Practical Active Currency Management for Global Bond Portfolios from a Thai Perspective

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This paper focuses on currency risk management using active and passive hedging strategies in formulating international bond portfolios. An active strategy is employed when investors partially or overly hedge against currency risk, while a passive strategy is when investors never hedge or fully hedge against currency risk. The evidence indicates that, when employing a passive strategy involving never hedging, Thai investors should not diversify internationally. However, active currency management, based on a simple application of technical trading rules, produces a better excess return per unit of risk under an international diversification framework, particularly from a Thai perspective. (JEL F31 G11)

1. Introduction

It is generally known that an investor who buys foreign currency bonds will have return from two sources; 1) the foreign currency return on the bond, equaling interest income plus capital gains or losses, reflecting an exposure to foreign currency interest rate risk, and 2) exchange rate gains or losses, reflecting an exposure to currency risk. As pointed out by Levich and Thomas (1993), the availability of effective currency risk hedging instruments allows an international investor to choose to be exposed to foreign currency interest rate risk only, to currency risk only, or to both. Therefore, the decision to hold foreign currency bonds can be made independently of the decision to bear or hedge currency risk.

Practically, some international investors may hedge the

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currency risk in their foreign currency securities; others may never hedge. However, there is a third alternative, called active currency management. Using an active currency management, a fund manager may turn his foreign currency problem into an opportunity. The question arises whether we can take foreign exchange exposure as an incremental source of return. Levich and Thomas (1993) showed that active trading strategies based upon simple technical trading rules can produce foreign exchange profit.

In the case of Thailand, the Securities and Exchange Commission (SEC) has permitted some asset management companies to establish and manage Foreign Investment Funds (FIF) as approved by the Bank of Thailand (BOT). This provides an opportunity for Thai investors to invest in international assets. Therefore, this study has two objectives; 1) to investigate whether global bond portfolios provide extra benefits to Thai investors, and 2) to investigate whether active currency management is superior to passive currency management for global bond portfolios. The results of this study will certainly be beneficial to asset management firms and also to other Thai institutional investors who are looking for an opportunity to invest internationally.

There are two sub-strategies associated with passive and active strategies. The passive strategy is the situation where investors choose to never hedge against foreign currency risk or to fully hedge against foreign currency risk, while the active strategy is the situation where investors partially hedge or overly hedge their positions against currency risk. For the purposes of this study, it is assumed that investors employing an active strategy make use of appropriate technical tools and an optimal hedge ratio approach.

This paper is organized as follows; Section 2 reviews the previous studies conducted with regard to international diversification and currency hedging strategies, while Section 3 focuses on the data and methodology employed. The empirical results will be presented in the fourth section, and the last section provides concluding remarks.

2. Prior Contributions

There has been a great deal of research published about the benefits of international diversification and currency hedging strategies using either stocks or bonds, or both, as a proxy of securities. The research can be separated into two groups focusing on; 1) the benefits of international diversification, and 2) both the benefits of international diversification and of currency hedging strategies.

Ibbotson, Carr, and Robinson (1982) examined the return on equities, domestic bonds and cross-border bonds of the U.S. and 17 foreign countries over a 21-year period from 1960-80. They found that foreign stocks and bonds generally outperformed U.S. securities, although the U.S. security was the outstanding performer in some periods. On a beta-adjusted basis, U.S. equities underperformed the market-value-weighted world equity market portfolio by -0.69 per cent per year, with a beta on the world market of 1.08. While bond yields were high in the United States, non-U.S. bonds benefited from appreciation against the dollar in the 1970s, making them superior investments from a U.S. dollar investor's perspective.

Odier and Solnik (1993) investigated whether global stock investment benefited from a satisfactory risk-return profile not only from the point of view of U.S. investors, but also for Japanese, British, and German investors. They observed what had changed over the 20 years they researched, and how the changes affected international investment. Lastly, they discussed some of the important issues for global investing, particularly the choice of benchmark and currency hedging. They assumed that currency risk was fully hedged for the world index. From the Japanese investor's point of view, the benefits of international risk diversification were even greater than for a U.S. investor. A similar conclusion could be drawn for investors of all the studied nationalities over the time period under review. Even though investing abroad means buying in some highly volatile markets and bearing some additional currency risks,

it appears that many of these risks get diversified away because of low correlations among the stocks markets of individual countries.

Eun and Resnick (1994) analyzed the gain from international diversification of investment portfolios from the Japanese perspective as well as from the U.S. perspective. The potential gains from international diversification were determined by solving for optimal international portfolios and comparing their risk-return characteristics to those of domestic portfolios. Seven markets were considered: Canada, France, Germany, Japan, Switzerland, the United Kingdom, and the United States. In solving for optimal international portfolios, monthly data for national bond and stock market indices from January 1978 through December 1989 were used. The optimal portfolio was identified by maximizing Sharpe's ratio.

