International bonds and the currency risk: How do macroshocks affect returns?

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Received 11 June 1998; revised 2 November 1998; accepted 7 September 1999

Abstract

The currency translation risk borne by international investors and the riskiness of returns on long-term bonds both affect international investors' decisions. For the U.S. investor, excess returns on German, Japanese, Canadian, and U.K. bonds have been positively correlated with the respective excess local currency returns (1978–1997). However, for investors who measure their performance in the currencies of these countries, the comparable correlation between U.S. bond returns and positions in U.S. dollars has been negative. Traditional interest rate or portfolio flow models fail to explain the asymmetry. A sticky-price model with spillover effects from the U.S. to other countries is used to explore the effect of macroshocks on these returns.

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JEL classification: F31; F42; G15

Keywords: Currency risk; Spillover effects; Cost of capital; Bond returns; VAR decomposition

1. Introduction

Over the last 20 years, Japanese, Canadian, German, and U.K. investors in U.S. bonds have faced a negative correlation between the $US returns on their bonds and the returns on holding currency positions in $US. The converse has been true for U.S. investors: They have seen a positive correlation between the returns on bonds denominated in the foreign currency and the returns from holding those foreign currencies.1 If investors’ expectations reflect the same asymmetry and they mean-variance optimize returns denominated in their own countries’ currencies, ceteris paribus, the U.S. should experience a lower cost of debt.

To see this, consider a portfolio containing home-country and foreign bonds.
both bonds have the same return distributions in local currency and are uncorrelated with the exchange rate, home-currency denominated returns on the unhedged foreign bonds will have a higher variance than the home-country bond returns. If the correlation between the returns on the foreign asset in local currency and the returns on the currency position is positive, the variance of the home-country denominated foreign bonds will be even greater. Conversely, if the correlation is negative, the adverse effect of the currency translation variance will be reduced, effectively providing a costless partial hedge. The relative differences in investor demand due to the asymmetrical risk will affect expected returns, with the negatively correlated bonds (U.S. bonds in this case) offering a lower return than would otherwise be the case.

In theory, the currency translation risk inherent in holding foreign bonds can be eliminated by taking offsetting positions in the currency market. Investors can eliminate the risk by selling forward 100% of the expected asset value, or it is theoretically possible to further optimize the combined position by choosing the mean-variance optimized percent to hedge based on estimates of returns and covariances. In practice, however, currency hedge positions involve transaction costs, and since returns are uncertain, hedges are less than perfect. For institutional reasons, portfolio managers may also separate the decisions involving international bond positions and currency positions. In practice, investors take unhedged positions in foreign bonds, and, consequently, understanding the relationship between bond and currency returns is important.

There are models that can be used to describe a theoretical relationship between bond and currency returns. First, consider the effects interest rates have on both returns. Suppose a country’s interest rates are shocked upward. Bond returns will move downward, but the currency may strengthen. Chow et al. (1997) attribute the exchange rate exposure observed for U.S. bonds from 1977 to 1989 to this model. Or consider the effects changing investor expectations have on the returns. If there is a shift in demand for a country’s bonds, there may be a concurrent shift in demand for the currency. This will be the case if international bond portfolio managers try to be fully invested in bonds and move funds among various countries’ bonds. The first of these models predicts a negative correlation between bond and currency returns, and the second, a positive correlation. Daily newspaper reports often choose one of these simple explanations, depending on which fits the covariance sign of that day’s returns. The asymmetry in the historical returns suggest that the actual links between currency and bond returns are due to a more complex mechanism than either of these models describes. In particular, the data suggest one in which macroshocks spill over from the U.S. to other countries.

The approach in this paper is to outline theoretical relationships between the asset and currency returns, primarily through effects of interest rates, inflation expectations, and risk premia, and to explore the relationships in VAR systems. The next section outlines the theory. Innovations in returns are decomposed into the changing expectations about future components of the returns. A traditional sticky-price, two-country model with spillovers is then used to predict the components’ time paths that may result from various shocks to the two economies. It is shown that the outcome is ambiguous: In particular, the speed with which inflationary expectations are incorpo-
rated into interest rates and exchange rates determines the correlation of returns. In
the following section, the macroeconomic variables in the model, as well as the variables
shown to forecast asset and currency returns, are used to construct four two-country
VAR systems, each representing the view of a U.S. investor holding foreign bonds.
To help resolve the ambiguity of the model, innovations produced by the VAR systems
are decomposed into their component parts and are analyzed to determine average
relationships between them. Finally, impulse responses to macroshocks are calculated.
These response functions provide a graphical view of the spillover effects and the
contemporaneous reaction of currency and bond returns to the resulting inflation and
interest rate innovations. A summary of results and conclusions follows.

2. Theory

Assume that the supply of bonds is relatively inelastic in the short run (one month)
and that returns are therefore determined primarily by shifts in demand. By expressing
returns as a difference equation in asset prices, an innovation in a one-period return
can be related to innovations in expected future asset prices, and, therefore, innovations
in expected future returns. These unexpected changes in future returns can then be
decomposed into various components relating to different types of “news.” For exam-
ple, nominal bond return innovations can be thought of as the sum of unexpected
changes to future real returns and inflation, and innovations in nominal exchange
rates as the result of unexpected changes in future real exchange rates, interest rates,
and inflation differentials between the two countries. In this way, news that affects
expected values of interest rates and inflation rates can be analyzed in terms of its
joint effect on current bond and currency returns. The methodology can be applied
to both theoretical models and empirical data.

Campbell and Shiller (1989) develop this approach to evaluate stock dividend-price
ratios in terms of expected future dividends and interest rates. Campbell (1991) and
Campbell and Ammer (1993) extend the concept to decompose the variances and
covariances of the innovations to stock and bond returns in the U.S. This paper further
extends the concept to decompose currency returns.

2.1. Bond returns

The decomposition of the bond returns follows (with a small change in notation
and sequence) Campbell and Ammer (1993). Let $br_{n,t+1}$ be the nominal return, over
the period $t+1$, on an $n$-period foreign bond, as shown in Eq. (1),

$$br_{n,t+1} = p_{n-t+1} - p_{n,t}$$

where $p_{n,t}$ is the log of the end-of-period-$t$ bond price. Solve forward Eq. (1) for price
$p_{n,t}$, resulting in Eq. (2),

$$p_{n,t} = p_{0,t+n} - \sum_{i=0}^{n-1} br_{n-i,t+1+i}$$
where the first term on the right is the log of the maturity price of 1, or zero. By taking expectations of Eq. (2) and substituting into Eq. (1), we arrive at Eq. (3):

$$br_{n+1} = -E_{t+1} \sum_{i=1}^{n-1} br_{n-i+1+i} + E_i \sum_{i=0}^{n-1} br_{n-i+1+i}$$

Solve for the innovation in the bond return as shown in Eq. (4),

$$br_{n+1} - E_t br_{n+1} = -(E_{t+1} - E_i) \sum_{i=1}^{n-1} br_{n-i+1+i}$$

or, since the return on the bond when held to maturity is determined by its price and coupon interest rate, any single period innovation must be offset by opposite future innovations.

