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Currency Hedging for International Investment Portfolios

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Currency Hedging for International Investment Portfolios

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Abstract

Currency Hedging for International Investment Portfolios

By

Jochen M. Schmittmann

This paper examines the benefits from hedging the currency exposure of international investments in single country equity and bond portfolios from the perspectives of German, Japanese, British and American investors. Over the period 1975 to 2009, currency risk constituted about a quarter of the risk of foreign equity investments and about 90 percent of the risk of foreign bond investments. Hedging currency risk substantially reduces the volatility of foreign investments at a quarterly investment horizon but also affects returns in economically meaningful magnitudes in some cases. Particularly Japanese investors would have benefited from the carry associated with exposure to currencies with higher yields than the Yen. Contrary to previous studies, we find that at investment horizons of up to five years the case for hedging for risk reduction purposes remains strong.

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Table of Contents

List of Tables

I. INTRODUCTION

A large number of studies have documented the gains from international diversification of investment portfolios (see, for example, Levy and Sarnat (1970) and Ang and Bekaert (2002) among many others). In addition to pure exposure to bonds or equities, international investments imply also a long position in foreign currency. This foreign currency exposure potentially alters the return and risk profile of international investments. International investors are therefore confronted with the decision to retain or to hedge the implicit currency exposure associated with investing abroad.

The optimal degree of currency hedging is controversial and depends on the motivation of investors' demands for currency. Based on risk considerations full hedging of currency risk, i.e. zero demand for currencies, is optimal assuming that foreign currencies are uncorrelated with other assets (Solnik, 1974). Expected excess returns on foreign currency potentially create a second, speculative source of demand for currencies. Black (1989) points out that each party in a currency trade can simultaneously perceive positive returns. The reason is that currency returns to investors in different countries are quoted in terms of different numeraire currencies. For example, a 50 percent increase in the Euro exchange rate per U.S. dollar results in a drop of the reciprocal exchange rate by only one third. This manifestation of Jensen's inequality is known as Siegel's paradox and can explain symmetric speculative demands for currencies. Campbell et al. (2010) highlight that the demand for currency generated by this effect is quite small in practice given the high volatility of currencies. A more important source of speculative demands for individual currencies, as opposed to all currencies simultaneously, is constituted by the apparent failure of uncovered interest rate parity (UIP). UIP implies that the interest rate differential between two countries is an estimate of future exchange rate change. The failure of UIP is well documented (see, for example, Fama (1984) and Engel (1996)).

For risk reduction purposes, Perold and Shulman (1988) recommend full hedging of investment related currency risk based on the assumption that currency returns are zero in the long-run and that correlations of currencies with other asset classes are close to zero on average. Their reasoning leads them to proclaim currency hedging as a “free lunch” for investors. The additional gains from hedging currency exposure are estimated to be as large as the gains from diversifying abroad in the first place. Similarly, Eun and Resnick (1988) show that currency risk is largely undiversifiable and that it reduces the gains from international diversification. In their study, they highlight the practical problem of estimation risk faced by investors when determining the amount to hedge. That is, the return on a foreign equity investment is unknown at the time the hedge arrangement is put into place. Investors can only hedge the expected return not the actual return. This effect is often neglected, particularly in studies using a log-return representation which implies continuous hedging.

Froot (1993) makes the case for not hedging exchange rate risk over long investment horizons. His argument is based on mean-reversion of real exchange rates to purchasing power parity (PPP). He tests the hypothesis that PPP provides an automatic hedge on 200 years of data for a U.K. based investor investing in the U.S. For equities, Froot finds that for investment horizons beyond one year full hedging does not reduce the variance of returns compared to no hedge. For bonds, hedging appears to be more useful as full hedging significantly reduces the variance of returns over holding horizons of up to five years.

Ideally, currencies should be evaluated as an asset in a portfolio context and not in a hedging context alone. Glen and Jorion (1993) combine bonds and stocks with optimal currency forward positions and find significantly improved Sharpe ratios. Campbell et al. (2010) conduct a similar analysis on a dataset with an additional 15 years of free-floating exchange rate data. Over their sample period the euro and Swiss franc are negatively correlated with world stock returns while the Australian dollar and the Canadian dollar are positively correlated with stock markets. Bonds are found to be almost uncorrelated with currencies thus implying that bond investors should fully hedge currency exposure.

While there is a clear academic case for currencies in a portfolio context, many practioners consider the currency component of their foreign investments in isolation as a pure hedging decision. Accordingly, providers of major hedged indices such as MSCI and S&P hedge each foreign currency in an index fully back into the base currency using beginning-of-period investment values. Practioners also tend to be pragmatic with respect to hedge ratios. A 2004 survey by Russell/Mellon shows that only about 13 percent of institutional investors use hedge ratios other than 0, 50 or 100 percent.

A likely reason for practioners not determining optimal hedge ratios in a portfolio context is the instability of the approach. We are sympathetic to the notion of ignoring potential correlations of currencies with equities. In our dataset we find that currency-equity correlations are very unstable and fluctuate from plus 40 percent in one decade to -40 percent in the next decade for some currency-equity pairs. Similarly, Black (1989a) shows that depending on the input data hedge ratios over a very wide range of values can be optimal.

In this paper, we consider the impact of hedging currency exposure from the perspectives of German, Japanese, British and American investors. We analyze the impact of hedging on the risk and return of bond and equity investments in France, Germany, Japan, the U.K, and the U.S. Our dataset covers almost the entire period of free-floating exchange rates.

While our methodological approach is in principle not new, we make three contributions. First, most studies take the position of a U.S. dollar based investor. We provide the perspectives of four major advanced economies and find that an investors' base currency matters significantly for drawing conclusions on a currency hedging policy. The financial crisis of the last years potentially has altered currency-asset correlation structures and the underpinnings of the currency carry trade. Our study is one of the first in this context to cover the entire period of financial turmoil until the end of 2009. Second, we improve on the data quality of hedged return series by using 3-month bank deposit rates instead of the traditionally used T-Bill rates. We find that T-bill rates as used in Campbell et al. (2010) are not entirely comparable across countries. Specifically, T-bill maturities for Germany are 12 months and for France a mix of 12 and 3 months. Japanese T-bills are extremely illiquid before 1999 resulting in stale prices for up to two years. Our third contribution is an assessment of the usefulness of currency hedging for investors with long investment horizons. Based on mean-reversion in real exchange rates, Froot (1993) argued that hedging reduces risk only over short investment horizons but may even raise risk at long horizons. Froot provides empirical evidence for his argument based on a U.K. investor investing in the U.S. The notion that long-term investors should not hedge currency risk or at least hedge less appears to have been widely adopted by practioners. We find that Froot's results do not apply in most of our base currency/foreign equity or bond combinations. Even for long-term investors with horizons of up to 5 years, hedging currency risk is a risk-minimizing strategy in most cases.

The remainder of the paper is organized as follows. Section II describes our dataset. Section III decomposes returns and variances of international investments into exchange rate and asset exposure. Section IV describes our hedging approach and contains results for quarterly returns. Section V discusses risk minimizing hedge ratios. Section VI analyzes the importance of the investment horizon for the decision to hedge and section VII concludes.

II. DATA

The sample data covers the period from January 1975 to December 2009. All data series are available on a monthly basis and we present results for investment horizons of up to five years. Country stock index returns are provided by Morgan Stanley Capital International (MSCI). Each of the indices is value-weighted, formed from all companies in the market that fulfill minimum requirements for size, liquidity and free-float, and adjusted for dividend payments on a daily basis. Long-term bond portfolio returns are not available prior to 1986 for all countries. We therefore use the approximation suggested by

Campbell, Lo, and MacKinlay (1997) to obtain holding-period returns from bond yields.[1] Government bond yields as well as spot exchange rates and Consumer Price Indices (CPI) are obtained from the IMF's International Financial Statistics (IFS). Three-month deposit rates are obtained from IFS in the case of Japan and DataStream for Germany, France, U.K. and U.S. With the introduction of the Euro interest rate differentials between Germany and France have virtually disappeared and there are of course no more exchange rate movements. We therefore only present the German perspective in all tables following table 1.

Table 1 reports arithmetic averages and standard deviations of rolling annual changes/real returns of the Consumer Price Index (CPI), 3-month deposit rates, stock and bond returns for the full sample period from 1975 to 2009. Returns are in local currency terms and adjusted for the local CPI. The table therefore allows for the comparison of

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[1] Campbell, Lo, MacKinlay (1997) derive a log-linear relation between holding-period returns and yields:

$$r_{c,n,t+1} \approx D_{cn} y_{cnt} - (D_{cn} - 1) y_{c,n-1,t+1}$$

where $r_{c,n,t+1}$ denotes the log return on a coupon bond with coupon rate c and n periods to maturity, y_{cnt} denotes the log yield on the bond at time t, and D_{cn} is its duration, which is approximated as

$$D_{cn} \approx \frac{1-(1+Y_{cnt})^{-n}}{1-(1+Y_{cnt})^{-1}}.$$

In our calculations, we treat all bonds as having a maturity of 10 years. We assume that bonds are issued at par, so that the coupon rate equals the yield on the bond.

To ensure the quality of the approximation, we compare results to returns based on the JP Morgan Government Bond Index (GBI) for the period December 1986 to December 2009. The average absolute annual difference ranges from 0.15 percent in the case of Germany to 0.48 percent for Japan. Regression analysis confirms that both return series track each other closely with R-squared around 95 percent. The approximation method appears to overstate volatility a bit by about 2 percent p.a.. Some differences are expected given that bonds underlying our yield data and bonds in the GBI are not exactly identical in terms of maturity, credit quality and liquidity. Therefore, we consider the approximation of returns from yields as providing a very good proxy of the holding period returns an investor would have earned.

returns domestic investor can expect in their respective markets. Returns to foreigners are addressed in the next section.

