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Exchange Rate Expectations and the Risk Premium: Tests for a Cross Section of 17 Currencies*

Jeffrey A. Frankel

University of California, Berkeley, CA 94720 and Institute for International Economics, Washington, DC 20036

Menzie D. Chinn

University of California, Santa Cruz, CA 95064

Abstract

Survey data on a broad cross section of 17 currencies are used to determine whether the forward discount moves primarily in response to changes in expectations of depreciation, or in the risk premium. We find that, in contrast to earlier studies involving developed country exchange rates, variation in the risk premium is a quantitatively significant factor in movements of the forward discount. However, changes in expectations also have a substantial effect.

1. Introduction

Many studies have found that the discount in the forward exchange market is a biased predictor of the future change in the spot exchange rate.[1] In the absence of further information, it is difficult to tell whether this finding is evidence of a time-varying exchange risk premium, as many authors claim, or whether investors' expectations themselves are subject to in-sample bias, as others argue. Recently a number of papers have attempted to use survey data as an independent source of information on investors' expectations.[2] These studies have tended to find little evidence of a time-varying risk premium. But they have been confined to exchange rates for four foreign currencies (the yen, mark, pound and Swiss franc) against the dollar. These may be five of the least risky currencies in the world, by the measure of inflation variability, for example.

It is possible that casting the net over a wider sample of countries, including smaller and less-developed countries, will turn up more evidence of a risk premium. On the other hand, in such a data set there may be even more reason for investors to have well-defined expectations of currency appreciation or depreciation, as reflected in either forward rates or survey data, than in the standard set of major industrialized currencies, where the "random-walk" model of zero expected change often seems to fit the data.

In this paper we apply a new data set to the problem of exchange rate expectations and the risk premium. This data set is derived from *Currency Forecasters' Digest* (CFD). CFD collects and publishes forecasts each month for several forecast horizons (for details, see the Data Appendix). The chief advantage of exploiting

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this data set is that it covers 17 exchange rates for which forward markets exist, including several for newly industrializing countries in Asia and for smaller developed countries in Europe and elsewhere. The hope is that with a much broader and more heterogeneous set of currencies, interesting new patterns can be identified. As in Froot and Frankel (1989), we allow for the possibility of measurement error in the survey data as a reflection of the "true" expectations of investors.

This paper is organized in the following fashion. The data and general approach are discussed in the next section. Then in Section 3, standard results showing the biased nature of forward rates as predictors of future spot rates will be replicated in this sample. The nature of the risk premium is then investigated in a setting where we have direct observations on the expected depreciation. Concluding remarks follow.

2. Data and General Methodology

Economists often look askance at the use of survey data. Critics of such data argue that economists should pay more attention to what people do than to what they say. However, alternative measures of expectations have their own limitations. Hence, macroeconomists have long resorted to various survey measures such as the Livingston survey of macroeconomic variables. Several recent studies have found that survey data do contain useful information about future events, such as Dokko and Edelstein (1989) regarding stock prices, Englander and Stone (1989) on inflation, and Fisher (1989) and Simon (1989) on money growth. One aspect of this data set which mitigates the severest criticisms is that the participants are closely involved in the relevant market—more so than in the Livingston survey for instance (see below). Hence the ever-growing literature using exchange rate survey data, cited in endnote 2.

The exchange rate forecasts we use are usually compiled on the fourth Thursday of each month. Our data set for 17 exchange rates runs from February of 1988 to February of 1991.[3] The survey includes some additional currencies that we exclude from our sample, because they either are not traded in forward markets, or begin toward the end of the sample period, or appear too intermittently to be useful.

The survey respondents are reported to number approximately 45, of which two-thirds are multinational firms, and the remainder forecasting firms or the economics departments of banks. We use as the measure of expectations the "consensus forecast" that CFD emphasizes. This measure is the harmonic mean:[4]

$$\bar{X} \equiv \frac{1}{\sum_{i=1}^{N} w_i \, (1/X_i)}, \quad \sum_{i=1}^{N} w_i = 1,$$

where X_i is the individual forecast, $w_i = 1/N$, and N is the number of forecasts.

The spot rates used to compute expected rates of change are contemporaneous with the forecast compilation, and are the London midday interbank middle rate, as reported in CFD.[5] The forward rates are similarly dated London close rates. The forward rates are also the arithmetic average of the bid and ask rates.

