International asset and currency allocation

Separate decisions for asset and currency allocation can significantly improve the performance of international fixed-income portfolios.

Adrian F. Lee

This article discusses the strategies available to investors in international fixed-income markets. Specifically, I concentrate on two elements of the process of building multi-currency portfolios: 1) the optimal asset portfolio, and 2) a separate optimal currency portfolio. The difference between the optimal asset exposure and the optimal currency exposure is termed the optimal hedge. The analysis demonstrates that portfolios constructed on the basis of this separation will always be expected to outperform portfolios that do not explicitly separate the asset and currency decision.

From a review of historical returns and risk on international fixed-income investment for the period 1971–1985, we shall see that currencies are a systematic source of risk and return in international portfolios. We shall also observe that currencies move relatively independently of local asset return, suggesting a need in practice to separate the asset investment decision from the currency exposure decision.

The paper then describes how the optimal portfolio structure for a multi-currency portfolio is defined by an optimal asset weight and an optimal currency exposure; when these weights differ for any one market, this implies a currency hedge or forward position. The optimal portfolio structure is then solved for, and identified by, expectations for local return, currency return, forward currency premiums, and all related variances and covariances.

The next step is to investigate whether it is necessary in practice to have any currency forecasting insight in order for the separation of asset and currency decisions to provide value added to the active management of assets. In other words, if exchange rates cannot be forecast, why should we consider currency exposure and risk management separately from the asset decision?

Simulation of the historical use of such optimal portfolio building techniques during the period 1971–1985 will show that this separation does provide considerable value added and that this result is not dependent on any currency forecasting ability.

The important implication of this analysis is that multi-currency portfolios managed according to this separation approach will inevitably outperform portfolios that are not invested in this way. Index portfolios are the most obvious example of portfolios whose asset and currency exposure are always equal. This result, although tested in the context of international fixed-income portfolios, appears general in its application and would be expected to apply for any multi-currency portfolio of assets.

Although the focus of this article is not on the diversification benefits of international fixed-income investment, several useful observations in this respect are relevant:

- Foreign currency exposure is not a significant component of the international fixed-income diversification argument.
- The optimally hedged portfolios identified and simulated take into account the diversification effect of the international fixed-income markets, as they are based on the optimization of a global portfolio structure that includes U.S. fixed-income assets. These simulations do not take into account the di-

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versification benefits of international fixed-income assets versus other assets, such as U.S. equities, real estate, convertibles, and international equities.

- From the perspective of optimizing an investor's total portfolio, the methodology described below is general. It suggests that, both in the context of long-run asset allocation decisions between asset classes and in the context of short-term investment management decisions, the separation of asset and currency decisions adds value in its own right.

HISTORICAL RETURNS AND RISKS OF INTERNATIONAL BOND MARKETS

A review of the performance of international bonds of the major economies over the last fifteen years appears in Figure 1, where we can see that different markets have offered sizably different opportunities for return. In each case, this display uses ten-year government bonds, or the longest available maturity. These differences are not just short-term differences but have persisted for periods as long as five years.

