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GLOBAL FIXED INCOME PORTFOLIO MANAGEMENT

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Abstract

Global income investing has become very popular over the last decade as investors worldwide sought more favorable risk-return tradeoffs by combining international positions with domestic alternatives. Global investing involves fixed income, equity, and derivative securities. This study focuses on the first aspect, fixed income. The performance of global fixed income investing is a function of the investor's home currency, the asset allocation chosen, and the degree to which currency risks are controlled through hedging or diversification. It is the authors' contention that while global fixed income investing is generally an attractive alternative to solely domestic investments, the risk-reward trade offs are often misunderstood because of improper risk and return estimates.

The primary purpose of this paper is to develop a model that properly specifies risks and returns, so that the global investor may make properly informed asset allocation/hedging decisions. The model's main advantage is that it contains a complete specification of each asset's risk and return, broken down into principal component parts, such as currency exposure and local return volatility. Current market data are used in favor of historical inputs whenever possible, and additional sources of ex ante data are discussed. Empirical results are generated using June 1992 and January 1996 as contrasting investment periods. The model results are useful in explaining observed investor behavior. Most of the solutions may be easily rationalized in terms of their expected returns and contribution towards reducing risk, including some of the subtle covariance relationships.

INTRODUCTION

Global investing has become very popular over the last decade as investors worldwide sought more favorable risk-return tradeoffs by combining international positions with domestic alternatives. Numerous studies examining the potential benefits of international diversification support this behavior; for example Levy and Lerman (1988), Chollerton, *et.al.* (1986), Perold and Schulman (1988), and Hogan, Greenleaf, and Kish (1995). Such global strategies target higher expected returns, but often include more volatility caused by currency risk exposure.

The performance of global fixed income investing, the focus of this paper, has been mixed and is very dependent on the investor's home currency, the asset allocation chosen, and the degree to which currency risks are controlled through hedging or diversification. It is our contention that while global fixed income investing is generally an attractive alternative to solely domestic investments, the risk-reward trade offs are often misunderstood because of improper risk and return estimates. This misspecification often results from relying solely on historical returns, which may not fully reflect future market conditions, to arrive at estimates of future returns and risks. A related problem is that tests of global investment performance typically use historical parameter estimates to derive the portfolios whose performance is measured against the same history. This methodology causes a bias which can overstate the rewards to be gained from global investing.

The primary purpose of this paper is to develop a model that properly specifies risks and returns, so that the global investor may make properly informed asset allocation/hedging decisions. The model's main advantage is that it contains a complete specification of each asset's risk and return, broken down into principal component parts, such as currency exposure and local return volatility. Current market data are used in favor of historical inputs whenever possible, and additional sources of ex ante data are discussed.

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The model results are also useful in explaining observed investor behavior. Most of the solutions may be easily rationalized in terms of their expected returns and contribution towards reducing risk, including some of the subtle covariance relationships. Also, most of the solutions are consistent with decision rules popular among real world investors. Using these model results, it is possible to infer some general macroeconomic implications. For example, the results suggest a “term structure parity” relationship whereby the co-existence of distinctly different term structures in different countries creates investment opportunities that might cause their shapes to move closer to one another.

DATA AND METHODOLOGY

Background

In order to provide for consistent instruments and pricing, the analysis only considers instruments traded on the Interbank market. These include short-term deposits and borrowings, short-term forward currency contracts (long and short), and long-term five year deposits, which are used as surrogates for zero coupon bonds.[1] Four major currencies are considered: the U.S. Dollar ($), the British Pound (£), the German Deutsche Mark (DM), and the Japanese Yen (¥). The analysis considers positions in all of the currencies and from the perspe ctive of each being treated as the home or numeraire currency from two contrasting time periods (June 1992 and January 1996). The data include spot exchange rates and interest rates for one month and five year deposits. Monthly observations for two 10-year sample period (June, 1982 through May, 1992 and January 1986 through December 1995) were obtained from Ibbotson Associates Data Files and used to formulate variability and correlation estimates. The June, 1992 and January, 1996 reference points serve as the basis for defining current market conditions for the volatile and stable sample periods respectively. Any statistical inputs are derived using the appropriate 10 year sample period. The following assumptions are used throughout this research:

Interest rate parity (IRP) is assumed to hold, so that short-term interest rates are linked to the corresponding spot and forward exchange rates.[2]

Bid-ask spreads are ignored, so that the borrowing and lending rates are equal and currency transactions are frictionless.

Exchange rate expectations play a pivotal role in specifying the expected return for positions denominated in foreign currencies. The assumptions used in specifying these expectations are explained in the discussion of foreign deposit returns.

