Playing Away from Home in the Credit Markets

Trading corporate bonds in different currencies

European Credit Derivatives Strategy

Danny White [AC]
(44-20) 7325-5066
danny.c.white@jpmorgan.com

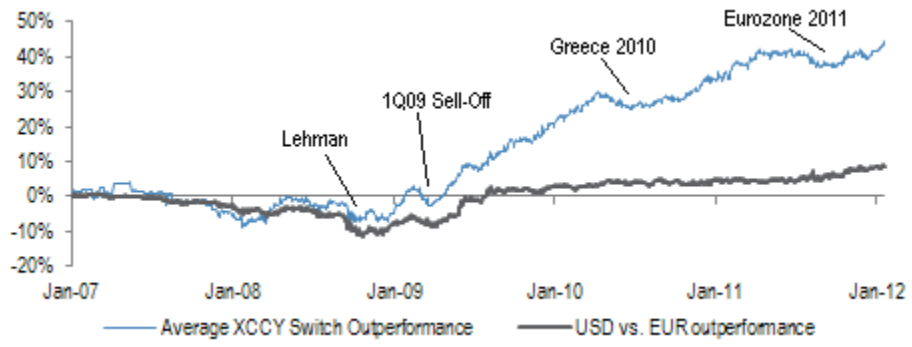
Saul Doctor [AC]
(44-20) 7325-3699
saul.doctor@jpmorgan.com

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

J.P. Morgan Securities Ltd.

- Over the past few years an increasing number of global corporates have diversified their funding to include foreign currency issues. This has led to a global market where bonds from the same company trade in different currencies, offering investors an opportunity to look outside their domestic currency for attractive investments.
- Investing in a different currency exposes an investor to large foreign exchange risk which they may be unwilling to bear. We show that simple hedging strategies involving either FX swaps or cross currency basis swaps allow investors to remove most of their foreign currency exposure.
- The difference between bonds in different currencies is driven by a number of factors including the cross currency basis, the quanto and the home-bias. We explain these factors and develop a model for the spread difference to allow investors to assess cross-currency relative value trades.
- Investing in foreign currency bonds has been a very profitable trading strategy over the past few years. A simple strategy of investing in cross currency opportunities with a z-spread pick up of greater than 150bp would have provided 44% outperformance over the past five years (Figure 1).
- We publish a monthly *Cross Currency Bond Report*, which highlights the most attractive cross currency opportunities in investment grade.

Figure 1: Credit Outperformance for Cross Currency Switches
P&L as % of Notional for systematic strategy based on EURUSD bond pairs with z-spread difference of greater than 150bp. Rebalancing every month. Bid/offer costs not included.



Source: J.P. Morgan.

See page 33 for analyst certification and important disclosures.

Danny White
(44-20) 7325-5066
danny.c.white@jpmorgan.com

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Danny White
(44-20) 7325-5066
danny.c.white@jpmorgan.com

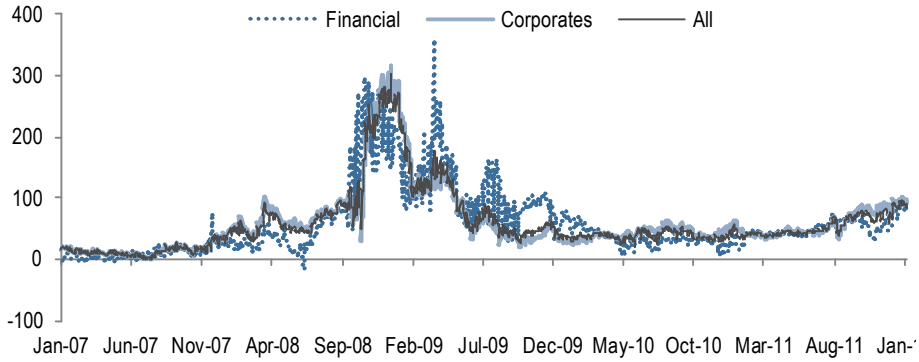
Introduction

Over the past few years an increasing number of global corporates have diversified their funding to include foreign currency issues. In some cases, US companies have issued euro-denominated bonds in order to fund euro liabilities, while in other cases euro based companies tapped the USD market in order to access an alternative investor base. This has given rise to bonds issues from the same company trading in different markets and in different currencies.

Until 2007, these different currency bonds tended to trade at very similar levels with few investors looking to invest in bonds outside their core currency. Over the past few years however, the widening cross currency basis, increasing correlation between spreads and "safe" currencies and illiquidity aversion has seen the basis between bonds in different currencies become bigger and more interesting (Figure 2).

Figure 2: Premium of EU Corporates issuing in USD to EUR

bp



Source: J.P. Morgan.

With market volatility remaining high, a number of opportunities currently exist for investors willing to look outside their home currency and invest in the companies they are familiar with, but in a different currency. In many cases, investors can pick up in excess of 200bp from investing in a bond in a currency other than their home currency.

This report has three sections. In Section 1 we look at how investors can hedge their currency exposure from investing in bonds of different currencies and show that investors can do this via FX swaps or cross currency basis swaps. In Section 2 we develop a framework for looking at whether investors in a different currency are truly compensated for the additional risk they take on by investing in a less liquid bond. Finally, Section 3 looks at whether investing in cross currency opportunities really allows investors to pick up excess spread. We show that investors would have been able to make 7.6% per annum of excess returns by following a simple strategy.

We have tried to keep the text as intuitive as possible and the mathematical framework is left for the Appendix.

Danny White
(44-20) 7325-5066
danny.c.white@jpmorgan.com

Hedging Cross-Currency Trades

- Cross-currency switches without an FX hedge leave the investor heavily exposed to FX risk, as well as credit and rates risk.
- Hedging cross-currency trades with FX swaps removes the majority of the FX risk but leaves the investor with the credit and rates risk of the foreign bond.
- Hedging with cross-currency basis swaps removes the majority of the FX risk as well as the foreign rates risk, but leaves the investors with the credit risk of the foreign bond.

Credit investors often wish to invest in bonds denominated in currencies other than that which they report in. Investors may wish to buy bonds in different currencies in order to gain exposure to different markets and economies across the globe, or to switch between two bonds issued by the same entity in different currencies in order to achieve a spread pickup.

Whatever the rationale, investing in bonds denominated in a currency other than the reporting currency entails a significant FX risk if left unchecked. This FX exposure can often overwhelm any credit exposure if unhedged, turning what was meant as a credit and rates trade into an FX trade.

There are a number of ways to hedge out FX exposure when investing in a foreign currency bond. Due to the high liquidity of vanilla FX products in major issuing currencies (USD, EUR, GBP, JPY etc) these hedges are often inexpensive and the benefits greatly outweigh the costs of hedging. In this section we discuss the different hedging options available to a credit investor and evaluate their effectiveness. For the sake of simplicity, we will discuss the options from the point of view of a EUR investor who wishes to invest in USD-denominated bonds, but the principles apply equally to any pair of currencies.

The perfect FX hedge would give a Euro investor buying a USD bond an identical P&L to a USD investor purchasing the same bond. As such, we shall evaluate the effectiveness of hedging by comparing the EUR and USD P&L for each hedge.

We examine three options:

1. **No FX hedging.**
2. **Hedging with FX swaps.**
3. **Hedging with cross-currency basis swaps**

In general, we find that not hedging at all is only suitable for investors who are looking to gain exposure to the foreign currency as well as the credit risk of the bond itself due to the large FX spot risk involved. Hedging with FX swaps is most suitable for investors who wish to replicate the total return (rates and credit) of the bond in its home currency; an investor who hedges with FX swaps is exposed to the USD rates market. Finally, hedging with cross-currency basis swaps removes both the foreign currency and foreign rates exposures, leaving the investor with the credit exposure of the foreign bond. This last option is best used for cross-currency switches based on differences in credit spreads as it enables the investor to best capture the credit outperformance while isolating the FX and rates exposures.

Danny White
(44-20) 7325-5066
danny.c.white@jpmorgan.com

Table 1 gives a graphical illustration of how an investor's exposures and risks change depending on the different FX hedge used.

Table 1: Different Risks and Exposures for a EUR investor purchasing a EUR or USD bond.

	EURUSD FX	EUR Rates	USD Rates	EUR Credit	USD Credit
EUR bond		✓		✓	
USD bond - no FX hedge	✓		✓		✓
USD bond - FX swap hedge			✓		✓
USD bond - XCCY swap hedge		✓			✓

Source: J.P. Morgan.

Appendix I gives an explanation of how we calculate the P&L from holding a bond denominated in a foreign currency depending on the FX hedge used.

Option 1: No hedging

In this case, the investor simply carries out a FX spot trade to buy dollars for euros and then purchases the USD-denominated bond. At the end of the trade, the investor sells the bond for USD and then carries out a second FX spot trade to convert the dollars back into euros.

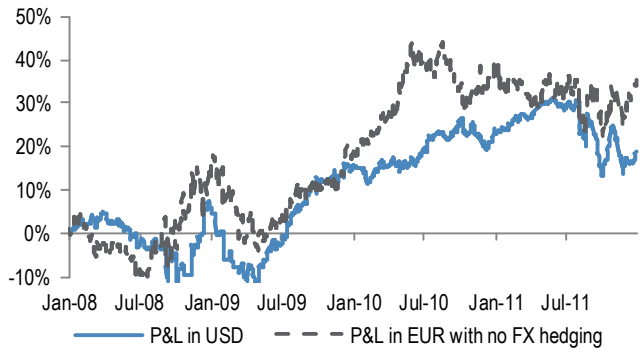
Investing in foreign currency bonds should only be carried out on an unhedged basis when the investor is intending to have exposure to the underlying currency as well as the credit and rates components.

This trade, while very simple to carry out, is also highly exposed to any change in the EURUSD spot rate. Investing in foreign currency bonds on an unhedged basis should only be carried out by those who are primarily looking for exposure to the foreign currency as well as exposure to the rates and credit risks of the foreign bond itself.

Figure 3 compares the P&L for a single USD-denominated bond[1] from the point of view of a USD and a EUR investor, assuming that the EUR investor has not hedged their FX exposure. We can see that there is a large deviation between the two P&Ls. Figure 4 compares the difference in the return from a hedged and an unhedged position with the P&L from an outright short EURUSD position; we can see that the discrepancy between the EUR and USD P&Ls can be largely explained by the FX spot moves.