The result indicates that for Japanese investors, the gain from international diversification accrues in terms of a lower risk, not in terms of a higher return. For the U.S. investors, on the other hand, the gain accrues not so much in terms of a lower risk as in terms of a higher return. Moreover, hedging exchange rate risk is found to generally increase the benefits from international investments for U.S. investors, but not for Japanese investors.

Solnik (1995) studied whether an internationally diversified portfolio has a smaller risk than a domestic portfolio. Also, he studied how many securities must be included in a portfolio in order to obtain reasonable diversification. The results show that once diversification increased, the risk of a portfolio decreased in all countries, but not proportionally. The marginal reduction in the portfolio variance of adding an extra security in the portfolio became smaller very quickly. The risk of portfolios was able to be reduced when extra stocks were added to only a certain level. The rate of return on any reasonably well-diversified portfolio will be highly correlated with that of the market as a whole, because all stock prices tend to move together.

The study showed that the variability of return of an internationally well-diversified portfolio would be one-tenth as risky

as a typical security and half as risky as a well diversified portfolio of U.S. stocks with the same number of holdings. While increasing the size of a domestic portfolio beyond 20 stocks seems to achieve only a relatively small incremental reduction in risk, a substantial reduction can still be achieved for an international portfolio of the same size. The result also showed that inter-industry diversification is inferior to inter-country diversification. In addition, the risk of an international portfolio unprotected against exchange risk is larger than for a covered portfolio using forward contracts. However, its total risk is still much smaller than for a comparable domestic portfolio.

Michaud et al. (1996) studied whether international equity investment is a route to higher returns and lower risks. The test was to compare the performance of a passive international investment strategy in international developed markets to the performance of U.S. equities since 1975. The result showed that an international index portfolio provided slightly more return, and more risk, than a domestic index over the period studied. A passive global portfolio consisting of 70% international and 30% domestic assets would have had nearly the same level of risk as the S&P 500 index and slightly more return. A global passive portfolio with roughly a 40/60 mix would have had significantly less risk, and slightly more return, than a purely domestic portfolio.

Vassal (2001) investigated the risk diversification benefits of multiple-stock portfolios. Monte Carlo techniques were used to simulate total returns of equity portfolios with varying numbers of holdings for the seven-year period ending December 31, 1999. The universe was based on the original constituents of the Russell 1000 as of December 31, 1992, adjusted for survivorship. The results suggest that there is a significant reduction in downside risk with the addition of only a few stocks to a portfolio. For example, the 18% frequency of a negative return for a one stock portfolio decreases to about 2% for portfolio with four stocks (equally weighted), and to less than 1% with six stock holdings. The

frequency of loss is 0% for a simulated portfolio with ten or more stocks. This analysis should help to encourage a client with few stock holdings to diversify across a greater array of stocks.

Black (1989) analyzed optimal currency risk and reward in international equity portfolios. He found that investors could increase their returns by holding foreign stocks in addition to domestic ones. Investors can also gain by taking an appropriate amount of exchange rate risk. The author derived a formula for an optimal hedge ratio which depends on three inputs, which are the expected return on the world market portfolio, the volatility of the world market portfolio, and the average exchange rate volatility. The formula in turn yields three rules: hedge foreign equities, hedge equities equally for all countries, and do not hedge 100 per cent of foreign equities.

Black and Litterman (1992) investigated the habits of investors who are generally aware of their asset allocation decisions on global portfolio optimization. The results show that investors will accept currency risk up to the point where the additional risk balances the expected return. Under certain simplifying assumptions, the percentage of foreign currency risk hedged will be the same for investors of different countries, giving rise to the term "universal hedging" for this equilibrium. They assess that universal hedging values between 75% and 85% are reasonable.

Levich and Thomas (1993) analyzed the merit of active currency risk management for international bond portfolios using data for the 1976-1990 periods. The result shows that active currency risk management based on a simple application of technical trading signals can improve substantially upon the risk-return profiles of passive currency strategies.

Reinert (2000) studied practical active currency management for equity portfolios. His research demonstrates the effectiveness of active currency management compared to unhedged and passively hedged strategies. Using a moving average-based trading rule, the results show that, for an equity portfolio with a significant interna-

tional allocation (e.g., greater than 10%), some active currency management strategies have consistently dominated both unhedged and passively hedged strategies. Specifically, for portfolios well diversified among major equity markets, a single, technically-based, active currency management strategy yields the highest risk-adjusted return in all rolling ten-year periods and in 21 of 24 rolling five-year periods over 1972-1999.

