CURRENCY RISK MANAGEMENT IN BOND PORTFOLIOS

Quantitative Currency Management

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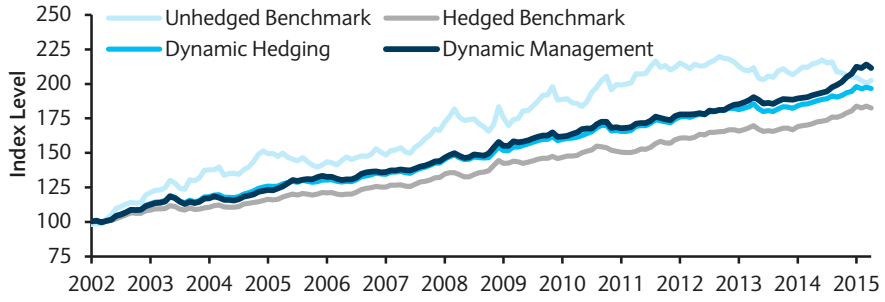
Recent volatility in the currency markets and the strengthening US dollar have made the topic "to hedge or not to hedge" popular once again. Despite advances in the development of alternate-weighted asset class benchmarks using risk and fundamental data, currency hedging in benchmarks remains rudimentary. Typically, the choice is restricted to either an unhedged or a fully currency hedged benchmark. We reassess the currency hedging landscape through the lens of factor-based investing, in the process developing a dynamic currency management framework as an alternative. Compared with passive currency hedging, this approach offers the potential to enhance portfolio performance by systematically harvesting currency returns via well-established alternative risk premia strategies.

- Market value-weighted global indices tend to concentrate exposure in a handful of currencies. As a result, a small set of liquid currencies can be used to hedge currency exposure efficiently.
- Carry and trend signals provide a mechanism for determining dynamic hedge ratios separately for each currency in a portfolio. Depending on investor preferences and institutional constraints, we present two options for determining these hedge ratios: Dynamic Hedging either retains or hedges out currency exposure, while Dynamic Management goes a step further and allows outright short currency exposure. Our baseline comparison in this paper is with the Barclays Global Treasury Index.
- The dynamic currency management framework can be used to construct an alternative benchmark that would be of particular interest to passive investors, as well as those who tactically manage currency risk and want to measure the benefits of active management.
- Since 2002, a US investor using the dynamic currency management framework would have achieved returns comparable to that of the unhedged benchmark index, with volatility comparable to that of the hedged benchmark index.

FIGURE 1

Dynamic Currency Management versus Static Benchmarks



Source: Barclays Research

Is currency risk peripheral or integral to portfolio returns?

A question on many investors' minds is whether the currency exposure embedded in global portfolios should be considered an integral part of the investment. This consideration has come to the fore once again since the US dollar began its strengthening cycle in the second half of 2014, the euro has been hamstrung by weak eurozone growth and concerns about Greece, and emerging markets have experienced divergent regional growth forecasts. To put the currency effect into perspective, since January 2013, a US investor's decision to hedge currency risk in the Barclays Global Aggregate Index would have resulted in a performance difference of almost 12%, a sizeable return for any fixed income investor (Figure 2). A similar example in equity markets was the effect of the yen on Japanese equity returns received by US investors (Figure 3).

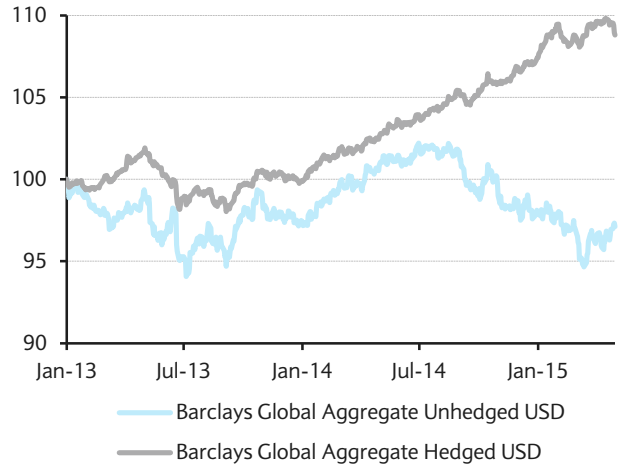
In developed market portfolios, currency returns are incidental to the investment, and bond portfolios are typically currency hedged. In this paper, we argue that dynamic currency management can unlock risk premia embedded in the currency markets and provide an additional source of uncorrelated returns for developed markets bond portfolios. In contrast, in emerging markets investments, currency returns are, in effect, the investment itself[1]. Thus, unlike in developed market investments, hedging currency exposure in emerging market portfolios is not strictly "hedging", but essentially amounts to active management. In this context, applying our dynamic currency management framework to emerging markets portfolios can be thought of as a systematic way to harvest risk premia embedded in emerging markets and can be characterized as an enhanced beta investment.

Two factors that strongly advocate for the management of currency risk in isolation from asset class risk are:

- The growing popularity of factor-based portfolio construction
- Investor realization that (bond and equity) manager expertise in currency management needs to be carefully assessed.

FIGURE 2

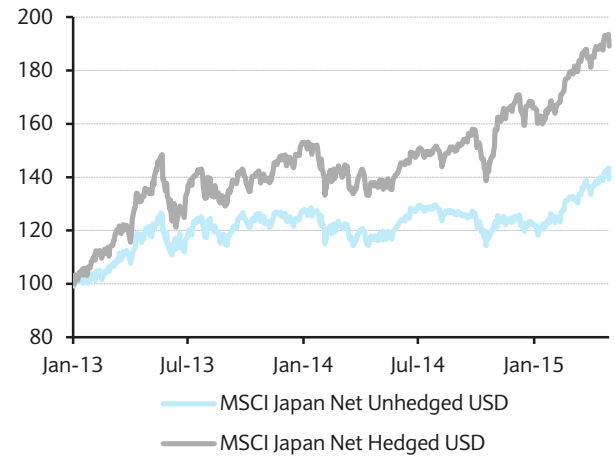
Global bond returns: Effect of hedging (Jan 2013-Apr 2015)



Source: Barclays Research

FIGURE 3

Japanese equity returns: Effect of hedging (Jan 2013-Apr 2015)



Source: Bloomberg

[1] See *Emerging Markets Investment Insight: It's almost all in the currency exposure*, November 2011 and *Replicating EM Risk Premia: Synthetic access to the EM local bond market*, September 2013.

Under these circumstances, managers need to be assigned appropriate benchmarks against which to measure performance. While alternatives to market value-weighting, such as fundamental- or factor-weighting, have gained significant attention, currency management has remained fairly rudimentary. Foreign investments are typically benchmarked to a fully currency hedged or unhedged index. As a result, many institutional investors choose to adopt a policy portfolio that passively hedges currency risk with a static hedge ratio (frequently 100% for bonds) while employing a currency overlay manager. The mandate of the overlay manager is to vary hedge ratios tactically to add returns.

In this paper, we propose a dynamic currency risk management framework that can be used to construct a benchmark index. This would be of interest to:

- Passive investors whose only options currently are either fully hedged or completely unhedged benchmarks; and
- Investors who tactically manage currency risk and want a more appropriate benchmark to measure the benefits of active management.

The decision on how to manage currency exposure in a global portfolio optimally is complex. Some of the questions that need to be addressed are:

- **Objective**: Is the aim to maximize expected returns, minimize expected risk or maximize expected risk-adjusted returns?
- **Liabilities**: Should the currency risk of liabilities be considered along with that of the asset portfolio?
- **Aggregation**: Should currency risk be considered at the aggregate portfolio level or manager/asset class level?

The "one-size-fits-all" approach is obviously problematic, given the range of specifications implied above. For the sake of simplicity, we focus our discussion on the issues related to managing the currency risk of a global government bond portfolio that is predominantly invested in developed markets. This can be easily extended across the asset class and currency spectrum to encompass a broad asset class benchmark or to more specific, narrowly defined portfolios. We divide the paper into three parts: discuss the motivation for managing currency risk in global portfolios; explain how well-established alternative risk premia signals such as carry and trend can be used to construct a currency management strategy; and highlight some practical issues encountered by practitioners. All results in the paper are shown for a US dollar investor. Our methodology can be applied, with similar results, to any base currency. Results for euro, sterling and yen base currency investors are shown in the Appendix.

The case for managing currency risk

It is widely accepted that investors can benefit from holding well-diversified portfolios. Traditionally, diversification has been sought via multiple asset classes and geographies. International asset diversification introduces currency risk into portfolios–a risk that long-term investors may or may not be compensated for bearing. For example, while an emerging market currency may reasonably be expected to appreciate over time, the same is not clear for a G10 currency. Currency returns can have a significant effect, especially over short time frames. Figure 4 shows the performance of unhedged and hedged global equity and fixed income benchmarks in 2014.

