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ABSTRACT

This paper examines uncovered interest rate parity (UIRP) and the expectations hypotheses of the term structure (EHTS) at both short and long horizons. The statistical evidence against UIRP is mixed and is currency- not horizon-dependent. Economically, the deviations from UIRP are less pronounced than previously documented. The evidence against the EHTS is statistically more uniform, but, economically, actual spreads and theoretical spreads (spreads constructed under the null of the EHTS) do not behave very differently, especially at long horizons. Partly because of this, the deviations from the EHTS only play a minor role in explaining deviations from UIRP at long horizons. A random walk model for both exchange rates and interest rates fits the data marginally better than the UIRP-EHTS model.

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1 Introduction

Uncovered Interest Rate Parity (UIRP) predicts that high yield currencies should be expected to depreciate. It also predicts that, *ceteris paribus*, a real interest rate increase should appreciate the currency. UIRP is one of the cornerstones of international finance, constituting an important building block of most important exchange rate determination theories such as the monetary exchange rate model, Dornbusch (1976)'s overshooting model or Krugman (1991)'s target zone model and dominating the discussion on exchange rate determination in most international textbooks. Nevertheless, there appears to be overwhelming empirical evidence against UIRP, at least at frequencies less than one year (see Hodrick (1987), Engel (1996) and Froot and Thaler (1990)). Given that this empirical evidence has not stopped theorists from relying on UIRP, it is fortunate that recent evidence is more favorable: Bekaert and Hodrick (2001) and Baillie and Bollerslev (2000) argue that doubtful statistical inference may have contributed to the strong rejections of UIRP at higher frequencies whereas Chinn and Meredith (2001) marshal evidence that UIRP holds much better at long horizons.

The long-horizon evidence regarding UIRP is somewhat puzzling at first sight. By construction, if UIRP holds in the short run, it should hold in the long run as long as the expectations hypothesis of the term structure of interest rates (EHTS) holds; that is, as long as the long rate equals the average expected future short rate over the life of the bond. It seems unlikely that the short-term deviations from UIRP would exactly offset the long-term deviations from the EHTS to make UIRP hold in the long run. In alternative models based on risk, a time-varying risk premium separates expected exchange rate changes from the interest differential and a time-varying term premium separates the long-term interest rate from expected future short rates. Consequently, these risk premiums would be driven by the same fundamentals and deviations from UIRP and the EHTS should be visible at both long and short horizons.

However, if inefficient markets or short-term market frictions prevent an immediate complete response of the exchange rate to an interest rate change, short-term deviations of

UIRP may occur while long-horizon UIRP holds (see Froot and Thaler (1990)). Similarly, term spreads may be poor predictors of short-run changes in interest rates, but good predictors of short rate changes over the long run, for which there is some empirical evidence (see Campbell and Shiller (1991)).

It is therefore worthwhile to re-examine UIRP and the EHTS simultaneously at long and short horizons. To do so, our main tool of analysis will be a vector autoregression (VAR) on exchange rate changes, interest rates and term spreads, drawing data from three countries: the US, the UK and Germany. The VAR not only allows us to disentangle the various hypotheses in a unified framework, it also makes it easy to conduct more powerful joint tests across both short and long horizons. Apart from the statistical significance, we also examine the economic significance of potential deviations from UIRP and the EHTS. Many policymakers conduct policy experiments imposing the EHTS for example (see Evans (1998) and Bernanke, Gertler, and Watson (1997)). If the EHTS does not hold statistically, but the spread as predicted by the EHTS and the actual spread are very highly correlated, assuming the EHTS in a policy analysis may be acceptable. Our framework allows us to investigate the economic significance of imposing different hypotheses.

Our main findings can be summarized as follows. The statistical evidence regarding UIRP is mixed, depending on the currency pair but not on the horizon. Economically, although our statistics show that UIRP deviations are important, it is crucial to adjust them for small sample biases. Our results here are of immediate relevance for a growing literature in international economics that makes use of an empirically calibrated "deviation from UIRP", see for example McCallum (1994). In comparison, the statistical evidence against the EHTS is more uniform across countries and horizons. Finally, the deviations from the EHTS are not economically important, indicating that analyzing the effects of policy experiments under the null of the EHTS may be useful.

The remainder of the paper is organized as follows. Section 2 reviews the main hypotheses, UIRP and the EHTS, and how they are related. Section 3 outlines our econometric procedure. Section 4 and section 5 present empirical results from the statistical and the economic perspective. We also consider one popular alternative hypothesis, that exchange rates and interest rates are random walks (see Meese and Rogoff (1983) and Mark (1995) for the first and Campbell and Shiller (1987) or Mankiw, Miron, and Weil (1987) for the latter). Section 7 concludes.

2 Expectations Hypotheses

Uncovered Interest Rate Parity (UIRP)

UIRP holds at the n-period horizon if

$$\frac{1}{n}\left(E_t s_{t+n} - s_t\right) = i_{t,n} - i^*_{t,n} + \alpha_n \tag{1}$$

where s_t is the logarithm of the spot exchange rate (local per foreign currency), $i_{t,n}$ and $i^*_{t,n}$ are the time-t continuously compounded domestic and foreign n-period interest rate respectively, and α_n is a constant risk premium. All interest rates are expressed in monthly rates.

Denote $\Delta s_t = s_t - s_{t-1}$. UIRP can be tested with the following regression:

$$\frac{1}{n}\sum_{i=1}^{n}\Delta s_{t+i} = \alpha_n + \beta_n^{uirp}\left(i_{t,n} - i^*_{t,n}\right) + \varepsilon_{t,t+n} \tag{2}$$

Under the null the slope coefficient equals one.

Expectations Hypothesis of the Term Structure (EHTS)

The EHTS holds if the long-term n-period interest rate $i_{t,n}$ is an unbiased estimator of the average expected short-term interest rate $i_{t+h,1}$ during the bond's life plus a constant term premium:

$$i_{t,n} = \frac{1}{n}\sum_{h=0}^{n-1} E_t\left(i_{t+h,1}\right) + c_n \tag{3}$$

A direct test of this hypothesis (see for example Campbell and Shiller (1991)) is the regression:

$$\frac{1}{k}\sum_{i=0}^{k-1} i_{t+im,m} - i_{t,m} = a_n + \beta^{ehts}_{n,m}\left(i_{t,n} - i_{t,m}\right) + u_{t+n-m} \tag{4}$$

where $k = n/m$ and $m < n$.

Under the EHTS, the slope coefficient in this regression should equal one.[1]

UIRP and EHTS

UIRP at horizon n is implied by UIRP at the short horizon (m periods, say) and the EHTS at horizon n. To see this, assume that the UIRP holds at the shorter-term m-period horizon:

$$\frac{1}{m}\sum_{j=1}^{m} E_t \Delta s_{t+j} = \alpha_m + i_{t,m} - i^*_{t,m}$$

and that the EHTS holds at the longer-term n-period horizon for both domestic and foreign interest rates:

$$i_{t,n} = a_n + \frac{1}{k}\sum_{j=0}^{k-1} E_t\left(i_{t+jm,m}\right)$$

$$i^*_{t,n} = a^*_n + \frac{1}{k}\sum_{j=0}^{k-1} E_t\left(i^*_{t+jm,m}\right)$$

where $k = n/m$. Then UIRP also holds at the n-period horizon

$$\begin{aligned} i_{t,n} - i^*_{t,n} &= a_n - a^*_n + \frac{1}{k}\sum_{j=0}^{k-1} E_t\left(i_{t+jm,m} - i^*_{t+jm,m}\right) \\ &= \frac{1}{n}\sum_{j=1}^{n} E_t \Delta s_{t+j} + a_n - a^*_n - \alpha_m \end{aligned} \tag{5}$$

As a consequence, although UIRP in the short run, UIRP in the long run and the EHTS at long horizons are three distinct hypotheses, a joint test requires testing only two out of these three hypotheses. Surprisingly, this close relationship between UIRP and the EHTS has been largely ignored in the literature. Campbell and Clarida (1987)

[1] Campbell and Shiller (1991) also investigate changes in the long-maturity bond yield over a shorter m-period time span. We do not focus on these EHTS-restrictions because they are not directly relevant for the link with UIRP and the empirical implementation suffers from a bias induced by lacking data on the $n - m$-period bond.

and Lewis (1990) jointly study foreign exchange and term structure returns but they test latent variable models not the Expectations Hypotheses. Bekaert and Hodrick (2001) do test both UIRP and the EHTS, but as Campbell and Clarida and Lewis, they only focus on short-horizon Eurocurrency data.

3 Econometric Methodology

3.1 Regression Tests

The error terms in regressions (2) and (4) are serially correlated when $n, m > 1$, and OLS standard errors are hence no longer consistent. By standard Generalized Methods of Moments (Hansen (1982)), the asymptotic distribution of the OLS estimator $\theta_n = (\alpha_n, \beta_n)$ in regression (2) is $\sqrt{T}\left(\widehat{\theta}_n - \theta_n\right) \sim N(0, \Omega)$, where $\Omega = Z_0^{-1} S_0 Z_0^{-1}$, $Z_0 = E(x_t x_t')$ with $x_t' = \left(1, i_{t,n} - i_{t,n}^*\right)$ and $S_0 = \sum_{j=-n+1}^{n-1} E\left(w_{t+n} w_{t+n-j}'\right)$ with $w_{t+n} = \epsilon_{t+n} x_t$. A consistent estimator of S_0 is

$$\widehat{S}_0 = C(0) + \sum_{j=1}^{n-1} [C(j) + C(j)']$$

where

$$C(j) = \frac{1}{T} \sum_{t=j+1}^{T} \left(w_{t+n} w_{t+n-j}'\right)$$

This is the Hansen and Hodrick (1980) estimator. However, $\widehat{S}_0$ may fail to be positive semi-definite. If it is not, we replace it with a Newey and West (1987) estimator with n lags. The estimator $\widehat{\Omega} = \widehat{Z}_0^{-1} \widehat{S}_0^{-1} \widehat{Z}_0$ thus obtained gives rise to our robust Hansen and Hodrick (1980) standard errors.

Regression tests have several disadvantages. First, the Hansen and Hodrick (1980) standard errors have very poor small-sample properties leading to over-rejection (See Hodrick (1992)). We examine below whether the regressions remain useful for our long-horizon tests. Second, the long-horizon regressions have fewer observations than short-horizon regressions, which complicates conducting efficient joint tests across horizons.

3.2 VAR Tests

An alternative to the simple regression tests that circumvents their disadvantages is to examine UIRP and the EHTS in the context of a VAR on exchange rate changes and interest rates. With a VAR, we can recover (implied) regression slopes from the VAR dynamics and conduct joint Wald tests of UIRP at short and long horizons and the EHTS. Moreover, if we impose the null hypothesis on the VAR dynamics, we can conduct Lagrange Multiplier (LM) and Distance Metric (DM) tests, which have superior size properties compared to the simple Wald test statistic (See Bekaert and Hodrick (2001)). Finally, the dynamics of exchange rates and interest rates under the null and the alternative reveal the economic significance of potential deviations from the null hypotheses.

The variables included in our 5-variable VAR are

$$y_t = \left(\Delta s_t, i_{t,3}, i^*_{t,3}, sp_{t,60}, sp^*_{t,60}\right)'$$

where * again indicates the foreign country, and we take the US as the domestic country. Here $sp_{t,60}$ ($sp^*_{t,60}$) is the term spread between the 60-month long rate and the 3-month short rate. We also estimate a cross-country system for Deutsche Mark/Pound rates with Germany functioning as the home country. Furthermore, we estimate two 7-variable VARs where the 12-month or the 36-month term spreads are included for all currency pairs. With these VARs, we can test both long- and shorter-horizon EHTS.

We select the optimal order of the VAR using the BIC criterion, and represent the companion form of the VAR (of order K say) in the usual way as

$$x_{t+1} = Ax_t + \xi_{t+1}$$

with $x_{t+1} = \left(y'_{t+1}, y'_t, \ldots, y'_{t+2-K}\right)'$, where we suppress the constant term.

Collect the parameters of the VAR (A, the constants and the innovation covariance matrix) in the vector θ. We obtain unconstrained estimates using the GMM by minimizing the objective function

$$g_T(\theta)' W g_T(\theta),$$

where W is a weighting matrix, and $g_T(\theta) \equiv \frac{1}{T}\sum_{t=1}^{T} g(x_t, \theta)$ is the standard set of orthogonality conditions for a VAR system. Hansen (1982) demonstrates that the optimal weighting matrix is the inverse of

$$\Omega = \sum_{k=-\infty}^{\infty} E\left[g(x_t, \theta)\, g(x_{t-k}, \theta)'\right]$$

Let Ω_T be a consistent estimator of Ω and let the weighting matrix W be optimally chosen as Ω_T^{-1}. Denote $G_T \equiv \bigtriangledown g_T(\theta)$. The parameter estimates are asymptotically distributed as

$$\sqrt{T}\left(\widehat{\theta} - \theta_0\right) \to \mathcal{N}\left(0, \left(G_T' \Omega_T G_T\right)^{-1}\right).$$

The hypotheses of UIRP and the EHTS impose different constraints on the parameters of the VAR. Let e_j be an indicator column vector that selects the j-th variable in the VAR. Using $E_t x_{t+k} = A^k x_t$ and straightforward algebra, we can show that UIRP at the 3-month horizon implies

$$\frac{1}{3} e_1' A (I - A^3)(I - A)^{-1} = e_2' - e_3' \tag{6}$$

while in the 5-variable VAR, UIRP at the 60-month horizon implies

$$\frac{1}{60} e_1' A (I - A^{60})(I - A)^{-1} = e_4' - e_5' + e_2' - e_3'.$$

Similarly the domestic 60-month EHTS imposes the restriction

$$e_4' = e_2' \left[\frac{1}{20}\left(I - A^{60}\right)\left(I - A^3\right)^{-1} - I\right]. \tag{7}$$

Let these constraints be summarized as

$$H_0 : q(\theta_0) = 0$$

Further denote the sample counterpart of $q(\theta)$ by $q_T(\theta)$ and its gradient by $Q_T \equiv \bigtriangledown q_T(\theta)$.

