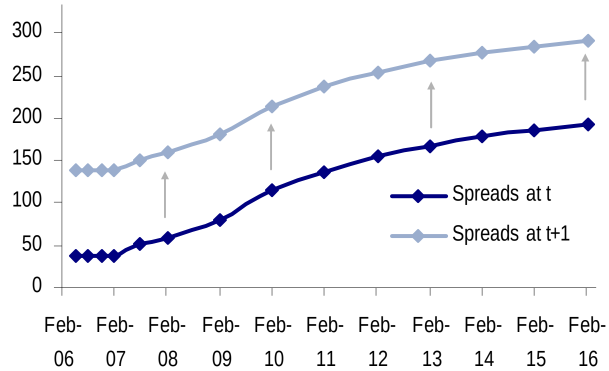
Figure 5: Parallel Shift in Par Spread Curve

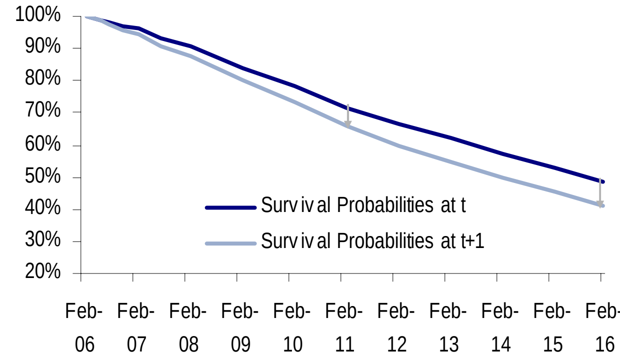
x-axis: Maturity Date; y-axis: Spread, bp



Source: JPMorgan

Figure 6: Survival Probabilities for Parallel Shift in Spreads

x-axis: Maturity Date; y-axis: Survival probability, %

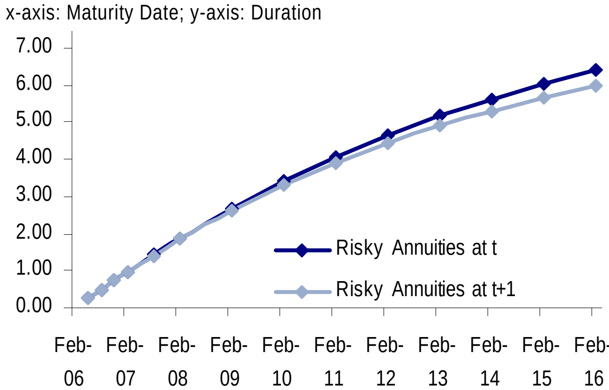


Source: JPMorgan

Looking at Equation [3], we can see this has the effect of making our Risky Annuities decrease more for longer maturity CDS contracts as Figure 7 shows.

Figure 7: 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. Figure 8 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.

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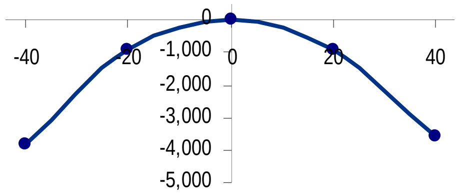
Figure 8: Convexity in a Duration-Weighted Curve Steepener

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 analyse the P+L impact from Convexity as it can have an impact on the likely profitability of a trade.