Hunter and Simon (2004) studied the benefits of international bond diversification. Their purpose was to assess whether U.S. investors holding broadly diversified domestic fixed-income and equity portfolios can obtain incremental diversification benefits from investing in international government bonds. The researchers could not reject their null hypothesis that unhedged foreign bond returns do not provide incremental diversification benefits when added to a broadly diversified domestic portfolio. The evidence suggests that the high volatility of unhedged foreign bond returns may account for this finding. On the contrary, they strongly reject the null hypothesis that hedged foreign bond returns do not provide incremental diversification benefits to the domestic portfolio. Hence, the benefits of international bond diversification persist on a currency-hedged basis.

3. Methodology and Data

A. Data

In this study, a global bond portfolio means a mix of Thai and non-Thai bond indices. We use the concept of sensitivity analysis applied in Levich and Thomas (1993) to allocate the investments in our global bond portfolios. The investment opportunity consists of five bond markets, which are the U.S., the U.K., Germany, Japan, and Thailand. The allocation among Thai and non-Thai bonds is presented in Table 4.

There are three types of weekly data used in the analysis;

bond indices, spot exchange rates, and forward exchange rates. The sample period is from January 1999 to October 2004. The index used for the international bond market is the JP Morgan Government Bond Index-Local Currency.[1] This is used because there is no international corporate bond index accepted worldwide. For the Thai bond market, the total return index from the Thai BDC is applied.[2]

The spot and forward exchange rates data are for one-week periods and correspond to the bid-price[3] of the last trading day of each week during the studied period. The data were collected from Bloomberg and the Bank of Thailand. The exchange rate data are in Thai Baht (THB) terms i.e. THB/USD, THB/GBP, THB/EUR, and THB/JPY. In this study, currency forward contracts will be used to hedge against exchange rate risk. Since this study is based on the Thai investor's perspective, the international investments are subjected to conversion into Thai baht at the end of each period. In addition, one week Repurchase rates from the Bank of Thailand will be used as a proxy of risk-free rate.[4] The return on foreign bonds for Thai investors consists of three components:

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[1] J.P. Morgan Government Bond Index is the most widely-used benchmark for measuring performance and quantifying risk across international fixed income bond markets. The indices measure the total, principal, and interest returns in each market and can be reported in 19 different currencies.

[2] Thai Bond Dealing Center (BDC) has developed this Bond index in order to track market performance. The index measures the price change, coupon, and accrued interest of Thai government bonds for all maturities i.e. short-term, medium-term, and long-term. Reference: www.ThaiBDC.or.th

[3] We are in the long position on international bonds so the bid price is suitable for this study.

[4] The appropriate risk free rate should be a default-free government-originated security that matches up the duration of the cash flows being analyzed, in this case, a one-week period. The average 7-days Repurchase rate from the Bank of Thailand during 1999-2004 was equal to 1.49% p.a.

a. Interest income earned or accrued.

b. The capital gain or loss on the bond, resulting from the inverse relationship between interest rates and bond prices.

c. The foreign exchange gain or loss, applied to the above two items.

B. Currency Management Strategies

There are only two major currency management strategies: passive and active. To never hedge, simply called an unhedged strategy against exchange rate risk, and to fully hedge against exchange rate risk are considered as passive strategies. The tactical hedge strategy and the currency overlay strategy are considered as active strategies. Explanations of the various currency management strategies follow.

1. Passive Currency Management

a. Unhedged Strategy

The unhedged global bond portfolio is a mix of an equally weighted portfolio of non-Thai indices and the Thai bond index without any currency hedging. To calculate the weekly returns for a THB-based investor, let B_t represent the initial purchase price of the bond in foreign currency (FC) terms. And Let S_t, represent the spot exchange rate, in THB/FC terms, on the purchase date. The product, B_tS_t, is the THB purchase price of the foreign bond. After one week, the value of the bond is B_{t+1}, representing the initial bond price plus the price change over the week plus accrued interest. The continuous rate of return on the foreign bond measured in THB on an unhedged basis is:

$$\mathbf{R_{THB,U}} = \mathbf{\ln (B_{t+1}S_{t+1} / B_tS_t) = \ln (B_{t+1} / B_t) + \ln (S_{t+1} / S_t)} \qquad (1)$$

$$\sigma_i^2 = \sigma_B^2 + \sigma_S^2 + 2\sigma_{BS} \qquad (2)$$

where the U subscript indicates a never-hedged position. Equation (1) shows that the unhedged THB return on the foreign bond has two components; 1) the return on the bond in foreign currency terms, and 2) the return on the foreign currency used to buy the bond.

