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TESTS OF RATIONALITY IN THE TURKISH FOREIGN EXCHANGE MARKET

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ABSTRACT The rationality of expectations has been tested in many foreign exchange markets using survey data. This study is aimed at gaining empirical insights about the expectations of market participants in the Turkish foreign exchange market. Using survey data provided by Central Bank of Turkey on the exchange rate of the Turkish lira against the US dollar, it is determined that the mean of expectations of market participants for one year and one month ahead were higher than the mean of actual depreciation.

The analysis resulted in rejection of the popular test for forward exchange rate unbiasedness in predicting the future spot exchange rate. Another test of rationality has also been checked and the result has been rejection as well, which can be interpreted that the forward premium contains additional information for exchange rate forecasts.

JEL D84, F31, G14

Keywords Forward exchange rate, Spot exchange rate, Foreign exchange market, Survey data

ÖZ Beklentilerin rasyonalitesi birçok döviz piyasasında, anket verileri kullanılmak suretiyle, test edilmiştir. Bu çalışmada Türkiye'de döviz piyasalarındaki piyasa oyuncularının beklentilerine ilişkin ampirik değerlendirmeler yapmak amaçlanmıştır. Türkiye Cumhuriyet Merkez Bankası tarafından yayımlanan ABD dolar kuruna ilişkin 1 yıl ve 1 ay vadeli beklentiler kapsamında piyasa oyuncularının ortalama beklentilerinin gerçekleşen değer kaybından yüksek olduğu tespit edilmiştir.

Forward döviz kurlarının gelecekteki spot döviz kurunun tahmininde yansızlığına ilişkin testler ise olumsuz sonuçlanmıştır. Beklentilerin rasyonelliğini değerlendirmek üzere, gerçekleşen devalüasyon ile beklenen devalüasyon regresyon analizine tabi tutulmuş ve 1 ay vade için beklentilerin gerçekleşmeler ile ters yönlü olduğu tespit edilmiştir.

TÜRK DÖVİZ PİYASASINDA RASYONELLİĞE İLİŞKİN DEĞERLENDİRMELER

JEL D84, F31, G14

Anahtar Kelimeler Forward döviz kuru, Spot döviz kuru, Döviz piyasaları, Beklenti anketi verileri

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1. Introduction

The theory of rational expectations was first proposed by John F. Muth in the early 1960s to describe the economic conditions under which outcomes depend predominantly on what people expect to happen. Rational expectations theory has been applied by many economists, including but not limited to A.C. Pigou, J.M. Keynes, and J.R. Hicks, who assigned a key role to expectations about the future in the determination of the business cycle. If the foreign exchange market is efficient, in the sense that all available information is used rationally by the risk-neutral agents, then the expected rate of return to speculation will be zero. This framework has been used to understand a variety of situations in which speculation about the future is a crucial factor in determining current action.

The main application of the concept of rational expectations is the efficient markets theory of asset prices. Since the 1980s, numerous studies have tested foreign exchange market efficiency on the assumption of rational expectations. It has been proposed that an efficient foreign exchange market for determining the spot and forward exchange rates is the one in which all available information is used rationally by risk-neutral agents. The popular hypothesis that the forward rate is an unbiased predictor of the spot foreign exchange rate in the future has been derived from the dual assumptions of rational expectations and risk neutrality. Rejection of this joint hypothesis thus means either rejecting the rational expectations assumption or acknowledging that the risk premium is non-zero and time varying.

In order to address the expectations of market participants many studies on foreign exchange market efficiency have relied on surveys.[1] Surveys provide representative indications, especially about the ex-ante risk premium, which is defined as the difference between the spot and the forward foreign exchange rate of a currency. The main advantage of employing survey data is to prevent assumptions from being made about the way expectations are formed, or reliance on some underlying model for determining expectations. Findings based on survey data have generally indicated a systematic rejection of the rational expectations hypothesis,

[1] Pesaran, H.M. and Weale, M. (2006); Takagi (1991); Maddala (1991) and MacDonald (2000a) summarized many of the findings in the area of survey data on exchange rate expectations.

meaning a time-varying risk premium is at work.[2] Rejection of this hypothesis has been attributed to either the risk premium incorporated in the forward foreign exchange rate or some form of irregularity in the rational expectations formation process.