Next, define foreign excess bond returns (in local currency): $ebr_{n+1} = br_{n+1} - \pi^*_t - r^*_t$, where $\pi^*$ and $r^*$ are the foreign country’s one-period inflation rate and one-period real (riskless) interest rate, respectively. Then, we arrive at Eq. (5):

$$ebr_{n+1} - E_t ebr_{n+1} = -(E_{t+1} - E_i) \sum_{i=1}^{n-1} (\pi^*_{t+1+i} + r^*_{t+1+i} + ebr_{n-i+j+1+i})$$

The innovation in foreign excess bond returns will equal minus the sum (over the remaining life of the bond) of innovations in foreign inflation, real interest rates, and excess returns. The last term can be thought of as the risk premium. For example, suppose there is news that increases expected inflation rates or real interest rates. Today’s long-bond yield will have to increase (resulting in a downward movement in the excess bond return) or the expected future excess returns will have to decrease.

In the latter case, the bond’s yield does not increase, so the decrease in expected future returns can be thought of as a decrease in the risk premium component of the yield: Investors are willing to hold the bond at the previous yield, even though expected future returns are lower.

2.2. Currency returns

Let $cr_{t+1}$ be the home-currency one-period real return from holding a Euro-deposit denominated in a foreign currency. Let $s_t$ be the log nominal exchange rate (end of period $t$), $i_t$ the Euro-deposit rate (known at end of period $t-1$), and $\pi_t$ the home-country inflation rate. Rates are continuously compounded. An asterisk (*) indicates a foreign variable. The lowercase Greek letter $\delta$ represents differentials between countries; uppercase $\Delta$, time period differentials. We now have Eq. (6):

$$cr_{t+1} = i^*_t + s_{t+1} - s_t - \pi_{t+1}$$

Let $\delta i_t^* = i^*_t - i_t$ and define “excess currency return” as $ecr_{t+1} = cr_{t+1} - (i_{t+1} - \pi_{t+1})$. Now we have Eq. (7):

$$ecr_{t+1} = \delta i^*_t + s_{t+1} - s_t$$

Solve forward for $s_t$ and take expectations as shown in Eqs. (8) and (9):
Define the real exchange rate $sr_t = s_t + p_t^* - p_t$, where $p_t$ and $p_t^*$ are the log price levels, as shown in Eq. (10),

$$s_{t+k} = s_t + (p_t - p_t^*) + \sum_{j=1}^{k} \Delta s_{t+j} - \sum_{j=1}^{k} \delta \pi_t^*$$

where $\Delta s_{t+1} = s_{t+1} - s_t$, and $\delta \pi_t^* = \pi_t^* - \pi_t$. Therefore, we have Eq. (11):

$$E[\text{limit}_{k \to \infty} (s_{t+k})] = s_t + (p_t - p_t^*) + E[\sum_{j=1}^{\infty} \Delta s_{t+j} - \sum_{j=1}^{\infty} \delta \pi_t^*]$$

Also, note from Eq. (7) that innovations in $ecr$ equal innovations in $s$, or, as shown in Eq. (12):

$$ecr_{t+1} - E[ecr_{t+1}] = s_{t+1} - E[s_{t+1}]$$

Now, substitute Eq. (11) into Eq. (9) and Eq. (9) into Eq. (12), to get Eq. (13):

$$ecr_{t+1} - E[ecr_{t+1}] = (E_{t+1} - E_t) \sum_{j=1}^{\infty} (\delta i_{t+1+j} - \delta \pi_{t+1+j} - ecr_{t+1+j})$$

$$+ \Delta s_{t+1+j} + (p_{t+1} - p_{t+1}^*) + s_{t+1} + \delta i_{t+1}$$

The last two terms in the braces are known at time $t$, and therefore their innovations are equal to zero. The innovation in the difference in the log price levels equals the innovation in $-\delta \pi_{t+1}^*$, so this term can be included in the sum of future inflation differentials.

The sum of future changes to the real exchange rate ($\Delta sr$) can be treated in several different ways. Consider the possible reasons why expectations of the real exchange rate may change: the fact that nontradables are included in $p$ and $p^*$, or that there are other measurement inconsistencies between $p$ and $p^*$; changes to the relative price of nontradables to tradables; changes in relative worldwide demand for the countries' goods; or changes in the stickiness of the prices. It could be argued that these shifts tend to be gradual or related to underlying trends in productivity. Since the term in Eq. (13) is the cumulative effect of all future changes, one could then argue that monthly innovations in the nominal exchange rate are not likely to be caused by changes in expectations associated with these trends. Therefore, one approach is to view the sum of future changes to the real exchange rate ($\Delta sr$) as a constant. Making the stronger assumption that relative Purchasing Power Parity (R.P.P.P.) holds over the infinite horizon makes the sum of $\Delta sr$ equal to zero. While results of studies of R.P.P.P. over longer periods are mixed, at the infinite horizon, this assumption is not unreasonable. The following equation is consistent with either assumption, or...
alternately, that changes in the real exchange rate are included in the future excess currency return term.\footnote{It is clear from analyzing high-frequency data that news about near-term inflation does not cause a one-for-one response in currency returns; that is, R.P.P.P. does not hold over short horizons. Whether one claims that the real exchange rate or the risk premium is changing over the short term is essentially a matter of definition.}

Eq. (14) says that innovations in excess currency returns are made up of the infinite sums of three components: innovations in nominal interest rate differentials, inflation rate differentials, and future excess returns (including changes in the real exchange rate, if any), which can be thought of as a risk premium. The first component enters positively and the last two negatively.

\begin{equation}
ecr_{t+1} - E[ecr_{t+1}] = (E_{t+1} - E_t) \sum_{j=1}^{\infty} (\delta i^*_t + \delta \pi^*_t - \delta r_{t+1+j})
\end{equation}

Consider, for example, news that increases the nominal interest rate ($i^*$) and its differential with the U.S. rate ($\delta i^*$) above its expected value. This could be related to news of future inflation, thereby increasing the expected inflation differential ($\delta \pi^*$) by a similar amount. The net effect on today’s exchange rate may therefore be negligible. If, on the other hand, the unexpected increase in foreign nominal interest rates is associated with a new forecast of firm monetary policy designed to ward off an increase in the inflation rate, the resulting innovation in the currency return may be positive. Even when the interest rate increase is associated with news of a future increase in inflation, there is the possibility that investors and speculators will try to take advantage of the more favorable nominal interest rate differential, with the intent of reversing their positions before the higher inflation affects the spot exchange rate.

For Eq. (14) to hold, the third component (future excess returns or the risk premium) will then have to decrease: Investors are willing to hold short-term deposits denominated in the foreign currency even though expected future returns are lower.