The constrained GMM objective function can be written as

$$L(\theta, \gamma) = -(1/2)\, g_T(\theta)' \, \Omega_T^{-1} g_T(\theta) - q_T(\theta)' \gamma \tag{8}$$

where γ is the vector of Lagrange multipliers.

Direct maximization of the objective function is difficult as these constraints are highly nonlinear. Instead, we employ the recursive algorithm described in Bekaert and Hodrick (2001). In brief, starting from a consistent estimator $\widetilde{\theta}$, which is usually the unconstrained estimator, we iterate on the following two equations derived from Taylor expansions of the first-order conditions to (8):

$$\overline{\theta} = \widetilde{\theta} - B_T^{-1/2} M_T B_T^{-1/2} G_T' \Omega_T^{-1} g_T\left(\widetilde{\theta}\right) - B_T^{-1} Q_T' \left(Q_T B_T^{-1} Q_T'\right)^{-1} q_T\left(\widetilde{\theta}\right)$$
$$\overline{\gamma} = -\left(Q_T B_T^{-1} Q_T'\right)^{-1} Q_T B_T^{-1} G_T' \Omega_T^{-1} g_T\left(\widetilde{\theta}\right) + \left(Q_T B_T^{-1} Q_T'\right)^{-1} q_T\left(\widetilde{\theta}\right)$$

where

$$B_T = G_T' \Omega_T^{-1} G_T$$
$$M_T = I - B_T^{-1/2} Q_T' \left(Q_T B_T^{-1} Q_T'\right)^{-1} Q_T B_T^{-1/2}$$

We consider three different test statistics of the null hypothesis, the Wald statistic

$$T q_T\left(\widehat{\theta}\right)' \left(Q_T B_T^{-1} Q_T'\right)^{-1} q_T\left(\widehat{\theta}\right) \to \chi^2(k);$$

the distance metric (DM) statistic

$$T g_T\left(\overline{\theta}\right)' \Omega_T^{-1} g_T\left(\overline{\theta}\right) \to \chi^2(k);$$

and the Lagrange multiplier (LM) statistic

$$T\overline{\gamma}' \left(Q_T B_T^{-1} Q_T'\right) \overline{\gamma} \to \chi^2(k).$$

The DM and LM statistics require estimation under the null. The degrees of freedom k of the χ^2-distribution depends on the VAR order.

3.3 Implied VAR Statistics

Let Ψ be the unconditional variance of y_t. Together with A, Ψ fully describes the dynamics of exchange rate changes, interest rates and spreads in the VAR. First, we compute implied slope coefficients that correspond to the regression slope coefficients of section 2. For example, in our 5-variable VAR, the implied 3-month UIRP regression slope is

$$\gamma_3^{uirp} = \frac{1}{3}\frac{e_1' A\left(I - A^3\right)\left(I - A\right)^{-1}\Psi\left(e_2 - e_3\right)}{\left(e_2' - e_3'\right)\Psi\left(e_2 - e_3\right)},$$

and the implied TS slope coefficient in equation (4) for the domestic 60-month interest rate is

$$\gamma_{60,3}^{ehts} = \frac{e_2'\left[\left(I - A^{60}\right)\left(I - A^3\right)^{-1}/20 - I\right]\Psi e_4}{e_4'\Psi e_4}.$$

Second, to further characterize the economic significance of deviations from the null hypotheses, we compute three alternative statistics. When UIRP holds, the expected exchange rate change should be perfectly correlated with the interest rate differential; its variability should equal the variability of the interest differential, and the variability of the foreign risk premium should be zero. Hence we compute

$$CORR^{uirp} = corr\left(\frac{1}{n}E_t\sum_{i=1}^{n}\Delta s_{t+i}, i_{t,n} - i_{t,n}^*\right) \tag{9}$$

$$VR^{uirp} = var\left(\frac{1}{n}E_t\sum_{i=1}^{n}\Delta s_{t+i}\right)/var\left(i_{t,n} - i_{t,n}^*\right) \tag{10}$$

$$SD^{uirp} = \left[var\left(\frac{1}{n}E_t\sum_{i=1}^{n}\Delta s_{t+i} + \left(i_{t,n}^* - i_{t,n}\right)\right)\right]^{0.5} \tag{11}$$

where the expression between parentheses in equation (11) is the foreign exchange risk premium, which we will refer to as $rp_{t,n}^{uirp}$.

Analogously, we compute the correlation $CORR^{ehts}$ between the actual spread and the "theoretical" spread as computed from expected future short rates, $\frac{1}{k}E_t\sum_{j=0}^{k-1} i_{t+jm,m} - i_{t,m}$, the corresponding variance ratio VR^{ehts} and the standard deviation of their difference SD^{ehts}. The difference between the theoretical spread and the actual spread can be thought of as the expected excess return to rolling over short-term interest contracts over a period of n months instead of holding the long bond till maturity.

Under the alternative of a time-varying risk premium, it is also interesting to examine Fama's (1984) "excess volatility puzzle". For many economists, a volatility of the risk premium larger than the volatility of expected exchange rate changes would appear excessive. Fama shows that the volatility of the "risk premium" is larger than that of expected changes in the exchange rate as long as the standard UIRP regression coefficient is less than 1/2. Assuming that the investors form their expectation about future exchange rates and interest rates based on current and historical values of our VAR variables only, we can compute the Fama (1984) volatility ratio,

$$EVR^{uirp} = var\left[rp_{t,n}^{uirp}\right]/var\left[\frac{1}{n}E_t\sum_{i=1}^{n}\Delta s_{t+i}\right],$$

at different horizons from our VAR estimates.[2] The concept nicely generalizes to deviations from the EHTS. When the ratio of SD^{ehts} to the variance of expected spot rate changes is larger than one, this would indicate excess volatility of term structure premiums.

Whereas the excess volatility statistics would be zero under the null of UIRP and the EHTS, they would converge to zero as the horizon increases under the short-term market inefficiency story.

3.4 Monte Carlo Analysis

Given recent evidence on the poor finite sample behavior of many test estimators, we conduct a bootstrap analysis of the finite sample properties of the Wald, LM and DM test statistics, the actual and implied regression slopes and the four economic significance test statistics. Our null model is a biased-corrected version of the constrained VAR with UIRP and the EHTS imposed. Appendix B describes the data generating process and the results in detail. Here, we only summarize our main findings.

First, the actual UIRP regression coefficients are downward biased at the 60-month horizon. Together with a dispersion that is typically larger at long horizons, this results in a wider confidence interval for long-horizon slopes. These biases are partly the reason

[2] It can be rewritten as $1 + var\left[i_{t,n} - i_{t,n}^*\right]/var\left[\frac{1}{n}E_t\sum_{i=1}^{n}\Delta s_{t+i}\right] - 2cov\left(i_{t,n} - i_{t,n}^*, \frac{1}{n}E_t\sum_{i=1}^{n}\Delta s_{t+i}\right)/var[\frac{1}{n}E_t\sum_{i=1}^{n}\Delta s_{t+i}]$. The second term on the right hand side is $1/VR^{uirp}$, and the third term equals $2 * CORR^{uirp}/(VR^{uirp})^{0.5}$.

for the very poor small-sample behavior of the t-statistics, especially at long horizons. Whereas the small sample distribution of the implied slope coefficients is similar to that of the OLS counterparts, its small sample properties are superior: the biases are generally lower and the implied t-statistics are much closer to normal.

The TS-slope coefficients are upward biased, confirming the Monte Carlo results in Bekaert, Hodrick, and Marshall (1997). The t-statistic distribution of the EHTS regression slope is somewhat closer to normal than its UIRP counterpart but it is still severely distorted. Again the VAR implied t-stats are much better behaved. Consequently, we do not report direct regression coefficients but focus entirely on the VAR results.[3]

Second, generalizing the findings in Bekaert and Hodrick (2001), the LM test statistic has little size distortion and its finite-sample distribution is well-approximated by the asymptotic χ^2 distribution. Hence, we only use the LM test for our VAR-based tests. The Wald statistic has the worst size distortion and its use invariably leads to over-rejection.

Third, the examination of the four economic significance statistics reveals important biases and wide finite-sample distributions. For example, the correlation and variance ratio statistics, also used by Campbell and Shiller (1991) in a study on the EHTS in the US, show downward (upward) bias. The bias is least severe for statistics involving the theoretical spread, exactly the hypotheses Campbell and Shiller (1991) focused on. Not surprisingly, the standard deviation of the risk premium is an upwardly biased statistic but the bias is economically large and is most severe for short-horizon UIRP premiums. This foreign exchange risk premium is exactly the variable that is a critical input in a number of recent analyses, such as McCallum (1994). The Fama excess volatility ratio statistic is also upwardly biased, with the bias less severe at shorter horizons and for the term structure tests.

In reporting these statistics below, we always add the Monte Carlo mean and a [2.5%, 97.5%] confidence interval based on the Monte Carlo analysis.

[3] Direct regression results are available upon request. We find that one reason for Chinn and Meredith (2001)'s claim that UIRP holds better at longer horizons is simply sample choice. When we restrict our sample to start only in 1980, the slope coefficients are closer to the ones Chinn and Meredith find.

4 Statistical Evidence on the Expectations Hypotheses

Table 1 reports the LM-test results for our base 5-variable VAR system with 3-month and 60-month interest rate data and the two 7-variable systems. The latter systems add the intermediate maturity to both "short" and "long" horizon tests in UIRP. Therefore, Table 1 contains joint tests across all possible combinations of maturities except those involving both 12-month and 36-month data.

We find no evidence against UIRP at either the 3-month or the 60-month horizon in the USD-DEM system at the 5% significance level (See Panel A). For the USD-GBP system, the results are more mixed. The LM test marginally fails to reject the null at the 3-month and the 60-month horizon separately in the 5-variable VAR. However, in the 7-variable systems we reject UIRP at the 5% level for short horizons but fail to reject at long horizons. Generally, the p-values are rather low. Hence, there is only weak evidence that the UIRP holds up better at long than at short horizons, and the intermediate maturities are key to help reject the hypotheses. The two joint tests across horizons that we could compute both reject at the 5% level. For the cross-country system of DEM-GBP, the LM test rejects UIRP at all horizons. We conclude that for UIRP, the horizon story seems to be a myth. In some cases, the statistical evidence against UIRP is even stronger at long horizons. Whether one rejects or not depends on the currency pair under investigation. These findings are potentially consistent with a time-varying risk premium explanation, where the variability of the risk premium varies across currencies.

Turning now to Panel B and the EHTS hypothesis, we find that the LM test yields rather uniform evidence against the EH. For the U.S., we reject the EHTS at all horizons apart from the joint test in the 3/36/60-month USD-GBP system. We always reject the EHTS in Germany at the 5% level independent of the VAR system. The evidence against the EHTS is the weakest for the GBP, at least in the DEM-GBP system, where we fail to reject the null at long horizons. However, it is likely that the presence of DEM instruments simply reduces the power of the test because in the USD-GBP system, the EHTS in the UK is rejected at both short and long horizons and jointly. The highest p-value is 5.25%. When we pool across countries, the EHTS is strongly rejected at short horizons in all systems. At longer horizons, we reject the EHTS at the 1% level in the USD-DEM system, at the 5% level in the USD-GBP system, but fail to reject the hypothesis at the 5% level in the 7-variable DEM-GBP systems. Nevertheless, the p-values are rather low.

Panel C contains joint tests of UIRP and the EHTS. Most of interest is the "UIPs TSl" hypothesis which not only imposes short-term UIRP and the long-term EHTS but also automatically long-term UIRP (see Section 2). This hypothesis is not equivalent to the joint UIRP hypothesis of Panel A, because that hypothesis did not require the EHTS to hold in both countries. For UIRP to hold both at the short and the long horizon, it must be true that the difference between the term premiums in the two countries is time-invariant. This might be the case in the USD-DEM system, where the weaker Panel A test does not reject but the Panel C test rejects. For the USD-GBP system, the two tests yield similar p-values, constituting only marginal evidence against the hypothesis. For the DEM-GBP system, testing the additional restrictions mostly weakens the test, although we still reject the null at the 5% level in the 3/36/60-month VAR and at close to the 5% level in the 5-variable VAR. As to the combination of short or long horizon UIRP with the EHTS at short horizons, we reject these null hypotheses in the USD-DEM and USD-GBP systems, but the evidence against the hypotheses is weaker in the USD-GBP system.

5 Economic Evidence on the Expectations Hypotheses

We now study the five economic significance test statistics: $IMPLIED$, the implied slope coefficient; $CORR$, the correlation between the interest rate differential (term spread) and the expected exchange rate change (expected interest rate changes); VR, the ratio of the variance of expected exchange rate changes (expected interest rate changes) and that of the interest rate differential (term spread); SD, the standard deviation of the foreign exchange market "risk premium" (term premium); and EVR, the excess volatility ratio. After analyzing the deviations from UIRP and EHTS in sections 5.1 and 5.2, we consider how imposition of various EH affects certain key impulse responses implied by the VAR.

5.1 Uncovered Interest Rate Parity

5.1.1 Patterns

Table 2 contains the results for the three different 5-variable systems. (USD-DEM, USD-GBP and DEM-GBP) in three panels. First consider the unconstrained estimation. The correlation statistics inherit the negative sign from the implied slope coefficients and hence expected exchange rate changes and current interest differentials are negatively correlated at both short and long horizons for all three currency pairs. In fact, the correlation is more negative at the 60-month horizon for two of the three currency pairs. The Monte Carlo analysis reveals that correlations are downward biased under the null (see Appendix B). Nevertheless, even the bias-corrected statistics, with the exception of $CORR$ in the USD-DEM system at the three-month horizon, remain negative.