Sensitivity Analysis at Horizon

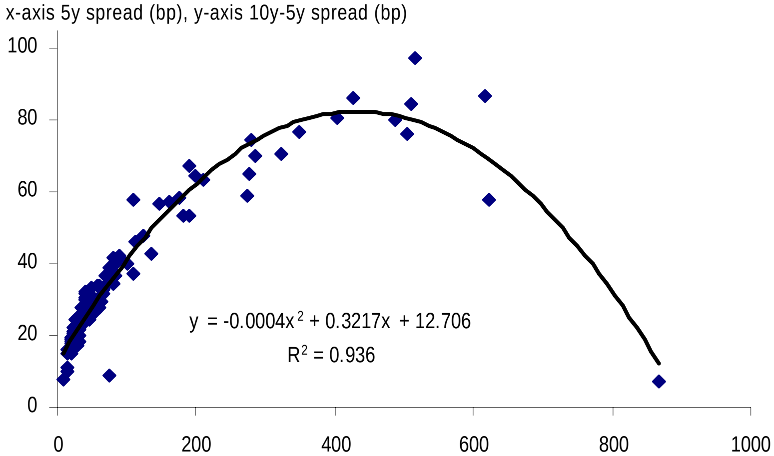
The sensitivity analysis we have been looking at is for instantaneous parallel moves in spreads. When we look at sensitivity analysis at the horizon of our trade we will also have to consider what we call the Horizon Effect. **This Effect means that our curve position can get longer or shorter risk over the life of the trade** and so our sensitivity analysis will reflect this. We discuss this in more detail in Appendix III: The Horizon Effect 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 Figure 9). 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.

Figure 9: 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 analyse 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.

d) Default Risk

Default risk is the company default exposure that we take when putting on our curve trade. This is relatively simple to analyse 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.

e) Breakevens & 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 3 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.

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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.

Table 6: 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

Appendix II shows 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 Table 6, 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.

Appendix III: The Horizon Effect 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 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

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Curve Trading Strategies

Two-Legged Curve Trades

In the first section of this note we outlined a framework for analysing 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:

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

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.

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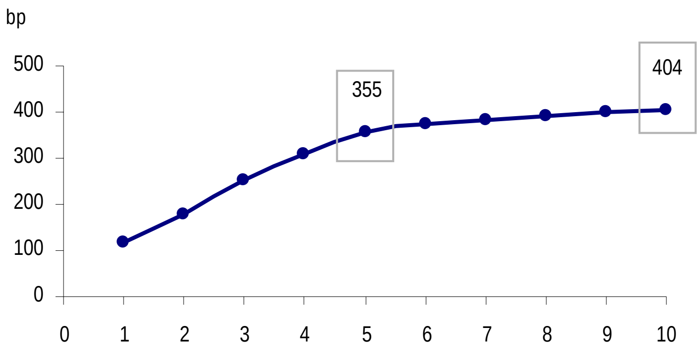
Carry

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 Figure 10.

Figure 10: Fiat SPA CDS Curve (as at Dec 17th 2004)



Source: JPMorgan

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 Table 7:

Table 7: 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

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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 (Table 7). The Slide on our equal-notional flattener is negative (-$60,759) which can be characteristic of higher spread names.

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.

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 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 Figure 10), 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 Table 7).

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.**

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.

Table 8: 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

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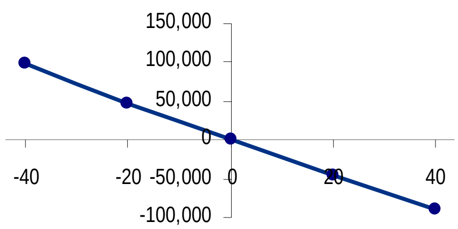
Table 8 shows the MTM of our trade to parallel spread changes. We first look at the actual MTM of the trade in rows 1-3, where we can see that this trade has a large directionality to it. Figure 11 shows this graphically and we have a negative MTM for spread widening and positive MTM for spread tightening. 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 Table 8 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.**

Figure 11: 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, as we examine in Appendix III: The Horizon Effect. Table 9 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 at the MTM effect less the Instantaneous MTM, in order to get just our Horizon Effect.

Table 9: 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

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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 Table 9).

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.

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. Table 10 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, so 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.

Table 10: 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 Table 11.

Table 11: 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
Current 5y at Horizon*	296	70,765	-60,563	-190,330	-318,544	-445,212
	316	147,036	16,917	-111,651	-238,676	-364,166
	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.

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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 Table 12 and Table 13.