The survey is conducted by the Central Bank of Republic of Turkey (CBRT) twice a month—it is undertaken in order to understand the expectations of the market participants regarding exchange rates for the US dollar (USD) and the euro against the Turkish lira (TRL) with 1-month, year-end, and 1-year forecast horizons. The results have provided an invaluable opportunity to test the efficiency of the Turkish foreign exchange market. The main contribution of this study is to provide a debut test using this Turkish foreign exchange market survey data with reference to the rational expectations of financial actors.

The spot and forward exchange rates of the Turkish lira against the USD and euro have been evaluated by many researchers, as within a data set of various currencies without special attention to market participant expectations. The contribution of this work to the relevant literature is the use of survey data available on the Turkish lira regarding foreign exchange rate expectations, which rarely, if ever, has been analyzed.

This study commences with a description of the survey data. The analysis section begins with a statistical evaluation of observations regarding actual and expected depreciation, as well as forecast error. In the subsequent section, forward rates are tested against realized spot exchange rates on ex-post basis, which has been the most popular test of forward foreign exchange rate bias. Thereafter, the rationality of expectations is investigated by testing the unbiasedness of expected foreign exchange rate depreciation when determining ex-post depreciation. The analysis section continues with the orthogonality test, in order to address efficient use of the information available at the time that expectations are formed. The last section of the analysis is an evaluation of risk premium incorporated into the forward foreign exchange rate.

2. Data

Although there may exist several in-house expectations surveys conducted by various financial institutions regarding TRL exchange rates against other currencies, the only publicly available survey is conducted by the CBRT. This survey is realized twice a month to determine expectations regarding the USD against the TRL on the interbank foreign exchange market. The

[2] See including but not limited to McDonald and Torrance (1990); MacDonald (2000a); Prat and Uctum (2007); Ruelke et al. (2010).

forecast horizons are 1 month, year-end, and 1 year. The survey was initiated on January 15, 2002 for 1-month expectations and revised on April 15, 2006 for including expectations for 1-year ahead. A non-probability sampling method based on the participation of selected respondents is applied. Respondents are selected from among experts and decision-makers in financial and private sectors, and among foreign financial institutions.[3]

On February 2001, Turkey announced its intention to float the TRL—after following a quasi-currency board/crawling peg exchange rate regime for over a year—as part of its economic reform program. Right after this structural change, implicit inflation targeting was applied in the period between 2002 and 2005. Since 2005, CBRT has applied a full-fledged inflation targeting framework. It can therefore be said that there occurred no major structural change in the Turkish foreign exchange market during the period covered by the data set.

Although the survey limits its analysis to the USD and TRL—and for the limited time horizons of 1 month, year-end, and 1 year—it is considered as representative of market expectations. The available data set also provides the opportunity to ascertain the effects of crisis (e.g., the domestic foreign exchange turbulence of 2002, or the global turmoil of 2008 and 2009) on market participant expectations. The monthly spot foreign exchange rates of the USD against the TRL, as well as the forward rates for the 1-month and the 1-year terms, have been gathered from Datastream.

In order to ensure the reliability of the regression analysis, unit root tests were performed for the time series data of the expected, spot and forward foreign exchanges rates of the USD against the TRL. Although three of the data sets were determined to have unit roots, all are stationary at the first difference level. Co-integration between variables were evaluated in the analysis.

3. Analysis

Throughout the analysis, all foreign exchange rate identifications refer to the rate of the USD against the TRL. Furthermore, S_t represents the natural logarithm of the spot foreign exchange rate at time t, while S_{t+k} represents the same rate at time t+k. The natural logarithm of the forward foreign exchange rate at time t for a horizon of k will be defined as $F_{t,t+k,}$ whereas the natural logarithm of the expected spot foreign exchange rate at time t+k will be defined as E_tS_{t+k}. Table 1 displays statistical summaries of actual appreciation ($S_{t+k} - S_t$), expected depreciation ($S_{t+k} - E_tS_{t+k}$) and forecast

[3] The data can be found at http://www.tcmb.gov.tr/yeni/eng/

error ($S_{t+k} - F_{t,t+k}$) for the 1-month and 12-month USD/TRL foreign exchange rates.