In both the USD-DEM and the USD-GBP systems, VR is above one at the 3-month horizon and below one at the 60-month horizon. In the DEM-GBP system, VR is also above one at the 60-month horizon. However, the statistic displays an upward bias of about 0.61 so that on a bias-corrected basis, VR is below one even in this system. This indicates that expected exchange rate changes are more variable than the corresponding interest rate differential in the shorter run, but not necessarily in the long run, even though interest rate differentials become less variable at longer horizons. Whereas it is tempting to ascribe this large variability in short-term expected exchange rate changes to irrational factors, these results are potentially consistent with a time-varying risk premium, characterized by a highly persistent component in expected exchange rate changes.

This is confirmed by investigating the standard deviation of the risk premium directly.

In all three systems, SD is substantially higher in the short run. Given the decomposition of long-horizon foreign exchange premiums, this must indicate persistent but mean-reverting short-run foreign exchange risk premiums and/or strongly negative correlation between short-run foreign exchange risk premiums and the term premium differential. To see this more clearly, note that the counterpart to equation (5) under the alternative of a time-varying risk premium is:

$$rp_{t,60}^{uirp} = \frac{1}{k} E_t \sum_{j=0}^{k-1} rp_{t+3j,3}^{uirp} + rp_{t,60}^{ehts*} - rp_{t,60}^{ehts} \tag{12}$$

where $rp_{t,60}^{ehts*}$ indicates the "foreign" term premium.

Alternatively, because the risk premium is the sum of expected exchange rate changes and the interest rate differential, the reduced variability at longer horizons is due to reduced variability in both components. Of course, the VR statistic shows that it is expected exchange rate changes that became relatively less variable.

Given these results, the EVR (excess volatility) patterns are not entirely surprising. Excess volatility comes about because the risk premium embeds the variability of its two components, expected exchange rate changes and interest-rate differentials, which are only weakly or even negatively correlated instead of perfectly correlated.

At the 3-month and the 60-month horizon respectively, the excess volatility ratio is 1.8931 and 3.5034 for the USD-DEM system, 1.9223 and 3.7533 for the USD-GBP system, and 1.7414 and 2.7939 for the DEM-GBP system. Our results are stronger than the U shape in volatility ratios documented in Bauer (2001), but they also support the conclusion that the "excess volatility" phenomenon does not go away in the long run. On the contrary, there is more excess volatility at long horizons, basically because the correlation between expected exchange rate change and interest rate differences does not become more positive and because the relative variability of expected exchange rate changes decreases. These results are hard to reconcile with a short-term market frictions or market inefficiency story. We conclude that most of the patterns we see are consistent with a time-varying risk premium model with mean-reverting factors.

5.1.2 Statistical Significance

To judge statistical significance, we rely on the critical values derived from the Monte Carlo analysis described in Appendix B and reported at the bottom of each panel in Table 2.

For the USD-DEM system all statistics could have been generated by a dynamic system which satisfies the EHs. However, for the USD-GBP and DEM-GBP systems, only the VR, SD and EVR at the long horizons fall comfortably within the 95% confidence interval.

The loss of power for the VR, EVR, and especially the SD statistic is interesting in its own right. Empirical estimates of the variability of the risk premium are often chosen as population moments to be matched in general equilibrium models attempting to explain the forward premium anomaly (See for example Bekaert (1996) and Duarte and Stockman (2001)). However, our analysis here shows that this statistic is severely upwardly biased, with the 2.5% quintile being at least 1.3946. Similarly, the classic excess volatility results relied on asymptotic statistics without an attempt to correct for small sample biases. Even under the null, we should expect to see ratio of at least 0.60 at short and 1.5 at long horizons.

Whereas the coefficient patterns described in 5.1.1 remain valid when we correct for small sample bias, small sample biases appear very important in judging the economic importance of the deviations from UIRP. The implied slope coefficients and correlation statistics reveal that the data remain grossly inconsistent with UIRP, but at the same time, standard statistics considerably exaggerate the deviation from UIRP. Bias-correcting the variability of the risk premium for example, typically leads to standard deviations less than 50% of the original estimate.[4]

[4] This being said, the VAR uses a particular limited information set to generate expected values, whereas the true information set is usually larger, potentially inducing more variable UIRP premiums. In Section 5.1.4, we expand the information set and show the estimate for the variability of the risk premium to be very robust.

5.1.3 Dynamics under Alternative Null Hypotheses

Next we examine how imposing different null hypotheses changes the dynamics of the system. Table 2 shows that imposing UIRP at one horizon almost invariably moves the economic significance statistics closer to their hypothesized values under the null of UIRP at the other horizon. Most strikingly, imposing the UIRP hypothesis in the short run moves the implied slope for the long-run UIRP regression much closer to one, and vice versa. For example, with the USD-DEM data, imposing the UIRP at the 3-month horizon brings the implied slope for the 60-month UIRP regression from -0.3741 under the unconstrained VAR up to 0.5183, while imposing the UIRP at the 60-month horizon brings the implied slope for the 3-month UIRP regression from -0.6007 to 0.6467. The deviations from UIRP at short and long horizons are clearly highly correlated making it again unlikely that the UIRP is satisfied at the long horizon but not at the short horizon.

The same is not true for the relation between UIRP and the EHTS. Imposing the EHTS has very different effects depending on the currency pair and the statistic. Of main interest here is the behavior of SD. The variance of the longer-horizon UIRP premium can be decomposed into the variance of the short-horizon UIRP premiums, the variance of the difference in domestic and foreign EHTS term premiums, and the covariance of these two terms. We can examine their relative importance by imposing either short-horizon UIRP or the EHTS. Comparing $SD\,(rp)$ computed under the unconstrained VAR, the constrained VAR under 3-month UIRP, and the constrained VAR under the 60-month EHTS across countries we find that imposing 3-month UIRP decreases the volatility of the long-horizon foreign exchange risk premium much more than does imposing the 60-month EHTS hypothesis. In fact, only between 12.24% (USD-DEM) and 19.51% (USD-GBP system) of the total variance is accounted for by variation in term premiums (what is left when UIRP short is imposed). Thus longer-term UIRP deviations appears to result primarily from short-term UIRP deviations.

If we assume a persistent risk premium with autocorrelation coefficient ρ, then under the null of the EHTS, the relative variability of long and short-horizon risk premiums is completely governed by ρ. In particular:

$$VAR[rp_{t,60}^{uirp}] = \frac{1}{20^2}\left(\frac{1-\rho^{60}}{1-\rho^3}\right)^2 VAR[rp_{t,3}^{uirp}]$$

From the 3 and 60 month statistics for $SD(rp)$, we infer that ρ would be 0.9380 for the USD-DEM risk premium, 0.9715 for the USD-GBP system and 0.9209 for the DEM-GBP system.

Imposing the EHTS also has the uniform effect of increasing the variability of expected exchange rate changes relative to interest rate differentials, especially at long horizons (see the VR statistics). The main mechanism here is the increased persistence of the VAR induced by imposing the EHTS which feeds into expected exchange rate changes.

To further summarize the information in the VARs, Figure 1 plots impulse responses (IR) from the interest rate to foreign exchange risk premiums. We adopt the Wold ordering of $\{sp_{t,60}^j,\ i_t^j,\ sp_{t,60}^1,\ i_t^1,\ \Delta s_t\}$ in orthogonalizing the shocks, assuming that a shock to the U.S. short rate does not affect foreign interest rates or the term spread contemporaneously. The shock is a 1% positive shock to the USD short rate.

We consider the 3-month excess return, $rp_{t,3}^{uirp} = \frac{1}{3}E_t\sum_{i=1}^{3}\Delta s_{t+i} - \left(i_{t,3} - i_{t,3}^*\right)$, the 60-month risk premium, $rp_{t,60}^{uirp} = \frac{1}{20}E_t\sum_{i=1}^{60}\Delta s_{t+i} - \left(i_{t,60} - i_{t,60}^*\right)$, and the 60-month cumulative short term foreign exchange premium $rp_{t,60,c}^{uirp}$, which is obtained by rolling over $rp_{t,3}^{uirp}$ every three months. The top (bottom) panel contains results for the USD-DEM (USD-GBP) system.

The solid lines which represent the data show that all expected excess returns respond negatively to a positive USD short rate shock, and the magnitude of the response is large (about 3% in the short and 2% in the long rate). Hence U.S. interest rate increases lower the expected return to foreign money market investments. When long-horizon UIRP is imposed the interest rate response of the short-horizon (long-horizon) premium dwindles to substantially less than 1%.

The right panel shows that the responses of the cumulative short-term premiums are very similar to the responses of the long-term premium; confirming that the behavior of short-term foreign exchange premiums dominates the behavior of long-term foreign exchange premiums.

Imposing the EHTS has different effects on the two systems, as should not be a surprise from the results reported in Table 2. Moreover, the implied foreign exchange risk premium dynamics are quite different from what we see in the data and what is implied by UIRP.

5.1.4 Robustness

It is conceivable that our conclusions are very sensitive to the exact information set used in the VAR, severely reducing their relevance. As indicated before, we also estimate two 7 variable VAR systems, for which we also generate all the statistics as in Table 2. Fortunately, the results are remarkably robust. In fact, it is not only the case that the patterns in the statistics are similar across VARs, but the point estimates of the various statistics are very close. To give one example, the volatility of the risk premium, which we would expect to be especially sensitive to the information set, is estimated to be 8.10% (2.89%) at the 3-month (60 month) horizon in the original 5 variable USD-GBP VAR system. In the corresponding 3/12/60 month system, our estimate is 8.07% (3.15%) and in the 3/36/60 month system, it is 8.45% (2.84%).

We are of course also interested whether the horizon patterns hold up and are uniform across the intermediate maturities. To examine this, Table 3 collects information from the 3 and 60-month horizons using the 5 variable VAR but also reports information for the intermediate maturities using the 7 variable VARs. We draw four conclusions:

1. UIRP deviations are economically important in that exchange rate changes are weak to negatively correlated with interest rate differentials. Importantly, there is not a clear horizon pattern in these correlations.

2. The VR statistic (variability of expected exchange rate changes to interest rate differentials) and the variability of the risk premium decrease monotonically with the horizon whereas the excess volatility ratio EVR increases monotonically with the horizon. Excess volatility is not a short-run phenomenon!

3. When we bias-correct the statistics, the results are mostly (but not always) preserved, but generally become much less pronounced. The economic deviations of UIRP are less strong than previously thought.

4. Imposing UIRP at different horizons than the horizon under examination on the VAR dynamics with one exception moves all statistics closer to their hypothesized values under the null, sometimes dramatically so. For example, the implied slopes and correlation statistics in the DEM-GBP system all become very close to one.

5.2 Expectations Hypotheses of the Term Structure

5.2.1 Patterns and Statistical Significance

Table 4 reports the economic statistics for the EHTS in the 5-variable system. We look separately at the USD and the DEM term structure based on the USD-DEM system, and the GBP term structure based on the USD-GBP system. Alternative estimates based on a different VAR system yield qualitatively similar results.

Moving to the statistics in Table 4, both the implied slopes and the correlation coefficients are positive and below one. Except for the US, the correlation coefficient does not appear significantly different from 1 based on the small sample critical values. Imposing UIRP has little effect on its value.

Expected future interest rates are more variable than the term spread for the USD and the GBP, but the variance ratio statistic is below one for the DEM. Only the DEM variance ratio statistic is significantly different from one. Imposing UIRP does not lead to a clear pattern in variance ratio changes, with the exception that imposing joint UIRP invariably increases the variance ratio. This is primarily caused by the higher persistence of the interest rate in the constrained systems.

The risk premium of rolling over short-term deposits versus holding long-term bonds has a volatility of about 1% for the DEM and the GBP, and about 1.65% for the US. These values could have been produced by a system that imposes the EH. Imposing UIRP has little effect on these values, except for increasing them when UIRP is imposed jointly for the DEM and GBP. This is at first somewhat surprising because when UIRP holds at both horizons, the term premium differential across countries must be time invariant. Clearly, this is not accomplished by clamping down the variability of both term premiums. The high variability of the term premiums is the result of the variability of the constrained term premium inheriting some of the variability of the US term premium and the increased persistence of the constrained systems.

We conclude that while the data statistically reject the EHTS, the dynamics of interest rates do not yield patterns that are very different from what we would observe under the EHTS. Figure 2 confirms these conclusions using impulse responses from a 1% interest rate shock to the 5-year term premiums. The term premium is defined as $rp_{t,60}^{esth} = \frac{1}{20}E_t \sum_{j=0}^{19} i_{t+3j,3} - i_{t,60}$. An increase in the interest rate contemporaneously decreases the term premium but the effect is never larger than 80 basis points and dissipates fast. Whereas this may be comforting for policy models imposing the EHTS while conducting policy analysis, we know from Section 5.1 that imposing EHTS does substantially change exchange rate dynamics. Similarly, it appears from Figure 2 that imposing UIRP on a VAR does change the dynamic responses of interest rates on term premiums in some cases. In particular, the effect on the DEM term premium is large when UIRP is imposed. Moreover, imposing UIRP at both horizons in the USD-GBP system leads to a strong persistent response of the term premium to the interest rate, which is, by construction similar in both currencies (see above).

5.2.2 Robustness and Horizon Effects

The 7 variable systems can again serve as robustness checks. Moreover, they allow us to analyze the EHTS at both short and long horizons. Our results are very robust across VAR systems. As an example, consider the correlation between the actual spread and the theoretical spread (average expected interest rate changes) for the USD at the 60-month horizon. Table 4 reports a correlation of 0.52. With the 7 variable systems, we estimate this correlation with four different information sets: it is 0.51 in the USD-DEM 3/12/60 month system; 0.50 in the USD-DEM 3/36/60 month system; 0.50 in the USD-GBP 3/12/60 month system and 0.49 in the USD-GBP 3/36/60 month system.

