IS EXCHANGE RISK PRICED BEYOND INTERTEMPORAL RISK?

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Abstract

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Abstract

Recent conditional tests show that exchange risk is priced in integrated international markets. However, these results are typically obtained assuming that intertemporal risk does not matter. We test an intertemporal international asset-pricing model where the investment opportunity set is dynamic. Using a conditional orthogonalization approach, we investigate whether the exchange risk is priced once the market and intertemporal risks are fully taken into account. We find that, in addition to the market and intertemporal risks, the exchange risk is an important determinant of risk premium. We also find that the intertemporal risk, which is often overlooked in the literature, is priced.

Keywords: International asset pricing models; exchange risk; intertemporal risk

I. INTRODUCTION

Recognizing that the risk premium varies over time, a large body of recent international finance literature makes use of conditional models. For instance, Dumas and Solnik (1995), De Santis and Gerard (1998), Carrieri (2001), De Santis, Gerard and Hillion (2003) and Carrieri, Errunza, and Majerbi (2005) find that the exchange risk is significant in both developed and emerging markets when they test conditional versions of the international asset-pricing model (IAPM) of Solnik (1974), Sercu (1980), and Adler and Dumas (1983). This contrasts with the earlier evidence based on unconditional test that the exchange risk is not priced (e.g., Solnik (1974), Stehle (1977), and Korajczyk and Viallet (1989)).

One important criticism of the results mentioned above is that they do not take into account intertemporal risk despite the mounting evidence that investment opportunities in international markets vary over time (e.g., Harvey (1991) and Ferson and Harvey (1993)). As shown by Merton (1973), the hypothesis of a constant investment opportunity set is restrictive because the portfolio holdings will also include hedge positions when the investor faces time-varying investment opportunities. In other words, if investment opportunities are stochastic, then the expected return on a portfolio may well differ from the riskless rate even if the portfolio is hedged against the market and exchange risks. Dumas and Solnik (1995) state that "a conditional static asset-pricing model is internally inconsistent." The authors point out that if a model is conditional, then it should also be intertemporal since investors anticipate the future variations of the instrumental variables and hedge them over their lifetime.

The goal of this paper is to investigate whether the exchange risk is priced once the intertemporal risk is taken into account. Dumas and Solnik (1995) suggest two ways to account for intertemporal risk in an international setting. The *first* is to use consumption-based asset-pricing models (e.g., Breeden (1979), Lucas (1978, 1982), and Stulz (1981)). While these models appear to be well specified theoretically, they are not suitable empirically given the measurement problems inherent in consumption data (e.g., Breeden, Gibbons, and Litzenberger (1989)). Recent studies by Ng (2004) and Chang et al. (2005) tackle this problem by linearizing the budget constraint to substitute out consumption using Campbell's (1993) framework. The results indicate that the world market risk is the main component, while intertemporal and exchange risks are less important.

The *second* approach to incorporate intertemporal risk is to extend Merton's model to an international setting. We follow this second avenue. A specification allowing for purchasing power parity (PPP) deviations and for stochastic investment opportunity was developed by Adler and Prasad (1992) and used by Robotti (2001). However, testing intertemporal IAPM models is difficult. One difficulty is to identify the state variables that represent the changing investment opportunities. According to Merton (1973, p.879), the interest rate is an element of the opportunity set because it is important, observable, and stochastic over time. In an international setting, exchange rate risk and inflation risk arise if the purchasing power indices are stochastic. In this paper, we argue that, since the exchange rates on the major currencies are also important, observable, and stochastic over time, they could be elements of the investment opportunity set.

Another empirically important issue is that exchange risk and intertemporal risk are potentially tangled together. In fact, if the countries purchasing power indices are among the state variables describing the change in the investment opportunity set, they may command a risk premium that will also remunerate some of the exposure to intertemporal risk, in addition to exchange risk.

To solve this problem, we develop an orthogonalization approach that consists in *conditionally* purging the exchange risk factors from their common co-variations with the market and intertemporal hedge factors. The resulting exchange factors can be interpreted as *pure* currency risks. With this conditional orthogonalization approach, we investigate whether investors require a premium to bear the exchange risk once they are fully compensated for their market and intertemporal risks exposure. We find that the exchange risk is indeed an important component of risk premium in addition to the market and intertemporal risks. We also find that intertemporal risk, as proxied by the returns on long-term bonds, is priced. We therefore conclude that both the exchange and intertemporal risks must be taken into account to properly price assets in integrated international markets.

The remainder of the study is structured as follows. The next section (Section II) lays out the model. Section III describes the data, presents some descriptive statistics, and outlines the methodology. Section IV discusses the empirical results. Some concluding remarks are offered in Section V.

II. THE MODEL

To investigate the role of the exchange risk beyond the intertemporal risk, we derive an intertemporal IAPM (I-IAPM) that contains both sources of risk. The intertemporal IAPM is derived in a framework similar to Adler and Prasad (1992) and Robotti (2001) and extends the classical IAPMs through the pricing intertemporal risk:[1]

$$E_t[r_{it+1}] = \gamma_{mt} Cov_t[r_{it+1}, r_{mt+1}] + \sum_{\ell=1}^{L+1} \gamma_{\pi t}^{\ell} Cov_t[r_{it+1}, r_{\pi t+1}^{\ell}] + \sum_{k=1}^{K} \sum_{\ell=1}^{L+1} \gamma_{kt}^{\ell} Cov_t[r_{it+1}, r_{kt+1}^{\ell}], \qquad (1)$$

where r_i is the instantaneous return on asset i in excess of the instantaneous interest rate on a domestic nominally riskless short-term bond, $\gamma_{mt} \equiv 1/\alpha^m$ is the equilibrium price of global market risk (where α^m is the aggregate risk tolerance), $\gamma_{\pi t}^{\ell} \equiv -H_P^{\ell} P^{\ell} / W^m \alpha^m$ and $\gamma_{kt}^{\ell} \equiv -H_k^{\ell} / W^m \alpha^m$ are the respective equilibrium prices of the risks associated with the inflation and the kth state variable of country ℓ (where W^m is the aggregate global wealth and P^{ℓ} is the level of the price index), and $H_P \equiv -J_{PW} / J_{WW}$ and $H_k \equiv -J_{kW} / J_{WW}$ are the cross preference coefficients obtained from the indirect value function J (where subscripts of J denote partial derivatives).[2]

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[1] A detailed derivation of the model is in available upon request.

