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Currency Hedging for Pension Funds, Endowments, and Foundations

February 2010

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Investors can minimize expected volatility and enjoy the benefits of international diversification by utilizing a simple formula that determines their portfolio's optimal currency hedge ratio.

Introduction

While the case for international diversification is well-established, the fact that international investments are denominated in foreign currencies often discourages investors from allocating a significant portion of their assets abroad. Wary of a mismatch between the currency denomination of their assets and that of their liabilities, most investors tend to have a much higher allocation in domestic assets than a pure market-capitalization weighted approach would dictate. This effect is known as the "home country bias."[1]

In this article, we establish a simple formula that consistently identifies the currency hedge ratio which will minimize the future volatility of an investment portfolio. Potentially, applying this formula will allow most investors to materially reduce the expected volatility of their portfolios and thus enjoy the full benefits of international diversification.

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Previous Attempts to Solve the Currency Hedging Puzzle

The currency hedging question has puzzled academics and practitioners since international investing became commonplace, coinciding with an era of free-floating exchange rates. In an early work on the topic, Andre Perold and Evan Shulman recommended fully hedging foreign currency exposure.[2] They observed that fully hedged German, U.K., and Japanese stocks and bonds were less volatile from a U.S. perspective from 1978–1987. Their analysis, however, did not consider the impact of this hedging on overall portfolio volatility, including domestic assets, nor did it consider other base currency perspectives besides the U.S. dollar.

Kenneth Froot challenged the fully-hedged result.[3] He used return data on U.S. stocks, bonds, bills, and real assets from a U.K. perspective from 1802 through 1990 to show that currency hedging actually increases the return variance over longer

[1] See, for instance, "International Diversification and International Equity Markets," Kenneth R. French and James M. Poterba, NBER Working Paper 3609, January 1991

[2] "The Free Lunch in Currency Hedging: Implications for Investment Policy and Performance Standards," Andre F. Perold and Evan Schulman, *Financial Analysts Journal,* May-June 1988

[3] "Currency Hedging Over Long Horizons," Kenneth A. Froot, NBER Working Paper No. 4355, May 1993

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Asset Management

observation periods (five to eight years). Froot's analysis, however, did not recognize that many investors have shorter holding periods. For example, an investor may have substantial interim cash flow requirements or may want the flexibility to rebalance his or her asset allocation more frequently than every five to eight years.

Grant Gardner and Thierry Wuilloud argued that a 50% hedge minimizes future regret.[4] The basis of their argument was that currencies may have significant unexpected returns. However, in the absence of a return expectation, there may be an optimal hedge ratio which minimizes expected volatility.

In the remainder of this article, we will demonstrate that hedge ratios calculated according to a popular optimization technique[5] do indeed result in portfolios with lower ex-post volatility.

DERIVATION OF THE OPTIMAL HEDGE RATIO FORMULA

An optimal hedge ratio minimizes the variance of a portfolio. If we consider a simplified portfolio which consists of a domestic asset, a foreign asset, and a forward currency contract which hedges the currency risk associated with the foreign asset, then the optimal hedge ratio can be determined using the following formula:

$$H = -\frac{d}{1-d}\,\beta_{DH} - \beta_{UH}$$

In the formula, "d" is the allocation to the domestic asset in percentage terms, "β_{DH}" is the beta of the currency hedge with the domestic asset, and β_{UH} is the beta of the currency hedge with the foreign asset. Notice that "1-d" is the allocation to the international asset. In practice, the hedge ratio "H" is constrained to be between 0 and 100%.

In this article, we applied the formula to calculate ex-ante optimal hedge ratios for a variety of portfolios and base currencies. We then compared the ex-post volatility of the resulting portfolios with three naïve strategies: full hedge, half-hedge, and no hedge.

Data and Methodology

In our analysis, we used Citi government bond and MSCI stock market index data to generate a time series of monthly returns from the perspective of seven countries: Australia, Canada, Switzerland, Germany, the United Kingdom, Japan, and the United States. Our time series begins in January 1985 and ends in December 2009.

Currency forward contract hedge return time series were constructed using exchange rate data from Reuters and short-term interest rate data from the British Bankers' Association.

