Overview
Many investors are experiencing disappointing yields from traditional assets within their domestic markets. As a consequence they are forced to cast their nets ever wider in the hunt for enhanced returns, often exposing themselves to foreign exchange (FX) risk.

Factors like interest rate differentials and changes in economic growth lead to constant FX movements around the world. It can be argued that exposure to these movements offers an opportunity to enhance portfolio diversification. But without careful management and deep understanding it also enhances risk – risk that hedging alone cannot always mitigate (and may in fact heighten).

This paper presents an in-depth analysis of FX risks and diversification benefits. We examine which currencies to hedge – and to what extent – in order to contain risk. We highlight the importance of the underlying asset class and illustrate our arguments through the example of a global equity portfolio in which diversification is underpinned by the efficient management of FX risk.

Introduction
Ever since the financial crisis of 2007/2008 the financial world has been overcast with uncertainty. First there were the direct impacts of the collapse of Lehman Brothers. Across the globe, financial markets and real economies crashed and governments engaged in expensive stabilising measures. Public indebtedness and bank bailouts led to the Euro crisis in 2011. Throughout this period central banks cut their interest rates to historical lows to support fiscal policy and reinvigorate the inter-bank and credit markets. Although global equity markets were deemed to have recovered by mid-2014, central banks are still pursuing their expansive policies in the face of lingering concerns over unemployment and GDP in Europe and the US. Whether the end of the current monetary policy regime (which must come eventually) is reflected in current equity prices, is subject to ongoing debate.

In an environment characterised by such profound economic uncertainty, diversification is even more important for investors. As equity and bond markets are both currently affected by the central bank rates alike, international diversification is arguably imperative. Yet trading in foreign securi-
Efficiently managing foreign exchange risk in the portfolio context

ties means holding local currencies and that introduces risk. It is the management of this risk that we seek to analyse here.

The market for FX is essentially of the over-the-counter variety. Banks offer interest-bearing deposit accounts denominated in a given currency. The fundamental point is that any investor who wishes to trade in foreign securities must hold the local currency.

Thus an investor from the Eurozone who wants to trade on the New York Stock Exchange must convert his money to US dollars before entering into any transactions; and an investor who wants to hold US corporate bonds must realise that they, too, will be denominated in US dollars. This has been the case ever since floating exchange rates were introduced when the Bretton Woods system began to crumble in 1973. As a consequence, international investors assume not only the risk associated with the particular security they are trading but also the risk associated with exchanging one currency for another.

Because FX deposit accounts are highly liquid and of short duration, FX may be viewed as part of the money market class of assets. This being the case, it is argued, it is possible to improve the overall risk-return profile of a portfolio by managing FX exposure to exploit the opportunities that arise from currency-related diversification.

An alternative school of thought is that FX constitutes an asset class of its own. The reasoning in this instance is that FX deposits are more volatile than domestic accounts and the spread in interest rates across currencies can be more substantial. Proponents of this view argue that an investor can try to earn money directly in the FX market through interest rate differentials or exchange rate speculation.

Is this really possible? There are grounds to be sceptical. The theory of the so-called uncovered interest rate parity suggests interest rate differentials will be offset by exchange rate movements, so eliminating any scope for arbitrage, while attempts in the academic literature to explain exchange rate movements through economic fundamentals have been almost entirely unsuccessful.

We deal with these more dubious claims first. In section 1 we illustrate why interest rate differentials provide no systematic investment opportunity, while in section 2 we discuss the feasibility of successfully predicting exchange rate movements. As will become clear, our analysis tends to substantiate the scepticism mentioned above.

In section 3 we go on to examine the potential gains and costs when hedging against FX exposure, showing how the strategic hedging of certain currencies might reduce volatility. Section 4 concludes.
1 Interest rate differentials across currencies

In this section we will illustrate that interest rate differentials are on average offset by exchange rate movements and therefore negate any systematic gains for an investor attempting to earn money from them directly. This is in keeping with the theory of uncovered interest rate parity (UIRP), which links the evolution of the spot rate between two currencies to the interest rate differential between the two respective countries.

