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Global fixed income: Considerations for U.S. investors

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Executive summary. Traditionally, U.S. investors have achieved diversification of a domestically focused portfolio primarily through the use of international equities. However, over the past ten years the global investable market has changed markedly, largely as a result of the growth and maturation of world bond markets combined with the ongoing globalization of businesses and capital flow. International bonds now make up more than 35% of the world's investable assets, and yet many domestic investors have little or no exposure to these securities. Are there empirical or practical considerations that would justify such a home bias in U.S. investors' portfolios?

We examine the strategic case for an allocation to international bonds by addressing their potential diversification benefits, risks, and costs, paying particular attention to the role of currency. For the average investor seeking to further mitigate volatility in a diversified portfolio, we find that foreign bonds can play such a role, assuming that the currency risk inherent to this asset class is hedged. While there is

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Doesn't a market cap-weighted index overweight the most indebted countries?

The short answer to this question is yes, in the sense that any market cap-weighted bond index will provide greater exposure to issuers with more debt outstanding. However, it is our view that market forces are generally efficient in demanding appropriate compensation for the expected risk of any investment. No government can simply dump its debt on the market without an expectation of a negative impact. Instead, the market sets a price and yield based on the risks of the issuer. A cap-weighted index approach ensures that investors are matching the risk and return profile assigned by the broad global bond market.

This issue has received much attention since the European sovereign-debt crisis began in 2010. Many have questioned the wisdom of tying investments to an index with explicit exposure to issuers such as Greece, a country viewed as having serious difficulties in repaying its obligations over the next few years.⁴ In such cases, bond market participants adjust prices

to reflect the expected risks and return of a country's debt, including any prospect of a default or restructuring event. This means that investors receive a level of yield in line with the market's assessment of the risks attending a given country's debt, as with any other bond.

A departure from market-cap-weighted exposure to international bonds assumes that the market is incorrect in its valuation and that there is a better way to invest. Alternative structures, such as indexes weighted by GDP, population, or land mass, may sound appealing, but lack any theoretical or real economic rationale as a method for investing. In addition, these metrics constitute freely available information and are therefore priced into the current value of a given issue. Choosing an investment strategy other than a cap-weighted index may involve a significant departure from the market's expectation of risk and return, and is therefore something that investors may want to consider carefully before implementing.⁵

Perhaps even more important, exposure to international risk factors may be worthwhile if the outlook for the U.S. fixed income market is poor. In addition, exposure to international bonds could offer clear long-term diversification benefits if international and U.S. market factors are sufficiently different, on average, over time. **Figure 2** indicates that this is the case: It shows how various countries' levels of interest rates and inflation—the two most important drivers of bond returns—have correlated with the U.S. levels since 1990. These low and varied correlations are evidence of the potential diversification benefit of adding international bonds to a U.S.-only bond portfolio.

The impact of adding international bonds to a diversified portfolio

Investing in international bonds entails exposure to the movements of global currencies. Although currency movements tend to be driven by fundamental factors over long horizons, it is well documented that currencies can and do deviate significantly from fair value in the short to intermediate term.⁶ These deviations create return volatility above the level inherent to the underlying investment. For example, if a U.S. investor were to purchase a German bund denominated in

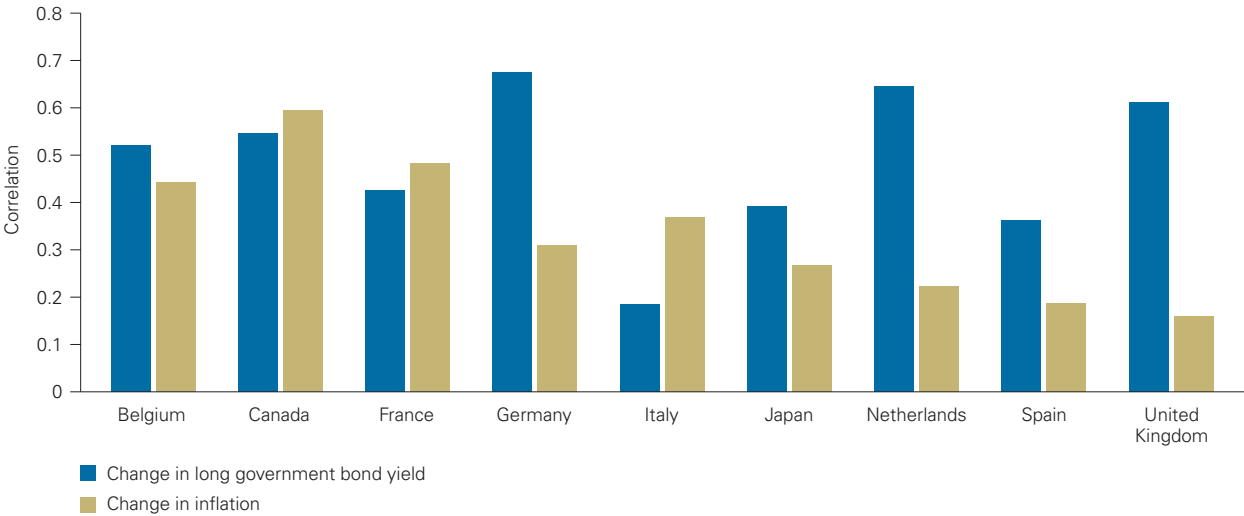
4 For a discussion of the potential outcomes of the Eurozone sovereign debt crisis, see *What's Next for the Eurozone?* (Lemco, Aliaga-Díaz, and Thomas, 2010).

