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Time-Varying Expected Returns in International Bond Markets

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ABSTRACT

This article examines the predictable variation in long-maturity government bond returns in six countries. A small set of global instruments can forecast 4 to 12 percent of monthly variation in excess bond returns. The predictable variation is statistically and economically significant. Moreover, expected excess bond returns are highly correlated across countries. A model with one global risk factor and constant conditional betas can explain international bond return predictability if the risk factor is proxied by the world excess bond return, but not if it is proxied by the world excess stock return.

A GROWING BODY OF LITERATURE describes predictable variation in U.S. and international asset returns. There are two competing views regarding the source of the predictability. Some authors interpret the return predictability as evidence of market inefficiency, while others attribute it to rational variation in required asset returns. In this article, I study predictable variation in international government bond returns, focusing on two questions: (1) Can the excess returns of long-term bonds be forecast using global or country-specific instruments? and (2) Is the observed behavior of expected excess bond returns consistent with a simple asset pricing model, market efficiency, and international market integration?

Studying this subset of capital markets is useful because bond returns are affected by relatively few factors. The excess returns of long-term government bonds[1] are subject only to interest rate risk. There is no default risk or cash flow uncertainty, and almost all foreign exchange risk can be hedged. The simplicity of government bonds facilitates the identification of useful forecasting instruments and the interpretation of empirical findings. Assuming ra-

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[1] I define "excess bond return" and "bond risk premium" as the realized one-period return of a long-term government bond in excess of the return of a one-period bond. I do not refer to the "term premium" because its definition in the literature has varied from the realized and expected excess bond return to the term spread (the difference between a long-term yield and a short-term yield).

tionality, any return predictability should reflect the time-varying reward for bearing interest rate risk.

I analyze the predictable variation in the monthly excess returns of long-term government bonds from January 1978 to June 1993 in the United States, Canada, Japan, Germany, France, and the United Kingdom. These markets, which amounted to six trillion dollars in December 1990, are the world's most liquid bond markets, so their return predictability is unlikely to be caused by data problems such as stale prices. I use broader government bond market indices than previous studies, and I identify powerful new forecasting instruments.

To date, few studies have analyzed the predictability of government bond returns outside the United States.[2] However, Mankiw (1986), Bisignano (1987), and Solnik (1993) forecast long-term bond returns using local instruments, finding that the local term spread has a significant ability to predict excess bond returns in many countries.

I choose instruments that are likely to contain information about time-series variation in expected bond risk premia: inverse relative wealth (the ratio of exponentially weighted past wealth to current wealth), the bond beta (a bond market's exposure to a stock market index), the term spread, and the real bond yield. The first two instruments are specific proxies for time-varying risk aversion and time-varying risk, respectively, and the last two are alternative proxies for the overall expected bond risk premium.

Theoretical arguments exist for why inverse relative wealth would capture variation in expected bond risk premia. Many earlier studies try to explain the predictable variation in bond returns with various measures of time-varying risk (e.g., Lauterbach (1989), Zhang (1992), and Boudoukh (1993)). These attempts have met with limited success, leading some authors to conclude that the bond return predictability reflects something other than a time-varying risk premium (see Mankiw (1986) and DeBondt and Bange (1992)). Time-varying risk aversion, as well as time-varying risk, may cause a time-varying risk premium, however. I propose that relative risk aversion (RRA) varies inversely with "relative wealth" and that such variation explains the observed countercyclic pattern in expected asset returns. Investors are more risk averse when their wealth is low relative to their past wealth. Given the higher risk aversion, they demand larger compensation for holding risky assets such as stocks and long-term bonds. My proxy for the aggregate RRA level is inverse relative stock market wealth.

[2] Empirical studies by Keim and Stambaugh (1986) and Fama and French (1989), among others, show that variables such as dividend yield and term spread can predict excess stock and bond returns in the United States. Harvey (1991) and Ferson and Harvey (1993) document predictable variation in international stock returns, Hodrick (1987) and Bekaert and Hodrick (1992) in foreign exchange returns, and Campbell and Clarida (1987) and Jorion (1992) in Eurodeposit returns. Fama and French (1989) and Chen (1991) point out that the variation in predicted U.S. asset returns is related to variation in economic conditions. Expected stock and bond returns tend to be high near business cycle troughs and low near business cycle peaks.

I report several new findings. The reward for bearing interest rate risk is small, on average, but it varies significantly over time. Both country-specific local instruments and common "world" instruments (GNP-weighted averages of the local instruments) can forecast excess bond returns, but the world instruments are somewhat better predictors. World inverse relative wealth, the world real bond yield, and the world term spread are positively related to future excess bond returns in all six countries. Thus, wealth-dependent relative risk aversion appears to be an important source of the time-variation in expected returns. The forecasting ability of these variables is statistically significant in most countries, and the R^2 values (4 to 12 percent) are larger than those reported in the earlier literature. These findings are robust (in subperiod analysis and in out-of-sample analysis) and economically significant. Dynamic trading strategies that exploit the return predictability of world bonds earn annual mean excess returns between 3 to 8 percent.

After describing the predictable variation in international bond returns, I try to address the challenge these patterns pose for financial economists. If rational variation in expected returns cause these patterns, a pricing model should be able to explain them as time-variation in risk or in risk aversion. Harvey (1991) and Ferson and Harvey (1993) use conditional asset pricing models to explain the predictable variation in international stock returns, with mixed results. There is no prior analysis of the government bond markets.

I specify simple conditional asset pricing models and test their ability to explain the bond return predictability. The test of a single latent variable model indicates that expected excess bond returns are proportional to the expected excess return of one unobservable risk factor. I try to identify a good observable proxy for this factor. I find that the world Capital Asset Pricing Model (CAPM), in which the risk factor is proxied by the world excess *stock* return, cannot explain the predictable variation in international bond returns. In contrast, a constant-beta model in which the risk factor is proxied by the world excess *bond* return is able to capture almost all the predictability. These findings imply that expected excess returns are highly correlated across international bond markets and less highly correlated between the world stock and bond markets.

The article is organized as follows. Section I motivates the choice of forecasting instruments. Section II presents the predictive regression results and examines the robustness and economic significance of these findings. Section III analyzes the common behavior of expected excess bond returns and the ability of simple asset pricing models to explain this behavior. Section IV concludes.

I. Discussing the Inputs to the Predictive Regressions

A. Predicting Excess Bond Returns in Local Currency Terms

Most earlier studies analyze the predictability of international stock returns in U.S. dollar terms (unhedged), while bond returns are analyzed in local currency terms. It is more informative to examine the bond market predictability separately from the foreign exchange market predictability than to study the predictability of unhedged bond returns. These returns are more driven by exchange rate changes than by interest rate behavior because foreign exchange markets tend to be more volatile than bond markets. Because this study focuses on the reward for interest rate risk, it examines excess bond returns in local currency terms. As an approximation, a bond's local-currency excess return can be viewed as the bond's currency-hedged excess return for any foreign investor, independent of his home currency.[3]

B. Motivating the Instruments: Inverse Relative Wealth

I will forecast bond returns using instruments that are reasonable determinants of the expected bond risk premium. My instrument choices include specific proxies for time-varying risk aversion ("inverse relative wealth" or *INVRELW*) and time-varying risk (historical bond beta), as well as two overall proxies for the expected bond risk premium.

Most earlier attempts to explain the time-variation in expected bond returns analyze several measures of time-varying risk (Lauterbach (1989), DeBondt and Bange (1992), and Boudoukh (1993)). Such measures cannot explain the observed countercyclic pattern in expected returns. I propose that wealth-dependent RRA, rather than time-varying risk, causes this pattern. Sharpe (1990) and Chen (1991) also argue that investors are more risk averse and demand a higher compensation for holding risky assets when their wealth is relatively low.

I first discuss models in which RRA varies with wealth and then describe my empirical proxy for wealth-dependent RRA. Marcus (1989) presents a two-period, two-asset model where identical agents have the utility function

$$U(W) = \frac{(W - \omega)^{1-\gamma}}{1 - \gamma} \tag{1}$$

where W is wealth, ω is subsistence wealth, and γ is a positive constant. This function implies wealth-dependent RRA level:

$$RRA = \frac{-WU_{WW}}{U_W} = \frac{\gamma}{1 - \dfrac{\omega}{W}} \tag{2}$$

Because agents suffer infinite disutility when $W = \omega$, rational agents never let their wealth reach or fall below the subsistence level. As an agent's wealth

[3] To see this, note that a foreign investor can buy a long-term bond and finance the purchase by borrowing short-term in the same currency. His currency exposure is then limited to the difference between the long-term bond's short-term return and the borrowing cost. The impact of such a currency exposure is small, so the foreign investor earns approximately the same bond risk premium as the local investor. A forward currency sale is an alternative way for the investor to hedge his currency exposure.

declines toward the subsistence level, he becomes increasingly risk averse. In contrast, as wealth increases, RRA approaches γ asymptotically from above. When $\omega = 0$, the function reduces to a power utility function, which exhibits constant RRA. Thus, decreasing RRA is a direct consequence of assuming a positive subsistence level.