By way of illustration, let us suppose an investor’s wealth, as denoted in the domestic currency, is $W_t$ at the beginning of period $t$. The investor can invest in a domestic bond and earn the domestic return $r_t$, meaning his wealth at the end of the period will be $W_{(t+1)}^'=W_t (1+r_t)$.

Alternatively, he can invest in a foreign bond with a return $r_t^*$. To do this he needs to convert his wealth at the beginning of the period to the foreign currency at the spot rate $S_t$, so that he holds $W_t S_t$ units of the foreign currency. His end-of-period wealth in this instance will be $W_t S_t (1+r_t^*)$. Crucially, the spot rate at the end of the period $S_{(t+1)}$ applies when he converts his wealth back to the domestic currency, as a result of which his wealth will be $W_{(t+1)}^{''}=W_t S_t S_{(t+1)} (1+r_{t+1}^*)$.

The theory of the UIRP states that the future spot rate $S_{(t+1)}$ must assume a value such that both of the investments described above lead to the same wealth. In other words, $W_{(t+1)}^'=W_{(t+1)}^{''}$.

Figure 1 (The uncovered interest rate parity) illustrates this relationship with an example from the pre-euro era. A British investor has 100 GBP (see top-left panel). Let us assume the annual return on British bonds equals 6.18% per annum\(^1\) and that the investor’s wealth at the end of the year will be 106.18 pounds sterling if he holds domestic bonds (see bottom-left panel).

Now let us assume the investor instead chooses to hold Italian bonds, with a return of 9.12% per annum. Let us further assume the spot rate at the beginning of the year is 1 GBP : 2,578.7620 ITL. The investor is able to purchase 257,876.20 ITL at the beginning of the year (see top-right panel) and will hold 281,626.60 ITL at end of the year when interest payments are due (see bottom-right panel). If a no-arbitrage condition is to hold then the spot rate at the end of the year has to be 1 GBP : 2,652.3507, meaning the investor is left with 106.18 GBP (see bottom-left panel).

Formally, this no-arbitrage condition relates the future spot rate to the current spot and interest rates: $S_{(t+1)}=S_t (1+r_{t+1}^*)/(1+r_t)$. The standard formulation of the UIRP applies the natural logarithm to this equation\(^2\): $s_{(t+1)}-s_t=r_{t+1}^*-r_t$

It is important to note, of course, that the above argument omits several key considerations. For instance, the investment horizon and the bond’s duration are confined to a single period, and uncertainty over spot and interest rates is disregarded. In essence, this scenario is both hypothetical and conveniently "neat".

---

1 The numerical values in this example are chosen to resemble realistic values for the period 1993 - 1998.

2 A linear approximation is used for the natural logarithm of interest rates and lower case letters denote the natural logarithm of spot exchange rates: $\ln(1+r_t)\approx r_t$ and $s_t=\ln S_t$. 
Accordingly, we will now demonstrate that the fundamental idea of the UIRP holds on average in real-world markets. We will do this by drawing on real-world data to show that spot rates evolve in such a way that interest rate differentials cannot be exploited systematically.

Let us consider two investment strategies:

1. An investor holds zero-coupon government bonds with three months to maturity. They are denominated in the domestic currency. At the end of each trading day he sells the bond, and at the beginning of the next trading day he buys a new bond with three months to maturity.

He thus keeps the duration constant and continuously earns the three-month interest rate. This strategy of maintaining a constant duration will henceforth be known as "rolling over" the portfolio.

2. An investor holds zero-coupon government bonds denominated in a foreign currency. He again fixes the duration at three months.

However, because he converts his portfolio to the domestic currency at the spot rate at the end of each trading day, he exposes himself to exchange rate risk.

To illustrate the performance of these two strategies we use historical spot exchange rates between the ITL and GBP. We also use the three-month interest rates of the respective countries.