Inflation, as measured by the CPI, has been highest in the U.K. with 5.6 percent per year followed by France (4.4 percent) and the U.S. (4.2 percent). Germany and Japan have experienced moderate inflation of 2.5 percent and 1.8 percent, respectively. Annualized real three-month rates on wholesale deposits with banks range from only 0.2 percent in Japan to 3.3 percent in France. Volatility of deposit rates has been low not exceeding 3.1 percent per year for any country. Real equity market returns to local investors vary substantially across countries. While a Japanese investor has only earned about 5.4 percent per year, a French investor has received 9.9 percent over the sample period. The equity premium over long-term bonds is just above 1 percent in Japan and substantially below the other markets. Equity returns are associated with substantial volatility in all countries with volatility being somewhat lower in the U.K and U.S. than in the other markets. Real returns on long-term government bonds are between 4 and 5 percent for all countries and volatilities are between 6 and 8 percent.

III. COMPONENTS OF INTERNATIONAL INVESTMENT RETURNS

In this section, we examine the effect of currency fluctuations on the return and risk of foreign investments. After establishing some notation, we present results from the viewpoint of investors based in Germany, Japan, the U.K., and the U.S.

Consider an investor who uses a certain base currency and is invested in a foreign currency investment. Her nominal unhedged return measured from time t - 1 to t is given by:

$$\tilde{r}_{U,t} = (1 + \tilde{x}_t)(1 + \tilde{e}_t) - 1 \qquad (1)$$

where $\tilde{x}_t$ is the return in foreign currency on the investment between time t - 1 and t; $\tilde{e}_t$ is the percentage change in the base currency per unit of foreign currency over the same period. The tilde symbol identifies random variables.

Equation (1) can be written as

$$\tilde{r}_{U,t} = \tilde{x}_t + \tilde{e}_t + \tilde{x}_t\tilde{e}_t \qquad (2)$$

Since the cross-product in equation (2), $\tilde{x}_t\tilde{e}_t$, is small in magnitude, $\tilde{r}_{U,t}$ can be approximated by[2]

$$\tilde{r}_{U,t} \approx \tilde{x}_t + \tilde{e}_t \qquad (3)$$

Based on equation (3), the variance of foreign investment returns is approximately

$$var(\tilde{r}_{U,t}) \approx var(\tilde{x}_t) + var(\tilde{e}_t) + 2cov(\tilde{x}_t\tilde{e}_t) \qquad (4)$$

[2] For quarterly returns $\tilde{x}_t\tilde{e}_t$ is smaller than 0.07 percent in absolute terms in all base currency-market combinations considered. However, for returns over longer periods the approximation is less precise.

As equation (4) shows, exchange rate fluctuations contribute to the variance of unhedged foreign investment returns through their own variance and their covariance with foreign asset returns.

The preceding analysis is analog for real returns:

$$\tilde{r}_{U,t} = (1 + \tilde{x}_t)(1 + \tilde{e}_t)/\left(1 + \tilde{\pi}_{d,t}\right) - 1 \qquad (5)$$

We adjust returns for inflation in an investor's home market, $\tilde{\pi}_{d,t}$, as opposed to adjusting returns for the inflation in the market where returns are achieved. The reason is that inflation in her home market is the relevant measure for an investor that tries to preserve her domestic purchasing power.

Table 2 presents exchange rate gains/losses, currency excess return, and unhedged equity and bond returns on a quarterly basis for investors investing in France, Germany, Japan, the U.K. and the U.S. Currency excess returns are returns from borrowing in domestic currency for 3-months, lending the proceeds in foreign currency for the same period, and exchanging back into domestic currency after three months to repay the domestic currency loan. We assume that investors can borrow and lend at the same rate.

The following example illustrates the table. A German investor investing in Japan would have gained 0.62 percent on average per quarter on exchange rate movements. An exchange rate gain implies a depreciation of the investor's home currency vis-à-vis the foreign currency, so in this case the German DM/Euro has on average depreciated against the Japanese Yen. The currency excess return from borrowing in DMs/Euros and lending in Yen is, however, a negative 0.11. This implies that the exchange rate gain for the

German investor is more than offset by the lower interest rate earned on the Yen deposit compared to the DM/Euro denominated loan. This is the flipside of the so-called currency carry trade.[3] The gains from favorable currency movements boost the returns to a German investor investing in the Japanese stock and bond market by about 0.62 percent compared to the domestic returns of a Japanese investor. The interaction term $\tilde{x}_t\tilde{e}_t$ adds an additional 0.03 percent. Against other currencies, German investors generally realized exchange rate losses on foreign investments as a result of a strong home currency. The losses against France all predate the introduction of the euro and indicate the depreciation of the Franc against the DM.

Japanese investors experienced exchange rate losses on investments in all countries considered in this study on the back of strong Yen appreciation. Currency excess returns from a Japanese perspective are substantial ranging from 0.35 percent for the U.S. to 0.67 percent for France on a quarterly basis. This is consistent with the fact that the Japanese Yen has been the funding currency for the global currency carry trade for many years. Positive currency excess returns imply that the Yen has not appreciated as much as suggested by uncovered interest rate parity.

The British Pound has depreciated on average against all other currencies in this study resulting in exchange rate gains on foreign investment for British investors.

[3] The currency carry trade involves borrowing in a low-yielding currency and lending the proceeds in a high-yielding currency. The trade is a bet against uncovered interest rate parity (UIP). UIP implies that the interest differential between a domestic and a foreign market is an estimate of the future exchange rate changes.

Similarly, U.S. dollar investors have gained from currency movements, except on their investment in the U.K.

The preceding discussion considers nominal returns. In real terms domestic inflation needs to be taken into account when comparing returns. In many cases exchange rate gains/losses compensate only partially for higher/lower domestic inflation. For example, in the case of the U.K., a country with high average inflation, domestic stock returns still exceed foreign stock returns despite substantial exchange rate gains.

Excess currency return pairs are generally above zero because percentage gains/losses are quoted in different numeraire currencies for investors from different countries an effect known as Siegel's paradox.

Table 3 presents the breakdown of the volatility of returns to international investors into different components. Exchange rate volatility contributes between 16 and 40 percent to the volatility of investing in foreign stock markets.[4] For bond portfolios, exchange rate risk dominates overall volatility contributing up to 95 percent of total unhedged return volatility. The larger relative importance of exchange rate risk for bond portfolios compared to equity portfolios explains why practioners tend to view hedging exchange risk in the case of bonds as much more important. The covariance of currency returns with bond and equity returns matters generally a lot less for overall investment volatility than currency volatility itself. In unreported results we also find covariance structures to be very unstable over time.

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[4] Excluding German investments in the French stock market as this includes both the pre-and post-Euro time period.

The covariance between local currency stock market returns and exchange rate movements is positive in all cases for a German investor. Exchange rate movements are thus found to reinforce, rather than offset, the stock market movements in this case. From a Japanese perspective covariances are positive except for the French stock market. For the U.K., with the exception of the Japanese stock market, and for the U.S. covariances between exchange rate changes and stock market returns are negative thus offsetting some of the stock market movement.

In the case of bond markets, German and U.S. investors have benefited from negative co-movement between local currency and exchange rate returns except for Japanese bonds. Yen-based investors have generally benefited from risk reduction through a negative covariance between bond and exchange rate returns, while British investors have experienced positive covariances.

Eun and Resnick (1988) extend the preceding analysis to a portfolio context. As they show, in the multi-currency case overall portfolio risk of foreign investment depends on (a) the covariances among stock market returns, (b) the covariances among the exchange rate changes, and (c) the cross-covariances among the stock market returns and the exchange rate changes.

IV. HEDGING CURRENCY RISK

The previous section has shown the substantial contribution of exchange rate risk to the overall risk of international investments. It is therefore natural for investor to consider hedging exchange rate exposure. In this section we develop a framework for calculating hedged returns and present empirical evidence on the extent of risk reduction attainable by hedging. We also address the impact of hedging on returns.

A. Hedging Methodology and Notation

One way to implement a currency hedge involves short-term borrowing in foreign currency and lending the proceeds in the investor's base currency. A fully hedged investor would borrow the present value of the expected foreign investment proceeds, i.e. $[1 + E(\tilde{x}_t)]/(1 + i_{f,t-1})$, where $i_{f,t-1}$ represents the foreign interest rate, and exchange the proceeds at the spot exchange rate into domestic currency to invest at the domestic interest rate $i_{d,t-1}$. At maturity the investor would repay the foreign currency loan valued $1 + E(\tilde{x}_t)$ with the expected proceeds on the foreign investment. This hedging strategy is imperfect to the extent that the realization of the return on the foreign investment deviates from its expectation at time t-1. For example, consider a U.S. dollar 10 million investment for a Japanese investor. Selling U.S. dollar 10 million to buy Yen perfectly hedges the exchange rate exposure for as long as the value of the investment remains U.S. dollar 10 million. However, any movement in the U.S. dollar asset value will reduce the effectiveness of the hedge. For instance, if the value of the Yen-hedged investment increases to U.S. dollar 12.5 million, the investment remains hedged only for the original U.S. dollar 10 million. The differential of U.S. dollar 2.5 million is fully exposed to currency movements. The quality of the hedge depends on the predictability of the underlying asset which is, inter alia, a function of the investment's volatility and the hedge horizon.

The preceding discussion shows that due to estimation risk it is impossible to obtain ex ante exactly the desired target hedge ratio, i.e. the proportion of an investment's currency exposure that is hedged. Eun and Resnick (1988) discuss and test several approaches to estimate $E(\tilde{x}_t)$ in the context of currency hedging. Practioners, however, often simply hedge the beginning-of-period value of their investments, in effect setting $E(\tilde{x}_t) = 0$.[5] We find that for quarterly returns this approach is sensible given the difficulties associated with forecasting returns. The data support this view – the average quarterly return due to the unhedged currency exposure of the difference between beginning- and end-of-period investment values is below 0.07 percent for all base currency/foreign investment combinations considered in this paper. In the empirical section, we therefore proceed by only hedging beginning-of-period investment balances. As we will discuss in section VI estimation risk can, however, have a very large impact on returns over long periods.