Table 12: 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 High Spread = Negative	Low Spread = Carry High Spread = Slide	MTM Loss	Neutral
Steepener	Negative	Low Spread = Negative High Spread = Positive	Low Spread = Carry High Spread = Slide	MTM Gain	Neutral

Source: JPMorgan

Table 13: 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[3]:

$MTM_{10y} = 1bp.Duration_{10y}.Ntnl_{10y}$, 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 Table 14.

Time (Carry & Slide)

Looking first at our Carry in Table 14, 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)**.**

[3] 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.

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Table 14: 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

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 Figure 10 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)

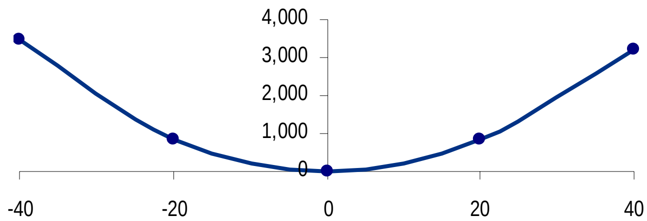
In terms of parallel curve movements (Duration effect) we have structured the trade so that it should be MTM neutral for a 1bp parallel change in spreads of the curve. However, there is also a Convexity impact from Spread widening to understand.

Figure 12 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)

Figure 12: Convexity for Duration-Weighted Flattener

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



Source: JPMorgan

Table 15 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.

Table 15: 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. Table 16 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 Appendix III: The Horizon Effect, our Duration-Weighted trade will become market directional over its life due to this Effect. We can see this in Table 16 as we get a market directional position where we have relative positive MTM for spreads tightening and negative for spreads widening (row 7 of Table 16).

Table 16: 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

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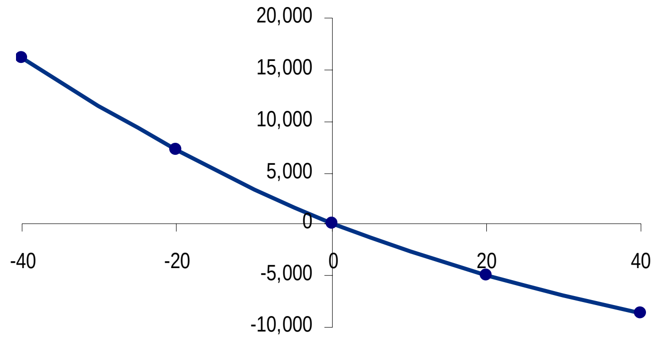
Figure 13 illustrates the Horizon Effect graphically – the full workthrough of this is detailed in Appendix III.

Figure 13: 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

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

Default Risk

We can see from Table 14 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 Table 17. 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 (see Appendix II: Calculating Breakevens for more on how we analyse Breakevens). As our Horizon Effect makes us longer risk over the life of the trade, we need increasing flattening if spreads widen at horizon, as Table 17 shows.

Table 17: 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

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Table 18 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.

Table 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	-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 Table 19 and Table 20.

Table 19: 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

Table 20: 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

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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:

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

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 Table 21, 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).

Table 21: 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

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Sensitivity to Spread Changes (Duration & Convexity)

We can see that our Carry-Neutral strategy is long risk for spread moves (see Row 3 of Table 22) 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 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).

Table 22: 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.

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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 Table 23 and Table 24.

Table 23: 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 Higher Spread: Generally Negative	Short Risk
Steepener	Zero (by definition)	Positive	Slide (by definition)	Lower Spread: Mixed Higher Spread: Generally Positive	Long Risk

Source: JPMorgan

Table 24: Sensitivity Summary for Carry-Neutral Curve Trades

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

Source: JPMorgan

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Appendix I: 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:

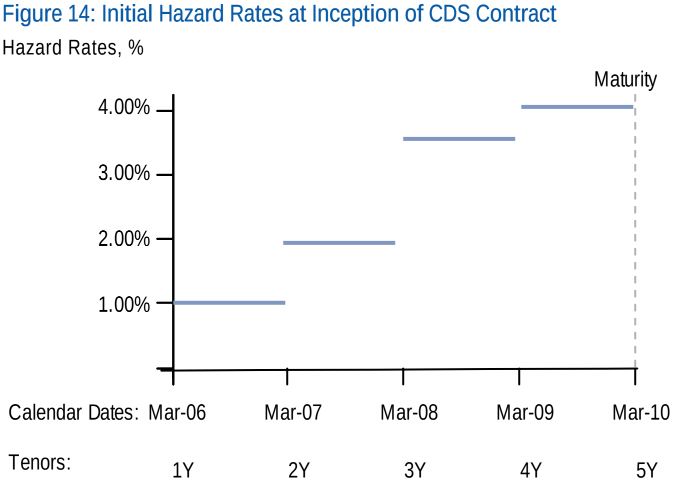
i) Hazard Rates / Spreads for a given tenor are kept constant[4]

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.

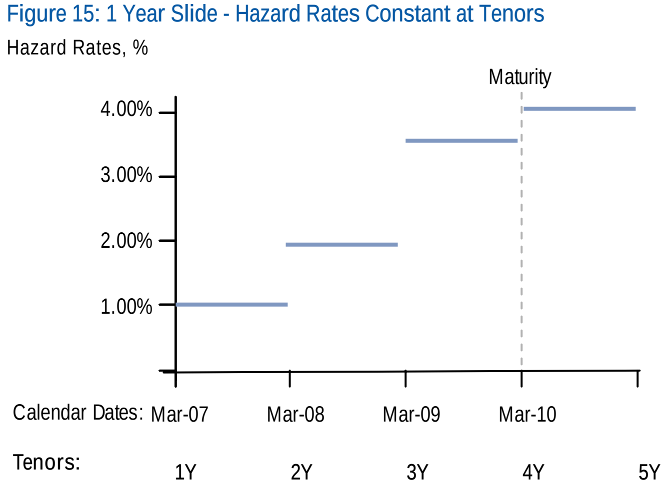
We can illustrate what this Slide means in terms of default probabilities and hazard rates in Figure 14 and Figure 15.

Figure 14: Initial Hazard Rates at Inception of CDS Contract



Source: JPMorgan

Figure 15: 1 Year Slide - Hazard Rates Constant at Tenors



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.

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

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

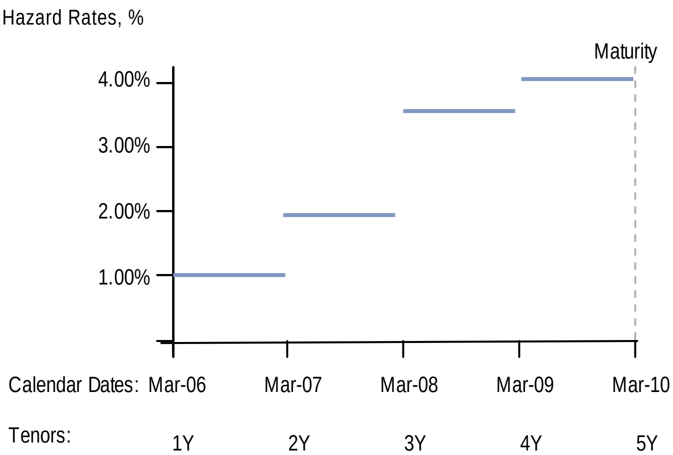
ii) Hazard Rates Constant for Each Calendar Point

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 Figure 16). 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 Figure 17. We could re-price our CDS contract after our 1 year horizon assuming that these hazard rates are constant for each calendar date.