Figure 3: P&L from investing in a USD bond with no FX hedging

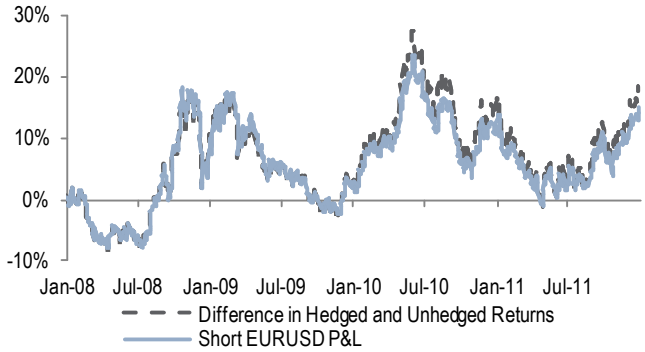
Cumulative P&L from investing in a USD bond with no FX hedging, from the point of view of a USD and EUR investor.



Source: J.P. Morgan.

Figure 4: Difference between hedged and unhedged P&L compared with a short EURUSD position.

The difference in cumulative P&L for a hedged and unhedged position compared with an outright EURUSD position.



Source: J.P. Morgan.

[1] Specifically the BAC 5¾ $ 2017 bond.

Danny White
(44-20) 7325-5066
danny.c.white@jpmorgan.com

Option 2: Hedging with FX Swaps

A EUR investor can hedge the FX exposure associated with purchasing a USD-denominated bond by structuring the trade using an FX swap. An FX swap involves a FX spot trade today, as well as an FX forward trade in the reverse direction at some agreed time in the future.

For example, in a 1 month EURUSD FX swap with a spot rate at 1.30 and a forward rate of 1.32 and a notional of €10,000,000 we would:

- Sell €10,000,000 for $13,000,000 today
- Buy €10,000,000 for $13,200,000 one month from now.

FX swaps are an effective way to hedge FX exposure from foreign currency bonds on a rolling basis.

The FX swap therefore not only allows the EUR investor to obtain the dollars they need to purchase the bond, it also agrees the rate at which they will exchange a fixed amount of EURUSD back at some future date. Because the amount to be exchanged back is fixed, any change in the bond price or any coupons paid during the period of the FX swap contract remain unhedged, but overall the FX exposure of the trade as a whole is greatly reduced when using FX swaps.

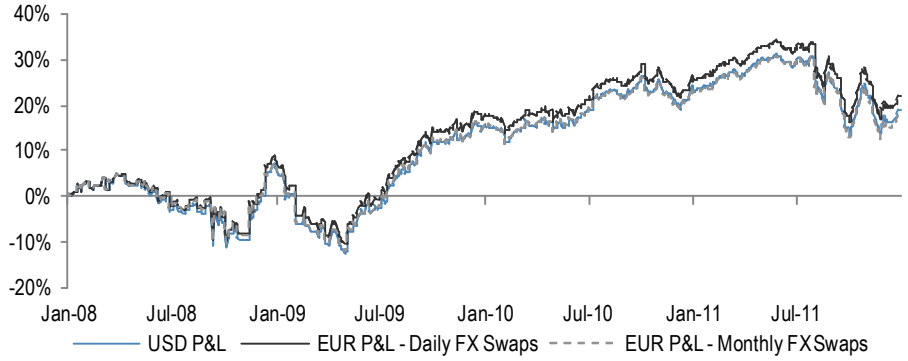
FX swaps between major currencies are highly liquid and trade with maturities of 1 day up until a year and beyond. An investor can use FX swaps on a rolling basis and reset the size of the hedge to account for any changes in the bond price or any coupons whenever the contract is rolled. We assume that at the rebalancing date, the investor converts all dollars back into euros (either via the second leg of the FX swap or additional FX spot transactions), then enters a new FX swap with a base notional equal to the number of euros now held. As such, any coupons paid out by the bonds are reinvested. We give a more detailed breakdown of the FX swap rolling process in Appendix I.

In this analysis we ignore any bid/offer costs from FX swaps; an overnight EURUSD FX swap will typically have a bid/offer of 0.01 cents and a 1 month FX swap of 0.15cents. This is very small compared to even the most liquid credit products; iTraxx Main typically has a bid-offer spread of 2-4 cents.

Figure 5 compares the P&L from the BAC 5¾ $ 2017 bond for a USD investor and a EUR investor who has hedged the FX exposure using either daily or monthly FX swaps. We can see that the EUR P&L tracks that of the USD investor very closely, showing that both daily and monthly hedging with FX swaps is an effective way to hedge the FX exposure of foreign-denominated bonds. We also note that using daily hedging over monthly hedging does not give any added tracking benefit in a low volatility market; as such we would recommend hedging on a monthly basis to reduce the amount of maintenance that the trade requires. For highly volatile currency pairs the hedging period becomes more important.

Danny White
(44-20) 7325-5066
danny.c.white@jpmorgan.com

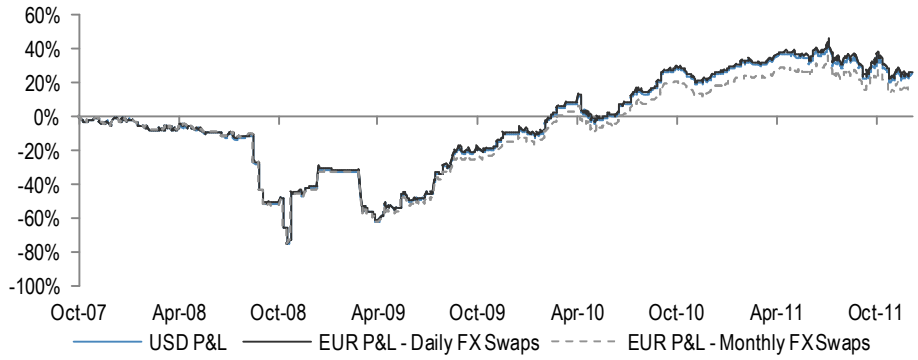
Figure 5: Foreign Bond P&L when hedging with FX swaps.
Cumulative P&L for BAC 5¾ $ 2017 for a USD investor compared with P&L for a EUR investor who has hedged with daily or monthly FX swaps.



Source: J.P. Morgan.

FX swaps remain a good hedge even when investing in highly volatile bonds, as shown in Figure 6. The AIG 6¼ $ 2036 bond had daily P&L swings of more than 20% during 2008-2009 but there was little slippage between the P&L for a USD investor and a EUR investor who had hedged using FX swaps.

Figure 6: Foreign Bond P&L when hedging distressed bonds with FX Swaps
Cumulative P&L for AIG 6¼ $ 2036 for a USD investor compared with P&L for a EUR investor who has hedged with daily or monthly FX swaps.



Source: J.P. Morgan.

Option 3: Hedging with Cross Currency Basis Swaps

An alternative to hedging with FX swaps is to hedge with cross currency basis swaps. In a cross currency basis swap, one party borrows a currency from the second party and simultaneously lends a different currency to the second party. The rate at which the currencies are lent/borrowed is based on LIBOR in that currency, with an adjustment made to the non-USD funding leg in order to account for differences in demand and supply. This adjustment is known as the *cross currency basis* and is a good measure of investors' needs to fund themselves in one currency over another.

For example, in a 1 year EURUSD basis swap with a spot rate of 1.30 and a cross currency basis of -80bp we would:

- Sell €10,000,000 for $13,000,000 today

- Receive 3m Euribor - 80bps on a running basis for one year.
- Pay 3m USD Libor on a running basis for one year.
- Buy €10,000,000 for $13,000,000 one year from now.

As with the FX swap discussed above, a cross currency basis swap allows a EUR investor to obtain the dollars required to purchase a USD-denominated bond while also locking in the rate at which the currencies will be re-exchanged in the future. The difference to the FX swap is that instead of re-exchanging at the forward rate, the cross currency basis swap re-exchanges at the initial spot rate and involves and exchange of LIBOR in each currency.

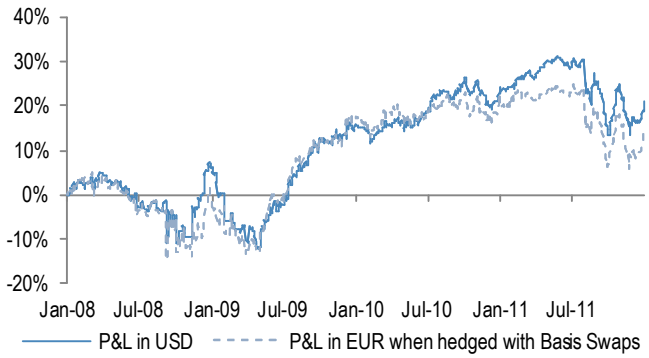
Hedging with cross currency basis swaps and maturity matched interest rate swaps allows EUR investors to receive the risk free spread in EUR, but the credit spread in USD.

In addition to the cross currency basis swaps, the investor can enter into two additional fixed-for-floating interest rate swaps in each currency with maturities matched to that of the bond, cancelling out the Libor components of the basis swap and effectively giving a fixed-for-fixed basis swap. The benefit of doing the additional interest rate swaps is that the investor, who has bought a USD bond, now effectively has a Euro rates position – i.e. receiving fixed on a Euro swap – while receiving the credit spread in USD. This differs from hedging with FX swaps, where both the risk-free and credit spreads are received in dollars and then converted back to euros.

Figure 7 compares the P&L from investing in the BAC 5¾ $ 2017 bond for a US investor with that of a EUR investor who has hedged with rolling 6m cross currency basis swaps and maturity matched interest rate swaps. We can see that there is a larger degree of tracking error between the two P&Ls than we saw when hedging with FX Swaps. This tracking error can largely be attributed to the EUR vs. USD swaps and basis P&L, as shown in Figure 8.

Figure 7: Foreign Bond P&L when hedging with cross currency basis swaps

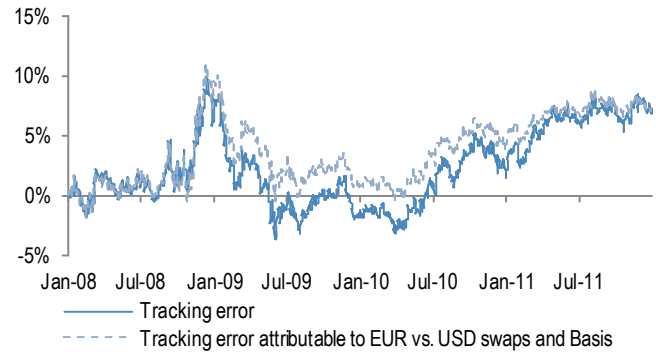
Cumulative P&L for BAC 5¾ $ 2017 for a USD investor compared with P&L for a EUR investor who has hedged with 6m cross currency basis swaps and maturity matched interest rate swaps.