The regressions are run on a pooled time series/cross section.[6] In this paper, we will be investigating the nature of the 3- and 12-month horizon forecasts. For those regressions involving the ability to forecast ex post exchange rates, there exists the econometric problem of overlapping observations. Since the data are sampled at intervals finer than the forecast horizon, the regression residuals will exhibit a moving average process of order $k - 1$, where k is the forecast horizon. This means that in order to make correct inferences, a Hansen (1982) serial correlation-robust estimate of the parameter covariance matrix should be used.[7]

3. Time Variation in the Risk Premium

Many studies have concluded that the forward discount is a biased predictor of the future spot rate. Controversy centers, however, on whether this bias is due to variation in the risk premium, or to a bias in expectations. Consider the following commonly estimated regression:

$$\Delta s_{t+k} = \alpha_1 + \beta_1 fd_{t,t+k} + u_{t+k}, \tag{1}$$

where $\Delta s_{t+k} \equiv s_{t+k} - s_t$, $fd_{t,t+k} \equiv f_{t,t+k} - s_t$, $f_{t,t+k}$ is the forward rate at time t for k months ahead, Δs is the annualized change in the log of the spot rate between the end of period t and $t + k$, and fd is the annualized log difference of the forward rate (at the end of period t for k months hence) and the spot rate at period t.

The null hypothesis of unbiasedness is represented as $\beta_1 = 1$. A constant is allowed to account either for a constant risk premium, or for the convexity term arising from Jensen's Inequality. The common finding is rejection of the null; with β_1 usually estimated to be closer to zero than to unity. This finding is most often

Term (k)	*3 month constrained*	*3 month unconstrained*	*12 month constrained*	*12 month unconstrained*
OLS $\hat{\beta}_1$	−0.671	−2.881	−0.370	−3.409
Het. SE	(0.251)	(0.466)	(0.159)	(0.303)
GMM SE	(0.409)	(0.645)	(0.455)	(0.629)
t: $\beta_1 = 0$	1.641	4.374***	0.815	5.420***
t: $\beta_1 = 0.5$	2.863***	5.149***	1.912**	6.215***
t: $\beta_1 = 1$	4.086***	5.924***	3.011***	7.010***
Chi^2 (2)	27.101***		15.720***	
Sig.	(0.000)		(0.000)	
Chi^2 (18)		71.404***		136.518***
Sig.		(0.000)		(0.000)
d.f.	571	555	423	407
$\bar{R}^2$	0.01	0.06	0.01	0.28
DW	0.580	0.720	0.156	0.323
White	3.081	15.729***	2.449	1.368

Table 1: Bias in the Forward Discount

Notes: Regression equation: $\Delta s_{t+k} = \alpha_1 + \beta_1 fd_{t,t+k} + u_{1,t+k}$; sample: February 1988–February 1991.

OLS β_1 is the point estimate from the OLS regression. OLS Het. SE is the White heteroskedasticity consistent SE. GMM SE is a heteroskedasticity and serial correlation consistent GMM standard error. GMM SE is from regressions with de-meaned data.

t is the absolute value of the t-statistic using the OLS point estimate and GMM standard error. Chi^2 is the Wald test for the null hypothesis that the constants (or constant) equal (s) zero and the slope coefficient equals unity, with 2 or 18 d.f.

White is a heteroskedasticity test, distributed chi^2, with d.f. equal to 3. (Note: tests are conducted on de-meaned data for the unconstrained regressions.)

*(**) [***] indicates significance at the 10% (5%) [1%] level.

taken to be evidence that most of the variation in the forward discount constitutes a time-varying risk premium, defined by $rp_{t,t+k} \equiv fd_{t,t+k} - \Delta s^e_{t,t+k}$.

It is of interest to begin our study by checking whether this standard empirical result is replicated in our sample. A pooled sample regression was run on equation (1). The results are presented in Table 1. As expected, the key parameter estimate is substantially below unity and indeed less than zero. The null hypothesis is resoundingly rejected, even when using standard errors that are robust with respect to both heteroskedasticity and serial correlation. The rejection of $\beta_1 = 1$ is especially strong when each country is allowed to have its own unconstrained constant term, as it should. (Even under the joint null hypothesis of a zero risk premium and rational expectations, there may be a constant convexity term that varies from country to country.)[8] The question is what the source of the bias in the forward discount is.