[2] Notice that the $(L+1) \times m$ intertemporal risk premiums in equation (1) could reduce to m intertemporal risk premiums if we further assume that the state variables driving changes in the investment opportunity set are the same across integrated countries.

It follows from equation (1) that the inflation premia in the IAPM can be interpreted as exclusive remuneration for the exposure to PPP deviations only if the investment opportunity set is constant. If the price indices are additional elements of state variables that describe the changes in the investment opportunity set, then the inflation premiums would be additional components of the intertemporal hedging premiums and equation (1) would be the extension of Merton's (1973) ICAPM to an international setup that would inherently accommodate PPP deviations. This shows why the exchange risk can potentially be interpreted as an intertemporal risk (if the stochastic inflation describes the changes in the investment opportunity set) and might also explain why the *horse race* results reported in Dumas and Solnik (1995) between the ICAPM and the IAPM is inconclusive. Below, we describe the conditional orthogonalization approach used to disentangle foreign exchange risk from intertemporal risk.

III. DATA AND METHODOLOGY

A. The data

We use monthly data on the Morgan Stanley Capital International (MSCI) world market index, the G4 (Germany, Japan, the United Kingdom, and the United States) market and bond indices over the period from January 1973 to December 2003 (372 observations). Because we are dealing with the developed markets, we assume that the local inflation rates are non-stochastic, so that the $L+1$ inflation factors collapse into L exchange risk factors. Merton (1973, p.789) suggests that interest rates can capture changes in investment opportunities. Following Turtle et al. (1994), Scruggs (1998), and Gerard and Wu (2004), we use the excess return on the long-term bond as a proxy for the intertemporal risk of each country.

Stock index returns adjusted for dividends are from MSCI. Bond indices are long-term benchmark government bond indices obtained from Global Financial Data. Exchange rates are from the International Finance Statistics (IFS) database. All returns are computed in US dollars, in excess of the three-month US Treasury Bill. The instruments (Z) used to forecast excess returns are a constant, a dummy for the month of January (JAN), the federal fund rate (FED), the dividend yield of the world market (DIV), and the US default (DEF) and term (TERM) premiums. All non-constant instruments are lagged variables. As detailed in what follows, some of the instruments play a triple role; they are used in the conditional orthogonalizations, in conditioning the prices of risk, and in predicting returns. DIV is taken from DRI Basic Economics while data for FED, DEF, and TERM originate from the Federal Reserve Statistical Release (H15).

INSERT TABLE I ABOUT HERE

Table I reports summary descriptive statistics for the world, four local markets, three exchange rates, and four long-term bond indexes. Panel A shows the moments of the returns as well as the test of predictability of the factors from the instruments. Both null hypotheses of normality and unpredictability are rejected at the conventional levels of statistical significance. The results motivate the use of a conditional method to test the intertemporal IAPM. Panel B of Table I shows that the covariances between the exchange rates and the market and bond factors are always significant, which motivates the conditional approach that we detail next.

B. Orthogonalization of the Factors

In order to disentangle the role of the exchange risk from its potential interaction with the intertemporal risk, we propose a conditional orthogonalization approach based on managed portfolios. As opposed to the unconditional orthogonalization, the conditional orthogonalization not only purges a variable from its common covariation with other factors, but also from its common covariation with the cross-products between the factors and the lagged instruments.

For the sake of illustration of the method, we discuss the orthogonalization of the first of the long-term bond factors r_{bt+1} with respect to the world market factor r_{mt+1}. This is done by running the following dynamic regression:

$$r_{bt+1} = \phi_{b0t} + \phi_{bmt} r_{mt+1} + u_{bt+1}, \tag{2}$$

where $\phi_{b0t} \equiv Z_t \delta_{b0}$ and $\phi_{bmt} \equiv Z_t \delta_{bm}$ are the time-varying intercept and slope of the dynamic regression (where the δ's are time-invariant parameters), and u_{bt+1} is a zero-conditional mean error term that is conditionally orthogonal to the market factor. We obtain the orthogonalized long-term bond factor by subtracting out the projection onto the market and its various cross-products with the instruments:

$$r_{bt+1}^{\perp} \equiv r_{bt+1} - \phi_{bmt} r_{mt+1}. \tag{3}$$

By construction, $r_b^{\perp}$ is conditionally orthogonal to r_m while $[r_m \; r_b^{\perp}]$ will span the same space as $[r_m \; r_b]$.[3]

This procedure amounts to allowing that an investor dynamically hedge the bond exposure to market risk using information in Z rather than passively *buy and hold* the market. Specifically, the vector ϕ_{b0t} represents portfolio loadings on lagged predictive variables Z for the long-term bond return, while ϕ_{bmt} are portfolio loadings for a managed portfolio that consists on investing in the market according to the value of Z_t.[4] To see how the conditional orthogonalization will impact the price of market risk, assume that the following restricted version of (1) holds: $E_t[r_{it+1}] = \gamma_{mt} Cov_t[r_{it+1}, r_{mt+1}] + \gamma_{bt} Cov_t[r_{it+1}, r_{bt+1}]$. Using (3), this pricing equation can be rewritten as: $E_t[r_{it+1}] = \gamma_{mt}^{\perp} Cov_t[r_{it+1}, r_{mt+1}] + \gamma_{bt} Cov_t[r_{it+1}, r_{bt+1}^{\perp}]$, where $\gamma_{mt}^{\perp} = \gamma_{mt} + \phi_{bmt}\gamma_{bt}$. This shows that the communalities between the market and the other factors can distort the measurement of the price of market risk.

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[3] Note that the conditional covariance between the return on asset i and the return on the bond hedged against market risk is equal to the conditional covariance between the return on asset i and the innovation u_{bt+1}, i.e. $Cov_t[r_{it+1}, r_{bt+1}^{\perp}] = Cov_t[r_{it+1}, u_{bt+1}]$. This covariance measures intertemporal risk purged from market risk, which is also the exposure of asset i to the innovation in the state variable.

[4] See Cochrane (2001, chap. 8) for a discussion on conditioning information and managed portfolios.

Since there are many ways to construct the orthogonal system, a criterion to determine the order of priority to enter the system is needed. We proceed as follows: *first*, we set the market factor as the first variable in the orthogonal system, and let this variable unaltered. Since we are interested in investigating the importance of the exchange risk beyond intertemporal risk, we conditionally orthogonalize the four long-term bond factors and then introduce them in the orthogonal system. We then add the three exchange factors, which are orthogonalized with respect to both the market and long-term bond factors.