Figure 2 (Short-term interest rates) shows the annualised three-month interest rates in Italy and the UK during the relevant period. Note that Italian interest rates were higher than their British counterparts almost for the duration. As suggested by the UIRP, the lira depreciated in relation to GBP – from 2165.5 ITL/GBP to 2743.43 ITL/GBP.

Figure 3 (Foreign and domestic bond returns) illustrates risk and return for the two investment strategies.

A British investor who held domestic bonds would have earned an average return of 6.18% at a volatility of 0.21% (all figures per annum). If he held Italian bonds he would have earned an average return of 5.56% at a volatility of 9.43%.

Similarly, an Italian investor who held domestic bonds would have earned an average return of 9.21% at a volatility of 0.71%. If he held British bonds he would have earned a return of 10.70% at a volatility of 9.85%.

For both investors a statistical comparison of the two strategies reveals an investment in the foreign asset would not have been significantly more or less profitable than an investment in the domestic asset during the period under consideration. In short, what we see here is the UIRP in action in a real-world setting.

---

3 The data are collected from Datastream at daily frequency for the period between 1 January 1993 and 31 December 1998. Until September 1992 both countries were part of the European Exchange Rate Mechanism and kept their currencies in close exchange rate bands. After the September 1992 crisis ("Black Wednesday") the Bank of England adopted a floating exchange rate regime. As of 1 January 1999 the European Exchange Rate Mechanism II became effective, fixing the exchange rate of the Italian lira to the euro. Hence the chosen timeframe covers the period between these two institutional landmarks.

4 Specifically, a two-sided Welch’s t-test is applied. For the British investor $t = -0.3430$ and $p = 0.7316$. For the Italian investor $t = 0.3435$ and $p = 0.7313$. 
2 The Predictability of Exchange Rates

Although the difference is statistically insignificant, it is right to acknowledge that the two investment strategies detailed above did not achieve exactly the same returns. Similarly, Figure 4 (Portfolio value of a UK investor) illustrates the evolution of the value of a British investor’s portfolio under the same two strategies, highlighting how the value of a foreign bond portfolio would fluctuate around its domestic counterpart.

It is evident, then, that temporary deviations from the UIP do exist; and exploiting these is the core concept of currency carry trades, where investors borrow in low-yielding currencies and invest in high-yielding currencies. A profitable carry strategy requires a reasonably precise prediction of future spot rates, and it is the feasibility of this approach that we will briefly consider now.

Many factors have been suggested as predictors in successfully forecasting spot rates. They include interest rates, differentials in prices and inflation, productivity, output, central bank reaction functions and current account imbalances. Perhaps the most thorough survey of the relevant literature is to be found in Rossi (2013), whose conclusions include the following observations: “Overall, although some predictors... reveal some predictive ability at long horizons, none of the predictors, models or tests systematically finds empirical support for superior exchange rate forecasting... Typically, when predictability appears it does so occasionally for some countries and for a short period of time.”

There are caveats, of course. Although they cannot be analysed meaningfully with regard to their risk-return profile, non-rule-based trading strategies that are event-driven or rely on a trader’s individual experience might be profitable in certain instances.

Yet the vast majority of the available evidence suggests most predictions of future spot rates are no more accurate than a random walk. In short, an investor might as well flip a coin. It therefore seems reasonable to view supposedly systematic strategies for currency carry trades with some caution.

3 Hedging FX risk in equities

So much for the two principal strategies based on the view that FX constitutes an asset class of its own. We now turn to the rival perspective – i.e. that FX should be seen as part of the money market class of assets.

To recap: a major implication of this view is that it should be possible to improve the overall risk-return profile of a portfolio by managing FX exposure and so exploiting the opportunities that arise from currency-related diversification. In other words, we should treat FX as a risk factor in the investment universe and aim to manage it to our advantage.