Table 5 reports the EHTS results over various horizons. The horizon effects are in many ways opposite to what we found with the UIRP statistics. The correlation between theoretical and actual spread increases with horizon, and is actually negative in the case of the USD at the 12-month horizon (but the negative coefficient would disappear when the downward bias is corrected for). The variance ratio increases with horizon,[5] as does the variability of the risk premium. The excess volatility ratio decreases with horizon. The strength of the horizon dependence depends on the currency examined, but the results are qualitatively robust across currencies. In other words, the forecasting power of spreads appears rather weak for short-term interest rates at short horizons but is better for interest rates over longer horizons. The market inefficiency story often told for UIRP seems to fit better for the EHTS. One possible reason for these findings is that monetary policy succeeds in keeping short term interest rates close to random walks and nearly unforecastable in the short run, but at longer horizons larger economic shocks do drive interest rates, and these are more importantly reflected in long-term interest rates.

When we impose the EHTS at one horizon, the statistics on the other EHTS virtually invariably move closer to their values predicted under the null. This again demonstrates the strong correlation of the EHTS at different horizons, suggesting that a unified explanation based on time-varying risk for example may be possible.

6 The random walk as an alternative model

Since the seminal article by Meese and Rogoff (1983), the random walk has often been described as the exchange rate model to beat, and some authors have even used it as a benchmark model in applied work (see for example West, Edison, and Cho (1993)).

[5] Given that the theoretical spread depends on future expected interest rates, this is to be expected when short rates follow a persistent AR(1) process. A derivation of this result is available upon request.

Of course, if the exchange rate is a random walk, UIRP does not hold. The lack of predictability for exchange rate changes translates into predictable excess returns in the foreign exchange market. So under a time-varying risk premium explanation, the random walk model implies a particular risk premium that is a negative function of the current interest rate differential. Similarly, Mankiw and Miron (1986) and Rudebusch (1995) have argued that the interest smoothing efforts of monetary policymakers make interest rates near random walks and the assumption of a unit root in interest rates has often been made in empirical work (see for example Mark and Wu (1998)). Mankiw and Miron even ascribe deviations from the EHTS to this near-random walk behavior of interest rates. In fact, similar to the foreign exchange case, a random walk interest rate implies that the rollover term premium would vary through time as a negative function of the current term spread.

We will call the joint assumption of a random walk for the log exchange rate and the two interest rates, the random walk model. In terms of our economic statistics, the random walk model has strong predictions. The Implied and CORR statistics should be exactly zero under the null of a random walk model, the variance ratio should be zero, the SD statistic should reflect the variance of interest rate differentials and the EVR ratio ought to be infinity.

Whereas, from a theoretical perspective, we do not find this model particularly appealing, its simplicity and prevalence in the literature make it worthwhile to examine whether the economic statistics we observe in the data are consistent with it. To this end, we simulate data from the model:

$$\begin{aligned} \Delta s_{t+1} &= \mu_1 + \varepsilon_{1t} \\ i_{t,3} &= \mu_2 + i_{t-1,3} + \varepsilon_{2t} \\ i^*_{t,3} &= \mu_3 + i^*_{t-1,3} + \varepsilon_{3t} \\ sp_{t,60} &= \mu_4 + \rho sp_{t-1,60} + \nu \left(i_{t-1} - i_{t-2}\right) + \varepsilon_{4t} \\ sp^*_{t,60} &= \mu_5 + \rho^* sp^*_{t-1,60} + \nu^* \left(i^*_{t-1} - i^*_{t-2}\right) + \varepsilon_{5t} \end{aligned} \tag{13}$$

where all coefficients are obtained from an equation-by-equation OLS estimation .

Note that short rate changes are unpredictable but help predict term spreads. Because the model is non-stationary, we change our typical Monte Carlo procedure by starting from the initial observations without discarding start up draws. We use an i.i.d bootstrap as in the other experiments, drawing from the residuals in Equation (13). Of course, a number of samples will yield non-stationary VARs, in which case we cannot compute our economic statistics. The distributions that we show in Tables 6 and 7 condition on stationarity. For the three systems, there were about 2,000 out of 25,000 experiments that yielded an explosive A - matrix. For these samples, it is literally true that EVR is infinity, VR is 0 etc., but we ignore this fact in the table.

Table 6 reports some characteristics of the empirical distributions for the various statistics summarizing UIRP deviations. For the USD/DEM system, we never reject the random walk model at the 5% level using the empirical critical values for the statistics. The evidence against UIRP, reported in Table 3, was also marginal in this system. For the USD-GBP system, the random walk model cannot generate the negative correlation and high variance ratios we observe in the data at short horizons, but it is not inconsistent with the statistics at the 60 month horizon. For the cross-rate system, the random walk model fails to match the negative correlation and high variance ratio for both short and long horizons. We count a few more rejections in Table 3 under the null of the UIRP, but overall the random walk model does not provide a dramatically better fit with the data.

In Table 7, we repeat this information for the EHTS statistics. Here an interesting paradox occurs. For the USD and DEM, the random walk model never rejects. It underpredicts the correlation between theoretical and actual spreads (in population they would be zero, but there is an upward bias of 0.2 to 0.3), and generates too high excess volatility statistics and too variable term premiums on average, but the observed statistics are well within a 95% empirical confidence interval around the mean. Here the random walk model fits the data better than the EHTS. For the GBP however, almost all data statistics are outside the empirical confidence intervals. The random walk model here is easily dominated by the EHTS. Overall, we conclude that the random walk model provides a marginally better fit with the data than UIRP and the EHTS, with the exception of term structure data for the GBP.

7 Conclusions

Theorists and policymakers have often ignored the deviations from UIRP and the EHTS demonstrated by empirical researchers. The consensus among empirical researchers so far is that the deviations from UIRP are too strong to be matched by theory,[6] whereas the evidence on the EHTS is decidedly mixed and differs across countries. One reason to motivate a continued use of the hypotheses in certain international theories or policy work may be that irrational behavior or short-term market frictions cause short-run deviations of the theory but that at longer horizons the theories hold up better. Scattered recent empirical evidence seems to support these contentions. In this paper, we overturn the conventional wisdom along various dimensions.

First, statistically, the evidence against UIRP is quite mixed, as Baillie and Bollerslev (2000) and Bekaert and Hodrick (2001) have pointed out before, and it is currency dependent. We also show that it is not horizon dependent. Deviations from UIRP seem to be not less severe at long horizons. In fact, Fama's excess volatility ratio is larger at long horizons. Perhaps this is not surprising. Our results are potentially consistent with a time-varying risk premium story for example, where the variability and persistence of risk premiums is different across countries. The presence of speculative capital of various proprietary desks in foreign exchange markets attempting to exploit deviations from UIRP (see Green (1992) for an illustration) suggests that it might be the long-term relation rather than the short-term relation that is affected by market frictions, since it is unlikely that these trading desks will keep capital tied up in such long-term contracts.

[6] There appears to be some evidence that UIRP holds up better in developing countries (Bansal and Dahlquist (2000) and in the 90's (Flood and Rose (2001)). However, interest rates in developing countries may be contaminated by country risk premiums.

Second, although our statistics show that UIRP deviations are economically important, it is critical to adjust them for small sample biases. Recent theoretical attempts to match the evidence (See Engel (1996) for a survey and Backus, Foresi, and Telmer (2001) for a recent example) have invariably focused on population moments estimated from the data. This has led to the recognition that foreign exchange premiums are extremely variable and not a single model of risk has come close to generating such excessive volatility. Our results demonstrate that the small sample upward bias in this statistic is extreme, a fact that should be taken into account both in theoretical work and in applied work that uses an empirically calibrated foreign exchange risk premium. It may also lead to a re-evaluation of the VAR results on monetary policy's role in exchange rate behavior, where UIRP deviations play an important role (see Eichenbaum and Evans (1995) and Faust and Rogers (1999)).

Third, the statistical evidence against the EHTS is more uniform across countries and horizons than the evidence against UIRP. For the EHTS at short horizons, the presence of long-term interest rates leads to more powerful tests than the tests usually constructed in the literature.

Fourth, economically the deviations from the EHTS are not very important, indicating that analyzing the effects of policy experiments under the null of the EHTS may be useful. Nevertheless, imposing the EHTS does change the VAR dynamics and affects the behavior of foreign exchange premiums.

Finally, a popular alternative model, the random walk model, fits the data marginally better than the UIRP-EHTS model but fails to match the term structure dynamics in the UK, which appear very consistent with the EHTS.

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Table 1: VAR-based Expectations Hypotheses Tests

	USD-DEM			USD-GBP			DEM-GBP		
	3/36/60m	3/12/60m	3/60m	3/36/60m	3/12/60m	3/60m	3/36/60m	3/12/60m	3/60m
Panel A: UIRP Tests									
UIP Short	15.9242	18.2930	4.6712	33.3951	26.9761	9.4966	31.7254	36.3987	14.5589
	(0.3180)	(0.1938)	(0.4573)	(0.0025)	(0.0194)	(0.0908)	(0.0044)	(0.0009)	(0.0124)
UIP Long	17.5211	15.6082	9.7159	23.6114	20.2938	10.6313	39.4183	24.6214	17.0804
	(0.2295)	(0.3379)	(0.0837)	(0.0510)	(0.1211)	(0.0592)	(0.0003)	(0.0385)	(0.0043)
UIP Joint	23.3671	22.9263	15.2244	$–^b$	32.9450	18.8895	47.8830	45.9573	19.5211
	(0.3247)	(0.3479)	(0.1241)	($–^b$)	(0.0468)	(0.0417)	(0.0007)	(0.0013)	(0.0341)
Panel B: EHTS Tests									
Domestic TS Short	17.6799	18.8900	$–^a$	13.2852	12.9869	$–^a$	19.9735	25.6445	$–^a$
	(0.0135)	(0.0085)	($–^a$)	(0.0347)	(0.0724)	($–^a$)	(0.0056)	(0.0006)	($–^a$)
Domestic TS Long	15.3414	16.7159	15.3927	15.1061	16.2890	12.6005	14.9291	16.1294	14.7388
	(0.0319)	(0.0193)	(0.0088)	(0.0347)	(0.0226)	(0.0274)	(0.0369)	(0.0240)	(0.0115)
Domestic TS	31.5128	24.8316	$–^a$	17.3907	$–^b$	$–^a$	32.3243	32.7016	$–^a$
	(0.0047)	(0.0363)	($–^a$)	(0.2360)	($–^b$)	($–^a$)	(0.0036)	(0.0032)	($–^a$)
Foreign TS Short	26.1020	22.6457	$–^a$	15.8615	22.2607	$–^a$	13.4151	24.8534	$–^a$
	(0.0005)	(0.0020)	($–^a$)	(0.0199)	(0.0023)	($–^a$)	(0.0626)	(0.0008)	($–^a$)
Foreign TS Long	23.4606	20.7820	20.4466	16.6421	13.9282	11.7181	8.3693	6.9398	6.3026
	(0.0014)	(0.0041)	(0.0010)	(0.0199)	(0.0525)	(0.0389)	(0.3012)	(0.4352)	(0.2779)
Foreign TS	34.2008	25.2319	$–^a$	30.1744	37.4081	$–^a$	35.6990	$–^b$	$–^a$
	(0.0019)	(0.0323)	($–^a$)	(0.0072)	(0.0006)	($–^a$)	(0.0012)	($–^b$)	($–^a$)
TS Short	38.8674	69.3878	$–^a$	24.4973	28.7627	$–^a$	28.1128	37.4158	$–^a$
	(0.0004)	(0.0000)	($–^a$)	(0.0399)	(0.0113)	($–^a$)	(0.0137)	(0.0006)	($–^a$)
TS Long	36.4519	29.5714	24.5659	26.3432	26.2835	19.1869	22.2286	20.6630	18.6356
	(0.0009)	(0.0087)	(0.0062)	(0.0234)	(0.0238)	(0.0380)	(0.0740)	(0.1106)	(0.0451)
Panel C: Joint Tests									
UIPs TSs	40.7372	34.4780	$–^a$	28.6456	33.1392	$–^a$	38.4449	45.2382	$–^a$
	(0.0060)	(0.0322)	($–^a$)	(0.1228)	(0.0447)	($–^a$)	(0.0114)	(0.0016)	($–^a$)
UIPl TSl	38.0505	32.5468	26.2010	30.2034	31.5195	23.9954	35.5748	28.2698	24.7116
	(0.0127)	(0.0515)	(0.0360)	(0.0880)	(0.0654)	(0.0652)	(0.0244)	(0.1327)	(0.0540)
UIPl TSs	40.9555	51.8688	$–^a$	29.4433	$–^b$	$–^a$	43.2352	49.9648	$–^a$
	(0.0057)	(0.0002)	($–^a$)	(0.1038)	($–^b$)	($–^a$)	(0.0029)	(0.0004)	($–^a$)

This Table reports the LM test statistics and their asymptotic p-values (in parentheses). "UIP Short" imposes UIRP at the 3-m horizon for the 3/60m system, 3-m and 12-m horizons for the 3/12/60 system, and 3-m and 36-m horizons for the 3/36/60 sytem. "UIP Long" imposes UIRP at the 60-m horizon for the 3/60m system, 12-m and 60-m horizons for the 3/12/60 system, and 36-m and 60-m horizons for the 3/36/60 system. "TS Short" imposes the EHTS at the 12-m horizon for the 3/12/60 system and 36-m horizon for the 3/36/60 system. "TS Long" imposes the EHTS at the 60-m horizon for all systems. "UIP joint" and "TS" impose the corresponding constraint at all horizons. "Short" and "Long" are abbreviated as "s" and "l" in joint hypotheses.

