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May 2026

The FX dimension: Evaluating currency hedging for global multi-asset portfolios

- **Currency exposure can materially change portfolio outcomes.** Returns on identical global assets can differ widely depending on the investor's home currency, making currency management a key portfolio decision – not an implementation detail.
- **Whether to hedge depends primarily on two factors: correlation and relative volatility.** Hedging reduces standalone currency risk, but its net effect on total portfolio volatility depends on whether the currency acts as a stabiliser or amplifier of asset returns.
- **A practical rule of thumb emerges.** Across various definitions of risk, investors in conservative, fixed income-oriented portfolios generally benefit from higher hedge ratios, while equity-oriented investors often gain meaningful diversification from leaving foreign exposure largely unhedged.

The real-world impact of currency on portfolio returns

Investors expand beyond their home markets to diversify portfolios and access a wider range of opportunities. This global allocation can improve risk-adjusted returns by tapping into different economies, but it introduces foreign currency exposure. Movements in exchange rates can materially affect investment outcomes, creating large differences for investors in different home currencies – even when underlying asset returns are identical.

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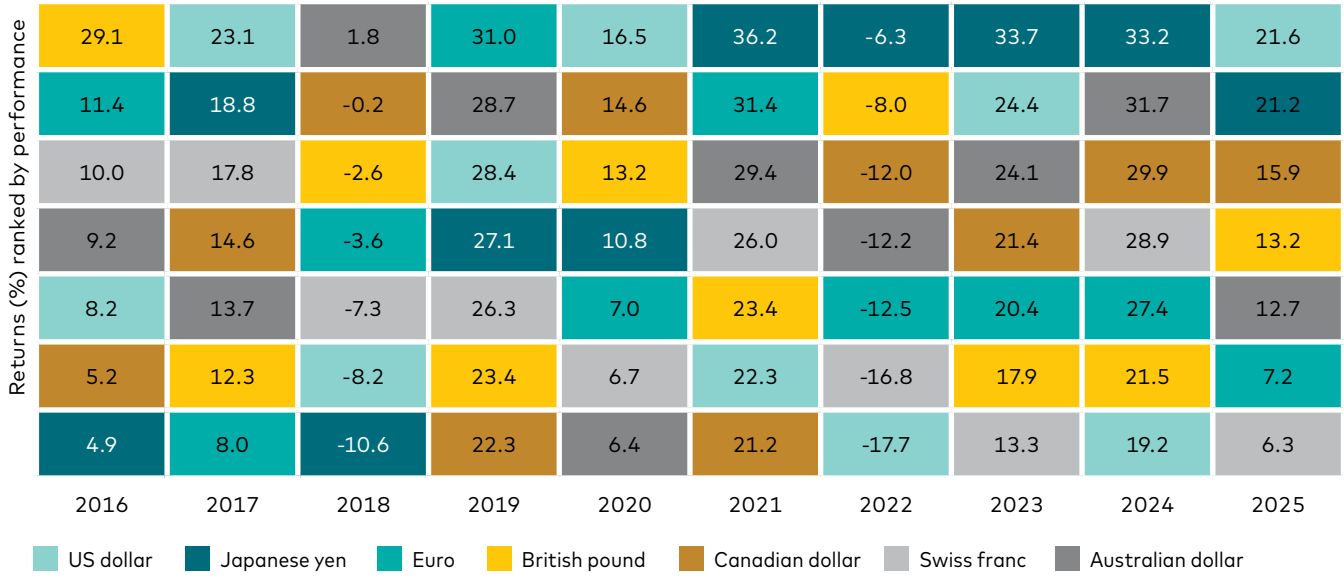
Consider the historical experience of global equity investors. **Figure 1** shows the ranked annual returns of the MSCI World Index in various currencies throughout the last decade. The figure highlights how the same basket of global equities (when measured in local currency terms) can deliver markedly different results once translated back into an investor's home currency. For example, in 2025, a US-based investor enjoyed a substantial gain of nearly 22%, while a Swiss investor saw a much smaller return of 6.3% due to adverse currency movements (i.e., the US dollar depreciating against the Swiss franc during the year).

FIGURE 1

Same index, different home-currency outcomes

Ranked annual returns of the MSCI World Price Index in various currencies, January 2016–December 2025



Sources: Vanguard calculations, using data from Bloomberg, L.P. Past performance is no guarantee of future returns. Data between 1 January 2016 and 31 December 2025.

Currency risk considerations go beyond hedging

Currency hedging is therefore important for managing the risk that foreign exchange changes bring to global portfolios. However, a common fallacy is that it eliminates the currency's influence on portfolio returns entirely.

Hedging can mitigate – but not eliminate – the impact of currency on returns

Firstly, it is useful to distinguish between foreign-exchange (FX) risk and FX return. FX hedging eliminates exposure to unexpected exchange-rate movements within the duration of the FX forward contract (typically one-to-three months) and therefore removes currency-driven return volatility. However, the expected return associated with currency carry – arising from interest-rate differentials and embedded in forward contracts – remains. Consequently, hedged portfolios may still exhibit currency-related return differences despite having no exposure to FX spot risk. That is, a forward FX hedge removes the uncertain component of currency returns associated with unanticipated spot exchange rate changes. However, the hedge embeds the interest-rate differential between the two currencies via the forward premium (or discount). As a result, even when hedged, there is a residual currency return impact from foreign assets.

