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Reexamining what survey data say about currency risk and irrationality using the cointegrated VAR

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Abstract

This paper reports new evidence of a time-varying risk premium, and against the usual interpretation of irrationality, in survey data for three major currency markets. Using the cointegrated VAR to better focus on the issue of persistence, the deviations from Uncovered Interest Parity are found to be non-stationary implying a time-varying risk premium. Further, the "relationship" between the forecast error and the lagged forward discount, which has been interpreted as implying irrationality, is a spurious regression, being non-stationary at the 1% level. In fact, the forecast error and forward discount do not even appear to share the same order of integration.

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1. Introduction

There is still much contention over the source of predictable currency returns, and predictable asset returns more generally.[1] An important question is whether these returns are unexploited due to risk or market inefficiency. A difficulty in answering this question is the joint hypothesis nature of most empirical testing. It is not clear whether the widespread rejection of rational expectations hypothesis (REH)-based risk premium models is occurring because of a misspecification of risk preferences or due to the auxiliary hypothesis of REH.[2] In order to delve into the source of excess returns, many studies have used survey data on traders' exchange rate forecasts allowing them to directly examine these questions individually: is there a time-varying risk premium and are traders "rational" in the sense of their forecast errors being a white-noise process?[3]

Taken as a whole, studies using survey data have found a non-zero premium and have rejected REH. This latter result has, in part, motivated much behavioral work which specifies traders as holding fixed forecasting biases.[4] It is worth emphasizing that such explanations often imply that one could make predictable profits, even risk-adjusted profits, simply by betting against the forward rate. This would constitute a truly gross form of market inefficiency.

This work reexamines these conclusions with a greater focus on the issue of persistence using a Cointegrated VAR.[5] This framework is better equipped to test for non-stationarity using more powerful multivariate tests. One month ahead expected excess returns are found to be non-stationary (even around a non-zero constant) for three major exchange rates (the British pound, Japanese Yen, and German mark against the US dollar). This non-stationarity suggests the time-varying risk premium is not merely relevant

[1] For currencies see Fama (1984) and Froot and Thaler (1990), for bonds see Campbell and Shiller (1991) and for equities see Mehra and Prescott (1985).

[2] See Lewis (1995) and Engel (1996) for surveys on the rejection of REH-based risk premium models in currency markets.

[3] For survey data studies not discussed in more detail later, see Dominguez (1986) MacDonald and Torrance (1988), and Ito (1990). Bachetta, Mertens and van Wincoop (2009) find predictable forecast errors in currency, bond, and equity markets.

[4] See for example Burnside et al. (2011) who specify market participants as underestimating the variance of their forecast errors and Gourinchas and Tornell (2004) who specify market participants as underestimating interest rate persistence. The latter does note that their finding could instead be related to robust control behavior however.

[5] See Johansen (1995) and Juselius (2006) for textbook discussion.

over longer horizons and for less developed nations, as has been suggested, once more powerful multivariate tests are used to focus on the presence of cointegration (or lack thereof).

Where this study departs from the literature even more dramatically is concerning the predictability of forecast errors. The "relationship" between the forecast error and the lagged forward discount is found to be non-stationary at high significance levels, suggesting that these previously observed correlations were actually the result of a spurious regression (Engle and Granger 1987). This draws serious doubt to the interpretation of survey data that individuals are simply unaware of these obvious profit opportunites from betting against the forward rate. To reinforce this point, in an alternative specification it is shown that the forecast error and lagged forward discount possess differing orders of integration, being I(0) and I(1) respectively, and consequently can not be related on statistical grounds.