The hedge ratio can be varied to arrive at investment portfolios that are over- or under-hedged to varying degrees. Investors may seek to take active currency risks based on their views on future currency movements. Many studies have also pointed out that hedging 100 percent of currency exposure is not optimal from a risk minimization standpoint when currencies and equities/bonds are correlated.

The domestic currency return on the borrowing/lending hedge over the period t-1 to t is given by

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[5] For an increasing number of bond and equity indices currency hedged versions have become available in recent years. These hedged indices are usually based on hedging the beginning-of-period balances to 100 percent.

$$\tilde{h}_t = \frac{1}{(1+\tilde{e}_t)}\frac{1+i_{d,t-1}}{1+i_{f,t-1}} - 1 \quad (6)$$

Let Φ_t be the hedge ratio. The return on a hedged investment is then a combination of the proportion of the expected investment value the investor chooses to hedge, the proportion of the expected investment value left unhedged, and the unexpected return on the investment which is exposed to currency risk:

$$\tilde{r}_{H,t} = \Phi_t[1 + E(\tilde{x}_t)](1 + \tilde{e}_t)(1 + \tilde{h}_t) + [1 - \Phi_t][1 + E(\tilde{x}_t)](1 + \tilde{e}_t) \quad (7)$$

$$+[(\tilde{x}_t - E(\tilde{x}_t)](1 + \tilde{e}_t) - 1$$

$$= \Phi_t[1 + E(\tilde{x}_t)]\frac{1+i_{d,t}}{1+i_{f,t}} + [1 - \Phi_t][1 + E(\tilde{x}_t)](1 + \tilde{e}_t)$$

$$+[(\tilde{x}_t - E(\tilde{x}_t)](1 + \tilde{e}_t) - 1$$

Proceeding by setting $E(\tilde{x}_t) = 0$, equation (7) simplifies to

$$\tilde{r}_{H,t} = \Phi_t\frac{1+i_{d,t-1}}{1+i_{f,t-1}} + [1 - \Phi_t](1 + \tilde{e}_t) + \tilde{x}_t(1 + \tilde{e}_t) - 1 \quad (8)$$

The same hedged result can be achieved with lower transaction costs by employing currency forward contracts.[6] An investor would sell the proportion of expected foreign currency proceeds that she wishes to hedge in the forward market capturing the forward exchange premium/discount f_t, equal to F_{t-1} / S_{t-1} -1, where F_{t-1} and S_{t-1} are, respectively,

[6] Additional means of implementing a currency hedge include currency options and swaps. However, for investment management purposes forwards and futures are the instruments of choice for hedging.

the forward and spot exchange rates in domestic currency equivalents. This hedging practice, of course, also leaves residual foreign exchange exposure through unexpected foreign currency proceeds. The hedged return based on a forward hedge is therefore given by

$$\tilde{r}_{H,t}^{k} = \Phi_{t}[1 + E(\tilde{x}_t)](1 + f_t) + [1 - \Phi_{t}][1 + E(\tilde{x}_t)](1 + \tilde{e}_t) \qquad (9)$$
$$+[(\tilde{x}_t - E(\tilde{x}_t)](1 + \tilde{e}_t) - 1$$

To see that hedging using borrowing/lending and hedging using forwards yields equivalent results if covered interest rate parity (CIP) holds, note that this arbitrage condition links the forward premium to interest rates:

$$\frac{1+i_{d,t-1}}{1+i_{f,t-1}} = 1 + f_t \qquad (10)$$

For this relationship to hold, both interest rates must be based on instruments with identical default risk, maturity, and liquidity. Given equation (10), equation (9) is identical with equation (7). In the absence of investment barriers, CIP must hold to preclude arbitrage opportunities. Empirical research generally finds strong evidence of CIP[7], although a recent study by Akram, Rime, and Sarno (2008) using high-frequency tick-data shows that very short-lived violations of CIP arise.

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[7] See, for example, Taylor (1987).

Using equation (10) in equation (8) yields

$$\tilde{r}_{H,t} = \Phi_t[1 + f_t] + [1 - \Phi_t](1 + \tilde{e}_t) + \tilde{x}_t(1 + \tilde{e}_t) - 1 \quad (11)$$
$$= \tilde{x}_t + \tilde{e}_t + \tilde{x}_t\tilde{e}_t + \Phi_t[f_t - \tilde{e}_t]$$

A comparison of equation (11) with the unhedged return on an international investment in equation (2) shows that by hedging exchange rate risk an investor replaces the stochastic gain or loss on the exchange rate, $\tilde{e}_t$, with the forward premium/discount, f_t, which is known at the time of the investment. If the investor hedges 100 percent of the beginning-of-period exchange rate exposure, equation (11) becomes

$$\tilde{r}_{H,t} = \tilde{x}_t + f_t + \tilde{x}_t\tilde{e}_t \quad (12)$$

B. Impact of Hedging on Returns

Currency hedging is sometimes described as a "free lunch" (Perold and Schulman, 1988) based on the argument that currencies add only volatility but have zero expected returns. In the preceding notation, currency hedging affects returns if the unconditional expectation of $\tilde{h}_t$ is different from zero.

From a theoretical perspective, if investors are risk neutral and have rational expectations, then $E(\tilde{h}_t) = 0$, a relationship know as uncovered interest parity (UIP). UIP implies that the interest differential between a domestic and a foreign market is an estimate of the future exchange rate changes. UIP, however, is not a pure arbitrage condition. To see this, suppose the 3-month U.S. interest rate is 5 percent and the 3-month euro interest rate is 3 percent. Risk neutral, rational investors must expect the U.S. dollar to depreciate by about 2 percent over the next 3 months to make both investments equally attractive. If, for example, risk neutral and rational investors would expect a smaller U.S. dollar depreciation of 1 percent, they would borrow in euros and lend in U.S. dollars, thus driving up euro rates and down U.S. dollar rates until the interest differential is also equal to 1 percent. This is clearly not a riskless arbitrage opportunity as exchange rates may not move in line with the parity condition.

Indeed, a large body of empirical literature finds that UIP does not hold, a failure often referred to as the forward discount bias.[8] Empirically, low interest currencies tend to not appreciate as much as the interest rate differential and high interest rate currencies do not depreciate as much as the interest rate differential.[9] The failure of UIP suggests that in some cases hedging affects expected mean returns of foreign investments.

C. Impact of Hedging on Volatility

For most investors, hedging currency exposure is about reducing the volatility of foreign investments. In subsection A. it was shown that hedging replaces the stochastic exchange rate gain/loss with the ex ante known forward premium/discount. The volatility of a hedged return series compared to the equivalent unhedged return series thus depends on the volatility of $\tilde{e}_t$ versus the volatility of f_t. In a preview of the findings presented in

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[8] For example, see the surveys by Engel (1996) and Froot and Thaler (1990).

[9] The failure of UIP is the impetus behind the carry-trade in foreign exchange markets.

subsection E., we find that the quarterly volatility of f_t is only about 7 to 16 percent of the volatility of $\tilde{e}_t$.[10] Hedging, therefore, has the potential to reduce volatility substantially at least at short investment horizons. Mean-reverting properties of exchange rate movements could potentially change this result for longer horizons, an issue addressed in section VI.

In addition to the volatility of foreign exchange, the correlation of currencies with other assets matters for the risk properties of investment-related currency exposure. For example, a foreign currency that tends to depreciate/appreciate when the foreign equity market increases/decreases offsets some of the risk of the underlying investment. Investors should ideally retain some exposure to such a currency. On the other hand, a currency that is found to reinforce asset market movements should be over-hedged, i.e. sold short.

D. Calculating the Forward Premium in Practice

The calculation of hedged returns requires data on interest rates in the investor's base currency and in the foreign currency. To be comparable across countries, interest rates should be based on instruments with the same maturity, credit risk and liquidity.

We consider 3-month deposit rates and 3-month T-bill rates as candidate rates that are available across countries. A problem with T-Bill rates is that no 3-month paper is issued by the German government and that France only started issuing 3-month paper in 1989. For Japan, 3-month government paper was relatively illiquid before 1999 and therefore,

[10] The exception is the bilateral case of Germany and France because exchange rate volatility is not present in the post-Euro part of the sample.

the Bank of Japan deemed the interest rate on these financing bills as not representative of market conditions in Japan (IMF, 2000). In support of this conclusion we find that the interest rate on Japanese T-bills is often stale before 1999, sometimes not changing for up to two years. For 3-month deposit rates, comparability across France, Germany, Japan, the U.S., and the U.K. is better than for T-Bills. Rates starting in 1975 are available in DataStream for all countries except Japan. For Japan the IMF's International Financial Statistics provide the relevant deposit time series.

We check the comparability of interest rates across countries by comparing interest rate based forward premia to forward premia derived from forward and spot exchange rates for the period 1990 to 2009. By covered interest rate parity both calculation approaches should yield the same result. Any systemic deviation would suggest that the employed interest rates are not comparable across countries. Table 4 presents the comparison of forward premia calculated from exchange rates and forward premia based on deposits and T-Bills for the U.S. dollar. The presented differences are for quarterly premia. Forward premia derived from deposit rates are generally closer to "true" exchange-rate-based forward premia. The improvement is particularly large for France, Germany, and Japan. This is consistent with the French T-Bill rate being partially and the German T-Bill rate being entirely based on 12-month maturity rates. For Japan, as mentioned above, the problem is likely to be the absence of a liquid secondary market for T-Bills until 1999. We conclude that deposit rates provide a more accurate approximation of the forward premium and continue by using deposit rates in our calculations.

E. Empirical ex post Analysis of Currency Hedging

In this section we present empirical evidence on hedged and unhedged investments in bond and equity portfolios for the full sample period 1975 to 2009. The academic literature has pointed out that hedge ratios deviating from 100 percent can be optimal in the presence of correlation between exchange rate and asset movements. A survey of the hedging policies of institutional investors in major markets in 2004 by Russell/Mellon finds however that about 87 percent of investors chooses to hedge 0, 50, or 100 percent of foreign currency exposure. The reluctance of practioners to calculate optimal hedge ratios and to treat currencies like other assets in a portfolio optimization framework may be partially attributable to the instability of hedge ratios (see, for example, Black 1989a). We proceed by presenting results for unhedged, fully hedged, and 50 percent hedged portfolios. Optimal hedge ratios are addressed in the next section.