In Marcus's model, the subsistence level is fixed, and the RRA and the expected market risk premium vary inversely with absolute wealth. It is more plausible that the subsistence level varies over time and the RRA varies inversely with relative wealth. Several recent studies formalize the idea that the subsistence level varies over time because of individual consumers' adaptive tastes. In the habit formation models of Sundaresan (1989) and Constantinides (1990), the subsistence level of consumption is endogenized as the exponentially weighted average of past consumption. Campbell and Cochrane (1994) develop another model in which the subsistence level is a function of past consumption, leading to countercyclic variation in the risk aversion level. Their model can explain various empirical observations that seem inconsistent with other consumption-based asset pricing models (e.g., long-horizon predictability of asset returns and the "equity premium puzzle").

In the empirical analysis, I use *INVRELW*—the ratio of past to current real wealth—as a proxy for the aggregate RRA level.[4] This choice is motivated loosely by a utility function with a subsistence level that varies with past wealth. The inverse ratio captures some of the nonlinearity in equation (2): RRA is more sensitive to changes in wealth at lower wealth levels. A significant positive relation between *INVRELW* and future asset returns should exist because many asset pricing models imply that expected asset risk premia are positively related to the aggregate RRA level.

My empirical proxy for aggregate wealth is the real stock market index. Stock markets represent only a small part of the world aggregate wealth (see Ibbotson, Siegel, and Love 1985)), but they constitute the most volatile segment and are positively correlated with most other parts of wealth. In addition, stock prices are timely and can be measured accurately, unlike broader macroeconomic production and consumption variables. My unpublished analysis indicates that such macroeconomic variables do not have significant ability to predict international bond returns.

[4] The appropriate span of historical data included in "past wealth" is somewhat arbitrary. I use an exponentially weighted average of past wealth levels, thus assigning smaller weights to the more distant wealth levels. I choose a smoothing coefficient value of 0.90 because I want to capture business cycle effects; the cumulative last 12 months' weight is 70 percent and the cumulative last 36 months' weight is 95 percent. The main inferences that follow are quite robust to other weighting schemes. The inverse relative wealth is

$$INVRELW_t = \frac{ewaW_{t-1}}{W_t} = \frac{(W_{t-1} + 0.9 * W_{t-2} + 0.9^2 * W_{t-3} + \ldots) * 0.1}{W_t} \tag{3}$$

where W_t is the real level of stock market at time t, and $ewaW_{t-1}$ is the exponentially weighted average of real stock market levels up to $t - 1$. This variable is related to the detrended stock price level Keim and Stambaugh (1986) use to predict U.S. asset returns.

As a preliminary data characterization, I examine the average business cycle behavior of *INVRELW* and the excess bond return. If *INVRELW* really reflects wealth-dependent RRA, whose variation causes time-variation in expected asset returns, one would expect both series to peak during cyclical contractions. Figure 1 shows the average value of U.S. *INVRELW* and the U.S. bond return at different stages of the business cycle.[5] As expected, *INVRELW* has a distinct countercyclic pattern. Furthermore, the excess bond return exhibits a similar pattern with a lag, so *INVRELW* appears to track well the business cycle pattern of the expected bond risk premium.

C. Motivating the Instruments: Bond Beta

Predictable variation in expected asset risk premia may be caused by time-varying risk as well as by time-varying risk aversion. Of the many possible instruments reflecting time-varying risk, I use the historical bond beta, i.e., the slope coefficient from a regression of excess bond returns on excess stock stock returns. This instrument is motivated by a CAPM with time-varying betas. A casual look at the data suggests that the relative risk of bonds (versus other assets) is not stable over time. For example, the U.S. bond market's relative volatility increased sharply in October 1979 after the Federal Reserve Bank changed its operating procedures.

D. Motivating the Instruments: Term Spread and Real Bond Yield

My individual proxies for time-varying risk aversion and time-varying risk are unlikely to capture all predictable variation in bond returns. Therefore, I also use two instruments that proxy for the *overall* expected bond risk premium.

The shape of the yield curve has often been used as a proxy for the expected bond risk premium (see Fama and Bliss (1987) and Campbell and Ammer (1993)). Campbell and Ammer (1993) show that the continuously compounded (per-period) yield of an n-period nominal discount bond is

$$y_{n,t} = \left(\frac{1}{n}\right) E_t \sum_{i=0}^{n-1} (\pi_{t+1+i} + \mu_{t+1+i} + x_{n-i,t+1+i}) \tag{4}$$

This yield (y) is a sum of three terms: the n-period average of expected inflation rates π; the n-period average of expected real rates of a one-period nominal bond μ; and the n-period average of expected bond risk premia x. Equation (4) shows that the bond yield contains information about future expected bond risk premia—but also about other future events. It is a noisy proxy for expectations of all three terms on the right-hand side of equation (4). Subtracting from the bond yield elements that reflect the expected future short rates ($y_1 = \pi + \mu$) should produce a less noisy proxy for the expected

[5] The computation of these average values is described below Figure 1. I focus on the U.S. markets between 1953 and 1992 to have high-quality data that covers several business cycles.

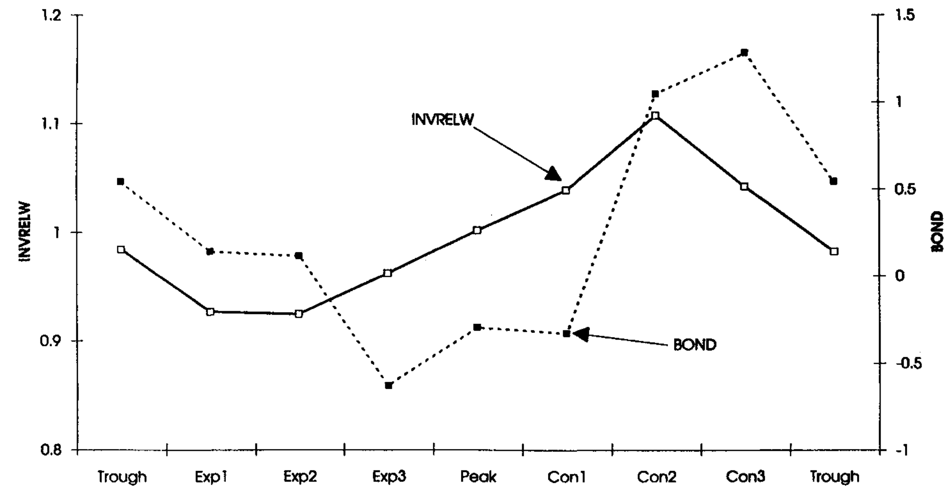

Figure 1. Average cyclical behavior of the U.S. inverse relative wealth and excess bond return, 1/1953 to 12/1992. Inverse relative wealth (*INVRELW*) is the ratio of the average past real stock market index level to the current index level (see Equation (3)), where the real stock market index is the value-weighted CRSP index deflated by the CPI. Excess bond return (*BOND*) is the monthly return of a long-maturity government bond in excess of a one-month Treasury bill rate (from Ibbotson Associates), expressed in percent. The average value of *INVRELW* and of the *BOND* is computed for eight "stage-of-the-business-cycle" subsamples, based on nine cycles between 1953 and 1992. Two subsamples include seven-month windows around each business cycle *peak* and *trough*, as defined by the National Bureau of Economic Research. In addition, each business cycle is split to three thirds of expansion (*Exp*1, *Exp*2, *Exp*3) and three thirds of contraction (*Con*1, *Con*2, *Con*3), and each month is assigned to one of these six subsamples. Note that the horizontal axis does not reflect the fact that expansions tend to be much longer than contractions.

risk premium. This motivates the use of the term spread and the real bond yield; both are differences between the bond yield and some other variable.

The per-period term spread can be written as

$$\begin{aligned} TERMSP_{n,t} &= y_{n,t} - y_{1,t} \\ &= \left(\frac{1}{n}\right) E_t \sum_{i=0}^{n-1} [(n-1-i)(\Delta y_{1,t+2+i}) + x_{n-i,t+1+i}] \end{aligned} \tag{5}$$

where Δy_1 is the change in the one-period nominal yield. To the extent that Δy_1 is unpredictable, variation in the term spread reflects only variation in expected bond risk premia.