Hedging and tactical asset allocation

Using hedging as a tactical tool has its own challenges. More specifically, it requires having a view about the unexpected part of currency returns, since the expected term is already priced in the forwards. For example, a tactical US-based investor who believes that the euro will appreciate relative to the US dollar may believe that they should leave their European equity allocation unhedged. However, if the euro ultimately appreciates by less than what was implied by the forward rate, the unhedged investor will underperform the hedged one.

Secondly, over long horizons, a rolling FX hedge still features uncertainty about the path of interest-rate differentials embedded in successive forward rates. In other words, hedging may materially reduce short-horizon return volatility driven by unexpected spot FX moves, but it does not mechanically "lock in" a single domestic-currency terminal value – because forward rates (and thus hedge returns) do follow closely spot exchange rates over time. Put another way, even if hedging reduces period-to-period volatility, long-horizon terminal wealth dispersion may be less affected because forward contracts are rolled and FX shocks compound differently[1].

Home bias can eliminate currency risk (at a price)

The size of an investor's domestic market is a key determinant of foreign-currency exposure within a global portfolio. Investors based in smaller equity markets – such as Australia or Canada – naturally hold a larger share of foreign-currency assets than those in large markets like the US. This higher exposure has direct implications for currency-hedging decisions: when most of the portfolio sits outside the home market, the potential impact of exchange-rate movements becomes materially greater, which can strengthen the case for hedging. **Figure 2** highlights this point by showing the foreign-currency exposure of global equity portfolios (on a market-capitalisations basis) from the perspective of different countries.

Importantly, the home bias decision is not independent of currency considerations. Indeed, the only way to fully eliminate FX risk is to avoid international investing altogether – but doing so sacrifices the diversification benefits that global portfolios are designed to capture. As a result, investors face a practical trade off: greater global diversification helps mitigate idiosyncratic market risk, while increased foreign exposure introduces currency risk (whether hedged or unhedged). The optimal degree of home bias therefore cannot be determined in isolation; it is closely linked to the optimal level of currency exposure.

FIGURE 2.

Home bias and currency exposure are linked decisions

Foreign-currency exposure from different country perspectives using unhedged equities and hedged bonds, as at 31 December 2025

	Australia	Canada	Eurozone	Japan	Switzerland	UK	US
Global equity (market-cap-weighted)	2%	3%	9%	5%	3%	4%	70%
Foreign-currency exposure in global equity	98%	97%	91%	95%	97%	96%	30%
Foreign-currency global exposure 60% stocks/40% bonds	59%	58%	55%	57%	58%	58%	18%

Notes: The figure displays implied foreign-currency exposure based on market-capitalisation weights. For a balanced 60% stocks/40% bonds portfolio, we assume the fixed income allocation was fully hedged. Home bias is defined as the overweighting of domestic stocks or bonds compared with the domestic percentage allocation in the global stock or bond market cap.

Sources: Vanguard calculations, based on data from Bloomberg, L.P.

1 Whether hedging meaningfully narrows the dispersion of terminal wealth depends on the horizon and on how volatile and persistent interest-rate differentials are relative to spot FX moves.

The key drivers of the hedging decision

To understand the impact of currency on a portfolio, it helps to look beyond the mechanics and focus on intuition.[2] Removing currency risk via hedging is not always volatility-reducing. The decision rests principally on two factors: the correlation between the foreign currency returns and the underlying asset, and the relative volatility of the two.[3]

First, consider the correlation. If the foreign currencies and the underlying assets tend to move in the same direction (i.e., positive correlation, where foreign currencies tend to strengthen against the home currency during up markets and vice versa), then exposure to foreign currencies amplifies the portfolio's swings, adding to total portfolio volatility. In that case, hedging is almost always the superior choice to remove that added risk. Instead, when currency and asset returns are negatively correlated, unhedged currency exposure can provide diversification benefits. However, even if the correlation is negative – implying a diversification benefit – hedging may still be necessary if the currency is simply too volatile relative to the asset. Put simply, if the "noise" of the currency's volatility is large enough, it will overwhelm any diversification benefit provided by the negative correlation.

Figure 3 shows that hedging is almost always beneficial for low-volatility portfolios, while outcomes for higher-risk portfolios depend more on correlation. This dynamic has significant implications for portfolio construction. For example, consider a portfolio with low volatility, such as a 20% stock/80% bond split. In this case, the volatility of the currency almost always overwhelms that of the underlying assets and hedging is consistently beneficial.[4] Conversely, for riskier portfolios (e.g., 80/20), the high volatility of the underlying equities makes the diversification benefit of the currency more relevant, rendering the hedging decision less clear-cut.

FIGURE 3.