5 See Philips et al. (2011) for a discussion of alternative methodologies used to construct equity indexes and Thomas and Bennyhoff (2012) for a similar analysis concerning fixed income benchmarks.

6 Two theoretical models of currency value involve price level and interest rate differences between countries. Purchasing power parity (PPP) states that identical goods sold in different countries must sell at the same price when translated into the same base currency. If PPP holds at the country level, real returns will be the same across countries, as exchange-rate movements and inflation differentials will offset each other. Interest rate parity (IRP) is based on the notion that the interest rate differential between the home and foreign markets will determine the change in the exchange rate, so that the realized rate of return on a risk-free government bond is the same in any market.

Figure 2. Inflation and bond yields in international markets show low average correlation with U.S. levels

Correlations of the key drivers of bond returns in the largest international markets versus the United States, 1990–2011



Sources: U.S. Federal Reserve, U.S. Bureau of Labor Statistics, various international government agencies via Thomson Reuters Datastream, and Vanguard.

euro, both the interest payments and the principal repayment would need to be converted from euro into U.S. dollars. The conversion would take place at the future exchange rate, which can change in ways either adverse or favorable to the bondholder. If the U.S. dollar were to appreciate, the investor would receive fewer dollars when the payment in euro was exchanged. The opposite would be true if the dollar depreciated.

Figure 3, on page 6, plots the volatility, defined here as the rolling 36-month standard deviation of returns, inherent to the U.S. dollar versus three major currencies, as well as the volatility inherent to the broad U.S. stock market and the broad

investment-grade U.S. bond market. It’s clear that, while the value of the dollar has cycled between periods of lower and higher volatility, on average its volatility has been between that of U.S. bonds and stocks. Because international bonds entail exposure to currency exchange rates, which in themselves are more volatile than the broad U.S. bond market, then adding international bonds to a portfolio would likely lead to a fixed income allocation with greater volatility than is traditionally associated with U.S. bonds. The key question is whether the low correlation of currency to traditional financial assets offers enough benefit to investors to overcome the inherent volatility of currency.⁷

7 Portfolio variance is a function of the weight and variance of each asset in the portfolio, as well as the covariance of each asset with every other asset: $\Theta^2_{\text{portfolio}} = (w_d^2 \Theta_d^2) + (w_f^2 \Theta_f^2) + (w_c^2 \Theta_c^2) + (2 * w_d * w_f * \text{cov}_{df}) + (2 * w_d * w_c * \text{cov}_{dc}) + (2 * w_f * w_c * \text{cov}_{fc})$, where $w_{d,f,c}$ represents the weights of domestic bonds, international bonds, and currency in the portfolio; the $\Theta^2_{d,f,c}$ represents their respective variances; and $\text{cov}_{df,dc,fc}$ represents the respective covariances among the returns on the domestic bonds, international bonds, and the currency basket.

A framework for asset allocation

Figure 7 shows that, on the basis of historical data, a volatility-minimizing investor would have been better off over the last 26 years with a sizable allocation to hedged international bonds. It is, however, important to consider the economic and financial environment in the quarter-century that produced these results. During this period, the United States and other developed markets experienced falling interest rates, disinflation, and the anchoring of long-term inflation expectations. Together these trends created a favorable return environment for bond investors (returns averaged 8.0% annually for diversified U.S. bonds, 9.2% annually for unhedged international bonds, and 7.0% annually for hedged international bonds). Given the environment today, bond investors must ask:

1. Are return expectations based on history reasonable?
2. Should hedging currency risk be expected to lead to lower returns?
3. Do asset allocation conclusions change as return expectations change?