Source: J.P. Morgan.

Figure 8: Difference in Foreign Bond P&L and XCCY Swap Hedged P&L compared with P&L attributable to basis and interest rate changes.

Total tracking error from Figure 7 compared with the tracking error attributable to basis and EUR vs. USD swap P&L.



Source: J.P. Morgan.

Defaults in Foreign Currency Bonds

An investor who has purchased a foreign currency bond will have a different exposure to a default event depending on whether a hedge has been used or not. The type of hedge (i.e. FX swap or basis swap) has a secondary effect as it gives an additional exposure to basis and swap rate risks.

The loss on default is a function of both the recovery rate and the change in FX upon default (Equation 1 and Equation 2); as such, correlation between defaults and FX changes can be highly important for foreign bond investors.

If the investor's home currency depreciates upon the foreign bond default it is preferable to not have hedged the FX risk.

If the investor's home currency appreciates upon the foreign bond defaulting it is preferable to have hedged the FX risk.

Equation 1: Default Loss For Unhedged Investors

R=Recovery Value P=Bond Price at Entry Date FX_0 = FX Rate at Entry Date
FX_1 = FX Rate at Default Date

$$Loss = \frac{R}{P} \times \frac{FX_0}{FX_1} - 1$$

Equation 2: Default Loss For Hedged Investors

R=Recovery Value P'=Bond Price at Last Hedging Date FX'_0 = FX Rate at Last Hedging Date
FX'_1 = FX Rate at Default Date

$$Loss = \left(\frac{R}{P'} - 1 \right) \times \frac{FX'_0}{FX'_1}$$

Both of these equations are based on the P&L framework we discuss in Appendix I.

In both of these cases, if the FX rate is unchanged upon default then the loss for a foreign currency investor matches that of a local currency investor, *R/P*-1. However, this is an unlikely occurrence and in reality any period of defaults is likely to be associated with high FX volatility. While a default is likely to cause a loss to all bondholders, depending on the behaviour of the FX rate upon default, it is preferable to be either hedged or unhedged.

In particular, if the investor's home currency **depreciates** upon default, unhedged investors will make a smaller loss than hedged investors.

Likewise, if the investor's home currency **appreciates** upon default, hedged investors will make a smaller loss than unhedged investors.

The correlation between defaults and FX rate changes can have an effect upon sovereigns and systemically important corporates.

However, for most corporate defaults we would not expect the FX/default correlation to be a large effect.

For EUR investors investing in USD bonds, the flight-to-safety to USD under stressed scenario means that typically in distressed markets the EUR depreciates with respect to dollar. As such, Euro-based holders of distressed USD bonds or those likely to see a sudden fall in value would generally prefer to be unhedged if they believe a short-term default is likely. This can be a useful technique when applied to positions that are difficult to unwind due to low liquidity.

Similarly, a USD investor holding a EUR-denominated bond with a risk of default should look to hedge their FX risk as the USD will likely appreciate upon any default.

It is important to stress that while this effect may be significant for sovereigns and large systemically important corporates, for many corporate defaults we would not expect a large FX rate change.

For more information on the effects of default and resultant FX changes see *Trading credit in different currencies via Quanto CDS*, A. Elizalde, 12th October 2010.

Danny White
(44-20) 7325-5066
danny.c.white@jpmorgan.com

Hedging Cross-Currency CDS and Basis Trades

In addition to cross-currency bond trades, investors commonly wish to sell or purchase CDS protection denominated in a different currency to that which they usually operate in. For European investors this is particularly relevant for sovereign CDS; the contracts referencing Western Europe sovereigns are usually denominated in USD (whereas most bonds are issued in EUR).

Hedging FX exposure in CDS trades

The low upfront costs of most CDS contracts mean that FX changes have considerably less effect on the P&L than bond trades.

For distressed names, FX hedging of CDS contracts becomes much more important.

Hedging FX exposures related to CDS is slightly different to bonds due to the unfunded nature of credit default swaps. Theoretically, CDS trades are less exposed to FX fluctuations due to the unfunded nature of the product; for investment grade names a CDS typically has a small upfront charge compared to the underlying notional and as the FX changes only apply to this upfront rather than the entire bond price/notional the effect of FX is in most cases smaller than in bond trades. In this case, investors may be happy not to hedge their FX exposure; a 5yr CDS contract trading with a running spread of 150bp and a coupon of 100bp will have an upfront of around 2.25% of notional. A 5% change in the FX rate would therefore result in approximately an 11bp P&L swing. This is negligible compared to the effect of the same FX change on the price of a bond trading close to par.

However, for distressed names trading with low bond prices/high CDS upfronts the effect is reversed and it becomes more important to hedge the FX exposure of foreign currency CDS contracts. If the investor is paying the upfront, they can follow the same techniques described above, paying euros and receiving dollars today via either an FX swap and then rebalancing the position to account for changes in the upfront or any coupons paid whenever the swap expires.

Basis Packages

Investors will often combine bonds and CDS into basis packages. It is entirely possible for one or both of the bond or CDS to be denominated in a foreign currency. Basis trades on Western European sovereigns in particular often combine Euro-denominated bonds and dollar-denominated CDS.

Investors who are looking to remove all FX exposure from these types of trades should hedge the value of the total initial cash outlay which is denominated in a foreign currency. For example, if a European investor enters a basis trade where the bond is denominated in euros and the CDS in dollars, they could hedge with FX swaps with an underlying notional equal to that of the CDS upfront in order to remove the FX exposure. If both the bond and the CDS are denominated in USD, the investor should enter FX swaps/cross-currency basis swaps with notional equal to the bond price plus the CDS upfront.

However, it may be with these types of trades that the investor wishes to leave the FX exposure of the foreign currency CDS unhedged in order to take advantage of any correlation between the FX rate and credit spread. A Euro investor who holds a EUR-denominated sovereign bond and USD CDS would quite likely prefer to not hedge the FX risk associated with this position as losses due to a sell-off in the bond will likely be accompanied by a USD appreciation and a greater increase in the value of the CDS contract. We discuss the effects of FX correlation and credit spreads in greater detail in *Trading credit in different currencies via Quanto CDS*, A. Elizalde, 12th October 2010.

Danny White
(44-20) 7325-5066
danny.c.white@jpmorgan.com

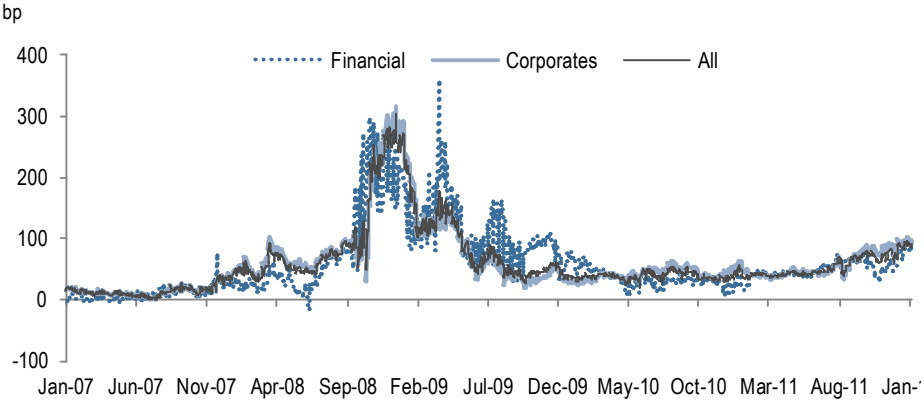
Modeling the Cross Currency Spread

- We develop a model to allow investors to take a view on whether cross currency bonds are cheap or expensive.
- Investors looking outside of their domestic currency take on:
  - **Cross-currency basis** for entering a swap switching one currency into another,
  - **Quanto** for investing in a currency that is correlated with risky assets,
  - **Home-bias** which we use as a catch all term to describe investors preference for a particular company issuing in one currency relative to another.
- US investors are currently shunning EUR bonds providing opportunities for those willing to take on illiquidity risk.

Bonds issued by a company in different currencies are not identical. Two bonds issued with the same terms, but in different currencies will be unlikely to trade at the same spread levels. In this section we look at the drivers of this spread differential trying to break it down into its component parts.

In most cases, the additional spread that an investor receives for investing in one currency relative to another is explained by measurable factors. These include the **cross-currency basis** for entering a swap switching one currency into another, the **quanto** for investing in a currency that is correlated with risky assets and the **home-bias** which we use as a catch all term to describe investors preference for a particular company issuing in one currency relative to another.

Figure 9: Premium of EU Corporates issuing in USD to EUR



Source: J.P. Morgan.

Our framework for comparing bonds issued by a company in one currency, FX_1, to another currency, FX_2, uses the following relationship:

Equation 3: Relationship between EUR and USD Spreads

$$Spread(FX_2) = Spread(FX_1) + Cross\ Currency\ Basis + Quanto + Home\ Bias$$

We would typically therefore not expect the spread of two bonds in different currencies to be zero unless the sum of the cross currency basis, the quanto and the home bias were zero.

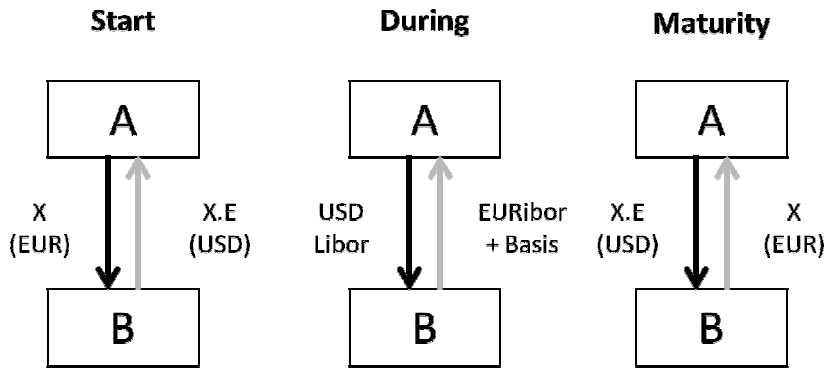
For example, suppose an investor is considering whether to buy a $-denominated bond issued by a European corporate. They spot a similar liquid €-denominated bond trading in the market at 100bp, the traded cross currency basis is 50bp and the quanto is 25bp. Assuming the home bias is zero would mean that they would expect the USD bond to trade at 175bp; if they thought the home bias should be closer to 50bp, they would expect the USD bond to trade at 225bp. While the investor will pick up 125bp from investing in the USD bond relative to the EUR bond, they receive this pick up but also take on additional risks.