It should be pointed out that the relationships in Eqs. (5) and (14) are dynamic identities which are intended to facilitate the testing of alternative models; they are not models of investor behavior or of economies.

2.3. Macroeconomic model

Eq. (5) decomposes the bond innovations into future innovations in three components: real interest rates, inflation, and a risk premium. Eq. (14) similarly decomposes currency innovations into nominal interest rate and inflation rate differentials, and a risk premium. Either a sticky-price model [see Dornbush (1989) and Blanchard & Fisher (1989)] or a flexible-price model with slow portfolio adjustment [see Grilli & Roubini (1995)] generate the relationships between prices, interest rates, and exchange rates that predict the time path of at least some of these components.\footnote{The joint effects on currency and asset returns from shocks to a country’s economy can then be examined to see, at least qualitatively, how the returns should be correlated. Shocks can include those from changes in monetary policy, as well as shifts in aggregate supply and}


demand. Interest rate and inflation changes resulting from the shocks can be limited to the country with the shock or allowed to partially spill over into the other country.

First, assume that there is no spillover effect between the investor’s country and the foreign country. The standard sticky-price model can be solved in the usual way for the dynamic paths of prices, interest rates, and exchange rates that result from various foreign-country shocks. There is an ambiguity in the predictions of the model. For instance, a positive money growth shock may lower nominal interest rates in the short run, even though the eventual higher rate of inflation will result in a higher interest rate. In terms of the IS-LM model, the money growth shock shifts the LM curve, reducing nominal and real interest rates (liquidity effect). Over time, the lower rates and higher real money balances increase spending and the demand for money, putting upward pressure on interest rates (income effect). The money growth shock also increases inflationary expectations, putting further upward pressure on nominal interest rates. Nominal interest rates eventually incorporate the increased money growth (the “Fisher effect”). Reichenstein (1987) reports that since 1975 in the U.S., there is little support for the liquidity effect. He concludes that this is probably due to rapid adjustment of inflationary expectations and money demand. On the other hand, Grier and Perry (1993) find that ARCH models produce significant liquidity effects from “M1” innovations. If the liquidity effect does dominate, the lower short-term interest rate may cause a depreciation of the currency, as well as reduce long-bond yields [assuming the change is not offset by an increase in the bond term spread (i.e., an increase in the risk premium or expected inflation)]. The reduced yield results in a capital gain on the bond. When viewed by an investor in another country, the net result is a negative correlation between the bond return denominated in the foreign currency and the return on the currency position. However, the bond yield is also influenced by the market’s expectations of future interest and inflation rates. If the expectations for future inflation are high enough, the term spread may increase making the bond return negative. Even the short-term interest rate may rise if the liquidity effect is small and inflationary expectations are rapidly incorporated into the current rate.

The ambiguity is compounded when spillover effects from the investor’s home country to the foreign country are considered. Interest rate and inflation shocks emanating in the home country will of course affect home-country returns, but they may also affect the interest and inflation rates in the foreign country, and, therefore, the foreign return. The magnitude of these spillover effects may depend on the relative size of the trade flows in both goods and financial assets. Political factors and efforts to coordinate monetary policy may also influence them.

Possible outcomes can be derived more formally and directly from Eqs. (5) and (14). First, make a distinction between two polar cases, one in which the liquidity effect drives interest rates and interest rate differentials between countries drive exchange rates, and one in which inflationary expectations drive both interest rates and exchange rates. The first instance is referred to as the “short-horizon” case, and the second as the “long-horizon” case. In the short-horizon case, prices are assumed to be sticky, the liquidity effect of monetary shocks dominates the income effect, and
Table 1
Responses of bond and currency return components to macroeconomic shocks

<table>
<thead>
<tr>
<th>Macro Shocks</th>
<th>Foreign Variables Response</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( \pi^* )</td>
</tr>
<tr>
<td><strong>Short Horizon Case</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Home Country Shock</strong></td>
<td></td>
</tr>
<tr>
<td>Without spillover</td>
<td>0</td>
</tr>
<tr>
<td>With spillover</td>
<td>0</td>
</tr>
<tr>
<td><strong>Foreign Country Shock</strong></td>
<td></td>
</tr>
<tr>
<td>Without spillover</td>
<td>0</td>
</tr>
<tr>
<td>With spillover</td>
<td>0</td>
</tr>
<tr>
<td><strong>Long Horizon</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Home Country Shock</strong></td>
<td></td>
</tr>
<tr>
<td>Without spillover</td>
<td>0</td>
</tr>
<tr>
<td>With spillover</td>
<td>+</td>
</tr>
<tr>
<td><strong>Foreign Country Shock</strong></td>
<td></td>
</tr>
<tr>
<td>Without spillover</td>
<td>+</td>
</tr>
<tr>
<td>With spillover</td>
<td>+</td>
</tr>
</tbody>
</table>

**Note:** In the short-horizon case, macro shocks are positive demand shocks and negative money growth shocks; in the long-horizon case, macro shocks are positive demand and positive money growth shocks. Short and long horizon represent the degree to which immediate responses incorporate the expectations of the longer-term path of inflation. In the short-horizon case, inflationary expectations do not immediately affect returns; in the long-horizon case, real rates remain fixed (Fisher effect) and exchange rates immediately respond to differences in inflation rates (relative purchasing power parity). Ecr and ebr are the one period innovations in the foreign excess currency and excess bond returns that result from changes in the sums of future expectations as defined in the appendix and equations (5) and (14) in the text. The variables, \( \pi^* \), \( i^* \), and \( r^* \) represent the sums of changes in future expectations. The asterisk * indicates a response in the foreign country. The variables \( \delta i^* \) and \( \delta \pi^* \) are the differences between the foreign and home country rates. The last column indicates the sign of the correlation between the excess bond and excess currency returns. Without spillover assumes that there is no response in a country to a shock in the other country; with spillover assumes that a country shock creates a similar, but lesser, response in the other country.

Table 1 summarizes the results predicted by this model. In the top section, the short-horizon assumptions hold and the macroshock is assumed to be either negative money growth or positive demand. Note that inflation is not affected but that foreign interest rates increase, causing a negative excess bond return. The currency return is determined by the change in the nominal interest rate differential between the two countries. If a home-country interest rate increase does not spill over (or spills over less than fully) to the foreign country, the interest rate differential decreases and the currency return is negative. However, if the shock emanates in the foreign country, the interest rate differential increases and the currency return is positive. The bottom panel summarizes the results of the long-horizon case. Now the macroshock is assumed...
to be either positive money growth or demand. Real rates remain constant (Fisher effect) and the immediate increase in inflationary expectations increases the foreign interest rate. The bond return is again negative, but now if the shock emanates from the foreign country, the inflation rate differential increases, causing a negative currency return (R.P.P.P.).