b. Fully-hedged Strategy

The fully-hedged global bond portfolio is based on one-week forward currency contracts, rolled over weekly. Suppose an investor wishes to lower his exposure to currency risk. After buying a foreign bond at a price B_t, one possible strategy is to sell all future coupon payments forward in exchange for THB as well as sell the final return of principal forward. This strategy is much like a currency swap that eliminates all currency risk and transforms this foreign bond into a THB bond. The return on this swapped bond should be nearly identical to a THB bond of the same maturity

Suppose instead that an investor pursues a less extreme strategy toward currency risk. Namely, he sells a one-week forward currency contract (priced at F_t) for an amount equal to next week's estimated value of the bond with accrued interest, B_{t+1}. The THB continuous rate of return measured in THB is:

$$\mathbf{R_{THB,\,H} = \ln (B_{t+1}F_t / B_tS_t) = \ln (B_{t+1} / B_t) + \ln (F_t / S_t)} \qquad (3)$$

$$\sigma_i^2 = \sigma^2_B + \sigma^2_F + 2\sigma_{BF} \qquad (4)$$

where the H subscript indicates a perfectly hedged position. The return also has two components; 1) the return on the bond in foreign currency terms, and 2) the one-week forward premium.

It is obvious from equations (2) and (4) that the risk of each strategy depends on; a) the variance of the foreign bond market return, b) the variance of foreign exchange rate, either spot or forward rate, and c) the covariance among the foreign bond market return and foreign exchange.

2. Active Currency Management

The case for active currency hedging also relies on several arguments. First, it presumes the existence of a trading rule that can beat the currency futures market. By this we mean that, on average, the trading rule earns a profit after accounting for transaction costs. Second, because no trading rule will earn a profit in every period, an active strategy presumes that these returns are large relative to the risks.

This paper considers a technical analysis approach and an optimal hedge ratio as tools to estimate the appropriate hedging portion for the tactical hedging strategy as well as the investment in currency portfolio for the currency overlay strategy. The technical hedging strategy is similar to that proposed by Levich and Thomas (1993). This paper uses two kinds of trading rule in order to indicate buy and sell signals, filter rules, and moving average crossover rules. These technical tools are commonly used in foreign exchange markets.

A filter rule is defined by a single parameter, **f**, as a filter size. If we express a rate in THB terms, then a filter rule can be defined as follows: buy the foreign currency whenever it rises by **f** percent above its most recent trough; sell the foreign currency whenever it falls **f** percent below its most recent peak. We examined seven filter rules with **f** values of 0.25%, 0.5%, 0.75%, 1%, 1.25%, 1.5%, and 1.75%.

As for the moving average cross over rule, it is defined by two parameters: the length (L) in trading days, of the longer moving average (MAL), and the length (S) of the shorter moving average (MAS). An L/S moving average rule can be defined as follows: If MAS exceeds MAL, then buy the foreign currency; if MAS is less than MAL, then sell the foreign currency; if MAS equals MAL, take no position. Three moving average crossover rules are based on L/S values of 5/1, 10/1, and 10/5 week(s).

a. Tactical Hedge Strategy

The tactical hedge portfolio actively hedges a percentage

of the global bond portfolio based on the signals from 10 technical trading rules. The tactical hedging strategy is one where the percentage of currency forward to sell for currency i, PT,i, based on our 10 technical trading rules, is determined by the following formula:

$$P_{T,i} = [10 - (N_{L,i} - N_{S,i})] \times 10\%, \text{ for } N_{L,i} >= 5, \quad (5)$$
$$= 100\% \qquad \text{for } N_{L,i} <= 4,$$

where $N_{L,i}$ and $N_{S,i}$ are the number of technical rules advocating long and short currency positions. The return on the tactically hedged portfolio (RT) is simply:

$$R_T = R_U(1 - P_T) + R_H(P_T), \quad (6)$$

Where RU is the return on the unhedged bond and RH is the return on the currency-hedged bond.

b. Currency Overlay Strategy

The currency overlay portfolio reflects the performance of the hedged global bond portfolio combined with a currency fund actively managed based on the signals from 10 technical trading rules. The currency overlay strategy is actually a combination of two separate investments; 1) a foreign currency bond position that is always hedged against currency risk, and 2) a currency position governed by the composite currency trading rule.