Both relative volatility and correlation affect portfolio risk

Hypothetical volatility impact from hedging across a variety of portfolio risk profiles and currency correlations

Portfolio-currency correlation	Underlying portfolio volatility: 2%	4%	6%	8%	10%	12%	14%	16%	18%	20%	22%	24%
1.0	-8.0%	-8.0%	-8.0%	-8.0%	-8.0%	-8.0%	-8.0%	-8.0%	-8.0%	-8.0%	-8.0%	-8.0%
0.9	-7.8%	-7.7%	-7.7%	-7.6%	-7.5%	-7.5%	-7.5%	-7.5%	-7.4%	-7.4%	-7.4%	-7.4%
0.8	-7.7%	-7.5%	-7.3%	-7.2%	-7.1%	-7.0%	-7.0%	-6.9%	-6.9%	-6.8%	-6.8%	-6.8%
0.7	-7.5%	-7.2%	-6.9%	-6.8%	-6.6%	-6.5%	-6.4%	-6.3%	-6.3%	-6.2%	-6.2%	-6.1%
0.6	-7.3%	-6.9%	-6.6%	-6.3%	-6.1%	-6.0%	-5.9%	-5.8%	-5.7%	-5.6%	-5.6%	-5.5%
0.5	-7.2%	-6.6%	-6.2%	-5.9%	-5.6%	-5.4%	-5.3%	-5.2%	-5.1%	-5.0%	-4.9%	-4.8%
0.4	-7.0%	-6.3%	-5.8%	-5.4%	-5.1%	-4.9%	-4.7%	-4.6%	-4.4%	-4.3%	-4.2%	-4.2%
0.3	-6.8%	-6.0%	-5.3%	-4.9%	-4.6%	-4.3%	-4.1%	-3.9%	-3.8%	-3.7%	-3.6%	-3.5%
0.2	-6.6%	-5.6%	-4.9%	-4.4%	-4.0%	-3.7%	-3.5%	-3.3%	-3.1%	-3.0%	-2.9%	-2.8%
0.1	-6.4%	-5.3%	-4.5%	-3.9%	-3.4%	-3.1%	-2.8%	-2.6%	-2.4%	-2.3%	-2.1%	-2.0%
0.0	-6.2%	-4.9%	-4.0%	-3.3%	-2.8%	-2.4%	-2.1%	-1.9%	-1.7%	-1.5%	-1.4%	-1.3%
-0.1	-6.0%	-4.6%	-3.5%	-2.7%	-2.2%	-1.7%	-1.4%	-1.2%	-1.0%	-0.8%	-0.6%	-0.5%
-0.2	-5.8%	-4.2%	-3.0%	-2.1%	-1.5%	-1.0%	-0.7%	-0.4%	-0.2%	0.0%	0.1%	0.3%
-0.3	-5.6%	-3.8%	-2.4%	-1.5%	-0.8%	-0.3%	0.1%	0.4%	0.6%	0.8%	1.0%	1.1%
-0.4	-5.4%	-3.4%	-1.8%	-0.8%	0.0%	0.5%	0.9%	1.2%	1.5%	1.7%	1.8%	1.9%
-0.5	-5.2%	-2.9%	-1.2%	0.0%	0.8%	1.4%	1.8%	2.1%	2.4%	2.6%	2.7%	2.8%
-0.6	-5.0%	-2.4%	-0.5%	0.8%	1.8%	2.4%	2.8%	3.1%	3.3%	3.5%	3.6%	3.8%
-0.7	-4.8%	-1.9%	0.3%	1.8%	2.8%	3.4%	3.8%	4.1%	4.3%	4.5%	4.6%	4.7%
-0.8	-4.5%	-1.4%	1.2%	2.9%	4.0%	4.6%	5.0%	5.3%	5.4%	5.6%	5.7%	5.8%
-0.9	-4.3%	-0.7%	2.3%	4.4%	5.5%	6.1%	6.4%	6.5%	6.7%	6.7%	6.8%	6.8%
-1.0	-4.0%	0.0%	4.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%

Notes: This is a hypothetical example of the difference in volatility between a hedged and an unhedged investment. We make different assumptions about portfolio volatility and currency correlations. Figure assumes 8% currency volatility. Red shading indicates hedging produces a higher volatility outcome, while green shading indicates hedging lowers portfolio volatility. For simplicity, the volatility comparisons focus on the removal of spot FX volatility; the return volatility of the hedge itself – driven by short-term interest-rate differentials – is typically small relative to asset volatility and is discussed separately.

Sources: Vanguard calculations.

2 Here we focus on the return of a basket of foreign currency exposures in the portfolio compared to the investor's base currency. For instance, for a US-based investor, we consider the weighted-average value of all foreign currencies embedded in international assets, such as global ex-US equities or global ex-US bonds, in relation to the US dollar.