Furthermore, to determine the order of priority among the bond factors, we project each bond return on the world market and the remaining three other bond factors. We rank the bonds from the lowest R^2. The bond least explained by the word market and the other bonds is *next* in the orthogonal system, and so on. We follow the same approach to determine the order in which the exchange rates enter the orthogonal system. Each exchange rate is regressed on the world, bond, and other exchange rate series with the least spanned exchange rate taken first. With this criterion, the world market factor is the first variable to enter the orthogonal system, followed by the US, Japanese, the UK, and German bond factors, followed by the British pound, the Japanese yen, and the German mark.

C. Non-Normality of Returns

In Table I, the Jarque-Bera test points toward a rejection of the null of normality of returns. This is an indication that a nonlinear risk-return relationship may be holding.[5] According to

[5] This, however, falls well beyond the scope of the present study, which focuses on disentangling the exchange risk from the intertemporal risk. See, e.g., Errunza and Sy (2005) for an IAPM that takes into account nonlinear risk-return relationships.

Harvey and Siddique (2000) and Guedhami and Sy (2005), a negative price of market risk can be inferred when conditional coskewness risk is ignored, mainly because such component explains many of the episodes of negative premiums. To control for this potential misspecification, we run some tests excluding the crash of October 1987.

D. Time-Varying Prices of Risk

Our theoretical model implies that the prices of risk are time-varying, although it does not specify the functional form. To test the model, we assume that the prices of risk vary linearly with the default and term risk premiums: $\gamma_{mt} = \varphi_m Q_t$, $\gamma_{\ell t}^{e} = \varphi_{\ell}^{e} Q_t$[6], and $\gamma_{bt} = \varphi_b Q_t$; where the φ's are weighting vectors and Q_t is the subset of Z_t that contains a constant, the default risk premium, and the term risk premium.[7]

E. The GLS System

Given the generality of the intertemporal IAPM, robustness is an issue. Therefore, we use a *generalized least squares* (GLS) system. The main advantage of using GLS is that it allows flexible estimations, robust estimates, and the retrieving of the various systematic components of risk premiums. Furthermore, the GLS' loss function that is minimized is the sum of the squared pricing error weighted by the relative noise. This is arguably an interesting loss function from an economic perspective.

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[6] Note that we substitute π for e to represent change in exchange rate. We do so to be consistent with the widely accepted assumption that local inflation is non-stochastic in developed markets.

[7] See, e.g., Jagannathan and Wang (1996) for a discussion of the pertinence of choosing these two business cycle variables for capturing time-variation in price of risk.

We derive the econometric system following Harvey (1989). We linearly filter the first moments of the asset's returns as follows:

$$v_{it+1} = r_{it+1} - (Z_t \delta_i + \rho_i r_{it}), \tag{4}$$

where the v's are the (zero-conditional mean) forecasting errors for the various premiums, and the δ's and ρ's are time-invariant weighting vectors used by investors to derive the expected excess returns.

With the forecasting errors defined in equation (4), and without assuming a particular functional form, the conditional covariance terms in the intertemporal IAPM ensue naturally as the expected values of the product between these errors and the factors. Further, the linearity property of the expectation operator yields the following restriction of the intertemporal IAPM:

$$E_t\left[r_{it+1} - v_{it+1}\left(Q_t \varphi_m r_{mt+1} + \sum_{\ell=1}^{L} Q_t \varphi_b^{\ell} r_{bt+1}^{\ell} + \sum_{\ell=2}^{L} Q_t \varphi_e^{\ell} r_{et+1}^{\ell} \right)\right] = 0, \tag{5}$$

where the term in square brackets can be seen as the prediction error of the model.

We estimate the parameters using the excess returns on twelve key assets ($i = 1 \ldots 12$): the world market index, the market indexes of the four countries, the long-term bonds of the four countries, and the three exchange rates. We then stack the forecasting and prediction errors into the following system:

$$\varepsilon_{t+1} = \begin{pmatrix} \left[r_{it+1} - (Z_t\delta_i + \rho_i r_{it})\right]' \\ \left[r_{it+1} - v_{it+1}\left(Q_t\varphi_m r_{mt+1} + \sum_{\ell=1}^{L} Q_t\varphi_b^{\ell} r_{bt+1}^{\ell} + \sum_{\ell=2}^{L} Q_t\varphi_e^{\ell} r_{et+1}^{\ell}\right)\right]' \end{pmatrix}' \tag{6}$$

and estimate the parameters by minimizing the following quadratic form: $J_{GLS} = T^{-1}\sum_{t=0}^{T-1}[\varepsilon_{t+1}]'\Omega^{-1}[\varepsilon_{t+1}]$, where the cross-equation covariance matrix Ω is estimated with Zellner's (1962) SUR effects from the first stage OLS residuals.[8]

IV. EMPIRICAL RESULTS

A. The GLS Estimation of the Intertemporal IAPM

The system of equations (6) is estimated by GLS with and without conditional orthogonalization of the factors as well as with and without October 1987. Table II answers our central question as of whether exchange risk is priced beyond intertemporal risk. Our main finding is that exchange risk is priced, even after conditionally orthogonalizing exchange rate to the market and all the bond factors. Further, the fact that the magnitude of the prices of currency risk is unchanged after orthogonalization provides support to the idea that the exchange risk is driven by the purchasing power risk, and it does not subsume intertemporal risk. More specifically, the estimated price of conditional covariance with the yen exchange rate is always positive and statistically significant while the price of pound

[8] The GLS estimation can be seen as a tradeoff between the robustness of the OLS and the efficiency of the GMM; see Cochrane (2001, sections 10.2 and 11.5) for the discussion of this issue. See also Pindyck and Rubinfeld (1981, p.331-333) for a detailed discussion of SUR effects.

covariance is always negative and highly significant. In contrast, the DEM risk is not priced after orthogonalization. This is not surprising as the exposure to the DEM risk is measured by the covariance of an asset return with the DEM's component which is orthogonal to the market, all the bonds, and all the other pure currency risks. The exclusion of the October 1987 crash does not affect any of these results.