As the range of currency positions is wider with the currency overlay strategy, the return on the currency overlay strategy (RCO) is given by:

$$R_{CO} = R_H + R_A, \quad (7)$$

where R_A is the return on the active composite trading rule, or:

$$R_A = \Sigma P_t \times \ln (F_{t+1} / F_t), \quad (8)$$

and P_t, the percentage of forward contracts to buy, satisfies

$-1 <= P_t <= +1.$

$$\mathbf{P_t = (N_L - N_S) \times 10\%.} \quad (9)$$

Sharpe's ratio (S) will be used to measure the portfolio performance.

$$S = \frac{E(R_p) - R_f}{\sigma_p} \quad (10)$$

$$= \frac{\sum_{i=1}^{N} W_i (R_i - R_f)}{\left[\sum_{i=1}^{N}\sum_{j=1}^{N} W_i W_j \sigma_{ij}\right]^{\frac{1}{2}}}$$

Subject to $\sum_{i=1}^{N} W_i = 1$ ***and*** $0 <= W_i <= 1$ (short-sale restriction for bond).

Where

W_i = the fraction of wealth invested in the i^{th} security

R_i = the expected return on the i^{th} security

σ_{ij} = the covariance of return between the i^{th} and j^{th} securities

σ_p = the standard deviation of returns on the portfolios.

3. Efficient Frontier by Maximizing Sharpe's Ratio

The tangency portfolio can be defined by solving the following maximization problem:

$$Max\ S = \frac{E(R_p) - R_f}{\sigma_p} \quad \textit{(Sharpe's Ratio)} \tag{11}$$

$$= \frac{\sum_{i=1}^{N} W_i (R_i - R_f)}{\left[\sum_{i=1}^{N}\sum_{j=1}^{N} W_i W_j \sigma_{ij}\right]^{\frac{1}{2}}}$$

Subject to $\sum_{i=1}^{N} W_i = 1$ *and* $0 <= W_i <= 1$ (short-sale restriction for bond).

4. Empirical Results

We should first observe the performance of the individual-currency bond portfolio with unhedged currency from Thai investors' perspectives. Table 1 shows the mean return, the volatility of return, and the Sharpe's ratio for individual bond portfolios with unhedged currency. The U.K., Germany, and U.S. markets yield the highest annual returns of 8.21% p.a., 8.20% p.a., and 7.83% p.a. respectively because of both the higher local interest rate and, on average, the currency appreciation against the Thai baht. The Japanese market yields the lowest annual return of 5.45% p.a. because of the lowest local interest, the currency appreciation, on average, against the Thai baht. In terms of risk, the Germany, U.K., and Japanese markets caused the highest return-volatility of 11.66% p.a., 10.75% p.a., and 10.31% p.a., respectively. The results show that the investment in overseas markets by Thai investors caused uncertainty of return greater than the investment in the Thai-only bond market, equal to only 3.82% p.a. The currency risk is significantly high in the view of local investors. The investment in the Thai-only bond market yields the highest Sharpe's ratio of 1.3218. The U.S., U.K., and Germany markets yield the Sharpe's ratios of 0.7897, 0.6253, and 0.5760 respectively. The Japanese markets yield the lowest Sharpe's ratio of 0.3843. This means,

when investors consider a never-hedge currency approach, they should not invest in overseas bond markets individually. The currency risk will govern the benefit from the superior local interest rate of other countries.

In addition, the total return can be classified into two sources, comprising bond return and currency return. The bond return equals the return in local currency of such a bond prior to translation into Thai baht terms. The currency return equals the gain/loss from currency translation from foreign currency to Thai baht. The U.S. bond yields a bond return of 5.89% p.a. and a currency return of 1.94% p.a. The U.K. bond yields a bond return of 4.46% p.a. and a currency return of 3.75% p.a. The German bond yields a bond return of 4.79% p.a. and a currency return of 3.41% p.a. The Japanese bond yields a bond return of 2.39% p.a. and a currency return of 3.06% p.a. The results show that the currency return has been the major part of the total return from foreign bond investment.

A. Correlation of Unhedged Return for Individual Bond Portfolios

Table 2 shows the correlation matrix of unhedged return for individual bond portfolios. The German, U.K., and U.S. markets have low and positive correlations of return with the Thai market of 0.0809, 0.0679, and 0.0124 respectively. The Japanese market has a negative correlation with the Thai market of 0.0147. Due to the fact that the Thai bond market has low correlation with the overseas bond markets, especially the Japanese market, there will be an excellent opportunity for international diversification for Thai investors.

However, the correlations of returns across the three western markets: U.S., U.K., and German, are relatively high. For instance, the U.K. and German markets have positive correlations of return with the U.S. markets of 0.6154, and 0.4164 respectively. The U.K. has the highest correlation of return with the German

market of 0.7627 because of geographical and geo-societal closeness. This means, when Thai investors incorporate all western bond markets in their portfolios, they may get less benefit from international diversification due to high correlation of return among those western countries.