FIGURE 4

2014 performance of unhedged and hedged asset class benchmarks

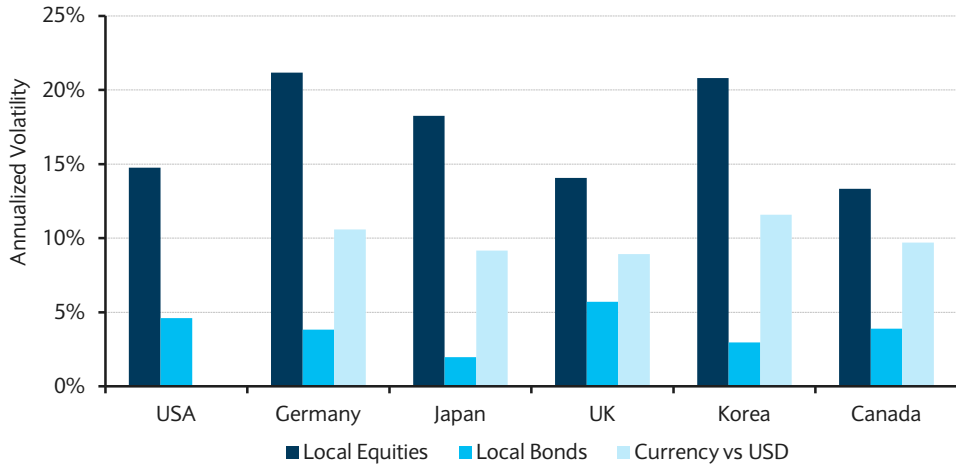
	Global Equities MSCI World Net USD TR		Global Fixed Income Barclays Global Aggregate USD TR	
	Unhedged USD	Hedged USD	Unhedged USD	Hedged USD
Total Return	4.94%	9.71%	0.59%	7.59%
Volatility	11.55%	11.92%	3.67%	1.46%
Sharpe ratio	0.41	0.80	0.12	5.06

Source: Bloomberg, Barclays Research

Regardless of return, currency exposure contributes to the risk of the investment. Given differences in the levels of asset class volatility, the case for managing currency exposure is strongest for global bond portfolios. Figure 5 displays the volatilities of local currency equity and bond returns and currency returns (versus the US dollar) for the six countries with the largest market value in the Barclays Global Treasury Index. Over the past 13 years, currency volatility was significantly greater than local bond return volatility for all five foreign countries (from the US perspective).

FIGURE 5

Comparing volatility: Local equity, local bond and currency returns for a US dollar investor (Jan 2002-Apr 2015)



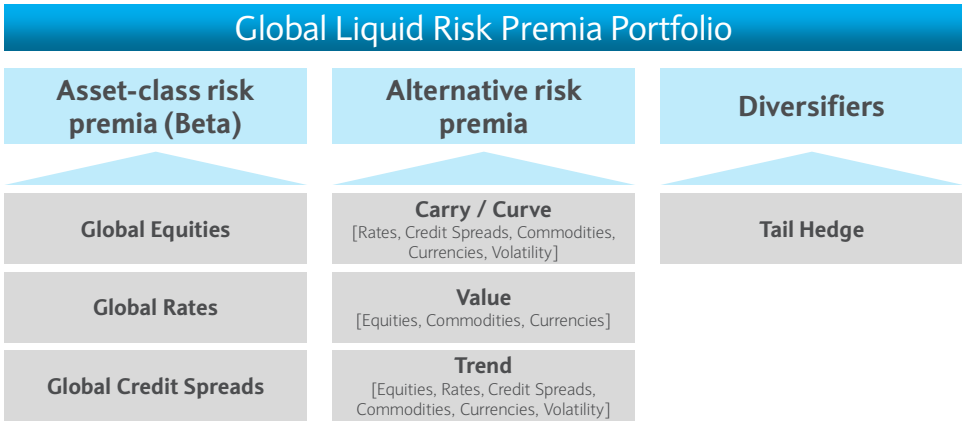
Source: Bloomberg, Barclays Research

Risk-based asset allocation

Before we address currency risk management, it is useful to revisit the role of risk in asset allocation. We have written about constructing well-diversified, robust portfolios using risk premia building blocks rather than asset class building blocks (see, for example, *Investing with Risk Premia Factors: Return sources, portfolio construction, and tail risk management*, July 2012). The key takeaway is that the investment universe should be thought of as systematic sources of risk and return (risk premia) that transcend asset class classifications. We advocate decomposing the different components of risk – for example the interest rate, credit and currency risk in a foreign corporate bond – and, in the absence of performance views, implementing a risk diversification policy across the identified risk premia. In addition to the standard asset risk premia (eg, equity and interest rates), the complete investment universe includes alternative risk premia such as those associated with carry, value and trend.

FIGURE 6

Systematic asset allocation example: Building blocks



Source: Barclays Research

The portfolio building blocks in the standard classification table are given in Figure 6. With the exception of the hedge, they each represent distinct risk premia, ie, the expectation of positive returns, in excess of the cash rate, in exchange for bearing certain recognized risks. We do not place currencies under the "traditional risk premia" umbrella since there is little evidence to suggest passive developed market currency exposure would accrue positive returns over time. Risk premia tend to display performance differences over the business cycle. In the absence of forecasts, a balanced exposure to all building blocks – typically via a risk-based approach – is advisable. The risk premia approach can be easily modified to fit an asset class-based view of the world, with the drivers of returns per asset class decomposed into the constituent risk premia. In the case of a fixed income investor, a typical decomposition would involve separating interest rate, credit spread and currency risk exposures. From an investment standpoint, the benefits are clear: it allows each source of returns to be optimally managed and the interaction effects between multiple factors to be more easily identified.

Almost all investors with international bond or equity exposure are aware of embedded currency risk. There are three options available to manage this: maintain the currency exposure (passively), fully hedge the exposure (statically), and get tactical exposure to currencies. While the first option is primarily adopted by emerging market debt investors (due to the available carry), developed market bond investors frequently adopt the latter two options. In the third case, asset owners often outsource the tactical currency management role to a currency overlay manager in the form of an absolute return mandate. The overlay manager typically implements the mandate in a two-step process: 1) hedge all currency exposures in the proportion of the benchmark weights and 2) add returns by taking on (unfunded) currency exposures as per fundamental or quantitative views. The aim is to provide additional sources of returns with a low correlation to the underlying asset returns.

In earlier publications, we have discussed the diversification properties of alternative risk premia across all asset classes. Here, we show how investors can apply these style-based signals to currency markets to construct robust tactical overlays.

How should we approach currency hedging?

The risk factor approach to investing essentially views the embedded currency exposure in a global bond portfolio as a distinct source of returns. In the case where there is only a single foreign currency in the bond portfolio, a standard mean-variance optimization (MVO) framework postulates the optimal currency hedge ratio as a function of the currency's

expected return and its forecasted covariance with the local bond return.[2] If the currency's expected return and its correlation to the local bond return are both zero, the optimal hedge ratio is 100%. It is less than 100% under two conditions:

1. The expected currency return is positive (return enhancement) or
2. Currency and local bond returns display a negative correlation (portfolio diversification)

When we extend this to a framework with two or more currencies, the calculation is considerably more complex. Additional terms that require consideration are the cross-correlations between all currency returns and all local bond returns. In a portfolio such as the Barclays Global Treasury Index (containing 24 currencies), this would require forecasting in excess of 850 correlations. In prior publications, we discuss the shortcomings of MVO (see, for example, *Risk-Based Asset Allocation*, June 2014), namely that forecasting correlations are challenging, short-term returns are difficult to predict accurately, MVO portfolios are not robust because the resulting weights are extremely sensitive to the forecasted returns and correlations, and some MVO solutions can be unintuitive.[3] By making some simplifying assumptions about correlations, we present a hedging solution that is computationally more tractable and yields intuitive solutions.

Empirical analysis suggests that, on average, correlations between currencies and local bond returns are near zero. We opt not to include cross-correlations – the chief source of complexity – in determining a currency's hedge ratio, because taken over a large number of instruments, these tend to shrink towards zero. Consequently, in our framework, a currency's hedge ratio requires only the expected return forecast of the currency's return.

Local bond and currency correlations

Over a 40-year period, the average correlations of local currency bond returns and currency returns were close to zero (Figure 7).

FIGURE 7

Correlations of local currency bond returns to currency returns (Jan 1975-Apr 2015)

	Investment currency	USA	EUR	JPY	GBP	KRW†	CAD	Avg |ρ|
Base currency	USA		15%	24%	4%	26%	10%	13%
	EUR	-18%		6%	8%	25%	-9%	11%
	JPY	-18%	-1%		-7%	0%	-12%	6%
	GBP	-11%	10%	12%		41%	-7%	13%
	KRW†	4%	2%	14%	-16%		-22%	10%
	CAD	-2%	16%	20%	7%	31%		13%
								11%

† Data for Korea were available only from 2002.

Note: For all six countries, Barclays Global Treasury Index data were used from 2002. From 1975 to 2002, local currency bond and currency returns for all countries except Korea were proxied using a combination of central bank and Bloomberg data. Source: Various central banks, Bloomberg, Barclays Research

[2] See Jorion (1994) and Campbell et al (2007).

[3] A mean-variance optimizer may assign a large positive weight to a currency with zero or negative expected returns if the diversification benefit of the currency return – due to low or negative forecasted correlations to other currencies or bonds – is deemed sufficient. In addition, if two currencies have positive expected returns but are highly correlated, a mean-variance optimizer may prescribe a long position in the currency with the higher expected return and a short position in the currency with the lower expected return. In such cases, a small error in expected return estimates can have a large effect on subsequently realized portfolio performance.