We evaluated three portfolios from each country's perspective: all stock; all bond; and balanced (60% stocks, 40% bonds). In all cases, the domestic asset was the local stock and/or bond market and the international asset was the market capitalization-weighted world ex-home country stock and/or bond market. We evaluated portfolios with varying degrees of international exposure: from 0 to 100% in 5% increments. In total, we considered 441 portfolios (three stock/bond mixes across seven countries and 21 international allocations).

For each portfolio, we used the first 10 years of available data (January 1985 through December 1994) to estimate the two beta parameters in the hedge ratio formula (see box at left) and applied the resulting optimal hedge ratio to the portfolio for the next three years. We then set the optimally hedged portfolio returns from January 1995 through December 1997 aside, extended the data window to include this period, and re-estimated the parameters and the hedge ratio for the next three years. In this way, we avoided any look-ahead bias and conformed to the asset allocation review period used by many institutional investors.

We used this methodology to generate 15 years of monthly returns for each portfolio (from January 1995 through December 2009). In the next section, we compared the volatilities of the portfolios over this period using the four currency hedging strategies described so far: full hedge, half-hedge, no hedge, and optimal hedge.

[4] "Currency Risk in International Portfolios: How Satisfying is Optimal Hedging?," Grant W. Gardner and Thierry Wuilloud, *Journal of Portfolio Management,* Spring 1995

[5] See, for instance, "The Minimum-Risk Currency Hedge Ratio and Foreign Asset Exposure," Mark Kritzman, *Financial Analysts Journal,* September-October 1993.

Analysis and Interpretation of the Results for Fixed Income Portfolios

Exhibit 1 illustrates how portfolio volatility varies for fixed income portfolios with varying degrees of international diversification. **Exhibits 1A** to **1G** show four hedging approaches (full hedge, half-hedge, no hedge, and optimal hedge) across seven countries (Australia, Canada, Switzerland, Germany, the United Kingdom, Japan, and the United States).

For fixed income portfolios, we found that fully hedged portfolios resulted in the lowest volatility for all countries. This finding is intuitive since exchange rates are significantly more volatile than government bond prices. Notably, the optimal hedging formula correctly identified the full hedge as the posture that would lead to the lowest volatility for fixed income portfolios.

Also noteworthy is that internationally diversified fixed income portfolios appear to have significantly lower volatility than purely domestic portfolios. For example, a purely domestic portfolio of U.S. Treasuries had a monthly annualized volatility of 4.65% from January 1995 through December 2009. Over the same period, an optimally or fully hedged portfolio with 75% in international government bonds and 25% in Treasuries (approximately equal to the United States market share of the global government bond market) had a monthly annualized volatility of 3.03% (see **Exhibit 1G**).

Exhibit 1: Comparison of four currency hedging methodologies for fixed income portfolios*

