OPTIMAL CURRENCY HEDGING STRATEGIES

Adrian F. Lee
Vice President,
J.P. Morgan Investment Management Inc.
London, England

INTRODUCTION AND OVERVIEW

This chapter discusses the strategies available to investors in international fixed income markets. Specifically, we concentrate on one important aspect of the management of multicurrency portfolios: the separation of the portfolio building process into (1) the optimal construction of an 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. We show 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.

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

We then describe how the optimal portfolio structure for a multicurrency portfolio is defined by an optimal asset weight and an optimal currency exposure—when they 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 premia and all related variances and covariances.

We then investigate whether or not it is necessary to have any currency forecasting insight in order for the separation of asset and currency decisions to provide any value added to the active management of assets. In other words, if exchange rates cannot be forecasted, does it make any sense to consider currency exposure and risk management separately from the asset decision?

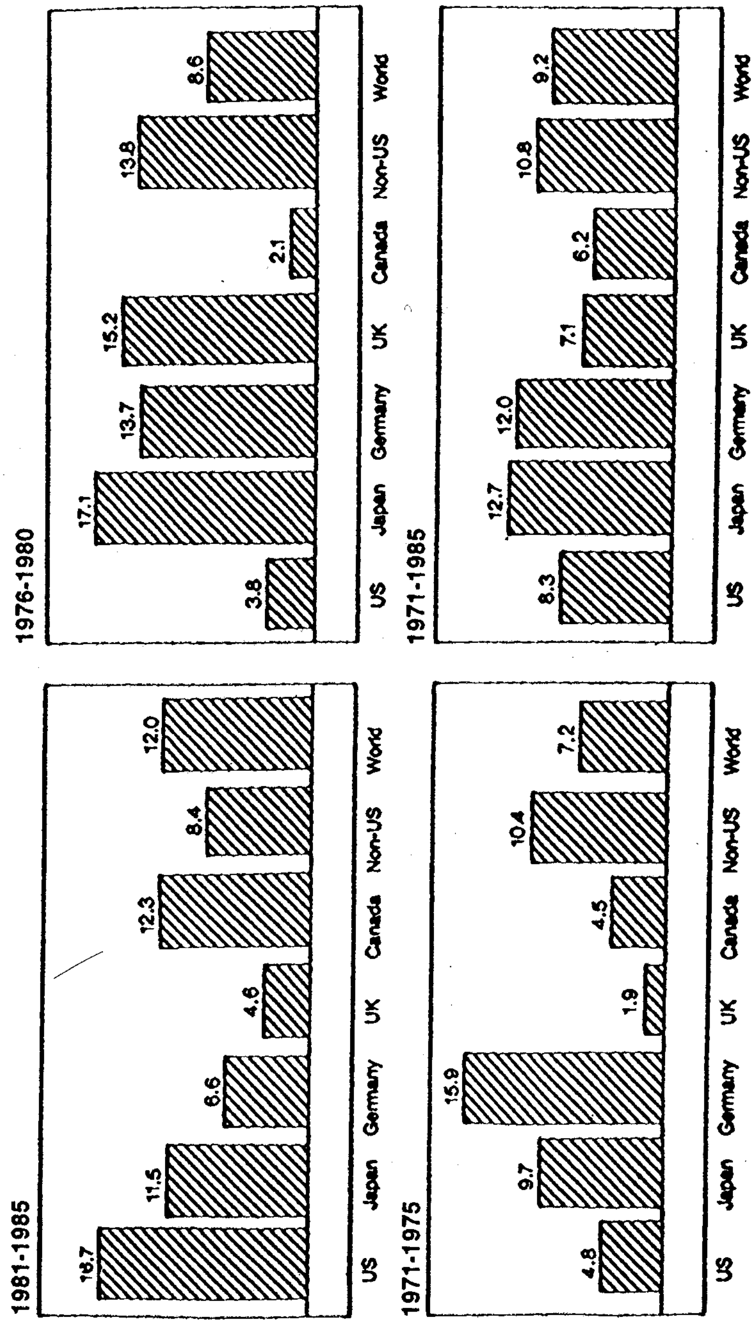
Through simulation of the historical use of such optimal portfolio building techniques over the period 1971-85, it is shown that this separation provides considerable value added and that this result is independent of the level of currency forecasting ability. The important implication of this analysis is that if multicurrency portfolios are managed according to this separation approach, then they will inevitably outperform portfolios not invested in this way. Index portfolios are the most obvious example of portfolios whose asset and currency exposure are always equal.