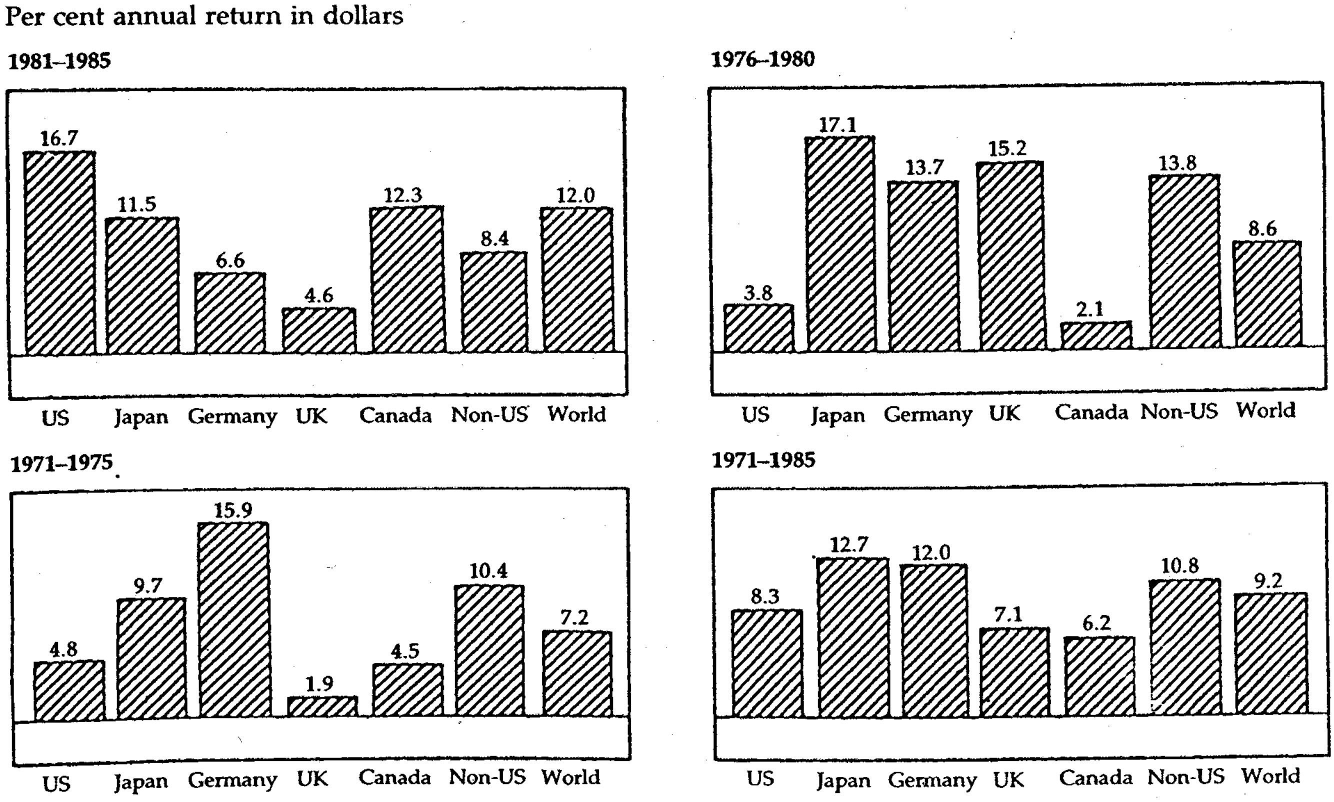
These return differentials between one market and another can provide an opportunity for an investor to invest outside the home market and earn a better return. Alternatively, if the differential is negative, this condition should be viewed as a risk. For example, a U.S. bond investor investing outside the U.S. home market in proportion to the market capitalization of non-U.S. markets over the period 1981–1985 would have lost return compared to what the portfolio would have returned in the domestic market. On the other hand, a similar strategy over the previous five years, 1976–1980, would have paid off handsomely.

A U.S. investor would have earned 10.8% a year over the total fifteen-year period from a market capitalization-weighted portfolio of non-U.S. bonds, compared to 8.3% from simply investing in the U.S. bond market alone. We can view these return differentials as the result of two separate sources of return — local bond market return and currency return. Figure 2 decomposes the total dollar returns to a U.S investor in international bond markets into the local bond market return and associated currency movement versus the U.S. dollar.

For example, the poor performance of the foreign markets from a U.S. perspective over the period 1981–1985 noted above was apparently due to moderate underperformance of the local markets coupled with weakness of the associated foreign currencies. We can also see that the outperformance of the foreign

FIGURE 1

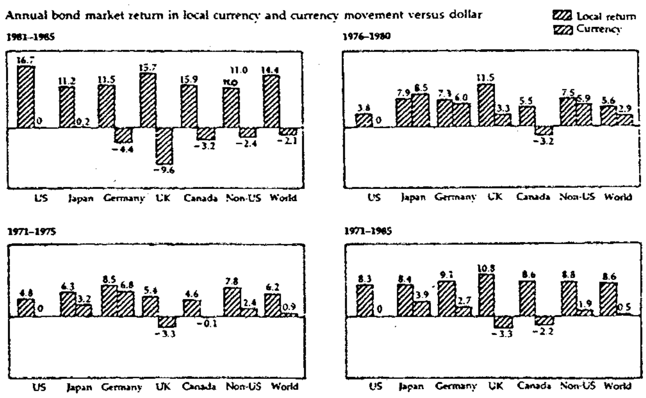
RETURNS FROM INTERNATIONAL FIXED-INCOME MARKETS 1971–1985



Source: J.P. Morgan Investment
Salomon Brothers Inc

FIGURE 2

RETURNS FROM INTERNATIONAL FIXED-INCOME MARKETS 1971–1985



Source: J.P. Morgan Investment
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markets in the period 1976–1980 is attributable to local outperformance and strong foreign currencies.