The per-period real bond yield can be written as

$$\begin{aligned} REALYLD_{n,t} &= y_{n,t} - \left(\frac{1}{n}\right) E_t \sum_{i=0}^{n-1} \pi_{t+1+i} \\ &= \left(\frac{1}{n}\right) E_t \sum_{i=0}^{n-1} (\mu_{t+1+i} + x_{n-i,t+1+i}) \end{aligned} \tag{6}$$

I use the recent year-on-year inflation rate as the expected inflation rate over the remaining life of the bond. This measure implicitly assumes that the inflation rate follows a random walk. If this assumption holds empirically and if the sum of the expected real rates μ is stable over time, variation in the real bond yield reflects variation in expected bond risk premia.

Equations (5) and (6) show that the term spread and the real bond yield contain information about expected bond risk premia *and* about expected future nominal or real rates. Thus, neither instrument is likely to be a perfect proxy for the expected bond risk premium. Because it is not clear a priori whether the term spread or the real bond yield is the less noisy proxy, I will use both instruments in my empirical analysis.

II. Describing Predictable Variation in International Bond Returns

A. Data Description

I examine the predictability of continuously compounded excess government bond returns in six industrialized countries—the United States, Canada, Japan, Germany, France, and the United Kingdom. These markets constitute more than 80 percent of the world bond markets. Moreover, the data availability and quality are better in these markets than in those of other countries.

I use monthly data from January 1978 to June 1993. The bond market data are probably most reliable in North America because the U.S. and Canada had fully deregulated capital markets at the beginning of the sample period. In the other countries, the liberalization of domestic and/or foreign capital controls occurred later. In addition, a liquid secondary market in government bonds developed in Japan only during the late 1970s and in France during the mid-1980s.[6]

The government bonds that I study are a subset of the Salomon Brothers World Bond Index (WBI), a value-weighted index of government bonds and Eurobonds with remaining maturities of at least five years. The WBI can be decomposed into subsectors, and I examine the government bond subsector (70 to 80 percent of the total) which is reliably priced, contains no default risk, and uses all the bonds in the subsector (although before 1985 some samplings were used). Earlier studies of international bond return predictability use few individual bonds to represent the whole market.[7] It is preferable to use government bonds also as short assets when analyzing excess bond returns. However, because half of the six countries in this study do not have a liquid Treasury bill market, I use one-month Eurodeposits as

[6] Otani and Tiwari (1981) and Patat (1989) describe the deregulation and development of the Japanese and French financial markets.

[7] An anonymous referee pointed out that the empirical results would be sharper if I could use maturity subsectors of each market instead of aggregate indices of the long-term bond market. For example, maturity-matched term spreads would be more precise predictors of excess bond returns than the unmatched spreads I use. However, return data on maturity-specific government bond portfolios are available outside the U.S. only since 1985.

the short asset (from Data Resources, Inc. and Salomon Brothers).[8] Eurodeposits are perceived to have a low default probability.

I also examine the predictability of the "world" excess bond return, which is a weighted average of excess bond returns for individual countries. I compute both real GNP weights and bond market capitalization weights. Because the weightings are quite similar, I report results only with the GNP weights.[9]

The predictive variables are *INVRELW*, the bond beta, the term spread, and the real bond yield. I use country-specific local instruments as well as their GNP-weighted averages, which I call the "world" instruments. All instruments are publicly known at the time of forecasting.

INVRELW is the ratio of (the exponentially weighted average of) past real wealth to current real wealth. I use each country's Morgan Stanley Capital International (MSCI) stock market index deflated by the consumer price index (CPI) to proxy for real wealth. I allow for the CPI's publication lag so as to make it available information. For the United States, I use the value-weighted Center for Research in Security Prices (CRSP) market portfolio because it is broader than the MSCI index.

The local bond beta is the slope coefficient from a regression of the monthly local bond return on the monthly local stock market return over the past twelve months. Using daily instead of monthly data would lead to more timely and accurate proxies for conditional bond risk. However, because daily data are available only in the United States, the bond beta I use in most of the empirical analysis is the slope coefficient from a regression of the daily U.S. bond return on the daily U.S. stock market return over the previous month.

For the term spread and the real bond yield, I have collected high-quality interest rate data from various sources. All rates are based on month-end data and expressed in continuously compounded yields. Because the best long-term bond yield series do not cover the entire sample period, I combine two series. For data after January 1985, I use the yield of the seven- to

[8] My unpublished analysis confirms that this article's main results are not affected if domestic rates such as Treasury bills are used instead of Eurodeposit rates. Excess bond returns are driven more by their volatile bond component than by the short asset component.

[9] Every quarter, I compute each country's nominal gross national (domestic) product in U.S. dollars to get the starting weights. Foreign exchange movements, therefore, do have an impact on the weights but not on the returns. Below are the average weights between 1978 and 1993 for both weighting schemes.

	Means (min–max) of the GNP Weights (in percent)		Means of the Bond Market-Cap Weights (in percent)
United States	47	(40–57)	52
Canada	5	(4–5)	2
Japan	21	(16–26)	29
Germany	11	(8–14)	4
France	9	(7–11)	5
United Kingdom	7	(6–9)	8

ten-year maturity subsector of Salomon Brothers' World Government Bond Index. Before 1985, I use series that have durations similar to this subsector.[10]

The term spreads are more sensitive to a mixing of default-free and default-risky assets than the excess bond returns are, so I use only government bond data whenever possible. From the long bond yield I subtract the three-month Treasury bill rate in the United States, Canada, and the United Kingdom (from Salomon Brothers), the gensaki rate in Japan (from Citibase), the par yield of a one-year government bond in Germany (from Bundesbank), and the Paris interbank loan rate in France (from the Organization for Economic Cooperation and Development, OECD).

The real bond yield is the difference between the long-term bond yield and the year-on-year inflation rate for the previous month (as a proxy for the expected long-term inflation). The lag ensures that this variable is available at the time of forecasting. For example, I subtract the January inflation rate (announced in February) from the February-end bond yield to predict the March bond return. The inflation rates are based on OECD-data, except that of the United States, which is based on the rental-equivalent CPI series (see Huizinga and Mishkin (1984)).

Table I presents summary statistics for the dependent and independent variables in the predictive regressions. The mean excess bond return is not significantly different from zero in any country. The Anglo-American bond markets are almost twice as volatile as the other bond markets, reflecting larger yield volatility and the longer average maturity of government debt. All the excess return series exhibit weak positive first-order autocorrelation. In contrast, the predictive instruments are very persistent.

The sample correlation coefficients between excess bond returns in different countries range from 0.33 to 0.55, except for the United States-Canada correlation (0.79). The world instruments are not highly correlated with each other; the only correlation larger than 0.30 is between the term spread and the real bond yield (0.64). *INVRELW* is negatively related to the other instruments.

B. International Predictive Regressions

This section examines whether excess bond returns can be forecast using local or global instruments. Each country's and the (GNP-weighted) world's monthly excess bond return is regressed on various instrument sets. Table II shows the simple regression results for each world instrument and the results from three multiple regressions. For comparison, the final regression shows the forecasting ability of local instruments. The slope coefficients, their t-statistics, the in-sample and out-of-sample R^2 values,[11] and the joint significance of all regressors are reported.

[10] United States—the five-year spot rate (from CRSP Fama-Bliss files); Canada—the average yield of five- to ten-year government bonds (from Bank of Canada); Japan—the par yield of a ten-year government bond (from Nomura Securities); Germany—the par yield of a ten-year government bond (from Bundesbank); France—the yield of a ten-year government bond (from Banque de France); and United Kingdom—the par yield of a ten-year government bond (from Bank of England).

[11] All R^2 values in this article are adjusted for degrees of freedom.

There is a natural concern about "data-snooping bias" when the significance of any return predictability finding is evaluated. I address this concern by conducting out-of-sample analysis and subperiod analysis. The out-of-sample analysis is based on the following steps. The excess bond return is regressed on a given instrument set using data between January 1978 and December 1979. The regression results are used to make a one-step-ahead forecast of the excess bond return for January 1980. This procedure is repeated for each month until June 1993 using all available data since 1978. Finally, the realized excess returns over the period 1980 to 1993 are regressed on the predicted excess returns (i.e., the estimated one-step-ahead forecasts). The out-of-sample R^2 is the adjusted coefficient of determination from this regression.

The simple regressions show that the world instruments can predict excess bond returns. *INVRELW*, the term spread, and the real bond yield are all significantly related to subsequent bond returns in most countries. The positive coefficient on *INVRELW* is consistent with the conjecture of wealth-dependent RRA, and the positive coefficients on the two other instruments are consistent with the hypothesis that they are noisy proxies for the overall expected bond risk premium. The coefficients on the bond beta are also positive, as expected, but they are never statistically significant. The term spread and the real bond yield tend to have larger in-sample R^2 value than *INVRELW*. But in the out-of-sample analysis, *INVRELW* is the only instrument with consistent predictive ability; in three countries, the out-of-sample R^2 value is even larger than the in-sample R^2 value.