HISTORICAL RETURNS AND RISKS OF INTERNATIONAL BOND MARKETS

Reviewing the performance of international bonds of the major economies over the last fifteen years (see Figure 1), we note that different markets have offered sizeably different opportunities for return. In each case we used 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. This differential between one market and another can be viewed as an opportunity for an investor to invest outside his home market and earn a better return. Alternatively, if the differential is negative, then this

FIGURE 1 RETURNS FROM INTERNATIONAL FIXED INCOME MARKETS 1971-1985

Percent annual return in dollars



Source: J. P. Morgan Investment and Salomon Brothers Inc condition should be viewed as a risk. For example, a U.S. bond investor investing outside his home market in proportion to the market capitalization of non-US markets over the period 1981–1985 would have lost return compared to what he would have achieved in his domestic market. However, a similar strategy over the previous five years, 1976–1980, would have paid off handsomely.

Over the total fifteen-year period a U.S. investor would have earned 10.8 percent p.a. from a market capitalization weighted portfolio of non-U.S. bonds compared to 8.3 percent from simply investing in the U.S. bond market alone.

These differentials in return to international investment are more appropriately viewed 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, over the period 1981–1985 the poor performance of the foreign markets from a U.S. perspective, noted above, can be traced to moderate underperformance of the local markets coupled with weakness of the associated foreign currencies. It can also be seen that the outperformance of the foreign markets in the period 1976–1980 was due to local outperformance and strong foreign currencies.