Currency returns

Over extended periods, investors with emerging market currencies exposure have benefited from currency appreciation. This is driven primarily by differences in productivity growth rates and institutional uncertainty and is termed the EM risk premium (see *The EM FX carry premium*, September 2010). In contrast, passive long exposure to developed market currencies has not yielded meaningful returns (Figure 8 and Figure 9). The yen base currency case is somewhat of an exception, as it realized annualized returns of nearly 1.2% (unsurprising, since the yen has been a popular funding currency in the carry trade).

FIGURE 8

Annualized currency excess returns (Jan 1975-Apr 2015)

Investment currency		USA	EUR	JPY	GBP	KRW†	CAD	Avg ER
Base currency	USA		0.07%	-0.34%	1.21%	1.56%	0.73%	0.65%
	EUR	-0.19%		-0.45%	1.03%	-0.18%	0.54%	0.15%
	JPY	0.30%	0.52%		1.53%	2.51%	1.03%	1.18%
	GBP	-1.24%	-1.16%	-1.56%		0.20%	-0.51%	-0.85%
	KRW†	-1.55%	0.11%	-2.47%	-0.23%		0.86%	-0.65%
	CAD	-0.73%	-0.66%	-1.06%	0.48%	-0.90%		-0.57%
								-0.02%

† Data for Korea were available only from 2002.

Note: Returns are annualized geometric returns over the sample period. For all six countries, Barclays Global Treasury Index data were used from 2002. From 1975 to 2002, currency returns for all countries except Korea were proxied using a combination of central bank and Bloomberg data. Source: Various central banks, Bloomberg, Barclays Research

FIGURE 9

Sharpe ratios of currency returns (Jan 1975-Apr 2015)

Investment currency		USA	EUR	JPY	GBP	KRW†	CAD	Avg SR
Base currency	USA		0.01	-0.03	0.12	0.13	0.11	0.07
	EUR	-0.02		-0.04	0.12	-0.02	0.05	0.02
	JPY	0.03	0.04		0.13	0.19	0.08	0.09
	GBP	-0.12	-0.13	-0.12		0.02	-0.05	-0.08
	KRW†	-0.13	0.01	-0.18	-0.02		0.08	-0.05
	CAD	-0.11	-0.06	-0.08	0.05	-0.08		-0.06
								0.00

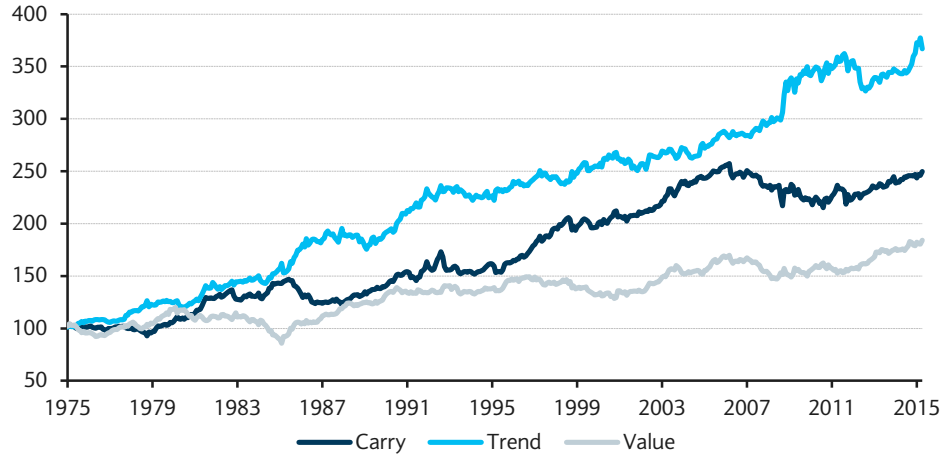
† Data for Korea were available only from 2002.

Note: For all six countries, Barclays Global Treasury Index data were used from 2002. From 1975 to 2002, currency returns for all countries except Korea were proxied using a combination of central bank and Bloomberg data.
Source: Various central banks, Bloomberg, Barclays Research

While there is little evidence to support the existence of an "asset class beta" in developed currency markets, alternative betas (commonly discussed as style betas) – the best known of which are carry, value and trend – can be harvested via the currency markets. We have elaborated on each of these styles in prior publications (for example, see *Barclays Capital Risk Premia Family: Sequencing the strategy genome*, May 2011). In brief, currency carry strategies involve investing in high yielding currencies and funding the investment in low yielding ones. Trend strategies seek to identify trends in currency movements and take long/short positions based on these. Value strategies seek to take long/short positions in currencies based on deviations from a model-implied fair value metric (e.g., the purchasing power parity (PPP) model). These alternative risk premia have been extensively documented in financial literature and have long been used by active investors in an attempt to earn superior risk-adjusted returns.

FIGURE 10

Carry, trend and value strategies' hypothetical performance (Universe: USD, EUR, JPY, GPB, KRW and CAD)



Note: For all six countries, Barclays Global Treasury Index data were used from 2002. From 1975 to 2002, currency returns for all countries except Korea were proxied using a combination of central bank and Bloomberg data. Data for Korea were available only from 2002.
Source: Various central banks, OECD, Bloomberg, Barclays Research

Based on the six-currency universe discussed earlier, Figure 10 illustrates the back-tested performance of simple implementations of strategies that utilize carry, trend and value signals. For simplicity, all returns are US dollar denominated, currencies are assigned equal notional weights within each of the three strategies and signal and weight rebalancing is carried out monthly:

- The carry strategy takes a long (short) position in all foreign currencies that have a positive (negative) interest rate differential vis-à-vis the US dollar.
- The trend strategy takes a long (short) position in any currency that has a positive (negative) excess return (ie, spot return plus carry return) versus the US dollar over the previous three months.
- The value strategy takes a long (short) position every month in any currency that is overvalued (undervalued) compared with its PPP in relation to the US dollar.

Over the past four decades, these simple strategies would have realized Sharpe ratios between 0.31 (value) and 0.66 (trend). This suggests that dynamic currency management using alternative risk premia signals has the potential to yield significant positive returns.

The return data in Figure 8 and Figure 9 represent full-sample statistics. Over shorter periods, individual currencies have accrued substantial gains or losses, but with cumulative returns tending to be mean-reverting over the longer run. In light of the success of alternative risk premia signals to predict expected short/mid-term currency movements, we believe risk-adjusted returns can be improved by utilizing these signals to inform the hedging decision.

Currency hedge ratio

The factor-based approach deems currencies to be a source of returns independent of fixed income markets. In this context, the question of establishing a suitable global bond benchmark – tantamount to defining the optimal hedge ratio – can be answered using a standard portfolio optimization framework. In a two-factor (bonds and currencies) portfolio, the optimal currency hedge ratio (h) is a function of the correlation between the currency return and local bond return and the currency's expected return:

$$h = 100\% + \beta_{local\ bond,FX} - [\lambda \cdot \mu_{FX}]$$

If currency returns are uncorrelated to local bond returns (ie, their beta is zero) and currencies do not provide positive expected returns, the default currency hedge ratio would be 100% (fully hedged). On the other hand, if currency returns are uncorrelated to local bond returns but expected returns are positive, it would suggest an optimal hedge ratio of less than 100%. The two scenarios above correspond to longer-run horizons for developed and emerging market investments, respectively.

Since we know currencies (even within G10 markets) are prone to large short-run fluctuations, a natural concern is the static nature of the hedge ratio. Echoing the sentiments of Keynes, investors will not see a long run without surviving the short run. For shorter holding periods, carry and trend signals have been shown to generate positive currency returns in both developed and emerging market currencies. In the following section, we demonstrate how a 100% currency-hedged benchmark can be modified by incorporating carry and trend signals to manage the currency risk for a global government bond portfolio dynamically.[4] These signals not only account for shorter-run fluctuations but more broadly capture the differences in expected return between developed and emerging markets. In light of difficulties forecasting correlations and the generally low correlations between currency returns and local bond returns, we maintain the assumption that $\beta_{\text{local bond, FX}}$ is zero.

Establishing a currency overlay framework

We outline a systematic currency hedging methodology that can be applied across asset classes. Our aim is to offer an alternative to the standard fully hedged/unhedged benchmarks and provide a roadmap for a tradable implementation.

- Alternative benchmark: We outline a dynamic hedging approach that recognizes the existence of positive long-term expected returns sourced from alternative risk premia in the currency markets. Asset owners can use the index as an alternative to the fully hedged/unhedged benchmarks currently available.
- Tradable implementation: Given the variation in market value by country and currency trading costs, we propose a transparent methodology that uses a select currency basket.

We illustrate our approach using two versions of the Barclays Global Treasury Index: the US dollar unhedged Index (Bloomberg ticker: BTSYTRUU) and US dollar hedged Index (Bloomberg ticker: BTSYTRUH)[5]. The index is a market value-weighted composite of bonds from 38 countries, denominated in 24 different currencies, and is rebalanced monthly to account for inclusions/exclusions based on specified criteria. The large variations in the size of issuance mean a small number of countries have a disproportionate weight in the index. As of April 2015, the top six currencies (US dollar, euro, yen, sterling, South Korean won and Canadian dollar) comprised greater than 93% of the total index weight (Figure 11).