The most striking result in the multiple regressions is the strong predictive ability of the world real bond yield and world *INVRELW* together. In-sample, they capture 4 to 11 percent of the bond return variation in different countries (and 0 to 7 percent out-of-sample). These R^2 values are larger than those reported in earlier studies. The two instruments are jointly significant at the 2 percent level in all countries, and the t-values of their regression coefficients almost always exceed 2.0. The ratio of their partial regression coefficients is quite similar across countries, suggesting that expected excess bond returns may be perfectly correlated. I will pursue this implication in Section III.

The results in Table II show that the world real bond yield and world *INVRELW* complement each other as predictive instruments. Their partial regression coefficients are 25 to 50 percent larger than the simple regression coefficients, and their combined predictive power is larger than the sum of the simple regression R^2 values. These two instruments capture much of the predictable variation in international bond returns. Adding the world term spread and the U.S. bond beta in the instrument set only increases the average R^2 from 7.0 percent to 8.3 percent. This addition reduces the coefficients of the real bond yield because it is highly correlated with the term spread.

The final regression shows that local instruments produce similar inferences, although their predictive ability is slightly worse than that of the world instruments (except in Canada). The average R^2 value for a set of four

Table I

Summary Statistics for International Bond Returns and Predictive Variables, 1/1978 to 6/1993

Summary statistics are presented separately for variables in the United States (*US*), Canada (*CA*), Japan (*JA*), Germany (*GE*), France (*FR*), the United Kingdom (*UK*), and the "world" (*WO*), a GNP-weighted average of six country-specific variables. *BOND* is the continuously compounded excess return (difference between the local currency asset return and the local currency one-month Eurodeposit rate) of the long-maturity government bond portfolio, expressed in percent per month. *INVRELW* or inverse relative wealth is the inverse of the detrended real stock market level, as defined in Equation (3). *BOND BETA* is the slope coefficient in a regression of the monthly local bond return on the monthly local stock market return during the past twelve months except for the bond beta in the last column, which is the slope coefficient in a regression of the daily U.S. bond return on the daily U.S. stock market return during the previous month. *TERMSP* or the term spread is the difference between the long-maturity government bond yield and the short-maturity government bond yield or its close substitute. *REALYLD* or the real bond yield is the difference between the long-maturity government bond yield and the year-on-year CPI inflation rate lagged by one month.

Panel A: Sample Means, Standard Deviations, and First-Order Autocorrelation Coefficients

	US	*CA*	*JA*	*GE*	*FR*	*UK*	*WO*
Bond							
Mean	0.082	0.012	0.087	0.020	−0.017	−0.021	0.061
Std.	2.917	3.054	1.743	1.554	1.666	2.813	1.983
AC1	0.134	0.211	0.175	0.176	0.140	0.095	0.191
INVRELW							
Mean	0.948	0.971	0.961	0.968	0.942	0.939	0.955
Std.	0.072	0.107	0.136	0.115	0.120	0.077	0.076
AC1	0.834	0.903	0.922	0.902	0.878	0.795	0.885
BOND BETA							
Mean	0.294	0.227	0.132	0.155	0.103	0.269	0.278
Std.	0.228	0.224	0.201	0.187	0.097	0.187	0.222
AC1	0.900	0.909	0.912	0.945	0.880	0.884	0.194
TERMSP							
Mean	1.300	−0.383	0.378	0.639	−0.248	−0.260	0.711
Std.	1.523	1.802	1.110	1.200	1.186	1.890	0.981
AC1	0.933	0.919	0.930	0.973	0.890	0.931	0.949
REALYLD							
Mean	4.032	4.272	3.657	4.274	3.682	3.605	3.951
Std.	2.267	2.192	1.480	1.161	2.287	2.799	1.765
AC1	0.965	0.949	0.906	0.938	0.980	0.943	0.967

Panel B: Sample Correlations Between Excess Bond Returns

	US	*CA*	*JA*	*GE*	*FR*	*UK*	*WO*
US BOND	1.000						
CA BOND	0.794	1.000					
JA BOND	0.417	0.398	1.000				
GE BOND	0.509	0.541	0.549	1.000			
FR BOND	0.340	0.410	0.365	0.518	1.000		
UK BOND	0.389	0.375	0.393	0.388	0.332	1.000	
WO BOND	0.951	0.825	0.623	0.663	0.491	0.540	1.000

Table I—*Continued*

Panel C: Sample Correlations Between Global Predictive Variables

	WO INVRELW	*US BOND BETA*	*WO TERMSP*	*WO REALYLD*
WO INVRELW	1.000			
US BOND BETA	−0.145	1.000		
WO TERMSP	−0.119	0.636	1.000	
WO REALYLD	−0.291	−0.100	0.151	1.000

local instruments is 6.2 percent, while the average R^2 value for a set of four world instruments is 8.3 percent. Harvey (1991) also finds that global instruments are better predictors than local instruments in international stock markets. These finds may reflect the integrated nature of these markets—in an integrated market, the market price of risk is determined by worldwide economic conditions rather than by local economic conditions. Alternatively, they may reflect poor data quality outside the United States.

Subperiod analysis shows that the documented relations are quite robust over time. The regression of world excess bond return on the four world instruments has an R^2 value of 24 percent between 1/1978 and 2/1983, 7 percent between 3/1983 and 4/1988, and 19 percent between 5/1988 and 6/1993.[12] Ilmanen (1994) studies the predictability of U.S. government bond returns between 1953 to 1992 and finds that similar instruments predict 5 to 10 percent of the monthly variation in short-maturity and long-maturity bond returns, both in-sample and out-of-sample, and during the whole period as well as during subperiods before 1978.

I conclude that excess bond returns in all six countries can be forecast by a small set of instruments and that wealth-dependent RRA is an important source of the time-variation in expected bond returns.[13,14] However, it is

[12] Bond returns were least predictable in the middle subperiod during which there was no recession in the major economies. This observation is consistent with the notion that predictability reflects business cycle related time-variation in expected returns, and it complements Tierens's (1994) finding that U.S. stock returns are more predictable during economic recessions than during economic expansions.

[13] I propose that the inverse relation between the relative level of the stock market and future bond returns reflects wealth-dependent RRA. Alternatively, the observed relation may be caused by wealth-dependent volatility (Zhang (1992)) or by wealth-dependent investor sentiment (Poterba and Summers (1988)).

[14] An anonymous referee suggested that *INVRELW*'s ability to predict bond returns might reflect the autocorrelation in bond returns and contemporaneous correlation between stock and bond returns. Based on his recommendation, I construct a measure similar to *INVRELW* using bond data, i.e., the inverse of relative bond market level. I find that this measure is weakly related to future bond returns (with t-value near 1.5), but *it has a different sign* than *INVRELW*. Declines in stock prices tend to be followed by increases in bond prices, while declines in bond prices tend to be followed by more declines in bond prices. This experiment shows that *INVRELW*'s predictive ability is not just picking up the autocorrelation in bond returns.

Table II

Regressions of Excess Government Bond Returns on Various Sets of "World" (*WO*) or Local (*LOC*) Predictive Variables 1/1978 to 6/1993

Dependent variables include bonds from six countries (the United States (*US*), Canada (*CA*), Japan (*JA*), Germany (*GE*), France (*FR*), the United Kingdom (*UK*)) and the "world" (*WO*), a GNP-weighted average of six country-specific variables. *BOND* is the excess return of the long-maturity government bond portfolio over the one-month Eurodeposit rate, expressed in percent per month. *INVRELW* is the inverse of the detrended real stock market level, as defined in Equation (3). The local *BOND BETA* is the slope coefficient in a regression of the monthly local bond return on the monthly local stock market return during the past twelve months. The U.S. *BOND BETA* is the slope coefficient in a regression of the daily U.S. bond return on the daily U.S. stock market return during the previous month. *TERMSP* is the difference between the long-maturity government bond yield and the short-maturity government bond yield or its close substitute. *REALYLD* is the difference between the long-maturity government bond yield and the year-on-year CPI inflation rate lagged by one month. b is the regression slope coefficient, and t is its t-statistic (standard error is adjusted for heteroscedasticity and first-order autocorrelation, see Newey and West (1987)). R^2 is the in-sample coefficient of determination (adjusted for degrees of freedom and expressed in percent), while "*oos* R^2" is the out-of-sample coefficient of determination. It is based on a regression for 1/1980 to 6/1993 where the realized excess bond returns are regressed on the predicted excess bond returns (rolling one-step ahead forecasts using available data since 1/1978). If the slope coefficient of that regression is negative, *oos* R^2 is reported to be -1 percent. "Joint significance" is the probability value of the chi-square statistic for testing the restriction that all regressors but constant have zero coefficients, expressed in percent.

