Exchange Rate Risk and Interest Rate: A Case Study for Turkey

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Abstract:

This paper examines the effect of exchange rate risk on interest rates within the uncovered interest rate parity condition for Turkey. When the interest rate is measured with the Treasury auction interest rate and the exchange rate risk is measured with the conditional variance of the exchange rate, then we found that there is a positive relation between the exchange rate risk and interest rate with the data from 1986:12 to 2001:01.

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Introduction

The adaptation of the flexible exchange rate regime in the 1970s and the accelerated integration of financial markets with globalization after the 1980s made the behavior of exchange rates important to understand financial aggregates. The purpose of this paper is to assess the effect of the exchange rate and its risk on interest rates for a small open economy in the case of Turkey. The exchange rate fluctuations introduce a risk on a return of an asset in foreign currency, and foreign investors might want to be compensated with higher risk premium. Therefore, it could be expected that there is a positive relationship between the exchange rate risk and interest rates. This study tests and finds that the exchange rate risk affects the interest rates positively in Turkey for the period from 1986:12 to 2001:01.

This study focuses on Turkey for several reasons. Firstly, the Turkish economy has opened up substantially since the 1980s with extensive developments in the financial sector. Secondly, high exchange rate deprecations and inflation have been the basic characteristics of the Turkish economy. Thus, observing the effects of exchange rate risk on the interest rates is more feasible in Turkey.

To the best of our knowledge, there is no study that looks at the effect of exchange rate risk on interest rates. There are various studies that have examined the effect of exchange rate risk on bank stock returns (see Tai, 2000 and the references cited therein). It is shown that the exchange rate risk could be another potential determinant of bank stock returns but interest rates are not examined. We use the Generalized Autoregressive Conditional Heteroscedastic (GARCH) process in order to model the time varying exchange rate risk. This study finds that conditional variance of exchange rates is positively related to the Turkish Treasury auction interest rates.

The remainder of the paper is organized as follows. Section 1 develops the methodology. Section 2 reports the empirical findings. Section 3 presents our conclusions.

1. Methodology

This section introduces the set of equations which are used to test the relation between exchange rate risk and interest rates. Three equations are specified: the exchange rate, the conditional variability of the exchange rate and the interest rate.

Following Akçay, Alper and Karasulu (1997) the exchange rate equation is modeled with an autoregressive process of order n (denoted by AR(n)):

$$ER_t = \beta_0 + \sum_{i=1}^{n} \beta_i ER_{t-i} + \varepsilon_t \qquad (1)$$

where ER_t is the domestic currency value of the foreign currency, β_0 is the constant term , β_i $(i = 1,2,...,n)$ are the coefficients of the i^{th} lag of the exchange rate; lastly, ε_t is the residual term that has conditional mean zero with time varying variance h_t:

$$\varepsilon_t / \Omega_{t-1} \sim (0, h_t) \qquad (2)$$

Here, Ω_{t-1} is the information set that includes all information available at time t-1 to economic agents. Here, we can specify the expected value of exchange rate as:

$$\mathrm{E}(ER_t / \Omega_{t-1}) = \beta_0 + \sum_{i=1}^{n} \beta_i ER_{t-i} \qquad (3)$$

It is important to note that h_t is time varying to measure the risk. Engle (1982) introduces the Autoregressive Conditional Heteroscedastic (ARCH) model to capture the time varying risk, which allows us to estimate the time varying conditional variance. Particularly, he specified h_t as:

$$h_t = \alpha_0 + \sum_{j=1}^{q} \alpha_{1j} \varepsilon_{t-j}^2 \tag{4}$$

and denoted as the ARCH(q) process. Bollersev (1986) extends the conditional variance specification by including lagged values of h_t to the right hand side of the equation (4). Particularly, Bollersev specified h_t as:

$$h_t = \alpha_0 + \sum_{j=1}^{q} \alpha_{1j} \varepsilon_{t-j}^2 + \sum_{j=1}^{p} \alpha_{2j} h_{t-j} \tag{5}$$

and denoted as the GARCH(p,q) process, here the GARCH specification requires that $\Sigma^q_{j=1}\alpha_{1j} + \Sigma^p_{j=1}\alpha_{2j}$ be less than one to satisfy the stationary condition and α_0, α_{1j}s and α_{2j}s be positive for the non-negativity condition. The GARCH specification has been used extensively in the literature to model exchange rate movements (for example, Akçay, Alper and Karasulu, 1997; Felmingham and Mansfield, 1997; and Tai, 2000).