3.1. Summary Statistics

Table 1. Summary Statistics on the USD/TRL Foreign Exchange Rate

	Mean	Standard Deviation	Min	Max
Month				
Actual Depreciation	0.0009	0.0172	-0.0363	0.0546
Expected Depreciation	0.0027	0.0084	-0.0514	0.0308
Forecast Error	-0.0017	0.0239	-0.0548	0.0809
1 year				
Actual Depreciation	0.0174	0.0655	-0.0931	0.1464
Expected Depreciation	0.0241	0.0206	-0.0233	0.0566
Forecast Error	-0.0067	0.0669	-0.1348	0.1068

For the period analyzed and for the both forecast horizons, the mean of market participants' expectations were found higher than the mean of actual depreciation. This may indicate a more risk-sensitive, even pessimistic, approach by market participants, since the forecast error increased by five times between the 1-month and 1-year forecasts. This finding is in line with summary statistics reported by Frankel and Froot (1987a, 1987b); MacDonald and Torrance (1990), and Dominquez (1986). However, Cavaglia et al. (1993) determined that the mean forecast error of foreign exchange rate expectations declined as forecast horizons increased. All of these studies focused on the currencies of developed countries, so discrepancies are not attributable to the currencies within the data set.

The low level of standard deviation of the expected depreciation, as compared to that of actual depreciation, needs elaboration. The relative concentration of expectations may be an indication that respondents used common references in forming their expectations. However, this finding also contradicts the findings of Cavaglia et al. (1993).

Figure 1 and Figure 2 display time series data of the natural logarithm of the spot exchange rates and that of the expected exchange rates of USD against the TRL for 1-month and 1-year forecast horizon, respectively. Referring to these figures, it is observed that the deviation between actual and expected depreciation is higher for the 1-year forecast horizon. Additionally, it is seen that the movements proposed by the expectations of the market participants are reflected into the spot exchange rate with lag which is longer for 1-year forecast horizon.

Figure 1. Actual Depreciation Versus Expected Depreciation 1-Month Forecast Horizon

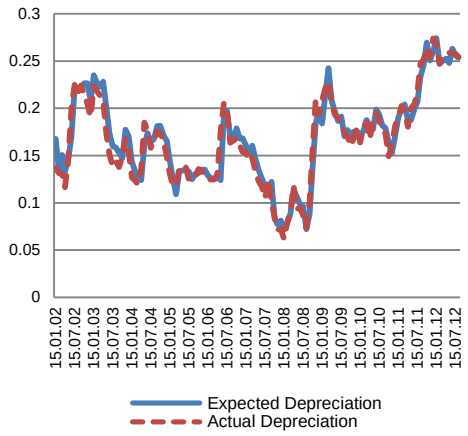
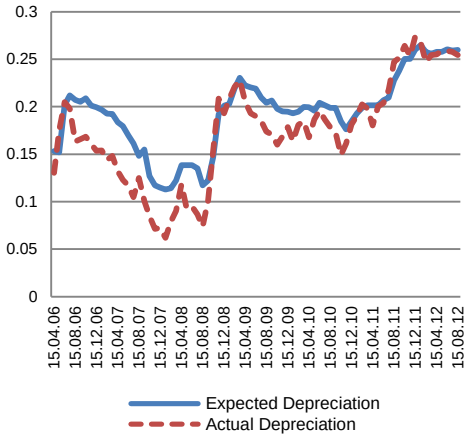


Figure 2. Actual Depreciation Versus Expected Depreciation 1-Year Forecast Horizon



3.2. Test of Unbiasedness for the USD/TRL Forward Foreign Exchange Rates

Foreign exchange market efficiency has been tested under the framework of interest parity that focuses on the rational expectations, the existence of a time varying risk premium and the orthogonality of the expectational errors. Within this framework, the forward rate is assumed to be an unbiased predictor of future spot exchange rates. However, numerous tests have failed to support this hypothesis, and this failure is identified in the literature as the famous forward premium puzzle. This section will review some of the work on the forward premium puzzle with an emphasis on the use of survey expectations.

The unbiasedness test for forward rates is generally performed by regressing the actual depreciation on the forward discount, plus a constant, as outlined in Equation 1. [4]

$$S_{t+k} - S_t = \alpha_1 + \beta_1\left(F_{t,t+k} - S_t\right) + \varepsilon_{t+k} \quad (1)$$

In Equation 1, S_t and S_{t+k} represent the natural logarithm of the spot exchange rate at time t and time t+k respectively, whereas $F_{t,t+k}$ represents the forward exchange rate set at time t for date t+k, and ε_{t+k} is the error term.