Consider first the results of this model as they apply to a U.S. investor in non-$US-denominated bonds. There are three situations consistent with the historical positive correlation between bond and currency returns: short-horizon with the U.S. shock spilling over to foreign country and long-horizon with a foreign shock (with and without a spillover back to U.S.). Next, use the same results, but reverse the investor positions to a non-U.S. country as the “home” country, in which case the “foreign” country represents the U.S. Again, there are three situations consistent with the historical negative correlation between bond and currency returns: short-horizon foreign (now U.S.) shock (with and without a spillover) and long-horizon home (now non-U.S.) with a spillover to foreign (now U.S.). The only situations consistent with the asymmetry of historical correlations are the short-horizon U.S. shock with a spillover and the long-horizon foreign shock with a spillover back to the U.S. Given the size of the U.S. economy relative to those of the other countries, the former appears more likely.

The predictions of the model can be summarized as follows:

1. In the case of bond returns, a money growth shock may shift yields in the short-run in one direction (liquidity effect), while putting longer-term pressure in the opposite direction (income effect).
2. In the case of currency returns, a demand shock may strengthen the currency in the short-run due to the short-term portfolio investment opportunities (from the higher interest rate differential), while weakening the currency in the long run due to the expected inflation (R.P.P.P.).
3. Spillover effects from the U.S. to other countries (but not the reverse) and the short-horizon assumption make the model consistent with the historical positive correlations observed by U.S. investors and the negative correlations observed by non-U.S. investors.
4. Although less plausible, spill-over effects from non-U.S. countries to the U.S. and the long-horizon assumption make the model consistent with observed correlations.

2.4. VAR specification and data summary

Although investors have access to large amounts of information, for purposes of this analysis, the information set is assumed to include only the last two periods’ interest rates, inflation rates, currency returns, and bond returns. Any changes in the next period’s returns not predicted by this information set are considered innovations. While this unrealistically small information set clearly limits the value of the analysis, past research has not discovered other available data that contribute significantly to predicting currency or bond returns.
Four separate VAR systems are estimated to provide forecasts of returns and their components. Each includes the fundamental U.S. and foreign (Japan, Germany, U.K., and Canada) variables for a single country. The estimated coefficients are then applied to the error terms to calculate linear combinations that are the innovations in future values of each variable (see Appendix). The Campbell and Ammer (1993) approach is used to decompose the variance in the excess bond return innovations into the sums of components forecasted by the system. The analogous decomposition (developed above) is applied to the unexpected excess currency returns. The correlations of the component innovations are then analyzed to determine the possible mechanisms by which bond and currency returns are linked.

While decomposition analysis provides insights into the relative importance and complex interaction of the system variables, the correlated errors make it difficult to see the separate effects of the shocks. Impulse response analysis overcomes this difficulty by isolating each shock. It also has the advantage of providing a view of the timing of responses. The variance-covariance matrix of the VAR errors is orthogonalized (Choleski factorization) and inverted into a moving-average representation so that the period-by-period response to an innovation in each variable can be examined without the errors being correlated.

The seven variables estimated, in order, are: U.S. inflation ($\pi_t$), interest rates on U.S. T-bills ($i_t$), foreign inflation ($\pi^*_t$), the foreign short-term rate on government bonds ($i^*_t$), the return on a forward currency position ($ecr_t$), the spread between the foreign long-term and short-term government bond yields ($ts_t$), and the excess long-term government bond return ($ebr_t$). Impulse response analysis using the Choleski factorization is sensitive to the ordering of the variables, and a thorough analysis of the possible orderings is beyond the scope of this paper. However, the order chosen for the reported analysis reflects an attempt to provide a quasi-structure to the system. The first four variables are assumed to be the most important indicators of policy or supply-demand shocks. The sequence of interest rates and inflation is somewhat arbitrary: Both are responses to the exogenous supply and demand shocks. Since short-term interest rates tend to react quickly to inflation shocks, interest rates follow inflation.\textsuperscript{10} U.S. variables precede the foreign variables based on relative size of the countries. The currency return is placed next as the response to the interest and inflation rates, and possibly as a partial determinant of bond prices. The term interest spread, along with interest rates, has been shown by Fama and French (1989) to forecast bond returns in the U.S., and is therefore placed before the excess bond returns.

Data for the periods 1978:01 to 1997:10 are from the International Financial Statistics (IFS) data base. All rates are monthly, continuously compounded. The timing of the interest rates, inflation rates, and excess returns is such that time-$t$ represents the return from the beginning to the end of the time-$t$ period.\textsuperscript{11} The term spread is the difference between the long- and short-term yields observed at the end of period $t$. Long-term bond returns are calculated based on the change in the yield over period $t$, and are therefore an estimated one-month return from holding a coupon bond (coupon percent assumed to be beginning yield). Excess bond returns are the difference
Table 2

<table>
<thead>
<tr>
<th>Variable</th>
<th>U.S.</th>
<th>Japan</th>
<th>Germany</th>
<th>Canada</th>
<th>U.K.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short-term interest</td>
<td>0.59</td>
<td>0.41</td>
<td>0.51</td>
<td>0.79</td>
<td>0.82</td>
</tr>
<tr>
<td>(i_t)</td>
<td>(0.24)</td>
<td>(0.22)</td>
<td>(0.20)</td>
<td>(0.31)</td>
<td>(0.26)</td>
</tr>
<tr>
<td>Inflation rate</td>
<td>0.46</td>
<td>0.21</td>
<td>0.25</td>
<td>0.54</td>
<td>0.60</td>
</tr>
<tr>
<td>(\pi_t)</td>
<td>(0.36)</td>
<td>(0.59)</td>
<td>(0.28)</td>
<td>(0.38)</td>
<td>(0.64)</td>
</tr>
<tr>
<td>Excess curr. rtrn.</td>
<td>NA</td>
<td>-0.04</td>
<td>-0.07</td>
<td>-0.01</td>
<td>0.11</td>
</tr>
<tr>
<td>(ecr_t)</td>
<td></td>
<td>(3.57)</td>
<td>(3.46)</td>
<td>(1.48)</td>
<td>(3.42)</td>
</tr>
<tr>
<td>Term spread</td>
<td>0.16</td>
<td>0.05</td>
<td>0.07</td>
<td>0.05</td>
<td>0.02</td>
</tr>
<tr>
<td>(ts_t)</td>
<td>(0.14)</td>
<td>(0.09)</td>
<td>(0.12)</td>
<td>(0.17)</td>
<td>(0.17)</td>
</tr>
<tr>
<td>Excess bond rtrn.</td>
<td>0.24</td>
<td>0.17</td>
<td>-0.08</td>
<td>0.13</td>
<td>0.19</td>
</tr>
<tr>
<td>(ebr_t)</td>
<td>(3.31)</td>
<td>(1.75)</td>
<td>(1.68)</td>
<td>(2.62)</td>
<td>(2.87)</td>
</tr>
<tr>
<td>Correlation: ebr, ecr,</td>
<td>-0.16*</td>
<td>0.33</td>
<td>0.11</td>
<td>0.27</td>
<td>0.14</td>
</tr>
<tr>
<td>78:01–97:10</td>
<td>(0.07)</td>
<td>(0.07)</td>
<td>(0.07)</td>
<td>(0.08)</td>
<td>(0.06)</td>
</tr>
<tr>
<td>78:01–87:12</td>
<td>-0.25*</td>
<td>0.43</td>
<td>0.29</td>
<td>0.42</td>
<td>0.17</td>
</tr>
<tr>
<td>88:01–97:10</td>
<td>-0.02*</td>
<td>0.20</td>
<td>-0.14</td>
<td>0.11</td>
<td>0.10</td>
</tr>
<tr>
<td></td>
<td>(0.11)</td>
<td>(0.11)</td>
<td>(0.11)</td>
<td>(0.10)</td>
<td>(0.07)</td>
</tr>
</tbody>
</table>