We now turn to look at each of these factors in more detail. We will focus on a USD versus EUR trade although the principles are the same for other currencies as well.

Cross Currency Basis Swap

An investor who buys a USD bond and wishes to exchange the dollar cashflows into euros would typically enter a cross currency basis swap. At inception of a €-$ cross currency swap, investor A pays €Xm and receives $X×Em from investor B, where E is the spot exchange rate. Investor A will then receive periodic payments of Euribor plus the basis on their €Xm and will pay USDLibor on the $X×Em for the life of the swap. At maturity, the principals are exchanged with investor A receiving €Xm and paying $X×Em (Figure 10).

Figure 10: Cross-currency Basis Swap contract



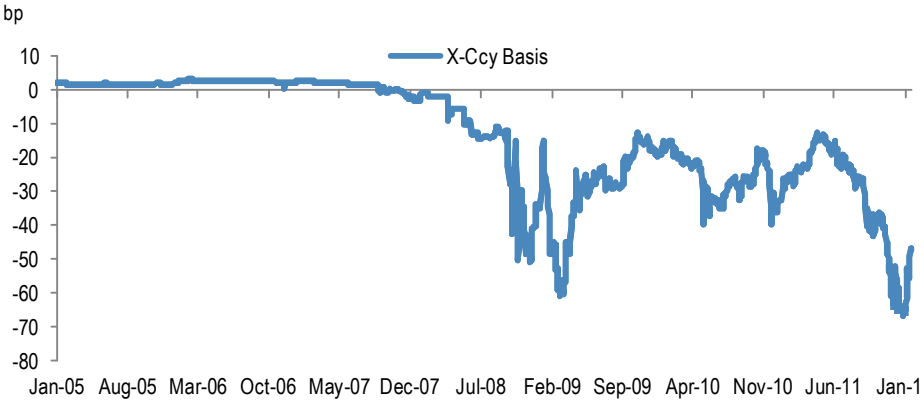
Source: J.P. Morgan

Historically investors have been able to enter cross currency basis swaps for close to flat premiums. In the past, European corporate issuing bonds into the USD market would in many cases swap the cashflows back into EUR paying a slight premium to do so. Investor A who is receiving Euribor payments would historically have received a slightly higher amount.

Over the past couple of years however, investors have been hoarding USD and have been loath to pay these away. When entering a cross currency swap, investor B who hands over USD initially has therefore demanded a higher return. Equivalently Investor A who is receiving EUR has had to receive less. The difference between Euribor and the actual amount received from the swap is called the cross currency basis and is shown in Figure 11; it currently stands at very negative levels.

Danny White
(44-20) 7325-5066
danny.c.white@jpmorgan.com

Figure 11: Cross Currency Basis 5y

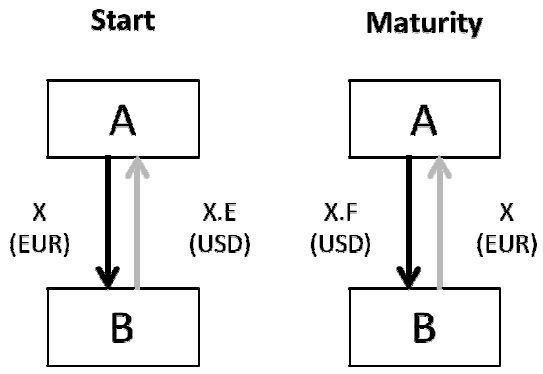


Source: J.P. Morgan

A Euro investor looking to purchase a USD corporate bond would therefore enter a cross currency swap handing over EUR and receiving USD which are then used to purchase the bond. Since the cross currency basis is negative, they would pay the cross currency basis, currently at 47bp. We would therefore expect a USD bond to trade 47bp wider than a EUR bond to compensate for this cost.

An alternative to hedging with a cross currency basis swap is to use an FX swap. In this trade an investor exchanges €X into $X×Em at inception of the swap and then agrees to swap the dollars back into euros at the end of the swap at the forward rate, F. The trade flows are shown in Figure 12. Note that the difference between the final payoff here and in the cross currency swap described earlier is that at maturity, the dollar borrower must pay back $X×Fm rather than $X×Em. This forward rate, F, incorporates the initial cross currency basis along with the difference in EUR and USD rates.

Figure 12: FX Swap



Source: J.P. Morgan.

Quanto

The second risk that a Euro investor in USD bond takes on is the quanto risk. The quanto risk describes the tendency for credit spreads to be correlated with USD. When credit spreads widen, the USD tends to appreciate. The loss from spread widening is therefore greater for an investor in USD bonds than for an investor in EUR bonds. Investors demand compensation for this risk.

Danny White
(44-20) 7325-5066
danny.c.white@jpmorgan.com

As an example, consider a EUR bond and a USD bond, both of which widen by 100bp. Assuming a duration of 4 on both bonds, an investor in either bond would lose 4% of their notional. Assuming that the FX value between EUR and USD remained the same, the loss on the EUR and USD bonds would be the same. Now suppose that the USD appreciates relative to the EUR. The USD investor has now made a bigger loss since the 4% USD loss is now greater than the 4% EUR loss.

We can see that an investor in a currency that appreciates with spread widening, in this case the USD, will therefore demand a higher premium on their corporate bonds to compensate for the additional risk they take on from the quanto. This quanto is driven by the spread moves and FX moves, or spread and FX volatility, as well as their correlation. We won't go into the details here, which we have discussed in *Trading credit in different currencies via Quanto CDS*, A. Elizalde, 12 Oct 2010, but the additional spread that an investor demands in USD relative to EUR is:

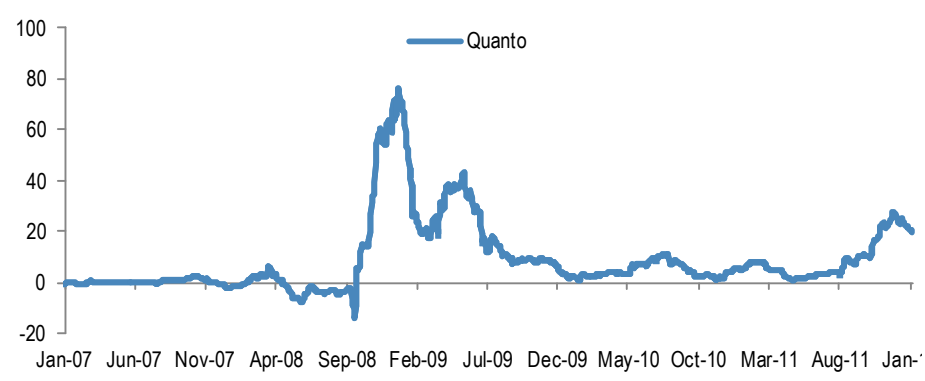
Equation 4: Theoretical Quanto

$$Quanto = Correlation \times Volatility(Spreads) \times Volatility(FX) \times \frac{Duration}{2}$$

The more volatile spreads and FX and the higher their correlation, the more compensation an investor will demand for making a bigger loss when spreads widen and USD appreciates or spreads tighten and USD depreciates.

The quanto we have calculated here is a theoretical value. In reality, an investor can trade the quanto if they can find a CDS contract in both $ and €. The traded quanto would reflect future expectation of correlation and volatility rather than historical values as the theoretical level gives. Typically traded quantos for corporate bonds are in the region of 5% of the spread, although as we have seen, they should change through times depending on volatility and correlation. Since we do not have a liquid quanto market in most cases, we use our theoretical approximation in our analysis. Figure 13 shows the historical quanto using the iTraxx Main for our corporate spread component.

Figure 13: Quanto Spread



Source: J.P. Morgan

Danny White
(44-20) 7325-5066
danny.c.white@jpmorgan.com

Home Bias

The final risk an investor in USD faces is the Home Bias. We use this as a catch all term to capture the additional spread an investor demands due to the lower liquidity of one bond relative to another. Typically Euro investors will invest in companies with headquarters based in Europe or who do most of their business in Europe. They will tend to shy away from US names issuing in EUR. Conversely, US investors tend to shy away from investing in European names issuing in USD since they are more familiar with US names. This makes European issuers in USD less liquid and typically trade at a premium in USD vs EUR and similarly US issuers trade cheaper in EUR than in USD.

This home bias is a risk that is more difficult to hedge out and in our view is the main reason for investing in foreign denominated bonds. It can be positive or negative depending on whether we are trading a US or European bonds. Equation 5 and Equation 6 show this relationship.

Equation 5: Relationship between EUR and USD Spreads for European Corporate

$$Spread(\$) = Spread(€) - Cross\ Currency\ Basis + Quanto + Home\ Bias$$

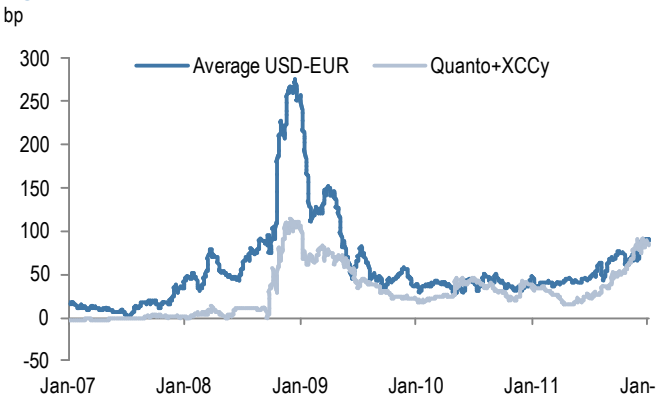
Equation 6: Relationship between EUR and USD Spreads for US Corporate

$$Spread(\$) = Spread(€) - Cross\ Currency\ Basis + Quanto - Home\ Bias$$

Historically the home bias has tended to be positive for both US and EU corporate issuing in their home currency. In Figure 14 we show the average USD-EUR spread for EU corporates while in Figure 15 we show the difference between this spread and cross currency basis and quanto, or the home bias. We do the same in Figure 16 and Figure 17 for US corporates.