INSERT TABLE II ABOUT HERE

The prices of intertemporal risk are highly significant in all cases. Nonetheless, their magnitude is substantially smaller as compared to those of the currency risks. This entails that for a given amount of risk, the premium required by investors to bear currency risk is larger than the premium investors require to bear intertemporal risk. Moreover, unlike the prices of foreign exchange risk, the magnitudes of the prices of intertemporal risk are sensibly affected by the orthogonalization procedure, suggesting that the bond factors capture some of the market risk.

We do not impose a positivity constraint on the market price of risk. On the full sample, the IIAPM yields a negative and significant price of global market risk of -0.24 (*t*-statistic = -5.05). When we use orthogonalized factors the magnitude and significance of the world price of market risk is substantially reduced to -0.14 (*t*-statistic = -2.25). These results show that the size and sign of the price of world market risk is affected by the common covariation with the factors. More importantly, consistent with the evidence in Harvey and Siddique (2000) and Guedhami and Sy (2005), we find that the negative price of market risk is mainly driven by October 1987, since the average price of market risk becomes positive and statistically significant (0.14; t-statistic = 3.02) when this month of market crash is trimmed from the estimation. This result is robust to system estimation using orthogonalized factors.

INSERT TABLE III ABOUT HERE

As reported in Table III, we formally reject the restrictions implied by the nested asset-pricing models (the CAPM, the IAPM, and the ICAPM). These models are rejected because either they ignore the exchange risk (the ICAPM) or the intertemporal risk (the classical IAPM), or both (the CAPM) in the intertemporal IAPM. Our results also confirm the restrictive nature of the static-price-of-risk models since we usually reject the null hypothesis of the invariance of the prices of risk.

We noted that that exchange rate might represent intertemporal risk to some extent. It turns out that although the foreign exchange rates capture some of the intertemporal risk in addition to PPP deviations in the IAPM, they seem to be poor proxies for the changes in the investment opportunity set. When more suitable proxies for the changes in the investment opportunity set, namely the long-term bonds, are introduced in a model that fully allows for both currency and intertemporal risk, we find that the exchange risk to be related to PPP deviations rather than to the stochasticity of investment opportunities.

B. The Goodness-of-Fit and Variance Decomposition

Table IV shows the goodness-of-fit of the intertemporal IAPM and the various nested special cases. The statistic reported is the *pseudo* adjusted R^2s for each of the twelve assets to be explained in system (6). This measure of fit is obtained by computing the ratio between the explained sum of squares and the total sum of squares from the intertemporal IAPM or its nested special cases. The term pseudo refers to the fact that the estimates are from the full system. For the CAPM and the IAPM, the adjusted R^2s can be compared with the figures reported in the Panel C of Table 4 of De Santis and Gerard (1998). The results of the systems estimated with and without conditional orthogonalization as well as with and without October 1987 are presented.

INSERT TABLE IV ABOUT HERE

Averages of the adjusted R^2s across the twelve test assets are shown in bold type. Both the IAPM and the ICAPM add value to the CAPM as shown by the increase in the explanatory power when we consider exchange risk or intertemporal risk in addition to market risk. However, the largest increase in the degree of explanatory power is obtained for the Intertemporal IAPM, i.e. when exchange risk and intertemporal risk are jointly taken into account.

A further insight into the contribution of each component to the total premium is in Table V. This table presents a decomposition of the variance of world market, local market, exchange rate, and long-term government bond premiums into seven systematic components (one world market risk, three exchange risk, and four intertemporal risk premia) and reports the variance of each component in proportion of the sum of the components' variances. The bottom panel (Panel M) of Table V reports the relative importance of each component across the twelve assets.

Across the twelve assets, the combined explanatory power of the three exchange risk factors is more than one third of the total variation providing evidence of the economic importance of the exchange risk. In addition, the total variation accounted by the foreign exchange risk is substantially unaffected by the orthogonalization as previously observed for the prices of currency risk. This shows that, to the extent that the proxies chosen to represent the investment opportunity state variables are suitable, currency risk is statistically and economically important beyond intertemporal risk.

INSERT TABLE V ABOUT HERE

The importance of the market factor, regardless of the inclusion of the 1987 crash, increases for all assets when conditionally orthogonal factors are used as opposed to raw factors. The increase is more than eightfold on average. For instance, for the US market the percentage of variance accounted for by the global market increases from 4.67%, without orthogonalization, to 33.81%, when conditionally orthogonal factors are used. Conversely, the total premium variation across assets explained jointly by all the bonds decreases dramatically after orthogonalization. This suggests that the importance of bond premiums in the un-orthogonalized system could be gained at the expense of the market premium. This also shows that to correctly assess the exposure and reward to the global market risk, it is crucial to use bond factors dynamically hedged against market risk. Including the return on a bond exposed to market risk will result in misleading—typically much lower—estimates of the market importance.

V. CONCLUSION

This paper investigates whether exchange risk is priced after market and intertemporal risks are fully taken into account. In other words, we ask whether, in addition to the global market risk and intertemporal risk premiums, investors require a premium to bear exchange rate risk. For that purpose we test a generalization of Adler and Dumas (1983) model allowing the investment opportunity set to change stochastically as in Adler and Prasad (1992) and Robotti (2001). We use the covariance with long term bond returns as proxy for the intertemporal risk.

One methodological contribution of this paper is to propose a conditional orthogonalization procedure. We argue that in a conditional setting also orthogonalization should be conditional, as investors dynamically hedge using all the information available at each time. Using this novel approach, we show that:

Pure exchange risk is priced and it is important statistically and economically. The magnitude of the prices of currency risk is also unchanged after conditional orthogonalization, which provides support to the conjecture that purchasing power risk is not only priced but does not subsume intertemporal risk.

The prices of intertemporal risk are highly significant in all cases, but their economic importance is smaller as compared to those of the currency risks. Nonetheless, the omission of the intertemporal risk factor might be an important misspecification as it may induce inaccurate estimates of prices of currency risk.

We find that the size and sign of the price of world market risk is affected by the common covariation with the bond factors and the presence of outliers such as October 1987. To correctly assess the exposure and reward to global market it is crucial to include orthogonalized bond factors.

In summary, we conclude that exchange and intertemporal risks are two important dimensions of investment that must be taken into account to properly price assets in integrated international markets.

REFERENCES

Adler, M., and B. Dumas, 1983, International portfolio selection and corporation finance: a synthesis, *Journal of Finance* 38, 925-984.