The interest parity conditions can help to explain the relationship between interest rates and exchange rates. Under perfect capital mobility, interest rate differences must be offset by expectations of exchange rate movements if the investors are risk averse and endowed with rational expectations. The domestic interest rate can exceed the foreign interest rate only if the domestic currency is expected to depreciate. This is known as *uncovered interest parity* (see Romer, 1996, pp. 210-12). However, we are not going to take into account foreign interest rates because they have lower values and stable movements relative to domestic interest rates.[1] Therefore, we can modify the interest rate equation to examine the effects of the expected exchange rate depreciation on domestic interest rates given by:

$$R_t = \gamma_0 + \gamma_1 \mathrm{E}(ER_t) + \eta_t \qquad (6)$$

where R_t is the nominal interest rate on domestic assets, η_t is the white noise process at time t, γ_0 is the intercept term, γ_1 is the coefficient of the expected depreciation, and the uncovered interest rate parity condition suggests that γ_1 is equal to one. In addition, we allow the effects of the exchange rate risk on interest rates, which is measured with conditional variances.

$$R_t = \gamma_0 + \gamma_1 \mathrm{E}(ER_t) + \gamma_2 h_t + \eta_t \qquad (7)$$

where γ_2 is the coefficient of the exchange rate risk.

Inflation risk could be another determinant of interest rates. Theory does not suggest a definite direction of the effect of inflation risk on interest rate. Chan (1994) and Evans (1998) argue that risky assets should offer higher return to investors as a compensation for assuming higher risk. Therefore, there should be a positive relationship between interest rates and inflation risk. On the other hand, Cukierman and Wachtel (1979) argue that governments can generate surprise inflation and decrease the interest rate. Thus, there should be a negative relationship between interest rates and inflation risk. In this study, rather than assessing the effect of inflation risk on interest rates, we will include the inflation risk on interest rate specification to control the inflation risk when we assess the effect of exchange rate risk on interest rates. When the inflation risk is introduced into the interest rate specification as an additional variable, the equation is specified as:

$$R_t = \gamma_0 + \gamma_1 \mathrm{E}(ER_t) + \gamma_2 h_t + \gamma_3 \pi_t + \eta_t \qquad (8)$$

where π_t is the measure of inflation risk at time t^2 and γ_3 is the coefficient of the inflation risk.

In this paper, it is assumed that there is an unidirectional causality running from the exchange rate and inflation risks to interest rate. However, the interest rate could also affect the exchange rate and inflation risks. This study assesses both risks with a class of ARCH models where the risk measure is a deterministic function of the squared lagged residual of the exchange rate (or inflation) as well as the lagged risk measure; the risk measure presented here is exogenous at a given time. Therefore, there is no simultaneity-biased problem in the estimation of equations 6, 7 and 8. Nevertheless, the effect of interest rates on those two risk measures is an interesting avenue to extend the current work; thus, it has been left for future research.

2. Empirical Results

This section presents an estimate of the exchange rate; exchange rate risk and interest rate equation by using monthly data from 1986:12 to 2001:01.[3] The exchange rate is measured as the logarithmic first difference of the foreign exchange basket values (Basket = 1 USD + 1.5 DM), the interest rate is the weighted average of the Treasury auction interest rate for the corresponding month[4], and the inflation is the first logarithmic first difference of wholesale price indices.[5] All the data are available from the data delivery system of the Central Bank of the Republic of Turkey.

When interest rate equations 6, 7 and 8 are estimated, expected exchange rate depreciation ($E(ER_t)$), exchange rate risk (h_t), and inflation risk (π_t) should be calculated first. Here we don't estimate equations (1) and (5) jointly to use their fitted values as a measure of expected exchange rate changes (or inflation) and exchange rate risk (or inflation risk). However, in order to calculate the expected exchange rate depreciation for any given period, we use all sample data for the estimation of the parameters, which are known for each mid-sample period. Therefore, equations (1) and (5) are estimated with rolling regressions.

In order to specify the exchange rate equation, the final prediction error criteria is used to find the lag order for the full sample. The suggested lag order of one is used in the estimation of the expected exchange rate changes in rolling regressions. Next, equations (6) and (7) are estimated for the interest rate equations where the exchange rate uncertainty is modeled with the GARCH(1,1) specification. The results for the full sample are reported in Table 1. We observed a positive but insignificant coefficient for the expected exchange rate depreciation in the interest rate equation. [6] On the other hand, when we include exchange rate risk as an additional explanatory variable for the interest rate, the interest rate equation shows that the estimated coefficient of the exchange rate risk is positive and statistically significant. This result suggests that the exchange rate depreciation risk increases interest rates. Moreover, the estimated coefficient of the expected depreciation is statistically significant and positive. This result is parallel to the uncovered interest parity conditions but the coefficient is less than 1 in a statistically significant fashion. Berument and Malatyalı (2001) argued that inflation risk also increases interest rates. Therefore, we modeled both the inflation risk and the exchange rate risk with the GARCH(1,1) process and used additional regressors in the interest rate equation.[7] Even if the estimated coefficient of the inflation risk is negative, it is statistically insignificant. Moreover, the estimated coefficients of both the expected depreciation and exchange rate risk are positive and statistically significant; hence, the results from the previous estimate are robust.