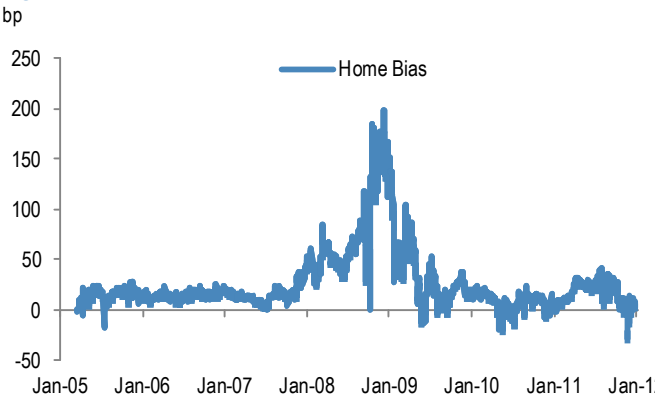
While the home bias in the case of EU corporate is currently close to zero, indicating that investors are on average not applying a premium to USD bonds, for US corporates the home bias is quite positive, indicating that investors in US corporate are demanding a large premium for investing in EUR denominated bonds.

Figure 14: Theoretical and Actual Basis for EU Corporates



Source: J.P. Morgan.

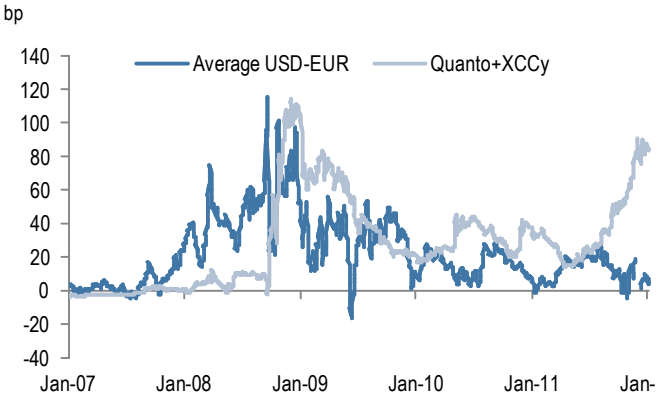
Figure 15: Home Bias for EU Corporates



Source: J.P. Morgan.

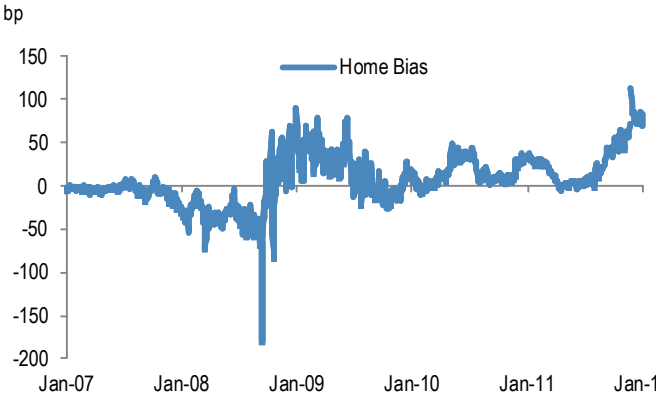
Danny White
(44-20) 7325-5066
danny.c.white@jpmorgan.com

Figure 16: Theoretical and Actual Basis for for US Corporates



Source: J.P. Morgan.

Figure 17: Home Bias for US Corporates



Source: J.P. Morgan.

Danny White
(44-20) 7325-5066
danny.c.white@jpmorgan.com

Profitability of Cross-Currency Switches

Cross-currency switches give reliable outperformance for spread pickups of over 100bp.

The typical timescale to realise the gains from these trades is one month.

- Cross-currency switches are a reliable source of outperformance when the FX exposure is hedged.
- The level of spread pickup required to achieve a reliable return is around 100bp.
- A cross-currency switch is most profitable in the first month following the appearance of a trading signal.
- Existing cross-currency switches typically perform badly during market sell-offs; however these sell-offs usually offer the greatest number of cross-currency opportunities.
- For liquid investment grade names, the outperformance from cross-currency switches is usually enough to outweigh the bid-offer costs.
- For less liquid names, the investor must decide whether the spread pickup on offer is enough to compensate for the transaction costs involved in a bond switch.

Investors will often try and take advantage of one issuer's bonds being priced differently across currencies through either bond pair trades (selling the more expensive bond and buying the cheaper bond) or more commonly in the case of real money investors, selling a bond that they already own and buying the cheaper bond in a cross-currency switch.

The latest cross-currency switch opportunities are highlighted in our:

Cross Currency Bond Report

Click to Open

These trades can often look very attractive - spread pickups of 200-300bp are not uncommon – but it is often unclear whether this is realised or not and what the P&L expectations should be for these trades.

To evaluate the profitability of cross-currency switches we build a universe of around 700 EUR-USD bond pairs from the same issuers with similar maturities to one another. We then use the historical z-spreads of these bonds to establish trading signals for each bond pair and from this establish an average historical return from EUR-USD cross-currency switches. We assume that whenever entering a cross-currency switch, the investor will always hedge the foreign currency P&L using daily FX swaps as historically FX swaps have given the smallest tracking error in the foreign bond P&L. Furthermore, we are primarily interested in the outperformance attributable to credit rather than rates, and so we remove any P&L effects from changes in the underlying risk-free rates of each currency.

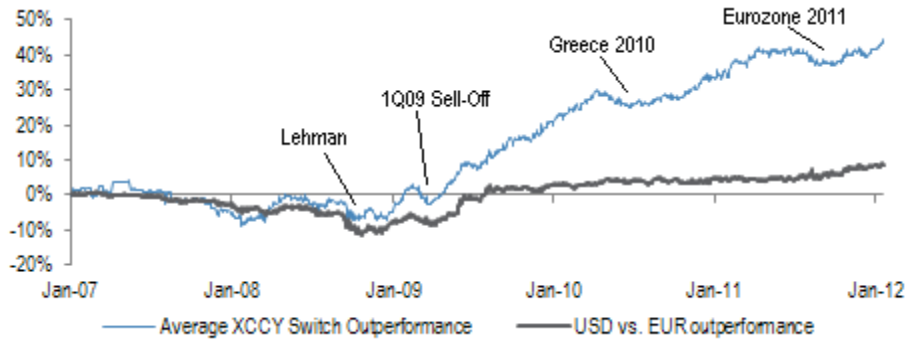
We construct a historical total return series from cross currency trades; this strategy takes a snapshot of the market at regular intervals (1 month, 3 months or 6 months) and identifies bond pairs which have traded with a spread pickup greater than a set level for the past three business days. We then calculate the average return from cross-currency switches on these bond pairs. At the next rebalancing, any bond pairs for which a signal still exists are maintained while the trade is unwound for any names for which the trade signal has disappeared.

Figure 18 shows the average return from cross-currency switches with a greater than 150bp pickup in spread since Jan 2007. We can see that since January 2007 these switches have given an outperformance of 43.9%, most of which came after 2008.

Danny White
(44-20) 7325-5066
danny.c.white@jpmorgan.com

For comparison purposes we include the average outperformance that a EUR investor could expect from investing in the USD-denominated bond market; the selective strategy far outperforms this.

Figure 18: Credit Outperformance for Cross Currency Switches
P&L as % of Notional for systematic strategy based on EURUSD bond pairs with z-spread difference of greater than 150bp. Rebalancing every month. Bid/offer costs not included.



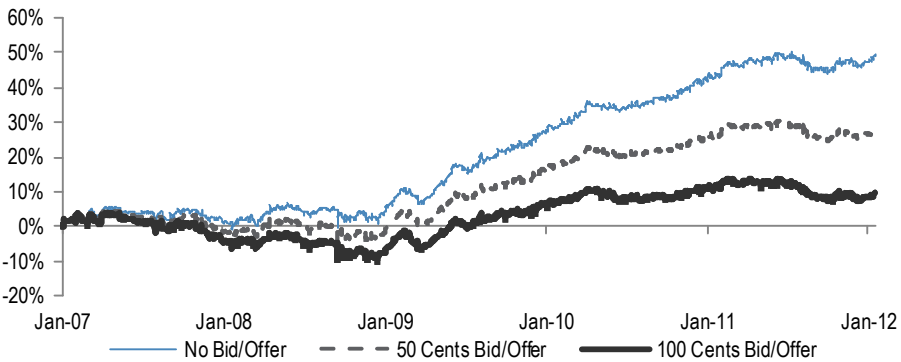
Source: J.P. Morgan.

Cross-currency switches perform well when markets are benign or rallying, but perform badly during large sell-offs.

From Figure 18, we note that on average cross-currency switches have performed badly during market sell-offs. By their very nature, cross-currency switches are, at a fundamental level, convergence trades and so typically perform well during benign market conditions, but perform badly during market sell-offs when risky asset spreads tend to deconverge. However, as can be seen from Figure 18, any loss during these more volatile periods is quickly recouped in the following months.

Figure 19 shows the effect of bid/offer costs on the outperformance of cross-currency switches, for average bid/offers of 50 and 100 cents per bond. While the bid/offer costs involved here can greatly reduce the P&L of the strategy, the absolute outperformance since 2007 has still been impressive on an absolute basis. The total P&L since 2007 has been 28.2% and 9.7% for 50 and 100 cent bid/offer assumptions respectively.

Figure 19: Effect of Bid/Offer costs on Cross-Currency Switch Outperformance
P&L as % of Notional.



Source: J.P. Morgan.

Danny White
(44-20) 7325-5066
danny.c.white@jpmorgan.com

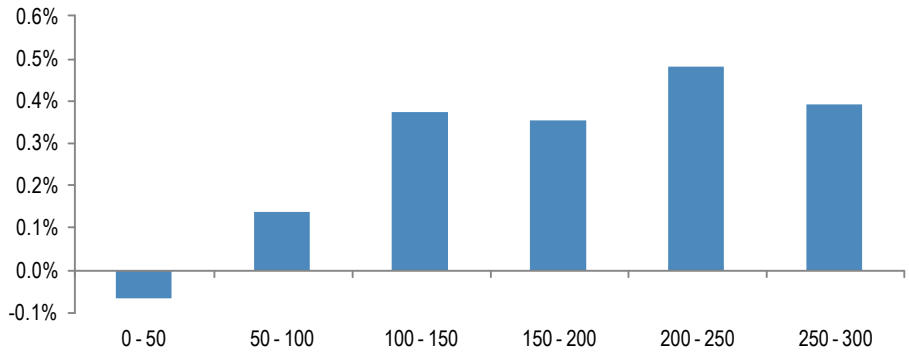
How big a spread pickup is needed to make cross-currency switches profitable?