3 Derivation shown in the Appendix.

4 See Harvey and Renzi-Ricci (2023) for further discussion of global fixed income portfolios.

Hedging the hedging decision: managing risk in an uncertain world

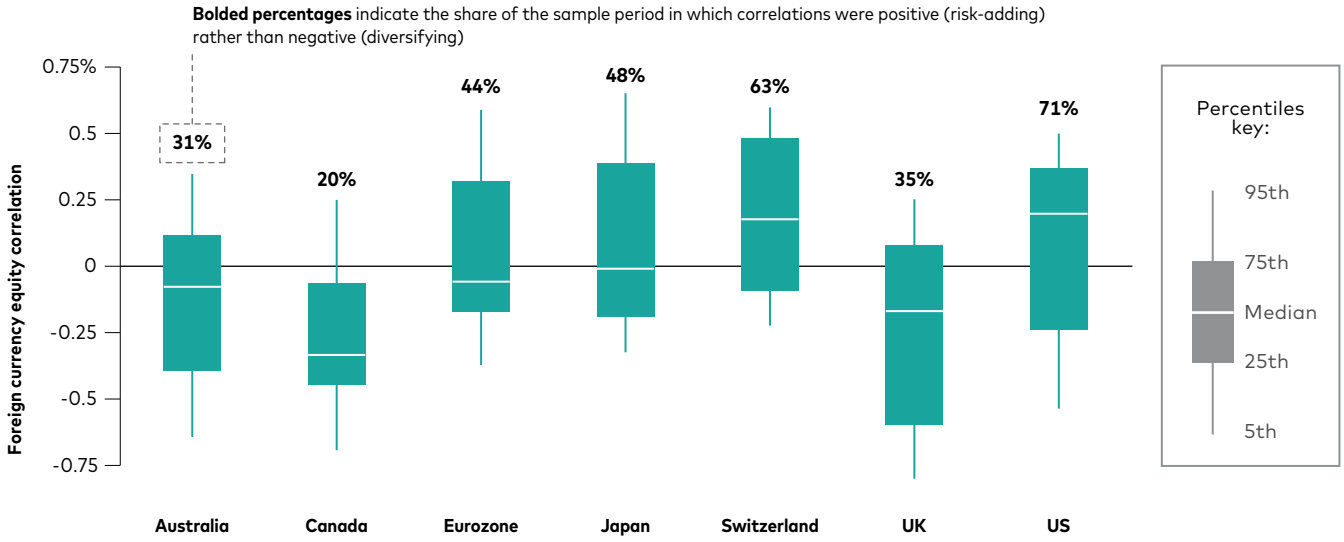
As we have seen, an investor would ideally hedge exposure to foreign currencies with historically positive correlations – typically the case for investors whose home-base currency is a so-called "safe-haven" or "risk-off" currency – and leave intact exposure to currencies with low or negative correlations – typically investors whose home-base currency is so-called "risky" or "risk-on" currencies. For example, investors based in Australia and Canada (countries with large exposures to global commodities) typically see their domestic currency appreciate in periods of strong global growth and equity upswings. Conversely, US-domiciled investors experience the opposite, with the US dollar appreciating during risk-off periods as global capital flocks to it in a flight to quality.[5]

However, these correlations have proven hard to predict in the long term, varying significantly across markets and through time, as shown in **Figure 4.** The boxed numbers below the chart indicate the share of the sample period in which correlations were positive (risk-adding) rather than negative (diversifying) from each region's perspective.

FIGURE 4.

Currency correlations have been highly variable, across both time and markets

Percentile distributions of ten-year foreign-currency-equity correlations from the stated currency regions' perspectives, January 1972–December 2025



Notes: Figure displays percentiles for ten-year correlations of annual returns, with correlations calculated between foreign currency and foreign equity from the perspective of the stated currency region. See appendix for details on data.

Sources: Vanguard calculations, based on data from MSCI, the International Monetary Fund, and Bloomberg, L.P. Data between 1 January 1972 and 31 December 2025.

5 Perspective matters too, in applying these labels. Throughout this paper, we have framed the hedging decision from a domestic perspective, looking out while examining foreign-currency exposure. From this perspective, investors might want to keep exposure to safe haven currencies and hedge exposure to risky currencies. Alternatively, an investor could examine their own domestic currency and come to the same conclusion, expressed in different terms. That is, investors with a "safe haven" domestic currency might want to hedge foreign currency exposure, whereas an investor with a "risky" domestic currency might want to leave foreign currency intact.