B. The Performance of the Individual-Currency Bonds with Alternative Currency Hedging Strategy

Table 3 shows the Sharpe's ratio of the individual-currency bond with alternative currency hedging strategies. For instance, the Japanese market yields Sharpe's ratios of 1.5810, 1.6869, and 1.9256 for the fully-hedged, tactical hedge, and currency overlay strategies respectively. For the U.S. and German markets, the investors get the same results as the Japanese market, i.e. the best performance is achieved by the currency overlay, the tactical hedge, and the fully-hedged respectively. The U.K. market yields a slightly different result, i.e. the fully-hedged strategy yields the lowest Sharpe's ratio. The results indicate that the fully-hedged strategy does not totally govern the never-hedge strategy. In comparison to the passive strategy, when investors apply active currency management, either tactical hedge or currency overlay, in their international bond portfolios, investment in overseas bond markets is distinctively attractive. For instance, the currency overlay strategy yields the highest Sharpe's ratios of 1.4365, 1.5627, 2.2803, and 1.9256 for the U.S., U.K., German, and Japanese bonds respectively.

C. The Performance of the International Bond Portfolios with Alternative Currency Hedging Strategy

For global bond portfolios, the allocation is gradually more aggressive in terms of international exposure. Table 4 shows the allocation of individual-currency bonds in the global bond portfolio. Portfolio 1 comprises 80%, 5%, 5%, 5%, and 5% in Thai, U.S.,

U.K., German, and Japanese bonds respectively. For Portfolios 2, 3, 4, and 5, we gradually reduce the allocation in Thai bonds and simultaneously increase the allocation in the foreign bonds by equal weight. The extreme case occurs in Portfolio 5 which comprises 0%, 25%, 25%, 25%, and 25% in Thai, U.S., U.K., German, and Japanese bonds respectively.

Table 5 shows very interesting results when those portfolios are integrated with the alternative hedging strategies. Portfolio 1 (local 80/inter 20) yields Sharpe's ratios of 1.4884, 1.5005, 1.7906, and 1.9499 for the unhedged, fully-hedged, tactical hedge, and currency overlay strategies respectively. On the other side, Portfolio 5 (local 0/inter 100) yields Sharpe's ratios of 0.7514, 1.0728, 1.8617, and 2.2662 for the unhedged, fully-hedged, tactical hedge, and currency overlay strategies respectively.

In summary, when investors invest a small portion in overseas bond markets, an active currency strategy will slightly enhance the performance of a global bond portfolio. When investors invest aggressively in overseas bond markets, an active currency strategy will significantly increase the performance of the global bond portfolio. Therefore, investors have to be concerned about currency management when investing internationally. A suitable currency hedging strategy will not only protect the investor from the currency risk but also enhance the performance of the global bond portfolios.

D. Efficient Frontier by Maximizing Sharpe's Ratio

The optimal portfolios for global bonds are now considered by maximizing Sharpe's ratio. The results are presented in Table 6 and discussed below.

1. Passive Currency Management :

a. Unhedged Strategy

When using the unhedged strategy, the optimal portfolio comprises Thai, U.S., German, and Japanese bonds in the percent-

ages of 75.44%, 18.36%, 2.64%, and 3.56% respectively. The results still confirm that when investors consider a never-hedged currency approach, they should not invest much in overseas bond markets. The currency risk will surpass both the benefit from the superior local interest rate of other countries and the benefit of the diversification. However, the optimal portfolio with the unhedged strategy yields a greater Sharpe's ratio of 1.5478, compared with Portfolios 1 to 5.

b. Fully-hedged Strategy

When using the fully-hedged strategy, the optimal portfolio comprises Thai, U.S., German, and Japanese bonds in the percentages of 33.93%, 2.58%, 14.18%, and 49.31% respectively. The optimal portfolio with the fully-hedged strategy yields the greater Sharpe's ratio of 2.1178, compared with Portfolios 1 to 5. The optimal portfolio is weighted heavily toward the Japanese bonds due to the fact that the fully-hedged Japanese bond has significantly higher Sharpe's ratio than the unhedged Japanese bond (1.5810 fully-hedged/ 0.3843 unhedged). Moreover, the negative correlation between Thai and Japanese markets generates excellent benefits of diversification.