For risk managers a crucial question arises straight away: to what extent should we hedge FX? For the remainder of this article we will focus on this question in the context of equity investments. Specifically, we will suggest which currencies to hedge and demonstrate the degree to which portfolio volatility might be reduced.
Let us begin by assuming an investor holds the MSCI World Index, which, as a global portfolio, necessarily contains equities denominated in a foreign currency. In such a scenario a positive return on foreign equity investment is diminished and can even turn into a loss when the foreign currency depreciates relative to the domestic currency.

Now let us consider a hedging strategy in which the equity portfolio is augmented by a portfolio of currency forwards. A hedge position is implemented for each foreign currency in the equity index so that a depreciation of the foreign currency leads to a compensating profit that stabilises overall performance. The costs of such a hedge arise from the fact that an appreciation of the foreign currency entails a loss in the forward position; trading costs might also have an impact, although these are not the focus of our discussion here.

Two further questions immediately arise. Firstly, should all foreign currencies be hedged or only some? Secondly, how big should the forwards portfolio be relative to the equities portfolio? We assess these issues from the perspective of an investor from the Eurozone. We draw on historical data for the MSCI World Index, examining spot and one-month forward rates for the euro in relation to all other currencies in the index, as well as the value-weighted shares therein. By way of a benchmark, an investor from the Eurozone who did not employ a currency hedge would have earned an average return of 6.76% per annum at a volatility of 16.65% during the period under consideration.

Table 1 (Correlation coefficients of FX and MSCI World returns) presents a matrix of the correlation coefficients of the returns on all currencies in relation to the euro and the MSCI World Index. Note that most cross-currency correlations are positive and that the correlation with equity returns (see far-right column) is positive for the majority of currencies as well. CHF and JPY are the only two currencies for which returns are negatively correlated. Accordingly, exposure to CHF and JPY provides a natural hedge against volatility in global equity markets for an investor from the Eurozone. From the perspective of risk management it is therefore optimal not to hedge these two currencies.

In addition, the correlation coefficient of USD with the MSCI World Index is less than 10% in absolute terms, whereas all other currencies exhibit coefficients of at least 20% in absolute terms. As the correlation between the USD and equity returns is close to zero, we might conclude that hedging the USD exposure will not reduce overall portfolio volatility. However, as we will see below, the situation is more complicated than might at first appear.

---

The data are provided by Bloomberg and collected at daily frequency between 31 March 2004 and 20 May 2014. With the euro as the domestic currency, the following foreign currencies are contained in the MSCI World Index, ordered by descending average share in the index: US dollar (USD), pound sterling (GBP), Japanese yen (JPY), Canadian dollar (CAD), Swiss franc (CHF), Australian dollar (AUD), Swedish krona (SEK), Hong Kong dollar (HKD), Singapore dollar (SGD), Norwegian krone (NOK), Israeli new shekel (ILS) and New Zealand dollar (NZD). The shares are presented in Figure 5 (Currency shares in the MSCI World Index).

---

The Hong Kong dollar is allowed to float only within a narrow band around a fixed rate vis-à-vis the US dollar and therefore exhibits a low correlation with the MSCI World Index as well.

---

5 The data are provided by Bloomberg and collected at daily frequency between 31 March 2004 and 20 May 2014. With the euro as the domestic currency, the following foreign currencies are contained in the MSCI World Index, ordered by descending average share in the index: US dollar (USD), pound sterling (GBP), Japanese yen (JPY), Canadian dollar (CAD), Swiss franc (CHF), Australian dollar (AUD), Swedish krona (SEK), Hong Kong dollar (HKD), Singapore dollar (SGD), Norwegian krone (NOK), Israeli new shekel (ILS) and New Zealand dollar (NZD). The shares are presented in Figure 5 (Currency shares in the MSCI World Index).

6 The Hong Kong dollar is allowed to float only within a narrow band around a fixed rate vis-à-vis the US dollar and therefore exhibits a low correlation with the MSCI World Index as well.
In the following simulations we implement the hedge strategy described above – i.e. we use a portfolio of currency forwards to augment an equity investment. Let us assume the forwards are "rolled over" on a daily basis. The size of the hedge position relative to the equity position is measured via the hedge ratio (HR). An HR of 65% means that for every euro invested in equities denominated in pound sterling, for instance, a total of 65 EUR cents is invested in a pound sterling hedge position. An HR of 100% will henceforth be known as a "full hedge".