2. Is There a Time-Varying Risk Premium?

Beginning with Froot and Frankel (1989) studies using survey data have evaluated the importance of a time-varying risk premium by testing whether Uncovered Interest Parity holds ex ante; that is expected returns equalize so the domestic return i_t equals the expected foreign return $s^e_{t+1|t} - s_t + i^*_t$. This is conducted by estimation of the following equation:

$$s^e_{t+1|t} - s_t = \alpha + \beta(i_t - i^*_t) + \varepsilon_t \tag{1}$$

where survey data is used to capture the expected future spot rate next period $s^e_{t+1|t}$ and the null hypothesis of UIP implies that $\alpha = 0$ and $\beta = 1$.[6]

Froot and Frankel rejected that $\alpha = 0$, but found estimates for β indistinguishable from one, suggesting a notable average premium, but one which was approximately constant, or at least uncorrelated with the interest differential (or forward rate). They thus concluded that it could not account for the forward rate bias. Due to the short survey data samples available to Froot and Frankel in the late 1980's, they pooled the data across exchange rates.

[6] Although this is the standard presentation of UIP, the survey data studies discuss it most often in reference to the forward discount or premium rather than the interest rate differential. The two are equivalent however given Covered Interest Parity which ensures no risk-free arbitrage opportunities.

Cavaglia, Verschoor, and Wolff (1993) found that the practice of pooling data tended to obscure the importance of the risk premium. Using bilateral data they, along with Chinn and Frankel (1994, 2002), began also rejecting the hypothesis that $\beta = 1$. Chinn and Frankel however suggested that the risk premium was primarily relevant for exchange rates between a developed and a developing country, where the assumption of perfect asset substitutability was less likely to hold.

The work here uses data from Money Market Service International (a common source of forecast data in the literature) for the Deutsche mark, British pound, and Japanese yen from 1982:11-2000:09 (the mark sample ends in 1998:12 however), and data from the IMF's IFS database on short-term (three-month) interest rates and spot rate data designed to correspond as closely as possible to the survey dates.

This work uses a differing econometric methodology from previous studies though; applying the Cointegrated VAR.[7] In the CVAR, we begin by examining the statistical properties of the model and determining the rank (found to be one in all cases).[8] We then explicitly test the restrictions imposed on the data, including the creation of the interest rate differential as well as the restrictions from the null hypothesis ($\alpha = 0$ and $\beta = 1$) to achieve over-identification and to estimate the model.[9] The focus is on the behavior of the error term. If the deviations from the imposed relationship are non-stationary, it indicates that UIP does not constitute an equilibrium relationship, and even expected returns do not tend to equalize, implying a role for risk. We can then relax this further by eliminating the restriction $\alpha = 0$ and test whether the risk premium can be represented as approximately constant, or whether it is in fact time-varying.

[7] See Hendry and Mizon (1993) and Hoover, Johansen, and Juselius (2006) for discussion of the general-to-specific CVAR methodology.

[8] Of particular note is that in order to obtain a statistically well-specified model, a break in level is required for the DM sample approximate to German reunification, though it is restricted to zero in the tests to accord with the hypotheses of interest. Juselius and MacDonald (2004) find an identical needed break in the DM sample. Failing to include the break in the baseline model tends to obscure the influence of the risk premium and the instability of the forecast error's correlations. It also demonstrates the importance of structural change.

[9] The restriction for the expected change in the exchange rate is not explicitly tested here since it is included as one variable. Doing so however would tend to lower the p-value, which is not problematic given we do still reject the null of stationarity.