[4] We do not use the PPP-based value signal since it is not applicable to emerging market currencies and, thus, would restrict the extension of the currency management framework to other geographies.
[5] Neither of these benchmark indices includes currency transaction costs.

FIGURE 11

Concentration of weight: Percentage of total index weight of the six largest currencies (Jan 2002-Apr 2015)

Source: Barclays Research

Given the variation in transaction costs per currency6 and issuance by country, we select this subset of six currencies to illustrate the merits of dynamic currency management. Without loss of generality, the discussion in this paper can be used to modify, expand or contract the currency set. The trade-off is the cost of currency management versus the potential reduction in tracking error against a benchmark that statically hedges all 24 currencies.

We back-test our tradable implementation from 2002. Prior to this date, we construct a proxy index starting in 1975 using 10-year bond data from the US, Germany, Japan, the UK and Canada. For ease of exposition, the proxy index weights during 1975-2001 were backfilled using the normalized average historical country weights in the Barclays Global Treasury Index as of the end of April 2015. Our analysis is net of estimated transaction costs, and the carry and trend signals used are identical to those described in the previous section.

Constructing the currency overlay

We present three distinct currency overlay portfolios.

1. **Static Hedging:** We first construct a tradable implementation of the Barclays Global Treasury US dollar hedged Index. We apply a five-currency overlay (EUR, JPY, GBP, KRW and CAD) on the unhedged bond index. For each of these currencies, 100% of the currency exposure is hedged. The notional amount of the currency forwards is sized to match the market value of the foreign bonds in the benchmark index. The remaining currency exposure in the benchmark is left unhedged. We chose these five currencies because they are liquid and tradable and, together with the US dollar, they comprise the majority of the currency exposure[7]. The results or operational complexity would not be very different had we selected a few more similarly liquid currencies. Tracking error is calculated versus the Barclays Global Treasury US dollar hedged Index.

[6] From 1-2bp for liquid currencies such as the EUR and GBP up to 10bp for some emerging market currencies such as the RUB and COP.

[7] In our analysis, we include a conservative estimate of currency forward trading costs by assuming a 6bp bid-offer spread for each of these currencies.

2. **Dynamic Hedging:** Every period, if our carry and trend signals predict positive currency returns for a given currency (of the five selected currencies), we retain some currency exposure by choosing a hedge ratio less than 100%. We compare the performance of the Dynamic Hedging portfolio to the Static Hedging portfolio to measure the efficacy of this dynamic approach.

3. **Dynamic Management:** This extends the dynamic hedging approach to replicate the mandate of an active currency overlay manager. Once again, carry and trend signals are used in tandem to modify the default hedge ratio of 100%. Positive signals reduce the hedge ratio below 100% (under-hedge), while negative signals increase the hedge ratio above 100% (over-hedge). Thus, the Dynamic Management approach is symmetric in its currency exposure and is more akin to how active currency overlay managers may position their portfolio to benefit from correctly identifying both appreciating and depreciating currencies.

Some key points pertaining to the general setup:

- Benchmark index weights are calculated at the end of each month. For ease of exposition, our analysis assumes the same-day implementation of currency hedges. The currency overlay is implemented through one-month currency forwards. A fully tradable implementation would typically use a two- or three-day lag between determination of the various currency forward positions and month-end trading of the forwards. The size of the lag affects the tracking error incurred versus a benchmark.

- Each period, the notional currency exposure for each currency forward is calculated using the expected end-of-period market value of each currency in the portfolio. Each bond's local currency expected return for the period, E^i_t, is predicted at the beginning of the period to be:

$$E_t^i = \left(1 + {}^{y_t^i}/_2\right)^{(1/6)}$$

  where y^i_t is the bond's yield. In any given month, the bond portfolio will either be slightly under- or over-currency hedged, given the amount that is hedged at the beginning of period is the estimated market value at the end of the period (ie, beginning-of-period market value plus yield).

- The Dynamic Hedging and Dynamic Management frameworks utilize the same signals (carry and trend) to vary hedge ratios. The only difference lies in the amount of currency exposure implied by the signal:

  - Dynamic Hedging allows for one of two possible hedge ratios: if the carry and trend signals both predict positive currency returns for a given currency, the hedge ratio is set to 50% (bullish); otherwise, it remains at 100% (neutral or bearish).

  - Dynamic Management allows for one of three possible hedge ratios: if the carry and trend signals both predict positive currency returns for a given currency, we set its hedge ratio to 50% (bullish). If both signals predict negative returns, we set its hedge ratio to 150% (bearish). If the two signals do not agree on the direction of expected currency returns, the hedge ratio is left unchanged at 100% (neutral).

  - While the bullish and bearish hedge ratios could be set to any value, we believe a 50% deviation from neutral is reasonable because it results in roughly equal risk allocations to the fixed income and currency premia, given the average volatilities of local currency bond and currency returns.

The aggregate return of each of these three portfolios is calculated as the sum of the Unhedged Bond Index returns and the currency overlay returns. The currency overlay return for each period (t,t+1) is a function of forward exchange rates, changes in spot exchange rates and the interest rate differentials between countries. For the Static Hedging case:

$$FXO^{S}_{t,t+1} = H\sum_{i=1}^{n}\left[w^{i}_{t}\cdot\left(1+E^{i}_{t}\right)\cdot r^{i}_{t,t+1}\right]$$

$$r^{i}_{t,t+1} = \frac{S^{i}_{t+1}-F^{i}_{t}}{S^{i}_{t}}$$

$FXO^{S}_{t,t+1}$ is the Static FX Overlay portfolio's return over the period t,t+1. i, w^{i}_{t}, y^{i}_{t} and $r^{i}_{t,t+1}$ represent the currencies in the overlay portfolio, the beginning-of-period weight of each currency in the Unhedged Bond portfolio, the beginning-of-period weighted average yield of each currency's bonds in the Unhedged bond portfolio and the period's currency return for each currency. S^{i}_{t+1} is the end-of-period spot exchange rate for currency i and F^{i}_{t} is the beginning-of-period forward exchange rate for currency i. The hedge ratio (H) is set to 1 for all currencies in the Static Hedging case.

In the case of the two Dynamic portfolios, the hedge ratio is a function of the carry and trend signals and is determined each period on a currency-by-currency basis. The equation for the returns of the Dynamic FX Overlay, $FXO^{D}_{t,t+1}$, is amended to:

$$FXO^{D}_{t,t+1} = \sum_{i=1}^{n} H^{i}_{t}\cdot\left[w^{i}_{t}\cdot\left(1+E^{i}_{t}\right)\cdot r^{i}_{t,t+1}\right]$$

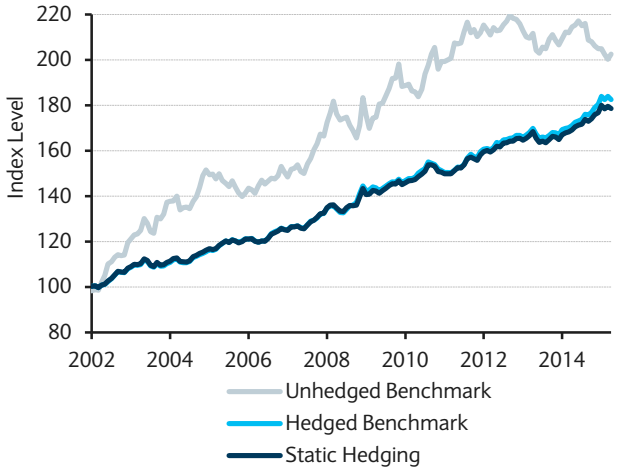
All performance statistics subsequently shown for the Static and Dynamic Hedging and Management overlays are net of estimated currency forward transaction costs.

Static Hedging tracks the benchmark

Over the sample period 2002-15, the statically hedged portfolio closely tracked the Hedged benchmark (Figure 12). Monthly deviations in the difference in returns were random, albeit with some time variation in the magnitude (Figure 13).

FIGURE 12

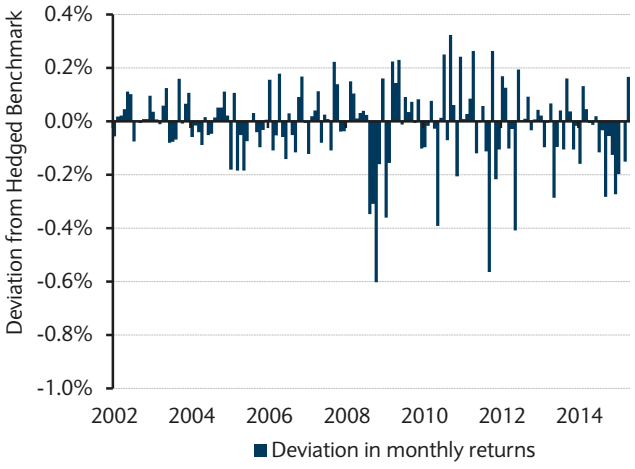
The Static Hedging approach closely tracks the benchmark



Source: Barclays Research

FIGURE 13

Monthly deviations display a random pattern



Source: Barclays Research

The performance statistics reflect the relatively small tracking error (14bp per month) between the Static Hedging portfolio and the fully hedged benchmark (BTSYTRUH). Risk-adjusted returns, along with downside risk metrics, are similar. Tracking error exists since the Static Hedging methodology hedges only five currencies and includes estimated currency overlay trading costs.