To assess whether the bias is due to expectational errors or a time-varying risk premium, one can regress the expected depreciation, $\Delta \hat{s}^e$ as estimated by the CFD survey, on the forward discount, as suggested by Froot and Frankel (1989). That is,

$$\Delta \hat{s}^e_{t,t+k} = \alpha_2 + \beta_2 fd_{t,t+k} + u_{2,t}, \tag{2}$$

where $\Delta \hat{s}^e_{t,t+k} \equiv \hat{s}^e_{t,t+k} - s_t$, and $\hat{s}^e_{t,t+k}$ is the expected spot rate at time $t + k$, based on the survey measures taken at time t.

The null hypothesis that the slope coefficient is zero is strongly rejected.[9] Thus, at least some of the variation in the forward discount must be due to expected

Term (k)	*3 month constrained*	*3 month unconstrained*	*12 month constrained*	*12 month unconstrained*
OLS $\hat{\beta}_2$	0.815	0.423	0.549	1.055
Het. SE	(0.107)	(0.148)	(0.058)	(0.116)
GMM SE	(0.182)	(0.203)	(0.097)	(0.185)
t: $\beta_2 = 0$	4.478***	2.858***	5.647***	5.703***
t: $\beta_2 = 0.5$	1.731*	0.520	0.505	3.000***
t: $\beta_2 = 1$	1.016	3.899***	4.649***	0.297
Chi^2 (2):	138.666***		41.807***	
Sig.	(0.000)		(0.000)	
Chi^2 (18):		334.58***		119.11***
Sig.		(0.000)		(0.000)
d.f.	600	584	601	585
$\bar{R}^2$	0.11	0.34	0.11	0.19
DW	0.776	1.047	0.665	0.770
White	30.082***	11.319***	8.780**	3.962

Table 2: Pooled Regression Test for Time Varying Risk Premium

Notes: Regression equation: $\Delta \hat{s}^e_{t,t+k} = \alpha_2 + \beta_2 fd_{t,t+k} + u_{2,t}$; sample: February 1988–February 1991.

OLS β_2 is the point estimate from the OLS regression. OLS Het. SE is a White heteroskedasticity-consistent standard error. GMM is a heteroskedasticity- and serial correlation- consistent GMM standard error, assuming MA processes of order two. Assuming higher order lags implies only slightly different results.

t is the absolute value of the t-statistic using the OLS point estimate and either the White heteroskedasticity-consistent or the GMM standard error.

Chi^2 is the Wald test for the null hypothesis that the constants (or constant) equal (s) zero and the slope coefficient equals unity, with 2 or 18 d.f. Sig. is the significance level of the rejection.

*(**) [***] indicates significance at the 10% (5%) [1%] level.

depreciation. In other words, one can reject the hypothesis that all of the variation in the forward discount is due to a time-varying risk premium.

The next question is whether *any* of the variation in the forward discount can be attributed to a risk premium or, in other words, whether we can reject the hypothesis of a unit coefficient. (Under the null hypothesis $\beta_2 = 1$, there are two possible interpretations of the error term: any time-varying risk premium that is *not* correlated with the forward discount, and random measurement error in the survey data.)

Here we get different answers depending on whether we look at the 3-month results or the 12-month results (see Table 2). Overall, there is more evidence to support the existence of a risk premium in this cross section of 17 currencies than there was in the earlier studies of five major currencies. The coefficient estimate of 0.55 is significantly different from 1, for example, in the case where the 12-month horizon is used and the intercept terms are constrained to be equal across currencies.[10] At the three-month horizon, one rejects the null hypothesis $\beta_2 = 1$ when the intercepts are *not* constrained. I.e., one rejects that all the variation in the forward discount is due to variation in expectations. Thus there is some evidence of a time-varying risk premium, unlike in the narrower five-currency sample of Froot and Frankel (1989).