Independent Variable	Dependent Variables						
	US BOND	*CA BOND*	*JA BOND*	*GE BOND*	*FR BOND*	*UK BOND*	*WO BOND*
WO INVRELW							
b	6.76	6.49	3.85	3.31	2.10	5.60	5.30
[t]	[2.41]	[1.97]	[2.01]	[2.31]	[1.21]	[1.78]	[2.64]
R^2	2.6	2.1	2.3	2.1	0.4	1.8	3.6
(*oos* R^2)	(5.6)	(3.1)	(1.1)	(6.8)	(−0.4)	(1.0)	(6.4)
US BOND BETA							
b	1.71	1.43	0.07	0.76	0.31	0.96	1.07
[t]	[1.55]	[1.30]	[0.09]	[1.50]	[0.61]	[0.88]	[1.48]
R^2	1.2	0.5	−0.5	0.6	−0.4	0.0	0.9
(*oos* R^2)	(−0.2)	(−0.4)	(−1.0)	(−1.0)	(−0.3)	(−1.0)	(−0.2)
WO TERMSP							
b	0.59	0.72	0.28	0.35	0.44	0.37	0.49
[t]	[1.71]	[2.01]	[1.48]	[1.96]	[3.39]	[1.62]	[2.10]
R^2	3.4	4.9	2.0	4.5	6.0	1.1	5.3
(*oos* R^2)	(0.0)	(0.9)	(−0.6)	(0.3)	(2.5)	(−1.0)	(1.1)
WO REALYLD							
b	0.39	0.36	0.13	0.17	0.16	0.19	0.28
[t]	[2.45]	[2.25]	[1.43]	[1.68]	[2.29]	[1.54]	[2.52]
R^2	5.1	3.8	1.2	3.2	2.4	0.9	5.7
(*oos* R^2)	(0.0)	(−0.5)	(−1.0)	(−0.1)	(0.1)	(−1.0)	(0.0)

Table II—*Continued*

Independent Variable	Dependent Variables						
	US BOND	*CA BOND*	*JA BOND*	*GE BOND*	*FR BOND*	*UK BOND*	*WO BOND*
WO INVRELW							
b	10.27	9.74	5.15	4.87	3.47	7.54	7.85
[*t*]	[3.57]	[2.73]	[2.72]	[3.22]	[1.90]	[2.36]	[3.89]
WO REALYLD							
b	0.52	0.48	0.19	0.23	0.20	0.29	0.38
[*t*]	[3.39]	[2.94]	[2.09]	[2.25]	[2.81]	[2.19]	[3.50]
R^2	11.2	8.8	5.3	8.0	4.2	4.2	13.6
(*oos* R^2)	(6.4)	(2.6)	(1.3)	(7.1)	(0.4)	(0.1)	(7.8)
Joint significance	0.0	0.3	0.7	0.2	1.1	1.8	0.0
WO INVRELW							
b	10.61	9.80	5.05	4.91	3.26	7.69	7.98
[*t*]	[3.70]	[2.74]	[2.68]	[3.29]	[1.75]	[2.37]	[3.94]
US BOND BETA							
b	1.89	1.88	0.27	1.01	0.62	1.27	1.30
[*t*]	[1.81]	[1.57]	[0.32]	[2.00]	[1.27]	[1.20]	[1.90]
WO TERMSP							
b	0.28	0.58	0.20	0.30	0.44	0.27	0.31
[*t*]	[0.70]	[1.31]	[0.89]	[1.59]	[2.76]	[0.92]	[1.14]
WO REALYLD							
b	0.39	0.24	0.12	0.11	0.03	0.17	0.25
[*t*]	[2.41]	[1.31]	[1.17]	[1.09]	[0.42]	[1.03]	[2.23]
R^2	12.3	10.7	5.0	10.1	7.0	4.4	15.3
(*oos* R^2)	(4.2)	(2.4)	(0.0)	(6.6)	(1.2)	(−0.3)	(5.5)
Joint significance	0.0	0.6	3.4	0.2	0.3	5.8	0.0
LOC INVRELW							
b	8.81	7.44	2.87	1.76	1.34	7.23	
[*t*]	[2.50]	[2.15]	[2.64]	[1.73]	[1.24]	[2.45]	
LOC BOND BETA							
b	0.12	1.42	0.40	−1.86	1.56	1.02	
[*t*]	[0.10]	[1.53]	[0.37]	[−2.02]	[0.86]	[1.00]	
LOC TERMSP							
b	0.31	0.23	−0.16	−0.12	0.23	−0.14	
[*t*]	[1.50]	[1.38]	[−0.83]	[−1.02]	[1.40]	[−1.14]	
LOC REALYLD							
b	0.23	0.16	0.32	0.03	0.15	0.25	
[*t*]	[1.58]	[1.66]	[2.55]	[0.34]	[2.31]	[2.80]	
R^2	9.7	11.6	4.8	2.6	5.1	3.6	
(*oos* R^2)	(1.6)	(0.1)	(−0.1)	(0.3)	(0.8)	(−0.3)	
Joint significance	0.3	0.1	4.9	2.2	3.1	0.8	

unlikely to be the only source because the two overall proxies have marginal predictive ability beyond that of *INVRELW*. This ability could be related to the time-varying amount and price of inflation risk.

C. Economic Significance of the Bond Return Predictability

In this subsection, I study whether the observed predictability patterns are economically significant. Table III compares the performance of dynamic trading strategies that exploit the world instruments' predictive ability to that of a static strategy (always holding the world long-term bond portfolio). All strategies are zero-investment strategies financed with the world one-month Eurodeposit. Dynamic strategies are rebalanced monthly based on the value of the predicted world excess bond return. The "scaled" strategy involves taking a positive or negative position in the world bond portfolio so that the size of the position is equal to the portfolio's predicted excess return (in percent). The "1/0" strategy involves holding one unit of the world bond portfolio if its predicted excess return is positive and none if it is negative. Results are reported using in-sample and out-of-sample estimates of the predicted world excess bond return. The in-sample estimates are fitted values from the regression of world excess bond return on world *INVRELW*, the world real bond yield, the world term spread, and the U.S. bond beta. The out-of-sample estimates are one-step-ahead forecasts based on rolling regressions that begin in January 1980 and use all available data since 1978.

The mean annual excess return of the static strategy is 0.73 percent and its reward-to-volatility ratio is quite low (0.03). The dynamic strategies perform much better. The scaled strategy earns mean annual excess return 8.09 percent (6.84 percent out-of-sample), while the 1/0 strategy earns 3.94

Table III

Performance of Static and Dynamic Trading Strategies with World Bonds, 1/1978 to 6/1993

The in-sample and out-of-sample performance of three investment strategies with the world long-maturity bond portfolio. The strategies are described in the main text. Mean is the annualized sample mean of monthly excess returns, expressed in percent. Std in the annualized sample standard deviation of monthly excess returns. Sharpe ratio is the sample mean over the sample standard deviation (not annualized). The in-sample results are based on period 1/1978 to 6/1993, while the out-of-sample results are based on period 1/1980 to 6/1993.

	Static:	Dynamic In-Sample		Dynamic Out-of-Sample	
	Always Bond	Scaled	1/0	Scaled	1/0
Mean	0.73	8.09	3.94	6.84	3.14
Std.	6.87	6.48	4.45	9.49	4.66
Sharpe ratio	0.03	0.36	0.26	0.21	0.19

percent (3.14 percent out-of-sample). Their reward-to-volatility ratios range from 0.19 to 0.36.[15]

The predictive ability of the world instruments appears to be economically significant. However, I have not adjusted the returns for transaction costs or for time-varying risk. The scaled strategy is quite transaction-intensive, and it assumes that government bonds may be shorted with the full use of proceeds. The "paper gains" this strategy earned during the early 1980s by shorting the bond markets could not have been realized in practice; thus, the reported results are overstated. The 1/0 strategy is based on the sign of the predicted excess bond return, not its magnitude. Because this simple strategy involves infrequent trading and no shortselling, the reported results are more reliable. In regard to time-varying risk, proper risk adjustment would at least take into account the fact that the volatility of the dynamic strategies changes in a predictable way when the asset weights change.

III. Common Predictable Variation in International Bond Returns

Thus far I have analyzed predictable return variation *separately* in each country. Next I focus on the *common* variation in expected bond returns. Table II provides preliminary evidence on this issue. First, the predictability patterns are broadly similar across countries. Second, the world instruments are somewhat better predictors than the local instruments. Third, the ratio of the partial slope coefficients of the two strongest predictors, the world real bond yield and world *INVRELW*, is almost the same in all countries. As explained below, this pattern suggests a high correlation between expected returns.