FIGURE 14

Static Hedging vs Hedged Benchmark (BTSYTRUH)

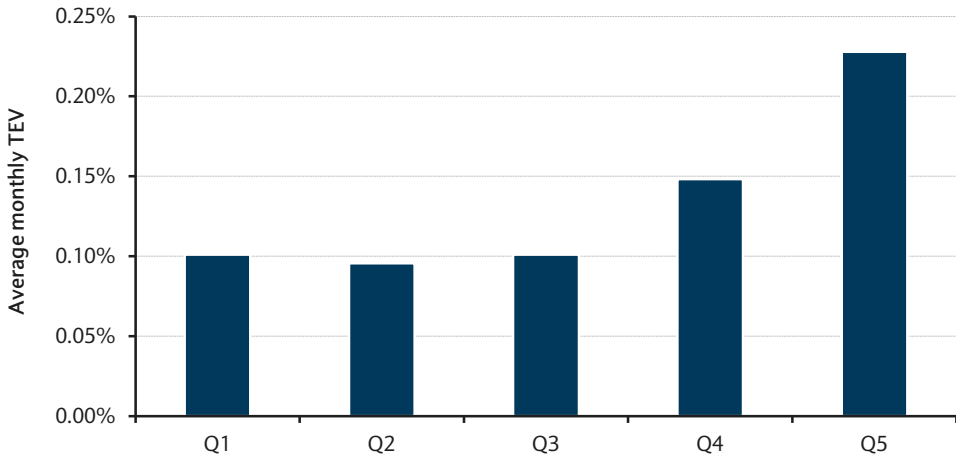
	Hedged Benchmark	Static Hedging
Full sample (2002–15)		
Annualized returns	4.6%	4.4%
Annualized volatility	2.8%	2.8%
Return/Volatility	1.63	1.56
Maximum drawdown	3.1%	3.0%
Skewness	-0.06	-0.18
TEV (bps / mo)		14
1st half (2002–08)		
Annualized returns	5.4%	5.3%
Annualized volatility	3.0%	3.0%
Return/Volatility	1.82	1.76
2nd half (2009–15)		
Annualized returns	3.8%	3.5%
Annualized volatility	2.7%	2.7%
Return/Volatility	1.40	1.32

Source: Barclays Research

Given the truncated set of selected currencies, investors typically want to know the factors affecting tracking error. In particular, does it increase during crisis periods? We examine the relationship between tracking error – defined as the absolute deviation from benchmark returns – and FX market implied volatility (The Barclays G10 FX Risk Index). Unsurprisingly, there is a progressive increase in TEV in the fourth and fifth quintiles, with little discernible difference during the other periods (Figure 15). This seems to imply that most of the time, the currency risk of the other eighteen currencies in the benchmark do not contribute greatly to portfolio risk, given their small market value weights.

FIGURE 15

Tracking error is a function of FX implied volatility levels



Source: Barclays Research

Dynamic Currency Hedging and Dynamic Currency Management

Using the Static Hedging framework as a starting point, we introduce simple, rules-based signals to construct the Dynamic Hedging and Management portfolios and back-test all three strategies over a forty-year period. The carry and trend signals are used on a per currency basis to vary the hedging overlay on a monthly frequency. The difference between the Hedging and Management cases is the amount of currency exposure when both signals have a bearish view on the foreign currency.

The no-view hedge ratio is 100%. To vary the hedge ratio, both signals must take the same view ('bearish'/'bullish'). In the event both measures signal a bullish environment for the foreign currency, 50% of the currency exposure is hedged. If both signals are bearish on the foreign currency, the hedge ratios differ:

- Dynamic Hedging: 100% of the bond notional is hedged for the month-ahead
- Dynamic Management: 150% of the bond notional is hedged for the month-ahead

FIGURE 16

Static Hedging, Dynamic Hedging and Dynamic Management: Measuring performance

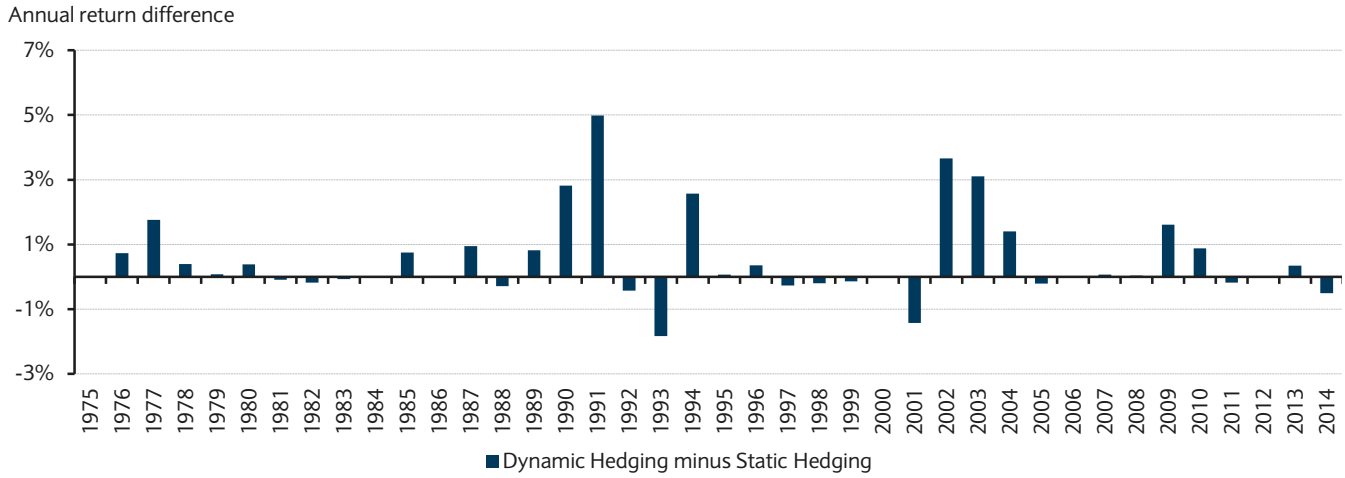
	Unhedged Benchmark (BTSYTRUU)	Hedged Benchmark (BTSYTRUH)	Unhedged Returns	Static Hedging	Dynamic Hedging	Dynamic Management
Full sample (1975-2015)						
Annualized returns			8.7%	8.2%	8.7%	9.7%
Annualized volatility			9.4%	4.9%	5.1%	5.0%
Return / Volatility			0.92	1.67	1.72	1.94
Maximum drawdown			19.5%	8.0%	8.0%	8.5%
Skewness			0.35	0.34	0.34	0.13
1st half (1975-95)						
Annualized returns			12.5%	10.5%	11.2%	12.0%
Annualized volatility			11.0%	5.8%	6.0%	5.7%
Return / Volatility			1.14	1.81	1.87	2.11
2nd half (1996-2015)						
Annualized returns			4.6%	5.6%	6.1%	7.2%
Annualized volatility			7.1%	3.5%	3.7%	4.0%
Return / Volatility			0.65	1.63	1.63	1.82
Benchmark history (2002-15)						
Annualized returns	5.4%	4.6%	5.4%	4.4%	5.2%	5.8%
Annualized volatility	6.9%	2.8%	6.9%	2.8%	3.3%	3.4%
Return / Volatility	0.79	1.63	0.79	1.56	1.58	1.70
TEV (bps / mo)				14	44	51
Information ratio				-0.33	0.37	0.64

Note: TEV is calculated with respect to the Hedged Benchmark Index. Information ratio is the ratio of annualized outperformance to annualized TEV. Source: Barclays Research

While the Dynamic Hedging model provided similar risk-adjusted returns to the Static Hedging model, it delivered an additional 55bp of returns per annum. The positive bias (both frequency and magnitude) of difference in annual returns between Dynamic Hedging and Static Hedging returns highlights the efficacy of the signals (Figure 17).