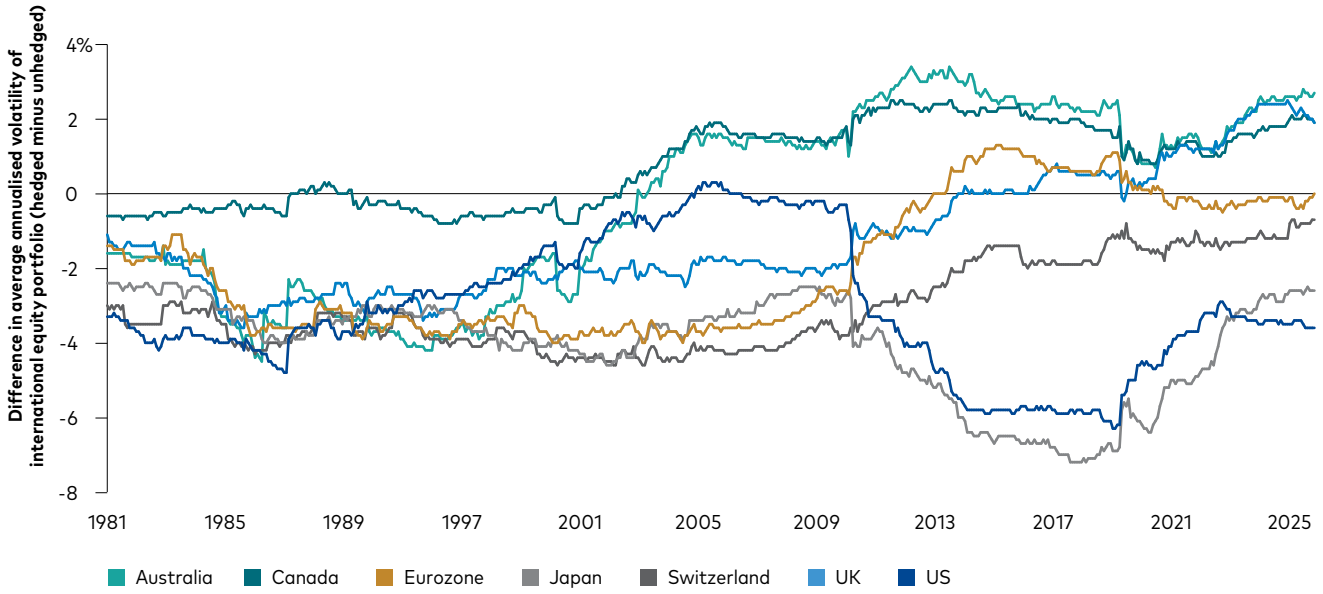
While Figure 4 focuses on the behaviour of currency–equity correlations, **Figure 5** translates these dynamics into realised volatility outcomes, which are ultimately what investors experience when implementing a hedging strategy. Echoing the correlation estimates in Figure 4, the volatility impact of hedging has been variable across both time and markets.

In addition, a notable conclusion from Figure 5 is that any hedging strategy that does depend on a given correlation being realised may experience long periods of time during which the intended risk reduction outcome is not realised, if it occurs at all. For example, based on past relationships before the Global Financial Crisis of 2007–08, many investors might have expected the euro to behave like a "safe-haven" currency, implying that euro-area investors would have favoured hedging their foreign-currency exposure, but this relationship flipped in the subsequent years, and has recently hovered around zero.

FIGURE 5.

Realised volatility outcomes can be unfavourable for long stretches

Rolling 10-year difference in annualised volatility of monthly returns between hedged and unhedged portfolios in developed foreign equity, January 1981–December 2025.



Notes: Figure displays difference in 10-year rolling annualised volatility of monthly returns between hedged and unhedged portfolios invested in foreign developed equity. See appendix for details on data.

Sources: Vanguard calculations, based on data from MSCI, the International Monetary Fund, and Bloomberg, L.P. Data between 1 January 1981 and 31 December 2025.

These results present an opportunity to place the cost of hedging into context. The volatility impact of hedging in any given 10-year period across the markets examined ranged from a 7.1% reduction in Japan (for the 10 years ended 2016) relative to remaining unhedged to a 3.5% increase in Australia (for the ten years ended 2010). So, although a hedging cost of, say, 0.25% to 0.50% on an annual basis[6] may sound relatively inexpensive, the benefit one is paying for may not be realised. Alternatively, considering the average over time aggregated across all the markets we examined, at –1.7% the risk reduction from hedging might be worth it, assuming an investor can access hedged products at a reasonable cost.[7]

6 These rough estimates of hypothetical cost assume transaction costs of 0.17% per year (the maximum from Figure 6) plus a higher expense ratio ranging from 0.08% to 0.33% to account for operation costs. These estimates are hypothetical but roughly align with typical financial products.

7 For example, consider an unhedged global equity portfolio with an expected return of 8% and expected volatility of 20%. Assuming that gross returns are equivalent between hedged and unhedged investments, an expected 1.9% reduction in volatility from hedging would result in an investor paying up to 0.76% in hedging costs and still generating a better risk-adjusted return by hedging foreign-currency exposure.

A potential solution to this uncertainty is to shift the focus away from forecasting currency behaviour and toward portfolio-level outcomes. Rather than attempting to fine-tune hedge ratios based on unstable correlations, investors can adopt simple hedging rules that implicitly adjust currency exposure as total portfolio risk changes.

Key considerations for evaluating currency hedging

Currency hedging decisions should be evaluated in the context of total portfolio risk and investor objectives – not in isolation from the broader portfolio. The considerations below narrow the problem from risk definition, to feasibility, to a practical portfolio-level solution.

Determine the relevant risk measure

Different investors face different risks. For some, volatility of total portfolio returns is the primary concern; for others, the risk of failing to meet spending needs or long-term liabilities may be more relevant. Currency exposure can affect each of these differently. Our analysis focuses on total portfolio volatility – a common and practical metric for both retail and institutional portfolios – while recognising that alternative objectives may lead to different conclusions.