$–^a$: Hypothesis undefined

$–^b$: Hypothesis not tested because of a singularity problem in the constrained VAR estimation

Table 2: Uncovered Interest Rate Parity at Short and Long Horizons

Panel A: USD-DEM, 3/60 System										
	UIP 3m					UIP 60m				
	Implied	**Corr.**	**VR**	**SD**	**EVR**	**Implied**	**Corr.**	**VR**	**SD**	**EVR**
Unconst.	-0.3741*	-0.2674	1.9574	5.8598	1.8931	-0.6007*	-0.6406*	0.8794	3.7002	3.5034
UIP Long/Short	0.5183	0.1289	2.8372	5.6153	1.1994	0.6467	0.7914	0.7203	1.2944	0.5234
TS Long	1.2761	0.7550	5.3653	5.1549	0.5345	1.2450	0.8038	4.8294	3.1948	0.4755
Mean	1.0173	0.6268	2.8619	4.5864	0.8111	0.8060	0.6639	1.6622	2.5465	1.5791
2.5%	-0.3124	-0.2769	0.3517	1.7117	0.1193	-0.4410	-0.5624	0.1008	0.6771	0.0449
97.5%	2.4333	0.9767	9.0111	8.6137	3.0964	2.0330	0.9943	6.0438	6.4712	9.9018
Panel B: USD-GBP, 3/60 System										
	UIP 3m					UIP 60m				
	Implied	**Corr.**	**VR**	**SD**	**EVR**	**Implied**	**Corr.**	**VR**	**SD**	**EVR**
Unconst.	-2.2587*	-0.9235*	5.9819*	8.1009*	1.9223	-0.5729*	-0.6490*	0.7794	2.8923	3.7532
UIP Long/Short	0.8780	-0.2554*	2.3351	4.8464	1.7625	0.3981	0.6752	0.2623	1.2774	2.1755
TS Long	-2.5040*	-0.8274*	9.3663*	9.3841*	1.6475	-2.8220*	-0.8657*	12.2900*	7.4407*	1.5753
Mean	0.9615	0.7512	1.7469	4.1376	0.6431	0.7751	0.7547	1.1766	2.3684	1.7937
2.5%	0.0111	0.0132	0.3010	1.5763	0.0656	-0.1146	-0.2282	0.0775	0.6995	0.0354
97.5%	1.8823	0.9856	4.7697	7.6287	2.9026	1.7779	0.9943	4.0568	5.5961	11.5802
Panel C: DEM-GBP, 3/60 System										
	UIP 3m					UIP 60m				
	Implied	**Corr.**	**VR**	**SD**	**EVR**	**Implied**	**Corr.**	**VR**	**SD**	**EVR**
Unconst.	-1.1982*	-0.5598*	4.5812	8.1587*	1.7414	-0.7746*	-0.6498*	1.4210	3.0029	2.7940
UIP Long/Short	1.0211	0.9157	1.1359	1.2391	0.1620	0.6229	0.6667	0.6801	1.1482	0.8535
TS Long	-1.0087*	-0.3738*	3.3494	6.9070*	1.7070	-1.3556*	-0.5600*	3.3923	3.8289	1.9029
Mean	0.9114	0.7030	1.7720	3.6663	0.7310	0.6494	0.5501	1.6070	2.4459	1.7316
2.5%	-0.0955	-0.1135	0.3087	1.3946	0.0767	-0.3406	-0.4308	0.1053	0.7351	0.0828
97.5%	1.8388	0.9821	4.7012	6.7868	3.2267	1.8880	0.9827	5.9695	6.1345	9.0057

This Table lists various test statistics for the 3m and 60m UIRP regressions (2) under different null hypotheses. IMPLIED refers to the implied regression slope coefficients. CORR refers to the correlation statistic. VR refers to the variance ratio statistic. SD refers to the standard deviation of the risk premium. EVR refers to the Fama excess variance ratio statistic. "UIP Long/Short" imposes "UIP Long" for "UIP 3m" regressions and "UIP Short" for "UIP 60m" regressions. The mean, 2.5% and 97.5% critical values are provided at the bottom of each panel. An asterisk indicates significance at 5% level using these empirical critical values. For explanations of other null hypotheses please refer to Table 1. The 2.5% and 97.5% critical values are based on the bootstrap analysis reported in Appendix B.

Table 3: Uncovered Interest Rate Parity over Various Horizons

		Implied	Corr.	VR	SD	EVR
Panel A: USD-DEM						
UIP 3m	Unconst.	-0.3741	-0.2674	1.9574	5.8598	1.8931
	Bias Corrected	-0.3914	0.1058	0.0955	1.2734	1.0820
	UIP Long	0.5183	0.1289	2.8372	5.6153	1.1994
UIP 12m	Unconst.	-0.5643	-0.3802	2.2026	5.3879	1.9664
	Bias Corrected	-0.4580	-0.0358	1.2291	1.5427	1.1242
	UIP 3&60	1.3763	0.8826	1.3029	1.3895	0.2211
UIP 36m	Unconst.	-0.5307	-0.4485	1.4000	4.3022	2.4724
	Bias Corrected	-0.3328	0.0272	-0.1814	1.5329	1.2841
	UIP 3&60	1.2834	0.9624	1.2430	0.7205	0.0781
UIP 60m	Unconst.	-0.6007	-0.6406	0.8794	3.7002	3.5034
	Bias Corrected	-0.4067	-0.3045	0.2172	1.1537	1.9243
	UIP Short	0.6467	0.7914	0.7203	1.2944	0.5234
Panel B: USD-GBP						
		Implied	**Corr.**	**VR**	**SD**	**EVR**
UIP 3m	Unconst.	-2.2587	-0.9235	5.9819	8.1009	1.9223
	Bias Corrected	-2.2202	-0.6747	5.2350	3.9633	1.2792
	UIP Long	0.8780	-0.2554	2.3351	4.8464	1.7625
UIP 12m	Unconst.	-1.4708	-0.7084	4.3107	6.0373	1.9144
	Bias Corrected	-1.4473	-0.5788	3.9610	2.0301	1.5296
	UIP 3&60	1.2694	0.8737	0.7786	1.0225	0.3040
UIP 36m	Unconst.	-0.9523	-0.7859	1.4683	3.7369	2.9782
	Bias Corrected	-0.6997	-0.4654	1.2655	1.3390	1.2215
	UIP 3&60	0.8942	0.8953	1.0249	0.8231	0.2070
UIP 60m	Unconst.	-0.5729	-0.6490	0.7794	2.8923	3.7532
	Bias Corrected	-0.3480	-0.4037	0.6028	0.5239	1.9595
	UIP Short	0.3981	0.6752	0.2623	1.2774	2.1755
Panel C: DEM-GBP						
		Implied	**Corr.**	**VR**	**SD**	**EVR**
UIP 3m	Unconst.	-1.1982	-0.5598	4.5812	8.1587	1.7414
	Bias Corrected	-1.1096	-0.2628	3.8092	4.4924	1.0104
	UIP Long	1.0211	0.9157	1.1359	1.2391	0.1620
UIP 12m	Unconst.	-1.4808	-0.7060	4.3993	6.2497	1.9005
	Bias Corrected	-1.3882	-0.2907	2.9470	3.2969	1.0492
	UIP 3&60	1.0901	0.9624	1.4595	0.7916	0.0919
UIP 36m	Unconst.	-1.0219	-0.7104	2.0690	3.8043	2.4711
	Bias Corrected	-0.7829	-0.2507	0.9240	1.2713	1.3154
	UIP 3&60	1.1717	0.9749	1.4797	0.5528	0.0730
UIP 60m	Unconst.	-0.7746	-0.6498	1.4210	3.0029	2.7940
	Bias Corrected	-0.4240	-0.1999	0.8140	1.5570	2.0624
	UIP Short	0.6229	0.6667	0.6801	1.1482	0.8535

This Table lists various test statistics for the UIRP regressions over various horizons. IMPLIED refers to the implied regression slope coefficients. CORR refers to the correlation statistic. VR refers to the variance ratio statistic. SD refers to the standard deviation of the risk premium. EVR refers to the Fama excess volatility ratio. "UIP Short" imposes the 3-month UIRP hypothesis while "UIP Long" imposes the 60-month UIRP hypothesis. The bias correction is done by adding back the small-sample biases, which are computed by subtracting the empirical mean values from the hypothesized values. The results for the "UIP 3m" and "UIP 60m" come from the 3/60 systems; the results for the "UIP 12m" and "UIP 36m" come from the 3/36/60 and the 3/12/60 systems respectively.

Table 4: Expectations Hypotheses of the Term Structure

Panel A: USD TS 60m					
	Implied	**Corr.**	**VR**	**SD**	**EVR**
Unconst.	0.7002	0.5201*	1.8119	1.6259	0.7791
UIP Short	0.6870	0.5531*	2.3535	1.7613	0.7038
UIP Long	0.5932	0.5682*	1.8708	1.5701	0.7037
UIP Joint	0.8655	0.6140*	2.1453	1.5880	0.6277
Mean	0.9177	0.8727	1.1319	0.9749	0.5235
2.5%	0.5226	0.6180	0.5208	0.3732	0.0320
97.5%	1.3073	0.9899	2.0934	1.8106	0.9251
Panel B: DEM TS 60m					
	Implied	**Corr.**	**VR**	**SD**	**EVR**
Unconst.	0.5154*	0.7911	0.4245*	1.1063	0.9274*
UIP Short	0.5425*	0.8316	0.6745	0.9794	0.4574
UIP Long	0.5049*	0.7904	0.7857	1.0933	0.4894
UIP Joint	1.3507	0.8002	2.1667*	1.5880*	0.3743
Mean	0.9297	0.9281	1.0176	0.5729	0.4235
2.5%	0.5542	0.7168	0.4842	0.1913	0.0126
97.5%	1.2330	0.9967	1.6512	1.2079	0.8048
Panel C: GBP TS 60m					
	Implied	**Corr.**	**VR**	**SD**	**EVR**
Unconst.	0.9486	0.8368	1.2852	1.0278	0.3019
UIP Short	0.7983	0.8046	0.9315	1.0149	0.4061
UIP Long	0.2623*	0.5872*	1.0343	1.5123	0.8121
UIP Joint	0.3014*	0.6308*	2.1078	1.8640	0.6054
Mean	1.0256	0.9095	1.3049	1.0924	0.3116
2.5%	0.5487	0.6894	0.4833	0.3923	0.0235
97.5%	1.4087	0.9944	2.2812	2.2833	0.8254

This Table lists various test statistics for the 60m TS2 regressions (4) under different null hypotheses. USD and DEM (GBP) statistics are from the 3/60-m USD-DEM (USD-GBP) system. IMPLIED refers to the implied regression slope coefficients. CORR refers to the correlation statistic. VR refers to the variance ratio statistic. SD refers to the standard deviation of the risk premium. EVR refers to the Fama excess variance ratio statistic. The 2.5% and 97.5% critical values are based on the bootstrap analysis reported in Appendix B.

Table 5: Expectations Hypotheses of the Term Structure over Various Horizons

Panel A: USD						
		Implied	**Corr.**	**VR**	**SD**	**EVR**
TS2 12m	Unconst.	-0.0171	-0.0243	0.4937	1.0214	3.0948
	Bias Corrected	-0.0072	0.0010	0.4586	0.7973	3.0406
	TS Long	0.2777	0.8771	0.4985	0.4213	0.5214
TS2 36m	Unconst.	0.3994	0.3341	1.4286	1.5373	1.1409
	Bias Corrected	0.4056	0.4386	1.1749	0.8965	0.9148
	TS Long	2.7551	0.9522	1.1209	0.3895	0.0934
TS2 60m	Unconst.	0.6757	0.5001	1.8256	1.6645	0.8075
	Bias Corrected	0.6574	0.5817	1.5738	0.7905	0.5920
	TS Short	0.9820	0.9881	0.8465	0.2306	0.0334
Panel B: DEM						
		Implied	**Corr.**	**VR**	**SD**	**EVR**
TS2 12m	Unconst.	0.1792	0.4067	0.1941	0.8961	4.3059
	Bias Corrected	0.1893	0.4345	0.1513	0.7183	4.2431
	TS Long	0.2554	0.7146	0.3663	0.6939	1.3683
TS2 36m	Unconst.	0.3716	0.6726	0.3053	1.1576	1.8408
	Bias Corrected	0.4136	0.7217	0.2829	0.7400	1.7218
	TS Long	1.0106	0.9569	0.8119	0.4567	0.1078
TS2 60m	Unconst.	0.5081	0.7849	0.4190	1.1578	0.9615
	Bias Corrected	0.5519	0.8172	0.4351	0.5487	0.8689
	TS Short	0.9863	0.9703	1.1270	0.4718	0.0594
Panel C: GBP						
		Implied	**Corr.**	**VR**	**SD**	**EVR**
TS2 12m	Unconst.	0.5587	0.6354	0.7730	0.6728	0.8482
	Bias Corrected	0.5331	0.6718	0.6248	0.2789	0.7600
	TS Long	0.2358	0.6039	1.1480	0.7678	0.7438
TS2 36m	Unconst.	0.9098	0.8360	1.1845	0.8541	0.3080
	Bias Corrected	0.9029	0.9152	0.9653	0.1082	0.1244
	TS Long	0.8193	0.9418	0.9821	0.4803	0.1175
TS2 60m	Unconst.	0.9773	0.8300	1.3863	1.0831	0.3115
	Bias Corrected	0.9267	0.9253	1.0062	0.0060	0.0729
	TS Short	1.1187	0.9532	1.1348	0.5314	0.0916

This Table lists various test statistics for the EHTS regressions over various horizons. IMPLIED refers to the implied regression slope coefficients. CORR refers to the correlation statistic. VR refers to the variance ratio statistic. SD refers to the standard deviation of the risk premium. EVR refers to the Fama excess volatility ratio. "TS Short" imposes the 36-month ESTH hypothesis while "TS Long" imposes the 60-month EHTS hypothesis. The bias correction is done by adding back the small-sample biases, which are computed by subtracting the empirical mean values from the hypothesized values. USD and DEM (GBP) statistics come from the USD-DEM (USD-GBP) systems. "TS2 36m" and "TS2 60m" ("TS2 12m") results come from the 3/36/60 (3/12/60 systems) systems.