Note: U.S. term-spread and excess bond return are not included in VAR system, but are shown for comparison. Short-term interest rate \(i\) is the T-bill rate in U.S. and a short-term government bond yield in other countries. Excess bond returns \(ebr\) are the difference between the monthly holding-period return on a long-term government bond (derived from bond yield changes reported by the IMF) and the return from holding a short-term bill over the same period. Excess currency returns \(ecr\) are the return on a forward currency position or, where forward rates are not available, the return on Euro deposits assuming covered interest parity holds. Term spread \(ts\) is the difference between the yield on a long-term government bond and the short-term interest rate. All rates are monthly, continuously compounded. Top panel: means (and standard deviations) for VAR variables 1978:01 to 1997:10 in percent per month, continuously compounded Bottom panel: correlation coefficients between excess bond and currency returns (standard errors)

* Correlations for U.S. are the simple average of the views of Japanese, German, Canadian, and U.K. investors who hold positions in U.S. bonds and U.S. dollars.


A two-lag system is suggested by both the Schwarz SC and Akaike AIC criteria. Likelihood-ratio tests strongly reject one-lag versions in favor of two lags; for some countries, the two-lag version is rejected when compared with three lags. A two-lag version is reported here.

Summary statistics are shown in Table 2. The short-term nominal interest rate and inflation rate in Japan and Germany are relatively low, and in Canada and the U.K. relatively high. The U.S. nominal interest rate and inflation rate are in the middle of the range, but the difference between the U.S. nominal interest rate and inflation rate (ex post real rate) is from 0.8% to 1.5% lower (annual basis) than the other countries’ real rates. This may reflect the international role of the U.S. dollar, or possibly, the partial currency hedge discussed above: Foreign investors in U.S. bonds may reduce their portfolio return variance due to the negative correlation between U.S. bond and U.S. dollar returns. Mean excess currency returns are close to zero, as theory predicts.
The correlations between the excess bond and currency returns are shown in the lower panel. In the U.S. column, the numbers are as viewed by the average (unweighted) non-U.S. investor holding U.S. bonds and $U.S. positions. The next four columns represent the views of U.S. investors holding foreign bonds and foreign currency positions. Japan’s correlations are the highest, and significant in both ten-year periods. Canada’s correlations are also high, but mainly in the first period. Germany’s and the U.K.’s are somewhat lower, but still positive and significantly different from zero in the first period. A pattern of weakening correlations is evident in both the U.S. and foreign numbers: The most recent ten-year results show that all return correlations, except Japan, are not significantly different from zero, with the point estimate for Germany negative.

2.5. Decomposition

Estimated coefficients from the VAR, along with Eqs. (5) and (14), are used to forecast the innovations in excess returns and the corresponding sums of future innovations in inflation and interest rates. The Appendix summarizes the algebra involved in these calculations. The notation in the following paragraphs uses variables without the time subscript to represent the innovations constructed this way.

For the bond return components, an average 10-year maturity is assumed. The innovations in the foreign real interest rate ($r^*$) are the differences between the innovations in the nominal interest rate ($i^*$) and inflation rate ($\pi^*$). Future innovations in the excess bond return, or the bond risk premium (brp), are not directly estimated, but are calculated as the residuals of the excess bond return innovations (ebr) not explained by the estimated future innovations in the real interest rate ($r^*$) and inflation rate ($\pi^*$).

For the currency return components, innovations in the short-term interest and inflation rate differentials ($\delta i^*$, $\delta \pi^*$) are calculated from the infinite sums of the four variables involved. Residual differences between these sums and the excess currency return innovations (ecr) are used for the sum of all future currency innovations, or the currency risk premium (crp). These calculations result in a set of related innovation component time-series, which can be analyzed in terms of significance and correlations.

Table 3 provides a simple measure of the relative importance of each “news” component to the innovations in excess returns. The top panel reports $R^2$ statistics from a regression of the unexpected excess bond return (ebr) on each of its components, while the bottom panel does the same for the unexpected excess currency return (ecr). In the top panel, it can be seen that all three components ($\pi^*$, $r^*$, brp) contribute to excess bond return shocks (ebr). In the bottom panel, the unexplained excess currency return (ecr) variance is shown to be mainly due to changes in the risk premium (crp). This is an indication of the VAR system’s limited ability to forecast currency returns. OLS regressions of the excess currency returns on VAR variables, appropriately lagged, have R-squares of 0.07 for Japan, 0.04 for Germany, 0.20 for Canada, and 0.06 for the U.K. Therefore, the currency risk premium (crp) is, by subtraction, the major factor. However, it is still possible to observe some effects from interest and inflation rate differentials ($\delta i^*$, $\delta \pi^*$), especially in Canada.
Table 3
R-squares from OLS regression of excess return innovations on individual components

Decomposition of Innovations
\[
\begin{align*}
\text{ebr} &= ebr_{t+1} - E_t[ebr_{t+1}] = -(E_{t+1} - E_t) \sum_{j=1}^{n-1} (\pi^n_{t+1+j} + r^n_{t+1+j} + \text{brp}_{t+1+j}) \\
\text{ecr} &= ecr_{t+1} - E_t[ecr_{t+1}] = (E_{t+1} - E_t) \sum_{j=1}^{n-1} (\delta \pi^n_{t+1+j} - ebr_{t+1+j} - crp_{t+1+j})
\end{align*}
\]

estimated with seven-variable, two-lag VAR

<table>
<thead>
<tr>
<th>Regression</th>
<th>Japan</th>
<th>Germany</th>
<th>Canada</th>
<th>UK</th>
</tr>
</thead>
<tbody>
<tr>
<td>ebr on (\pi^*)</td>
<td>0.54</td>
<td>0.10</td>
<td>0.29</td>
<td>0.71</td>
</tr>
<tr>
<td>ebr on (r^*)</td>
<td>0.76</td>
<td>0.24</td>
<td>0.45</td>
<td>0.26</td>
</tr>
<tr>
<td>ebr on brp</td>
<td>0.06</td>
<td>0.23</td>
<td>0.28</td>
<td>0.27</td>
</tr>
<tr>
<td>ecr on (\delta i^*)</td>
<td>0.07</td>
<td>0.02</td>
<td>0.19</td>
<td>0.00</td>
</tr>
<tr>
<td>ecr on (\delta \pi^*)</td>
<td>0.09</td>
<td>0.07</td>
<td>0.17</td>
<td>0.02</td>
</tr>
<tr>
<td>ecr on crp</td>
<td>0.84</td>
<td>0.95</td>
<td>0.79</td>
<td>0.68</td>
</tr>
</tbody>
</table>