Adler, M., and B. Prasad, 1992, On universal currency hedges, *Journal of Financial and Quantitative Analysis* 27, 19-38.

Bera, A. K., and C. M. Jarque, 1982, Model specification tests: A simultaneous approach, *Journal of Econometrics* 20, 59-82.

Breeden, D., 1979, An intertemporal asset pricing model with stochastic consumption and investment opportunities, *Journal of Financial Economics* 7, 265-296.

Carrieri, F., 2001, The Effects of liberalization on market and currency risk in the European Union, *European Financial Management* 7, 259-290.

Carrieri, F., V. Errunza, and B. Majerbi, 2003, Global price of foreign exchange risk, Working paper, McGill University, Canada.

Chang, J-R., V. Errunza, K. Hogan, and M-W Hung, 2005, An Intertemporal International Asset Pricing Model: Theory and Empirical Evidence, *European Financial Management* 11, No. 2, 173-194.

De Santis, G., and B. Gerard, 1998, How big is the premium for currency risk? *Journal of Financial Economics* 49, 375-412.

De Santis, G., B. Gerard and P. Hillion, 2003, The relevance of currency risk in the EMU, *Journal of Economics and Business* 55, 427-462.

Dumas, B., and B. Solnik, 1995, The world price of foreign exchange risk, *Journal of Finance* 50, 445-479.

Errunza, V., and O. Sy, 2005, A three-moment international asset-pricing model: Theory and evidence, *Working paper*, McGill University.

Fama, E. F., and G. W. Schwert, 1977, Asset returns and inflation, *Journal of Financial Economics* 5, 115-146.

Fama, E. F., and K. R. French, 1998, Value versus growth: the international evidence, *Journal of Finance* 53, 1975-1999.

Ferson, W. E., and C. R. Harvey, 1991, The variation of economic risk premiums, *Journal of Political Economy* 99, 385-415.

Ferson, W. E., and C. R. Harvey, 1993, The risk and predictability of international equity returns, *Review of Financial Studies* 6, 527-566.

Gerard, B. and Wu, G., 2005, How Important Is Intertemporal Risk for Asset Allocation?, forthcoming, *Journal of Business*.

Grauer, F. L. A., R. H. Litzenberger, and R. Stehle, 1976, Sharing rules and equilibrium in an international market under uncertainty, *Journal of Financial Economics* 3, 233-256.

Guedhami, O., and O. Sy, 2005, Does conditional market skewness resolve the puzzling market risk-return relationship? Forthcoming in the *Quarterly Review of Economics and Finance*.

Harvey, C. R., 1989, Time-varying conditional covariances in tests of asset pricing models, *Journal of Financial Economics* 24, 289-317.

Harvey, C. R., 1991, The world price of covariance risk, *Journal of Finance* 46, 111-157.

Harvey, C. R., and A. Siddique, 2000, Time-varying conditional skewness and the market risk premium, *Research in Banking and Finance* 1, 27-60.

Jagannathan, R., and Z. Wang, 1996, The conditional CAPM and the cross-section of expected returns, *Journal of Finance* 51, 3-53.

Jegadeesh, N., 1990, Evidence of predictable behavior of security returns, *Journal of Finance* 45, 881-898.

Karolyi, G. A., and R. Stulz, 2003, Are assets priced locally or globally? in The HANDBOOK OF THE ECONOMICS OF FINANCE, G. Constantinides, M. Harris, and R. Stulz, eds., North Holland, Amsterdam.

Korajczyk, R., and C. Viallet, 1989, An empirical investigation of international asset pricing, *Review of Financial Studies* 2, 553-585.

Lintner, J., 1965, The valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets, *Review of Economics and Statistics* 47, 13-37.

Lucas, R. E. Jr., 1978, Asset prices in an exchange economy, *Econometrica* 46, 1429-1445.

Ng, D., 2004, The international CAPM when expected returns are time-varying, *Journal of International Money and Finance* 23, 189-230.

Petkova, R., 2005, Do the Fama-French factors proxy for innovations in predictive variables?, *Journal of Finance Forthcoming.*

Robotti, C., 2001, The Price of Inflation and Foreign Exchange Risk in International Equity Markets, Working Paper 2001-26, Federal Reserve Bank of Atlanta.

Sharpe, W. F., 1964, Capital asset prices: A theory of market equilibrium under conditions of risk, *Journal of Finance* 19, 425-442.

Solnik, B., 1974, An equilibrium model of the international capital market, *Journal of Economic Theory* 8, 500-524.

Stehle, R., 1977, An empirical test of the alternative hypotheses of national and international pricing of risky assets, *Journal of Finance* 32, 493-502.

Stulz, R., 1995, International portfolio choice and asset pricing: An integrative survey, in The Handbook in Operations Research and Management Sciences, R.A. Jarrow, M. Maksimovic, and W.T. Ziemba, eds., North-Holland, Amsterdam, 201-223.

Swanson, N. R., and H. White, 1997, Forecasting economic time series using flexible versus fixed specification and linear versus nonlinear econometric models, *International Journal of Forecasting* 13,439-461.

Turtle, H., Buse, A., & Korkie, B. 1994, Tests of conditional asset pricing with time-varying moments and risk prices. *Journal of Financial and Quantitative Analysis*, 29, IS29.

Zellner, A., 1962, An efficient method of estimating seemingly unrelated regressions and tests for aggregation bias, *Journal of American Statistical Association* 57, 348-368.

APPENDIX

Table I

Descriptive Statistics, 1973–2003

This table reports summary descriptive statistics for the world, four local markets, three exchange rates, and four long-term bond indexes. All returns are reported as a percentage per month in US dollars. All returns are reported in excess of the three-month US Treasury Bill. The sample covers the period January 1973 to December 2003 (372 observations). Two and one asterisks denote statistical significance at the 1 and 5 percent levels, respectively. The line labeled "B-J" shows Bera-Jarque's χ^2 statistic for the test of normality while "F-value" reports the Fisher test of predictability of the index excess return from the instruments and the lagged index excess return. The instruments used to forecast excess returns (a constant, JAN, FED, DIV, DEF, and TERM) are described in the data section.