Table 6: Uncovered Interest Rate Parity under the Random Walk Null

Panel A: USD-DEM, 3/60 System

	UIP 3m					UIP 60m				
	Implied	**Corr.**	**VR**	**SD**	**EVR**	**Implied**	**Corr.**	**VR**	**SD**	**EVR**
Data	-0.3741	-0.2674	1.9574	5.8598	1.8931	-0.6007	-0.6406	0.8794	3.7002	3.5034
2.5%	-0.8924	-0.8561	0.0701	2.1582	0.2389	-0.7421	-0.9662	0.0112	1.4949	0.2046
97.5%	1.5514	0.9290	5.8102	16.6823	15.6230	0.9854	0.9761	2.2220	15.5018	90.0993
Mean	0.2215	0.1735	1.3582	6.7886	3.4814	0.1130	0.1737	0.4750	5.3665	15.5018
Median	0.1814	0.2384	0.8221	5.7940	1.8340	0.1103	0.3351	0.2163	4.1668	4.8003

Panel B: USD-GBP, 3/60 System

	UIP 3m					UIP 60m				
	Implied	**Corr.**	**VR**	**SD**	**EVR**	**Implied**	**Corr.**	**VR**	**SD**	**EVR**
Data	-2.2587	-0.9235*	5.9819*	8.1009	1.9223	-0.5729	-0.6490	0.7794	2.8923	3.7532
2.5%	-0.9449	-0.8923	0.0446	2.6902	0.3656	-0.6615	-0.9782	0.0061	2.0653	0.4859
97.5%	0.9965	0.9057	3.4753	19.3450	23.7088	0.6750	0.9766	1.3420	18.5891	164.2669
Mean	0.0190	0.0193	0.8861	7.9680	5.4300	0.0085	0.0130	0.2802	6.7252	28.8370
Median	0.0160	0.0282	0.5049	6.8936	2.9678	0.0076	0.0342	0.1162	5.4439	9.7430

Panel C: DEM-GBP, 3/60 System

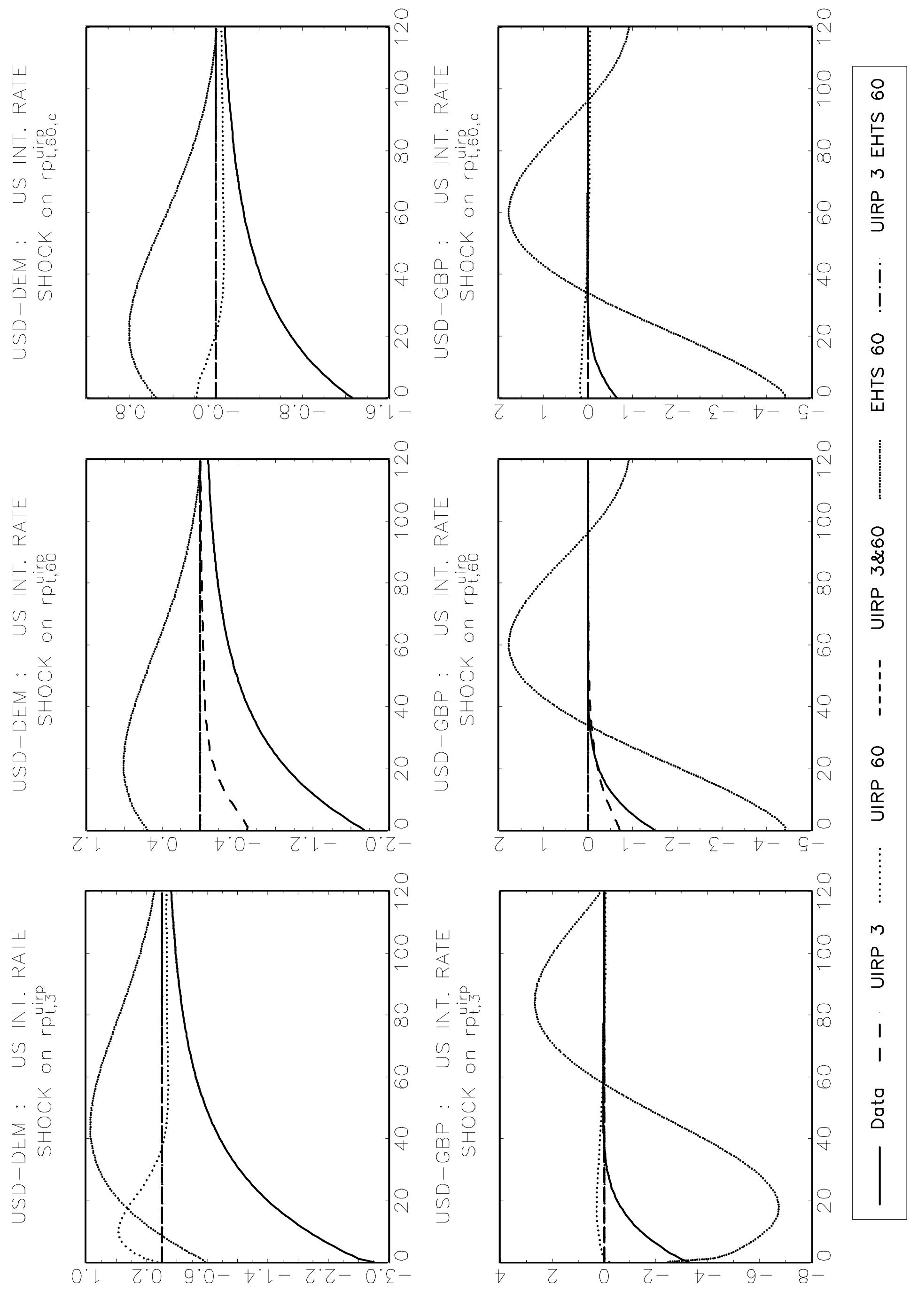
	UIP 3m					UIP 60m				
	Implied	**Corr.**	**VR**	**SD**	**EVR**	**Implied**	**Corr.**	**VR**	**SD**	**EVR**
Data	-1.1982*	-0.5598	4.5812*	8.1587	1.7414	-0.7746*	-0.6498	1.4210*	3.0029	2.7940
2.5%	-1.0428	-0.9085	0.0410	2.6257	0.4890	-0.7440	-0.9787	0.0077	1.9805	0.6541
97.5%	0.8017	0.8757	3.3623	16.8225	26.0573	0.5996	0.9685	1.3527	15.9394	129.5001
Mean	-0.0765	-0.0757	0.7976	7.2886	6.2175	-0.0627	-0.1214	0.2738	6.1258	25.5175
Median	-0.0602	-0.1005	0.4856	6.3538	3.3000	-0.0605	-0.2332	0.1320	5.0391	9.5089

This Table provides the empirical distributions of various economic statistics for the UIRP regressions under the null that the exchange rate process and the short rate processes are random walks with a drift. IMPLIED refers to the implied regression slope coefficients. CORR refers to the correlation statistic. VR refers to the variance ratio statistic. SD refers to the standard deviation of the risk premium. EVR refers to the Fama excess variance ratio statistic. “Data” refers to statistics calculated from the actual data. The summary statistics are the Mean, the Median and the 2.5% and 97.5% critical values. An asterisk indicates significance at 5% level using the empirical critical values.

Table 7: Expectations Hypotheses of the Term Structure under the Random Walk Null

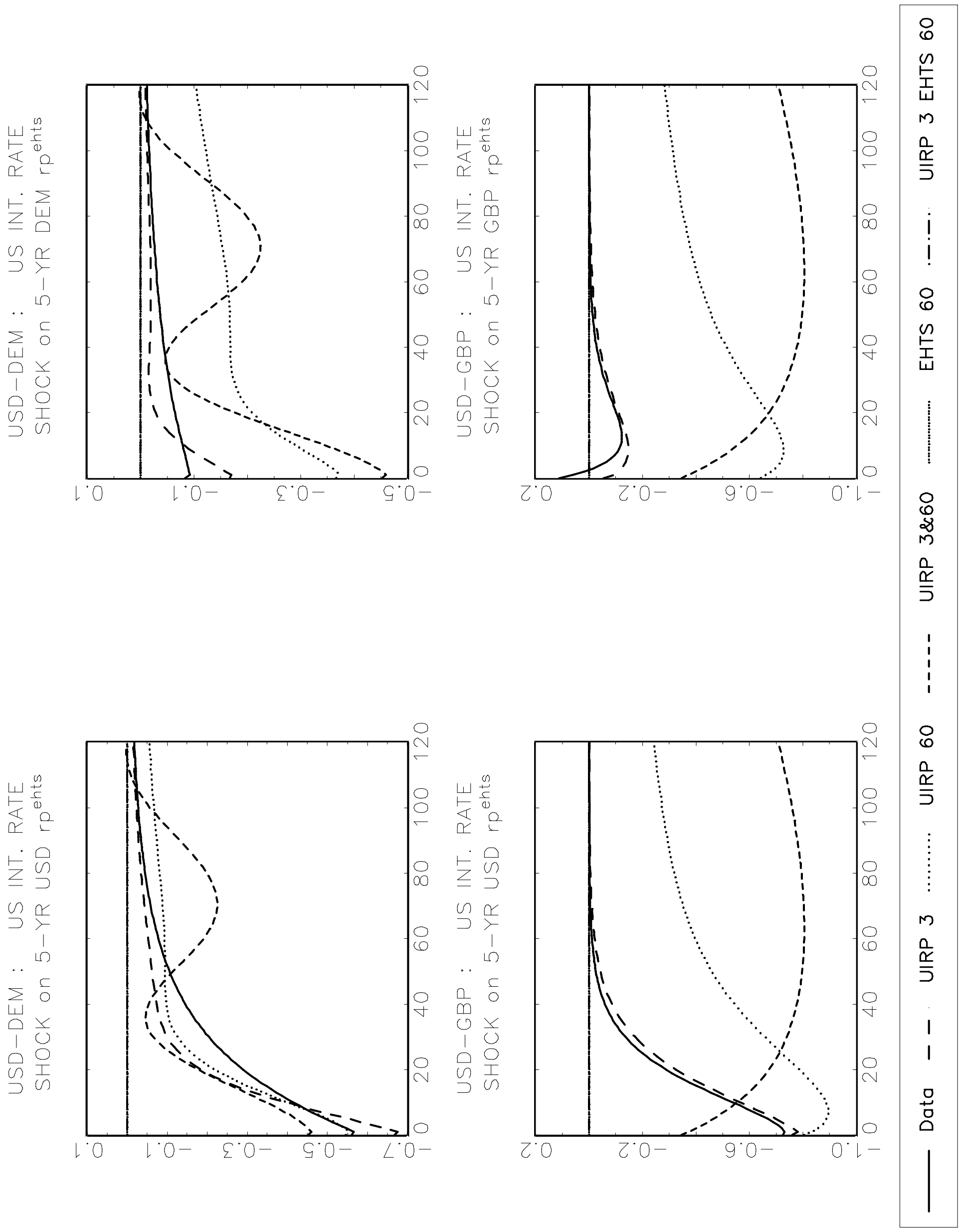
Panel A: USD					
	Implied	**Corr.**	**VR**	**SD**	**EVR**
Data	0.7002	0.5201	1.8119	1.6259	0.7791
2.5%	-0.3678	-0.2956	0.3714	1.0598	0.7470
97.5%	0.7005	0.5985	3.2017	3.1020	3.3173
Mean	0.2358	0.2148	1.4313	1.8175	1.6631
Median	0.2600	0.2380	1.3119	1.7181	1.3695
Panel B: DEM					
	Implied	**Corr.**	**VR**	**SD**	**EVR**
Data	0.5154	0.7911	0.4245	1.1063	0.9274
2.5%	-0.2191	-0.3568	0.0906	0.8186	0.8034
97.5%	0.5585	0.8245	0.8728	3.4062	10.4254
Mean	0.2065	0.3347	0.4083	1.7189	4.6834
Median	0.2188	0.3720	0.3828	1.5636	2.4902
Panel C: GBP					
	Implied	**Corr.**	**VR**	**SD**	**EVR**
Data	0.9486*	0.8368*	1.2852	1.0278*	0.3019*
2.5%	-0.4098	-0.3612	0.3100	1.1151	0.6020
97.5%	0.7763	0.7135	2.8437	3.9092	3.7916
Mean	0.2657	0.2517	1.2834	2.1561	1.6300
Median	0.2941	0.2795	1.1887	2.0100	1.3499

This Table provides the empirical distributions of various economic statistics for the EHTS regressions under the null that the exchange rate process and the short rate processes are random walks with a drift. IMPLIED refers to the implied regression slope coefficients. CORR refers to the correlation statistic. VR refers to the variance ratio statistic. SD refers to the standard deviation of the risk premium. EVR refers to the Fama excess variance ratio statistic. "Data" refers to statistics calculated from the actual data. The summary statistics are the Mean, the Median and the 2.5% and 97.5% critical values. An asterisk indicates significance at 5% level using the empirical critical values. USD and DEM (GBP) statistics come from the USD-DEM (USD-GBP) system.



This figure plots the impulse responses of the foreign exchange risk premiums to a 1% positive shock to the U.S. interest rate. The upper (lower) panel is based on the USD-DEM (USD-GBP) system. $rp_{t,3}^{uirp}$ ($rp_{t,60}^{uirp}$) refers to the 3-month (5-year) foreign exchange risk premiums. $rp_{t,60,c}^{uirp}$ refers to the 5-year cumulative short term premium, which is obtained by rolling over $rp_{t,3}^{uirp}$ every three months. The solid line is computed from the data. The null hypotheses imposed are 3-month UIRP (the long dashed line), 60-month UIRP (the thin dotted line), joint UIRP (the short dashed line), the 60-month TSEH (the thick dotted line) and all hypotheses (the dash dotted line).