Note: All innovations (variables without time subscripts) estimated (1987–1997) with a 7-variable VAR with ordered variables: US inflation rate (\(\pi\)), US T-bill rate (\(i\)), foreign inflation rate (\(\pi^*\)), foreign short-term interest rate (\(i^*\)), foreign excess currency return (ecr), foreign long-short interest spread (ts), and foreign excess bond return (ebr). The variables \(\delta i^*\) and \(\delta \pi^*\) represent the differences between foreign and U.S. rates. All variables as defined in equations (5) and (14) in text and in the appendix. Component estimates represent sums of changes in future expected values associated with an innovation in the excess returns as defined in table above. The currency risk premium (crp) and bond risk premium (brp) are calculated as the difference between the sum of the other two estimated components and the excess returns. \(R^2\)'s are from a regression of the unexpected excess return on each of the components separately.

Table 4 shows the correlation coefficients between each of the components of bond and currency return innovations. In the top row for each country, note the strong positive relationship between the nominal interest rate differential (\(\delta i^*\)) and the nominal foreign rates (\(\pi^*\) and \(r^*\)). This result is counter to the argument that U.S. interest rate shocks spill over to other countries. In the second line, note the correlation between the inflation differential (\(\delta \pi^*\)) and the foreign inflation (\(\pi^*\)): In Japan it is negative, suggesting a U.S. spillover, but it is strongly positive in Canada and the U.K., suggesting a dominance of foreign shocks.

The strongest link between excess return innovations is seen in the third row. With the exception of the U.K., changes to the currency risk premium (crp), which is the major factor in determining excess currency returns, are positively correlated with the major factors that determine excess bond returns— inflation (\(\pi^*\)) and real interest rate (\(r^*\)) changes. These positive correlations outweigh the negative correlations between the currency risk premium (crp) and the bond risk premium (brp).

Another exception for the U.K. is noted: Inflation news is uncorrelated with bond return risk. In the other three countries, the bond risk premium (brp) is negatively correlated with inflation shocks (\(\pi^*\)). It is possible that the market has less confidence that the U.K. central bank will react to inflation with a change in monetary policy. In the other countries, investors may believe that central bank target ranges will
In terms of the ambiguity of the model, the correlations discussed above are more consistent with the dominance of foreign inflation shocks and the long-horizon case. However, decomposition analysis does not isolate the effects of individual shocks; impulse response analysis orthogonalizes the VAR system errors, thereby providing a way to view the responses of each individual variable to a particular shock.

### 2.6. Impulse responses

Orthogonalized innovations produced by the VAR systems are calculated and selected results are plotted in Figs. 1–3. The Monte Carlo Integration approach (100 draws) outlined in Doan (1992) is used to calculate standard errors, and the bands on the graphs are set at plus and minus one standard error. The variance-covariance matrix is orthogonalized by a Choleski factorization, so the responses are scaled to a shock of one standard error of the shocking variable’s residual. Six graphs are

---

### Table 4
Correlations (standard errors) of components of currency and bond return innovations

Estimates based on seven-variable, 2-lag VAR (see Table 3)

<table>
<thead>
<tr>
<th></th>
<th>δπ*</th>
<th>crp</th>
<th>π*</th>
<th>r*</th>
<th>brp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>δi*</td>
<td>-0.46 (0.09)</td>
<td>0.55 (0.09)</td>
<td>0.68 (0.11)</td>
<td>0.82 (0.12)</td>
<td>-0.41 (0.10)</td>
</tr>
<tr>
<td>δπ*</td>
<td>-0.60 (0.08)</td>
<td>-0.94 (0.11)</td>
<td>-0.76 (0.11)</td>
<td>0.74 (0.10)</td>
<td></td>
</tr>
<tr>
<td>crp</td>
<td>0.69 (0.09)</td>
<td>0.69 (0.10)</td>
<td>-0.51 (0.08)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>π*</td>
<td>0.92 (0.13)</td>
<td>-0.82 (0.11)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>r*</td>
<td></td>
<td>-0.66 (0.11)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Germany</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>δi*</td>
<td>0.68 (0.10)</td>
<td>0.33 (0.07)</td>
<td>0.48 (0.09)</td>
<td>0.67 (0.11)</td>
<td>-0.40 (0.08)</td>
</tr>
<tr>
<td>δπ*</td>
<td>0.28 (0.07)</td>
<td>0.23 (0.07)</td>
<td>0.39 (0.08)</td>
<td>0.07 (0.07)</td>
<td></td>
</tr>
<tr>
<td>crp</td>
<td>0.46 (0.07)</td>
<td>0.43 (0.08)</td>
<td>-0.37 (0.06)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>π*</td>
<td>0.94 (0.12)</td>
<td>-0.67 (0.09)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>r*</td>
<td></td>
<td>-0.51 (0.08)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canada</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>δi*</td>
<td>0.79 (0.11)</td>
<td>0.39 (0.10)</td>
<td>0.79 (0.12)</td>
<td>0.96 (0.14)</td>
<td>-0.33 (0.11)</td>
</tr>
<tr>
<td>δπ*</td>
<td>0.09 (0.09)</td>
<td>0.87 (0.09)</td>
<td>0.90 (0.11)</td>
<td>-0.14 (0.14)</td>
<td></td>
</tr>
<tr>
<td>crp</td>
<td>0.16 (0.09)</td>
<td>0.26 (0.10)</td>
<td>-0.13 (0.07)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>π*</td>
<td>0.82 (0.12)</td>
<td>-0.41 (0.11)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>r*</td>
<td></td>
<td>-0.19 (0.11)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U.K.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>δi*</td>
<td>0.33 (0.10)</td>
<td>0.21 (0.08)</td>
<td>-0.01 (0.05)</td>
<td>0.69 (0.14)</td>
<td>-0.36 (0.12)</td>
</tr>
<tr>
<td>δπ*</td>
<td>-0.08 (0.07)</td>
<td>0.79 (0.09)</td>
<td>-0.20 (0.08)</td>
<td>-0.27 (0.10)</td>
<td></td>
</tr>
<tr>
<td>crp</td>
<td>-0.12 (0.06)</td>
<td>0.32 (0.07)</td>
<td>-0.14 (0.07)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>π*</td>
<td>-0.61 (0.07)</td>
<td>0.04 (0.07)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>r*</td>
<td></td>
<td>-0.35 (0.09)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: see Table 3.
Fig. 1 shows the response of the German variables to a shock to U.S. inflation. The pattern is representative of the other countries, although the U.K. currency return response is not significant. Foreign inflation responds to U.S. inflation shocks in the same direction, but one-half or less the amount. In general, these responses are consistent with the short-horizon case in which positive U.S. shocks spill over, to a lesser degree, and cause losses on both the foreign bond and foreign currency positions.