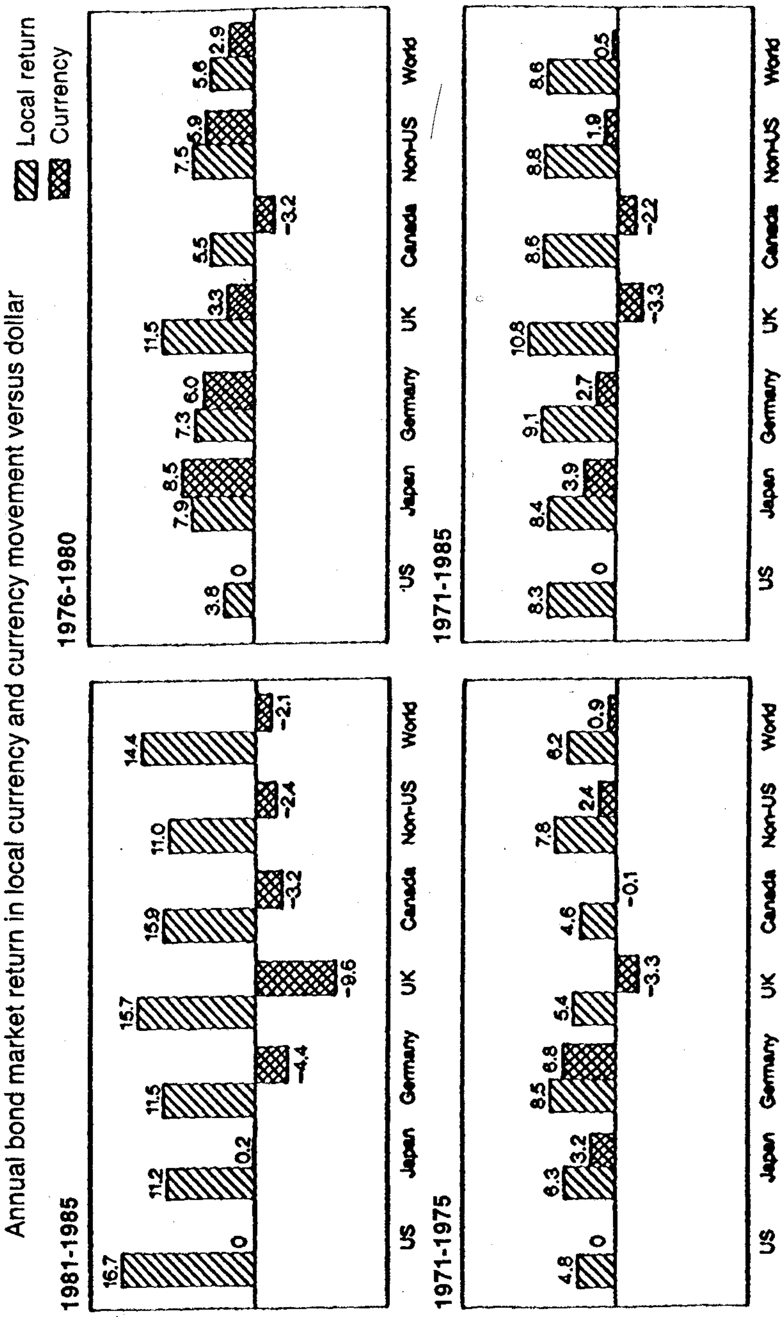
Figure 2 clearly indicates that currencies are a significant source of return in international bond portfolios and that they can add to or detract from return even over periods as long as five years. Also, currency return appears to be rather independent of local market return.

In other words, currencies do not appear to move together in any systematic way, nor is a strong currency uniquely associated with a strong bond market. 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 (see Figure 3).

The correlations of a local bond return and its own currency (versus the dollar in this case), 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 Ger-

FIGURE 2 RETURNS FROM INTERNATIONAL FIXED INCOME MARKETS: 1971–1985

Annual bond market return in local currency and currency movement versus dollar



Source: J. P. Morgan Investment and Salomon Brothers Inc

FIGURE 3 CORRELATIONS OF RETURNS FROM LOCAL BOND MARKETS AND CURRENCY 1971–1985

U.S.	1						
Japan	.20	1					
Germany	.37	.37	1				
U.K.	.23	.19	.21	1			
Yen	.13	[.34]	.15	.14	1		
DM	.11	.23	[.25]	.01	.54	1	
Sterling	.16	.14	.20	[.25]	.46	.54	1

Source: J. P. Morgan Investment

many and the United Kingdom are 0.25 and 0.25 in their respective currencies. Therefore, the bond investment and the underlying exposure to that currency clearly cannot be viewed as one and the same investment.

While currency movements have been a rather uncertain source of return over the last fifteen years (they can be positive or negative), they have been a constant source of risk. This constant risk can be observed in Figure 4 by comparing the risk (standard deviation of return) of a diversified portfolio of all non-U.S. bonds and 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.