EXHIBIT 1A: AUSTRALIA

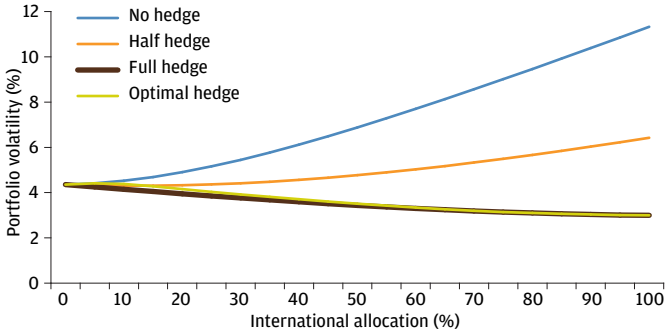


EXHIBIT 1B: CANADA

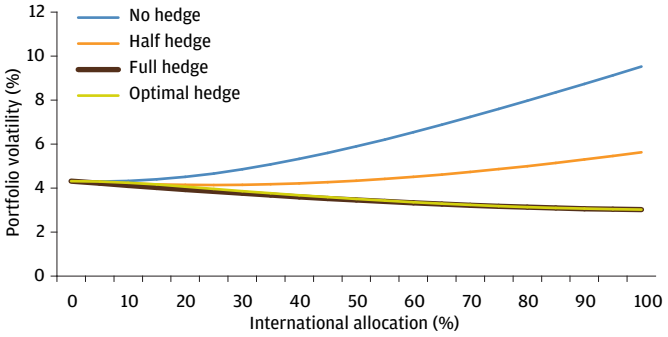


EXHIBIT 1C: SWITZERLAND

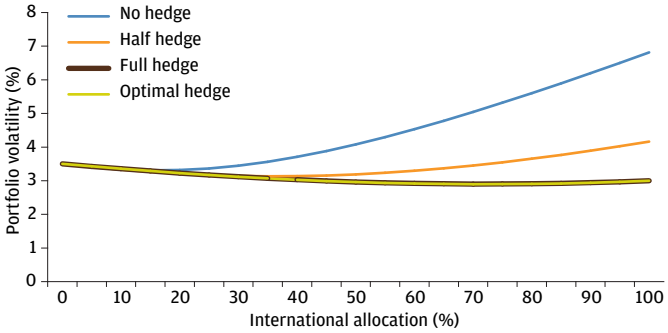


EXHIBIT 1D: GERMANY

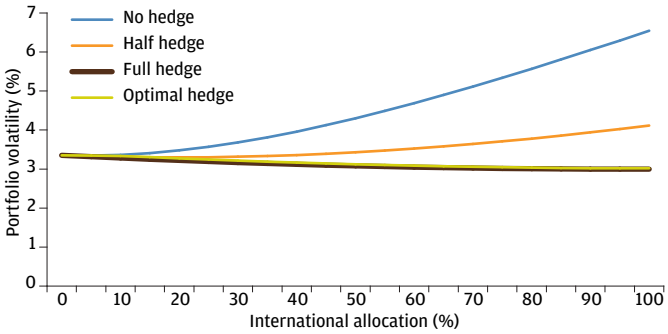
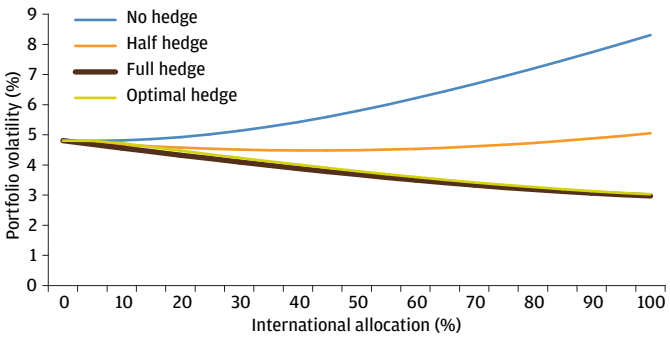


EXHIBIT 1E: UNITED KINGDOM



* Source for Exhibits 1A through 1G: J.P. Morgan estimates based on data from MSCI, Citi, Reuters, and British Bankers Association via DataStream.

EXHIBIT 1F: JAPAN

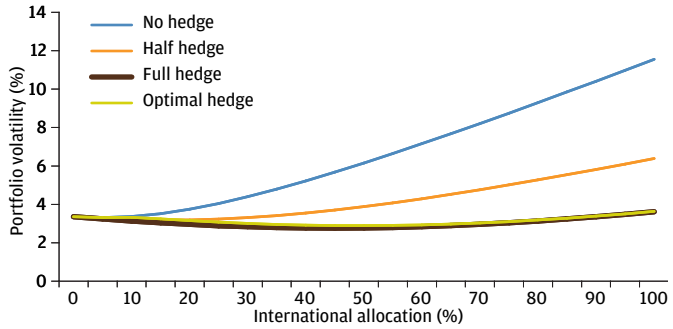
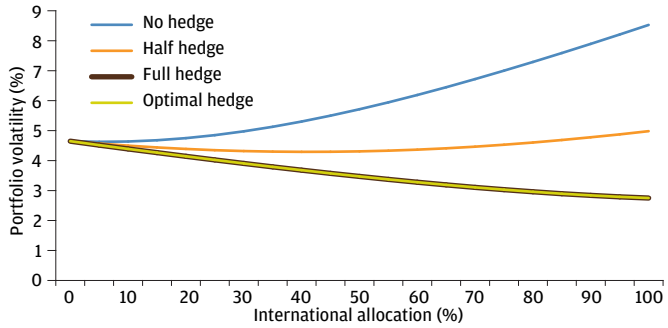


EXHIBIT 1G: UNITED STATES



Analysis and Interpretation of the Results for Equity Portfolios

Exhibit 2 illustrates how portfolio volatility varies for equity portfolios. For Australia and Canada, the unhedged portfolios had the lowest volatility for all international allocations (see 2A and 2B). This pattern reflects the commodity orientation of Australian and Canadian exports. Since Australian and Canadian terms of trade are more favourable when commodity prices are high, the Australian and Canadian dollars tend to rise during periods of brisk economic growth. Of course, equity markets also tend to rise during periods of high economic growth. Since hedging international equities from an Australian or a Canadian perspective involves buying Australian and Canadian dollars against a basket of other currencies, the hedge will tend to produce profits at the same time that equity markets are advancing, and produce losses when equities are falling. Therefore, a currency hedge is not a diversifier within these two countries.