Table 5 shows returns on unhedged and fully hedged single-country equity and bond portfolios on a quarterly basis. Returns are additive, therefore, with the results for no hedging and 100 percent hedging, results for any other hedge ratio can be obtained. In almost all cases the null hypothesis of equal means of hedged and unhedged quarterly returns cannot be rejected at conventional levels. The substantial sample variance of the return series, especially for equities, makes it difficult to find statistically significant differences. In economic terms, many of the return differentials between hedged and unhedged portfolios are, however, substantial. For example, a Japanese investor in the French stock market would have earned quarterly returns of 2.75 percent without hedging currency risk and only 2.1 percent on a hedged basis. The difference is not statistically significant but an approximate annual return differential of 2.6 percent over the last 34 years is very relevant to investors.

For German investors returns are generally higher on an unhedged basis than on a hedged basis except in the case of investments in Japan. Excluding investments in France, British investors have yielded higher returns if they chose to hedge currency risk. Japanese and American investors have experienced generally lower returns if hedged.

The in some cases economically substantial return differentials between hedged and unhedged returns point to a failure of UIP. Differences are especially large in the case of Yen-based investors who would generally have yielded higher returns without hedging. Going back to table 2, this finding may surprise given that Japanese investors would have experienced exchange rate losses against all other currencies. The explanation is that for the Yen the forward premium, f_t, is generally even more negative than the exchange rate loss, $\tilde{e}_t$. Interest rate differentials have thus predicted an even larger Yen appreciation than actually materialized. Japanese investors who choose to remain unhedged on their international investments in effect engage in a carry trade speculating that the Yen will not appreciate as much as suggested by UIP. The Japanese experience also highlights that currency hedging does not allow international investors to access local asset returns as sometimes stated. Investors cannot avoid clear trends in their home currency against foreign currencies; they can only exchange certainty about the outcome in the form of the forward premium against the ex ante unknown exchange rate movement.

We now turn to the potential of currency hedging to reduce risk. Table 6 presents standard deviations for unhedged, half hedged and fully hedged bond and equity portfolios. Hedging currency risk reduces the risk of international investments in almost all cases significantly statistically as well as economically. The case for hedging is particularly apparent for bond portfolios. For bond portfolios hedging 100 percent of currency exposure is the dominant strategy from a risk reduction standpoint. Hedging is more effective for bonds because, as table 3 shows, currency risk makes up a large portion of the overall risk of international bond portfolios. Full hedging reduces risk more than half hedging in all cases except the French and German stock markets from a U.K. investor perspective and the German stock market from a U.S. perspective. However, for stocks the difference between a full and half hedge is statistically not significant at the 5 percent level in most cases.

We conclude that for bonds hedging unequivocally reduces risk at quarterly horizons but, depending on an investor's base currency, the risk reduction may come at the price of lower returns. For equities there is also strong evidence for the effectiveness of hedging to reduce quarterly return volatility.

V. OPTIMAL HEDGE RATIOS

To this point we have only considered no, half, and full hedging of currency risk, which are by far the most popular hedging strategies with institutional investors. Optimal hedge ratios, however, are usually defined as the hedge resulting in the greatest risk reduction.

We estimate optimal hedge ratios for German, Japanese, British and American investors investing in foreign equity and bond markets. From equation (11) it follows that minimizing the variance of a hedged return with respect to the hedge ratio, Φ, is equal to

$$\min_{\Phi} \mathrm{Var}(\ \tilde{x}_t + \tilde{e}_t + \tilde{x}_t\tilde{e}_t - \Phi_t[\tilde{e}_t - f_t]) \tag{13}$$

The first three terms in equation (13) are equal to the unhedged return. In order to find the risk minimizing hedge ratio we perform an OLS estimation of the following equation:

$$\tilde{r}_{U,t} = \alpha + \beta[\tilde{e}_t - f_t] + \varepsilon_t \tag{14}$$

where the estimate of β is the estimate of the minimum-variance hedge ratio.

We present estimated minimum-variance hedge ratios and associated Newey-West standard errors to correct for autocorrelation due to overlapping return intervals in table 7. Optimal hedge ratios for investments in foreign bond portfolios are essentially one for investors in all base currencies. Since correlations between bond returns and exchange rate movements are in some cases not insignificant, the reason must be that bond volatility is dominated by exchange rate volatility. For equities the case is more interesting because the volatility of this asset class is higher so that equity market – exchange rate correlations matter.

From a German perspective the risk minimizing hedge strategy over the sample period would have been to hedge about 100 percent of currency exposure in all cases except the UK stock market. For the UK stock market German investors should have hedged 140 percent of currency exposure, i.e. they should have taken a short position in the British pound. The reason for this is an unusually large positive correlation of 16 percent between the UK stock market in local currency and the DM/euro exchange rate versus the British pound. The UK stock market has tended to do well/bad when the Pound has appreciated/depreciated against the German currency. The exchange rate movements have therefore magnified the stock market movements. The effect is particularly strong in the second half of the 1970s and early 1980s when the UK experienced severe economic problems combined with a plummeting currency. However, the effect is also there, to a lesser degree, in recent years. A possible explanation is that economic problems in the U.K as proxied by falling stock prices lead to capital outflows into Germany and thus a falling pound versus the DM/Euro. Correlations of the German exchange rate versus the Yen and the U.S. dollar with these country's respective stock markets are very close to zero over the entire period. In the first half of the sample period the correlations are large and positive, similar to the UK, but this is offset by large negative correlations in the latter part of the sample.

For Japanese investors risk minimizing hedge ratios are statistically indistinguishable from one in all cases. In sub-periods there are strong positive and negative correlations between the Yen exchange rate and foreign stock markets but overall there is no consistent effect so that correlations for the entire sample period are close to zero.

As a mirror image to German investors, U.K. investors should have retained some exposure to the German currency. The German stock market has tended to do well/badly when the British Pound has appreciated/depreciated against the German currency. A similar effect exists for investments in the French stock market but this is entirely due to the second half of the sample period after the Euro introduction. The DM/euro thus has been a "safe haven" currency for British investors – it has done well during falling stock markets.

Similar to British investors, but to a lesser extent, risk-minimizing U.S. investors should have under-hedged their stock market investments in Germany and France. For investments in Japan and the U.K. the optimal hedge ratio is indistinguishable from one.

VI. Hedging and the Investment Horizon

The analysis to this point has been based on quarterly returns and their associated variances. We demonstrated empirically that hedging in almost all cases reduces risk at a quarterly return horizon. In this section, we turn to the question of whether the preceding results apply at longer investment horizons, an issue of relevance for long-term investors such as endowments. In doing so, we consider investment horizons of up to 5 years while continuing to hedge returns using three-month interest rates.

At investment horizons longer than one quarter, results on the efficacy of currency hedging for reducing the risk of a foreign investment are potentially different depending on the properties of exchange rates over longer horizons as compared to short horizons. At short horizons exchange rate fluctuations are dominated by changes in real exchange rates. Over long horizons, Purchasing Power Parity (PPP) suggests that real exchange rates are mean reverting. There is a vast literature on whether PPP holds but some consensus appears to have emerged that real exchange rates mean revert over long horizons.[11] A problem of traditional empirical tests is lack of power to reject the random walk hypothesis for exchange rates. One approach to circumvent this is by using very long sample periods (100 to 200 years) – these studies find support for PPP.[12] Recently, studies that incorporate nominal price rigidities, transaction costs, and non-linear adjustments are able to detect evidence in favor of PPP over shorter sample periods.

Froot (1993) applies the insights from research on real exchange rate mean reversion using long-term data sets to currency hedging. Based on empirical evidence over 200 years from the perspective of a British investor investing in the United States, Froot argues that for long-term investors mean reversion towards PPP provides a "natural hedge". Specifically, he finds that for horizons of more than four years, the volatility of a hedged portfolio of stocks exceed the volatility of the equivalent unhedged portfolio. For bond portfolios the cross-over point is about 8 years.[13]

Although, to our best knowledge, there are no further studies substantiating Froot's findings, his analysis has been influential with practioners.[14] Froot's empirical analysis is limited to the case of a U.K. based investor investing only in the U.S. An additional caveat pertains to the 200 year dataset. It is not clear that exchange rate behavior in a fixed regime or during the gold standard is comparable to the post-Bretton Woods period.

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[11] Survey articles on this literature are Froot and Rogoff (1995), and Taylor and Taylor (2004).

[12] For example, Frankel and Rose (1996), and Lothian and Taylor (1996).

[13] Froot uses returns adjusted for the investor's home country inflation. In unreported results, we do not find that adjusting nominal returns for domestic inflation changes the results by much or in a systemic way. We therefore present results for nominal returns.

[14] For example, a report by Sayee Srinivasan and Steven Youngren from the Chicago Mercantile Exchange states "*If one trades with the attitude of 'investing for the long-run', ignoring short-term dynamics of currency returns could be a perfectly valid strategy*." Similar statements can often be found in information pieces by investment advisors.

We proceed by testing the proposition that hedging is less effective at long investment horizons on our free-floating exchange rate data set covering the perspectives of German, Japanese, British and American investors. A potential problem with our 35 year data set is that we do not have sufficient independent observations. For instance, in the case of a 5 year investment horizon we have only seven independent return intervals. This could limit the statistical significance of our results at long horizons. We acknowledge that the use of rolling returns implies overweighting of the observations in the middle of the sample. We maintain our quarterly hedging strategy and calculate hedged returns over k-periods as the product of quarterly returns: ${\tilde{r}_{H,t}}^{k} = \left[\prod_{i=0}^{k-1}(1 + {\tilde{r}_{H,t+i}}^{1})\right] - 1$.