Furthermore, currencies are a source of return that is independent from local market return. This apparent relative independence of bond markets and currencies is borne out by an analysis of the correlations of local bond market returns and currency returns, as we can see in Table 1.

The correlations of a local bond return and its own currency, while positive in all cases, are quite small. The highest is 0.34 in the case of the Japanese bond market and the yen versus the U.S. dollar. The equivalent numbers from Germany and the U.K. are 0.25 and 0.25 in their respective currencies. Therefore, it is clear that bond investment and the underlying exposure to that bond's currency cannot be viewed as one and the same investment.

Table 1 also shows the correlations of returns from international markets expressed in dollars. By comparing the correlation of the U.S. bond market with local returns from non-U.S. markets versus the correlation of the U.S. market with foreign markets expressed in U.S. dollars, we see that currencies do not seem to be critical to the international diversification arguments. In other words, the correlation of the U.S and Japanese bond markets was 0.20 over the period, suggesting benefits to diversifying out of the U.S. market; the correlation of returns expressed in U.S. dollars was 0.24, so including the effect of currencies marginally worsens the diversification argument.

If currency movements have been an uncertain source of return over the last fifteen years, they have also been a constant source of risk. This constant risk can be observed in Figure 3, which compares the risk (standard deviation of return) of a diversified portfolio of all non-U.S. bonds with a hypothetical portfolio made up of the local returns from the same markets. Consistently, in each of the five-year periods, the effect of currencies has been to approximately double the risk of the portfolio of the underlying local markets.

In summary, a review of the returns and risks of international bond investment over the last fifteen years shows that local market and currency returns, the two key variables affecting returns, are separate sources of return. Currencies, while not a systematic source of return, are a systematic source of risk in international bond portfolios.

These two observations have two significant implications for the way in which investors should manage international bond portfolios:

1. Currency risk should be managed rather than simply ignored or assumed.
2. The management of an international bond portfolio should separate the process into the management of local bond market exposure and currency exposure.

TABLE 1

Correlations of Returns from International Bond Markets and Currencies 1971–1985

U.S. (local)	1.00						
Japan (local)	0.20	1.00					
Germany (local)	0.37	0.37	1.00				
U.K. (local)	0.23	0.19	0.21	1.00			
Yen (US dollar)	0.13	0.34	0.15	0.14	1.00		
DM (US dollar)	0.11	0.23	0.25	0.01	0.54	1.00	
Sterling (US dollar)	0.16	0.14	0.20	0.25	0.46	0.54	1.00
U.S. local	1.00						
Japan (in dollars)	0.24	1.00					
Germany (in dollars)	0.31	0.57	1.00				
U.K. (in dollars)	0.29	0.40	0.43	1.00			

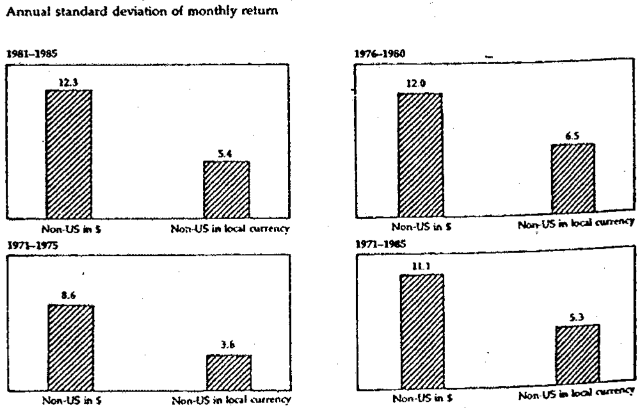
Source: J.P. Morgan Investment

THE SEPARATION OF ASSETS AND CURRENCIES — OPTIMAL PORTFOLIO CONSTRUCTION

Mathematically, the return on a multi-currency

FIGURE 3

CURRENCY RISK ASSOCIATED WITH INTERNATIONAL FIXED-INCOME INVESTMENT



Source: J.P. Morgan Investment

bond portfolio is the product of the returns from two separate portfolios — the local asset portfolio and a currency portfolio. (See Appendix I.) An investor seeking to maximize total return and minimize risk in the investor's home currency must maximize the sum of the returns from the local asset portfolio and the currency portfolio while minimizing the sum of their risks. The analytical solution to this optimization problem is readily identified through quadratic optimization techniques.