Return Formulations

Domestic deposits are defined as short-term Eurocurrency deposits, with maturities matching the one-month investment horizon used in the empirical analysis. These deposits are made in the home currency and represent the risk free asset, whose return, R_D, is equal to the domestic deposit rate, i. The home currency return on a foreign deposit, $\tilde{R}(D_x)$ is based on the known deposit rate in the foreign currency and the uncertain change in the exchange rate over the investment horizon. This return relationship is shown in equation 1, where i_x is the deposit rate in currency x, S_{x0} is the current direct spot exchange rate, and $\tilde{S}_x$ is the future direct spot exchange rate prevailing at the end of the investment holding period.[3]

Equation 1

$$(1+\tilde{R}(D_x)) = (1+i_x)\frac{\tilde{S}_x}{S_{x0}}$$

The uncertain element, $\tilde{S}_x$ is defined in terms of its expected value, ES_x, and a random term, $\tilde{d}_{Sx}$.

Equation 2

$$\tilde{S}_x = ES_x + \tilde{d}_{Sx}$$

Determining the expected values of future exchange rates is an important issue that will significantly impact the model inputs and the corresponding results. This issue has been studied extensively and two competing theories have emerged: (1) the forward expectations, or simple efficiency hypothesis, posits that the forward rate is an unbiased estimator of the future spot rate, and (2) the random walk hypothesis which argues that the current spot rate is the best predictor of the future spot rate.[4]

Because finding the most efficient exchange rate forecasting method is beyond the scope of this paper, our analysis addresses the expectations issue by allowing for the expectation to be a linear combination of the current spot and the current forward rate, F_{x0}.

Equation 3

$$ES_X = \alpha S_{X0} + (1-\alpha)F_{X0}$$

The forward expectations and random walk hypothesis theories then hold as special cases of this formulation; if α = 0, then forward expectations holds, whereas a value of α = 1 corresponds to a random walk. The portfolio manager may chose at each investment period which forecast or combination of forecasts he/she believes to be appropriate for that investment horizon.[5] For example, given a shorter investment horizon it may be more appropriate to chose the random walk or a combination which favors the random walk. For a longer investment horizon, say one year, the forward expectations or combination favoring forward expectations may be more appropriate. With this in mind, a conservative approach using a value of α = .5 is also shown in the empirical analysis as a compromise between the two competing hypotheses.

Substituting equations 2 and 3 into equation 1, the home currency return on a foreign deposit is given by:

Equation 4

$$(1+\tilde{R}(D_x)) = (1+i_x)\frac{\alpha S_{x0} + (1-\alpha)F_{x0} + \tilde{d}_{Sx}}{S_{x0}}$$

Under the IRP assumption, the term F_{x0}/S_{x0} may be represented by $(1+i)/(1+i_x)$. Moreover, $\tilde{d}_{Sx}$ is defined as $(1+i_x)(\tilde{d}_{Sx}\, S_{x0})$, so that the return on foreign deposits is approximated as:[6]

Equation 5

$$\tilde{R}(D_x) = i_x + (1-\alpha)(i-i_x) + \tilde{\varepsilon}_{Sx}$$

Taking the expected value of equation 5 leaves:

Equation 6

$$E(\tilde{R}(D_x)) = i_x + (1-\alpha)(i-i_x)$$

Rearranging terms we have:

Equation 6A

$$E(\tilde{R}(D_x)) = i + \alpha(i_x - i)$$

Using equations 5 and 6, the standard deviation of home currency deposit returns is:

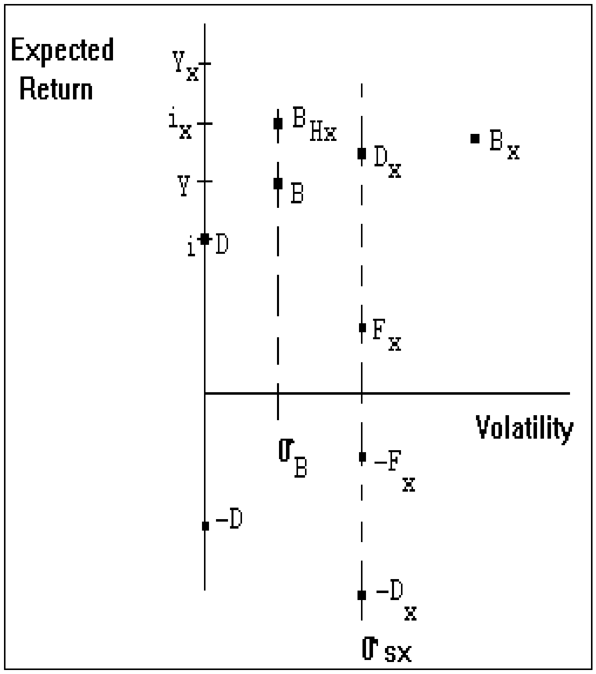
Equation 7

$$\sigma_{Dx} = \sigma_{Sx}$$

The expected return formulation in equation 6A implies that for $\alpha>0$, the expected return will be equal to the domestic deposit rate, i, plus some fraction of the interest rate differential. Thus for $\alpha>0$, foreign currencies with higher deposit rates provide an excess return above the riskless domestic deposit rate.

These relationships are also illustrated in Figure 1, where D and D_x denote the location of the domestic and foreign deposits respectively. Note that the expected return falls between the corresponding domestic (i) and foreign deposit (i_x) rates. This result corresponds to the expected exchange rate parameter, α, being between zero and one. The closer your forecast is to a random walk, the higher the expected return in this situation. The volatility of return for a foreign deposit, σ_{Dx}, is not affected by the parameter α and is the same as the exchange rate volatility, σ_{Sx}.