Variable	World	Local market				Exchange rates			Long-term bond			
		US	Japan	UK	Germany	Yen	BP	DM	US	Japan	UK	Germany
	Panel A. Summary statistics											
Mean	0.299	0.347	0.148	0.395	0.378	0.279	-0.074	0.195	0.198	0.319	0.286	0.358
Std. Dev.	4.317	4.614	6.519	6.598	6.418	3.324	3.028	3.336	2.679	4.475	3.725	4.118
Minimum	-19.016	-24.283	-22.171	-24.678	-28.034	-11.525	-12.769	-12.174	-10.571	-13.637	-11.125	-15.232
Median	0.537	0.670	0.204	0.499	0.409	-0.104	-0.027	0.191	0.221	0.278	0.037	0.321
Maximum	13.267	15.748	21.148	44.274	21.171	15.009	13.135	11.847	12.582	17.039	14.137	13.357
Skewness	-0.586**	-0.552**	0.051	0.527**	-0.550**	0.397**	-0.070	0.045	0.174	0.343**	0.155	-0.048
Exc. Kurtosis	1.588**	2.350**	0.448	5.908**	1.815**	1.581**	1.893**	1.016**	2.257**	1.367**	0.600**	0.762**
B-J	60.36**	104.49**	3.280	558.20**	69.80**	48.54**	55.85**	16.12**	80.81**	36.27**	7.06*	9.13*
F-value	3.34**	2.17*	2.60*	3.27**	1.34	2.19*	1.94	2.65*	3.62**	2.63*	3.25**	3.17**
	Panel B. Unconditional correlation coefficients											
World	1.000	0.856**	0.677**	0.709**	0.648**	0.294**	0.236**	0.214**	0.170**	0.317**	0.285**	0.262**
US market		1.000	0.309**	0.555**	0.480**	0.012	-0.016	-0.015	0.195**	0.052	0.042	0.047
Japan market			1.000	0.377**	0.366**	0.579**	0.280**	0.279**	0.099	0.550**	0.295**	0.283**
UK market				1.000	0.482**	0.213**	0.417**	0.218**	0.138**	0.230**	0.517**	0.259**
Germ. Market					1.000	0.203**	0.271**	0.386**	0.108*	0.218**	0.258**	0.429**
Japanese yen						1.000	0.451**	0.551**	0.140**	0.875**	0.422**	0.512**
British pound							1.000	0.659**	0.171**	0.417**	0.891**	0.589**
Deutsche Mark								1.000	0.209**	0.503**	0.557**	0.899**
US LT bond									1.000	0.253**	0.247**	0.395**
Japan LT bond										1.000	0.428**	0.544**
UK LT bond											1.000	0.570**

Table II

GLS Estimation of the Intertemporal International Capital Asset Pricing Model, 1973–2003

This table reports the result from the GLS estimation of the intertemporal IAPM system:

$$\varepsilon_{t+1} = \begin{pmatrix} \left[r_{it+1} - (Z_t \delta_i + \rho_i r_{it}) \right]' \\ \left[r_{it+1} - v_{it+1} \left(Q_t \varphi_m r_{mt+1} + \sum_{\ell=2}^{L} Q_t \varphi_e^{\ell} r_{et+1}^{\ell} + \sum_{\ell=1}^{L} Q_t \varphi_b^{\ell} r_{bt+1}^{\ell} \right) \right]' \end{pmatrix}', \tag{6}$$

where r_i is the excess return on twelve key assets: the world market index, the market and long-term bonds indexes of the four countries (the US, Japan, the UK, and Germany), and the three exchange rates (the British pound, the Japanese Yen, and the Deutsche Mark). The terms r_m, r_e^{ℓ}, and r_b^{ℓ}, stand for the world market, the exchange rate, and long-term bond factors; we run the system with and without orthogonalizing these factors. Finally, Z contain our six instruments (see Section III.A), of which the subset Q contains a constant and the default and term premiums. For each price of risk, we report the mean value with the t-statistic that it is equal to zero (in parentheses below), the percentage of its positive values {in braces}, and the robust p-value from the Wald test that it varies with the instruments [in brackets below]. All the variables are expressed in US dollar. The sample covers 372 monthly observations (from January 1973 to December 2003).

Price of conditional covariance	Full sample				Sample without October 1987			
	"Raw" factors		"Orthogonalized" factors		"Raw" factors		"Orthogonalized" factors	
	Mean (t-statistic)	{% positive} [p(constant)]	Mean (t-statistic)	{% positive} [p(constant)]	Mean (t-statistic)	{% positive} [p(constant)]	Mean (t-statistic)	{% positive} [p(constant)]
World market	-0.237	{32.26}	-0.136	{41.13}	0.142	{49.60}	0.206	{50.40}
	(-5.051)	[<.001]	(-2.253)	[<.001]	(3.023)	[<.001]	(3.333)	[<.001]
Japanese yen	2.449	{94.35}	2.385	{92.47}	2.528	{96.23}	2.481	{94.07}
	(40.043)	[0.038]	(29.681)	[0.006]	(45.325)	[0.051]	(31.790)	[0.008]
British pound	-4.010	{4.03}	-3.260	{9.14}	-4.070	{3.5}	-3.435	{5.93}
	(-30.186)	[<.001]	(-23.943)	[<.001]	(-31.54)	[<.001]	(-25.709)	[<.001]
Deutsche Mark	-0.395	{47.04}	0.147	{49.73}	-0.561	{45.28}	-0.146	{46.36}
	(-3.29)	[<.001]	(1.117)	[<.001]	(-4.256)	[<.001]	(-1.027)	[<.001]

Table II – *Continued*

Price of conditional covariance	Full sample				Sample without October 1987			
	"Raw" factors		"Orthogonalized" factors		"Raw" factors		"Orthogonalized" factors	
	Mean (*t*-statistic)	{% positive} [*p*(constant)]	Mean (*t*-statistic)	{% positive} [*p*(constant)]	Mean (*t*-statistic)	{% positive} [*p*(constant)]	Mean (*t*-statistic)	{% positive} [*p*(constant)]
US bond	0.870 (15.578)	{79.57} [<.001]	1.298 (17.766)	{83.87} [<.001]	0.579 (10.129)	{67.92} [<.001]	0.965 (14.961)	{81.13} [<.001]
Japanese bond	-1.373 (-15.884)	{19.35} [<.001]	0.431 (10.671)	{71.24} [<.001]	-1.648 (-21.066)	{13.48} [<.001]	0.223 (6.522)	{65.23} [<.001]
UK bond	2.807 (25.803)	{89.25} [<.001]	0.350 (11.232)	{77.69} [0.004]	2.798 (26.615)	{89.49} [<.001]	0.321 (10.809)	{77.36} [0.007]
German bond	1.092 (14.137)	{70.97} [0.002]	0.356 (10.013)	{75.27} [0.021]	1.279 (14.963)	{73.05} [<.001]	0.474 (12.651)	{79.78} [0.011]

Table III

Test of the Restrictions implied by the Nested Pricing Models, 1973–2003

This table reports the results from the formal test of the restrictions of the IAPM, ICAPM, and CAPM on the intertemporal IAPM. The IAPM implies that intertemporal risk does not matter, ICAPM implies that PPP holds so that exchange risk is not priced, and the CAPM implies that neither exchange risk nor intertemporal risk is priced. We test these restrictions using Wald tests. We report the χ^2-statistic along with the robust *p*-value. The sample covers 372 monthly observations (from January 1973 to December 2003).