[4] This equation is the most popular test of forward market unbiasedness, and is employed by many researchers. References include Longworth (1981), Hsieh (1984), Fama (1984), Huang (1984), Froot and Frankel (1989), Hodrick (1987), Froot and Thaler (1990), Engel (1995), Lewis (1995), Froot and Frankel (1989), Bansal and Dahlquist (2000), Bekaert and Hodrick (2001), Flood and Rose (2002), Nikolaou and Sarno (2006), Alper, C.E. et al. (2009).

The null hypothesis of forward discount unbiasedness is presented as H_0: α=0 and β=1. Under this hypothesis, Equation 1 states that the change in the spot exchange rate at time t+k will be equal to the forward exchange rate set at time t for the date t+k and random error.

With reference to the determination that forecast error will be serially correlated where forecast horizons are longer than the observation period (Hansen and Hodrick, 1980), and to the autocorrelation identified in regression residuals, the Newey West estimation procedure has been used for each forecast horizon, along with the trend-seasonal default values. The results are presented in Table 2.

Table 2. Test of USD/TRL Forward Discounts

$$S_{t+k} - S_t = \alpha_1 + \beta_1\left(F_{t,t+k} - S_t\right) + \varepsilon_{t+k}$$

Horizon	# of Obs.	α	F-prob α=0	β	F-prob β=1
1-month	127	0.0017	0.4832	-0.1313	0.0035
1-year	65	0.0576	0.2108	-0.9300	0.1450

Before analyzing the results given in Table 2, it is noteworthy to mention the liquidity of the Turkish foreign exchange market in order to address the reliability of the findings throughout the analysis. According to a BIS Report dated April 2013, the average daily foreign exchange transaction volume has reached to USD 70 billion, ranked 21st out of 54 foreign exchange markets.[5] The gradual increase realized in average daily transaction volume can be taken as an indication of rational pricing in the Turkish foreign exchange market.

The results given in Table 2 confirm the usual finding of a strong forward rate bias for forecast horizons under 95% confidence level. The calculated β coefficients are significantly less than zero; the coefficient is statistically significant for only the 1-month forecast horizon. The findings reconfirm the existence of the forward premium puzzle, which reveals itself with β closer to minus unity, rather than plus unity, as assumed. Several studies have attempted to solve this puzzle, including those of Goodhart, McMahon, and Ngama (1992); Sarno (2005); Sarno, Valente, and Leon (2006); Sercu and Vinaimont (2006); Kearns (2007); Chakraborty and Haynes (2008) and Chakraborty and Evans (2008). However, none of the explanations has been widely accepted.

[5] http://www.bis.org/publ/rpfx13fx.pdf

3.3. Rationality of the Survey Data

Some researchers attribute the identified bias of the forward exchange rates in predicting the future spot exchange rate to irrational behaviors by exchange rate forecasters, and to those who refer to the existence of a risk premium, as well as to those who refer to both.

Two standard tests are used to test the rationality of the survey data: the test of unbiasedness, which examines whether the expected exchange rate is an unbiased predictor of the spot rate in the future, and the test of orthogonality, which examines whether expectational error stems from the forward discount.

The regression in Equation 2 is used for the test of unbiasedness:

$$S_{t+k} - S_t = \alpha + \beta\left(E_t S_{t,t+k} - S_t\right) + \varepsilon_{t+k} \quad (2)$$

In Equation 2, S_t and S_{t+k} represent the natural logarithm of the spot exchange rate at time t and time t+k respectively, whereas E_tS_{t+k} represents the natural logarithm of the expected future spot exchange rate set at time t for date t+k as expressed by the survey respondents, and ε_{t+k} is the error term. The null hypothesis of rational expectations implies that $\alpha=0$ and $\beta=1$, meaning that the natural logarithm of the actual depreciation is equal to the natural logarithm of the expected depreciation plus the error. With the same reasoning as explained before, the Newey West estimation procedure, along with the trend-seasonal default values, has been used to realize the regressions for each forecast horizon.