Figure 1: Impulse Responses of Foreign Exchange Risk Premiums



This figure plots the impulse responses of the 5-year term premium ($rp^{ehts}_{t,60}$) to a 1% positive shock to the U.S. interest rate. The upper (lower) panel is based on the USD-DEM (USD-GBP) system. The solid line is computed from the data. The null hypotheses imposed are 3-month UIRP (the long dashed line), 60-month UIRP (the thin dotted line), joint UIRP (the short dashed line), the 60-month TSEH (the thick dotted line) and all hypotheses (the dash dotted line).

Figure 2: Impulse Responses of Term Premiums

Appendix

A Data

Our data for the US, UK and Germany zero-coupon bond yields is an updated version of the data originally used by Jorion and Mishkin (1991). We thank Philippe Jorion for generously providing us with the data. The Jorion-Mishkin data set consists of monthly observations from 1972:0l through 1991:12 on implied zero-coupon yields with maturities of 3, 12, 24, 36, 48, and 60 months. These yields are constructed from observations on outstanding government bonds. Data from 1990:l to 1996:9 on zero-coupon bond yields with maturities of 3, 12, 36, and 60 months for the three currencies were obtained from a New York investment bank that wishes to remain anonymous. The exchange rate data are from Datastream.

B Monte Carlo Analysis

We examine the finite sample properties of various test statistics using a bootstrap analysis.

The Data Generating Processes (DGP)

We use various constrained VAR systems as the basis for a DGP. For the 5-variable VAR system, the DGP uses the constrained estimates under the null of 3-month UIRP and the 60-month EHTS, that is, all EHTS are imposed. For the 7-variable VAR system, we investigate two different sets of constrained estimates. The first set imposes 3-month UIRP and the intermediate-horizon (12- or 36-month depending on the system) EHTS, and the second set imposes 3-month UIRP and 60-month EHTS. In all of our experiments, we bootstrap the unconstrained VAR residuals in an i.i.d. fashion. Bekaert and Hodrick (2001) examine a subset of our statistics in an analogous VAR system and show that the small sample results are robust to an alternative DGP that employs a GARCH model for the residuals.

We correct the constrained estimates for small sample bias with a procedure also used by Bekaert and Hodrick (2001). We start by bias-correcting the unconstrained VAR parameter estimates. To this end, we use an i.i.d. bootstrap of the unconstrained residuals to generate $50,000$ data sets, each of the same length as the actual data (after throwing out the first $1,000$ data points to diminish the effect of starting values). For each of the $50,000$ samples, we recalculate the unconstrained parameters. We subtract the mean of these estimates from the original unconstrained parameters θ_u to obtain the small sample bias. We then add back this bias estimate to the unconstrained estimates θ_u to obtain the bias-corrected estimates $\widetilde{\theta}_u$. To bias-correct the constrained VAR, we use $\widetilde{\theta}_u$ to simulate a very long series ($51,000$ observations with the first $1,000$ observations discarded). We then subject this series to the iterative procedure as described in section 3.2 to obtain the bias-corrected constrained estimates. Those estimates are what we use in generating the simulation data.

Due to the high persistence of the interest rates, we sometimes[7] encounter the problem that the bias-corrected constrained estimates have an eigenvalue that is larger than one in absolute value. In such cases we correct the eigenvalues and restore stationarity using a procedure described in Appendix C.

For each DGP, we simulate $25,000$ data samples, each consisting of the same number of observations as the actual data. For each data sample, we compute the actual and the implied univariate regression slope coefficients, the economic significance test statistics, and the Wald, LM and DM test statistics for each hypothesis of interest. The remaining analysis in this section focuses on the 5-variable VAR system. The 7-VAR systems serve as a robustness check.

Wald, LM and DM statistics

The empirical sizes of the Wald, LM and DM test statistics for a 5% test are shown

[7] This happens with the unconstrained bias-corrected estimates for all two 7-variable USD-DEM and DEM-GBP systems; with the constrained estimates under the null of 3-month UIRP and 60-month EHTS for the 3/12/60m USD-DEM systems, under the null of 3-month UIRP and 36-month EHTS for the 3/12/60 USD-GBP system, and under both nulls for the 3/36/60m USD-DEM and USD-GBP systems

in Table A1, Panel A. The empirical size is defined as the percentage of Monte Carlo experiments where the test statistics generated under the null exceed the 5% critical value of a χ^2 distribution. While all three test statistics show some size distortion, the Wald statistic is by far the worst. For example, the empirical size of the Wald statistic for the 60-month EHTS hypothesis is 72.3% for the USD-DEM system and 77.1% for the USD-GBP system. The smallest distortion occurs for the "UIP short" hypothesis in the USD-DEM system, where the empirical size is 11.09%. The DM test also produces empirical sizes larger than 5% except for the joint test case in the USD-GBP system. However, the upward size distortion is much smaller than for the Wald test. The LM test produces empirical sizes closest to the asymptotic value of 5%. It is slightly conservative, meaning it will lead to under-rejection in some cases.

Panel B of Table A1 reports the empirical 95% critical value of the Wald, LM and DM test statistics together with the critical value of the corresponding χ^2 distribution. Consistent with Panel A, the LM statistic has empirical critical values that are closest to that of a χ^2 distribution.

Overall, our results confirm the findings in Bekaert and Hodrick (2001) that the χ^2 distribution is a good approximation to the distribution of the LM test statistic in finite samples. The Wald test widely used in empirical research produces the worst size distortion and invariably leads to serious over-rejection.

Bekaert and Hodrick (2001) also show that all these tests have similar power properties making the LM-statistic the obvious test statistic to use in empirical work.

Slope Coefficients

Tables A2 to A5 study the small sample properties of the slope coefficients in various UIRP and EHTS regressions. We look at both direct OLS regression slopes and slope coefficients implied by the VAR systems, and report the mean, standard deviation and the 2.5% and 97.5% quantiles. The actual parameter estimates from the data are reported in the last column in each table.

Focusing first on the slope coefficients in Tables A2 and A4. The bias for the 3-

month UIRP regression slope is relatively small, and the difference between the OLS regression slope and the implied slope is also insignificant. At a longer horizon, the 5-year UIRP slope coefficient is significantly downward biased. Bekaert and Hodrick (2001) document downward bias for UIRP regression slopes at the 12-month horizon. Together our results indicate that the downward bias in the UIRP regression gets larger as the horizon increases. This bias-pattern would make it less likely to find coefficients close to 1 at longer horizons than at short horizons. Tauchen (2001) finds upward biases in UIRP regressions but his results are based on a very short sample and a very different DGP that assumes a stationary exchange rate.

As in Bekaert, Hodrick, and Marshall (1997), the EHTS display upward bias. Overall, the absolute values of the biases are somewhat lower with the implied slopes and so are the dispersions. Nevertheless, the slope distributions are quite similar.

Comparing the standard deviations of the slope coefficients, we can see that the dispersion of the UIRP slopes are more widely dispersed than the TS regression slopes in (4). The dispersion of the UIRP slopes is large enough to imply negative 2.5% quantiles, with the long-horizon critical values lower than the short-horizon ones. The 2.5% critical values for the term structure regressions are never negative.

As stressed by Li and Maddala (1996) and Bauer (2001), it is important to base inference on "asymptotically pivotal" statistics, that is, statistics with a limit distribution that does not depend on unknown parameters. Hence, we also examine the empirical distributions of the t-statistics which satisfy this criterion. Table A3 shows the empirical distributions of the t-statistics for direct OLS regression slope coefficients. These t-statistics are computed using Hansen and Hodrick (1980) standard errors. Since the UIRP regression slope is downward biased at longer horizons, it is no surprise that we observe on average negative t-statistics at longer horizons. At the 5-year horizon, the 2.5% and 97.5% empirical critical values for the t-statistics of the UIRP slope coefficients are -9.2093 and 5.2401 for the USD-DEM system, and -9.6211 and 4.2258 for the USD-GBP system, which are remarkably different from their asymptotic critical values ± 1.96. These severe distortions makes it difficult to use this regression for empirical tests. Whereas the EHTS t-stats are marginally better behaved, its distribution remains very far from the $\mathcal{N}(0,1)$ distribution we expect.

Table A5 shows the empirical distributions of the t-statistics for the implied slope coefficients. They are qualitatively similar to the corresponding entries in Table A3 while the biases are smaller and the standard deviation is now close to one, its asymptotic value. This indicates that the implied slope t-stat provides a better test in finite samples than the standard regression t-statistic.

Economic Significance Statistics

The small sample properties of the three economic significance statistics defined in section 3.2 are documented in Table A6 to Table A8.

Table A6 presents the empirical distribution of the correlation statistics. While there is a downward bias in all correlation statistics, the downward bias is more severe for the UIRP than for the EHTS regressions. The degree of downward bias in the correlation statistic for the UIRP at the short horizon is comparable to that at the longer horizon. The 2.5% empirical critical values for the UIRP correlation statistics go into the negative territory except in the case of 3-month UIRP for the USD-GBP system.

Table A7 presents the empirical distribution of the variance ratio statistics. All variance ratio statistics are upwardly biased, indicating that on average the variability of expected future asset prices is larger than the variability of current interest rate differentials. For the UIRP regressions, the upward bias in the variance ratio statistic is larger for the short horizons and economically large. In the USD-DEM system, the average variance ratio varies from 2.862 at the 3-month horizon to 1.662 at the 5-year horizon, while in the USD-GBP system, it decreases from 1.747 at the 3-month horizon to 1.177 at the 5-year horizon. The ratio of the standard deviation of the "theoretical spread" versus actual spread only shows significant bias in the UK.

Table A8 presents the empirical distribution of the standard deviation of foreign exchange and term premiums. The SD statistics are upwardly biased in all cases, which is anticipated as the statistic is bounded below by zero. The bias is more significant in the UIRP regressions than in the EHTS regressions. For the UIRP regressions, the mean of the SD statistic is larger at shorter horizons. It decreases from 4.586 at the 3-month horizon to 2.547 at the 5-year horizon in the USD-DEM system, and decreases from 4.138 at the 3-month horizon to 2.368 at the 5-year horizon in the USD-GBP system.

Table A9 presents the empirical distribution of the excess variance ratio statistic. The EVR statistic, which should be zero under the null, is upwardly biased for all systems, with the bias mostly worsening with horizon. Going from the 3-month to the 5-year horizon, the bias increases from 0.8111 to 1.5791 in the USD-DEM system, from 0.6431 to 1.7937 in the USD-GBP system, and from 0.7310 to 1.7316 in the DEM-GBP system. The confidence intervals are very wide for the UIRP statistics but lower than 1 for the EHTS statistics. The standard deviations of the empirical distribution of this statistic are unreasonably high because of one outlier observation. For example, for the USD/DEM system, dropping the maximum EVR statistic leads to more reasonable standard deviations of 1.1295, 4.7629, 0.4671, 0.4488, 1.0702 and 1.3900.

C Eigenvalue Correction

Melino (2001) and Bekaert and Hodrick (2001) show that the various null hypotheses impose restrictions on the eigenvectors of A. Consider an eigenvalue decomposition

$$A = P\Lambda P^{-1} \tag{14}$$

where Λ is the diagonal matrix of eigenvalues and P is the matrix with corresponding eigenvectors. Without loss of generality, we can normalize P so that $P_{1j} = 1 \ \ \forall j$ where P_{ij} denotes the (i,j)-th entry in the P-matrix . To derive the restrictions imposed by 3-month UIRP, substitute (14) into (6) and multiply both sides by P from the right-hand side. This gives

$$\frac{1}{3}\frac{\Lambda_j\left(1-\Lambda_j^3\right)}{1-\Lambda_j} = P_{3j} - P_{2j} \quad \forall j$$

Similarly by substituting (14) into (7) and simplifying, we obtain the restrictions of the domestic 36-month EHTS on the eigenvectors:

$$\frac{1}{36}\frac{\Lambda_j\left(1-\Lambda_j^{36}\right)}{1-\Lambda_j}=P_{5j}-P_{4j}+P_{3j}-P_{2j}\quad\forall j$$

When there exist eigenvalues with absolute values larger than one in a constrained system, we replace them with +/-0.99 and modify the eigenvector matrix P according to the relevant restrictions as discussed above. We can think of the resulting system as the constrained VAR estimates under the additional requirement that the system be stationary.

Table A1: Empirical Size of Test Statistics under the Null (5% Test)

Panel A: Empirical Size (in %)

	USD-DEM			USD-GBP		
Constraint	**Wald**	**LM**	**DM**	**Wald**	**LM**	**DM**
UIP Short	11.0905	4.3882	9.1277	14.2782	3.2421	11.0198
UIP Long	12.0078	5.4047	10.3343	26.5590	5.1621	15.0917
UIP Joint	29.0236	6.9832	16.0076	46.4427	2.7295	14.9494
TS Long	72.2780	10.4335	16.2968	77.0817	5.2028	23.3617
UIPs TSl	73.9060	5.8965	8.2476	81.2309	0.8176	3.7384

Panel B: 95% Critical Value

	USD-DEM			USD-GBP			χ^2	
	Wald	**LM**	**DM**	**Wald**	**LM**	**DM**	**df**	95%
UIP Short	13.9182	10.7516	12.8644	15.7789	10.2200	13.6723	5	11.0705
UIP Long	14.6839	11.2429	13.4203	23.7108	11.1356	14.9992	5	11.0705
UIP Joint	46.9183	19.2414	22.9091	84.8897	17.0766	22.0989	10	18.3070
TS Long	137.3161	20.3749	22.5465	177.8543	18.3708	23.9268	10	18.3070
UIPs TSl	152.7214	25.4593	26.6124	205.8911	22.1193	24.2639	15	24.9958

Panel A of this Table provides the empirical sizes of various test statistics under different constraints. The empirical size is the percentage of the Monte Carlo replications where the test statistic exceeds the 5% critical value of a χ^2 distribution. Panel B lists the 95% critical values of various test statistics under different constraints. df refers to the degrees of freedom of the asymptotic χ^2 distribution.