The regression is also capable of shedding light on a claim set forth by Fama (1984) and Hodrick and Srivastava (1986) (FHS) that expected depreciation is less variable than the exchange risk premium. The FHS claim is:

$$\operatorname{var}(\Delta s^e_{t,t+k}) < \operatorname{var}(rp_{t,t+k}). \tag{3}$$

To see the relevance of the regression results for this claim, note that (3) can be rewritten as

$$\operatorname{var}(\Delta s^e_{t,t+k}) < \operatorname{var}(fd_{t,t+k}) + \operatorname{var}(\Delta s^e_{t,t+k}) - 2 \times \operatorname{cov}(fd_{t,t+k}, \Delta s^e_{t,t+k}).$$

Rearranging,

$$\frac{1}{2} \geqslant \frac{\operatorname{cov}(fd_{t,t+k}, \Delta s^e_{t,t+k})}{\operatorname{var}(fd_{t,t+k})}. \tag{4}$$

As Froot and Frankel (1989) observe, the probability limit of the β coefficient in (2) is

$$\operatorname{plim} \hat{\beta} = \frac{\operatorname{cov}(u_{t,t+k}, fd_{t,t+k}) + \operatorname{cov}(\Delta \hat{s}^e_{t,t+k}, fd_{t,t+k})}{\operatorname{var}(fd_{t,t+k})}. \tag{5}$$

Assuming that the measurement error is uncorrelated with the forward discount, then the probability limit of the regression estimate is the same as the expression in the RHS of (4). Hence, if one can reject the null hypothesis that $\beta_2 \leqslant 0.5$, then one is rejecting the FHS hypothesis that the variation in the expectation of depreciation is less than the variation in the risk premium.

At the 12-month horizon one can reject the hypothesis $\beta_2 \leqslant 0.5$, but at the 3-month horizon one cannot. Again, there is slightly more evidence of a time-varying risk premium than in the narrower sample of countries considered in Froot and Frankel (1989).

We can improve on the results in Table 2 by using Zellner's technique of seemingly unrelated regressions (SUR) to take advantage of the positive correlation of error terms that probably exists across dollar exchange rates. In periods when forecasters are optimistic regarding the dollar, for example, their forecasts of the dollar value of most of the other individual currencies will go down. SUR results are reported in

Term (k)	3 month	3 month (constrained intercept)	3 month	3 month
SUR $\hat{\beta}_2$	0.596	0.253	0.308	0.234
SE	(0.042)	(0.058)	(0.057)	(0.066)
AR (1)		0.416		0.247
SE		(0.039)		(0.041)
t: $\beta_2 = 0$	14.243***	4.375***	5.360***	3.534***
t: $\beta_2 = 0.5$	2.286**	4.259***	3.368***	4.030***
t: $\beta_2 = 1$	9.619***	12.879***	12.140***	11.606***
d.f.	35	33	21	19
Term (k)	12 month	12 month (constrained intercept)	12 month	12 month
SUR $\hat{\beta}_2$	0.502	0.401	0.732	0.321
SE	(0.015)	(0.024)	(0.053)	(0.047)
AR (1)		0.367		0.232
SE		(0.040)		(0.042)
t: $\beta_2 = 0$	33.472***	16.626***	13.713***	6.823***
t: $\beta_2 = 0.5$	0.133**	4.125***	4.377***	3.809***
t: $\beta_2 = 1$	33.200***	24.958***	5.057***	14.447***
d.f.	35	33	21	19

Table 3: SUR Test for Time-Varying Risk Premium

Notes: Regression equation: $\Delta\hat{s}^e_{t,t+k} = \alpha_2 + \beta_2 fd_{t,t+k} + u_{2,\ t}$; sample: February 1988–February 1991. Omits Singapore dollar and South African rand because of missing observations. SUR β is the point estimate from the SUR procedure. SE is the symptotic standard error.

*(**) [***] indicates significance at the 10% (5%) [1%] level.

Table 3. We also correct for the first-order autocorrelation which appears to be present.

In Table 3 there is no longer a major difference between the results at the 3-month and 12-month horizons. In both cases, we can easily reject both the extreme of a zero coefficient and a unit coefficient. In other words, while we find statistically significant evidence for the importance of expected depreciation as before, we now also find as strong evidence for the importance of an exchange risk premium as an explanation for part of the variation in the forward discount. Indeed, the coefficients are below one half, and the standard errors are small enough that the difference is statistically significant. This finding implies that a little more than half of the variation in the forward discount is attributable to the variation in the risk premium.

4. Conclusions

The one consistent finding we obtain is rejection of the null hypothesis that all of the variation in the forward discount is due to variation in the risk premium. This result does not obtain because of the particular characteristics of the specific sample being investigated, but seems to generalize to different periods, and narrower sets of exchange rates. Nevertheless, casting the net over a wider cross section of currencies has clearly turned up more evidence in favor of the risk premium than was evident in earlier tests of the five major currencies.