Table 3. Test of USD/TRL Unbiasedness

$$S_{t+k} - S_t = \alpha + \beta\left(E_t S_{t,t+k} - S_t\right) + \varepsilon_{t+k}$$

Horizon	# of Obs.	α	F-prob α=0	β	F-prob β=1
1-month	127	0.0022	0.0992	-0.4760	0.0000
1-year	65	0.0106	0.5754	0.2810	0.3481

The results from Table 3 show two different situations for each forecast horizon. For 1-month duration, the β coefficient is negative (statistically significant at 95% confidence level), meaning that actual depreciation was realized in the opposite direction of the expectations. For 1-year duration, the results indicate a fairly consistent rejection of the null hypothesis that expected depreciation is an unbiased predictor of realized depreciation. This rejection is both attributable to α being significantly different from zero and β being significantly different from one. For this maturity, the expected and actual depreciation move in the same direction; however, this relationship fails to be achieved at 95% confidence level. This finding may indicate that

market participants take different approaches to formulating their expectations for the period covered. The short-term scope may have inhibited survey respondents from making forecasts even in the right direction when judged on ex-post forecast errors. For the 1-year horizon, rational forecasts went in the right direction but were demonstrated to be biased.

The bias determined need not imply that expectations are formed irrationally. It is naïve to argue that market participants use irrational exchange rate forecast models, incorporating many variables from financial markets, as well as fundamentals; the failure of the models to predict the spot exchange rate in the future may stem from volatility in expectations and departures from rationality.

Within this framework, Bacchetta and van Wincoop (2004) have put forward a theory of exchange rate determination which incorporates the fact that exchange rate forecasters regularly change the weight they attach to different economic variables, as evidenced in a variety of survey studies (Cheung and Chinn 2001). They propose that market makers continuously evaluate realized foreign exchange rate changes with the motivation of finding leading macroeconomic indicator(s). They then use these indicators as a scapegoat, prioritizing them while formulating their expectations, and then shifting other scapegoats as applicable. Another explanation for the market participant expectations' deviation from the rationality was developed by Gourinchas and Tornell (2004), who showed that the forward premium puzzle arises from systematic distortions in investors' beliefs about the interest rate process. Westerhoff (2003) considered chartists and fundamentalists as different agents in FX markets by successfully displaying realistic exchange rate dynamics. Also, Menkhoff, Rebitzky, and Schroder (2009) explained misalignments of the exchange rate and exchange rate changes through heterogeneity under the chartist–fundamentalist approach. From another perspective, Rime (2003) determined that observation of market-wide trading processes is crucial for market participants to set the 'correct' exchange rate.

3.4. Test of Orthogonality

Another aspect of rationality is concerned with the efficient use of information available at the time expectations are formed. This is tested with the orthogonality test, which is performed on the assumption that if economic agents use all available information rationally, expectational error should be orthogonal to any variable in the information set at the time the expectations are formed, which is assumed to be the forward foreign exchange rate.

Equation 3 tests orthogonality:

$$S_{t+k} - E_t S_{t+k} = \alpha + \beta\left(F_{t,t+k} - \mathrm{S_t}\right) + \mathrm{e_{t+k}} \quad (3)$$

In Equation 3, S_t and S_{t+k} represent the natural logarithm of the spot exchange rate at time t and time t+k respectively, whereas E_tS_{t+k} represents the natural logarithm of the expected future exchange rate set at time t for date t+k as expressed by the survey respondents, $F_{t,t+k,}$ represents the natural logarithm of the forward foreign exchange rate at time t for a maturity of k, and ε_{t+k} is the error term. The null hypothesis implies that $\alpha=0$ and $\beta=0$, meaning that the natural logarithm of the forecast error is equal to the natural logarithm of the forward discount. With the same reasoning as explained before, the Newey West estimation procedure, along with the trend-seasonal default values are used to realize the regressions of each forecast horizon.

Table 4. Test of USD/TRL Orthogonality

$$S_{t+k} - E_t S_{t+k} = \alpha + \beta\left(F_{t,t+k} - \mathrm{S_t}\right) + \mathrm{e_{t+k}}$$

Horizon	# of Obs.	α	F-prob α=0	β	F-prob β=0
1 month	127	0.0042	0.3290	-0.9558	0.1650
1 year	65	0.0617	0.2290	-1.6056	0.2660

The results of Table 4 indicate a strong rejection of the hypothesis that the expectational error is orthogonal to the forward exchange rates. This rejection is both attributable to α being significantly different from zero and to β being significantly different from zero. The β coefficient is less than zero, and near or more than minus unity, indicating a negative relation between the forecast error and the forward premium. Dominguez (1986) and Cavaglia et al. (1993) had similar results. This finding means that the forward premium contains additional information for exchange rate forecasts, paving the way for a new research topic about the existence of time-varying risk premia.