Nested asset pricing models	Full sample				Sample without October 1987			
	"Raw" factors		"Orthogonalized" factors		"Raw" factors		"Orthogonalized" factors	
	Wald	p-value	Wald	p-value	Wald	p-value	Wald	p-value
IAPM	105.64	[<.001]	101.55	[<.001]	103.33	[<.001]	74.36	[<.001]
ICAPM	97.44	[<.001]	53.57	[<.001]	102.49	[<.001]	56.41	[<.001]
CAPM	190.21	[<.001]	167.57	[<.001]	165.07	[<.001]	140.99	[<.001]

Table IV

Goodness-of-Fit of the Intertemporal IAPM and the Nested Pricing Models, 1973–2003

This table reports the goodness-of-fit from the estimation of the intertemporal IAPM (I-IAPM) as well as the nested models (the IAPM, the ICAPM, and the CAPM). The statistic reported is the "pseudo" adjusted R^2s for each of the twelve assets to be explained in system (6), which is obtained by computing the ratio between the explained sum of squares and the total sum of squares. The assets are the excess return on the world market index, the market and long-term bonds indexes of the four countries (the US, Japan, the UK, and Germany), and the three exchange rates (the British pound, the Japanese Yen, and the Deutsche Mark). The sample is from January 1973 to December 2003.

Premium equation	I-IAPM				IAPM				ICAPM				CAPM	
	Full Sample		No Oct. 1987		Full Sample		No Oct. 1987		Full Sample		No Oct. 1987		Full	No
	"Raw"	"Ortho"	"Raw"	"Ortho"	"Raw"	"Ortho"	"Raw"	"Ortho"	"Raw"	"Ortho"	"Raw"	"Ortho"	"Raw"	"Raw"
World market	10.58	10.85	8.94	9.33	3.65	5.18	2.37	6.96	4.24	6.03	2.40	4.28	1.18	1.25
US market	10.73	11.38	8.83	9.53	3.93	4.57	2.30	6.44	4.74	6.75	2.33	4.37	0.92	0.85
Jap. market	7.32	7.29	6.76	6.85	2.85	3.46	2.56	4.86	1.78	2.50	1.43	2.22	0.14	0.65
UK market	15.34	15.61	14.73	15.15	5.48	8.57	4.62	11.27	5.51	8.55	4.22	7.38	2.35	2.76
Germ. market	7.27	7.48	5.95	6.29	1.82	3.03	0.90	3.30	2.67	4.48	1.52	3.44	0.45	0.11
Yen	7.22	1.01	6.73	1.11	2.12	0.12	1.79	0.81	0.01	-1.82	-0.37	-1.74	-1.43	-0.80
Pound	10.34	0.85	10.10	0.90	1.57	0.27	1.23	0.53	2.00	-0.64	1.55	-0.71	-0.47	-0.28
Mark	9.32	-0.18	9.00	-0.13	1.66	-0.69	1.39	-0.47	1.84	-1.04	1.47	-0.99	-0.89	-0.70
US LT bond	5.86	6.54	5.49	5.76	1.07	4.05	1.07	4.75	1.51	2.11	1.11	1.27	-0.21	0.08
Japan LT bond	7.45	5.04	7.08	4.79	2.93	1.03	2.48	3.09	1.39	1.20	0.79	0.50	-0.49	0.22
UK LT bond	11.68	8.22	11.34	8.40	2.07	2.49	1.65	4.08	2.97	2.84	2.54	2.73	-0.42	0.09
Germ. LT bond	9.09	3.34	8.77	3.64	1.61	0.39	1.24	1.03	1.88	0.05	1.51	0.34	-1.21	-0.88
Average	**9.35**	**6.45**	**8.64**	**5.97**	**2.56**	**2.71**	**1.97**	**3.89**	**2.55**	**2.58**	**1.71**	**1.92**	**-0.01**	**0.28**

Table V

Variance Decomposition of Risk Premia, 1973–2003

This table uses the intertemporal IAPM system to decompose the variance of world, local market, exchange rate, and long-term bond premiums into seven systematic components (one world market premium, three exchange rate premiums, and four intertemporal hedge premiums) and reports their variance in proportion of the sum of the components' variances. The last line reports the mean values across the twelve assets to be explained in system (6). All the numbers are reported in percent and sum to 100 percent. The sample covers 372 monthly observations (from January 1973 to December 2003).

Source of systematic risk	Full sample		Sample without October 1987	
	"Raw" factors	"Orthogonalized" factors	"Raw" factors	"Orthogonalized" factors
	Panel A. The world market premium			
World market	5.40	38.16	6.38	45.73
Yen	12.99	11.45	13.08	13.40
Pound	23.81	19.56	20.20	21.87
Deutchmark	8.33	3.63	10.76	4.63
US long-term Gov. bond	1.78	12.10	1.97	7.04
Japan long-term Gov. bond	15.06	11.76	16.73	3.59
UK long-term Gov. bond	23.98	1.79	21.21	1.78
German long-term Gov. bond	8.65	1.54	9.67	1.97
	Panel B. The US market premium			
World market	4.67	33.81	6.06	43.20
Yen	11.78	9.51	12.13	11.54
Pound	25.64	21.32	21.15	24.41
Deutchmark	8.33	3.26	10.92	4.47
US long-term Gov. bond	2.12	13.81	2.47	8.04
Japan long-term Gov. bond	12.15	15.12	14.15	4.71
UK long-term Gov. bond	26.56	1.49	23.60	1.51
German long-term Gov. bond	8.75	1.68	9.53	2.12
	Panel C. The Japanese market premium			
World market	3.06	26.87	2.98	28.81
Yen	17.01	18.10	16.31	19.57
Pound	22.60	26.30	22.22	28.12
Deutchmark	7.26	3.98	8.71	4.72
US long-term Gov. bond	1.19	10.12	1.12	7.01
Japan long-term Gov. bond	21.84	8.80	21.23	5.51
UK long-term Gov. bond	20.83	3.70	19.85	3.51
German long-term Gov. bond	6.21	2.12	7.59	2.76
	Panel D. The UK market premium			
World market	4.90	38.82	4.86	42.77
Yen	6.46	6.26	6.24	7.31
Pound	34.47	26.19	33.13	29.57
Deutchmark	6.20	4.15	7.76	4.93
US long-term Gov. bond	0.95	10.52	0.99	6.98
Japan long-term Gov. bond	7.90	8.95	8.26	2.79
UK long-term Gov. bond	31.49	3.29	29.94	3.28
German long-term Gov. bond	7.64	1.83	8.81	2.37