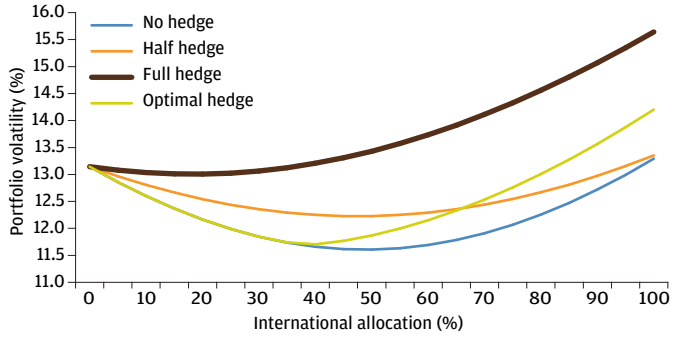
In contrast, fully hedged portfolios had much lower volatility than the other alternatives in Switzerland and Japan (see 2C and 2F). Switzerland and Japan are characterized by large net surplus international investment positions relative to the size of their economies. During periods of risk aversion, when equities are generally being sold, Swiss and Japanese investors tend to repatriate assets and buy their own currencies, driving the value of the currency higher. Since hedging international equities from a Swiss or a Japanese perspective requires the purchase of Swiss Francs or Japanese Yen against a basket of foreign currencies, the hedge will tend to produce gains when equity markets are falling and losses when they are rising. Therefore, a currency hedge helps reduce risk in these two countries.

For Germany, the United Kingdom, and the United States, fully hedged portfolios and half-hedged portfolios had similar volatility. As an aside, international diversification was particularly beneficial from a German perspective because its domestic equity market was very volatile over the period.

For all countries, the optimal hedge formula did a good job of predicting the hedge ratio that would produce equity portfolios with the lowest volatility. There were only two instances when the formula was “fooled”. For high international allocations from an Australian or a Canadian point of view, the unhedged portfolios had the lowest risk, while the optimal hedge formula recommended a partial hedge for those portfolios. We don’t view this as a serious misjudgment by the formula, as it is unlikely that an Australian or Canadian investor with more than 50% of their assets invested abroad would remain completely unhedged.

Exhibit 2: Comparison of four currency hedging methodologies for equity portfolios*

EXHIBIT 2A: AUSTRALIA



* Source for Exhibits 2A through 2G: J.P. Morgan estimates based on data from MSCI, Citi, Reuters, and British Bankers Association via DataStream.