FIGURE 1
Investment Positions



Exchange rate volatility (σ_{Sx}) is defined here as the standard deviation of the exchange rate forecast error, based on deviations of the spot exchange rate from its expected value. Most studies use the volatility of the historical change in the exchange rate for this parameter; however, on an expectational basis the investor is only concerned with how accurate the investor's forecast is. Expected exchange rate volatility and the volatility of the historical change in the exchange rate will coincide only when the investor is assuming a random walk when predicting the future spot exchange rate (α=1). If the random walk is not used the volatilities will be slightly different, but over a short investment horizon the model solutions should not be significantly different from each other.

The stated assumptions imply that borrowing in any currency is an exact opposite position from lending in that currency. This is reflected in the notation where the borrowing variables are the same as lending, except for a sign change. Also, as seen in Figure 1, their return formulations differ only in sign except for the standard deviations which are positive by definition. Long and short forward contracts may be used to hedge, to speculate, and to create synthetic positions. Their returns are derived from the returns associated with domestic and foreign deposits. Under the IRP and frictionless market assumptions, a foreign deposit hedged by a short forward currency contract provides a riskless rate of return equal to the domestic deposit rate. In equation form this would be:

Equation 8

$$D = D_x - F_x$$

where F_x is the forward contract. This equation may be rearranged to solve for long or short forwards ($\pm F_x$), domestic lending or borrowing ($\pm D$), and foreign lending or borrowing ($\pm D_x$).

For example, equation 9 expresses the short forward position, $-F_x$, as being equivalent to the combination of domestic lending, D, and foreign borrowing, $-D_x$. As such, the return associated with short forwards is the same as the combined returns of domestic lending and foreign borrowing. Later in the analysis this relationship will play an important role in deriving the return of hedged positions that employ short forward positions; for example, see the discussion of hedged foreign bonds. Based on this equivalence the short forward return, expected return, and volatility of return are defined in equations 10 through 12.

Equation 9

$$-F_x = D - D_x$$

Equation 10

$$\tilde{R}(-F_x) = \alpha(i - i_x) + \varepsilon_{Sx}$$

Equation 11

$$E(\tilde{R}(-F_x)) = \alpha(i - i_x)$$

Equation 12

$$\sigma_{Fx} = \sigma_{Sx}$$

The positions of long and short forward contracts can be seen by F_x and $-F_x$ on Figure 1. Notice the forward contracts will involve the same level of volatility associated with foreign deposits and borrowing positions.

Domestic and foreign zero coupon bond positions are approximated by long-term (five-year) deposits traded on the Interbank market.[7] The return on a domestic long-term deposit is the yield, Y, plus a stochastic term reflecting the sensitivity to changes in yield. This is shown in equation 13, where Y denotes the yield, M is the modified duration which is equal to the maturity of the deposit, and $\tilde{\varepsilon}_Y$ is decimal change in yield.[8] The corresponding expected return and volatility of return formulations follow as equations 14 and 15.

Equation 13

$$\tilde{R}(B) = Y - MY\tilde{\varepsilon}_Y$$

Equation 14

$$E(\tilde{R}(B)) = Y$$

Equation 15

$$\sigma_B = MY\sigma_Y$$

Foreign bond returns have two elements of uncertainty: local bond risk which contains the volatility of bond prices within their own currency and currency risk. Equation 16 is the foreign equivalent to equation 5, the domestic return formulation, except that the foreign bond yield is denoted as Y_x and that the sensitivity term from equation 13 has been included.

Equation 16

$$\tilde{R}(B_x) = Y_x - M_x Y_x \tilde{\varepsilon}_{Yx} + (1-\alpha)(i - i_x) + \tilde{\varepsilon}_{Sx}$$

The expectation of equation 16 can be written as:

Equation 17

$$E(\tilde{R}(B_x)) = Y_x + (1-\alpha)(i - i_x)$$

And the volatility associated with foreign bonds is defined as equation 18.

Equation 18

$$\sigma_{Bx} = [(M_x Y_x \sigma_{Yx})^2 + \sigma^2_{Sx} - 2M_x Y_x \sigma_{Sx}\sigma_{Yx}\rho_{YS}]^{1/2}$$

The first two terms pertain to the foreign bond's local risk and the exchange rate risks, respectively. The last term addresses the interaction between these risks. In theory this last term should be negative, since the correlation coefficient, D_{YS}, should be positive, reflecting the usual inverse relationship between yields and the strength of a currency. Overall, the risk of a foreign bond's return is dominated by the foreign exchange risk.[9] The position of foreign bonds is denoted by the point B_x on Figure 1, and corresponds to a modestly positive coefficient of correlation. It is important to note how much farther to the right on the volatility scale the foreign bond is in relation to the domestic bond, B, a result consistent with the above discussion on volatility.