To address the first question, it is important to note that interest rates today are much lower than they were in 1985. Absent high yields at the start, the historical return scenario is not likely to be repeated. In addition, current inflation expectations, arguably the most important driver of interest rate levels, are largely stable across developed markets. This suggests that a scenario in which interest rates climb significantly to the levels seen in the 1980s—though *possible*—may be viewed as having a low probability. Given the market and economic

conditions in 2011, a likely forward-looking scenario is one in which nominal yields across developed markets rise gradually, creating a drag on bond returns in the short term, but compensating investors with higher yields over time.¹³ As a result, investors may want to start with current levels of yield as the baseline for forward long-term return expectations and then possibly factor in a modest premium to account for an increase in income as yields rise to more normal levels.

The last 25-plus years also were characterized by long-term depreciation of the U.S. dollar. This is why unhedged international bonds outperformed hedged bonds by 2.2 percentage points a year, on average. Since unhedged bonds heighten portfolio volatility and suggest a bearish view on the U.S. dollar, the critical questions then are: Should investors expect the U.S. dollar to continue a long-term slide, and would such depreciation effectively counter the higher volatility? Investors considering these points should note that short-term currency movements are widely thought to follow a random walk (Solnik, 1974; Meese and Rogoff, 1983; Perold and Schulman, 1988). Although there is evidence that over a long-enough time horizon, structural differences between countries can force currencies to a fundamental equilibrium (Meredith and Chinn, 1998; Mark, 1995), these structural factors—price levels and trade flows, for example—are inherently long-term in nature, and changes in them therefore tend to be anticipated and priced in by securities markets. As a result, we believe that an allocation to unhedged international bonds that is driven by views on potential currency returns should be considered with care.

13 For more on Vanguard's outlook for the U.S. fixed income market, see *Vanguard's Economic and Investment Outlook* (Davis and Aliaga-Díaz, 2012).

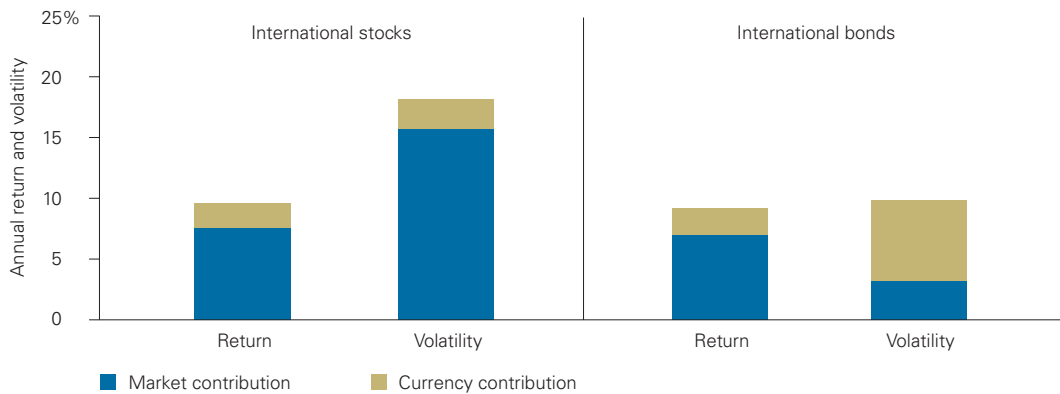
Why hedge international bonds and not international stocks?

A natural question arising from this report is whether currency risk should also be hedged within an international equity allocation. When considering this question, it's essential to recall the relationship between asset volatility and currency volatility. As discussed in footnote 7 (page 5), the correlations of the assets combine with the volatilities of the assets to result in a total volatility statistic. In the case of bonds, currency exposure adds significant volatility to an asset that

is relatively stable in price. Stocks, on the other hand, already have high volatility, so the effect of adding currency volatility is less pronounced. These relationships are shown in **Figure 8**. For international stocks, the benefit of hedging is smaller, while the costs remain the same.¹⁴ On the other hand, the benefits of hedging currency risk in international bond portfolios generally outweigh the costs.

Figure 8. Hedging currency risk has much greater impact in bonds than in stocks

Mitigating currency volatility would have had a modest effect on the overall volatility of stocks, but a meaningful effect on the volatility of bonds. This chart reflects annualized returns and volatility for the period 1985–2011.



Notes: International stocks are represented by the MSCI World ex USA Index through 1987 and the MSCI All Country World Index ex USA thereafter. International bonds are represented by the Citigroup World Government Bond Ex-US Hedged Index through 1989 and the Barclays Capital Global Aggregate ex-USD Hedged Index thereafter.

Sources: Thomson Reuters Datastream, Barclays Capital, Citigroup, Dow Jones, MSCI, and Vanguard.

¹⁴ For more on the decision of whether to hedge currency in an international stock portfolio, see Vanguard's research paper *Currency Management: Considerations for the Equity Hedging Decision* (LaBarge, 2010).