Turkey experienced a self-inflicted financial crisis in April 1994. It is argued that this could have been introduced by a structural change in Turkish financial markets (see Alper, Berument and Malatyalı, 2001). In order to account for these changes, we estimate the model by using two sub-samples. The first sub-sample uses data from 1986:12 to 1993:12 and the results are reported in Table 2. The second sub-sample uses data from 1995:01 to 2001:01 and the estimates of the model are reported in Table 3.

Table 2 suggests that the estimated coefficients of the expected depreciation are positive and statistically significant in all three specification of the interest rate equation. The estimated coefficient of the depreciation risk is negative but statistically insignificant. Hence, the results reported here do not support the hypothesis that there is a positive relationship between the exchange rate risk and interest rates.

Table 3 reports the results from the post crisis period. The estimated coefficient for the expected depreciation rate is positive and statistically significant. Importantly, *as the uncovered interest rate parity* suggests, we cannot reject the null hypothesis that the coefficient of the expected depreciation is one. The estimated coefficient of the exchange rate risk is positive and statistically significant; these results are robust, even after the inflation risk is controlled. Hence, the positive relationship between exchange rate risk and interest rates as well as the evidence on the uncovered interest rate parity are stronger for the post-1995 period in Turkey.

It is interesting to note that for the full sample as well as for the post-1995 sample, the exchange rate risk explains the behavior of the interest rate in a statistically significant fashion. However, this relationship is not statistically significant for the pre-1994 period. Rather than the positive estimated coefficient that was expected, the estimate was negative. One possible explanation that could be offered is that the importance of the net open positions (denomination mismatch of assets and liabilities of the banks' balance sheets) of Turkish banks, and hence their vulnerability to exchange rate movements, have increased throughout 1990s.

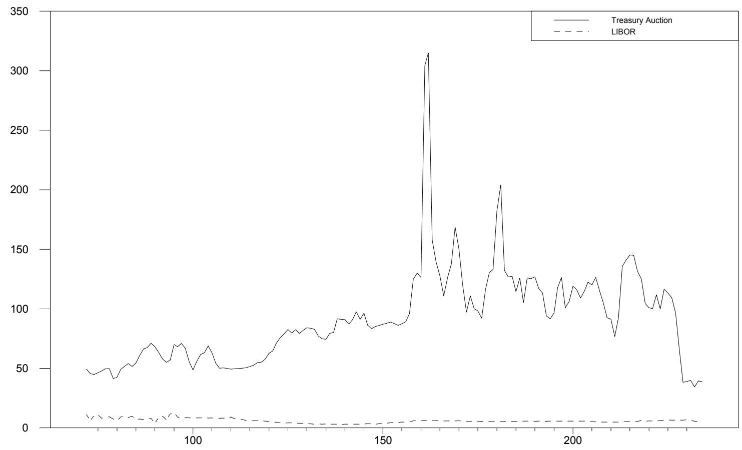
One could argue that there is an ARCH effect on the interest rate and the reason for its high level is the high interest rate risk; therefore, the interest rate risk should be included in the regression analysis. In order to address this issue, the ARCH-LM test was performed on the estimate of equation (8) for the full sample and two sub-samples for 6, 12 and 18 lags. All these test statistics suggest the presence of the ARCH effect. Next, the interest rate risk was incorporated into the interest rate equation with the GARCH-in-Means procedure. However, the estimated coefficient of the interest rate risk was positive, although not statistically significant for either of the samples. Moreover, the estimates of the other coefficients were robust.

3. Conclusion

This paper tests if there are any effects of exchange rate risk on interest rates. The data from Turkey suggests that a higher exchange rate risk increases interest rates. When the data from 1995:01 2001:01 is used, the supporting evidence is stronger. Moreover, we find that we cannot reject the null hypothesis that there is a one-to-one relationship between the expected depreciation and interest rates. This result is robust after considering the inflation risk.

Notes

1. One may take the monthly LIBOR rate in USD as a measure of foreign interest rate. For the full sample, the mean of the treasury auction interest rate and the LIBOR are 91.46 and 6.00, *respectively.* Hence, the average of the treasury auction interest rate is 15 times the LIBOR average. Moreover, the standard deviations are 40.66 and 1.87 for the treasury auction interest rate and the LIBOR. Hence, the auction rate is 21.74 times more volatile. Last, as the following figure suggests, the treasury auction interest rates are higher and more volatile than the LIBOR for all the samples. Therefore, we can safely exclude foreign interest rate from the uncovered interest rate parity condition.