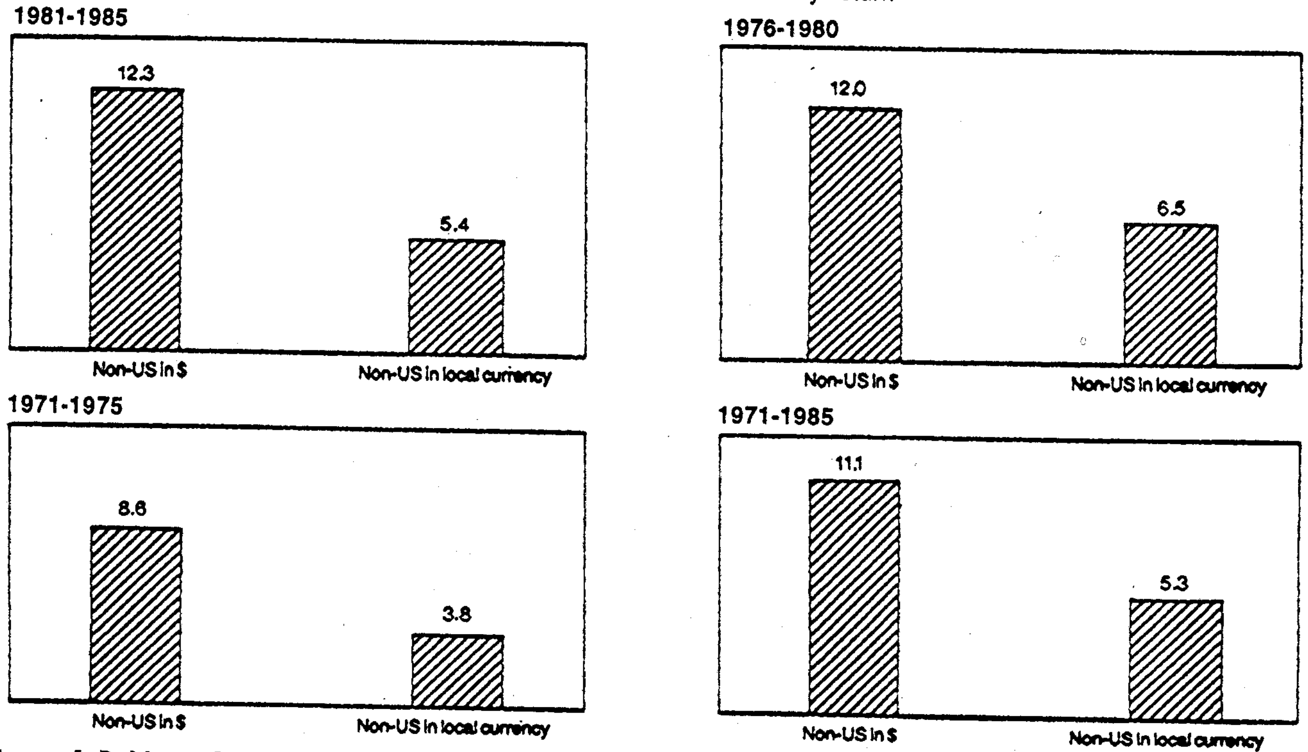
In summary, a review of the returns and risks of international bond investment over the last fifteen years indicates that (1) local market and currency returns (the two key variables affecting returns) are separate sources of return and (2) currencies, while not a systematic source of return, are a systematic source of risk in international bond portfolios.

These observations have two significant implications for the management of international bond portfolios on an ongoing basis:

1) Currency risk should be managed rather than simply ignored or assumed.

FIGURE 4 CURRENCY RISK ASSOCIATED WITH INTERNATIONAL FIXED INCOME INVESTMENT

Annual standard deviation of monthly return



Source: J. P. Morgan Investment

2) The management of an international bond portfolio should be based on the separation of the process into the management of local bond market exposure and currency exposure.

THE SEPARATION OF ASSETS AND CURRENCIES—OPTIMAL PORTFOLIO CONSTRUCTION

Mathematically, the return on a multicurrency bond portfolio is the product of the returns from two separate portfolios—the local asset portfolio and a currency portfolio. An investor seeking to maximize total return on his own currency and minimize risk in his own 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 to this problem involves the separation of the economic outlook into the outlook for local asset returns, interest rates and currency returns. The identification of local risks, currency risks and the estimation of interdependencies of currencies and assets are important inputs. Figure 5 provides an example of such forecasts for local bond market returns, currency returns and risks in the case of the bond markets in the United States, Japan, Germany and the United Kingdom. These numbers would normally reflect investment management expectations and not past or historical results.