Finally, we turn to the question of how return expectations might affect our previous volatility-focused analysis. For this purpose it is useful to construct an efficient frontier, a graph showing the entire set of asset combinations that would achieve a given expected return with the least expected risk under specified assumptions. In this analysis we use long-run projections of returns, volatilities, and correlations of the four primary asset classes.¹⁵ The output can be viewed as a reasonable starting point for the construction of a strategic long-term portfolio. **Figure 9**, on page 14, displays the efficient frontiers we generated under two scenarios.

The portfolios shown in Figure 9a exclude any potential return related to long-term appreciation or depreciation of the U.S. dollar. In other words, we imposed a baseline assumption that the presence or absence of currency hedging makes no meaningful difference to long-term return expectations. The results show that any allocation to unhedged international bonds is inefficient; that is, there are other portfolios with less risk that offer the same expected return. This analysis validates the results we discussed earlier: The most risk-averse investors may consider an allocation to hedged international bonds for diversification purposes. Investors with less risk-aversion may look more to the U.S. bond market for diversification. The rationale here is that because of the exposure to corporate bonds, the U.S. bond market may be incrementally more volatile but may also offer incrementally higher returns (because of the typically higher yields offered on corporate bonds).¹⁶ Nonetheless, Figure 9a suggests that hedged international bonds may have a place in a broadly diversified portfolio.

Because unhedged international bonds do not appear in Figure 9a, it is reasonable to ask whether they might show up in the optimized portfolio allocations under different assumptions. Because the volatility impact of currency exposure is unlikely to go away, we focused on returns—specifically, how much depreciation in the value of the U.S. dollar would be needed for unhedged international bonds to warrant an allocation?

Figure 9b shows the portfolio combinations that result if we assume that the U.S. dollar depreciates by 100 basis points a year (100 basis points of additional return was the first level at which unhedged international bonds appeared at a meaningful allocation). Under this assumption, which would imply a roughly 10% cumulative decline in the dollar over the next ten years, unhedged bonds do appear, albeit in marginal quantities (at most, 8% of the portfolio in this example). Of course, with more aggressive assumptions regarding the dollar's decline, the incremental allocation to unhedged bonds would possibly increase.

A follow-up question is: How reasonable is it to expect 1% of additional yearly return from exposure to a basket of currencies over the long term? Note that this additional return would have to result from *unexpected* future dislocations between the U.S. and global economies. That is because securities markets are forward-looking. In other words, if investors collectively believed currencies would head in a certain direction, the anticipated currency return would be factored into intermediate- and long-maturity bond prices today. That said, given the elevated levels of uncertainty in the global economic environment, unexpected future developments could result in sizable currency movement.

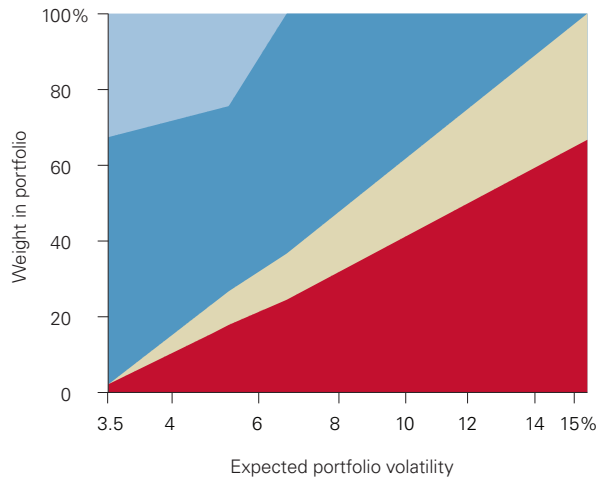
15 The projections discussed here represent outcomes generated by the Vanguard Capital Markets Model for U.S. stocks, U.S. bonds, and international stocks. For both hedged and unhedged international bonds, we assumed that starting yields represented the best approximation for future returns. However, to account for the likelihood of rising interest rates, we added a small premium to expected bond returns. We assumed that historical volatilities and correlations were reasonable expectations going forward. For more information about the Vanguard Capital Markets Model, see page 18.

16 The international fixed income market, and thus any index that tracks it, consists mainly of government-issued securities. The Barclays Capital Global Aggregate ex-USD Bond Index, for example, is about 11% corporate securities; by contrast, corporates make up approximately 20% of the Barclays Capital U.S. Aggregate Bond Index. Many foreign corporations use other means (e.g., bank loans) for their financing needs.