In practice, the solution involves partitioning the economic outlook into the outlook for local asset returns and for currency returns. The identification of local risks, currency risks, and forward premiums, and estimation of interdependencies of currencies and assets are also important inputs. Table 2 gives an example of such forecasts for local bond market returns, currency returns, and risks in the case of the four bond markets — U.S., Japan, Germany, and the U.K. Not shown are the relevant forward premiums and expected covariance matrix. These numbers normally would reflect investment management expectations and not past or historical results.

These inputs permit us to develop optimal portfolios through the use of quadratic optimization techniques. (See Appendix II.) The resulting optimal portfolios are characterized by an optimal asset exposure and a uniquely associated optimal currency exposure. Where these exposures are different for a given market, a currency hedge is required to alter the currency exposure from that of the local asset exposure. The term "hedge" in this context is misleading, in the sense that the hedge is used to *alter* the exposure from one currency to another and does not necessarily imply hedging foreign currency back into base currency.

TABLE 2

Portfolio Construction — An Illustration

Bond Market	Expected Local Return	Standard Deviation
U.S.	9.3	9.2
Japan	9.2	6.5
Germany	10.0	7.0
U.K.	11.9	10.8
Currency	**Expected Appreciation Vs. Dollar**	
Yen	8.4	15.7
Deutschmark	9.0	11.8
Sterling	5.2	16.9

Source: J.P. Morgan Investment

Table 3 gives an illustration of this optimal procedure using as input the expectations from Table 2. A range of optimal portfolios for differing levels of risk are shown. For example, at higher levels of risk, Portfolio No. 5 is optimal, and the analysis suggests a 100% exposure to the German bond market but only a 12% exposure to the DM, thus implying hedging 88% of the DM exposure into the other currencies including the U.S. dollar.

These six portfolios represent the maximum dollar expected return for each level of risk in U.S. dollars. The actual level of risk chosen is a function of the investor's risk preferences and total return objectives.

In order to highlight the importance of the separation of assets and currencies in this optimization process, we can contrast these portfolios with portfolios built on the basis of an investment process that simply adds together local asset and currency return into one composite measure of attractiveness, without hedging of currency positions.

The results of these two contrasting methods of portfolio construction are shown in Figure 4. It graphs the return and risk opportunity set of portfolios ranging from low risk and return on the bottom left to high risk and return in the top right. For any given level of risk, portfolios based on the separation of assets and currency (the higher line) are always expected to return more than portfolios that do not take this separation into account and do not allow for hedging.

This consistent value added to explicit sepa-

TABLE 3

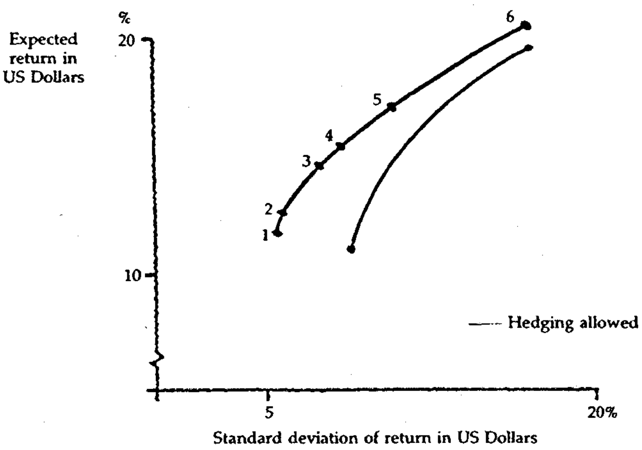
Efficient International Fixed-Income Portfolios

Portfolio No.	Bond Market Exposure %				Currency Exposure %				Expected Return In Dollars	Standard Deviation In Dollars
	U.S.	Japan	Germany	U.K.	Yen	DM	Sterling	Dollar		
1	15	48	28	9	0	0	0	100	11.7	5.5
2	5	43	48	4	0	0	2	98	12.5	5.7
3	0	19	81	0	5	0	11	84	14.5	7.4
4	0	6	94	0	9	2	15	74	15.5	8.6
5	0	0	100	0	15	12	23	50	17.0	15.8
6	0	0	100	0	25	20	55	0	20.5	16.8