In this section, I examine how closely correlated the expected excess bond returns are across countries, and I ask whether the common predictable variation in excess bond returns is consistent with a simple asset pricing model and market integration.

A. The Degree of Correlation between Expected Excess Bond Returns

A test of a single latent variable model (*SLVM*) provides a formal way to assess whether expected excess bond returns in various countries are perfectly correlated (see Campbell and Clarida (1987) and Hodrick (1987)). *SLVM* assumes that conditional betas (β_i) in a one-factor model are constant and that the expected excess return of the risk factor (λ_t) is linear in a set of forecasting instruments: $\lambda_t = \Sigma_{n=0}^{N} \theta_n Z_{n,t}$ where the instrument set consists of a $(N + 1)$ vector $\mathbf{Z}_t (Z_{0,t}$ is a constant) and where θ_n are the coefficients on

[15] Similar analysis for six individual countries shows that, in each country, the average returns and reward-to-volatility ratios of the dynamic strategies are higher than those of the static strategies "always hold long-maturity bonds" or "always hold short-term deposits."

these instruments. *SLVM* implies that expected excess returns of all assets are proportional to λ_t and, thus, perfectly correlated. The expected excess return of asset i over the nominally riskless asset is

$$\begin{aligned} E_t(r_{i,t+1}) &= \beta_i \lambda_t \\ &= \beta_i \left(\sum_{n=0}^{N} \theta_n Z_{n,t} \right) \\ &= \sum_{n=0}^{N} \omega_{in} Z_{n,t} \end{aligned} \tag{7}$$

where $\omega_{in} = \beta_i \theta_n$. Expected excess returns vary across assets only to the extent that their betas are different. When M excess returns are regressed on $N + 1$ forecasting instruments, *SLVM* imposes the restriction that the ratio of any two regression coefficients should be constant across forecasting equations.

These cross-equation restrictions can be tested using Hansen's (1982) generalized method of moments (GMM). This method is built on the orthogonality of the regression residuals $u_{i,t+1}$ with the instrument set $\mathbf{Z}_t$. Given a sample of T observations, the GMM forms a vector of $M(N + 1)$ orthogonality conditions $\mathbf{g} = \text{vec}(\mathbf{u}'\mathbf{Z})$, where $\mathbf{u}$ is the TxM-matrix of residuals and $\mathbf{Z}$ is the $Tx(N + 1)$-matrix of instruments. An algorithm searches for parameter values that minimize the quadratic form $\mathbf{g}'\mathbf{W}\mathbf{g}$, where $\mathbf{W}$ is a weighting matrix. The minimized quadratic form (multiplied by T) serves as a goodness-of-fit statistic for the model. It is asymptotically chi-square distributed with degrees of freedom equal to the number of overidentifying restrictions. The statistic reflects the correlation between each residual series and each instrument series in the system. Thus, a high chi-square statistic indicates that the residuals are predictable, which is evidence against the model restrictions.

Table IV presents the results of estimating a system of six equations using four predictive instruments besides a constant: world *INVRELW*; the world real bond yield; the world term spread; and the U.S. bond beta. The world instruments are used because they are better predictors than the local instruments. There are 30 orthogonality conditions and 10 parameters to be estimated, leaving 20 overidentifying restrictions to be tested. The chi-square statistic has a p-value of 98.1 percent; thus, the data offer no evidence against the model restrictions. The expected excess return of all bonds appear to be perfectly correlated. As additional diagnostics, I regress the model residuals on the four world instruments and on the corresponding four local instruments. The coefficients of determination in these regression are negative or close to zero.

Cumby and Huizinga (1992) note that the chi-square statistic tests whether the data contain statistically significant deviations from the null hypothesis of perfect correlation between expected returns. Yet, the test may not be informative about how far the data are from the null hypothesis. A high

Table IV

Estimating and Testing a Single Latent Variable Model, 1/1978 to 6/1993

Results from estimating a single latent variable model (*SLVM*) using generalized method of moments (GMM)

$$\begin{bmatrix} r_{1,t+1} \\ r_{2,t+1} \\ \vdots \\ r_{6,t+1} \end{bmatrix} = \begin{bmatrix} \theta_0 & \theta_1 & \cdots & \theta_4 \\ \beta_2\theta_0 & \beta_2\theta_1 & \cdots & \beta_2\theta_4 \\ & & \vdots & \\ \beta_6\theta_0 & \beta_6\theta_1 & \cdots & \beta_6\theta_4 \end{bmatrix} \begin{bmatrix} Z_{0,t} \\ Z_{t,t} \\ \vdots \\ Z_{4,t} \end{bmatrix} + \begin{bmatrix} u_{1,t+1} \\ u_{2,t+1} \\ \vdots \\ u_{6,t+1} \end{bmatrix}$$

where r_1 is the U.S. excess bond return and $r_2, \ldots, r_6$ are the excess bond returns in Canada (CA), Japan (JA), Germany (GE), France (FR), and the United Kingdom (UK). $\beta_2, \ldots, \beta_6$ are the estimated "relative beta" coefficients for these countries, and $u_1, \ldots, u_6$ are the residuals. The predictive instruments $Z_0, \ldots, Z_4$ include a constant, world inverse relative wealth, the world real bond yield, the world term spread, and the U.S. bond beta. $\theta_0, \ldots, \theta_4$ are the estimated coefficients on these instruments. The t-statistics (t) on the estimated coefficients use standard errors adjusted for heteroscedasticity and first-order autocorrelation (see Newey and West (1987)). *CHISQ* is T times the minimized value of the GMM objective function. The degrees of freedom (d.f.) is equal to the number of overidentifying restrictions. p is the significance level for testing the model's overidentifying restrictions, expressed in percent. Residual predictability is the coefficient of determination (adjusted for degrees of freedom, expressed in percent) when the residuals from the *SLVM* estimation are regressed on the four global instruments above or on the corresponding four local instruments.

		US	CA	JA	GE	FR	UK
β_i		1.00	0.95	0.43	0.52	0.40	0.56
$(t(\beta_i))$		(–)	(5.98)	(3.79)	(5.06)	(3.54)	(3.27)
θ_0 $(t(\theta_0))$	−10.49 (−4.39)						
θ_1 $(t(\theta_1))$	8.93 (3.99)						
θ_2 $(t(\theta_2))$	0.26 (2.33)						
θ_3 $(t(\theta_3))$	0.62 (2.14)						
θ_4 $(t(\theta_4))$	1.91 (2.31)						
Specification test							
CHISQ (d.f.)	9.14 (20)						
p	98.1						
Residual predictability (global)		−1.2	−2.1	−1.1	−1.9	−1.3	−1.6
Residual predictability (local)		−1.9	0.4	2.3	−1.8	0.8	0.7

p-value may indicate that expected returns are perfectly correlated, but it may also be caused by low power. Therefore, Cumby and Huizinga (1992) argue that the sample correlation between expected returns and the estimated standard error of this correlation coefficient should be examined directly.

Table V presents the correlation coefficients of the predicted excess bond returns as well as their asymptotic standard errors. The predicted excess returns are the fitted values from an unrestricted regression of excess bond returns on world *INVRELW*, the world real bond yield, the world term

Table V

Correlation Matrix of Fitted Expected Excess Returns, 1/1978 to 6/1993

The simple correlation coefficients of the predicted excess bond returns in the United States (*US*), Canada (*CA*), Japan (*JA*), Germany (*GE*), France (*FR*), the United Kingdom (*UK*), and the world (*WO*), with their asymptotic standard errors in parentheses. The predicted excess bond returns are the fitted values from regressing the excess bond returns on four predictive instruments (world inverse relative wealth, the world real bond yield, the world term spread, and the U.S. bond beta). The computation of the asymptotic standard errors is described in Cumby and Huizinga (1992).