Figure 1: DM/USD Expected Excess Returns

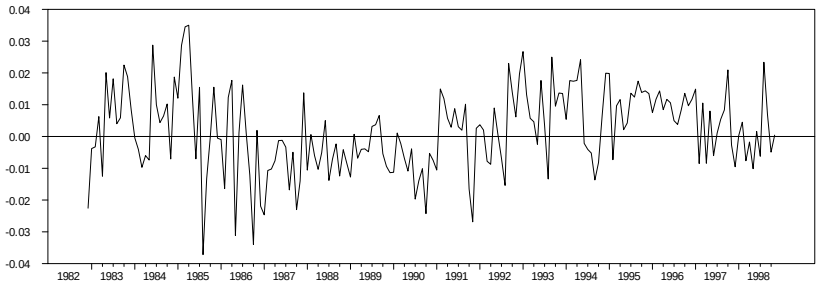


Figure 2: JY/USD Expected Excess Returns

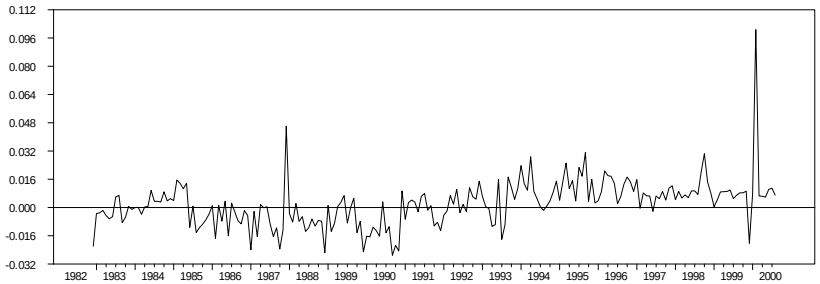
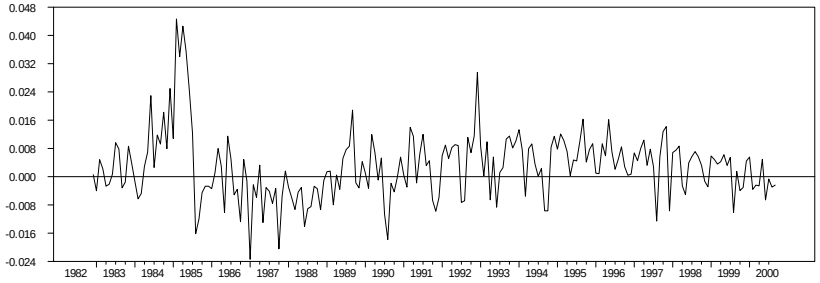


Figure 3: BP/USD Expected Excess Returns



There is a large amount of variability in the measures of the expected excess return, but perhaps more importantly there is also a seemingly notable degree of persistence, prolonged periods where the expected excess return is

primarily positive or negative. This tentative observation will be formally tested now.

The results reported below show the tests of UIP. The p-value reported is the test of a stationary error term.

Table I: Tests of ex ante UIP
$(s^e_{t+1|t} - s_t) + i^*_t - i_t = \varepsilon_t$

	$p-value\ of\ the\ stationary\ of\ \varepsilon_t$
BP	0.038
JY	0.000
DM	0.017

As can be seen, the null hypothesis of a stationary error term (and the restrictions implied by the null hypothesis of UIP) is clearly rejected for all three samples.[10] Further, this is true even here examining a short-time horizon and developed countries only, which is contrary to some of the previous conclusions in the literature.

Next we can examine whether the risk premium can be represented as approximately constant.

Table II: Tests of a constant premium
$(s^e_{t+1|t} - s_t) + i^*_t - i_t - \alpha = \varepsilon_t$

	$p-value\ of\ the\ stationary\ of\ \varepsilon_t$
BP	0.033
JY	0.000
DM	0.018

In all cases we can again see that the null is rejected. Even when allowing for a non-zero constant, the deviations from the relationship are so persistent as to reject stationarity. This provides strong evidence that the risk premium appears to be fluctuating over time.[11] The economic interpretation is that

[10] The error-correction vector has been omitted since the relationships are non-stationary and the coefficients are not interpretable.

[11] Frydman and Goldberg (2007) and Frydman, Goldberg and Stillwagon (2013) provide evidence that the survey data risk premium is related to the deviation or "gap" between the expected exchange rate and its benchmark value of purchasing power parity. This solidifies the interpretation that this persistent error is in fact related to risk, as opposed to a persistent measurement error. It appears that even survey measures of ex-ante returns are correlated with time-t information.

market participants are viewing the bonds of these nations as not only imperfect substitutes, but actually that the perceived relative risk between them is changing notably over time. This suggests that any narrative attempting to account for currency returns absent a notion of time-varying risk is, at the very least, incomplete. Expected returns clearly cannot be reconciled solely through irrationality or transaction costs.[12]