From these inputs optimal portfolios can be identified using quadratic optimization techniques. 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, then a currency hedge is required to alter the currency exposure from that of the local asset exposure. The term "hedge" is a little misleading in this context, 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. Figure 6 illustrates this optimal procedure using as

FIGURE 5 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
Deutschemark	9.0	11.8
Sterling	5.2	16.9

input the expectations from Figure 5. 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 suggests a 100 percent exposure to the German bond market, but only a 12 percent exposure to the DM, implying hedging 88 percent of the DM exposure into the other currencies, including the U.S. dollar.

These six portfolios represent the maximum expected dollar 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 whole optimization process, these portfolios can be contrasted 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. In other words, portfolios constructed in a way that does not allow for hedging of currency positions.

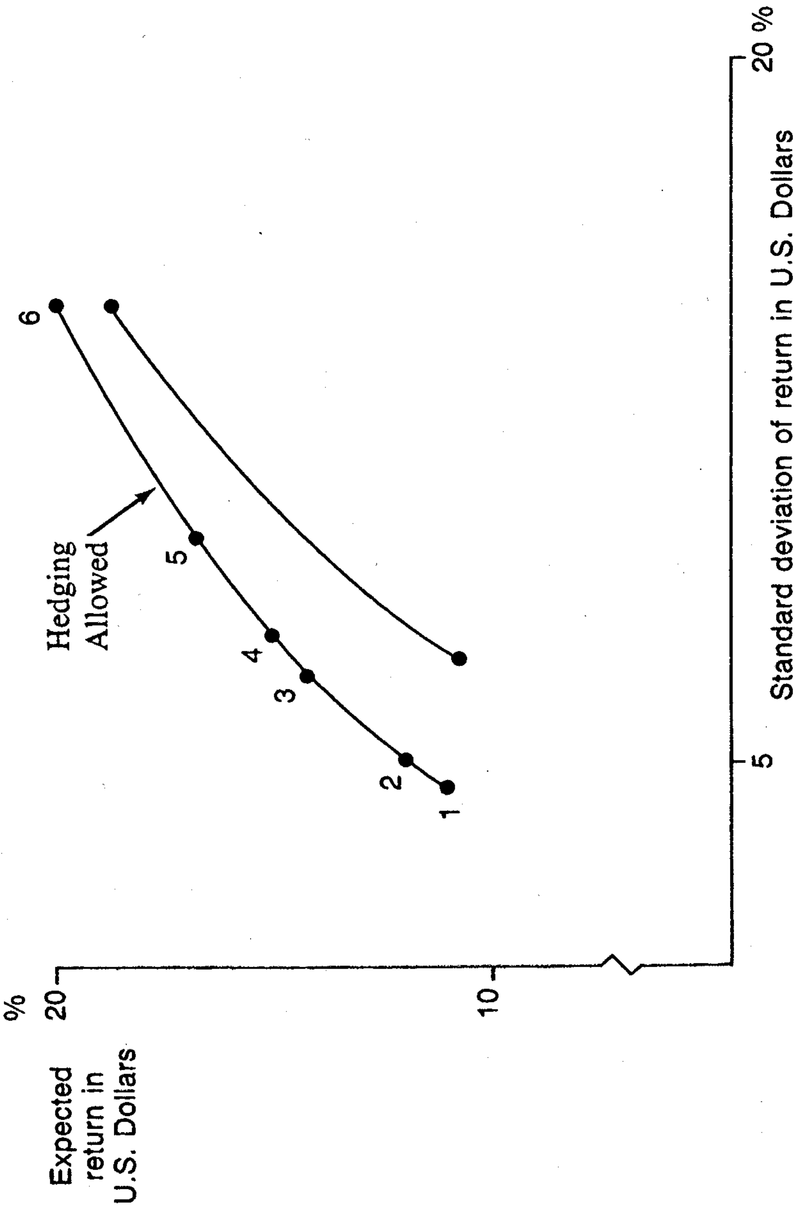
Figure 7 details the results of these two contrasting methods of portfolio construction, charting the return and risk opportunity set of portfolios ranging from low risk and return on the bottom left