Table 8 presents the ratio of the variance of unhedged returns to the variance of hedged returns at investment horizons ranging from one quarter to 5 years. We do not provide p-values for the F-Stats because of the autocorrelation due to overlapping returns. For investments in foreign stock markets, the evolution of the relative variance of unhedged returns to hedged returns varies across base currencies and stock markets. However, there is clearly no general pattern of a decrease of the variance ratio with the investment horizon. In many cases, the variance ratio even increases with longer investment horizons, particularly for investments in the U.S. stock market. A large and monotonous fall in the variance of hedged to unhedged stock investments is only present for U.K. investors investing in the Japanese stock market. For investments in bond portfolios variance ratios decrease strongly, albeit not monotonously, between quarterly and five year horizons. It is noteworthy that the variance ratio decreases particularly strongly going from one quarter to one year. The decrease in the relative variance of unhedged portfolios comes however from very high levels in favor of currency hedging. Even at a five year investment horizon the case for hedging bond portfolios is very strong, with the unhedged variance being larger than the hedged variance by a factor of three and higher in many cases.

To determine optimal hedge ratios at horizons beyond one quarter, we switch to using log-returns.[15] The advantage of continuously compounded returns is that return components scale up additively over time which allows us to estimate the minimum-variance hedge through a regression of the k-period unhedged return on the contemporaneous currency excess return:[16]

$$\tilde{r}_{U,t}{}^{k} = \alpha^{k} + \beta^{k}\left(-\tilde{h}_{t}{}^{k}\right) + \varepsilon_{t}^{k} \tag{15}$$

where the log return on the hedge, $\tilde{h}_t{}^k$, is given by the sum of the quarterly log hedge returns:

[15] We have not used log-returns in our quarterly analysis because it entails the unrealistic assumption of continuous hedging. Continuous hedging means that hedges are "perfect" and there is no estimation problem. In that case, we have for the hedged return $\tilde{r}_{H,t} = \tilde{x}_t + f_t + \tilde{x}_t f_t$ instead of $\tilde{r}_{H,t} = \tilde{x}_t + f_t + \tilde{x}_t \tilde{e}_t$. There is therefore a difference between the hedge result assumed in academic studies that use continuously compounded returns and the actual experience of investors whose hedges are necessarily imperfect due to ex ante unknown returns. The difference between continuous hedging and quarterly hedging can be substantial over longer periods – for some five year periods we find differences in returns between quarterly hedging and continuous hedging of up to 120 percent. This shows that estimation risk is not a triviality that should lightly be assumed away in favor of mathematical simplicity. For our regression purposes we can assess the importance of the continuous hedge assumption by comparing quarterly returns in tables 7 and 9. Differences are small and do not affect the interpretation of the results.

[16] The non-log regression framework we have used for quarterly returns in equation (14) does not easily scale up to multiple periods.

$$\tilde{h}_t{}^k = \sum_{i=0}^{k-1} \tilde{h}_{t-i}{}^1, \qquad \tilde{h}_t{}^1 = -\tilde{e}_t + i_{d,t-1} - i_{f,t-1} \tag{16}$$

In regression (14), β^k is the minimum variance hedge ratio for the k-period return. Froot shows that if $\beta = 1/2$ the variance of hedged and unhedged returns is equal.[17] For $\beta > 1/2$, the variance of hedged returns is smaller than that of unhedged returns and the reverse if $\beta < 1/2$.

Table 9 presents the results of the OLS estimation of equation (15) along with heteroskedasticity and autocorrelation robust standard errors. Standard errors generally increase with the investment horizon as there are less data points and autocorrelation becomes more of a problem. As expected from table 8, there is no general decrease in the minimum variance hedge ratio as the investment horizon increases. For German investors, the hypothesis of a hedge ratio of one cannot be rejected for any of the foreign stock markets at any horizons. For investments in Japanese stocks and bonds there seems to be even a case for shorting the Yen versus the German currency. Only for investments in U.S. bonds is the 95 percent interval of the hedge ratio consistently below one. For investments in all markets we can reject that the variance of hedged and unhedged returns is equal, i.e. $\beta^k = 1/2$, at the 5 percent level.

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[17] With log returns the hedged return can be written as $\tilde{r}_{H,t}{}^k = \tilde{r}_{U,t}{}^k + \tilde{h}_t{}^k$. Equality of the variance of unhedged and hedged returns, $Var(\tilde{r}_{U,t}{}^k) = Var(\tilde{r}_{U,t}{}^k - [-\tilde{h}_t{}^k])$, then implies $Var\left(-\tilde{h}_t{}^k\right) = 2Covar(\tilde{r}_{U,t}{}^k, -\tilde{h}_t{}^k)$. Because the OLS estimator of β^k in equation (15) is $\beta^k = Covar(\tilde{r}_{U,t}{}^k, -\tilde{h}_t{}^k)/ Var\left(-\tilde{h}_t{}^k\right)$ equality of variances implies $\beta^k = 1/2$.

From a Japanese perspective, currency hedging indeed appears to be less effective at increasing investment horizons except for the French bond market. Particularly for the French, German, and U.K. stock markets minimum variance hedge ratios fall to only 30, 21, and 48 percent, respectively. Large standard errors allow however for only very imprecise estimates in the case of stocks. For foreign bond investments, standard errors are smaller, so that in the case of the U.S. and the U.K. less than full hedging is the risk minimizing hedge strategy at the 5 percent confidence level for horizons greater than one quarter. However, even in these cases we can reject the hypothesis of equal variances of hedged and unhedged returns in favor of hedged returns having a smaller variance.

For U.K. based stock market investors, the case for fully hedging investments in France and Germany appears relatively weak although very large standard errors make any interpretation difficult and even over-hedging is a statistical possibility. For investments in the Japanese and U.S. stock markets as well as for investments in foreign bond markets, if anything, hedging seems to become more effective at longer horizons. From a U.S. perspective, there is statistically significant evidence that less than full hedging is optimal for the German and U.K stock and bond markets.

In conclusion, currency hedging appears to effectively reduce the variance of foreign investment returns not only at short investment horizons but also at horizons of up to 5 years in most cases. At the same time, at long investment horizons less than full hedging is in some cases optimal. There are, however, also a few cases where over-hedging is potentially an effective risk minimizing strategy at long horizons. Foreign investments in the Japanese stock market stand out in this respect. The explanation appears to lie in the profitability of using the Yen as a funding currency for the carry trade. These carry trade profits are almost uncorrelated with Japanese stock market returns. Thus going short in Yen has on average generated uncorrelated positive returns for stock market investors and provided some diversification.

Our results are in stark contrast to Froot's findings who concludes that "there is no evidence at relatively long horizons that currency hedging provides a reduction in return variation". We show that results depend on investors' base currency and investment targets. In general, going completely unhedged does not appear to be the appropriate risk-minimizing strategy even at investment horizons of up to 5 years.

VII. Conclusion

We document the importance of currency risk for international investors. Currency risk contributes up to 40 percent to the overall risk of foreign equity investments and up to 95 percent of the overall risk of foreign bond investments. Hedging currency exposure is equivalent to replacing the very volatile and stochastic exchange rate component of international investment returns with the ex ante known and much less volatile forward premium or discount.

In addition to the exchange rate volatility itself, the correlations of currencies with bonds and equities are a second channel through which currency exposure affects foreign investment risk. For bonds we find that co-movement with foreign exchange is only of secondary importance because exchange rate volatility relative to bond volatility is so large. In the case of equities, co-movement with currencies is of importance in a few cases. However, in our sample, correlations of currencies with other assets are extremely unstable over time. We are therefore cautious in recommending optimal hedge ratios calibrated on historical data for practical portfolio purposes.

At quarterly horizons, the case for hedging currency risk is very strong, particularly for bonds. No exposure to currencies is generally the variance minimizing strategy for international bond investors. For equities, minimum variance hedge ratios are statistically indistinguishable from full hedging at the 5 percent level with the exception of a German investor investing in the U.K. stock market and a U.K. investor investing in Germany. These exceptions to full hedging are a result of the relatively large positive correlation between the British Pound and the British and German stock markets.

Currency excess returns are not zero in most cases. The decision to hedge currency risk versus maintaining active positions in currencies thus impacts returns on foreign investments. While currency excess returns are small compared to equities or bonds and return differences between hedged and unhedged portfolios are usually not statistically significant, some cases stand out. We show that Japanese investors would generally have benefited from keeping the currency exposure associated with their investments. By doing so, they would have boosted their return by engaging in a carry trade. This finding is in line with the status of the Yen as the funding currency of the global currency carry trade over the last decades. Hedged returns are generally lower than unhedged returns for Japanese investors because forward rates anticipated a stronger Yen appreciation than actually materialized.

Contrary to evidence by Froot (1993) the investment horizon is of limited importance for the decision to hedge currency risk. Froot argued that mean reversion in real exchange rates would provide a “natural hedge” over long return intervals. We do not find a general pattern for horizons ranging from one quarter to five years that would justify the recommendation to investors with long investment horizons to hedge significantly less. For bonds, hedged returns are less volatile than unhedged returns at all horizons. In some cases less than full hedging becomes optimal at longer horizons, most notably for U.S. investors investing in U.K. bonds and Japanese investors in German, British and U.S. bond portfolios. However, there are also cases where over-hedging, i.e. shorting the foreign currency, becomes optimal. The cases that stand out most in this regard are German and British investors in Japanese bonds. For equities there are a few, statistically not significant, cases where the variance of hedged portfolios exceeds the variance of unhedged portfolios at long horizons. These are U.S. investors invested in German stocks and Japanese investors engaged in the German and British stock markets. In some instances, particularly for investments in Japan, over hedging becomes increasingly attractive at longer horizons for risk minimization purposes. We conclude that there is no clear general relation between the investment horizon and the effectiveness of currency hedging.

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Table 1. Summary Statistics

Arithmetic averages and standard deviations of rolling annual changes/returns in percentages. Data coverage extends from 1975M1 to 2009M12. All following tables use data from the full sample period unless otherwise specified. Data are on a monthly basis. CPIs and bond yields are obtained from the IMF's IFS. Stock market returns are from Morgan Stanly International. Three-month interbank deposit rates are from IFS for Japan and from DataStream for the other countries.