Table V - *Continued*

Source of systematic risk	Full sample		Sample without October 1987	
	“Raw” factors	“Orthogonalized” factors	“Raw” factors	“Orthogonalized” factors
	Panel E. The German market premium			
World market covariance	3.03	30.14	3.46	37.77
Yen covariance	10.58	11.69	10.26	13.02
Pound covariance	29.71	19.58	28.09	21.49
Mark covariance	8.84	5.72	10.79	6.89
US LT bond covariance	1.31	14.93	1.34	9.04
Japan LT bond covariance	12.14	11.57	12.25	4.72
UK LT bond covariance	26.06	3.79	24.06	3.60
German LT bond covariance	8.33	2.59	9.74	3.45
	Panel F. The Japanese yen premium			
World market covariance	1.41	10.41	1.35	10.84
Yen covariance	26.56	48.95	25.45	53.70
Pound covariance	16.59	12.57	16.50	12.91
Mark covariance	7.07	3.74	8.23	4.27
US LT bond covariance	0.91	7.21	0.93	5.05
Japan LT bond covariance	29.89	12.50	29.50	8.27
UK LT bond covariance	13.04	2.91	12.52	2.65
German LT bond covariance	4.54	1.71	5.53	2.31
	Panel G. The British pound premium			
World market covariance	0.39	12.83	0.39	16.39
Yen covariance	4.89	5.49	4.79	5.74
Pound covariance	46.06	46.43	45.40	47.97
Mark covariance	4.59	6.56	5.83	7.24
US LT bond covariance	0.43	10.96	0.39	7.97
Japan LT bond covariance	4.56	8.76	4.64	6.12
UK LT bond covariance	33.61	6.87	31.69	6.04
German LT bond covariance	5.48	2.10	6.86	2.53
	Panel H. The Deutsche mark premium			
World market covariance	0.76	14.52	0.83	15.89
Yen covariance	9.95	12.00	9.34	12.56
Pound covariance	32.86	17.27	31.69	17.93
Mark covariance	11.75	29.95	13.75	31.63
US LT bond covariance	0.76	12.01	0.72	8.55
Japan LT bond covariance	10.56	4.52	10.36	3.34
UK LT bond covariance	24.92	5.02	23.10	4.50
German LT bond covariance	8.46	4.71	10.21	5.61
	Panel I. The US long-term bond premium			
World market covariance	1.96	13.48	2.54	17.99
Yen covariance	5.58	5.77	5.36	6.49
Pound covariance	28.78	36.94	27.11	39.98
Mark covariance	7.75	4.57	9.67	5.62
US LT bond covariance	6.65	24.87	7.57	19.35
Japan LT bond covariance	12.85	9.93	11.33	6.07
UK LT bond covariance	25.80	2.89	23.50	2.66
German LT bond covariance	10.63	1.55	12.92	1.84

Table V - *Continued*

Source of systematic risk	Full sample		Sample without October 1987	
	"Raw" factors	"Orthogonalized" factors	"Raw" factors	"Orthogonalized" factors
	Panel J. The Japanese long-term bond premium			
World market covariance	1.94	14.03	2.51	18.51
Yen covariance	5.66	5.55	5.46	6.17
Pound covariance	29.05	37.10	27.31	40.44
Mark covariance	7.71	4.48	9.58	5.50
US LT bond covariance	6.54	24.60	7.51	19.03
Japan LT bond covariance	12.71	9.90	11.34	5.97
UK LT bond covariance	25.88	2.82	23.61	2.57
German LT bond covariance	10.51	1.53	12.69	1.81
	Panel K. The UK long-term bond premium			
World market covariance	1.99	14.02	2.61	18.38
Yen covariance	5.66	5.71	5.45	6.44
Pound covariance	28.63	37.25	26.95	40.22
Mark covariance	7.64	4.55	9.51	5.60
US LT bond covariance	6.73	24.36	7.71	18.96
Japan LT bond covariance	13.04	9.71	11.53	5.93
UK LT bond covariance	25.94	2.84	23.67	2.62
German LT bond covariance	10.37	1.56	12.57	1.86
	Panel L. The German long-term bond premium			
World market covariance	1.95	13.58	2.55	17.95
Yen covariance	5.62	5.33	5.41	6.03
Pound covariance	28.86	38.62	27.14	41.34
Mark covariance	7.68	4.36	9.56	5.45
US LT bond covariance	6.74	24.11	7.72	18.97
Japan LT bond covariance	12.85	9.75	11.38	5.93
UK LT bond covariance	25.82	2.76	23.55	2.56
German LT bond covariance	10.48	1.49	12.69	1.77
	Panel M. The average across the twelve premiums			
World market covariance	**2.62**	**21.72**	**3.04**	**26.19**
Yen covariance	**10.23**	**12.15**	**9.94**	**13.50**
Pound covariance	**28.92**	**28.26**	**27.24**	**30.52**
Mark covariance	**7.76**	**6.58**	**9.59**	**7.58**
US LT bond covariance	**3.01**	**15.80**	**3.37**	**11.33**
Japan LT bond covariance	**13.80**	**10.11**	**13.56**	**5.24**
UK LT bond covariance	**25.33**	**3.35**	**23.36**	**3.11**
German LT bond covariance	**8.34**	**2.03**	**9.90**	**2.53**