2. Active Currency Management :

a. Tactical Hedge Strategy

When using the tactical hedge strategy, the optimal portfolio comprises Thai, U.S., German, and Japanese bonds with the percentages of 42.05%, 6.22%, 21.07%, and 30.66% respectively. The results still confirm that, with active currency management, investors are able to invest aggressively in overseas bond markets. The optimal portfolio with the tactical hedge strategy yields a greater Sharpe ratio of 2.3893, compared with Portfolios 1 to 5.

b. Currency Overlay Strategy

When using the currency overlay strategy, the optimal portfolio comprises Thai, U.S., German, and Japanese bonds with the percentages of 38.91%, 1.95%, 31.64%, and 27.50% respectively.

The optimal portfolio with the currency overlay strategy yields a greater Sharpe's ratio of 2.8378, compared with Portfolios 1 to 5. When investors compare performance among the alternative currency hedging strategies, the optimal portfolio with the currency overlay strategy yields the highest Sharpe's ratio. The results indicate that active currency management governs passive currency management. In addition, currency return has been the major part of the total return from foreign bond investment, especially for the active currency management approach.

It is not surprising that the U.K. bond market has not been incorporated in the optimal portfolio for any currency management approaches. From the correlation matrix in Table 2, it is obvious that the U.K. market is the most significantly dependent with other markets. Therefore, investment in the U.K. market could not be greatly beneficial to global bond portfolios.

5. Conclusion

This paper focuses on currency risk management in formulating international bond portfolios. First, the performance of the individual-currency bond portfolio, with unhedged currency from the perspective of the Thai investor, has been considered. The results show that investment only in the Thai bond market yields the highest Sharpe's ratio. This means, when investors consider a never-hedged currency approach, they should not invest in overseas bond markets individually. The currency risk will govern the benefit from the superior local interest rate of other countries. However, when the investors use an alternative hedging strategy, it yields a better risk-return profile for the bond portfolios. The results indicate that the currency overlay strategy yields the highest Sharpe's ratio.

When the correlation of unhedged return for individual bond portfolios has been considered, the Thai bond market has low correlation with the overseas bond markets. Thus, there will be an excellent opportunity for international diversification. However,

the correlations of return across western markets are relatively high because of the very near geographical and geo-societal areas. This means, when Thai investors incorporate all western bond markets in their portfolios, they may get less benefit from international diversification.

Moreover, various global bond portfolios are established by gradually reducing the allocation in Thai bonds and simultaneously increasing the allocation in foreign bonds. The results indicate that when investors invest a small portion in overseas bond markets, the active currency strategy will slightly enhance the performance of the global portfolio. When investors invest aggressively in overseas bond markets, the active currency strategy will significantly increase the performance of the global portfolio. Therefore, investors have to be concerned about currency management when investing internationally. A suitable currency hedging strategy will not only protect the investor from currency risk but also enhance the performance of global bond portfolios.

When the optimal portfolios for global bonds are considered by maximizing the Sharpe ratio, the results still confirm the previous findings. When investors consider a never-hedged currency approach, they should not invest much in overseas bond markets. However, the optimal portfolio with a currency overlay strategy yields the highest Sharpe ratio. The results also indicate that active currency management governs passive currency management. In conclusion, global bond portfolios provide diversification benefits to the Thai investors; especially when applied with active currency management.

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Table 1 Sharpe's Ratios for Individual Bond Portfolios with Unhedged Currency Strategy, 1999 - 2004, Thai Investor Perspective, Annual Basis.

	U.S.	U.K.	Germany	Japan	Thailand
ER (%p.a.)	7.83%	8.21%	8.20%	5.45%	6.54%
STDV.	8.02%	10.75%	11.66%	10.31%	3.82%
Rf [1] (%p.a.)	1.49%	1.49%	1.49%	1.49%	1.49%
Sharpe's Ratio	0.7897	0.6253	0.5760	0.3843	1.3218
Bond R. (%p.a.)	5.89%	4.46%	4.79%	2.39%	6.54%
CCY R. (%p.a.)	1.94 %	3.75%	3.41%	3.06%	-

[1]The average 7-days Repurchase rate from the Bank of Thailand during 1999-2004 was equal to 1.49% p.a.

The table shows the mean return, the volatility (standard deviation) of the mean return, and Sharpe's ratio for individual bond portfolios with unhedged currency. All percentage figures are on an annual basis. The data are on a weekly basis for the years 1999 - 2004. The compensation between return and risk results in the Sharpe ratio, the return per unit of risk. In addition, the total return can be classified into two sources, comprising bond return (Bond R.) and currency return (CCY R.).

Table 2 Correlation Matrix of Unhedged Return for Individual Bond Portfolios, 1999 - 2004, Thai Investor Perspective.