Data Appendix

Currency Forecasters' Digest is published monthly. The publication indicates that the forecasts apply to a specific date, usually either the third or fourth Thursday in the month. The forecasts include 1, 3, 6 and 12-month horizon forecasts, with the following measures: harmonic mean, arithmetic mean and modal mean. Contemporaneously dated spot rate data are also provided. All rates are converted to domestic currency units per US dollar.

The following currencies are surveyed:

Mnemonic	*Currency*	*FR*	*A?*	*T/I*
DM	West German DM	F		
FFR	French franc	F		
DKR	Danish krone	F		
UK	UK pound sterling	F		
NTH	Netherlands guilder	F		
SFR	Swiss franc	F		
SKR	Swedish krona	F		
IRE	Irish punt	F		
BFR	Belgian franc	F		
LIR	Italian lira	F		
NKR	Norwegian krone	F		
SP	Spanish peseta	F		
YEN	Japanese yen	F		
TAI	Taiwanese dollar			
AUS	Australian dollar	F		
SNG	Singapore dollar	F	A	
PHL	Philippine peso		A	
KOR	Korean won			
SAR	South African rand	F	A	
CAN	Canadian dollar	F		
ARG	Argentine austral			
MEX	Mexican peso			
CHL	Chilean peso			T
BRZ	Brazilian cruzeiro/ado			I
BOL	Venezuelan bolivar			T

Key: F, Forward rate available; A, Alternating monthly; T, Series terminates before Feb. 1992; I, Many missing values due to currency change.

Forward rates are the arithmetic average of bid and ask rates at London close, as reported by DRIFACS.

To minimize the number of missing observations, a recursive Chow-Lin (1976) procedure for interpolation of missing values was used for the expectations series. The missing observations are November 1989, February 1990 and April 1990. The related series used in the interpolation procedure is the contemporaneous (log) spot rate.

Notes

1. See Hodrick (1987) and Froot and Thaler (1990) for surveys of findings in the rational expectations methodology.
2. See Dominguez (1986), Frankel and Froot (1987, 1990), Froot and Frankel (1989), Goodhart (1988), Ito (1990), MacDonald (1992). A review of this emerging literature is available in Takagi (1991).
3. These data are proprietary with *Currency Forecasters' Digest* of White Plains, NY and were obtained by subscription by the Institute for International Economics. The survey has apparently been conducted for some years, but the subscription did not begin until 1988.
4. The harmonic mean contrasts with other measures of central tendency which give either more weight to the extremes (such as arithmetic averages) or no weight (as in the trimmed mean). The modal or median response is available, but looks very similar to the harmonic mean. Regressions of the harmonic mean on either the arithmetic mean, or the mode, yield R^2 in excess of 94%.
5. We estimated the data collection date to be approximately one week before the compilation date. Problems with dating have been encountered in other samples (such as the AMEX survey). In other studies, attempts to adjust the data to accommodate different dating schemes have yielded similar regression results. Using an alternative timing scheme, different point estimates are obtained; however, the conclusions on the hypothesis tests are usually unchanged.
6. We also ran regressions on individual time series (reported in an appendix to NBER Working Paper No. 3806). The results are consistent with those reported in this paper in a qualitative sense, although there is much variation in the estimated slope coefficients, as one would expect from the relatively small number of observations in each time series.
7. This is case (v) of Hansen's (1982) GMM technique. Other applications to overlapping exchange rate forecasts, in a strictly rational expectations methodological framework, include Hansen and Hodrick (1980, 1983). These standard errors are also heteroskedasticity consistent; the White chi^2 tests indicate that heteroskedasticity is a problem in most of the regressions.
8. The constant terms are not reported in the tables, to conserve space. This result also obtains in individual time-series regressions, even with GMM standard errors (in the appendix cited in endnote 6).
9. Results of these regressions report GMM standard errors since there is some evidence of serial correlation. Although the correlation is not due to overlapping observations, empirically, assuming MA (2) errors in calculating robust standard errors appears appropriate. Assuming higher order MAs yielded similar estimates of the standard errors. The presence of residual serial correlation could be consistent with several factors—either a serially correlated measurement error, or a serially correlated risk premium—even under the null hypothesis of a unit coefficient.
10. This can be considered a more powerful test of the no-risk-premium hypothesis than the unconstrained case, because under that null hypothesis all intercept terms are zero.

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