EXHIBIT 2B: CANADA

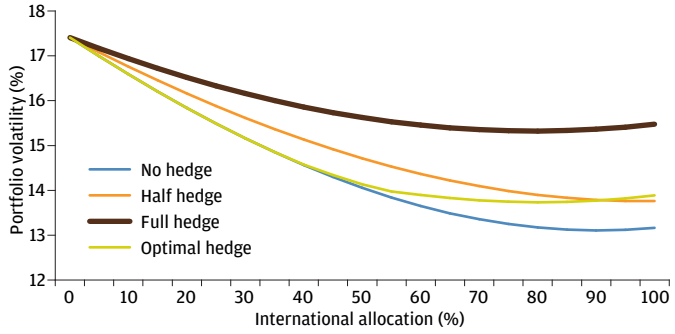


EXHIBIT 2C: SWITZERLAND

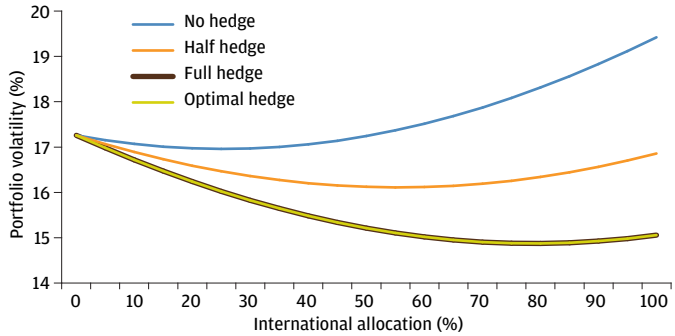


EXHIBIT 2D: GERMANY

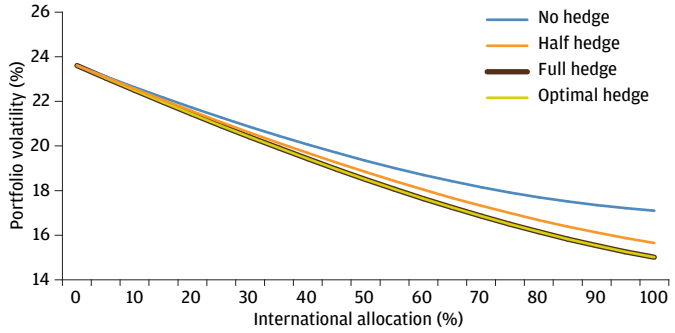


EXHIBIT 2E: UNITED KINGDOM

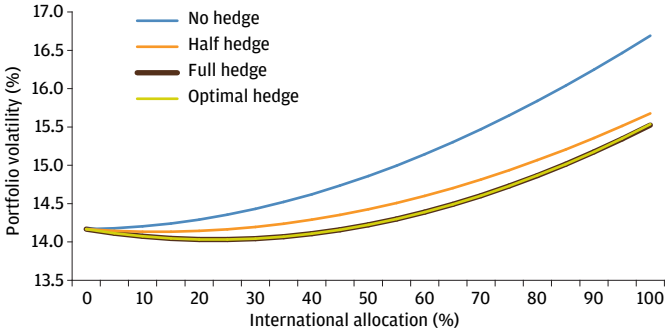


EXHIBIT 2F: JAPAN

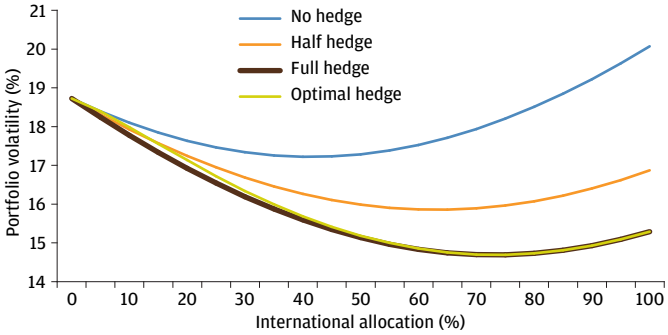
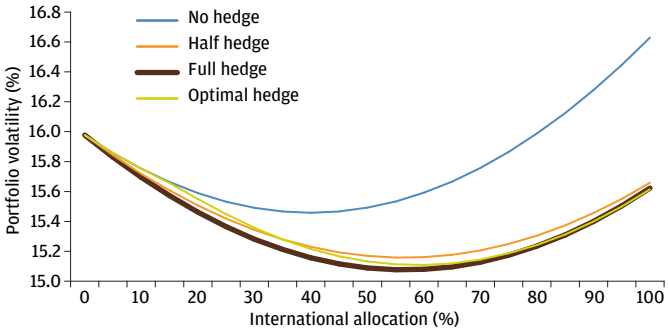


EXHIBIT 2G: UNITED STATES



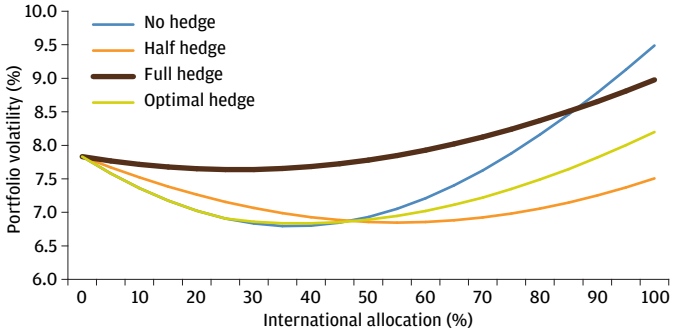
Analysis and Interpretation of the Results for Balanced Portfolios