Source: J.P. Morgan Investment

FIGURE 4

EFFICIENT INTERNATIONAL FIXED-INCOME PORTFOLIOS



Source: J.P. Morgan Investment

ration of assets and currencies is important. These optimally separated or optimally hedged portfolios will always be expected to outperform portfolios that exclude hedging. This result is independent of the inputs used — expected returns, risks, and covariances — although the amount of the value added from separation will vary according to the inputs.

The critical question remains whether this expected outperformance of the optimally hedged portfolios can be realized in practice. In other words, how much of the expected outperformance is contingent on the ability to forecast currency returns?

The simulation results below will show that international bond portfolios constructed using quadratic optimization techniques and explicitly separating assets and currencies will consistently outperform portfolios that do not allow for this separation. This finding holds even under the most pessimistic assumptions about currency forecasting ability.

HISTORICAL SIMULATION OF OPTIMAL CURRENCY HEDGING TECHNIQUES 1971–1985

In order to test whether the expected excess returns associated with using the optimal hedging techniques of the previous section can in practice be realized, I simulated the use of such techniques in the major international bond markets over the last fifteen years.

I compared two basic types of portfolios: one that held asset and currency exposure equal and constant over the period versus the optimally hedged portfolio that held the *same* asset exposure but allowed the currency exposure to alter according to what the currency forecast optimization technique suggested for currency exposure.

In a simple two-country case where asset exposure is fixed at 50% for each country, the optimal hedge weight is given by:

$$\frac{(FP - E[C])\lambda + COV(DA,C) + COV(FA,C) + VAR(C)}{2\,VAR(C)}$$

where:

- FP = Forward premium;
- E[C] = Forecast currency appreciation;
- λ = Reward/risk ratio;
- DA = Return on domestic asset;
- FA = Return on foreign asset; and
- C = Currency return.

Simulation Methodology

Each quarter the optimally hedged portfolio was constructed using naive estimates of risk and correlation from historical data up to that point and using alternative assumptions with respect to actual currency return forecast. The asset exposure was held constant. The currency forecast was of the general form:

Currency Forecast = Actual Currency Return + Forecast Bias + Random Error.

Forecast bias is a consistent error of forecasting currency return around the actual return. Random error is a random term with mean zero and standard deviation equal to volatility of the forecast.

I derived the optimally hedged portfolio for each quarter on the basis of those purely historical inputs and then calculated its return. The return was then compared to that of a portfolio that held the same asset mix and a currency exposure equal to asset exposure — that is, no hedging was allowed.

Simulation Results

The results over the period 1971–1985 for the U.S., Japanese, German, and U.K. bond markets are portrayed in Figure 5.

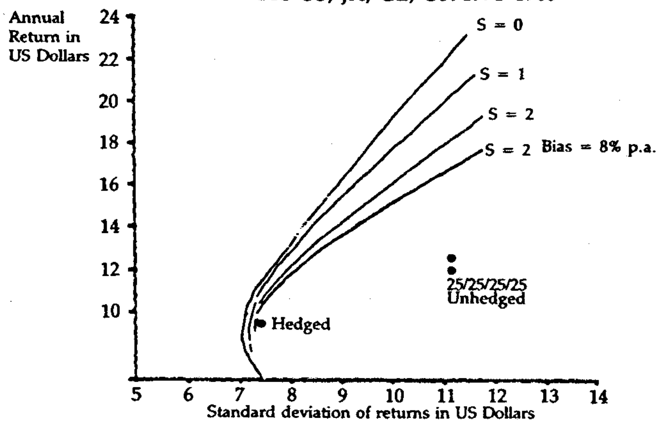
An unhedged balanced portfolio consisting of 25% in dollar, yen, deutschmark, and sterling assets had a return in dollars of 12.2% a year and an annual standard deviation of 11.1%. A continuously and fully hedged portfolio had an annual return of 9.8% and standard deviation of 7.3%. These two portfolios represent the extremes of never hedging and always hedging.