In the case of U.S. interest rate shocks, the foreign interest rate response is about
one-third or less the amount and is spread over several periods. In most cases, the result is an immediate decrease in excess bond returns. However, the effects on currency returns are not as consistent or pronounced. Fig. 2 shows the response of the German variables to the U.S. T-bill shock. The pattern in the other countries is similar, except that the responses tend to be delayed 1–3 months.

The joint effect on currency and bond returns from a foreign inflation shock varies greatly—from insignificant responses in Japan and the U.K., to a delayed currency response in Canada, to significant immediate responses in Germany. Fig. 3 shows the German responses to a German inflation shock. Interest rates respond with a delay, thereby allowing an immediate negative currency return to accompany the negative bond return. As the interest rate catches up, eventually increasing the interest rate differential with the U.S., bond and currency returns both become positive. The reverse spillover effect on U.S. inflation is less than 10% of the German shock. The effect is similarly small for the other countries’ inflation shocks.

Summarizing the impulse analysis, one can say that the primary mechanism explaining the observed positive correlation between bond and currency returns is the
spillover effect of U.S. inflation and interest rate shocks. Increases in U.S. rates cause increases in foreign rates, but to a lesser degree. The decreased interest rate differentials with the U.S. weaken the currencies, while the local increases in interest and inflation concurrently lower bond returns. This result is consistent with the “short-horizon” model: Interest rate differentials dominate and inflationary expectations are not immediately incorporated into current exchange rates. The one exception is the German inflation shock, which produces significant negative responses to both bond and currency returns. Although there is an increase in the interest rate differential, there is a decrease in the currency return. This suggests that “long-horizon” inflationary effects may be at work in Germany.

3. Summary and conclusions

This paper explores the relationship between foreign bond and currency returns. Returns are broken down into their fundamental components. The possible ways in which macroeconomic shocks may jointly affect the components are anticipated from
a simple sticky-price model. Two-country VAR systems are estimated to analyze the
fundamental components and covariances of bond and currency returns.

The results of the analysis should be interpreted in the context of the VAR system
used. Investors have a substantially broader information set than that represented by
the seven variables and two lags in the system. Accepting this limitation, the analysis
identifies the types of shocks that should result in positive or negative covariances
between currency and bond returns.

Unexpected excess bond return variances are the result of news affecting all compo-
nents. For excess currency innovations, there is limited evidence that variances are
driven by unexpected changes in future interest rate and inflation rate differentials
with the U.S.; most of the variance is in the residual or risk premium. Canada’s
currency returns are most strongly affected by the interest and inflation differences.
This may be due to the higher degree of goods’ market integration between Canada
and the United States. In all countries, news that increases expectations of future
inflation and interest rates (bond return fundamentals) also increases the currency
risk premium. The expectation of increases in future foreign interest and inflation
rates lowers the current period’s excess bond return, while the higher risk premium
lowers the current period’s excess currency return.

An interesting contrast between the U.K. and the other countries is noted. In
Germany, Japan, and to a lesser degree Canada, news about future inflation is nega-
tively correlated with the bond risk premium; this is not true in the U.K. The bond
markets’ expectations of policy responses to inflationary shocks may differ due to the
reputations of the central banks.¹⁹

The analysis of correlations between return components does not help explain how
there can be positive correlations between foreign bond and currency returns, viewed
from the U.S., while over the same period, negative correlations are viewed by foreign
countries. However, impulse response analysis does give weight to the argument that
spillover effects from U.S. shocks are an important factor in explaining the asymmetry.
If foreign bond and currency return responses are both relatively significant, they
tend to be in the same direction for U.S. shocks. This is also consistent with the
assumption that inflationary expectations are not immediately incorporated into cur-
rent returns. In particular, currency returns generally respond initially to interest rate
differentials, even when inflation is increasing. Inflationary shocks in Germany also
appear to contribute to the positive correlation between German bond and currency
returns. However, the limitations of the investor information set and the ordering
sensitivity of the Choleski factorization used to generate impulse responses should
be considered in drawing conclusions.

While the analysis helps to explain what has happened over the last 20 years, it
offers no insight into what appears to be a weakening of these relationships in the
most recent years. It may be that increasing international portfolio flows, including
equity flows, are becoming more important. The return expectations that drive these
flows are of course dependent on interest and inflation rates. However, many other
factors, such as real growth and profitability, need to be considered. In this paper,
these factors are, by construction, included in the risk premia. Models with time-
varying bond and currency risk premia, possibly as a function of changing growth, profitability, and fiscal and monetary policy, may provide the answer. It is hoped that future research will explore this possibility.

The 1987–1988 breakpoint for separating the periods is chosen mainly because it is the midpoint of the 20 years of data. However, 1987 is also the year of two possibly relevant events: the Louvre Agreement in February, and the worldwide stock market crash in October. It is possible that periodically negotiated exchange rate targets, which are not made public, and secretive central bank intervention since the time of those events, have changed the pattern of returns. If this is the case, any cost-of-capital advantage U.S. firms experienced from the asymmetry of correlations may have disappeared.

Appendix

The two-lag VAR can be described as shown in Eq. (A1),

\[
Z_{t+1} = AZ_t + BZ_{t-1} + \omega_{t+1}
\]  

(A1)

where \( Z \) is the vector of VAR variables, \( A \) and \( B \) are matrices of coefficients and \( \omega \) is the vector of errors. This can be restated in “companion form” as a one-lag VAR, as shown in Eq. (A2),

\[
\begin{bmatrix}
Z_{t+1} \\
Z_t
\end{bmatrix} =
\begin{bmatrix}
A & B \\
I & 0
\end{bmatrix}
\begin{bmatrix}
Z_t \\
Z_{t-1}
\end{bmatrix} +
\begin{bmatrix}
\omega_{t+1} \\
0
\end{bmatrix}
\]  

(A2)

or, further, as shown in Eq. (A3):

\[X_{t+1} = CX_t + \epsilon_{t+1}\]  

(A3)

Through recursive substitution and taking expectations, the \( j^{th} \) period innovation is given by Eq. (A4):

\[(E_{t+1} - E_t)X_{t+1+j} = C\epsilon_{t+1}\]  

(A4)

Time \( t+1 \) innovations and sums of future innovations are shown by Eqs. (A5):

\[(E_{t+1} - E_t)X_{t+1} = \epsilon_{t+1}\]

\[(E_{t+1} - E_t)\sum_{j=1}^{\infty}X_{t+j} = (I - C)^{-1}\epsilon_{t+1}\]

\[(E_{t+1} - E_t)\sum_{j=1}^{\infty}X_{t+1+j} = C(I - C)^{-1}\epsilon_{t+1}\]

\[(E_{t+1} - E_t)\sum_{j=1}^{n}X_{t+1+j} = (I - C)^{-1}(C - C^n)\epsilon_{t+1}\]  