2. Berument and Malatyalı (2001) argue that the inflation risk can be modelled similar to the exchange rate risk.

3. The sample ended in 2001:01 in order to exclude the financial crisis period started in February 19, 2001.

4. The treasury could open auctions at various maturities for its borrowings. When the auction interest rates are calculated, the weigted interest rate is taken with the amount of borrowing in each auction as the interest rate for the corresponding month without accounting for different maturities of auctions.

5. The Central bank of the republic of Turkey publicly announced that they will follow the exchange rate market by observing the basket of 1 US dollar and 1.5 German mark various times in the past (see Berument, 2001).

6. The level of significance is 5%, unless otherwise mentioned.

7. The inflation and the depreciation of the exchage rate are highly correlated series with each other. The Central Bank of the Republic of Turkey had been announcing the excahge rate every morning wıth a close margin to buy and sell, and markets used to follow these rates very closely for the time period this paper considers. Hence, on measuring the exchange rate (risk), we can exclude the effect of inflation (risk) but not vice versa (see IMF Staff Country Report, 2000). Therefore, it is quite difficult to measure inflation risk. However, the narrow span of the availablity of the sample does not allow us to measure inflation risk properly. Hence, we attempt to control inflation risk when we like to asses the effect of the exchage rate risk on interest rates. Lastly, following Berument and Malatyalı (2001), the inflation is modeled with the autoregressive 1 process with monthly dummies, and the conditional variance of inflation is measured as a GARCH(1,1) process.

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Table 1

The estimates of equations (6), (7) and (8) for the full sample.

$$R_t = \underset{(12.2286)}{7.2729} + \underset{(0.9852)}{0.1119}\,\mathrm{E}(ER_t) + \eta_t$$

$$R_t = \underset{(17.4194)}{6.6039} + \underset{(2.1308)}{0.1810}\,\mathrm{E}(ER_t) + \underset{(25.0737)}{0.0193}\,h_t + \eta_t$$

$$R_t = \underset{(16.8601)}{6.6643} + \underset{(1,9656)}{0.1921}\,\mathrm{E}(ER_t) + \underset{(9.0472)}{0.0223}\,h_t - \underset{(-1.4012)}{0.0004441396}\,\pi_t + \eta_t$$

- The numbers under the estimated coefficients are the t-ratios.
- ER_t is the exchange rate, h_t is the conditional variance of the exchange rate, π_t is the conditional variance of the inflation, R_t is the interest rate, η_t is the residual of the interest rate equations at time t.

Table 2

The estimates of equations (6), (7) and (8) for the sub-sample from 1986:12 to 1993:12.

$$R_t = \underset{(8.0913)}{4.1691} + \underset{(2.7982)}{0.4229}\,\mathrm{E}(ER_t) + \eta_t$$

$$R_t = \underset{(7.9295)}{4.2020} + \underset{(2.8206)}{0.4228}\,\mathrm{E}(ER_t) - \underset{(-0.7306)}{0.0112}\,h_t + \eta_t$$

$$R_t = \underset{(8.5075)}{4.5470} + \underset{(2.8760)}{0.4546}\,\mathrm{E}(ER_t) - \underset{(-1.0108)}{0.0156}\,h_t - \underset{(-5.9845)}{0.0015271259}\,\pi_t + \eta_t$$

- The numbers under the estimated coefficients are the t-ratios.
- ER_t is the exchange rate, h_t is the conditional variance of the exchange rate, π_t is the conditional variance of the inflation, R_t is the interest rate, η_t is the residual of the interest rate equations at time t.

Table 3

The estimates of equations (6), (7) and (8) for the sub-sample from 1995:01 to 2001:01.

$$R_t = \underset{(4.9178)}{5.9638} + \underset{(2.9042)}{0.8933}\,\mathrm{E}(ER_t) + \eta_t$$

$$R_t = \underset{(4.9083)}{5.7605} + \underset{(3.0505)}{0.8798}\,\mathrm{E}(ER_t) + \underset{(2.5249)}{0.0851}\,h_t + \eta_t$$

$$R_t = \underset{(3.3294)}{7.6157} + \underset{(3.2160)}{0.9345}\,\mathrm{E}(ER_t) + \underset{(2.3625)}{0.0805}\,h_t - \underset{(-0.9385)}{0.0083993392}\,\pi_t + \eta_t$$

- The numbers under the estimated coefficients are the t-ratios.
- ER_t is the exchange rate, h_t is the conditional variance of the exchange rate, π_t is the conditional variance of the inflation, R_t is the interest rate, η_t is the residual of the interest rate equations at time t.