3. Is the Forecast Error Related to the Forward Discount?

The studies using survey data then go on to examine the other possible source of the forward discount anomaly, violations of REH. A common test is to examine the relationship between the forecast error, and the forward discount from the preceding period. Analogously here we estimate:

$$s_t - s^e_{t|t-1} = \alpha + \beta(i_{t-1} - i^*_{t-1}) + \varepsilon_t \tag{2}$$

Again in the Cointegrated VAR we test the restrictions implied by the relationship, including both the restriction used to produce the measure of the forecast error on the left hand side and of the interest rate differential. In this case, α and β are given free parameters. If $\alpha = \beta = 0$ and ε is a white-noise process, this is a necessary condition for REH to hold. If β is significant, then it suggests individuals are mis-forecasting "systematically" and could improve their performance simply by altering the weight they attach to the interest rate differential. This would be consistent with the common interpretation that one could make excess profits simply by betting against the forward rate, and is the standard result in the survey data literature.

If however the relationship is non-stationary, then we have a spurious regression and should conclude that the two variables are not in fact related. This would tend to overturn the interpretation that is typically attached to the finding of a correlation between the forecast error and forward premium. An indication of the results can be gleaned just from a simple view of the two series, the forecast error and the lagged interest rate differential.

[12] See for example Burnside, Eichenbaum and Rebelo (2009) and Lyons (2001) who explain currency returns via market microstructure. This does not mean these cannot be partial explanations, but the survey evidence suggests the importance of a time-varying risk premium as well.

Figure 4: DM/USD forecast error (in black) and the lagged interest rate differential (in blue)

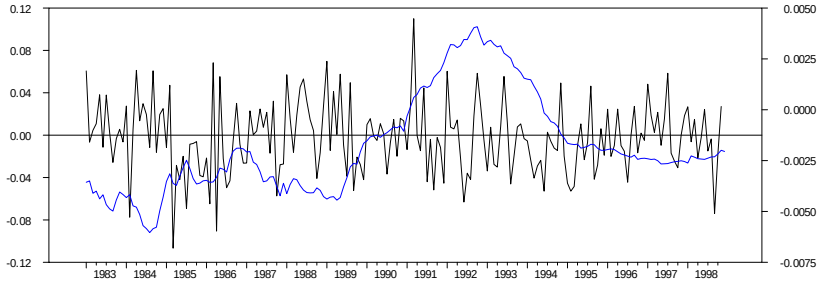


Figure 5: JY/USD forecast error (in black) and the lagged interest rate differential (in blue)

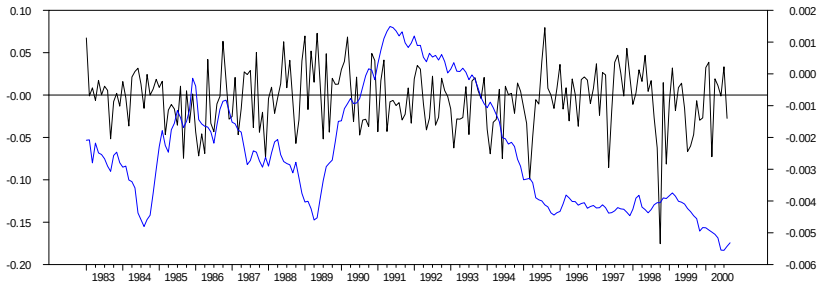
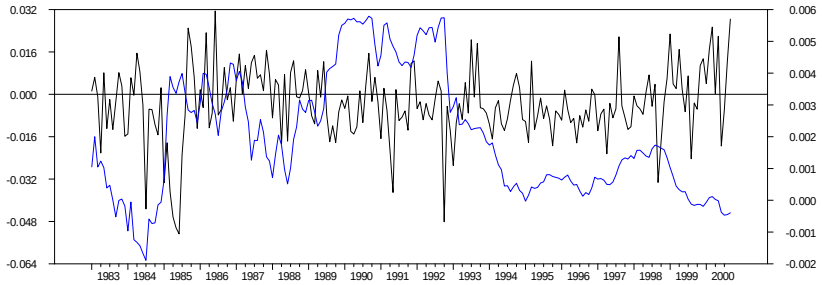


Figure 6: BP/USD forecast error (in black) and the lagged interest rate differential (in blue)



There appear to be some sub-periods where the forecast error and previous period's interest rate differential co-move, particularly for the BP sample,

but the divergences appear quite persistent and the two series even appear to be of differing orders of integration. This tentative observation will be rigorously tested in what follows. In each sample, again the rank is one so the VAR reduces to a single equation error-correction model.