Figure 20 shows the expected return from a EUR-USD cross-currency switch, based on the initial spread difference between the two bonds. We find that for spread pickups of less than 100bp, the results are not conclusive and there is no discernible outperformance from switches at these levels, especially considering the bid-offer costs involved in a switch. However, for pickups of greater than 100bp there is a notable outperformance from cross-currency switches; for a cross-currency switch with an initial spread pickup of greater than 100bp we would expect a 0.3%-0.5% outperformance in the first month alone.

The spread pickup required to make a cross-currency switch profitable is around 100bp.

Figure 20: Average outperformance of cross-currency bond switch in month following signal based on initial spread differential.

Left Y-Axis: Average P&L as % of Notional in month following trade signal. X-Axis: Difference in z-spreads at trade inception. Bid/offer costs not included.



Source: J.P. Morgan.

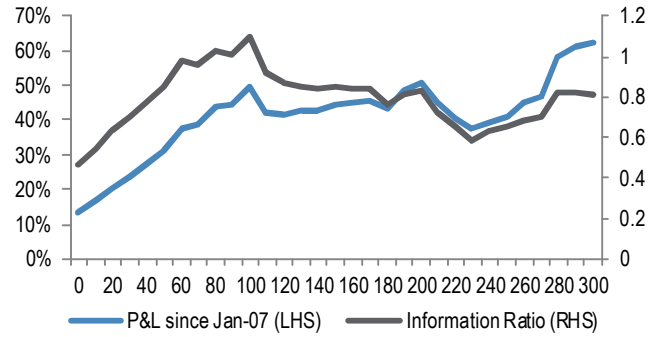
There does not seem to be any direct relationship between higher spread differentials and outperformance past 100bp, though due to the low number of bond pairs trading with wider spreads (as shown in Figure 22) it is difficult to establish an exact relationship between outperformance and the spread differential when the latter is very high. However, for bonds with higher bid/offer spreads a higher spread pickup would generally be required in order to make the switch attractive.

Figure 21 shows how the outperformance and information ratio of cross-currency switches change as we alter the spread pickup we require in order to make a switch As we increase this threshold, the return increases, but at a lower rate once we reach a threshold of around 100bp. The information ratio increases at first, reaching a maximum for a spread cutoff of around 100bp, but then decreases slightly. The lower number of bonds that meet the more stringent spread requirements (as shown in Figure 22) mean that the average outperformance is more volatile for higher spreads.

Danny White
(44-20) 7325-5066
danny.c.white@jpmorgan.com

Figure 21: P&L since 2007 and Information Ratio as a function of absolute z-spread difference required to generate a trading signal

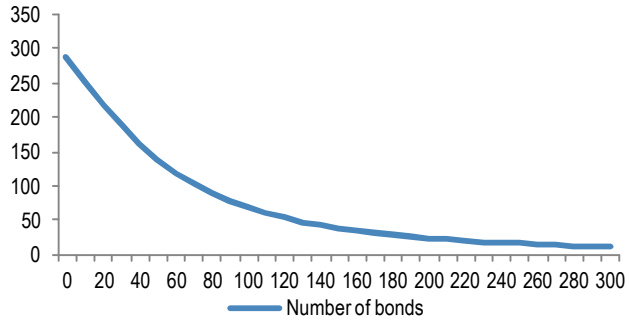
Left Y-Axis: P&L as % of Notional since Jan-07. Right Y-Axis: Information Ratio. X-Axis: Absolute Z-Spread difference required to generate a trading signal. Assumes portfolio is rebalanced on a monthly basis. Bid/offer costs not included.



Source: J.P. Morgan.

Figure 22: Average number of trading signals at each rebalance as function of absolute spread difference required to generate a trading signal.

Y-Axis: Average number of trading signals at each rebalancing point. X-Axis: Absolute Z-Spread difference required to generate a trading signal.



Source: J.P. Morgan.

These results are in line with the intuitive concept of giving preference to cross-currency switches with higher spread differentials between the two bonds.

What is a suitable trade horizon for cross-currency switches?

An investor usually enters a cross-currency switch in order to take advantage of a spread pickup between two similar maturity bonds issued by the same entity. Typically, the investor will not have to wait until the maturity of the bonds to fully realise this spread pickup; in many cases the spreads reconverge at some point in the future and the investor claims the outperformance resulting from the convergence of these spreads.

Most of the outperformance from a cross-currency switch is realised in the first month after the signal.

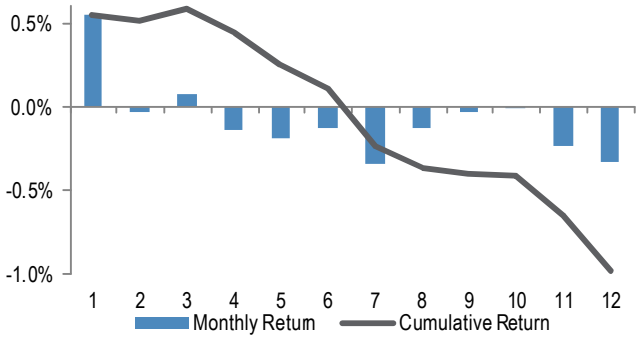
We find that the vast majority of the outperformance from cross-currency switches comes in the first month after the initial switch is made. Figure 23 shows the average monthly P&L from a cross-currency switch based on the time since the switch was entered. It can be clearly seen that the outperformance tends to be concentrated in the first month since the switch; the following months show little in the way of positive outperformance and even suggest a negative effect from holding these positions too long. This is most likely due to the spread differential normalising in the first few months after the trading signal appearing and the position being held unnecessarily.

In Figure 24, we compare the average outperformance from cross-currency switches which are held for 1 month, 3 months and 6 months periods; if the trade signal still exists at the end of that period the trade is kept on, otherwise it is taken off. New trades are entered at the start of each period. We find that the 1 month strategy significantly outperforms the other strategies; when the portfolio is rebalanced on a monthly basis there are 12 months each year which are the first month after the trade signals, compared to only 4 opportunities for a 3 month strategy and 2 for a 6 month strategy.

There are also likely to be additional attractive opportunities that have not been captured by the 1 month rebalancing strategy. In this case we have rebalanced the 1 month strategy at the start of every month; bond pairs that suddenly become attractive one week into the month but have normalised by the end of the month would not be captured by the 1 month strategy shown here.

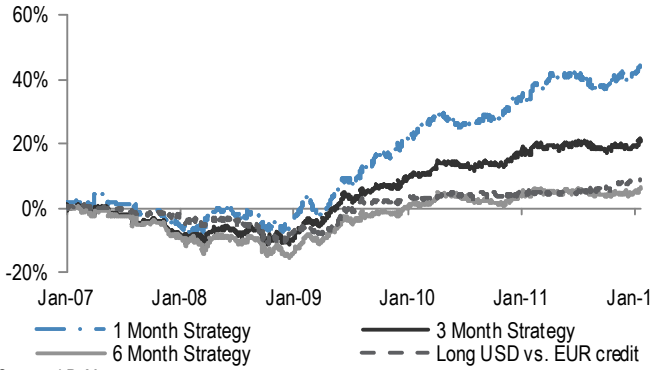
Danny White
(44-20) 7325-5066
danny.c.white@jpmorgan.com

Figure 23: P&L from Cross-Currency Switch based on number of months since switch was made.
P&L as % of Notional. 150bp threshold for selecting trades. Bid/offer costs not included.



Source: J.P. Morgan.

Figure 24: Profitability of cross-currency switches depending on frequency of rebalancing.
P&L as % of Notional. 150bp threshold for selecting trades. Bid/offer costs not included.



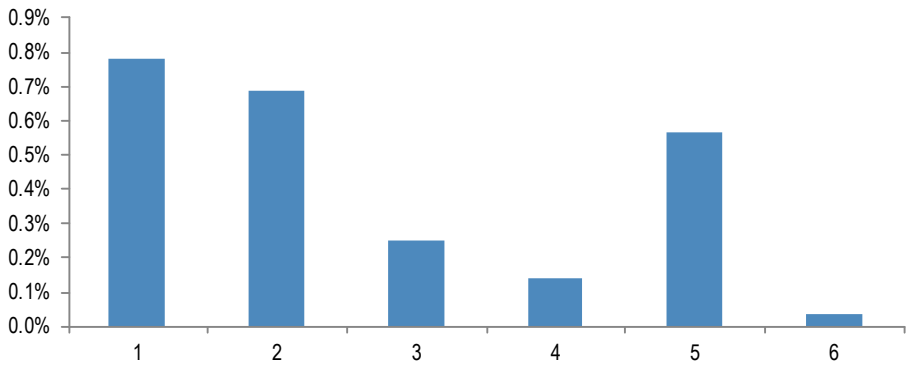
Source: J.P. Morgan.

From these results, we would recommend that investors enter cross-currency switches with an aim of making the majority of the return over the first month of the trade. Furthermore, it is advisable to scan the market for opportunities as frequently as possible, in order to maximise the number of potential trades.

The P&L results shown in Figure 20 do not include any bid/offer costs associated with switching. The viability of the cross-currency switch will depend upon the size of the bid-offer that must be crossed; less liquid names are unlikely to make attractive candidates for cross-currency switches as the bid-offer is likely to be higher than the 0.5% we hope to make in the initial month after the trade. However, for liquid investment grade names with bid-offers on the order of 10-20 cents these trades can be very attractive.

Figure 25 displays the average P&L in the month following the most recent trade signal based on the number of the months that the trade signal has existed for. The largest returns are for those bonds for which trade signals first appeared in either this month or the previous month, with lower returns for trades for which signals have existed for three months or more. This suggests that bond pairs for which signals have existed for three months or more have a more fundamental reason for trading at different spread levels, and the greatest opportunities are found in bond pairs that have recently diverged.

Figure 25: Average Monthly P&L based on number of months that signal has existed for.
Average P&L as % of Notional in Month following most recent trade signal, based on number of months that trade signal has existed for. Based on 100bp spread threshold.



Source: J.P. Morgan.