A foreign bond's currency exposure may be eliminated by selling that currency forward over the investment horizon. Since the exchange rate risk is removed by the hedge position, the returns are independent of the exchange rate expectations and their outcomes. However, the hedged bond return still contains the interest rate risk of the foreign bond market.[10] The return on a hedged foreign bond is equal to the bond's local return plus the difference between the domestic and foreign short-term interest rates (i - i_x). This relationship can be rationalized by noting that the short forward position is equivalent to domestic lending and foreign borrowing (see the discussion on forwards for equation 8). Here the foreign borrowing offsets the currency risk associated with the foreign bonds. Thus, leaving the investor with an expected return equal to the sum of first, the foreign bond return in its local currency devoid of any currency risk, and second the interest rate differential, i - i_x, reflecting the spread between the lending rate, i, and the borrowing rate, i_x.

For example, consider the case of the U.K. investor contemplating the purchase of a U.S. bond currently yielding 7%, while the U.K. and U.S. short-term rate are 4% and 9%, respectively. The expected return over the short-term holding period would be 12%; the 7% bond yield plus the 5% spread in short-term rates. At the same time the risk would be the local (U.S.) bond risk, since the currency risk exposure has be removed via the offsetting effects of being long in U.S. bonds and borrowing dollars.

The return expressions pertaining to the hedged bonds are given in equations 19 through 21.

Equation 19

$$\tilde{R}(B_{Hx}) = Y_x + (i - i_x) - M_{xY_x}\tilde{\varepsilon}_{Yx}$$

Equation 20

$$E(\tilde{R}(B_{Hx})) = Y_x + (i - i_x)$$

Equation 21

$$\sigma_{BHx} = \sigma_{Bx}$$

If the local interest rate volatility of the foreign bond is about equal to the domestic bond volatility and the forward premium is positive, then the return on a hedged foreign bond can be represented by a point such as B_{Hx} on Figure 1.[11]

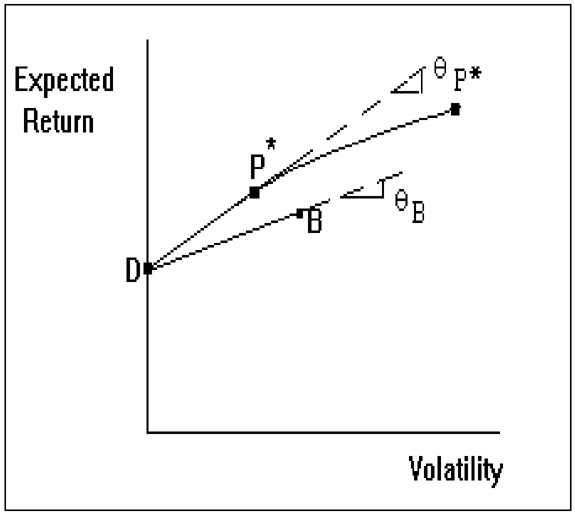
Optimization Methodology

Our overall objective is to identify the efficient set of portfolios that provide the least risk (volatility) for a given level of return. This optimization takes place against a given set of choices (decision variables) and constraints.[12] The models are largely unconstrained except for the non-negativity conditions (a mathematical requirement) and the expected return constraint that is varied to trace out a family of solutions. Other constraints may be added to reflect such restrictions as controlling foreign exchange exposure, or limiting the use of short forward contracts to hedging purposes.

Excluding borrowing, Figure 2 shows the efficiency frontier, which starts at the riskless deposit rate and moves on a linear course through P^*. At P^*, the critical solution, the riskless asset is no longer present and the efficiency frontier becomes concave. If one allows borrowing at a rate equal to the lending rate, then the efficiency frontier must be revised. The revised efficiency frontier will overlay the original frontier set from D through P^*, but will lie on the extension of that line beyond P^* (see the broken line extending through P^* in Figure 2). Being linear throughout, the revised efficiency frontier has a constant E-F trade off over all levels of volatility. Figure 2 also includes the efficient set of domestic alternatives, which involves combinations of domestic short-term borrowing and lending with domestic bonds. These combinations also form a linear efficient set, which starts at D and passes through B, the domestic bond position.

The relative attractiveness of "going global" may be ascertained by comparing the slope of the domestic frontier with that of the revised global set. The steeper the global slope relative to domestic alternatives, the more attractive global investing becomes. These slopes are denoted by θ_{P*} (global) and θ_B (domestic) in Figure 2. It should be noted that the global efficient set must always dominate or, at worst, be equivalent to the set of domestic alternatives. This follows from the fact that global investing allows more choices and does not exclude domestic alternatives. Although the global solution must dominate, the degree of domination plays a major role in determining the foreign allocation in a portfolio.