3.4. Test of Risk Premium

The results of these tests reaffirm the bias of the USD/TRL forward foreign exchange rate in predicting the spot rate in the future; the primary explanation for this among researchers has been the risk premium. This means that rational market players quote forward exchange rates in such a way that they use all the relevant information to form their expectations plus the risk premium as they perceive it.

If the foreign exchange market is efficient, the financial actors form their expectations by using all the available information; they also quote the forward exchange rates using an expectation formation process. In this framework, except from error term, the expected depreciation is supposed to be equal the forward discount (premium). This is tested with the following equation, which often appears in the literature (Frankel and Froot 1987; Cavaglia et al. 1994; Nieuwland et al. 1998):

$$E_t S_{t+k} - S_t = \propto + \beta(F_{t+k} - S_t) + \varepsilon_t \quad (4)$$

In Equation 4, S_t represents the natural logarithm of the spot exchange rate at time t, E_tS_{t+k} represents the natural logarithm of the expected future exchange rate set at time t for date t+k as expressed by the survey respondents, $F_{t+k,}$ represents the natural logarithm of the forward foreign exchange rate at time t for a maturity of k, and ε_{t+k} is the error term. The null hypothesis of perfect substitutability implies that $\alpha=0$ and $\beta=1$. Under this hypothesis, if the correlation between the risk premium and the forward discount is zero, then β will equal 1. With the same reasoning as explained before, the Newey West estimation procedure—using trend-seasonal default values—is used for each forecast horizon to realize the regressions.

Table 5. Test of USD/TRL Substitutability

Horizon	# of Obs.	α	F-prob α=0	β	F-prob β=1
1-month	127	0.0024	0.2402	0.8245	0.6005
1-year	65	-0.0041	0.7068	0.6623	0.2472

The results provide a fairly consistent rejection of the null hypothesis, which indicates that the forward premium contains additional information for the exchange rate forecasts of the USD against the TRL for forecast horizons of 1-month and 1-year. Thus, variation in the forward discount for both forecast horizons reflects a statistically significant degree of variation in the risk premium. Despite the suggestion in the burgeoning literature that both irrationality and time varying risk premia are responsible for foreign exchange rate bias, almost all of these studies have been concerned with testing for the existence of time-varying risk premia. However, in the debut study realized by MacDonald (2006b), which attempted to empirically model the risk premium generated from survey data, the main result was that "risk premium is alive and well in the foreign exchange market." A more vivid study ended with the finding that risk premium is well determined by the conditional expected variance of change in the real exchange rate, agents' real net market value in assets and a constant composite risk aversion coefficient.

4. Conclusion

This study has been aimed toward gaining empirical insights about the expectations of market participants in the Turkish foreign exchange market. Using only publicly available survey data provided by the Central Bank of the Republic of Turkey, and only for the exchange rate of the Turkish lira against the US dollar, it has been determined that for the period analyzed—and for both of the forecast horizons—the mean expectations of market participants were higher than the mean actual depreciation. This may indicate a more risk-sensitive, even pessimistic, approach by participants in the Turkish financial markets. The relative concentration of these expectations is another interesting finding, possibly indicating that the respondents use common references while forming their expectations.

The results of the analysis have ended in rejection of the popular test for foreign exchange rate unbiasedness in predicting the future spot exchange rate. The rationality of survey expectations was tested by regressing the ex-post depreciation with the expected depreciation; in doing so, it was determined that 1-month forecast horizon expectations went in the opposite direction as actual depreciation. This finding may indicate that market participants take different approaches to forming their expectations for 1-month and 1-year horizons.

In the relevant literature, another test of rationality has been concerned with efficient use of the information available at the time expectations are formed. This was tested by regressing the expectational error with the forward discount; the result was rejection, which can be interpreted as the forward premium containing additional information for exchange rate forecasts. This additional information is identified as the risk premium, which has been one of the most popular topics in the literature on foreign exchange rate determination. The test of substitutability reveals that variation in the forward discount for both forecast horizons reflects a statistically significant degree of variation in the risk premium.

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