Reported below are the results with the p-value representing the test of a stationary error term. The typically interpreted t-values are reported in parentheses below the coefficient estimates to provide comparison to previous literature.

Table III: Tests of a relationship between the forecast error and forward discount

$s_t - s^e_{t|t-1} - \beta(i_{t-1} - i^*_{t-1}) - \alpha = \varepsilon_t$

	β	α	$p-value\ of\ the\ stationary\ of\ \varepsilon_t$
BP	0.783	0.005	0.009
	(1.475)	(3.534)	
JY	1.692	-0.004	0.000
	(3.330)	(-2.846)	
DM	0.429	0.002	0.004
	(0.850)	(1.017)	

In the first two cases, we obtain results similar to the previous literature in that the coefficients of α and/or β appear significant, which has been interpreted as violating REH, though we do not reject this necessary condition for REH for the DM sample. As can be seen however, in all cases we reject that the "relationship" between the forecast error and the interest rate differential is stationary. This non-stationarity implies that the relationship is a spurious regression. The "significant" coefficients are not t-distributed, and are inconsistent and cannot be interpreted.[13] This draws major question to the notion that market participants are mis-forecasting in a very specific way perpetually and that the systematic forecasting errors can be exploited for profit.

To reinforce this point, we can impose the restrictions associated with the forecast error and the forward premium and test for the stationarity of each. Figures 4-6 certainly seem to indicate differing persistent properties for the forecast error and lagged interest rate differential, where the former appears to be much more stationary. Now we will test this more formally.

[13]For this reason the error-correction vector has been omitted again since it as well will not be interpretable.

Table IV: Tests of the null of an I(0) variable

	$s_t - s^e_{t\|t-1}$	$i_{t-1} - i^*_{t-1}$
BP	0.126	0.000
JY	0.525	0.000
DM	0.217	0.000

There is a clear pattern of soundly rejecting the lagged interest rate differential as I(0) at even the .1% level, and failing to reject the null of stationarity for the forecast error. This suggested difference in the order of integration between the two further supports the conclusion that the forecast error and forward premium are not related, at least in the way that has typically been presented. Of course this does not rule out the possibility that other available information may predict forecast errors over a given period, including the forward discount differenced or cointegrated with other variables, but it does belie the most commonly purported piece of evidence in support of predictable forecast errors.

4. Conclusion

This work uses an alternative econometric approach, the Cointegrated VAR, to re-examine the literature on the presence of a risk premium and predictable forecast errors in survey data. The results corroborate previous studies which find clear evidence of a time-varying risk premium, though here it is true even across developing countries and at shorter (one-month) horizons. This highlights the importance of focusing on the persistence of deviations from UIP and doing so with more powerful multivariate tests. This result may explain the poor empirical performance of standard monetary models, which assume UIP holds ex ante, and suggests that models which attempt to explain exchange rates absent a notion of risk, be it through market microstructure or non-REH forecasting, are at the very least incomplete.

The results differ even more dramatically however in clearly refuting the interpretation of a systematic bias in forecasting relative to the forward discount. The relationship between the forecast error and the lagged interest rate differential is found to be non-stationary, implying that the reported correlations are the result of a spurious regression. To reinforce this deduction, it is found that the forecast error and forward discount differ in terms of the order of integration. The forecast error appears to be stationary but the lagged interest rate differential is rejected as stationary at the .1% level

for all three samples. This suggests that the most extreme interpretations of irrationality and market inefficiency drawn from survey data are dubious at best. This work highlights the importance of examining the presence of cointegration between forecast errors and available information to ensure the correlations suggesting systematic misforecasting are not the result of a spurious regression.

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