(A5)

Define seven vectors to represent the seven VAR variables (\( \pi, \i, \pi^*, i^*, \text{ecr}, \text{ts}^*, \text{ebr} \)) \( e_i \), indexed by \( i = 1 \) through 7, with a 1 in the \( i^{th} \) row and zeros in all other rows. Premultiply the right-side matrices in the above Eqs. (A5) by the appropriate vector
(transposed) to derive forecasts of each term in Eqs. (5) and (14) in the paper. To simplify notation, the variables ebr and ecr without subscripts represent the one period innovations in foreign excess bond and currency returns [left side of Eqs. (5) and (14) in text]. The other variables without time subscripts represent the sums of innovations as defined in Eqs. (5) and (14). The terms “brp” and “crp” represent the residual risk premia; that is, the sums of future innovations in excess returns. See Eq. (A6).

\[
ebr = e^*\epsilon \\
\pi^* = e^*_i (I - C)^{-1}(C - C^o)\epsilon \\
r^* = e^*_i (I - C)^{-1}(C - C^o)\epsilon - \pi^* \\
brp = -ebr - \pi^* - r^* \\
ecr = e^*_d \epsilon \\
\delta i^* = e^*_d C(I - C)^{-1}\epsilon - e^*_d C(I - C)^{-1}\epsilon \\
\delta \pi^* = e^*_d (I - C)^{-1}\epsilon - e^*_d (I - C)^{-1}\epsilon \\
crp = -ecr + \delta i^* - \delta \pi^* \quad (A6)
\]

Acknowledgments

I am grateful to two anonymous referees and the editor for helpful comments and suggestions.

Notes

1. The numbers are shown in Table 2 and discussed in the Data section. Several studies have noted the positive correlation faced by U.S. investors and the need to hedge the currency risk (e.g., Black & Litterman, 1991). Adler and Simon (1986) note a similar positive relationship for currency and stock returns, and comment that they see no fundamental reason to explain it. An asymmetrical effect of interest rate shocks on exchange rates is noted in Grilli and Roubini (1995) (see Note 7).

2. Given the relatively high variance in currency returns, a very high negative correlation between the currency and bond return is required to offset the added currency variance. If expected local-currency return distributions are equal and the currency risk is fully hedged, a two-country, two-asset optimization will call for a 50/50 mix of assets. In an unhedged situation with no correlation between currency and foreign bond returns, the optimal percentage of foreign assets is substantially lower 50%. If the currency return’s standard deviation is twice that of the asset return—a reasonable assumption for bonds—it requires that the two returns be perfectly negatively correlated for the optimal mix of foreign bonds to be restored to 50%.
3. Note that the foreign short-term nominal interest rate $i^* = r^* + \pi^*$. Since $i^*_{t+1}$ is known at the end of period $t$, $\pi^*_{t+1} + r^*_{t+1} - E_t[\pi^*_{t+1} + r^*_{t+1}] = 0$ and hence does not become a part of the right side of Eq. (5).
4. While it is possible to maintain the separation between the two components, there is no satisfactory way to measure them. Hence, in the analysis to follow, no additional information is gained by the theoretical separation.
5. Flexible price models which do not allow for any real effects from monetary shocks are limited in their price and interest rate dynamics. However, the Grilli and Roubini (1995) model captures the effects of both the change in liquidity from monetary policy and the inflationary expectations. They point out that empirically, their model is the same as the sticky-price model.
6. See Leeper and Gordon (1992) for analysis and critique of models with liquidity effects.
7. In Grilli and Roubini (1995), the effects of monetary policy on exchange rates between the G-7 countries are explored. Using a VAR system including short-term interest rates, they note that positive innovations in U.S. interest rates result in an appreciation of the $US, while positive interest rate innovations in the other countries depreciate their currencies. They argue that this asymmetry may be due to a leader-follower monetary policy, possibly complemented by the smaller countries' endogenous inflation responses to U.S. monetary shocks. Their empirical analysis provides some support for these arguments.
8. Since the inflation differential $\delta\pi^*$ and the interest rate differential $\delta i^*$ both increase by the same amount, it is not obvious from Eq. (14) how the excess currency return is negative. Note that the sum of the expected changes in the inflation rate differential includes one more period than the sum of the interest rate differential. This is the result of assuming R.P.P.P. holds in each period; that is, we are holding the risk premium constant in the analysis, so that immediate shocks to inflation affect the exchange rate, but not the interest rates inherent in the starting currency position.
9. Fama and French (1989) show that excess stock returns help predict excess bond returns. VAR systems including this variable have been tested and do not change the qualitative results reported in this paper.
10. The qualitative results of the impulse response analysis are robust to the ordering of interest rates and inflation.
11. The $t+1$ U.S. and foreign short-term interest rates are known at the end of period $t$. However, in order to capture the underlying dynamics of the system, all rates represent the actual returns over the period.
12. The mean monthly returns for some countries may appear quite large; however, they are not significantly different from zero. Some currency returns calculated over the subperiods before and after January 1985, are significantly different from zero. In the early period, all the currencies show average negative excess returns of at least one standard error; in the later period, the average returns are all positive to about the same degree. These data indicate that uncovered interest parity did not hold as the $US appreciated prior to 1985, nor as it depreciated subsequently.
13. Correlations for foreign investors holding $US bonds during the period 78:01–97:10 are: Japan, –0.11; Germany, –0.18; Canada, –0.19; and U.K., –0.16.

14. Data for France and Italy are also available, but are not shown. Their correlations are close to zero over the full period. It may be that currency movements within the EMS are influenced more by government intervention.

15. In order to simplify the calculation of future errors, the two-lag system is transformed into a one-lag system of 18 variables; the last 9 being the one-period lags of the first nine variables. This is also included in the appendix.

16. Recall that Eq. (5) is derived using a pure-discount bond, which will have a somewhat longer duration than a coupon bond of the same maturity. Therefore, there is a potential mismatch between the data used to estimate the VAR and the decomposition equation. Since actual durations in the data vary among countries and over time as yields change, no attempt is made to adjust the pure-discount maturity assumption precisely to the data. However, results are robust to small (e.g., 20%) changes in the maturity assumption.

17. This may help explain the fact that the total excess bond return variances differ between Germany (2.0) and the U.K. (6.9).

18. This means that the number of basis point of response should not be compared from one shock to another. For example, the standard error of the residual for U.S. T-bills is about 8 basis points, but the comparable figure for the U.K. short-term interest rate is only 0.4 basis points.

19. In 1997, the central bank of the U.K. gained substantial independence. It will be interesting to see if this change affects relative excess bond returns in the future.

References