FIGURE 2
Efficiency Frontiers



EMPIRICAL RESULTS

Model Inputs

The empirical results are generated from two reference dates: June, 1992 (our volatile market perspective) and January 1996 (our stable market perspective). Table 1, Section A shows current market data as it existed for our two reference dates.[13] For example, the deposit and bond yields for Germany in 1992 were 9.81 and 8.69 percent respectively. The estimates pertaining to volatilities (shown in Section B) and correlations (Shown in Section C, D, and E) were obtained using historical data from June, 1982 through May, 1992 and from January 1985 through December 1995 for the 1992 and 1996 scenarios respectively. In each case, these volatilities and correlations are defined relative to the perspective of each currency. For example, the volatility (standard deviation) of the German bond yield and exchange rates were 5.40 and 12.26 percent respectively for 1992. Correlations in 1992 between the German bond returns and its counterparts in the U.S., the U.K., and Japan were 0.30, 0.44, and 0.40 respectively. The volatilities and correlations can be used to generate the covariability between the local bond risk and risk associated with the various currencies. As mentioned previously, the exchange rate volatilities are based on the observed deviations from the expected exchange rate. There are alternative choices in estimating volatility from historical data by using different sample periods or changing the periodicity. Also, one might derive volatility estimates by other means such as using the implied volatilities based on option prices.

Results

The portfolio solutions shown in Table 2 reflect the composition of the critical portfolio from the U.S. perspective as the numeraire. The results are shown from three expectations perspectives: the random walk (α=1), the compromise position (α=0.5), and forward expectations (α=0) for both reference dates. Notice that the desired return in June 1992, a period of high rates relative to the January 1996 rate structure, was 12 percent versus the targeted rate of 8 percent in 1996. As expected, the results show a great deal of global investing during the period of volatile interest and exchange rates (June 1992) and little venturing outside the home markets during the stable period (January 1996). These two contrasting periods help to illustrate that the advantages of global investing is dependent upon the current macro economic environment.

In 1992, the U.S. solution shows large positions in foreign deposits reflecting the relative advantage in going global to pick up the high yields offered in both the U.K. and German markets under both the random walk and compromise assumptions. These results are due to the steep domestic term structure present in the U.S. at the time of the investment (June, 1992) and the relatively high interest rates offered from the relatively flat but inverted curves in both the U.K. and German markets and the assumption that the deposit rate differential is not completely offset by exchange rate expectations.[14] A large position in U.S. bonds along with a modest allocation to Japanese bonds are made, due largely to the big spread over their respective deposit rates. Borrowings within the Japanese market also shows a large exposure that exceeds the value of the bond positions.

Thus the Japanese bonds are "over-hedged". The hedged Japanese bonds provide an expected return equal to the Japanese bond yield plus the U.S./Japan short-term interest rate differential. The short forward yen positions that are in excess of the bond positions have a negative expected return given by " (i-i_x). Thus, their attractiveness must lie in their risk reduction potential. In this case there is a favorable correlation between the returns on U.S. bonds and the short yen forward contracts. Although the allocations are different under the assumptions of the random walk and compromise positions, the rationale is consistent for both.

TABLE 1
Summary Data

A. Current Market Inputs								
	United States		United Kingdom		Germany		Japan	
	'92	'96	'92	'96	'92	'96	'92	'96
Deposits	4.06	5.56	10.13	6.38	9.81	3.63	4.72	0.48
Bond Yield	7.06	5.69	9.50	7.08	8.69	5.08	5.88	2.38
Exch. Rate	N/A	N/A	1.83	1.50	0.62	0.67	0.01	0.01
B. Volatility								
	United States		United Kingdom		Germany		Japan	
Bond Yield	11.19	9.91	10.08	9.70	5.40	5.61	6.17	6.58
Exch. Rate	N/A	N/A	12.19	12.19	12.26	12.26	11.81	12.12
C. Correlations (bond returns)								
US	1.00	1.00	0.32	0.35	0.30	0.34	0.48	0.48
UK	0.32	0.35	1.00	1.00	0.44	0.53	0.33	0.39
Germany	0.30	0.34	0.44	0.53	1.00	1.00	0.40	0.39
Japan	0.48	0.48	0.33	0.39	0.40	0.39	1.00	1.00
D. Correlations (exchange rates)								
US	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UK	0.00	0.00	1.00	1.00	0.77	0.77	0.61	0.58
Germany	0.00	0.00	0.77	0.77	1.00	1.00	0.72	0.66
Japan	0.00	0.00	0.61	0.58	0.72	0.66	1.00	1.00
E. Correlations (exchange rates/bond returns)								
US	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UK	-0.06	-0.04	-0.25	-0.21	-0.05	0.06	-0.23	-0.16
Germany	-0.15	-0.12	-0.10	-0.05	-0.12	0.00	-0.31	-0.21
Japan	-0.03	-0.02	-0.14	-0.15	-0.19	-0.14	-0.42	-0.31

TABLE 2
Results (U.S. Perspective)

E(Return 1992) = 12%; E(Return 1996) = 8%

	α=1		α=0.5		α=0	
	'92	'96	'92	'96	'92	'96
Deposit$	0.13	1.11	0.00	1.21	1.00	1.00
Deposit£	0.41	0.29	0.81	0.58	0.00	0.00
DepositDM	0.78	0.00	1.56	0.00	0.00	0.00
Deposit¥	0.00	0.00	0.00	0.00	0.00	0.00
Borrow$	0.00	0.00	0.74	0.00	0.00	0.00
Borrow£	0.00	0.00	0.00	0.00	0.00	0.00
BorrowDM	0.00	0.20	0.00	0.40	0.00	0.00
Borrow¥	0.85	0.44	1.70	0.87	0.00	0.00
Bonds$	0.42	0.00	0.84	0.00	0.00	0.00
Bonds£	0.00	0.00	0.00	0.00	0.00	0.00
BondsDM	0.00	0.11	0.00	0.22	0.00	0.00
Bonds¥	0.11	0.13	0.23	0.26	0.00	0.00
σ (%)	0.15	0.02	0.60	0.09	0.00	0.00