	France	Germany	Japan	United Kingdom	United States
Consumer Price Index (CPI)					
Average	4.39	2.51	1.79	5.65	4.19
Standard Deviation	3.99	1.67	2.64	4.74	2.91
Real 3-month Deposit Rate					
Average	3.26	2.49	0.19	2.66	2.02
Standard Deviation	2.84	1.57	1.56	3.11	2.24
Real Equity Index (MSCI)					
Average	9.89	8.46	5.38	8.45	7.56
Standard Deviation	24.97	24.43	22.57	16.92	17.26
Real Bond Returns (IFS)					
Average	4.86	4.90	4.27	5.03	4.17
Standard Deviation	7.82	6.11	6.43	7.23	8.15

Table 2. Quarterly Returns to International Investments

This table presents exchange rate gains/losses, currency excess returns, and unhedged equity and bond returns for German, Japanese, British, and American investors investing in France, Germany, Japan, the U.K. and the U.S.. All entries are in percentages. The exchange rate gain/loss is the change in the investor's base currency per unit of foreign currency over one quarter. The currency excess return is the return to an investor of borrowing in her domestic currency to invest in foreign currency deposits. Unhedged stock and bond returns are the sum of local currency returns, exchange rate gains/losses and interaction between local currency and exchange rate returns.

	France	Germany	Japan	United Kingdom	United States
German perspective					
Exchange rate gain/loss ($\tilde{e}_t$)	-0.41	-	0.62	-0.57	-0.24
Currency excess return	0.22	-	-0.11	0.23	0.04
Equities: unhedged return ($\tilde{x}_t + \tilde{e}_t + \tilde{x}_t\tilde{e}_t$)	3.10	2.70	2.34	3.29	2.75
Bonds: unhedged return ($\tilde{x}_t + \tilde{e}_t + \tilde{x}_t\tilde{e}_t$)	1.80	1.84	2.10	2.00	1.72
Japanese perspective					
Exchange rate gain/loss ($\tilde{e}_t$)	-0.70	-0.27	-	-0.89	-0.67
Currency excess return	0.67	0.46	-	0.64	0.35
Equities: unhedged return ($\tilde{x}_t + \tilde{e}_t + \tilde{x}_t\tilde{e}_t$)	2.75	2.45	1.70	2.91	2.32
Bonds: unhedged return ($\tilde{x}_t + \tilde{e}_t + \tilde{x}_t\tilde{e}_t$)	1.51	1.55	1.46	1.66	1.29
U.K. perspective					
Exchange rate gain/loss ($\tilde{e}_t$)	0.35	0.79	1.44	-	0.43
Currency excess return	0.20	0.00	-0.09	-	-0.07
Equities: unhedged return ($\tilde{x}_t + \tilde{e}_t + \tilde{x}_t\tilde{e}_t$)	3.80	3.42	3.21	3.81	3.39
Bonds: unhedged return ($\tilde{x}_t + \tilde{e}_t + \tilde{x}_t\tilde{e}_t$)	2.60	2.66	2.95	2.59	2.43
U.S. perspective					
Exchange rate gain/loss ($\tilde{e}_t$)	0.13	0.57	1.04	-0.11	-
Currency excess return	0.49	0.29	0.02	0.41	-
Equities: unhedged return ($\tilde{x}_t + \tilde{e}_t + \tilde{x}_t\tilde{e}_t$)	3.58	3.20	2.73	3.68	3.00
Bonds: unhedged return ($\tilde{x}_t + \tilde{e}_t + \tilde{x}_t\tilde{e}_t$)	2.36	2.42	2.52	2.47	1.98

Table 3. Decomposition of the Volatility of Quarterly Stock and Bond Market Returns

This table presents the variance decomposition of quarterly unhedged equity and bond returns. All entries are in percentages. Column (1) contains the variance of local currency returns, column (2) the variance of exchange rate gains/losses, column (3) the covariance and column (4) the correlation of local currency and exchange rate returns. Column (5) shows the overall variance of unhedged returns. Columns (6) through (9) show the percentage contributions of variance components to the overall variance of unhedged returns. Additional terms in column (9) include the variance of ($\tilde{x}_t$ * $\tilde{e}_t$) the covariance of ($\tilde{x}_t$, $\tilde{x}_t$ * $\tilde{e}_t$) and the covariance of ($\tilde{e}_t$, $\tilde{x}_t$ * $\tilde{e}_t$).

Panel A: German and Japanese perspectives

	(1) var($\tilde{x}_t$)	(2) $var(\tilde{e}_t)$	(3) cov($\tilde{x}_t$,$\tilde{e}_t$)	(4) cor($\tilde{x}_t$,$\tilde{e}_t$)	(5) var($\tilde{r}_{U,t}$)	(6) (1) / (5) * 100%	(7) (2) / (5) *100%	(8) [2 * (3) / (5)]*100%	(9) Additional terms
German perspective									
Stock Market									
France	1.19	0.03	0.02	0.10	1.25	94.98	2.50	3.07	-0.54
Germany	1.12	-	-	-	1.12	100.00	-	-	-
Japan	0.96	0.37	0.01	0.01	1.38	69.43	26.76	0.86	2.96
U.K.	0.91	0.21	0.07	0.16	1.26	71.61	16.52	11.18	0.69
U.S.	0.63	0.33	0.01	0.02	0.98	64.04	33.61	2.04	0.31
Bond Market									
France	0.04	0.03	0.00	-0.10	0.07	60.97	47.78	-10.72	1.98
Germany	0.03	-	-	-	0.03	100.00	-	-	-
Japan	0.03	0.37	0.01	0.09	0.43	7.62	85.48	4.70	2.20
U.K.	0.04	0.21	0.00	-0.04	0.25	14.05	83.46	-2.42	4.91
U.S.	0.04	0.33	-0.02	-0.14	0.35	10.93	94.52	-9.06	3.61
Japanese perspective									
Stock Market									
France	1.19	0.34	-0.03	-0.04	1.43	83.14	23.69	-3.85	-2.98
Germany	1.12	0.34	0.03	0.04	1.49	75.02	22.55	3.44	-1.01
Japan	0.96	-	-	-	0.96	100.00	-	-	-
U.K.	0.91	0.43	0.03	0.04	1.38	65.62	30.81	4.01	-0.44
U.S.	0.63	0.35	0.02	0.04	0.99	63.52	34.94	3.65	-2.11
Bond Market									
France	0.04	0.34	-0.01	-0.08	0.37	10.70	90.80	-5.05	3.56
Germany	0.03	0.34	-0.01	-0.12	0.35	8.08	95.37	-6.72	3.26
Japan	0.03	-	-	-	0.03	100.00	-	-	-
U.K.	0.04	0.43	-0.02	-0.16	0.45	7.89	95.37	-8.71	5.45
U.S.	0.04	0.35	-0.01	-0.07	0.38	9.95	90.14	-3.96	3.87

Panel B: British and American perspectives

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	$\text{var}(\tilde{x}_t)$	$\text{var}(\tilde{e}_t)$	$\text{cov}(\tilde{x}_t,\tilde{e}_t)$	$\text{cor}(\tilde{x}_t,\tilde{e}_t)$	$\text{var}(\tilde{r}_{U,t})$	(1) / (5) * 100%	(2) / (5) *100%	[2 * (3) / (5)]*100%	Additional terms
					U.K. perspective				
Stock Market									
France	1.19	0.21	-0.07	-0.14	1.30	91.52	16.37	-10.88	2.99
Germany	1.12	0.23	-0.10	-0.19	1.18	94.67	19.29	-16.23	2.27
Japan	0.96	0.73	0.05	0.05	1.83	52.22	39.88	4.97	2.93
U.K.	0.91	-	-	-	0.91	100.00	-	-	-
U.S.	0.63	0.34	-0.05	-0.10	0.89	70.78	38.36	-10.69	1.55
Bond Market									
France	0.04	0.21	0.01	0.08	0.28	14.29	76.17	5.22	4.31
Germany	0.03	0.23	0.01	0.15	0.29	9.77	78.18	8.26	3.79
Japan	0.03	0.73	0.03	0.17	0.84	3.91	87.03	6.38	2.68
U.K.	0.04	-	-	-	0.04	100.00	-	-	-
U.S.	0.04	0.34	0.00	0.04	0.40	9.48	84.61	2.18	3.74
					U.S. perspective				
Stock Market									
France	1.19	0.31	-0.06	-0.10	1.42	84.02	21.99	-8.64	2.63
Germany	1.12	0.33	-0.09	-0.15	1.33	84.24	24.85	-13.45	4.35
Japan	0.96	0.37	-0.02	-0.03	1.35	70.70	27.45	-2.92	4.78
U.K.	0.91	0.32	-0.01	-0.02	1.24	73.11	25.50	-1.80	3.19
U.S.	0.63	-	-	-	0.63	100.00	-	-	-
Bond Market									
France	0.04	0.31	-0.01	-0.07	0.35	11.42	89.06	-4.64	4.16
Germany	0.03	0.33	0.00	-0.02	0.37	7.77	89.96	-1.23	3.49
Japan	0.03	0.37	0.01	0.09	0.44	7.50	84.76	4.69	3.06
U.K.	0.04	0.32	-0.01	-0.11	0.35	10.17	91.36	-6.75	5.21
U.S.	0.04	-	-	-	0.04	100.00	-	-	-

Table 4. Forward Premia versus the U.S. dollar

This table provides a comparison of forward premia against the U.S. dollar derived from forward and spot exchange rates with forward premia derived from interest rate differentials over the period 1990 to 2009. Exchange rate based forward premia provide a benchmark to assess the comparability of interest rates across countries. Panel A contains forward premia based on differentials in three-month bank deposit rates compared to exchange rate based forward rates. Panel B contains forward premia derived from T-Bill rate differentials compared to exchange rate based forward rates.