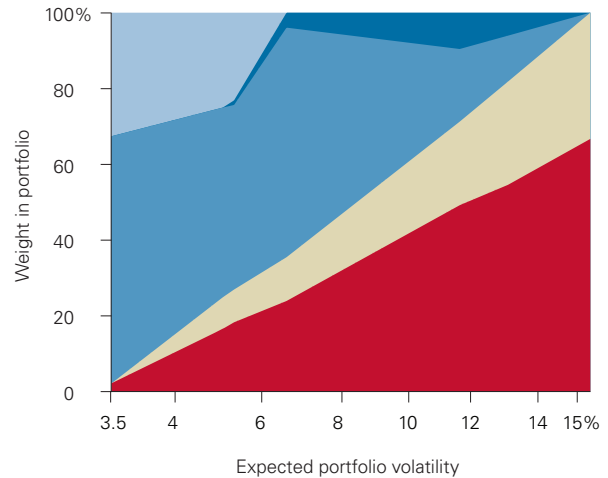
Figure 9. Efficient-frontier analysis: Portfolio simulation results with and without assumed return from U.S. currency depreciation

With reasonable forward-looking expectations for returns and covariances, hedged international bonds can be considered a viable diversification tool for more risk-averse investors. These charts show the portfolio weight of each major asset class over the efficient frontier: the set of portfolios with the highest expected return for a given level of expected volatility. We show two different currency return scenarios, demonstrating that holding unhedged international bonds represents a bearish view toward the dollar.

a. Assuming no return from changes in the dollar's value



b. Assuming the dollar depreciates by 1% annually



■ U.S. stocks
 ■ International stocks
 ■ U.S. bonds
 ■ International bonds hedged
 ■ International bonds unhedged

Notes: For this analysis we applied one constraint—no portfolio may weight international assets above their global market-cap weighting. Although not shown above, the results based on an opportunity set specifically excluding hedged bonds indicate that an overall portfolio allocation to unhedged international bonds does appear for certain investors, with or without the assumption of 1% annual dollar depreciation. Unhedged international bonds are absent from Figure 9a because they were not optimal in any scenario lacking assumptions about the U.S. dollar. In Figure 9b, which assumes steady depreciation of the dollar over ten years, unhedged bonds do appear, though minimally. For a detailed description of the VCMM, please see the text box on page 18.

Sources: Vanguard projections using data derived from the Vanguard Capital Markets Model and Barclays Capital.

Investors wishing to position their portfolios for the possibility of such extreme, unexpected dollar depreciation may consider using unhedged international bonds. For example, although both U.S. stocks and U.S. bonds historically have performed well during

periods of significant dollar depreciation, there is no clear and consistent relationship, as there is between unhedged international bonds and the dollar during such periods.¹⁷

17 Since 1985, dollar returns have explained less than 6% of the variance in both U.S. stocks and bonds (measured as the R-squared between security returns and those of the Federal Reserve's trade-weighted dollar index), while the movement of the dollar explained 80% of unhedged international bonds' returns, making them a much better hedge against adverse dollar scenarios. Over the same period, U.S. stocks and bonds returned 1.4% and 0.9%, respectively, on average during months in which the dollar declined by more than 1%. Unhedged international bonds returned 3.5% during those same months.

Note: R-squared refers to a measure of how much of a security's past returns can be explained by the returns from a given index.

Emerging-market bonds

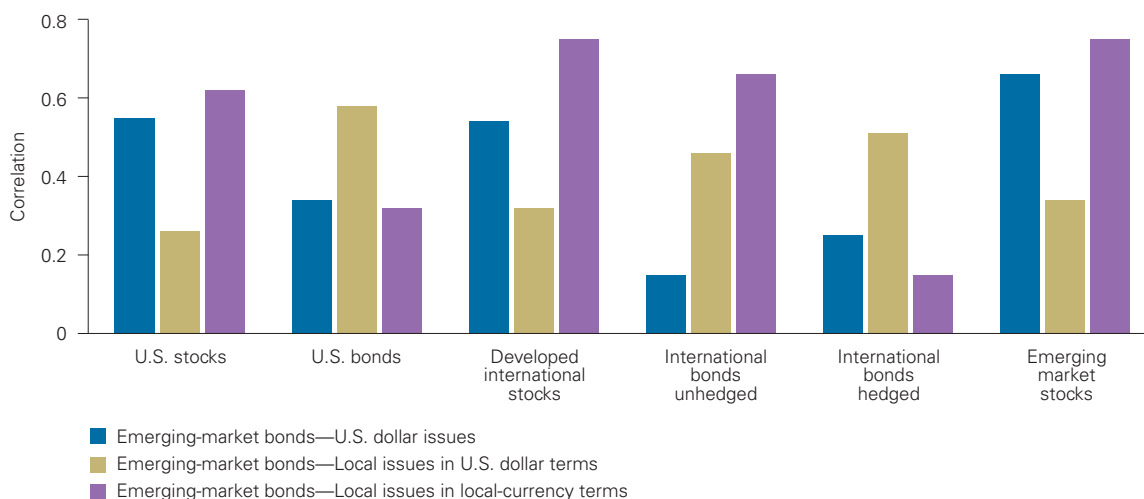
Like emerging-market stocks, fixed income securities issued by governments and companies in emerging markets may have a role in a diversified portfolio. Because broad bond indexes are typically limited to investment-grade securities, many emerging markets are excluded from major benchmarks such as the Barclays Capital Global Aggregate Index. As a result, investors who desire complete coverage of the global fixed income market might consider a separate allocation to emerging-market bonds.