Implementation – especially costs – is crucial

Currency hedging is not frictionless. Investors must choose the instrument (typically forward contracts), hedge ratio and rebalancing frequency. More frequent rebalancing can keep hedge ratios closer to target but may raise turnover and costs; less frequent rebalancing may lower costs but allow meaningful deviations at exactly the wrong time (for example, after large equity moves that also change currency exposures).

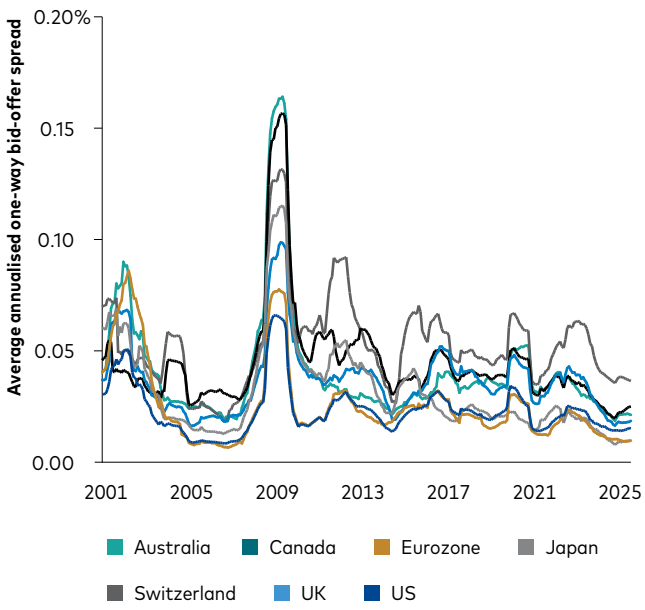
Costs arise from bid-ask spreads, transaction expenses and operational complexity, and these can vary across currencies and over time. Although costs have generally declined in liquid currency markets, they can still meaningfully reduce the net benefit of hedging, particularly for long-term investors. As **Figure 6** illustrates, bid-ask spreads for major currency pairs have broadly declined since the early 2000s but remain non-trivial.

In summary, costs raise the threshold for hedging benefits to be worth pursuing. Investors should frame these costs against the expected volatility reduction from hedging, particularly over longer horizons where costs compound and may outweigh modest volatility reductions.

FIGURE 6.

Estimated transaction costs for rolling FX hedges across major currencies

12-month average annualised one-way bid-offer spread to hedge majority of MSCI World Price Index back to stated currency, January 2001–December 2025



Notes: Figure displays annualised bid-offer spread associated with hedging the MSCI World Price Index from each currency's perspective, calculated as one-half of the spread between the bid and offer quotes of forward rate points, as an annualised percentage of the midpoint spot rate. We included the weighted-average cost to hedge the seven largest foreign currencies, weighted by the capitalisation weights of the MSCI World Price Index. This weighting methodology produced a cost estimate that hedges about 95% of the foreign-currency exposure.

Sources: Vanguard calculations, based on data from Bloomberg, L.P. Data between 1 January 2001 and 31 December 2025.

Synthesising the decision for multi-asset portfolios

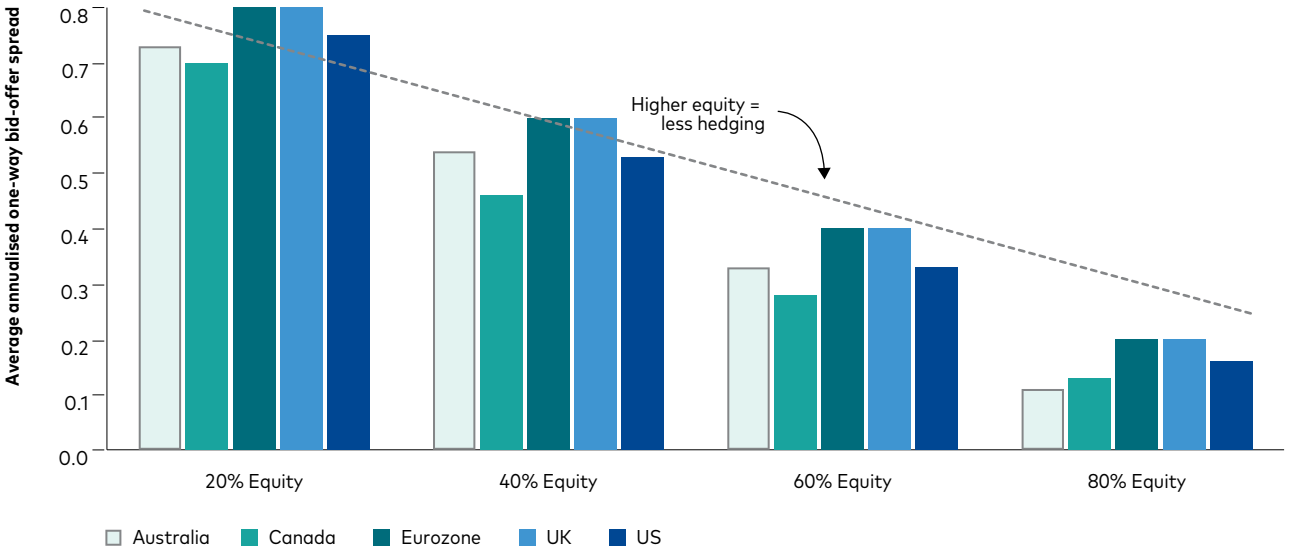
As highlighted previously, two forces determine the importance of hedging for volatility reduction: (i) the correlation between currency moves and the portfolio's risk assets, and (ii) the relative volatility of currency returns versus the underlying portfolio. Focusing on the latter of these, a simple implementation rule emerges: Hedge fixed income and leave equity unhedged. Intuitively, as the underlying portfolio becomes lower volatility (higher bond weight), currency becomes a larger share of total risk, and a higher hedge ratio becomes the more robust risk-mitigation choice.