In contrast, various actively hedged portfolios consistently outperformed these reference portfolios, in terms of both return and risk. The points along each line in Figure 5 represent a different reward-to-risk ratio used in the optimization technique, with each line corresponding to a different assumption as to currency forecasting ability.

The line S = 0 represents the performance of

FIGURE 5

SIMULATED OPTIMAL HEDGING STRATEGIES
BOND MARKETS US, JA, GE, UK 1971–1985



Source: J.P. Morgan Investment

the optimally hedged portfolios, assuming no bias in currency forecasting and perfect forecasting ability. This portfolio outperformed the passively unhedged portfolio by 12% a year with the same level of risk. S is the variance of the forecast error.

The lines S = 1 and S = 2 represent the results of an optimally hedged portfolio, assuming no forecasting bias but that the variance of currency forecasting error is equal to one times and two times the actual currency volatility over the period. Variance of currency forecasting error equal to actual currency volatility represents a situation of no insight. Error greater than actual volatility can be thought of as representing a distorted situation, by which the forecasting process actually adds error beyond what is inherent in the process. The line S = 2 and bias = 8% per year represent extremely pessimistic assumptions about currency forecasting ability, perhaps unrealistically pessimistic.

No allowance for transaction cost has been made in these simulations. The turnover observed in the portfolio and transaction costs in exchange markets are such that significant excess returns are still likely to remain after adjusting for transaction costs.

CONCLUSIONS

In summary, the results of these historical simulations using naive forecasting methodologies suggest strongly that, by explicitly taking into account the potential differences between local asset return and currency return, and by identifying optimal asset and currency exposure, the resulting portfolio will inevitably outperform portfolios that do not explicitly separate the asset decision from the currency decision.

The intuitive rationale for this outperformance is the simple value added by separating decisions and balancing the currency exposure across countries in relationship to the relative risks of the currencies, especially in the absence of significant currency insights.

In practice, active investment management of assets and currencies will inevitably provide greater value added than these naive forecasting techniques. Therefore, the potential for outperformance from the separation of assets and currencies should be considerably greater than the possibilities suggested here.

APPENDIX I

Optimal Hedging Strategies

Decomposition of Sources of Return

$$PR = \sum_{i=1} (w^i - h^i)\,([(1 + r^i)(1 + c^i)] - 1) + h^i\,(r^i + FP^i)$$

$$= \sum_{i=1} (w^i - h^i)\,(r^i + c^i) + h^i\,(r^i + FP^i)$$

Adding and subtracting $\sum w^i FP^i$

$$= \sum w^i\,(r^i + FP^i) + (w^i - h^i)\,(c^i - FP^i)$$

$$= \sum \text{asset weight}^i\,(r^i + FP^i) + \text{currency weight}^i\,(c^i - FP^i)$$

where:

- PR = Portfolio return
- w = Asset weight
- h = Hedge weight
- r = Local asset return
- c = Currency return
- FP = Forward premium

APPENDIX II

Optimal Hedging Strategies

Multi-currency Portfolio Optimization

$$E\,[PR] = \sum \text{asset weight}^i\,(E\,[r^i] + FP^i) + \text{currency weights}^i\,(E\,[c^i] - FP^i) = \begin{bmatrix} a \\ x \end{bmatrix}' E \begin{bmatrix} R \\ C \end{bmatrix}$$

$$VAR\,[PR] \quad \begin{bmatrix} a \\ x \end{bmatrix}' V \begin{bmatrix} a \\ x \end{bmatrix}$$

$$\text{Min } VAR\,[PR] \text{ S.T. } E\,[PR] = u,\ \begin{bmatrix} a \\ x \end{bmatrix}' \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} = 1\,1$$

$$\text{Solution} \quad \begin{matrix} a^* \\ x^* \end{matrix} = \begin{bmatrix} u\,1\,1 \end{bmatrix} \left[E\begin{bmatrix} R \\ C \end{bmatrix}' V^{-1} E\begin{bmatrix} R \\ C \end{bmatrix} \right]^{-1} E\begin{bmatrix} R \\ C \end{bmatrix}' V^{-1}$$

where:

- E = Expected value operator
- a = Vector of asset weights
- x = Vector of currency weights
- R = Vector of local asset returns plus forward premiums
- C = Vector of currency returns minus forward premiums
- V = Variance covariance matrix
- u = Vector of constants