Emerging-market bonds are typically offered in two variations, denominated in a major currency such as U.S. dollars, euro, or pounds sterling, or denominated in a country's local currency. Traditionally, bonds denominated in U.S. dollars were more common; however, in recent years bonds issued in other major currencies and local currencies have increased their market share. In fact, today local-currency issues are more common (in terms of market capitalization) than issues denominated in major currencies.

Emerging-market bonds generally carry higher yields than developed-market bonds because they carry greater risks, such as political instability or uncertainty about inflation. For the same reason, emerging-market bonds have also experienced significantly higher volatility than developed-market bonds. However, because the two types of markets tend to have quite different risks, we would expect correlations between their securities to be relatively low, implying a potential diversification benefit. **Figure 10** presents the historical correlations between traditional financial assets and both U.S. dollar-denominated and local-currency-denominated emerging-market bonds. Because of these bonds' place in the global market, as well as the potential for additional diversification, allocating some assets to emerging-market bonds as part of a broadly diversified international bond investment can make sense for certain investors.

Figure 10. Emerging-market bonds can provide additional diversification benefit

Emerging-market bonds, regardless of their country or currency of issue, showed attractively low correlations with major asset classes, both hedged and unhedged, over the period 2002–2011.



Notes: U.S. stocks are represented by the Dow Jones Wilshire 5000 Index through May 2005 and the MSCI US Broad Market Index thereafter. U.S. bonds are represented by the Barclays Capital U.S. Aggregate Bond Index. Developed international stocks are represented by the MSCI World ex USA Index. International bonds are represented by the Barclays Capital Global Aggregate ex-USD Index (Unhedged and Hedged). Emerging-market stocks are represented by the MSCI Emerging Markets Index. Emerging-market bonds are represented by the J.P. Morgan Emerging Markets Bond Index and the J.P. Morgan Global Bond Index—Emerging Markets.

Sources: Thomson Reuters Datastream, J.P. Morgan, Barclays Capital, Dow Jones, MSCI, and Vanguard.

The impact of the forward premium

Investors may also consider accounting for the cost of hedging a currency that is trading at a forward premium (or discount) to its spot exchange rate, a result of a “no arbitrage” relationship in short-term interest rate differentials between two countries. This effect can be thought of as a “haircut” (or a “premium”) to the yield. Consider this example: A U.S. investor wants to purchase a 1-year German bund and hedge his exposure to the euro. The investor would convert his dollars to euro at the spot rate and purchase the bund. To hedge his euro exposure, the investor would enter into a 1-year forward contract, to “lock in” a forward exchange rate. Often, the forward contract will not be equal to the spot rate, resulting in a forward premium or discount. A loss on the forward contract could be considered a haircut to the bond’s yield, while a gain may be considered a boost. Of course, the dollar may also be trading at a forward discount relative to other currencies, thus reducing the potential for a large haircut due to hedging when investing across several international markets.

Generally speaking, hedging is implemented over a shorter horizon than in the above example (typically over a one- to three-month horizon). The short-term rates used to set forward exchange rates at these horizons reflect a country’s current monetary policy, while intermediate- and long-term rates reflect economic fundamentals such as inflation differentials. Because long-term currency trends are driven by the fundamentals reflected in long rates, any forward premium or discount due to short-term interest rate differentials between countries may be expected to wash out over time. This is especially true when comparing the United States to a multilateral group of countries that are likely to be in different stages of their business cycles.