The 1996 results are a stark contract to the 1992 allocations. Within a flat term structure, there were few opportunities to gain from global investing. The allocations show that the U.S. investor had relatively modest positions in foreign bonds. Sizable positions in both German and Japanese borrowings was undertaken to take advantage of the extremely low interest rate environment that existed. The majority of investing was in deposits in both the home country and abroad in the U.K.

The 1992 U.K. results, shown in Table 3, are dominated by the large positions in home country deposits since this offers the highest desired return. Small positions are also taken in German deposits, borrowings in both the U.S. and Japanese markets, and U.S. and Japanese bonds. Since the U.K. was experiencing relatively high deposit rates, there was little to be gained from going outside the home market other than to use the global borrowings for domestic investing. These results were consistent for both the random walk and the compromise assumptions. Again the results for 1995 show little incentive to venture outside the domestic markets except for borrowing within the German and Japanese markets and small positions in German and Japanese bonds.

The 1992 German solutions, shown in Table 4, are very similar to the U.K. solutions, since both currencies involve high deposit rates and the inverted term structures shown in Table 1. Also, these currencies tend to move together when measured against another currency such as the dollar or yen. As with the U.K. solution, the majority of the investment funds remains in the domestic deposits. Small allocations are made in borrowing both U.S. dollars and Japanese Yen and investing in the U.S. bond market. In 1996, deposits were again the dominant investment. But unlike 1992, a sizable amount of funds went into foreign bonds and a significant amount of funds were borrowed within the Japanese market.

The Japanese solutions for 1992, shown in Table 5, are dominated by deposits in the U.K., Germany, and in the home market. The other significant positions were U.S. borrowing and investing in U.S. Bonds. The results were consistent with both the random walk and compromise expectations. In 1996, the investment allocations were dominated by U.S. and U.K. deposits, domestic and German borrowings, and bond investments from Germany and within the home market.

TABLE 3
Results (U.K. Perspective)

E(Return 1992) = 12%; E(Return 1996) = 8%

	α=1		α=0.5		α=0	
	‘92	‘96	‘92	‘96	‘92	‘96
Deposit$	0.00	0.10	0.00	0.20	0.00	0.00
Deposit£	1.04	1.14	1.09	1.29	1.00	1.00
DepositDM	0.23	0.00	0.46	0.00	0.00	0.00
Deposit¥	0.00	0.00	0.00	0.00	0.00	0.00
Borrow$	0.19	0.00	0.39	0.00	0.00	0.00
Borrow£	0.00	0.00	0.00	0.00	0.00	0.00
BorrowDM	0.00	0.09	0.00	0.20	0.00	0.00
Borrow¥	0.19	0.31	0.40	0.62	0.00	0.00
Bonds$	0.10	0.00	0.21	0.00	0.00	0.00
Bonds£	0.00	0.00	0.00	0.00	0.00	0.00
BondsDM	0.00	0.08	0.00	0.17	0.00	0.00
Bonds¥	0.01	0.08	0.03	0.16	0.00	0.00
σ(%)	0.01	0.02	0.04	0.05	0.00	0.00

TABLE 4
Results (German Perspective)

E(Return 1992) = 12%; E(Return 1996) = 8%

	α=1		α=0.5		α=0	
	‘92	‘96	‘92	‘96	‘92	‘96
Deposit$	0.00	0.19	0.00	0.38	0.00	0.00
Deposit£	0.11	0.54	0.22	1.08	0.00	0.00
DepositDM	1.21	0.68	1.42	0.36	1.00	1.00
Deposit¥	0.00	0.00	0.00	0.00	0.00	0.00
Borrow$	0.22	0.00	0.44	0.00	0.00	0.00
Borrow£	0.00	0.00	0.00	0.00	0.00	0.00
BorrowDM	0.00	0.00	0.00	0.00	0.00	0.00
Borrow¥	0.23	0.78	0.46	1.55	0.00	0.00
Bonds$	0.12	0.00	0.24	0.00	0.00	0.00
Bonds£	0.00	0.00	0.00	0.00	0.00	0.00
BondsDM	0.00	0.16	0.00	0.32	0.00	0.00
Bonds¥	0.01	0.20	0.02	0.41	0.00	0.00
σ(%)	0.01	0.06	0.04	0.26	0.00	0.00

TABLE 5
Results (Japanese Perspective)