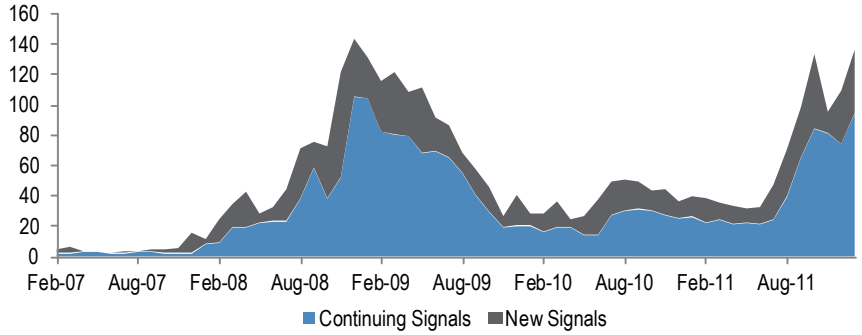
Danny White
(44-20) 7325-5066
danny.c.white@jpmorgan.com

How does the number of viable cross-currency opportunities change with time?

Figure 26 displays the number of available bond pairs that have spread pickups of greater than 100bp throughout time. We highlight those bond pairs which have only breached the 100bp threshold in the past month and those which have had spread differentials of greater than 100bp for one month or more.

Cross-currency spreads typically widen during sell-offs, leading to more entry opportunities at these points in time.

Figure 26: Number of available EUR-USD bond pairs with spread pickups of greater than 100bp.
Continuing signals refers to bond pairs which had a spread pickup of greater than 100bp in the previous month. New signals refers to bond pairs whose spread pickup has increased to more than 100bp this month.



Source: J.P. Morgan.

It can be clearly seen that the number of bond pairs meeting the 100bp threshold greatly increases during market sell-offs; out of a universe of around 700 bond pairs almost 150 traded with a spread pickup of more than 100bp at the end of 2008. Recently, we have seen a similar increase in the number of bond pairs meeting this criteria; there are currently a similar number of opportunities to the 2008/09 period.

During more benign market periods the number of bond pairs trading with wider spread pickups falls significantly. Between January 2010 and June 2011 there were around 25-50 bond pairs available, with around 10-25 new tradeable bond pairs becoming available each month.

Typically, around 1/3rd of the pairs available at the start of each month are new signals and around 2/3rds are bond pairs remaining from the previous month.

Do historical Cross-Currency Switches favour USD or EUR markets?

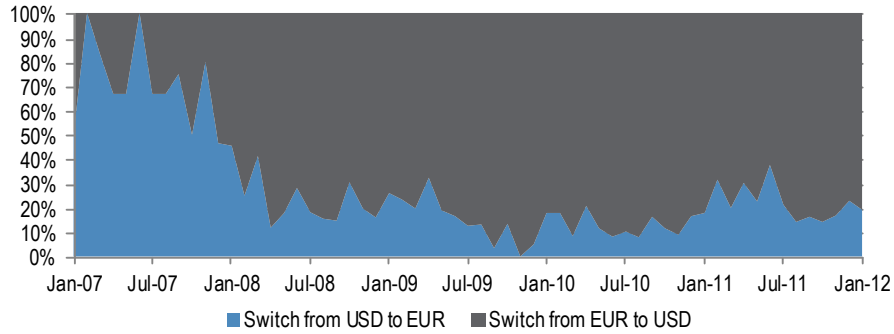
In the *Modeling the Cross Currency Spread* section we discuss how USD corporate bonds typically trade with wider spreads than their EUR-denominated counterparts, an effect of which can mainly be attributed to the cross currency basis and quanto effects.

Historically cross-currency switches have focused on switching EUR bonds into USD bonds, due to the wider spreads associated with USD bonds.

Figure 27 shows how the historical preference for USD or EUR bonds in cross-currency switching since spreads widened in mid-2007. The larger number of European corporates issuing in the USD market compared to US corporates issuing in euros has meant that most of the opportunities arise from switching into dollar bonds from euros.

Danny White
(44-20) 7325-5066
danny.c.white@jpmorgan.com

Figure 27: Historical preference for EUR or USD bonds
% of Cross Currency Switches from one currency to the other



Source: J.P. Morgan.

Danny White
(44-20) 7325-5066
danny.c.white@jpmorgan.com

Appendix I: Cross-Currency Bond P&L

In the *Hedging Cross Currency Trades* section we discussed the effectiveness of various FX hedges on cross-currency bond trades. In this appendix we give a more detailed explanation of the P&L calculations and mechanics of each hedge.

1. No FX Hedging

In this case we assume that the investor starts with X euros and performs an FX spot transaction to convert these into dollars, which are then used to purchase a USD-denominated bond. The mark-to-market is calculated by assuming the investor sells the bond and converts the dollars back into euros through a second FX spot transaction.

At the close of business on Day 0, the investor has X euros and converts them into dollars at the FX spot rate of FX_0, such that the investor now holds $X\,FX_0$ dollars. These dollars are used to purchase bonds at the end of day purchase price of P_0.

24 hours later, the new EURUSD rate is FX_1 and the new bond price is P_1. Due to the changes in the bond prices, the investor now holds bonds worth $X\,FX_0\,P_1/P_0$ dollars. Converting this back to euros at the new FX spot rate of FX_1 gives us our new Euro balance, as shown in Equation 7.

Equation 7: Number of euros held after one days trading.

X = Initial number of euros FX_i = FX rate at COB on Day i P_i = Bond Dirty Price at COB on Day i

$$Euros\ at\ end\ of\ Day\ 1 = X\frac{FX_0}{FX_1}\frac{P_1}{P_0}$$

Given that we started with X euros, we can express this as a % P&L by subtracting X and then dividing by X, as shown in Equation 8.

Equation 8: % P&L after one days trading.

FX_i = FX rate at COB on Day i P_i = Bond Dirty Price at COB on Day i

$$\%\ P\&L\ at\ end\ of\ Day\ 1 = \frac{FX_0}{FX_1}\frac{P_1}{P_0} - 1$$

We can extend this beyond the first day of trading to a generic bond price P_i and FX rate FX_i. Furthermore, we can account for any coupon dates during the period we hold the bond for by holding them as cash and assuming that we convert them back to euros only when we unwind the trade. The generalised P&L is shown in Equation 9

Equation 9: Cumulative % P&L after *i* days - not reinvesting coupons.

FX_i = FX rate at COB on Day i P_i = Bond Dirty Price at COB on Day i C_j = Coupon paid on Day j.

$$\%\ P\&L\ at\ end\ of\ Day\ i = \frac{FX_0}{FX_i}\frac{P_i + \sum_{1<j<i} C_j}{P_0} - 1$$

If the coupons are instead re-invested in the USD denominated bonds, we make a small adjustment to Equation 9 in order to account for this.

Danny White
(44-20) 7325-5066
danny.c.white@jpmorgan.com

Equation 10: Cumulative % P&L after *i* days - with reinvestment of coupons.

FX_i = FX rate at COB on Day i P_i = Bond Dirty Price at COB on Day i C_j = Coupon paid on Day j.

$$\%\ P\&L\ at\ end\ of\ Day\ i = \frac{FX_0}{FX_i}\prod_{j=0}^{i-1}\left(\frac{P_{j+1}+C_{j+1}}{P_j}\right)-1$$

2. Hedging with FX Swaps.

The first option we recommend for hedging FX exposure when carrying out cross-currency bond trades was to use FX swaps. Investors would typically not enter an FX swap with a maturity equal to that of the bond, but would instead look to enter shorter-dated FX swaps and rebalance on regular intervals (in the *Hedging Cross Currency Trades* section we examined hedging on daily and monthly intervals).

Let us again assume that an investor initially has X euros on Day 0, where the bond dirty price is P_0 and the EURUSD rates is FX_0. Furthermore, the FX Forward rate (for an unspecified maturity) is FX'_0.

At the maturity of the FX swap, the bond price is now P_1 and the EURUSD rate is now FX_1. The value of our bonds in dollars is shown in Equation 11.

Equation 11: Value of bonds in Dollars at FX Swap Maturity

FX_i = FX rate at COB on Day i P_i = Bond Dirty Price at COB on Day i C_j = Coupon paid on Day j.
X = Initial number of euros.

$$Value\ of\ Bonds\ in\ \$\ at\ FX\ Swap\ Maturity = XFX_0\frac{P_i+\sum_{1<j<i}C_j}{P_0}$$

However, from the return leg of the FX swap we are able to swap back $X\,FX'_0$ dollars into X euros. Once this has been completed the investor will hold X euros as well as a remaining balance of dollars, which will be converted back into euros via an FX spot transaction at the current spot rate of FX_i. The equivalent number of euros that the investor holds is shown in Equation 12.

Equation 12: Value of bonds in euros at FX Swap Maturity

FX_i = FX rate at COB after ith FX swap maturity P_i = Bond Dirty Price at COB after *i*th FX swap maturity C_j = Coupons.X = Initial number of euros. FX_i = FX forward rate

$$Bond\ Value\ in\ €\ at\ FX\ Swap\ Maturity = X + X\left(\frac{FX_0}{FX_i}\frac{P_i+\sum C}{P_0}-\frac{FX'_0}{FX_i}\right)$$

The cumulative % P&L is shown in Equation 13.

Equation 13: Cumulative % P&L after first FX Swap maturity

FX_i = FX rate at COB after ith FX swap maturity P_i = Bond Dirty Price at COB after *i*th FX swap maturity C_j = Coupons. FX_i = FX forward rate

$$\%\ P\&L\ after\ one\ FX\ Swap = \frac{FX_0}{FX_1}\frac{P_i+\sum_{During\ FX\ Swap}C}{P_0}-\frac{FX'_0}{FX_1}$$

If we assume that at the end of the FX swap the investor immediately enters another FX swap, we can calculate the return at the maturity of the *i*th FX swap.

Danny White
(44-20) 7325-5066
danny.c.white@jpmorgan.com

Equation 14: Cumulative % P&L after *i*th FX Swap maturity

FX_i = FX rate at COB after ith FX swap maturity P_i = Bond Dirty Price at COB after *i*th FX swap maturity C_j = Coupons. FX_i = FX forward rate

$$\%\ P\&L\ after\ ith\ Swap = \prod_{j=0}^{i-1}\left(1 + \frac{FX_j}{FX_{j+1}}\frac{P_{j+1} + \sum_{During\ FX\ Swap} C}{P_j} - \frac{FX'_j}{FX_{j+1}}\right) - 1$$

We can also calculate the P&L in between FX swap rebalancings, based on the bond prices, FX rates and FX forward levels both now and at the last rebalance date. This is demonstrated in Equation 15.