Figure 7 shows how this portfolio-level logic can be implemented in practice for multi-asset global investments from different regional perspectives. hedge ratios fall systematically as portfolios become less conservative – moving from roughly 70–80% in 20% equity portfolios compared to 10–20% for 80% equity portfolios across the five domiciles shown.

FIGURE 7.

Example currency hedge ratios for multi-asset global portfolios

Currency hedge ratios across different regions



Notes: Figure assumes the average FX correlation shown in Figure 4 and the equity market capitalisation weights shown in Figure 2. The assumed equity home bias ratios were 40% for Australia, 30% for Canada, 9% for the euro area, 20% for the UK, and 60% for the US. The assumed bond home bias ratios were 30% for Australia, 60% for Canada, 10% for the euro area, 20% for the UK, and 70% for the US. The bond market capitalisation weights were calculated as 2% for Australia, 3% for Canada, 9% for the euro area, 4% for the UK, and 41% for the US.

Sources: Vanguard calculations, based on data from Bloomberg, L.P.

Moreover, even when considering other hedging decision drivers, this rule of thumb can still be surprisingly effective, as summarised in **Figure 8**. For traditional risk mitigation, three channels are important:

- **FX behaviour in risk-off episodes.** For investors whose home currency may depreciate during market downturns, foreign currency exposure is more likely to amplify portfolio swings, strengthening the case for hedging. Here, the key exception is the US dollar's "safe haven" correlation channel, which may justify higher overall hedging for USD-based investors.
- **Portfolio risk level.** As portfolios shift toward defensive allocations, the relative importance of currency volatility rises; the framework therefore implies higher hedge ratios in more conservative funds.

- **FX exposure in the defensive sleeve.** Investors based in smaller domestic markets generally carry larger embedded foreign-currency exposure in a globally diversified portfolio, making FX a more material contributor to total risk and further supporting higher hedge ratios in practice.

Figure 8 also highlights two practical overlay considerations that matter: **tracking error vs peer benchmarks** (where investors prefer not to enable FX movements to dominate deviation from a benchmark) and **long-term domestic macro risks** (where maintaining some foreign-currency exposure can diversify risks tied to domestic inflation, deficits, or currency debasement).

FIGURE 8.
Drivers of the currency hedging decision

Implied hedging approaches different objectives

Driver	Directional recommendation	Australia	Canada	Europe	UK	US
Traditional portfolio risk mitigation						
FX behaviour in risk-off episodes	If home currency is "safe haven" → FX hedging is more valuable	✓	✓	✓	✓	✗
Portfolio risk level	More conservative portfolios → higher hedge ratio	✓	✓	✓	✓	✓
FX exposure in the defensive sleeve	Higher bond FX exposure → more hedging	✓	✓	✓	✓	✓
Additional risk considerations						
Tracking error vs peer benchmarks	Minimise FX as a source of TE	✓	✓	✓	✓	✓
Long-term domestic macro risks (e.g., inflation, deficits, debasement)	Maintain some FX diversification (primarily via unhedged equities)	✓	✓	✓	✓	✓

Notes: The figure illustrates how a simple hedging rule – hedging bonds while leaving equities unhedged – produces portfolio level hedge ratios that align with most portfolio risk objectives. Optimal hedge ratios vary with many factors including portfolio composition, investment horizon and risk measure. Based on historical correlations and volatility relationships across developed markets.
Sources: Vanguard.

Conclusion: Navigating currency risk in a global portfolio

Currency risk is an unavoidable consequence of global investing, but managing it effectively is less about forecasting exchange rates and more about understanding how currency exposure interacts with asset risk at the portfolio level. Hedging decisions should therefore be viewed as part of portfolio construction – not as isolated, asset-by-asset choices.

Across developed markets, two patterns emerge. Hedging foreign fixed income exposure almost always reduces portfolio risk, as bond volatility is low relative to currency volatility. For foreign equities, the case is more nuanced. When currency–equity correlations are low or negative – as they have been on average over long horizons – unhedged currency exposure can provide diversification, particularly during periods of market stress.