Practical considerations for a long-term strategic investor

Beyond empirical analysis, additional qualitative factors such as portfolio objectives, costs, and other operational considerations could influence the decision to include international bonds in a diversified portfolio. For example:

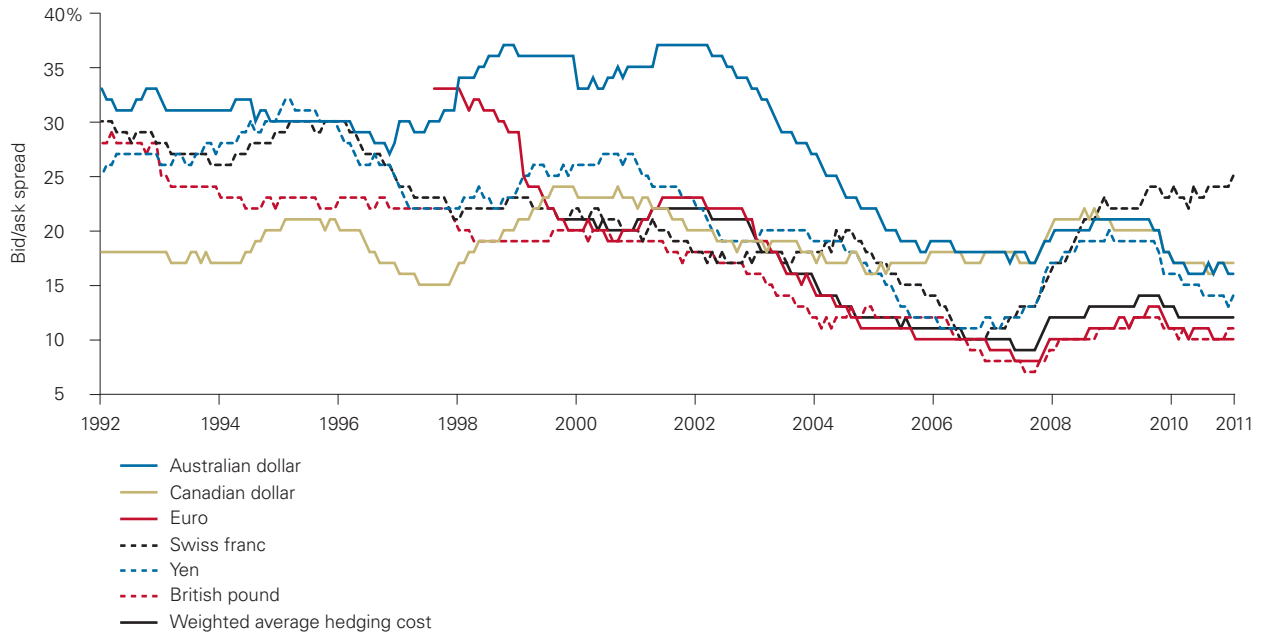
- Holding no U.S. bonds (as observed in Figure 7) would represent a significant deviation not only from the capitalization weightings in the global bond market but also from the standard asset allocation framework for U.S. investors.
- Ignoring the U.S. fixed income market in favor of bonds issued abroad leaves no exposure to U.S. Treasury securities, a proven diversifier during economic and financial downturns.
- Correlations across developed markets have displayed a persistent rising trend in both equity and fixed income markets. If this trend continues, the diversification benefits of international securities will likely decrease in magnitude (though not disappear).
- International bonds are generally government bonds. For investors seeking higher yields, U.S. corporate bonds may be a better fit.
- Foreign fixed income markets are still not as easily accessed as foreign equity markets, as demonstrated by generally higher transaction costs.

The costs of hedging

An important consideration for an investor weighing the benefits of international bonds is the potential cost of implementing a currency hedge. To examine this issue, **Figure 11** shows the historical annualized bid-ask spread on 1-month currency forward contracts, a reasonable approximation of the annual trading costs of hedging. Notwithstanding the spike in 2008–2009 as the global recession took hold, spreads have trended downward and remain at low levels, suggesting that investors might expect minimal drag on their returns relative to the diversification benefits that can be achieved.

Figure 11. The cost of hedging currency risk has declined over time

Hedging costs: Annualized bid/ask spread for 1-month forward relative to U.S. dollar



Notes: We used the annualized bid/ask spread on a 1-month currency forward contract as a proxy for the cost of implementing a constant rolling hedge for each individual currency. In practice, 3- or 6-month forwards may be used. The weighted average hedging cost is approximated by combining the currency forwards according to the historical market weight of the outstanding debt of each entity.

Sources: Thomson Reuters Datastream, Barclays Capital, and Vanguard.

Conclusion

International fixed income securities make up a significant portion of the global investable market. While investors in international bonds are exposed to the risk of interest rate movements, the political landscape, and the economies of many different markets, we've shown that the primary factors driving international bond prices are relatively uncorrelated to the same U.S. factors, which implies a diversification benefit. Of course, investors are also exposed to currency movements, which have an important role in determining the risk of international bonds. We've shown that on average, the volatility of currencies can overwhelm any diversification benefit that international bonds may bring to a

diversified portfolio. On the other hand, with that currency risk hedged, an allocation to international bonds can lead to lower average portfolio volatility over time.