Equation 15: Mark-to-Market P&L

FX= FX Spot Rate - current (Now) or at last rebalance (Entry).
P= Bond Dirty Price - current (Now) or at last rebalance (Entry).
FX' = FX Forward to fixed maturity - current (Now) or at last rebalance (Entry).
$P\&L_{Previous}$ = The % P&L at the most recent rebalancing date.

$$= \left(\frac{FX_{Entry}}{FX_{Now}}\frac{P_{Now} + \sum_{Since\ Entry} C}{P_{Entry}} + \frac{FX'_{Now} - FX'_{Entry}}{FX_{Now}}\right) \times (1 + P\&L_{Previous}) - 1$$

Note that upon the maturity of the FX Swap, $FX'_{Now} = FX_{Now}$ (i.e. the 0-day forward rate equals the spot rate) and Equation 15 is equivalent to Equation 14.

These equations hold because we assume that we can trade in and out of the bonds without crossing bid/offer and readjust the size of the FX swap to adjust the current Euro balance. The following is an example of how rolling an FX swap would work in reality:

Rolling an FX Swap: An Example

Day 0: FX = 1.3 P=100 Investor holds equivalent of 100€
Investor enters 1-day FX swap, buys 130 dollars worth of bonds.

Day 1: FX = 1.3 P=100 Investor holds equivalent of 100€
Over the first trading day there were no changes to the FX rate or bond price. The investor is required to swap 130 dollars for 100 euros in the return leg of the 1st FX swap. Rather than selling the bonds and crossing the bid/offer unnecessarily, he enters an offsetting 1 day FX swap starting today, paying 100 euros and receiving 130 dollars. The front leg of this FX swap cancels out the return leg from the previous day's FX swap and no other cashflows take place.

Day 2: FX = 1.3 P=105 Investor holds equivalent of 105€
The bond price increased strongly today; the investor now holds bonds worth 130×(105/100) = 136.5 dollars. The investor has an obligation to swap back 130 dollars into euros, but as before does not want to cross bid/offer by selling the bonds. As with the previous day, the investor enters an offsetting FX swap starting today, paying 100 euros and receiving 130 dollars in the front leg of the new FX swap which cancels out the return leg of the previous day's FX swap.

Day 3: FX = 1.2 P=105 Investor holds equivalent of 105.42€
On the 3rd trading day the bond price stayed constant but the euro depreciated against the dollar. The investor still holds bonds worth 136.5 dollars and has an

obligation to convert 130 dollars back into 100 euros. The remaining 6.5 dollars can only be converted back into euros at the new spot rate of 1.2; if the investor unwound the entire position they would hold 100+6.5/1.2 = 105.42 euros.

The investor still does not wish to unwind the entire bond position and wishes to roll over the FX swap to the next day. However, due to the change in the underlying FX rate the investor can no longer swap 100 euros into 130 dollars in order to directly offset the return leg of the previous day's FX swap. Instead, the investor must choose whether to keep the dollar or euro amount constant.

To keep the euro amount constant, the investor would enter a new FX swap, exchanging 100 euros for 120 dollars. This only partially cancels out the previous day's FX swap return leg; the investor needs an additional 10 dollars to make up the 130 required for yesterday's swap. To fund this shortfall the investor must sell 10 dollars worth of bonds, leaving the investor holding bonds worth 126.50 dollars, or 105.4 euros at a spot rate of 1.2

To keep the dollar amount constant, the investor would enter a new FX swap exchanging 108.3 euros for 130 dollars. The dollar portion of the yesterday's FX swap has been matched, alleviating the need for the investor to sell any bonds, but the investor must instead allocated an extra 8.33 euros to the trade in order to maintain it. In this case the investor holds bonds worth 136.5 dollars, equivalent to 113.75 euros at a spot rate of 1.2. This is equal to the 105.42 euros the position was worth before the notional was changed plus the extra 8.33 euros the investor contributed to the position.

In essence, in an environment where the investor's home currency is depreciating they are faced with a choice; contribute more capital to the position or be forced to sell bonds.

The notional adjustment required at the maturity of the FX swap is proportional to the % change in the FX spot rate over the period. The FX move we used in the above example is a relatively large change and in most cases a relatively small adjustment would be required. However, due to this required notional adjustment it may be preferable to use longer maturity (e.g. month instead of daily) FX swaps in order to reduce the frequency of notional adjustment required.

3. Hedging with Cross Currency Basis Swaps

Calculating the P&L when hedging with a cross-currency basis swap (and maturity matched interest rate swaps) becomes more complicated due to the extra interest rate swap and basis terms.

We can break down the P&L from this type of trade into five separate components, each attributable to either the bond, XCCY basis swap or the maturity-matched interest rate swaps.

Bond

Bond P&L - in USD

XCCY Basis Swap

FX component - in EUR
Basis compenent - in EUR

Maturity Matched Interest Rate Swaps

USD Interest Rate Swap P&L - in USD
EUR Interest Rate Swap P&L - in EUR

The total P&L in EUR can be expressed as a sum of these, with adjustments for the currency of each component.

Equation 16: Total Cumulative Cross Currency Bond and Basis Swap Package P&L

FX = FX rate

$$Total\ P\&L\ = Bond\ P\&L + FXP\&L + BasisP\&L + USD\ IRS\ P\&L + EUR\ IRS\ P\&L$$

As with the previous examples, we can express the hedged Bond P&L using the FX rate and entry and exit, as well as the dirty bond prices and the value of any coupons dispensed throughout the period. This equation differs from Equation 13 slightly as the FX rate of the return leg of the swap is equal to the FX spot rate upon entry date, rather than the FX forward rate.

Equation 17: Combined Cumulative Bond and FX Hedge P&L

FX_i = FX rate P_i = Bond Dirty Price at COB after *XCCY* swap maturity C_j = Coupons.

$$Bond\ P\&L\ = \frac{FX_0}{FX_i}\frac{P_i + \sum C}{P_0} - \frac{FX_0}{FX_i}$$

For the USD interest rate swap, the P&L is the sum of the carry from the swap as well as any P&L from changes in the swap rate. An investor using a XCCY basis swap to purchase USD-denominated bonds will be paying fixed on the USD interest rate swap leg and so will have a negative carry and will profit if swap rates increase. The floating leg of the interest rate swap is cancelled out by the floating leg of the XCCY basis swap. Furthermore, any P&L from the USD interest rate swap will be denominated in USD, so we must use the current FX spot rate to convert these flows back into euros.

Equation 18: Cumulative USD Interest Swap P&L

FX_i = FX rate at COB after XCCY swap maturity P_i = Bond Dirty Price at COB after *XCCY* swap maturity C_j = Coupons t-t_0 = Time since trade entry.

$$USD\ Swap\ P\&L = \frac{FX_0}{FX_i}[(S_1^{USD} - S_0^{USD}) \times USDSwapDuration - S_0^{USD}(t - t_0)]$$

Similarly, an investor buying USD-denominated bonds using a XCCY basis swap will be receiving Euro rates, and so will have a positive carry position from Euro swaps and will profit if Euro rates fall.

Equation 19: Cumulative EUR Interest Swap P&L

FX_i = FX rate at COB after XCCY swap maturity P_i = Bond Dirty Price at COB after *XCCY* swap maturity C_j = Coupons. t-t_0 = Time since trade entry.

$$EUR\ Swap\ P\&L = (S_0^{EUR} - S_1^{EUR}) \times EURSwapDuration + S_0^{EUR}(t - t_0)$$

Danny White
(44-20) 7325-5066
danny.c.white@jpmorgan.com

Finally, we must also take into account the P&L due to the cross currency basis itself. An investor who is buying USD bonds through a XCCY swap will be receiving the basis (though at the current time the EURUSD basis is highly negative so the investor will actually pay an amount). Furthermore, the investor will profit if the EURUSD basis becomes less positive/more negative.

Equation 20: Cumulative Basis P&L

α_i = Cross currency basis on date i $t\text{-}t_0$ = Time since trade entry.

$$Basis\ P\&L = (\alpha_0 - \alpha_1) \times XCCYSwapDuration + \alpha_0(t - t_0)$$

Danny White
(44-20) 7325-5066
danny.c.white@jpmorgan.com

Danny White
(44-20) 7325-5066
danny.c.white@jpmorgan.com

Danny White
(44-20) 7325-5066
danny.c.white@jpmorgan.com

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JP Morgan European Credit Research

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

Team Assistant
Rebecca Bernini
(44 20) 7742-2754
rebecca.bernini@jpmorgan.com

High Grade and High Yield Research Groups

Financials

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

Enrico Longato
(44-20) 7777-3147
Enrico.longato@jpmorgan.com
www.morganmarkets.com/analyst/enricolongato

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

Credit Derivatives & Quantitative Research

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

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

Danny White
(44-20) 7325-5066
Danny.c.white@jpmorgan.com
www.morganmarkets.com/analyst/dannywhite

Support Analyst
Harpreet Singh
harpreet.x.singh@jpmorgan.com

Credit Strategy

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

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

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

Emerging Market Corporates

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

Zafar Nazim
(44-20) 7777-9132
zafar.nazim@jpmorgan.com
www.morganmarkets.com/analyst/zafarnazim

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

Consumer & Retail

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

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

Ela Kurtoglu
(44-20) 7325-4787
ela.n.kurtoglu@jpmorgan.com
www.morganmarkets.com/analyst/elakurtoglu

Autos & Chemicals

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

Danielle Ward
(44-20) 7742-7344
danielle.x.ward@jpmorgan.com
www.morganmarkets.com/analyst/danielleward

General Industrials

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

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

Venn Saltirov
(44-20) 7742-0388
venn.saltirov@jpmorgan.com
www.morganmarkets.com/analyst/vennsaltirov

ABS & Structured Products

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

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

Flavio Marco Rusconi
(44-20) 7777-4461
flaviomarco.rusconi@jpmorgan.com
www.morganmarkets.com/analyst/Flaviomarcorusconi

Support Analyst
Suraj Dey
suraj.dey@jpmchase.com

TMT – Telecoms/Cable, Media & Technology

David Caldana, CFA
(44-20) 7777 1737
david.caldana@jpmorgan.com
www.morganmarkets.com/analyst/davidcaldana

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

Malin Hedman
(44-20) 7325 9353
malin.b.hedman@jpmorgan.com
www.morganmarkets.com/analyst/malinhedman

Support Analyst
Himanshu Routray
himanshu.x.routray@jpmorgan.com

Energy and Infrastructure

Ryan Staszewski, CFA
(44-20) 7777-1981
ryan.m.staszewski@jpmorgan.com
www.morganmarkets.com/analyst/ryanstaszewski

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