FIGURE 17

Dynamic hedging versus Static Hedging: Mapping outperformance (1975-2014)

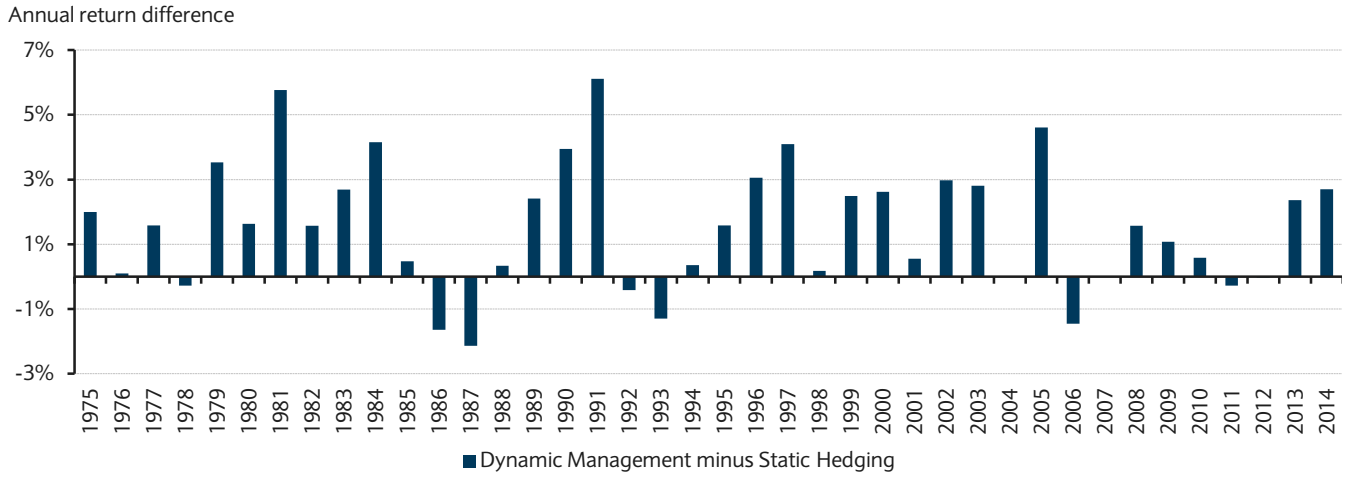


Source: Barclays Research

By allowing currency exposures to be symmetric – by allowing over-hedging of foreign currencies if both signals are bearish – we see a clear benefit in terms of risk-adjusted returns (relative to the Dynamic Hedging case) while giving-up little in downside risk (Figure 17). Figure 18 shows this increased benefit to returns: 155bp per annum over Static Hedging.

FIGURE 18

Dynamic Management versus Static Hedging: Mapping outperformance (1975-2014)



Source: Barclays Research

From Benchmark to Strategy: A practitioner's considerations

The hedging methodology discussed above can be easily adapted to include more currencies. In the static case, a larger currency set would reduce tracking error while potentially raising the average cost of hedging as more illiquid currencies are introduced. The dynamic approach to currency management provides investors with an alternative set of benchmarks to the standard "all-or-nothing" approach to hedging. These benchmarks are of particular interest to investors who employ currency overlay managers and those who believe alternative risk premia can be fruitfully harvested in the currency world. In this section, we briefly examine a few topics that are of interest to practitioners.

Other Base Currencies

Our results can be extended to other base currencies. Summary results for euro, sterling and yen investors in the Barclays Global Treasury Index are shown in Figure 19, with more detailed results presented in the appendix. Over the forty-year back-test period, Dynamic Management would have generated returns in excess of Static Hedging of more than 1% per annum in each of these currencies.

FIGURE 19

Static Hedging versus Dynamic Hedging and Dynamic Management: Annualized Returns and Volatility (Jan 1975–Apr 2015)

	Unhedged returns	Static Hedging	Dynamic Hedging	Dynamic Management
EUR				
Annualized return	7.8%	7.4%	8.0%	8.5%
Annualized volatility	7.5%	4.9%	4.8%	5.0%
Return / Volatility	1.0	1.5	1.7	1.7
Maximum drawdown	19.0%	10.3%	9.0%	9.0%
GBP				
Annualized return	9.8%	10.5%	10.8%	11.8%
Annualized volatility	9.4%	5.0%	5.1%	5.5%
Return / Volatility	1.0	2.1	2.1	2.2
Maximum drawdown	24.4%	7.1%	7.1%	7.1%
JPY				
Annualized return	6.2%	5.3%	6.5%	6.7%
Annualized volatility	7.9%	4.8%	5.1%	5.1%
Return / Volatility	0.8	1.1	1.3	1.3
Maximum drawdown	26.0%	12.4%	11.6%	11.6%

Source: Barclays Research

Refining Carry and Trend Signals

The carry and trend signals described in this report are intentionally simple implementations. While this may be desirable in a benchmark, many practitioners believe that more sophisticated signals and more frequent rebalancing would yield superior results to the ones we have shown. We agree with this to an extent and have written about how to construct more sophisticated carry and trend currency strategies.[8] While complex carry and trend signals and other enhancements such as stop-loss triggers, strength-of-signal measures, incorporation of mean-reversion dynamics or volatility-based risk indicators have been shown to perform better than simple implementations, practitioners also need to be mindful of selection bias and over-optimization of strategy parameters. We prefer a balanced approach: we advocate some use of signals and filters, but we caution against straying too far from a robust approach that includes parsimonious parameterization. Greater complexity is generally accompanied by lower conviction in the ability of a strategy to perform as well out of sample as it does in a back-test.

Cash flow management

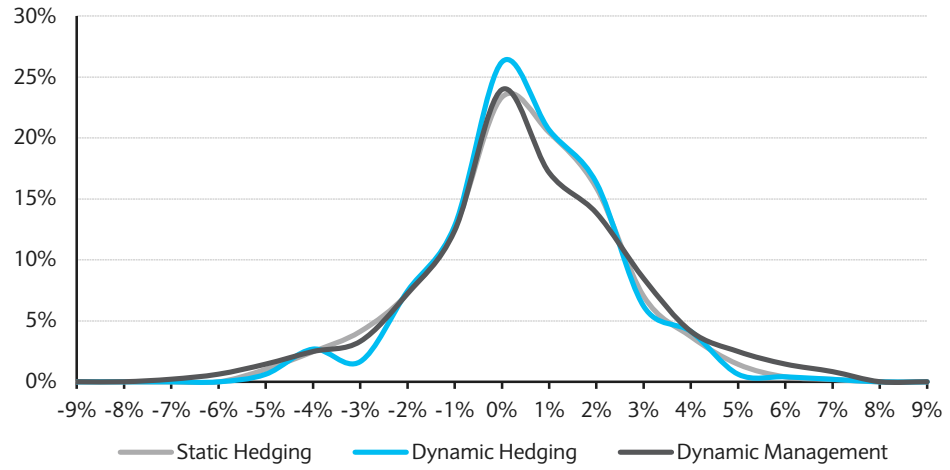
Until now, we have treated the currency overlay as a completely unfunded portfolio component and included no expenses other than bid-offer costs. In practice, currency forwards would need to be physically or cash settled each month at maturity. If a loss is booked on the currency forwards, the investor has to settle the difference by selling some of the portfolio's assets, borrowing the required funds or initially setting some capital aside to

[8] *The EM FX carry premium: Exploiting growth differentials through systematic trading strategies*, September 2010.
The G10 FX Carry Premium: Refining and timing the crash risk premium, November 2010.
Active Tail Risk Hedging: Improving the risk-return profile of the FX carry trade, January 2011.
Quantitative Investment Strategies: Diversified Trend Following, February 2014.

meet such cash flow requirements. This is a reflection of the true cost of currency management and is applicable to replicating the passive, statically hedged benchmark as well. An indication of the cash flows required to settle monthly currency forward positions can be inferred from the distribution of currency overlay returns shown in Figure 20. The worst 5% of monthly returns over the prior forty years averaged -4.44%, -4.28% and -5.12% for the Static Hedging, Dynamic Hedging and Dynamic Management strategies, respectively.

FIGURE 20

Distribution of currency overlay returns (Jan 1975-Apr 2015)



Source: Barclays Research

Pegged, Managed or Illiquid Currencies

Pegged or managed currencies can present tail risk in the form of outsized moves that may not be expected solely from daily returns observations. A recent example is the decision of the Swiss National Bank (SNB) to de-peg the franc from the euro in January 2015. The 23% single-day appreciation of the franc (on a trade-weighted basis) highlighted the latent risk embedded in pegged currencies. While this does not directly affect the framework we have proposed, it could have an effect on the distribution and expected shortfall of currency overlay returns just discussed. More advanced strategies that consider risk metrics in determining positioning (eg, risk-adjusted carry or trend signals) may be similarly affected. Two broad-based approaches to deal with this risk are to use market signals to determine periodically whether expected returns are sufficient compensation for exposure to "de-pegging" risk and to impose currency exposure limits. Both market data (eg, options skew and IMM net long positioning) and concentration limits (eg, a single currency cannot exceed 10% of basket exposure) can help manage this risk.

Access to certain emerging market currencies is via non-deliverable forwards (NDFs). These are cash-settled forward contracts that broadly mimic non-convertible currencies (typically versus the US dollar). While arbitrage constraints usually mean the onshore rates are close to the offshore rates, basis risk does exist. Under these circumstances, investors would need to assess the cost-benefit trade-off of maintaining a local clearing presence to access the onshore currency rates. In situations where liquidity for either onshore or NDF markets is very thin, a proxy hedge via a more liquid currency might be a more viable option than paying the bid-offer spread on directly hedging the illiquid currency.

Extending the framework

The dynamic currency management approach can be extended to other types of benchmark indices or custom portfolios. It can also be fine-tuned to benefit from correctly forecasting time varying correlations.

Emerging Markets

Emerging market economies tend to have persistently higher interest rates than developed countries, given economic growth rate differentials. The resulting carry trade profile means the long EM currency portfolio is considered an important part of the total return of the investment. As a result, emerging markets investments are typically not currency hedged and are managed to unhedged benchmark indices.