To make the strategic decision to include international bonds in a diversified portfolio, an investor should weigh the trade-offs among several factors: the potential to reduce portfolio volatility, exposure to the largest global asset class, the costs of implementation, and the investor's own views on the future path of the U.S. dollar. Based on our findings, we believe that most investors should consider adding hedged foreign bonds to their existing diversified portfolios.

The Vanguard Capital Markets Model

The Vanguard Capital Markets Model (VCMM) is a proprietary financial simulation tool developed and maintained by Vanguard's Investment Counseling & Research and Investment Strategy Groups. The VCMM forecasts distributions of future returns for a wide array of broad asset classes. These include U.S. and international equity markets, several maturities of the U.S. Treasury and corporate fixed income markets, international fixed income markets, U.S. money markets, commodities markets, and certain alternative investment strategies. The results shown in this paper are drawn from 10,000 VCMM simulations based on market data and other information available as of December 31, 2011.

The VCMM is grounded on the empirical view that the returns of various asset classes reflect the compensation investors receive for bearing different types of systematic risk (or beta). Using a long span of historical monthly data, the VCMM estimates a dynamic statistical relationship among global risk factors and asset returns. Based on these calculations, the model uses regression-

based Monte Carlo simulation methods to project relationships in the future. By explicitly accounting for important initial market conditions when generating its return distributions, the VCMM framework departs fundamentally from more basic Monte Carlo simulation techniques found in certain financial software. The reader is directed to the research paper *Vanguard Capital Markets Model* (Wallick, Aliaga-Díaz, and Davis, 2009) for further details.

The primary value of the VCMM is in its application to analyzing potential client portfolios. VCMM asset-class forecasts—comprising distributions of expected returns, volatilities, and correlations—are key to the evaluation of potential downside risks, various risk-return trade-offs, and diversification benefits of various asset classes. Although central tendencies are generated in any return distribution, Vanguard stresses that focusing on the full range of potential outcomes for the assets considered, such as the data presented in this paper, is the most effective way to use VCMM output.

References

- Davis, Joseph, and Roger Aliaga-Díaz, 2012. *Vanguard's Economic and Investment Outlook*. Valley Forge, Pa.: The Vanguard Group.
- LaBarge, Karin Peterson, 2010. *Currency Management: Considerations for the Equity Hedging Decision*. Valley Forge, Pa.: The Vanguard Group.
- Lemco, Jonathan, Roger Aliaga-Díaz, and Charles J. Thomas, 2010. *What's Next for the Eurozone?* Valley Forge, Pa.: The Vanguard Group.
- Mark, Nelson C., 1995. Exchange Rates and Fundamentals: Evidence on Long-Horizon Predictability. *American Economic Review* 85(1): 201–18.
- Meese, Richard A., and Kenneth S. Rogoff, 1983. Empirical Exchange Rate Models of the Seventies: Do They Fit Out of Sample? *Journal of International Economics* 14: 3–24.
- Meredith, Guy, and Menzie D. Chinn, 1998. *Long-Horizon Uncovered Interest Rate Parity*. NBER Working Paper 6797. Cambridge, Mass.: National Bureau of Economic Research.
- Perold, André F., and Evan C. Schulman, 1988. The Free Lunch in Currency Hedging: Implications for Investment Policy and Performance Standards. *Financial Analysts Journal* 44(3): 45–50.
- Philips, Christopher B., 2011. *Considerations for International Equity*. Valley Forge, Pa.: The Vanguard Group.
- Philips, Christopher B., Francis M. Kinniry Jr., David J. Walker, and Charles J. Thomas, 2011. *A Review of Alternative Approaches to Equity Indexing*. Valley Forge, Pa.: The Vanguard Group.
- Solnik, Bruno, 1974. An Equilibrium Model of the International Capital Market. *Journal of Economic Theory* 8(4): 500–524.
- Stockton, Kimberly A., Scott J. Donaldson, and Anatoly Shtekhman, 2008. *Liability-Driven Investing: A Tool for Managing Pension Plan Funding Volatility*. Valley Forge, Pa.: The Vanguard Group.
- Thomas, Charles J., and Donald G. Bennyhoff, 2012. *A Review of Alternative Approaches to Fixed Income Indexing*. Valley Forge, Pa.: The Vanguard Group.
- Wallick, Daniel W., Roger Aliaga-Díaz, and Joseph Davis, 2009. *Vanguard Capital Markets Model*. Valley Forge, Pa.: The Vanguard Group.



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