FIGURE 6 EFFICIENT INTERNATIONAL FIXED INCOME PORTFOLIOS

Portfolio No.	Bond Market Exposure %				Currency Exposure %				Expected Return in dollars	Standard Deviation in dollars
	US	Japan	Germany	UK	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 7 EFFICIENT INTERNATIONAL FIXED INCOME PORTFOLIOS



Source: J. P. Morgan Investment

to high risk and return on the top right. Obviously, for any given level of risk, portfolios based on the separation of assets and currency (the higher line) always are expected to return more than portfolios not taking this separation into account and not allowing for hedging.

This consistent value added to explicit separation of assets and currencies is important. These optimally separated—or optimally hedged—portfolios will always be expected to outperform portfolios that do not allow hedging. This result is independent of the inputs used, i.e., expected returns, risks and covariances, although the value added from separation will vary according to the inputs.

The critical question remains whether or not 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 in the next section will show that even under the most pessimistic assumptions about currency forecasting ability, international bond portfolios constructed emphasizing quadratic optimization techniques and explicity separating assets and currencies will consistently outperform portfolios not allowing for this separation, i.e., portfolios that constantly assume equal asset and currency exposures.

HISTORICAL SIMULATION OF OPTIMAL CURRENCY HEDGING TECHNIQUES 1971–1985

In order to test whether or not the expected excess returns associated with using the optimal hedging techniques of the previous section can be realized in practice, we simulated the use of such techniques in the major international bonds markets over the last fifteen years. We compared two basic types of portfolios: one that held asset and currency exposure equal versus the optimally hedged portfolio that held the same asset exposure, but allowed the currency exposure to alter according to what the optimization techniques suggested for currency exposure.

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

$$\text{Currency Forecast} = \text{Actual Currency Return} + \text{Forecast Bias} + \text{Random Error}$$

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

Each quarter the optimally hedged portfolio was derived on the basis of those purely historical inputs and the return calculated. The return was then compared to that of a portfolio that held the same asset mix and a currency exposure equal to asset exposure, i.e., no hedging was allowed.