Panel A: Deposit-rate-based versus exchange-rate-based

	U.S./U.K.	U.S./Japan	U.S./France	U.S./Germany
Mean absolute deviation	0.08	0.11	0.04	0.04
Standard deviation of deviation	0.12	0.25	0.05	0.05

Panel B: T-Bill-based versus exchange-rate-based

	U.S./U.K.	U.S./Japan	U.S./France	U.S./Germany
Mean absolute deviation	0.11	0.19	0.10	0.11
Standard deviation of deviation	0.15	0.19	0.10	0.07

Table 5. Returns on Hedged and Unhedged Equity and Bond Portfolios

This table reports the quarterly returns on unhedged and fully hedged stock and bond portfolios. Hedged returns are based on rolling quarterly hedges of beginning-of-period balances. Reported T-statistics are based on the null hypothesis of equal returns.

Panel A: German and Japanese perspectives

			Tests of significance	
			No hedge vs. full hedge	
	No hedge	Full hedge	T-stat	P-value
German perspective				
Stock Market				
France	3.10	2.88	0.28	78.24
Germany	2.70	-	-	-
Japan	2.34	2.45	-0.15	87.96
U.K.	3.29	3.07	0.31	75.65
U.S.	2.75	2.72	0.06	95.07
Bond Market				
France	1.80	1.59	1.40	16.13
Germany	1.84	-	-	-
Japan	2.10	2.21	-0.34	73.14
U.K.	2.00	1.78	0.85	39.63
U.S.	1.72	1.68	0.12	90.07
Japanese perspective				
Stock Market				
France	2.75	2.10	0.84	40.01
Germany	2.45	1.99	0.58	56.19
Japan	1.70	-	-	-
U.K.	2.91	2.29	0.85	39.63
U.S.	2.32	1.98	0.55	58.39
Bond Market				
France	1.51	0.85	2.10	3.61
Germany	1.55	1.09	1.51	13.20
Japan	1.46	-	-	-
U.K.	1.66	1.03	1.83	6.73
U.S.	1.29	0.95	1.06	29.15

Panel B: British and American perspectives

	No hedge	Full hedge	Tests of significance No hedge vs. full hedge T-stat	 P-value
		U.K. perspective		
Stock Market				
France	3.80	3.61	0.24	80.70
Germany	3.42	3.43	-0.01	98.89
Japan	3.21	3.31	-0.12	90.52
U.K.	3.81	-	-	-
U.S.	3.39	3.47	-0.13	89.57
Bond Market				
France	2.60	2.41	0.69	49.21
Germany	2.66	2.67	-0.04	97.03
Japan	2.95	3.05	-0.22	82.97
U.K.	2.59	-	-	-
U.S.	2.43	2.51	-0.24	80.86
		U.S. perspective		
Stock Market				
France	3.58	3.10	0.61	54.30
Germany	3.20	2.92	0.37	71.18
Japan	2.73	2.72	0.02	98.73
U.K.	3.68	3.28	0.56	57.72
U.S.	3.00	-	-	-
Bond Market				
France	2.36	1.88	1.59	11.17
Germany	2.42	2.13	0.93	35.11
Japan	2.52	2.51	0.04	97.15
U.K.	2.47	2.07	1.33	18.51
U.S.	1.98	-	-	-

Table 6. Quarterly Standard Deviations of Hedged and Unhedged Equity and Bond Portfolios

This table reports the standard deviations of quarterly returns with no, half, and full hedging of currency exposure. F-statistics and associated p-values are provided on the right hand side to test the statistical significance of the difference in variances.

Panel A: German and Japanese perspectives

				Tests of significance					
				No hedge vs. full hedge		No hedge vs. half hedge		Half hedge vs. full hedge	
	No hedge	Half hedge	Full hedge	F-stat	P-value	F-stat	P-value	F-stat	P-value
German perspective									
Stock Market									
France	11.19	10.94	10.74	1.09	20.06	1.05	32.00	1.04	35.50
Germany	10.58	-	-	-	-	-	-	-	-
Japan	11.74	10.50	10.05	1.37	0.08	1.25	1.10	1.09	18.79
U.K.	11.24	10.08	9.36	1.44	0.01	1.24	1.30	1.16	6.62
U.S.	9.92	8.46	7.86	1.59	0.00	1.37	0.06	1.16	6.70
Bond Market									
France	2.56	2.09	1.87	1.87	0.00	1.50	0.00	1.24	1.29
Germany	1.69	-	-	-	-	-	-	-	-
Japan	6.57	3.74	1.83	12.88	0.00	3.09	0.00	4.16	0.00
U.K.	5.00	2.98	1.89	7.03	0.00	2.82	0.00	2.49	0.00
U.S.	5.91	3.35	2.09	8.01	0.00	3.13	0.00	2.56	0.00
Japanese perspective									
Stock Market									
France	11.96	10.94	10.63	1.27	0.81	1.19	3.51	1.06	27.66
Germany	12.21	11.04	10.56	1.34	0.16	1.22	1.97	1.09	18.44
Japan	9.79	-	-	-	-	-	-	-	-
U.K.	11.75	10.08	9.33	1.58	0.00	1.36	0.09	1.17	5.79
U.S.	9.96	8.37	7.70	1.67	0.00	1.41	0.02	1.18	4.36
Bond Market									
France	6.11	3.50	0.85	9.94	0.00	3.04	0.00	3.27	0.00
Germany	5.94	3.28	1.82	10.69	0.00	3.27	0.00	3.27	0.00
Japan	1.81	-	-	-	-	-	-	-	-
U.K.	6.68	3.64	1.91	12.25	0.00	3.37	0.00	3.63	0.00
U.S.	6.20	3.49	2.05	9.11	0.00	3.15	0.00	2.89	0.00

Panel B: British and American perspectives

				Tests of significance					
				No hedge vs. full hedge		No hedge vs. half hedge		Half hedge vs. full hedge	
	No hedge	Half hedge	Full hedge	F-stat	P-value	F-stat	P-value	F-stat	P-value
U.K. perspective									
Stock Market									
France	11.40	10.94	10.97	1.08	21.65	1.09	19.89	0.99	47.54
Germany	10.87	10.54	10.76	1.02	41.75	1.06	26.37	0.96	33.59
Japan	13.54	11.15	10.11	1.79	0.00	1.48	0.00	1.22	2.34
U.K.	9.51	-	-	-	-	-	-	-	-
U.S.	9.43	8.26	8.06	1.37	0.07	1.30	0.34	1.05	30.81
Bond Market									
France	5.28	3.21	1.93	7.51	0.00	2.71	0.00	2.77	0.00
Germany	5.40	3.21	1.80	9.02	0.00	2.83	0.00	3.18	0.00
Japan	9.17	5.02	1.87	3.33	0.00	24.02	0.00	7.20	0.00
U.K.	1.88	-	-	-	-	-	-	-	-
U.S.	6.35	3.72	2.18	8.48	0.00	2.92	0.00	2.90	0.00
U.S. perspective									
Stock Market									
France	11.90	11.12	11.03	1.16	6.08	1.14	8.43	1.02	43.18
Germany	11.52	10.84	10.92	1.11	13.46	1.13	10.59	0.99	44.29
Japan	11.64	10.47	10.15	1.31	0.27	1.24	1.51	1.06	26.81
U.K.	11.13	9.98	9.57	1.35	0.10	1.24	1.30	1.09	19.51
U.S.	7.94	-	-	-	-	-	-	-	-
Bond Market									
France	5.91	3.36	1.85	10.22	0.00	3.10	0.00	3.30	0.00
Germany	6.06	3.36	1.68	13.01	0.00	3.25	0.00	4.00	0.00
Japan	6.62	3.73	1.87	12.51	0.00	3.15	0.00	3.98	0.00
U.K.	5.88	3.30	1.86	9.98	0.00	3.18	0.00	3.14	0.00
U.S.	1.96	-	-	-	-	-	-	-	-

Table 7. Estimated Minimum Variance Hedge Ratios

For investors from each base currency perspective, minimum-variance hedge ratios for quarterly returns are obtained by regressing the unhedged return on the row stock and bond markets on the associated exchange rate gain minus the forward premium. All regressions include an intercept. We run monthly regressions on overlapping quarterly returns. Standard errors are corrected for autocorrelation due to overlapping intervals using the Newey-West procedure.

	Stocks		Bonds	
	Minimum variance hedge ratio	Standard errors of MV hedge ratio	Minimum variance hedge ratio	Standard errors of MV hedge ratio
German perspective				
France	-	-	-	-
Germany	-	-	-	-
Japan	1.00	0.23	1.03	0.02
U.K.	1.39	0.12	0.99	0.03
U.S.	1.04	0.13	0.95	0.03
Japanese perspective				
France	0.95	0.13	1.01	0.02
Germany	1.05	0.14	0.97	0.02
Japan	-	-	-	-
U.K.	1.08	0.09	0.97	0.02
U.S.	1.05	0.10	0.97	0.03
U.K. perspective				
France	0.72	0.18	1.05	0.03
Germany	0.55	0.14	1.05	0.03
Japan	1.05	0.12	1.04	0.02
U.K.	-	-	-	-
U.S.	0.84	0.15	1.01	0.03
U.S. perspective				
France	0.82	0.18	1.00	0.02
Germany	0.70	0.16	1.00	0.02
Japan	0.92	0.14	1.02	0.02
U.K.	1.00	0.14	0.98	0.02
U.S.	-	-	-	-

Table 8. Variance Ratios of Unhedged and Fully Hedged Returns over Different Horizons

This table presents the ratio of the variance of unhedged and hedged returns. Variances are calculated over rolling return intervals ranging from one quarter to five years. Hedged returns are based on rolling quarterly hedges of beginning-of-period balances.