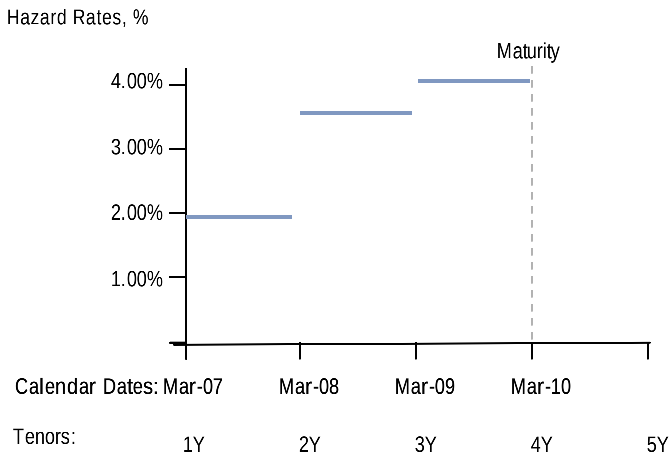
This would result in a lower positive MTM than method i) for upward sloping curves.

Figure 16: Initial Hazard Rates at Inception of CDS Contract



Source: JPMorgan

Figure 17: 1 Year Slide - Hazard Rates Constant at Calendar Dates



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.

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Appendix II: Calculating Breakevens

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

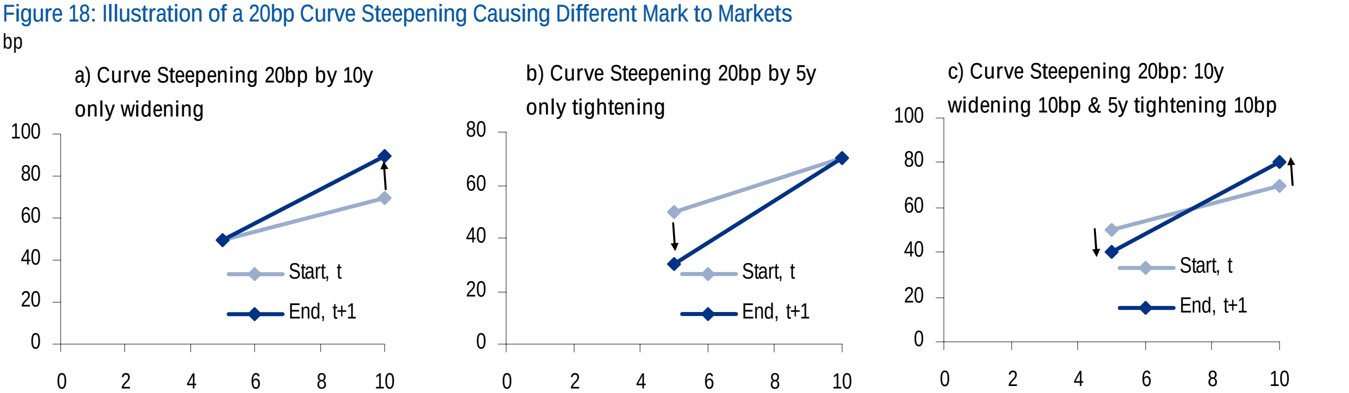
$$MTM_{Curve\ Trade,\ t\ to\ t+1} = (\Delta S_{5y,\ t\ to\ t+1} \,.\, A_{5y,t+1} \,.\, Ntnl_{5y}) \;+\; (-\Delta S_{10y,\ t\ to\ t+1} \,.\, A_{10y,t+1} . Ntnl_{10y})$$

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 breakeven.

Figure 18: Illustration of a 20bp Curve Steepening Causing Different Mark to Markets



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 Table 25. The Breakeven for Time is the highlighted row where the 5y point is unchanged over

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the horizon and therefore our current trade moves to the Slide-Implied point. The table shows that the 5y point will slide to 336bp and at this level the 10y breakeven is 375bp which is a breakeven curve of 39.3bp. The current curve is 49bp but the Slide Implied curve is 66bp, which means that the curve needs to flatten 27.2bp (shaded row, column 7) to Breakeven at horizon – this must mean the trade has negative Time so we need quite a lot of curve flattening to breakeven. 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. As we can see, the 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.

Table 25: Breakeven Curve Movements Analysis – Current 5y Spread = 355bp, Current 10y – 5y Curve = 49bp, Slide Implied Curve = 66bp

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

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Appendix III: The Horizon Effect

Sensitivity analysis of curve trades at their horizon can be a complex issue. In this Appendix 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.