Let us first consider each currency separately and examine how the overall portfolio volatility evolves as the HR is increased by 10% increments. For all currencies except the USD, JPY and CHF we find a monotonously decreasing relationship between overall portfolio volatility and HR, reflecting the positive correlations outlined in Table 1. Larger hedge positions in JPY and CHF increase portfolio volatility, showing these currencies may be considered safe havens to which investors might flee when global equity markets are under pressure.

The USD plays a special role. Figure 6 (Risk profile of single currency hedge) plots relative changes in overall portfolio volatility against the HR for USD, GBP and JPY. For a USD hedge portfolio volatility initially decreases, reaching a minimum at an HR of around 30%, but thereafter increases, reaching its original level at an HR of around 60%. A full hedge of USD position increases the volatility by around 2%, which is close to the effect of a full hedge of JPY. This result could not have been inferred from the comparison of return correlations conducted above. The returns of JPY exhibit a -23% correlation with the MSCI World Index returns, compared to USD's +9%.

To reconcile our findings on return correlations with the relationship between portfolio volatility and USD HR we compare the volatility of the MSCI World Index with the overall portfolio volatility when a full USD hedge is implemented. Specifically, we calculate these volatilities over the past 126 trading days, so allowing us to observe variations in volatility over time. The volatility of the hedged portfolio is measured relative to the index volatility.

The same pattern can be seen during the 2011 euro crisis. With volatility in equity markets peaking once more, USD hedge again increased portfolio volatility considerably. In both cases the volatility contribution of the USD hedge returned to negative only with a lag.

Despite the large share of equities denominated in USD in the MSCI World Index, the effect of a USD hedge on portfolio volatility as depicted in Figure 6 seems rather small, ranging from -0.5% to +2%. It is worth noting, though, that these figures are calculated using the entire sample, and Figure 7 shows they are merely the average of positive and negative effects depending on the state of the market. Temporarily, there can be substantial reductions or amplifications of portfolio volatility.
Table 2 (*Portfolio skewness in the face of a single-currency full hedge*) presents the sample skewness of portfolio returns when a full hedge is implemented for each of the foreign currencies. It also shows the relative change in absolute skewness compared to the stand-alone equity portfolio. Intuitively speaking, the skewness measures how uneven returns are distributed above and below the mean. A negative skewness indicates that returns substantially below the mean are more likely than returns substantially above the mean. If no currency hedge is implemented then the sample skewness of the equity portfolio is -2%.

A full hedge of USD currency risk increases the absolute portfolio skewness by 49% – i.e. from -2% to -3%. This reflects our previous finding that a USD hedge dampens volatility when equity markets are calm but amplifies volatility even further when markets are in distress. Overall, large negative returns become more likely than large positive returns.

This explains the non-monotonous relationship between the USD HR and portfolio volatility. For small HRs of up to 30% the increase in skewness remains modest and the portfolio volatility is reduced because of the positive (albeit small) correlation between USD and MSCI World Index returns. The portfolio returns become more and more skewed to the left as the HR becomes larger, as a result of which this effect starts to dominate overall portfolio volatility.

We do not observe a similar interaction for other currencies. A full hedge of GBP reduces rather than increases the absolute skewness and therefore does not interfere with the volatility reduction through correlation of returns. A full hedge of JPY increases the absolute skewness of portfolio returns by 12.9%, but, because the currency and equity returns are negatively correlated anyway, the effects through skewness and correlation work in the same direction. For all other currencies the change in absolute skewness due to a full hedge is negligible.

Based on our analysis of the hedging of foreign currencies in the MSCI World Index, we can propose the following guidelines for managing FX risk:

1. For an investor from the Eurozone CHF and JPY served as a natural hedge against global equity risk during the period considered. Provided they continue to play this role, these two currencies should not be hedged.