	US	*CA*	*JA*	*GE*	*FR*	*UK*	*WO*
US	1.000						
	(–)						
CA	0.977	1.000					
	(0.030)	(–)					
JA	0.935	0.954	1.000				
	(0.119)	(0.106)	(–)				
GE	0.973	0.999	0.949	1.000			
	(0.051)	(0.009)	(0.092)	(–)			
FR	0.855	0.942	0.896	0.941	1.000		
	(0.136)	(0.088)	(0.136)	(0.087)	(–)		
UK	0.980	0.981	0.962	0.983	0.874	1.000	
	(0.057)	(0.062)	(0.104)	(0.057)	(0.152)	(–)	
WO	0.995	0.992	0.960	0.989	0.898	0.989	1.000
	(0.007)	(0.016)	(0.079)	(0.026)	(0.097)	(0.042)	(–)

spread, and the U.S. bond beta. The correlations are very large and accurately measured; except for France, the correlations always exceed 93 percent and are within one standard error from unity. The regulation of the French bond market in the first years of the sample would seem to account for its lower correlations (85 to 94 percent).[16] These correlations are much larger than those reported in Campbell and Clarida (1987) and in Cumby and

[16] Further analysis indicates that international bond markets have become increasingly integrated during the sample period. If these markets are driven by one risk factor and their relative risks are constant, market integration implies that expected excess bond returns are perfectly correlated across countries. (Note that integration alone—without a particular pricing model—need not imply perfect correlation. If there are multiple risk factors or if relative risks vary over time, imperfect correlations may be consistent with integration.) When I split the sample period into two halves (at 9/1985), the average pairwise correlation between different countries' predicted excess bond returns is 82 percent in the first half and 91 percent in the second half. The increases in correlations are largest for France and Japan, the most regulated and segmented markets in the early 1980s.

Huizinga (1992) between international money market, stock market, and foreign exchange returns.[17]

Figure 2 graphically illustrates the close comovement in the predicted excess bond returns among the six countries. All series are negative between 1978 to 1981 and peak at 1982 (worldwide recession), 1984 (real yields peak), 1987 (after the stock market crash), and 1990 (U.S. recession and the Gulf crisis).

B. Explaining the Predictability Patterns With an Asset Pricing Model

Financial economists continue to debate about the source of the asset return predictability. One key question in this debate is whether a simple asset pricing model can explain the observed predictable variation in asset returns.[18]

The *SLVM* test was interpreted above as data characterization: its results show that expected excess bond returns move fully synchronously. Alternatively, one can view it as a test of a very simple asset pricing model, with one unobservable factor and constant conditional betas. I next try to identify a good observable proxy for the unobservable risk factor. Finding an observable proxy would facilitate the economic interpretation of the results in Table IV. In particular, it is not clear a priori whether the latent variable reflects expected return variation common to all assets or whether it reflects variation specific to government bonds. Harvey (1991) shows that global financial market variables can forecast international stock returns and that a world CAPM explains much of the predictable variation (although the model can be rejected). Given the similarity between Harvey's and this article's findings, it would be interesting to see whether the same factor explains both international stock and bond return predictability.

The first proxy is, therefore, *the world excess stock return* (a GNP-weighted average of six local excess stock market returns). This factor represents general "market risk" and is motivated by the conditional CAPM. Harvey (1991) and Stulz (1994) present sufficient (but quite restrictive) conditions for the CAPM to hold in an international context.

[17] The inference that expected excess returns are perfectly correlated is conditional on the instrument set used in the analysis. Using maturity-matched and country-specific yields and bond returns could lead to more precise estimates of asset-specific expected returns and, thus, to lower correlations. Stambaugh (1988) studies the common predictable variation in short-maturity U.S. Treasury bill returns and finds that when maturity-specific term spreads are used as instruments, a *SLVM* can be rejected. Unfortunately, maturity-specific data are not available for non U.S. markets; but I find that the main results are robust to using country-specific instruments instead of common global instruments. For example, when the excess bond returns of two countries are predicted using *both* countries' local real bond yield and local *INVRELW* as instruments, all correlations between the predicted excess returns exceed 90 percent, except in France (60–86 percent).

[18] This question has not been previously addressed using government bond data. Ferson and Harvey (1993) find that multiple factors are needed to explain the predictable variation in international stock returns, while Campbell and Clarida (1987) and Jorion (1992) find that the predictable variation in international Eurodeposit returns is consistent with a *SLVM*.

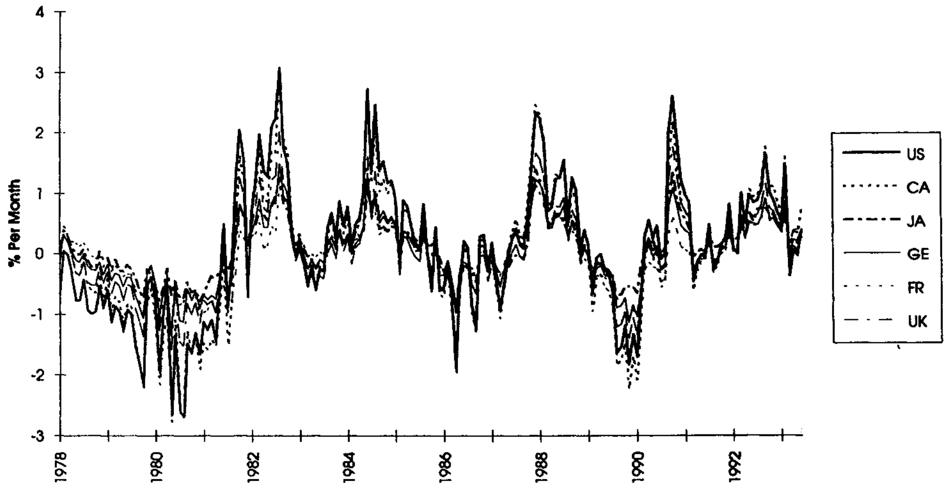

Figure 2. Predicted excess bond returns in six countries, 1/1978 to 6/1993. The predicted excess bond returns in the United States (US), Canada (CA), Japan (JA), Germany (GE), France (FR), and the United Kingdom (UK) are the fitted values from in-sample regressions of each country's excess bond return on world inverse relative wealth, the world real bond yield, the world term spread, and the U.S. bond beta.

The second proxy, *the world excess bond return*, represents global interest rate risk. There is little theoretical justification for a model in which interest rate risk is the *only* risk factor. Instead, I conjecture that multiple risk factors—one of which is interest rate risk—influence asset prices, and that government bonds have zero sensitivities to all factors other than interest rate risk. In such a setting, a one-factor model can describe the bond subset's behavior, and the expected excess returns on all bonds are perfectly correlated with the expected excess return of the world bond portfolio.[19]

A one-factor model with constant conditional betas implies that any predictability in excess asset returns is due to the time-variation in the market price of risk (λ_t). When asset returns are regressed on the risk factor, the intercept should be zero and the regression residuals should not be predictable by past information. The GMM specification test provides a natural

[19] It is hard to evaluate the empirical validity of this conjecture because there is currently no widely accepted multifactor model with a strong theoretical foundation. (For a survey of the literature on international asset pricing models, see Stulz (1994).) Most empirical studies use models with prespecified risk factors. One plausible multifactor model has one stock factor and one bond factor. Evans (1994) finds that such a model explains most of the predictable variation in U.S. stock and bond returns. My unpublished analysis, which is available on request, shows that when the six countries' excess bond returns are regressed on the world excess bond return and on the world excess stock return, the coefficients on the latter are never significantly different from zero. This finding is consistent with my conjecture that bonds have zero sensitivities to "the other" risk factors.

way to examine these restrictions in a multi-country system. GMM estimation is based on a system of the following $M(N+1)$ orthogonality conditions:

$$E[(\mathbf{r}_{t+1} - \boldsymbol{\beta} h_{t+1}) \otimes \mathbf{Z}_t] = \mathbf{0} \tag{8}$$

where $\mathbf{r}_{t+1}$ is a vector of M excess bond returns, $\boldsymbol{\beta}$ is a vector of M coefficients, h_{t+1} is the risk factor proxy (the world excess stock or bond return), and $\otimes$ denotes a Kronecker product. Again, the instruments are world *INVRELW*, the world real bond yield, the world term spread, the U.S. bond beta, and a constant. There are 30 orthogonality conditions and 6 parameters to be estimated, leaving 24 overidentifying restrictions to be tested.

Table VI shows that the world excess stock return is a poor observable proxy for the unobservable risk factor, while the world excess bond return is an excellent proxy. A model with a stock factor can be rejected at the 10 percent level, and it explains only a small part of the bond return predictability. In contrast, a model with a bond factor cannot be rejected (the chi-square statistic has a high p-value of 98.8 percent), and there is no sign of residual predictability.[20] Furthermore, the sample correlation of the latent variable with the predicted world excess bond return is almost 99 percent (versus only 33 percent with the predicted world excess stock return).

Clearly, a simple world CAPM cannot explain the observed bond return predictability. Expected stock and bond returns in international asset markets are not perfectly correlated. This finding might indicate that stock and bond markets are segmented or, more likely, that the asset pricing model is too simple. Multifactor models are probably needed to explain both bond and stock market behavior even if these markets are integrated (yet, bonds may have zero sensitivities to all the risk factors other than the interest rate risk).