The results for balanced portfolios of stocks and bonds are shown in **Exhibit 3**. For Australia and Canada, unhedged portfolios exhibited the lowest volatility at relatively low levels of international exposure (less than 50% for Australia, less than 70% for Canada). This was due to foreign currency exposure diversifying the equity allocations in these portfolios. As international exposure rose, however, half-hedged portfolios became the least volatile, reflecting the influence of a higher allocation to international bonds. For both countries, the optimal hedging formula did a good job of selecting the best hedge ratio irrespective of the level of international exposure, remaining unhedged at low levels of international exposure and applying a partial hedge to higher levels of international exposure.

The results for all other countries were broadly in line with the results for equity portfolios presented in **Exhibit 2**.

Exhibit 3: Comparison of four currency hedging methodologies for balanced portfolios*

EXHIBIT 3A: AUSTRALIA



* Source for Exhibits 3A through 3G: J.P. Morgan estimates based on data from MSCI, Citi, Reuters, and British Bankers Association via DataStream.

EXHIBIT 3B: CANADA

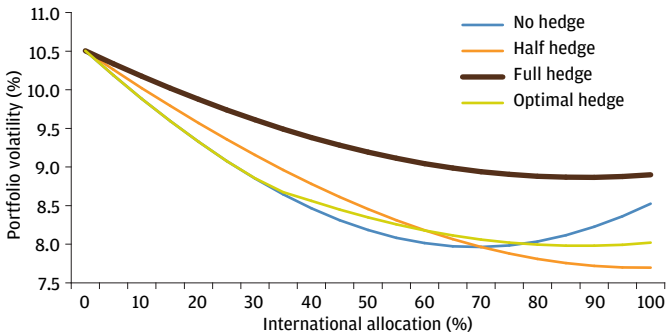


EXHIBIT 3C: SWITZERLAND

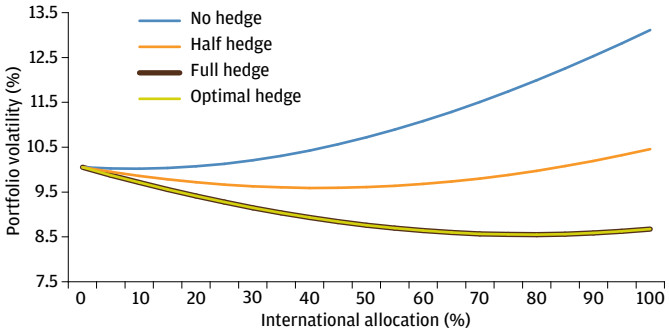


EXHIBIT 3D: GERMANY

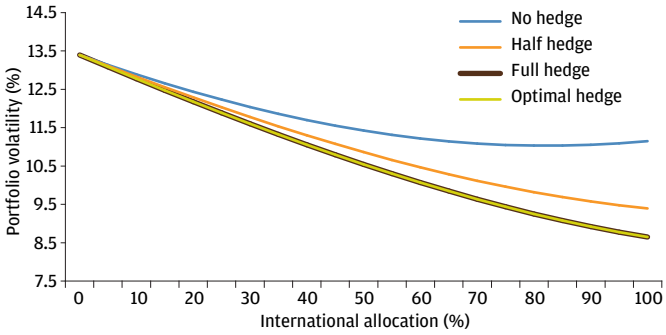