	Thailand	**U.S.**	**U.K.**	**Germany**	**Japan**
Thailand	1.0000	0.0124	0.0679	0.0809	-0.0147
U.S.		1.0000	0.6154	0.4164	0.2884
U.K.			1.0000	0.7627	0.3423
Germany				1.0000	0.3195
Japan					1.0000

The table shows the correlation matrix of unhedged return for individual bond portfolios. The correlation is normally ranged from +1 to -1. A positive correlation means the returns move together; a negative correlation means the returns move in the opposite direction. Low correlation is beneficial for the portfolios in terms of risk diversification.

Table 3 Sharpe's Ratios for Individual-Currency Bond Portfolios with Alternative Currency Hedging Strategies, 1999 - 2004, Individual Currency, Thai investor's Perspective.

	U.S.	U.K.	Germany	Japan	Thailand
Passive :					
Unhedged	0.7897	0.6253	0.5760	0.3843	1.3218
Fully-hedged	0.8822	0.3374	1.0487	1.5810	NA
Active :					
Tactical Hedge	1.3815	1.3625	1.7717	1.6869	NA
Currency Overlay	1.4365	1.5627	2.2803	1.9256	NA

The table shows Sharpe's ratios for the individual-currency bonds with alternative currency hedging strategies. There are two major currency management strategies, which are passive and active. There are two sub-strategies in both the passive strategy and the active strategy. To never hedge, simply called the unhedged strategy, against exchange rate risk and to fully hedge against exchange rate risk are considered as a part of the passive strategy. The tactical hedge strategy and the currency overlay strategy are considered as part of the active strategy.

Table 4 The Allocation for International Bond Portfolios, 1999 - 2004, Global Portfolios.

	Port 1	Port 2	Port 3	Port 4	Port 5
Thailand	80%	60%	40%	20%	0%
U.S.	5%	10%	15%	20%	25%
U.K.	5%	10%	15%	20%	25%
Germany	5%	10%	15%	20%	25%
Japan	5%	10%	15%	20%	25%
Total	100%	100%	100%	100%	100%

The table shows the allocation of individual-currency bonds in the global bond portfolios. The global portfolios look gradually more aggressive due to increasing international exposure. The allocation in Thai bonds gradually reduces and simultaneously the allocation in foreign bonds increases by equal weight. These portfolios were created to investigate the results when they integrate with the alternative currency hedging strategies.

Table 5 Sharpe's Ratios for International Bond Portfolios with Alternative Currency Hedging Strategies, 1999 - 2004, Global Portfolios, Thai Investor Perspective.

	Port 1	Port 2	Port 3	Port 4	Port 5
Passive :					
Unhedged	1.4884	1.3517	1.1042	0.8991	0.7514
Fully-hedged	1.5005	1.6232	1.5745	1.3840	1.0728
Active :					
Tactical Hedge	1.7906	2.1400	2.1837	2.0402	1.8617
Currency Overlay	1.9499	2.4325	2.5435	2.4301	2.2662

The table shows Sharpe's ratios when those portfolios integrate with the alternative currency hedging strategies. The results show that active currency management dominates passive currency management.

Table 6 The Allocation and Sharpe's Ratios of The Optimal-Global Bond Portfolios for Alternative Currency Hedging Strategies, 1999 - 2004, Thai Investor Perspective, Annual Basis.

	Passive		**Active**	
	Unhedged	Fully-hedged	Tactical	CCY Overlay
Thailand	75.44%	33.93%	42.05%	38.91%
U.S.	18.36%	2.58%	6.22%	1.95%
U.K.	0%	0%	0%	0%
Germany	2.64%	14.18%	21.07%	31.64%
Japan	3.56%	49.31%	30.66%	27.50%
Total	100%	100%	100%	100%
ER (% p.a.)	6.78%	6.24%	9.38%	12.21%
STDV.	3.42%	2.24%	3.30%	3.78%
R_f (% p.a.)	1.49%	1.49%	1.49%	1.49%
Sharpe's Ratio	1.5478	2.1178	2.3893	2.8378
Bond R. (% p.a.)	6.22%	4.23%	4.86%	4.83%
CCY R.(% p.a.)	0.56%	2.01%	4.52%	7.38%

The optimal portfolios for global bonds are considered by maximizing Sharpe's ratio. The results still confirm that when the investors consider a never-hedge currency approach, they should not invest much in overseas bond markets. On the contrary, the optimal portfolio with the currency-overlay strategy yields the highest Sharpe's ratio. The overall results also indicate that active currency management governs passive currency management.

In addition, the total return can be classified into two sources comprising bond return and currency return. The currency return has been the major part of the total return from foreign bond investment, especially for the active currency management approach.