Overall, the behavior of the six bond markets is consistent with market efficiency and integration and with a model in which bonds are influenced by one priced risk factor. The changing price of a global interest rate risk factor can explain almost all predictable variation in excess bond returns. This result complements the findings of Ferson and Harvey (1993) and Evans (1994) that time-varying risk prices drive asset return predictability more than time-varying betas do. However, a conclusive answer to the question "Is the behavior of expected excess bond returns consistent with a simple asset pricing model?" requires an empirical study with other asset returns (inter-

[20] Given my finding that predicted excess bond returns are almost perfectly correlated, any linear combination of excess bond returns should capture the bond return predictability. Therefore, it is not surprising that a model with the world bond factor can explain such predictability. However, the model could still be rejected because the GMM specification test also tests the model restriction of zero intercepts. Only linear combinations (risk factor portfolios) that are on the conditional minimum variance frontier should produce zero intercepts.

Table VI

Estimating a One-Factor Model with an Observable Risk Factor, 1/1978 to 6/1993

Results from estimating a one-factor asset pricing model with constant conditional betas. The following multi-country system is estimated using the generalized method of moments (GMM):

$$r_{i,t+1} - \beta_i * h_{t+1} = u_{i,t+1} \quad \text{for } i = 1, \ldots, 6$$

where r_i are the excess bond returns in six countries (see Table I), β_i are their estimated sensitivities to the risk factor, and u_i are the residuals. The risk factor h is proxied either by the world excess stock return (*WOSTOCK*) or by the world excess bond return (*WOBOND*). Four instruments and a constant are used in the estimation, world inverse relative wealth, the world real bond yield, the world term spread, and the U.S. bond beta. *CHISQ* is T times the minimized value of the GMM objective function. The degrees of freedom (d.f.) is equal to the number of overidentifying restrictions. p is the significance level for testing the model's overidentifying restrictions, expressed in percent. Correlation with Latent Variable is the sample correlation between the predicted risk factor (using the four global instruments above) and the single latent variable estimated in Table IV. Average Residual Predictability is a simple average of six country-specific coefficients of determination (expressed in percent) when the residuals from the model estimation are regressed on the four global instruments above or on the corresponding four local instruments.

	CHISQ	(d.f.)	p	Correlation with Latent Variable	Average Residual Predictability (Global)	Average Residual Predictability (Local)
WOSTOCK	33.31	(24)	9.8	33.3	6.7	5.7
WOBOND	11.14	(24)	98.8	98.7	−1.2	−0.8

national stock returns and foreign exchange returns) and a better-motivated multifactor model.

IV. Conclusions

This article characterizes time-variation in expected excess government bond returns in six countries and tests whether this variation is consistent with a simple asset pricing model. There are several new findings.

A small set of financial market variables can forecast international bond returns. Wealth-dependent relative risk aversion appears to be an important source of the bond return predictability. Expected excess bond returns in all six countries are high when relative wealth is low and when real bond yields and term spreads are high. These findings are statistically and economically significant.

Expected excess returns are very highly correlated across international bond markets but not across bond and stock markets. An international asset pricing model with one risk factor and constant conditional betas is able to explain the bond return predictability if the factor is proxied by the world excess bond return, but not if it is proxied by the world excess stock return. A natural path for future research is to study the behavior of international stock and bond returns together.

REFERENCES

Bekaert, Geert, and Robert J. Hodrick, 1992, Characterizing predictable components in excess returns on equity and foreign exchange markets, *Journal of Finance* 47, 467–509.

Bisignano, Joseph R., 1987, A study of efficiency and volatility in government securities markets, Working paper, Bank for International Settlements.

Boudoukh, Jacob, 1993, An equilibrium model of nominal bond prices with inflation-output correlation and stochastic volatility, *Journal of Money, Credit, and Banking* 25, 636–665.

Campbell, John Y., and John Ammer, 1993, What moves the stock and bond markets? A variance decomposition for long-term asset returns, *Journal of Finance* 48, 3–37.

Campbell, John Y., and Richard H. Clarida, 1987, The term structure of euromarket interest rates: an empirical examination, *Journal of Monetary Economics* 19, 25–44.

Campbell, John Y., and John H. Cochrane, 1994, By force of habit: A consumption-based explanation of aggregate stock market behavior, Working paper, Harvard University.

Chen, Nai-fu, 1991, Financial investment opportunities and the macroeconomy, *Journal of Finance* 46, 529–554.

Constantinides, George M., 1990, Habit formation: A resolution of the equity premium puzzle, *Journal of Political Economy* 98, 519–543.

Cumby, Robert E., and John Huizinga, 1992, Investigating the correlation of unobserved expectations. Expected returns in equity and foreign exchange markets and other examples, *Journal of Monetary Economics* 30, 217–253.

DeBondt, Werner F. M., and Mary M. Bange, 1992, Inflation forecast errors and time variation in term premia, *Journal of Financial and Quantitative Analysis* 27, 479–496.

Evans, Martin D. D., 1994, Expected returns, time-varying risk, and risk premia, *Journal of Finance* 49, 655–679.

Fama, Eugene F., and Robert R. Bliss, 1987, The information in long maturity forward rates, *American Economic Review* 77, 680–692.

Fama, Eugene F., and Kenneth R. French, 1989, Business conditions and expected returns on stocks and bonds, *Journal of Financial Economics* 25, 23–49.

Ferson, Wayne E., and Campbell R. Harvey, 1993, The risk and predictability of international equity returns, *Review of Financial Studies* 6, 527–566.

Hansen, Lars P., 1982, Large sample properties of generalized method of moments estimators, *Econometrica* 50, 1029–1054.

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

Hodrick, Robert J., 1987, *The Empirical Evidence on the Efficiency of Forward and Futures Foreign Exchange Markets* (Harwood Academic Publishers, New York).

Huizinga, John, and Frederic S. Mishkin, 1984, Inflation and real interest rates on assets with different risk characteristics, *Journal of Finance* 39, 699–712.

Ibbotson, Roger G., Laurence B. Siegel, and Kathryn S. Love, 1985, World wealth: Market values and returns, *Journal of Portfolio Management* 12, 4–23.

Ilmanen, Antti, 1994, Time-varying expected returns in international bond markets, Doctoral dissertation, Graduate School of Business, University of Chicago.

Jorion, Philippe, 1992, Term premiums and the integration of the eurocurrency markets, *Journal of International Money and Finance* 11, 17–39.

Keim, Donald B. and Robert F. Stambaugh, 1986, Predicting returns in the bond and the stock markets, *Journal of Financial Economics* 17, 357–390.

Lauterbach, Beni, 1989, Consumption volatility, production volatility, spot-rate volatility, and the returns on treasury bills and bonds, *Journal of Financial Economics* 24, 155–179.

Mankiw, N. Gregory, 1986, The term structure of interest rates revisited, *Brookings Papers on Economic Activity*, 61–110.

Marcus, Alan J., 1989, An equilibrium theory of excess volatility and mean reversion in stock market prices, NBER Working paper No. 3106.

Newey, Whitney K., and Kenneth D. West, 1987, A simple, positive, semi-definite heteroscedasticity and autocorrelation consistent covariance matrix, *Econometrica* 55, 703–708.

Otani, Ichiro, and Siddharth Tiwari, 1981, Capital controls and interest rate parity: The Japanese experience, 1978–81, *IMF Staff Papers* 28, 793–815.

Patat, J.-P., 1989, International interest rate linkages and monetary policy in France, in *International Interest Rate Linkages and Monetary Policy* (Bank for International Settlement, Basle), pp. 96–115.

Poterba, James M., and Lawrence H. Summers, 1988, Mean reversion in stock prices: Evidence and implications, *Journal of Financial Economics* 22, 27–59.

Sharpe, William F., 1990, Investor wealth measures and expected return, Seminar proceedings from *Quantifying the Market Risk Premium Phenomenon for Investment Decision Making*, The Institute of Chartered Financial Analysts, 29–37.

Solnik, Bruno, 1993, The performance of international asset allocation strategies using conditional information, *Journal of Empirical Finance* 1, 33–55.

Stambaugh, Robert F., 1988, The information in forward rates. Implications for models of the term structure, *Journal of Financial Economics* 21, 41–70.

Stulz, René M., 1994, International portfolio choice and asset pricing: An integrative survey, NBER Working paper No. 4645.

Sundaresan, Suresh M., 1989, Intertemporally dependent preferences and the volatility of consumption and wealth, *Review of Financial Studies* 2, 73–89.

Tierens, Ingrid, 1994, Business cycle variation in equity return predictability, Working paper, Graduate School of Business, University of Chicago.

Zhang, Chu, 1992, Time varying and sign changing term premiums, Doctoral dissertation, Graduate School of Business, University of Chicago.