E(Return 1992) = 12%; E(Return 1996) = 8%

	α=1		α=0.5		α=0	
	'92	'96	'92	'96	'92	'96
Deposit$	0.00	0.45	0.00	0.89	0.00	0.00
Deposit£	0.31	0.81	0.61	1.61	0.00	0.00
DepositDM	0.80	0.00	1.60	0.00	0.00	0.00
Deposit¥	0.19	0.00	0.00	0.00	1.00	1.00
Borrow$	0.72	0.00	1.43	0.00	0.00	0.00
Borrow£	0.00	0.00	0.00	0.00	0.00	0.00
BorrowDM	0.00	0.54	0.00	1.08	0.00	0.00
Borrow¥	0.00	0.37	0.63	1.73	0.00	0.00
Bonds$	0.42	0.00	0.85	0.00	0.00	0.00
Bonds£	0.00	0.00	0.00	0.00	0.00	0.00
BondsDM	0.00	0.33	0.00	0.66	0.00	0.00
Bonds¥	0.00	0.32	0.00	0.65	0.00	0.00
σ(%)	0.14	0.22	0.54	0.86	0.00	0.00

ANALYSIS OF GENERAL RESULTS

General Results

This section generalizes upon the solution results by identifying market conditions that make certain types of investments attractive within a global setting as reinforced by our two reference dates, June 1992 and January 1996. Deposit rate differentials are important in two regards. First, there is the obvious difference in the deposit rates of return. Second, there are implications to the exchange rate expectations, which affect the return expectations of all foreign investments. By assuming IRP and rejecting the forward expectations hypothesis, deposit rate differentials enter into all of the return expectations. Specifically, if a foreign deposit rate is lower than the domestic rate, then the exchange rate expectation is favorable. Another major consideration is the relative steepness of the domestic and foreign term structures. If the domestic structure is steep, then foreign investment will lose some of its relative attractiveness, since the domestic opportunity set provides a good risk-return trade off. This type of situation dominated the U.S. sample period results in 1992.

If the foreign term structure is steep relative to the domestic structure, then the foreign bond investment may be favored on three counts: 1) the long-term bonds might provide yields that are higher than domestic alternatives, 2) the expected return may be augmented by favorable exchange rate expectations if the foreign deposit rates are lower than the domestic rates, and 3) hedged foreign bonds will provide the local bond yield, plus the difference in deposit rates (i–i_x). Hedging may be quite useful to augment returns and dampen the currency risk. Hedging was used extensively in all of the solutions that involved foreign bonds. In the case of the U.K., German, and Japanese perspectives, hedged U.S. bonds were a major component of their portfolio allocations in 1992. This result may be attributed to the relatively low yield on U.S. deposits and the resultant favorable forward premium. Another influence on the solutions is the volatilities and correlations concerning the various currencies and bonds. All else being equal, foreign investment is supported by favorable correlations. If the correlations are such that risk reduction occurs, then some positions may be selected even though they have negative expected returns and/or high volatility.

Macro Effects

In this section we examine the impact that the decisions associated with these models might have on prices, yields, and international investment flows. In order to examine these issues it is first necessary to restate the solutions, so the aggregate investment allocations are better quantified. The solutions shown in Tables 2 through 5 are restated in Table 6 to reflect the aggregate flow of funds into and out of the four countries. Notice that deposits and bond investments reflect positive flows into the country and borrowings represent negative flows out of the country. Table 6 further generalizes the following: (1) the short forward positions in a foreign currency are substitutes for using domestic deposits and foreign borrowing(see equation 9), (2) any domestic or foreign borrowing are included in the corresponding deposit as a negative entry, and (3) the short-term deposit (borrowing) position with the bond allocations are combined. The column entries correspond to the allocation of 1.00 unit (or 100 percent) of a given currency to the various country investment alternatives that correspond to the rows. For a given currency (column), the total of the allocations must be 1.00. The row entries then represent the investment flowing into a particular country (row) from the various home countries (columns). The row totals for each respective year then portray the aggregate demand for each of the country's investments.

The results from Table 6 may provide some insights into the net investment flows between currencies. In particular, the row totals relate to the aggregate demand for positions denominated in each of the currencies, as each row corresponds to a particular currency. Since the allocations over all currencies must total 400 (the sum of the row and column totals), the relative demand must be bench-marked against a norm of 1.00 for each of our two test periods.

For instance, the row totals for 1992 under the random walk suggest a rather large flow out of Japan representing a -95 percent net position (-0.74 - 0.18 - 0.22 + 0.19), with surpluses flowing into the other three countries. Here pound- and DM-denominated positions are the most popular showing net positions of 187 (i.e. 0.41 + 1.04 + 0.11 + 0.31) and 302 (i.e. 0.78 + 0.23 + 1.21 + 0.80) percent respectively. Dollar positions are fairly neutral at 6 percent (i.e. 0.55 - 0.09 - 0.10 - 0.30). This U.S. result may appear to be inconsistent relative to the popularity of the U.S. bonds in the empirical results. The U.S. bond positions held by foreign investors were almost fully hedged with short positions in dollar forwards which are equivalent to borrowing dollars and making local deposits. Thus the allocations to U.S. bonds are offset by the corresponding borrowing in the dollar. Looking back to Tables 2 through 5, there is a strong demand for U.S. bonds and no demand for U.S. deposits. This would tend to cause bond yields to fall and deposit rates to rise so that the term structure would flatten. A similar result is obtained relative to the yen related deposits and bonds. In regard to the U.K. and the DM there appears to be a strong demand for their short-term deposits and no demand for their bonds. This would make a case for their inverted term structures to flatten and, perhaps, turn positive.