A look at the recent performance of the Barclays EM Local Currency Government 10% Country Capped Index indicates that unhedged exposure, from a USD base currency perspective, yielded returns of 5.6% per annum since the beginning of 2009 (Figure 21). The performance statistics are restricted to a shorter window due to data constraints. While the returns of the unhedged benchmark index are attractive, they were accompanied by significant volatility, in excess of 11%. In contrast, the fully currency hedged benchmark had nearly 2% lower annualized returns, but a considerably higher risk-adjusted return (Return/Volatility), due to the significant reduction in volatility that hedging the currency exposure provided. Yet investors' preference for unhedged emerging markets investments (as opposed to levered currency hedged investments) highlights both a desire to avoid leverage (often a function of institutional constraints), with the added risks it can bring, and the belief that emerging markets investments are intrinsically currency investments.

FIGURE 21

EM Local Currency Government 10% Country Capped USD Index (Jan 2009-Apr 2015)

	Unhedged Benchmark (EML1TRUU)	Hedged Benchmark (EML1TRUH)	Static Hedging	Dynamic Hedging	Dynamic Management
Annualized returns	5.6%	3.8%	3.4%	4.7%	4.8%
Annualized volatility	11.4%	3.3%	3.6%	5.2%	5.1%
Return/Volatility	0.5	0.9	0.9	0.9	0.9
Maximum drawdown	14.3%	6.0%	6.3%	7.9%	7.7%

Source: Barclays Research

In the context of systematic currency management, as opposed to "hedging" in the Global Treasury Index case, we now apply our dynamic currency management framework to the EM local currency bond benchmark index. To maintain a similar approach to the developed market study, we choose to manage dynamically 14 of the benchmark's 22 currencies that currently represent more than 90% of the market value of the index.[9]

[9] We dynamically manage the Brazilian real, Czech koruna, Hungarian forint, Indonesian rupiah, Israeli shekel, Korean won, Malaysian ringgit, Mexican peso, Turkish new lira, Philippine peso, Polish zloty, Russian ruble, South African rand and Thai baht. We assume bid-offer spreads of 12bp for each of these currencies and show performance net of this estimated currency forward trading cost. We leave the Argentine peso, Chilean peso, Colombian peso, Croatian kuna, Egyptian pound, New Romanian leu, Nigerian nairu or Peruvian new sol unhedged due to a lack of adequate liquidity in them.

FIGURE 22

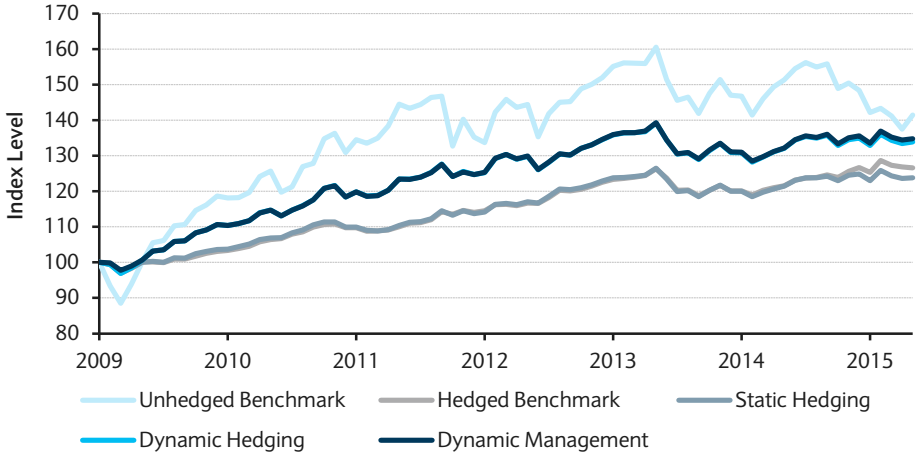
Total weight contribution of the 14 liquid currencies (Jan 2009-Apr 2015)

Source: Barclays Research

Since the carry of emerging markets currencies is generally positive with respect to the US dollar, the Dynamic Management strategy rarely shorts a currency outright. As a result, the Dynamic Hedging and Dynamic Management strategies have very similar positions and performance. Given that many investors face leverage constraints, these portfolios maintain the attractive risk-adjusted returns of the fully hedged benchmark, but with an extra 1% of return per annum.

FIGURE 23

Dynamic Currency Management versus Static Benchmarks in Emerging Markets



Source: Barclays Research

A recent Barclays publication[10] took a different approach to managing currency risk in emerging markets portfolios. Since the funding currency (typically a developed markets currency) is not part of the investment universe, funding currency risk is identified as a large source of currency risk in emerging markets portfolios. The publication's authors proposed diversifying funding by using additional developed markets currencies, thus reducing currency risk without losing the currency exposure that is integral to emerging markets investments. If such a funding currency-risk diversification approach is of interest to investors, our framework can easily be extended to account for multiple base currencies, since each sub-portfolio can be considered as a standalone implementation.

[10] Desclée, A., Maitra, A., Polbennikov, S., "Diversifying Base Currency Risk", Barclays Research (2015)

Credit, Equity and Multi-asset Portfolios

While we do not show results here, the currency management framework we have proposed can be extended to cover credit, equity or multi-asset portfolios as well. The key considerations are the correlations of currency returns to the local currency asset returns. Where compelling evidence does exist that long-term correlations are not zero, it would be necessary to modify the default hedge ratio in the hedging equation to reflect that.

Time-varying returns and correlations

As part of our analysis, we used average returns and correlations for several currencies over a long horizon. We have argued that the returns of static exposure to developed market currencies and the correlations between currency returns and local currency government bond returns both mean-revert around zero. Thus, 100% is a reasonable default hedge ratio for these currencies for long-term investors.

Over shorter periods, returns and correlations are time-varying and significantly different than zero. However, short-term returns are notoriously difficult to predict correctly, and correlations can also be tough to forecast well. If an investor believes he or she has the skill to forecast these variables accurately, it would warrant modifying the hedge ratio equation to reflect these forecasts. We do caution that good results from mean-variance portfolio construction depend heavily on good forecasts of these input variables. Those who attempt to capture these time-varying dynamics should consider using a more robust portfolio construction approach such as risk parity, risk budgeting or a Black-Litterman framework.

Conclusion

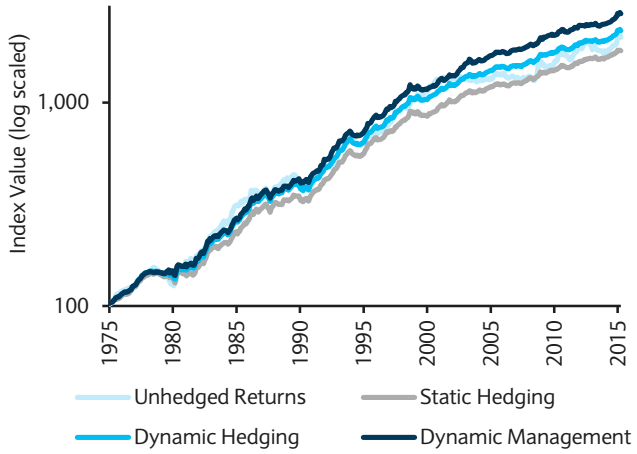
The use of alternative risk premia signals to tilt from the 0% or 100% hedged baseline is intended to provide the flexibility of adapting the framework to suit bespoke portfolios. While we have been cautious about the use of correlations, given the difficulty in constructing forecasts, our modular approach allows investors to introduce complexity in a stepwise manner without compromising the transparency of the framework. Dynamic currency management is not expected to result in better performance than passive (statically hedged or unhedged) exposure all the time. In fact, there will almost certainly be sub-periods of underperformance. However, over long periods, across multiple currency regimes, superior risk-adjusted returns are observed in all G4 base currencies.

Appendix

Results for EUR as base currency

FIGURE 24

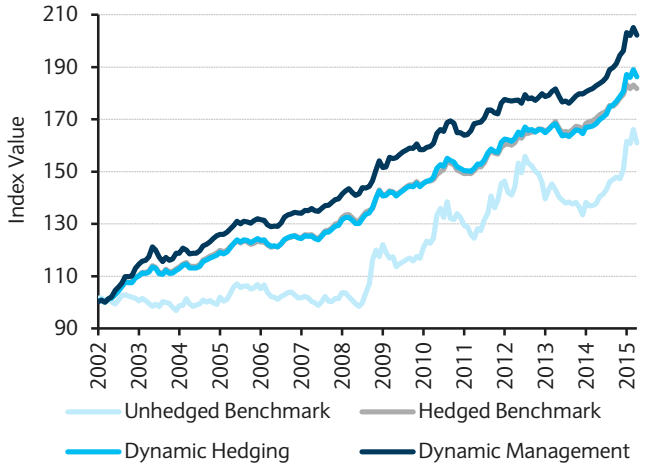
Unhedged Returns, Static Hedging, Dynamic Hedging and Dynamic Management: 1975-2015