2. A full hedge of GBP seems advisable. This currency has a relatively high share in the MSCI World Index, and hedging against it did not reduce portfolio performance during the period considered.

3. The USD serves as a natural hedge when equity markets are volatile. Hedging USD exposure in normal times and leaving this position open in stress periods can offer significant potential to reduce portfolio volatility. However, it is vital to note that this strategy depends on an ability to identify stress periods.

---

Symmetric distributions have a skewness of 0. The Jarque-Bera test exploits this property among others to test whether a sample was drawn from a normal distribution. In our current example we cannot reject the hypothesis of a normal distribution for the MSCI World returns. Likewise, we cannot reject the hypothesis of normally distributed returns when a full hedge is implemented for any of the foreign currencies, despite the increase in absolute skewness documented in Table 2 (*Portfolio skewness in the face of a single-currency full hedge*).
As a final step, let us hedge all foreign currencies simultaneously and compute the HRs for each so that the overall portfolio volatility is minimised. This is achieved by a full hedge of the pound sterling, the Norwegian krone, the Canadian dollar, the Australian dollar, the Swedish krona, the New Zealand dollar, the Singapore dollar and the Israeli new shekel; a hedge ratio of 18.3% for the US dollar; and no hedging for the remaining currencies. The strategy is in keeping with the guidelines proposed above.

The volatility of this optimised portfolio is 16.09% per annum, whereas the corresponding figure for the stand-alone equity portfolio is 16.65%. The potential gains from hedging FX risk in global equity portfolios might therefore seem rather limited, but we should keep in mind that the meagre reduction in volatility is most probably caused by the ambivalent role, as described previously, of the US dollar. A dynamic hedging strategy that adjusts the US dollar hedge to the current state of the market could prove more effective.

Our findings are in line with the results obtained by De Santis and Gérard (1998), who also drew on data for the MSCI World Index and found the share of currency risk in total portfolio risk is small on average but might be substantial during certain periods. Given that stocks denominated in US dollars make up more than 50% of the MSCI World Index, portfolio volatility is particularly responsive to the management of US dollar risk. Campbell et al (2010) consider a more balanced global equity portfolio in which each currency has a weight of around 14%, leading to a scenario in which the risk-minimising hedge for an investor from the Eurozone reduces the annualised portfolio volatility from 17.67% to 12.51%.

4 Conclusion

The ability to successfully manage the risks associated with foreign exchange has become increasingly attractive as more investors turn to international portfolio diversification in the face of low-yielding domestic markets. The issue has been whether risk management of this kind is possible and, if it is, whether it can prove genuinely effective. In this article we investigated this question by discussing FX in a portfolio context from two different perspectives.

We began with an examination of two potential strategies based on the view that FX constitutes an asset class of its own. Firstly, using the uncovered interest rate parity, we showed interest rate differentials across currencies cannot be exploited to increase returns, as they will be offset by exchange rate adjustments. Secondly, we briefly surveyed the academic literature on exchange rate predictability and concluded that systematic exchange rate speculation strategies remain dubious at best.

It is the second view of FX that offers significantly more hope. From this perspective the argument is that FX should be regarded as part of the money market class of assets and that risk managers should therefore be able to improve the overall risk-return profile of a portfolio by exploiting the opportunities that arise from currency-related diversification. In short, the theory is that we should be able to treat FX as a risk factor in the investment universe and aim to manage it to our advantage.
To test this theory we assessed a hedging strategy in the context of a global equity portfolio that relies on taking hedge positions in foreign currencies via forward contracts. We found that for an investor from the Eurozone CHF and JPY provide a natural hedge against global equity risk; that a full hedge of GBP is advisable; and that the USD seems to require a dynamic strategy that adjusts to market conditions. Although the overall potential for volatility reduction through mitigating exchange rate risk might be reduced in the event of further transaction costs that were not considered here, our analysis has allowed us to propose a number of guidelines for the risk management of FX.

5 References