EXHIBIT 3E: UNITED KINGDOM

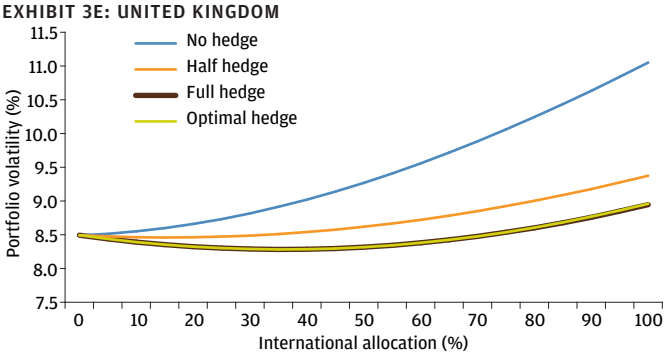


EXHIBIT 3F: JAPAN

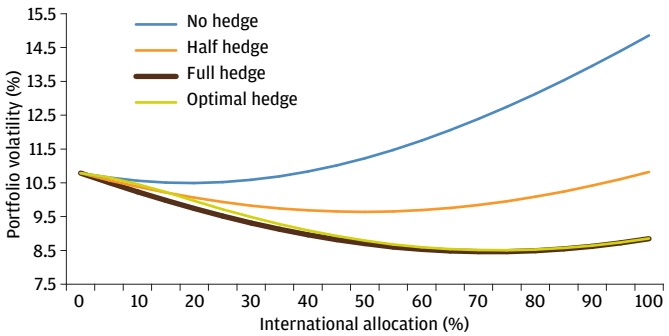
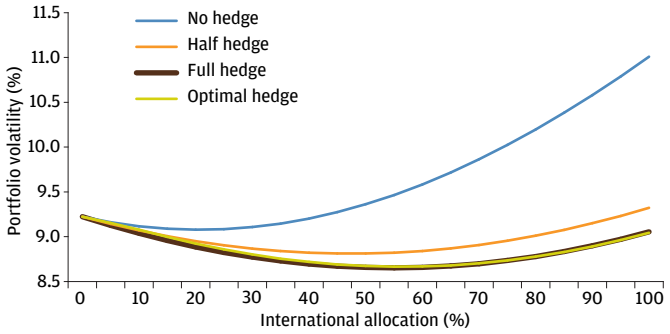


EXHIBIT 3G: UNITED STATES



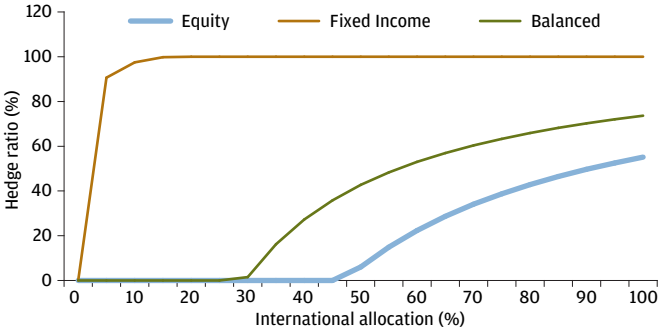
What Are the Current Hedging Recommendations?

In this section, we use all 25 years of available history to determine up-to-date optimal hedge ratio estimates for each of the 441 portfolios. The results are presented in **Exhibit 4**. Unsurprisingly, the recommendations for Australia and Canada are similar. For fixed income-oriented investors based in these countries, any international exposure should be fully hedged. However, only equity and balanced investors with international exposure exceeding 50% should consider hedging (see **4A** and **4B**).

For investors based in Switzerland, Germany, Japan, the United Kingdom, and the United States, full hedging is appropriate for most investors (see **4C, 4D, 4E, 4F** and **4G**). The only exception is that a small amount of foreign currency exposure, about 4%, offers some diversification for fixed income-oriented investors based in Continental Europe or Japan.

Exhibit 4: recommended risk-minimizing hedge ratios*

EXHIBIT 4A: AUSTRALIA



* Source for Exhibits 4A through 4G: J.P. Morgan estimates based on data from MSCI, Citi, Reuters, and British Bankers Association via DataStream.