Taken together, these forces imply that optimal currency hedging depends on total portfolio risk rather than on individual assets in isolation. A simple and widely used rule of thumb – hedging most foreign bonds while leaving foreign equities largely unhedged – naturally produces hedge ratios that rise as portfolio risk falls and decline as portfolio risk increases. As shown in Figure 7, this approach approximates theoretical optimal hedge-ratio outcomes across regions under empirically common correlation assumptions.

Importantly, this framework does not rely on stable correlations or precise forecasts of currency behaviour. By focusing on portfolio-level risk and adopting simple, robust hedging principles, investors can capture most of the benefits of currency hedging while preserving the diversification value of currency exposure – without over-engineering solutions to an inherently uncertain problem. For advisers constructing global multi-asset portfolios, this means currency hedging decisions should be driven by overall risk posture, not by attempts to forecast currencies or optimise asset-level hedges.

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Appendix

Return data sources

For this paper's returns data, we used the developed market equity universe, defined as those countries in the MSCI World Price Index. "Foreign equity" for each currency region is defined as the MSCI World ex [market] Index – for example, the MSCI World ex-US Index for a US dollar perspective. For markets in which such an index is not produced by MSCI, we created a custom benchmark using MSCI's market capitalisation data to infer the foreign region from the MSCI World and MSCI [market] for each country. For pre-1999 history for the euro area, we computed a custom index by cap-weighting the individual euro constituent countries.

Our currency returns are the cap-weighted basket of currencies comprising the foreign developed-equity universe for each market. We computed this by measuring the difference in price returns between the foreign-equity investment in local (no currency impact) returns relative to the price returns translated to that region's currency. In cases where MSCI does not produce an index in the desired currency, we translated the index using exchange rates from the IMF's International Financial Statistics database.

In measuring correlation and volatility, we used the local version of the equity index (with currency return removed) as a proxy for a hedged investment. This approach ignores the small return impact from hedging but allows for a longer historical analysis, since hedged benchmarks have limited data available. Although our local benchmarks would not be suitable for comparing average returns between hedged and unhedged investments over extended periods, they are an effective proxy for a hedged investment when comparing volatility and correlations. For example, when evaluating the MSCI World Index hedged to Australian dollars versus the index in local terms (with no currency return), performance statistics show that the two track each other very closely on a monthly frequency (see **Figure A-1**).

FIGURE A-1.

Comparison of MSCI World hedged indices with the MSCI World local index: January 1988 – December 2025

	USD	JPY	GBP	AUD	Local
Volatility	13.9%	13.8%	13.9%	14.0%	13.8%
Correlation with local index	1.000	0.999	0.999	0.998	1.000
Beta with local index	1.001	0.995	1.002	1.010	1.000
R-squared with local index	1.000	0.998	0.998	0.996	1.000
Tracking error to local index	0.31%	0.66%	0.63%	0.89%	N/A

Notes: Table compares statistics based on monthly price returns of MSCI World Index, hedged to the stated currency, relative to MSCI World local (currency return removed) index. Beta is a measure of the magnitude of stock price fluctuations in relation to the ups and downs of a given market index. R-squared is a measure of how much of a security's past returns can be explained by returns from the market in general, as represented by a given index.

Sources: Vanguard calculations, based on data from Bloomberg, L.P.

Theory of a risk management approach to currency exposure

The framework below formalises the intuition developed in the main paper. The key result – equation (5) – shows that the optimal hedge ratio depends on the correlation between currency and asset returns and the ratio of their volatilities.

Consider a domestic investor who holds a portfolio of foreign assets. Let r_s be the return on the foreign asset portfolio (in foreign-currency term); r_f be the return on the foreign currency (change in the exchange rate); σ_s, σ_f be the volatilities of the asset return and currency return; and ρ be the correlation between r_s and r_f. The investor can sell a fraction h of the foreign-currency exposure forward.

The domestic-currency return on the hedged portfolio (to first-order approximation, ignoring the second order $r_s \cdot r_f$. cross-term) is:

$$r_p\ (h) = r_s + (1 - h)r_f \qquad (1)$$

When h=0 the position is unhedged, whereas when h=1 the currency exposure is fully eliminated.

From equation (1):

$$\mathrm{Var}(r_p) = \sigma_s^2 + (1 - h)^2 \sigma_f^2 + 2(1 - h)\rho\sigma_s\sigma_f \qquad (2)$$

Differentiating equation (2) with respect to h and setting to zero yields:

$$\frac{(\partial \mathrm{Var}(r_p)}{\partial h} = -2(1 - h)\sigma_f^2 - 2\rho\sigma_s\sigma_f = 0 \qquad (3)$$

Solving for the optimal hedge ratio h*:

$$h^* = 1 + \rho \frac{\sigma_s}{\sigma_f} \qquad (4)$$

Equivalently, we can solve for the optimal unhedged currency weight:

$$w^*_f = 1 - h^* = -\rho \frac{\sigma_s}{\sigma_f} \qquad (5)$$

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