Source: Barclays Research

FIGURE 25

Benchmarks, Dynamic Hedging & Dynamic Management: 2002-15



Source: Barclays Research

FIGURE 26

Static Hedging, Dynamic Hedging and Dynamic Management: Measuring performance

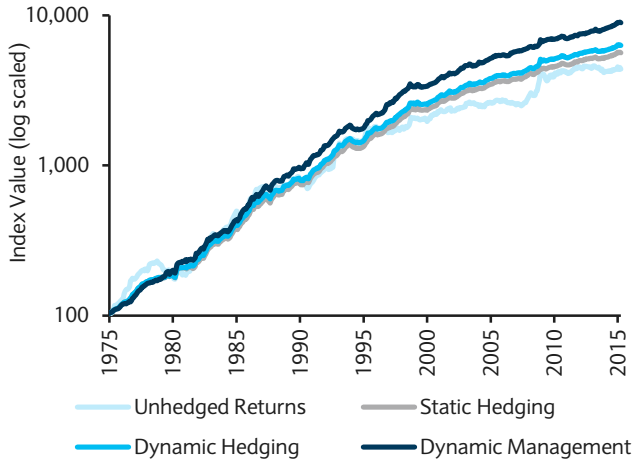
	Unhedged Benchmark (BTSYTREU)	Hedged Benchmark (BTSTTREU)	Unhedged Returns	Static Hedging	Dynamic Hedging	Dynamic Management
Full sample (1975 - 2015)						
Annualized returns			7.8%	7.4%	8.0%	8.5%
Annualized volatility			7.5%	4.9%	4.8%	5.0%
Return / Volatility			1.05	1.52	1.66	1.71
Maximum drawdown			19.0%	10.3%	9.0%	9.0%
Skewness			0.52	0.16	0.11	0.08
1st half (1975 - 1995)						
Annualized returns			9.8%	9.5%	10.1%	10.8%
Annualized volatility			7.6%	5.8%	5.7%	5.7%
Return / Volatility			1.29	1.62	1.79	1.89
2nd half (1996 - 2015)						
Annualized returns			5.7%	5.2%	5.8%	6.2%
Annualized volatility			7.3%	3.4%	3.7%	4.0%
Return / Volatility			0.79	1.52	1.58	1.55
Benchmark history (2002 - 2015)						
Annualized returns	3.6%	4.6%	3.6%	4.4%	4.8%	5.4%
Annualized volatility	7.3%	2.9%	7.3%	2.9%	3.1%	3.4%
Return / Volatility	0.49	1.60	0.49	1.55	1.52	1.57
TEV (bps / mo)				8	28	50
Information ratio				-0.50	0.20	0.47

Note: TEV is calculated with respect to the Hedged Benchmark Index. Information ratio is the ratio of annualized outperformance to annualized TEV. Source: Barclays Research

Results for GBP as base currency

FIGURE 27

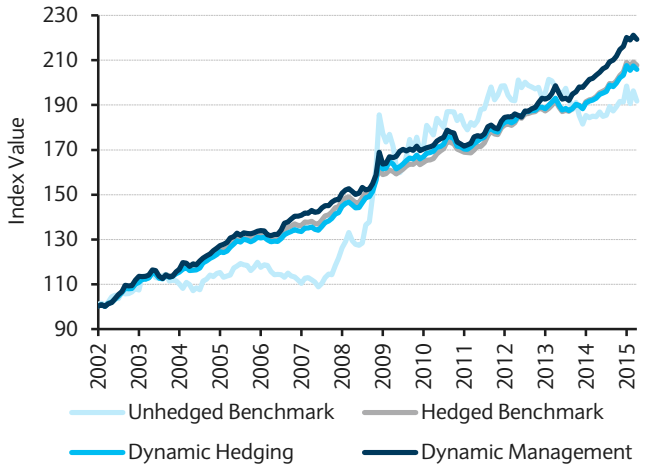
Unhedged Returns, Static Hedging, Dynamic Hedging and Dynamic Management: 1975-2015



Source: Barclays Research

FIGURE 28

Benchmarks, Dynamic Hedging & Dynamic Management: 2002-15



Source: Barclays Research

FIGURE 29

Static Hedging, Dynamic Hedging and Dynamic Management: Measuring performance

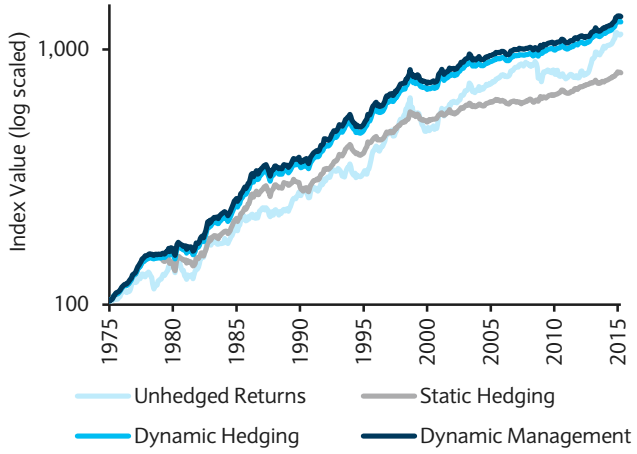
	Unhedged Benchmark (BTSYTRGU)	Hedged Benchmark (BTSYTRGH)	Unhedged Returns	Static Hedging	Dynamic Hedging	Dynamic Management
Full sample (1975 - 2015)						
Annualized returns			9.8%	10.5%	10.8%	11.8%
Annualized volatility			9.4%	5.0%	5.1%	5.5%
Return / Volatility			1.04	2.11	2.12	2.16
Maximum drawdown			24.4%	7.1%	7.1%	7.1%
Skewness			0.83	0.37	0.47	0.37
1st half (1975 - 1995)						
Annualized returns			14.8%	14.2%	14.7%	15.8%
Annualized volatility			10.1%	5.8%	5.9%	6.2%
Return / Volatility			1.46	2.43	2.50	2.56
2nd half (1996 - 2015)						
Annualized returns			4.7%	6.6%	6.8%	7.5%
Annualized volatility			8.4%	3.5%	3.9%	4.3%
Return / Volatility			0.56	1.87	1.76	1.76
Benchmark history (2002 - 2015)						
Annualized returns	5.0%	5.6%	5.0%	5.4%	5.6%	6.1%
Annualized volatility	8.7%	2.9%	8.7%	3.0%	3.5%	3.6%
Return / Volatility	0.58	1.96	0.58	1.81	1.59	1.67
TEV (bps / mo)				11	40	60
Information ratio				-0.62	-0.03	0.21

Note: TEV is calculated with respect to the Hedged Benchmark Index. Information ratio is the ratio of annualized outperformance to annualized TEV. Source: Barclays Research

Results for JPY as base currency

FIGURE 30

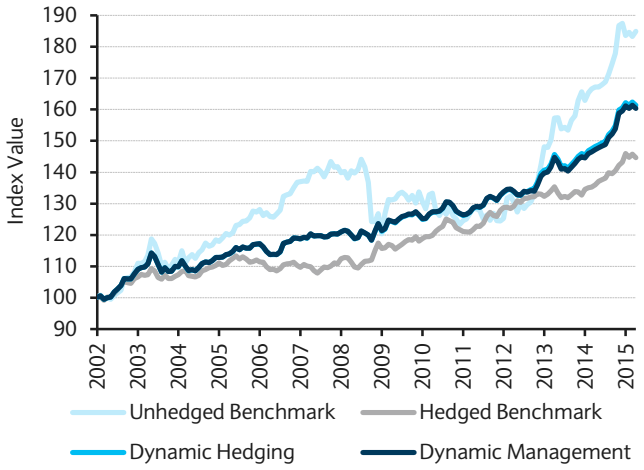
Unhedged Returns, Static Hedging, Dynamic Hedging and Dynamic Management: 1975-2015



Source: Barclays Research

FIGURE 31

Benchmarks, Dynamic Hedging & Dynamic Management: 2002-15



Source: Barclays Research

FIGURE 32

Static Hedging, Dynamic Hedging and Dynamic Management: Measuring performance

	Unhedged Benchmark (BTSYTRJU)	Hedged Benchmark (BTSYTRJH)	Unhedged	Static Hedging	Dynamic Hedging	Dynamic Management
Full sample (1975 - 2015)						
Annualized returns			6.2%	5.3%	6.5%	6.7%
Annualized volatility			7.9%	4.8%	5.1%	5.1%
Return / Volatility			0.79	1.10	1.28	1.30
Maximum drawdown			26.0%	12.4%	11.6%	11.6%
Skewness			-0.53	0.08	0.02	0.03
1st half (1975 - 1995)						
Annualized returns			7.0%	7.5%	8.7%	9.0%
Annualized volatility			7.9%	5.8%	5.8%	5.8%
Return / Volatility			0.89	1.28	1.52	1.56
2nd half (1996 - 2015)						
Annualized returns			5.4%	3.0%	4.2%	4.1%
Annualized volatility			8.0%	3.3%	4.2%	4.2%
Return / Volatility			0.68	0.91	1.00	0.99
Benchmark history (2002 - 2015)						
Annualized returns	4.7%	2.8%	4.7%	2.8%	3.7%	3.6%
Annualized volatility	6.7%	2.8%	6.7%	2.7%	3.3%	3.3%
Return / Volatility	0.70	0.99	0.70	1.02	1.12	1.10
TEV (bps / mo)				19	68	68
Information ratio				-0.06	0.36	0.34

Note: TEV is calculated with respect to the Hedged Benchmark Index. Information ratio is the ratio of annualized outperformance to annualized TEV. Source: Barclays Research

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