EXHIBIT 4B: CANADA

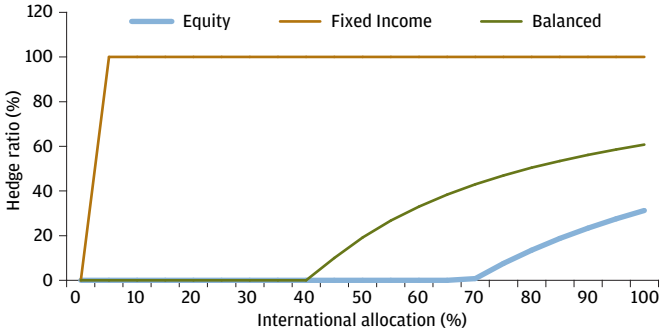


EXHIBIT 4C: SWITZERLAND

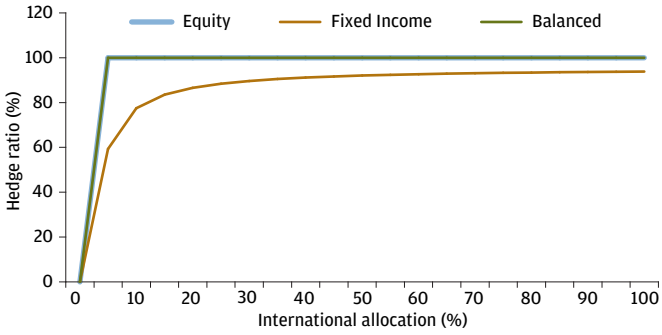


EXHIBIT 4D: GERMANY

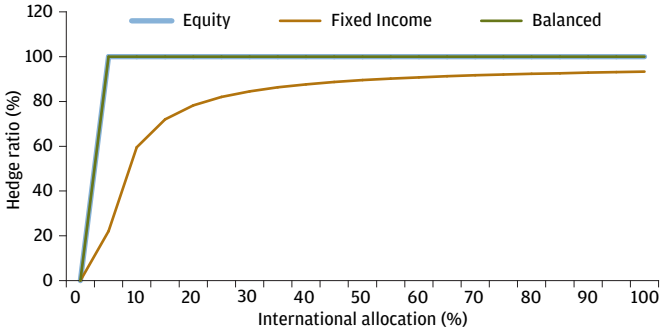


EXHIBIT 4E: UNITED KINGDOM

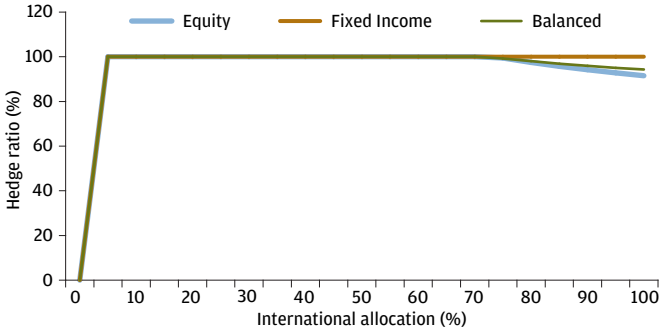


EXHIBIT 4F: JAPAN

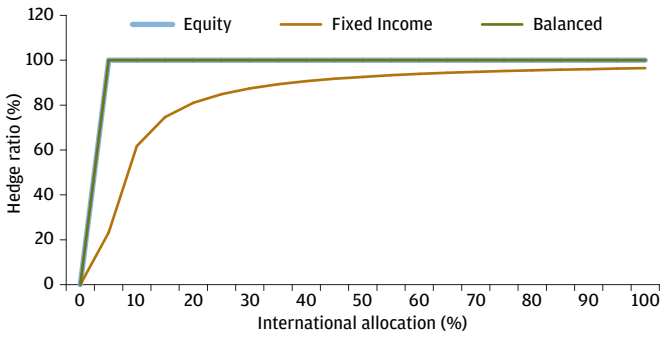
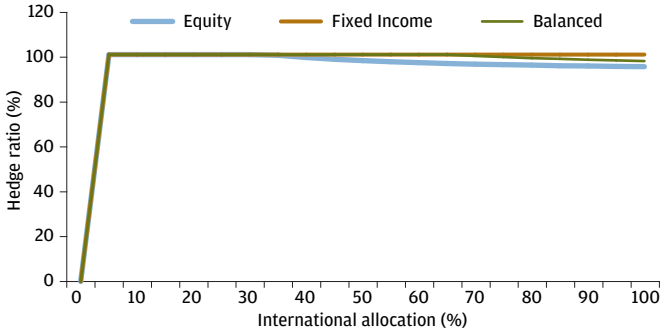


EXHIBIT 4G: UNITED STATES



Conclusion

In this article, we have shown that our optimal hedge ratio formula can consistently select the currency hedge ratio that will minimize the future volatility of portfolios from all major base currency perspectives. Furthermore, by demonstrating the application of the formula, the risk reducing benefits of international diversification become apparent. This can easily be seen by the downwardly sloping optimal hedge line on every chart in **Exhibits 1–3** as international allocation increases from 0% to 100%. If international investments can be made with low implementation costs and without sacrificing expected return, then international diversification, properly hedged, is indeed a "free lunch".