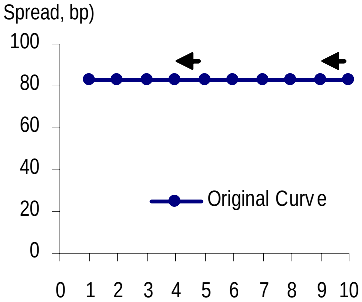
The Horizon Effect can be most easily seen by the difference in our sensitivity analysis for a Duration-Weighted trade between *instantaneous* changes in spread and changes in spread *at horizon*. The reason we have a Horizon Effect is because our Risky Annuities change over the life of a trade. This 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:

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 Figure 19, where only the effect of time passing changes the Risky Annuities.

Figure 19: Maturity Effect
Flat Spread Curve (x-axis: Maturity, years; y-axis: Spread, bp)

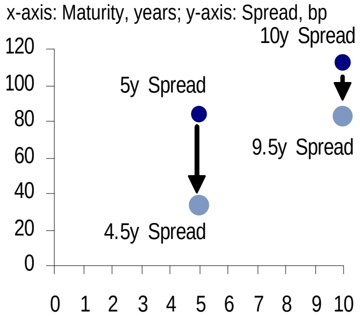


Source: JPMorgan

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 Figure 20.

Figure 20: Roll / Slide Effect (bp)
x-axis: Maturity, years; y-axis: Spread, bp



Source: JPMorgan

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.

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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 Table 26). We analyse this curve trade for a 6 month horizon. The curve for Fiat SPA is shown in Figure 21.

Table 26: 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

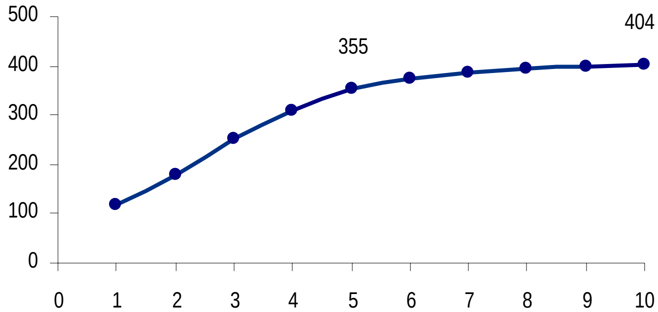
Positive Convexity from Parallel Spread Moves in Isolation

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 Figure 22). 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.

Figure 21: Fiat SPA Credit Curve

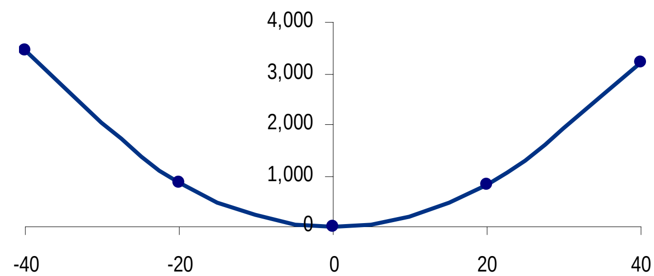
x-axis: Maturity in years; y-axis: Spread, bp



Source: JPMorgan

Figure 22: 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 Figure 23 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.

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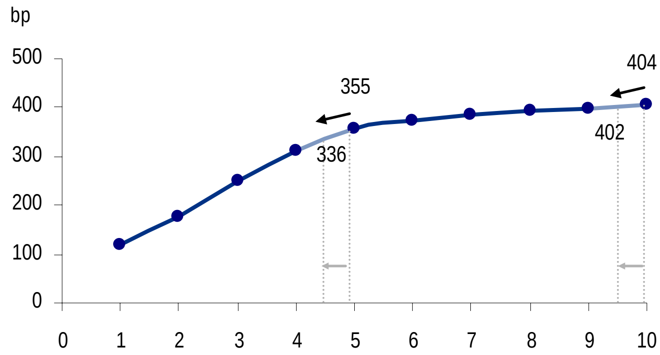
Figure 23: Slide Impact on Spread and Maturity



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 effect 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. Table 27 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.