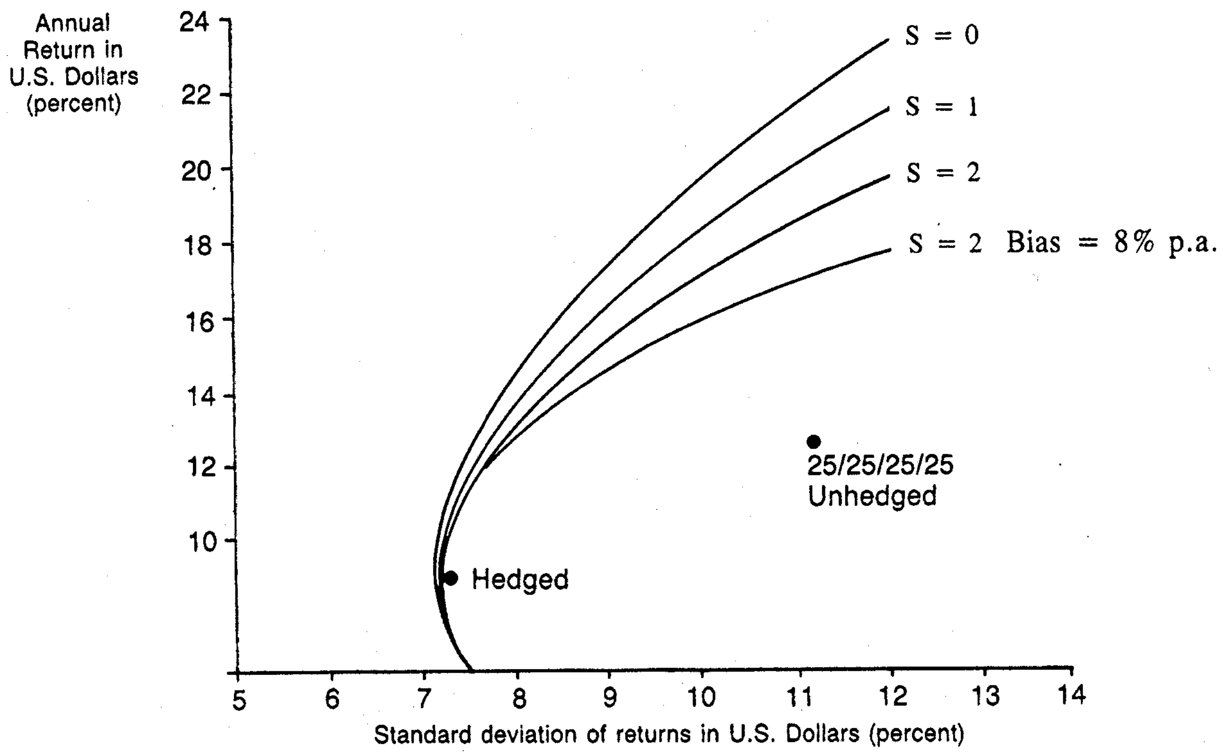
The results over the period 1971–1985 for the U.S., Japanese, German and U.K. bond markets are portrayed in Figure 8. An unhedged balanced portfolio consisting of 25 percent in dollar, yen, deutschmark and sterling assets had a return of 12.2 percent per annum (p.a.) and an annual standard deviation of 11.1 percent p.a. On the other hand, a continuously, fully hedged portfolio had a return of 9.8 percent p.a. and a standard deviation of 7.3 percent p.a.

In contrast, various optimally hedged portfolios at alternative levels of risk and under differing assumptions, as represented by the four lines on Figure 8, consistently outperformed the unhedged portfolio and the continuously hedged portfolio, both in terms of return and risk.

The line S = 0 represents the performance of the optimally hedged portfolio at various levels of risk, assuming no bias in currency forecasting and no error, i.e., perfect forecasting ability. This portfolio outperformed the passively unhedged portfolio by 12 percent p.a. with the same level of risk.

The lines S = 1 and S = 2 represent the results of an optimally

FIGURE 8 SIMULATED OPTIMAL HEDGING STRATEGIES
US, JA, GE, UK BOND MARKETS 1971-1985



Source: J. P. Morgan Investment

hedged portfolio, assuming no forecasting bias but that the currency forecasting error is equal to one time and two times the actual currency volatility. Currency forecasting error equal to currency volatility represents a situation of no insight. Error greater than actual volatility represents a distorted situation by which the forecasting process actually adds error beyond that which is inherent risk in the system. The line S = 2 and bias = 8 percent p.a. represents extremely pessimistic assumptions about currency forecasting ability, possibly even unrealistically pessimistic.

Under all these sets of assumptions the optimally hedged portfolio outperforms the others in terms of return and risk. Under the most pessimistic case this outperformance is of the order of 4 percent p.a.

No allowance for transaction costs 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 adjustment for transaction costs.

In summary, the results of these historical simulations using naive forecasting methodologies strongly suggest 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 portfolios 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 to (1) separating decisions and (2) balancing the currency exposure across countries in relationship to the relative risks of the currencies. The risks and interdependencies of the currencies amongst themselves have been *relatively* stable historically, so that optimization using historical values as inputs provides value added.

In practice, it is reasonable to assume that active investment management of assets and currencies must inevitably provide greater value added than the naive forecasting techniques used above; therefore, the potential for outperformance should be considerably greater than shown.