Panel A: German and Japanese perspectives

	Horizon					
	1 Quarter	1 Year	2 Years	3 Years	4 Years	5 Years
German perspective						
Stock Market						
France	1.09	1.10	1.16	1.22	1.23	1.25
Germany	-	-	-	-	-	-
Japan	1.37	1.60	1.42	1.28	1.35	1.41
U.K.	1.44	1.61	1.62	1.60	1.63	1.49
U.S.	1.59	1.80	2.06	2.44	2.51	2.53
Bond Market						
France	1.87	1.42	1.48	1.48	1.48	1.50
Germany	-	-	-	-	-	-
Japan	12.88	6.01	4.11	3.67	3.41	2.94
U.K.	7.03	3.29	2.91	2.73	3.51	3.86
U.S.	8.01	3.27	3.06	3.74	3.58	3.45
Japanese perspective						
Stock Market						
France	1.27	1.32	1.47	1.32	1.11	1.15
Germany	1.34	1.27	1.34	1.22	1.12	1.16
Japan	-	-	-	-	-	-
U.K.	1.58	1.78	2.05	1.98	1.74	1.30
U.S.	1.67	1.84	2.37	2.77	2.70	2.34
Bond Market						
France	9.94	5.17	4.22	3.65	3.14	3.29
Germany	10.69	4.15	2.55	2.21	2.55	3.00
Japan	-	-	-	-	-	-
U.K.	12.25	5.60	5.11	4.94	4.99	4.69
U.S.	9.11	3.82	3.22	3.28	2.58	1.89

Panel B: British and American perspectives

	Horizon					
	1 Quarter	1 Year	2 Years	3 Years	4 Years	5 Years
			U.K. perspective			
Stock Market						
France	1.08	1.06	1.04	1.05	1.18	1.30
Germany	1.02	0.97	0.99	0.93	0.99	1.11
Japan	1.79	1.96	1.41	1.30	1.27	1.07
U.K.	-	-	-	-	-	-
U.S.	1.37	1.35	1.31	1.45	1.45	1.45
Bond Market						
France	7.51	3.77	3.50	3.15	3.26	3.26
Germany	9.02	4.61	4.00	3.32	2.97	2.77
Japan	24.02	10.33	5.69	4.34	3.97	2.72
U.K.	-	-	-	-	-	-
U.S.	8.48	4.00	3.54	3.76	3.32	2.69
			U.S. perspective			
Stock Market						
France	1.16	1.38	1.61	1.46	1.44	1.51
Germany	1.11	1.26	1.25	1.00	0.94	1.04
Japan	1.31	1.58	1.99	2.02	1.95	1.74
U.K.	1.35	1.45	1.55	1.40	1.31	1.01
U.S.	-	-	-	-	-	-
Bond Market						
France	10.22	6.02	7.22	6.62	5.92	6.04
Germany	13.01	6.26	6.22	5.29	4.25	3.65
Japan	12.51	6.55	5.98	5.26	4.00	2.85
U.K.	9.98	4.23	3.43	2.95	2.43	1.62
U.S.	-	-	-	-	-	-

Table 9. Estimated Minimum Variance Hedge Ratios over Different Horizons

This table presents estimates of variance minimizing hedge ratios for investments in foreign stock and bond markets at investment horizons of one quarter to five years. Minimum variance hedge ratios are estimated by regressing unhedged returns on the inverse of the return on a currency hedge (the domestic currency return of borrowing in foreign currency to hold domestic deposits). All regressions include an intercept. Standard errors are corrected for autocorrelation due to overlapping intervals using the Newey-West procedure.

Panel A: German and Japanese perspectives

	Horizon											
	1 Quarter		1 Year		2 Years		3 Years		4 Years		5 Years	
	Minimum Variance Hedge	Standard Error	Minimum Variance Hedge	Standard Error	Minimum Variance Hedge	Standard Error	Minimum Variance Hedge	Standard Error	Minimum Variance Hedge	Standard Error	Minimum Variance Hedge	Standard Error
German perspective												
Stock Market												
France	-		-		-		-		-		-	
Germany	-		-		-		-		-		-	
Japan	1.02	*(0.20)*	1.34	*(0.23)*	1.43	*(0.29)*	1.66	*(0.36)*	1.75	*(0.43)*	1.93	*(0.56)*
U.K.	1.34	*(0.12)*	1.32	*(0.19)*	1.19	*(0.27)*	1.21	*(0.27)*	1.14	*(0.26)*	1.10	*(0.30)*
U.S.	1.04	*(0.13)*	1.01	*(0.16)*	1.07	*(0.18)*	1.20	*(0.18)*	1.17	*(0.18)*	1.17	*(0.18)*
Bond Market												
France	-		-		-		-		-		-	
Germany	-		-		-		-		-		-	
Japan	1.02	*(0.02)*	1.11	*(0.07)*	1.24	*(0.12)*	1.37	*(0.16)*	1.44	*(0.17)*	1.55	*(0.14)*
U.K.	0.96	*(0.03)*	0.88	*(0.05)*	0.82	*(0.10)*	0.82	*(0.14)*	0.89	*(0.13)*	0.96	*(0.15)*
U.S.	0.93	*(0.03)*	0.83	*(0.07)*	0.79	*(0.09)*	0.83	*(0.09)*	0.82	*(0.08)*	0.80	*(0.08)*
Japanese perspective												
Stock Market												
France	0.99	*(0.16)*	0.95	*(0.26)*	0.91	*(0.39)*	0.60	*(0.40)*	0.33	*(0.35)*	0.30	*(0.31)*
Germany	1.08	*(0.17)*	0.85	*(0.27)*	0.74	*(0.43)*	0.42	*(0.49)*	0.26	*(0.41)*	0.21	*(0.35)*
Japan	-		-		-		-		-		-	
U.K.	1.08	*(0.11)*	1.01	*(0.18)*	0.91	*(0.22)*	0.78	*(0.22)*	0.67	*(0.27)*	0.48	*(0.32)*
U.S.	1.05	*(0.11)*	0.96	*(0.17)*	1.01	*(0.24)*	0.99	*(0.24)*	0.94	*(0.25)*	0.93	*(0.26)*
Bond Market												
France	0.99	*(0.02)*	0.97	*(0.06)*	1.00	*(0.08)*	0.97	*(0.08)*	0.96	*(0.09)*	1.06	*(0.14)*
Germany	0.96	*(0.02)*	0.88	*(0.07)*	0.82	*(0.10)*	0.75	*(0.12)*	0.76	*(0.11)*	0.77	*(0.11)*
Japan	-		-		-		-		-		-	
U.K.	0.94	*(0.02)*	0.83	*(0.05)*	0.78	*(0.07)*	0.75	*(0.08)*	0.73	*(0.08)*	0.74	*(0.08)*
U.S.	0.95	*(0.03)*	0.83	*(0.07)*	0.75	*(0.08)*	0.71	*(0.08)*	0.67	*(0.06)*	0.62	*(0.06)*

Panel B: British and American perspectives

	Horizon											
	1 Quarter		1 Year		2 Years		3 Years		4 Years		5 Years	
	Minimum Variance Hedge	Standard Error	Minimum Variance Hedge	Standard Error	Minimum Variance Hedge	Standard Error	Minimum Variance Hedge	Standard Error	Minimum Variance Hedge	Standard Error	Minimum Variance Hedge	Standard Error
U.K. perspective												
Stock Market												
France	0.66	*(0.16)*	0.43	*(0.37)*	0.17	*(0.45)*	0.12	*(0.52)*	0.34	*(0.56)*	0.56	*(0.63)*
Germany	0.53	*(0.13)*	0.34	*(0.30)*	0.34	*(0.40)*	0.27	*(0.45)*	0.38	*(0.47)*	0.50	*(0.57)*
Japan	1.06	*(0.11)*	1.21	*(0.21)*	1.21	*(0.27)*	1.42	*(0.28)*	1.49	*(0.36)*	1.67	*(0.66)*
U.K.	-		-		-		-		-		-	
U.S.	0.85	*(0.15)*	0.75	*(0.23)*	0.73	*(0.22)*	0.88	*(0.18)*	0.94	*(0.17)*	1.07	*(0.20)*
Bond Market												
France	1.02	*(0.03)*	1.10	*(0.10)*	1.13	*(0.16)*	1.17	*(0.21)*	1.23	*(0.21)*	1.30	*(0.23)*
Germany	1.03	*(0.03)*	1.11	*(0.07)*	1.15	*(0.13)*	1.12	*(0.16)*	1.06	*(0.13)*	1.03	*(0.16)*
Japan	1.03	*(0.02)*	1.10	*(0.04)*	1.15	*(0.06)*	1.26	*(0.08)*	1.37	*(0.10)*	1.58	*(0.16)*
U.K.	-		-		-		-		-		-	
U.S.	0.99	*(0.03)*	0.99	*(0.09)*	0.99	*(0.12)*	0.99	*(0.12)*	0.98	*(0.11)*	0.96	*(0.14)*
U.S. perspective												
Stock Market												
France	0.80	*(0.18)*	0.86	*(0.31)*	0.77	*(0.34)*	0.63	*(0.32)*	0.61	*(0.32)*	0.57	*(0.32)*
Germany	0.68	*(0.17)*	0.65	*(0.29)*	0.50	*(0.28)*	0.38	*(0.26)*	0.39	*(0.23)*	0.40	*(0.22)*
Japan	0.89	*(0.14)*	1.05	*(0.22)*	1.14	*(0.34)*	1.21	*(0.42)*	1.31	*(0.56)*	1.35	*(0.71)*
U.K.	0.96	*(0.15)*	0.98	*(0.23)*	0.88	*(0.26)*	0.70	*(0.26)*	0.62	*(0.25)*	0.39	*(0.22)*
U.S.	-		-		-		-		-		-	
Bond Market												
France	0.98	*(0.02)*	0.98	*(0.07)*	1.04	*(0.10)*	1.03	*(0.10)*	1.03	*(0.09)*	1.03	*(0.10)*
Germany	0.98	*(0.02)*	0.96	*(0.07)*	0.96	*(0.09)*	0.91	*(0.10)*	0.87	*(0.08)*	0.82	*(0.06)*
Japan	1.00	*(0.02)*	1.03	*(0.07)*	1.08	*(0.10)*	1.09	*(0.12)*	1.07	*(0.15)*	1.04	*(0.17)*
U.K.	0.95	*(0.02)*	0.86	*(0.07)*	0.79	*(0.10)*	0.71	*(0.12)*	0.67	*(0.09)*	0.58	*(0.07)*
U.S.	-		-		-		-		-		-	