Table 27: 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					

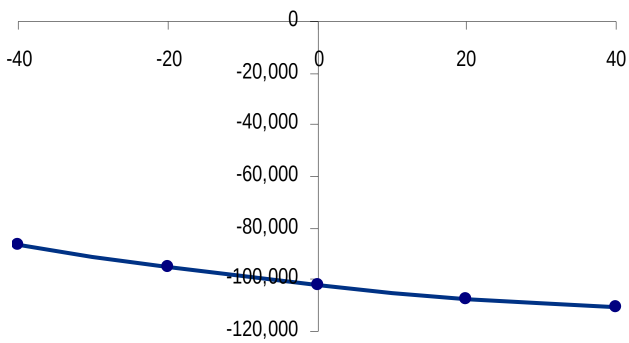
Source: JPMorgan

Isolating the Horizon Effect

We can see the impact of this Horizon Effect when we look at sensitivity analysis at horizon. Figure 24 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 Figure 25 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 Figure 25 to Figure 22 to see how we get a very different pattern for a change in spreads at the start of the trade and at its horizon.

Figure 24: Sensitivity Analysis at Horizon Including Slide

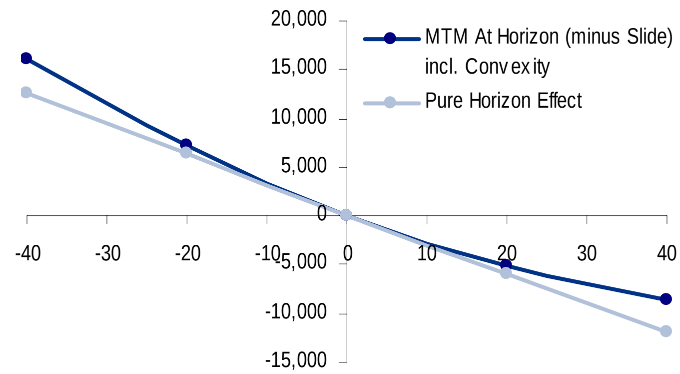
x-axis: Spread Change at Horizon (bp), y-axis: Trade MTM ($)



Source: JPMorgan

Figure 25: Sensitivity Analysis at Horizon minus Slide

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



Source: JPMorgan

We summarise 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 Table 28. The trade is now longer risk and so has a more negative MTM as spread widen and a less negative MTM as spreads tighten.

Table 28: 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 the how the Horizon Effect will give them a longer or shorter risk position over the life of the trade.

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	Overweight	Neutral	Underweight
EMEA Credit Research 5-year CDS or most liquid securitiy	30.4%	45.2%	24.4%
IB Clients*	29.0%	48.0%	23.0%

**Percentage of investment banking clients in each category.*

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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 uses the following fundamental credit recommendations: Improving (the issuer's credit profile/credit rating likely improves over the next six to twelve months), Stable (the issuer's long-term credit profile/credit rating likely remains the same over the next six to twelve months), Deteriorating (the issuer's long-term credit profile/credit rating likely falls over the next six to twelve months), Defaulting (there is some likelihood that the issuer defaults over the next six to twelve months).

Valuation & Methodology: In JPMorgan's credit research, we assign a rating to each issuer (Overweight, Underweight or Neutral) based on our credit view of the issuer and the relative value of its securities, taking into account the ratings assigned to the issuer by credit rating agencies and the market prices for the issuer's securities. Our credit view of an issuer is based upon our opinion as to whether the issuer will be able service its debt obligations when they become due and payable. We assess this by analyzing, among other things, the issuer's credit position using standard credit ratios such as cash flow to debt and fixed charge coverage (including and excluding capital investment). We also analyze the issuer's ability to generate cash flow by reviewing standard operational measures for comparable companies in the sector, such as revenue and earnings growth rates, margins, and the composition of the issuer's balance sheet relative to the operational leverage in its business.

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