Table A2: Empirical Distribution of Actual Regression Slopes

Panel A : USD-DEM VAR System					
	Mean	**S.D.**	**2.5%**	**97.5%**	**Data**
UIP 3m	1.0254	0.6694	-0.2679	2.4044	-0.3707
UIP 5y	0.7314	0.7843	-0.8653	2.2410	-0.2007
TS D 5y	1.0249	0.2526	0.5304	1.5225	0.6731
TS F 5y	1.0493	0.2107	0.6259	1.4576	1.2836
Panel B : USD-GBP VAR System					
	Mean	**S.D.**	**2.5%**	**97.5%**	**Data**
UIP 3m	0.9598	0.4620	0.0205	1.8675	-1.9243
UIP 5y	0.6836	0.6288	-0.5689	1.9102	0.3325
TS D 5y	1.0468	0.2545	0.5507	1.5557	0.6731
TS F 5y	1.2032	0.3040	0.5888	1.7807	1.4183
Panel C : DEM-GBP VAR System					
	Mean	**S.D.**	**2.5%**	**97.5%**	**Data**
UIP 3m	0.9072	0.4775	-0.1060	1.8118	-1.1867
UIP 5y	0.5233	0.7358	-0.8714	1.9833	-1.7569
TS D 5y	1.0358	0.1969	0.6355	1.4179	1.2836
TS F 5y	1.2154	0.2962	0.6187	1.7853	1.4183

This Table provides summary statistics for the empirical distributions generated from a constrained VAR with bootstrapped residuals. The summary statistics are the Mean, the Standard Deviation (S.D.) and the 2.5% and 97.5% critical values. "Data" refers to the statistics calculated from the actual data. "D" and "F" in the TS regressions refer to the first and the second country respectively in the name of the VAR.

Table A3: Empirical Distribution of Actual Regression Slope T-Statistics

Panel A : USD-DEM VAR System					
	Mean	**S.D.**	**2.5%**	**97.5%**	**Data**
UIP 3m	0.0284	1.0626	-2.0791	2.1285	-1.3596
UIP 5y	-1.0715	3.7289	-9.2093	5.2401	-1.8628
TS D 5y	0.0868	1.8418	-3.6872	3.6100	-1.0790
TS F 5y	0.3960	1.8897	-3.3154	4.1289	1.4931
Panel B : USD-GBP VAR System					
	Mean	**S.D.**	**2.5%**	**97.5%**	**Data**
UIP 3m	-0.0828	1.0589	-2.1659	1.9957	-2.5693
UIP 5y	-1.5174	3.6524	-9.6211	4.2258	-1.4423
TS D 5y	0.2143	1.8197	-3.4348	3.6586	-1.0790
TS F 5y	1.0898	1.8018	-2.1183	4.9895	2.5477
Panel C : DEM-GBP VAR System					
	Mean	**S.D.**	**2.5%**	**97.5%**	**Data**
UIP 3m	-0.1772	1.0582	-2.2598	1.9013	-2.8760
UIP 5y	-1.8736	3.4463	-9.7387	3.4464	-6.3525
TS D 5y	0.3340	1.9041	-3.4348	4.2182	1.4931
TS F 5y	1.1998	1.8516	-2.1198	5.2529	2.5477

This Table provides summary statistics for the empirical distributions generated from a constrained VAR with bootstrapped residuals. The summary statistics are the Mean, the Standard Deviation (S.D.) and the 2.5% and 97.5% critical values. “Data” refers to the statistics calculated from the actual data. “D” and “F” in the TS regressions refer to the first and the second country respectively in the name of the VAR.

Table A4: Empirical Distribution of Implied Regression Slopes

Panel A : USD-DEM VAR System					
	Mean	**S.D.**	**2.5%**	**97.5%**	**Data**
UIP 3m	1.0173	0.6864	-0.3124	2.4333	-0.3741
UIP 5y	0.8060	0.6330	-0.4410	2.0330	-0.6007
TS D 5y	0.9177	0.1980	0.5226	1.3073	0.7002
TS F 5y	0.9297	0.1739	0.5542	1.2330	0.5154
Panel B : USD-GBP VAR System					
	Mean	**S.D.**	**2.5%**	**97.5%**	**Data**
UIP 3m	0.9615	0.4664	0.0111	1.8823	-2.2587
UIP 5y	0.7751	0.4864	-0.1146	1.7779	-0.5729
TS D 5y	0.9445	0.1760	0.6004	1.2915	0.6331
TS F 5y	1.0256	0.2158	0.5487	1.4087	0.9486
Panel C : DEM-GBP VAR System					
	Mean	**S.D.**	**2.5%**	**97.5%**	**Data**
UIP 3m	0.9114	0.4882	-0.0955	1.8388	-1.1982
UIP 5y	0.6494	0.5812	-0.3406	1.8880	-0.7746
TS D 5y	0.9440	0.1602	0.6033	1.2354	0.5049
TS F 5y	1.0720	0.2335	0.5493	1.4923	0.8501

This Table provides summary statistics for the empirical distributions generated from a constrained VAR with bootstrapped residuals. The summary statistics are the Mean, the Standard Deviation (S.D.) and the 2.5% and 97.5% critical values. "Data" refers to the statistics calculated from the actual data. "D" and "F" in the TS regressions refer to the first and the second country respectively in the name of the VAR.

Table A5: Empirical Distribution of Implied Regression Slope T-Statistics

Panel A : USD-DEM VAR System					
	Mean	**S.D.**	**2.5%**	**97.5%**	**Data**
UIP 3m	0.0153	0.9441	-1.8349	1.8883	-1.2259
UIP 5y	-0.3434	0.9078	-2.2205	1.3218	-1.5906
TS D 5y	-0.5142	1.0530	-2.8194	1.2881	-1.6588
TS F 5y	-0.3735	0.9806	-2.4712	1.4406	-1.6187
Panel B : USD-GBP VAR System					
	Mean	**S.D.**	**2.5%**	**97.5%**	**Data**
UIP 3m	-0.0781	0.9914	-2.0535	1.8674	-3.0635
UIP 5y	-0.6322	1.0701	-2.9892	1.1208	-4.5684
TS D 5y	-0.4109	1.0754	-2.7658	1.4648	-2.3020
TS F 5y	0.2700	0.9480	-1.4340	2.2624	-0.3383
Panel C : DEM-GBP VAR System					
	Mean	**S.D.**	**2.5%**	**97.5%**	**Data**
UIP 3m	-0.1698	0.9656	-2.0980	1.7342	-3.1514
UIP 5y	-0.8439	1.0933	-3.2680	0.9083	-3.3995
TS D 5y	-0.3404	0.9882	-2.4090	1.4932	-1.4375
TS F 5y	0.4537	0.9692	-1.2780	2.4323	-0.7083

This Table provides summary statistics for the empirical distributions generated from a constrained VAR with bootstrapped residuals. The summary statistics are the Mean, the Standard Deviation (S.D.) and the 2.5% and 97.5% critical values. "Data" refers to the statistics calculated from the actual data. "D" and "F" in the TS regressions refer to the first and the second country respectively in the name of the VAR.

Table A6: Empirical Distribution of the Correlation Statistic

Panel A : USD-DEM VAR System					
	Mean	**S.D.**	**2.5%**	**97.5%**	**Data**
UIP 3m	0.6268	0.3316	-0.2769	0.9767	-0.2674
UIP 5y	0.6639	0.4074	-0.5624	0.9943	-0.6406
TS D 5y	0.8727	0.1008	0.6180	0.9899	0.5201
TS F 5y	0.9281	0.0799	0.7168	0.9967	0.7911
Panel B : USD-GBP VAR System					
	Mean	**S.D.**	**2.5%**	**97.5%**	**Data**
UIP 3m	0.7512	0.2559	0.0132	0.9856	-0.9235
UIP 5y	0.7547	0.3140	-0.2282	0.9943	-0.6490
TS D 5y	0.8927	0.0863	0.6752	0.9928	0.4880
TS F 5y	0.9095	0.0849	0.6894	0.9944	0.8368
Panel C : DEM-GBP VAR System					
	Mean	**S.D.**	**2.5%**	**97.5%**	**Data**
UIP 3m	0.7030	0.2867	-0.1135	0.9821	-0.5598
UIP 5y	0.5501	0.3843	-0.4308	0.9827	-0.6498
TS D 5y	0.9462	0.0657	0.7689	0.9981	0.9228
TS F 5y	0.9169	0.0812	0.7077	0.9936	0.8457

This Table provides summary statistics for the empirical distributions generated from a constrained VAR with bootstrapped residuals. The summary statistics are the Mean, the Standard Deviation (S.D.) and the 2.5% and 97.5% critical values. "Data" refers to the statistics calculated from the actual data. "D" and "F" in the TS regressions refer to the first and the second country respectively in the name of the VAR.

Table A7: Empirical Distribution of the Variance Ratio Statistic

Panel A : USD-DEM VAR System					
	Mean	**S.D.**	**2.5%**	**97.5%**	**Data**
UIP 3m	2.8619	2.5164	0.3517	9.0111	1.9574
UIP 5y	1.6622	2.2576	0.1008	6.0438	0.8794
TS D 5y	1.1319	0.4092	0.5208	2.0934	1.8119
TS F 5y	1.0176	0.3109	0.4842	1.6512	0.4245
Panel B : USD-GBP VAR System					
	Mean	**S.D.**	**2.5%**	**97.5%**	**Data**
UIP 3m	1.7469	1.2202	0.3010	4.7697	5.9819
UIP 5y	1.1766	1.2394	0.0775	4.0568	0.7794
TS D 5y	1.1410	0.3540	0.5862	1.9630	1.6826
TS F 5y	1.3049	0.4578	0.4833	2.2812	1.2852
Panel C : DEM-GBP VAR System					
	Mean	**S.D.**	**2.5%**	**97.5%**	**Data**
UIP 3m	1.7720	1.3176	0.3087	4.7012	4.5812
UIP 5y	1.6070	4.3613	0.1053	5.9695	1.4210
TS D 5y	1.0091	0.2862	0.5100	1.6274	0.2993
TS F 5y	1.4047	0.5130	0.4781	2.5022	1.0105

This Table provides summary statistics for the empirical distributions generated from a constrained VAR with bootstrapped residuals. The summary statistics are the Mean, the Standard Deviation (S.D.) and the 2.5% and 97.5% critical values. "Data" refers to the statistics calculated from the actual data. "D" and "F" in the TS regressions refer to the first and the second country respectively in the name of the VAR.

Table A8: Empirical Distribution of SD(rp)

Panel A : USD-DEM VAR System					
	Mean	**S.D.**	**2.5%**	**97.5%**	**Data**
UIP 3m	4.5864	2.8221	1.7117	8.6137	5.8598
UIP 5y	2.5465	3.5902	0.6771	6.4712	3.7002
TS D 5y	0.9749	0.8492	0.3732	1.8106	1.6259
TS F 5y	0.5729	0.7044	0.1913	1.2079	1.1063
Panel B : USD-GBP VAR System					
	Mean	**S.D.**	**2.5%**	**97.5%**	**Data**
UIP 3m	4.1376	1.7571	1.5763	7.6287	8.1009
UIP 5y	2.3684	1.6939	0.6995	5.5961	2.8923
TS D 5y	0.8501	0.3693	0.3104	1.5100	1.6291
TS F 5y	1.0924	0.6782	0.3923	2.2833	1.0278
Panel C : DEM-GBP VAR System					
	Mean	**S.D.**	**2.5%**	**97.5%**	**Data**
UIP 3m	3.6663	1.6920	1.3946	6.7868	8.1587
UIP 5y	2.4459	2.1057	0.7351	6.1345	3.0029
TS D 5y	0.5832	0.3560	0.1816	1.2544	0.9991
TS F 5y	1.2626	1.1894	0.4468	2.8389	0.9203

This Table provides summary statistics for the empirical distributions generated from a constrained VAR with bootstrapped residuals. The summary statistics are the Mean, the Standard Deviation (S.D.) and the 2.5% and 97.5% critical values. "Data" refers to the statistics calculated from the actual data. "D" and "F" in the TS regressions refer to the first and the second country respectively in the name of the VAR.

Table A9: Empirical Distribution of Fama Excess Volatility Ratio

Panel A : USD-DEM VAR System					
	Mean	**S.D.**	**2.5%**	**97.5%**	**Data**
UIP 3m	0.8111	1.2254	0.1193	3.0964	1.8931
UIP 5y	1.5791	6.0428	0.0449	9.9018	3.5034
TS D 5y	0.5235	32.1486	0.0320	0.9251	0.7791
TS F 5y	0.4235	32.1635	0.0126	0.8048	0.9274
Panel B : USD-GBP VAR System					
	Mean	**S.D.**	**2.5%**	**97.5%**	**Data**
UIP 3m	0.6431	1.1424	0.0656	2.9026	1.9223
UIP 5y	1.7937	7.6655	0.0354	11.5802	3.7532
TS D 5y	0.2534	0.7754	0.0243	0.7195	0.8418
TS F 5y	0.3116	8.0481	0.0235	0.8254	0.3019
Panel C : DEM-GBP VAR System					
	Mean	**S.D.**	**2.5%**	**97.5%**	**Data**
UIP 3m	0.7310	1.2005	0.0767	3.2267	1.7414
UIP 5y	1.7316	4.0138	0.0828	9.0057	2.7940
TS D 5y	0.1518	0.4610	0.0083	0.6471	0.9675
TS F 5y	0.4137	15.2802	0.0259	0.8194	0.3070

This Table provides summary statistics for the empirical distributions generated from a constrained VAR with bootstrapped residuals. The summary statistics are the Mean, the Standard Deviation (S.D.) and the 2.5% and 97.5% critical values. “Data” refers to the statistics calculated from the actual data. “D” and “F” in the TS regressions refer to the first and the second country respectively in the name of the VAR.