The results in Table 6 also suggest that there is a type of "term structure parity" relationship, whereby if dramatically different structures exist in major currencies as with the 1992 test period, then investment opportunities will open up so as to bring the term structures more into alignment. This is not to suggest any type of arbitrage relationship such as interest rate parity. Instead, these forces are normal responses to favorable risk - return tradeoffs that present themselves.

CONCLUSION

This research has developed a global fixed income portfolio selection model that may be applied to a variety of circumstances. The robust specification of the complex risk and return relationship allows one to obtain the optimal solution to the right problem and to avoid many of the pitfalls that have befallen similar applications. The model may be formulated using some combination of current market input and historical data that are readily available, while the solutions are easily obtained using standard quadratic programming software. The portfolio solutions are consistent with financial theory and practice and many of the results are easy to rationalize in terms of the model inputs.

TABLE 6
Investment Flows

α = 1 (Random Walk)

Investment Flow		U.S. '92	U.S. '96	U.K. '92	U.K. '96	Germany '92	Germany '96	Japan '92	Japan '96
From:	U.S.	0.55	1.11	-0.09	0.10	-0.10	0.19	-0.30	0.45
	U.K.	0.41	0.29	1.04	1.14	0.11	0.54	0.31	0.81
	Germany	0.78	-0.09	0.23	0.01	1.21	0.84	0.80	-0.21
	Japan	-0.74	-0.31	-0.18	0.23	-0.22	-.57	0.19	-0.05
	Total	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

α = 0.5 (Compromise)

Investment Flow		U.S. '92	U.S. '96	U.K. '92	U.K. '96	Germany '92	Germany '96	Japan '92	Japan '96
From:	U.S.	0.10	1.21	-0.18	0.20	-0.20	0.38	-0.58	0.89
	U.K.	0.81	0.58	1.09	1.29	0.22	1.08	0.61	1.61
	Germany	1.56	-0.18	0.46	-0.03	1.42	0.68	1.60	-0.42
	Japan	-1.47	-0.61	-0.37	-0.46	-0.44	-1.14	-0.63	-1.08
	Total	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

ENDNOTES

1. For other studies using long term Eurocurrency deposits are surrogates for zero coupon bonds see: Hauser and Levy 1991a,b.
2. Several studies have shown interest rate parity to hold within the Interbank market. See Beidleman, Hilley and Greenleaf (1979), and Frankel (1990).
3. Direct stands for units of home currency per unit of foreign currency. All the exchange rate variables are defined on a direct basis.
4. See for example Meese and Rogoff (1983).
5. Tests of simple efficiency have been soundly rejected in the literature and tests which add a risk premium to the forward rate have met with only limited success. For example, see Levich (1985) and Goodhart (1988). For studies of exchange rates following a random walk see Meese and Rogoff (1983) and Ahking and Miller (1987).
6. The approximation referred to above deals with such terms as $(1 + i)/(1 + i_x)$, which may be approximated by $(i - i_x + 1)$. This substitution becomes less valid as one considers larger rate differentials that might be associated with longer holding periods.
7. This convention is used since it is difficult to find bond market references that contain standard terms across several currencies; they may have different maturities, coupons, credit risks, political risk, etc.
8. The product $M*Y$ defines the bond's elasticity, while ε_Y represents the relative change in yield over the investment period. Here the interest sensitivity term is an elasticity expression, which may be defined as $(dV/V)/(dY/Y)$ and V is the value of the bond. When multiplied by $,_Y = dY/Y$, one obtains the relative change in value, dV/V.
9. This has been shown empirically by Hauser and Levy (1991a,b), where the exchange rate volatility accounted for approximately seventy percent of the total volatility of a foreign bond's return.
10. Technically a small amount of exchange rate risks remain. The amount hedged may not exactly equal the future value of the bond. However, a dynamic or rolling hedging strategy may be used to adapt to these changes so that currency risk may be virtually eliminated.

11. Although domestic bond volatilities may vary from currency to currency, they are usually close enough to make this comparison, see the main diagonal of Table 2 for references of historical bond volatilities.

12. Mathematically the investor's global optimization problem would be as follows:

$$\textit{Subject to: } \sum_{kx} x_{kx} - R$$

$$\min_{x} \sum_{kx,lz} x_{kx} x_{lz} \sigma_{kx,lz}$$

where X_{kx} is the proportion invested in asset k in currency x and X_{lz} is the proportion invested in asset l in currency z. The term $F_{kx,lz}$ is the covariance of the asset returns and R is the expected return.

13. Forward exchange rates can be derived from these deposit and spot exchange rates using IRP.

14. With $\alpha = .5$, the favorable difference in deposit rates is only partially offset by the negative exchange rate expectations.

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