The Effect of Exchange Rate Uncertainty On Interest Rate in Turkey

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Abstract
The emergence of freely floating exchange rate systems along with the globalization of financial markets has increased the significant movements in the exchange rates. Concerning with this process, our paper tries to empirically indicate how monthly exchange rate volatility and interest rate are linked in Turkey during 2002 to 2011. We proxy the uncertainty of exchange rate with the conditional variance of monthly exchange rate data using GARCH Model specification. Then we test the causality between inflation uncertainty and interest rate using Granger Causality Test and Impulse Response Analysis. Empirical results indicate that the interest rates increase with the higher level of exchange rate uncertainty leading to additional risk premium. These findings also present significant concerns for policy makers adopting the Inflation Targeting after 2001 in Turkey.

Keywords: Exchange rate volatility, interest rate, GARCH.

JEL Classification:C51, E43, F31.

Introduction

Liberalization of financial markets and adoption of free floating exchange rate regimes have increased the volatility of exchange rates in developing markets. Accordingly, increasing exchange rate uncertainty has brought additional risk premium for financial assets in developing economies. Indeed, preference of free floating exchange rate regime increased the uncertainty of exchange rates dramatically while one key feature of fixed exchange rate regime is to have lower exchange rate volatility in the past. Furthermore, under this volatility era, developing countries have heavily been dollarized and also do not have established foreign exchange derivatives markets properly. Consequently, the vulnerability of emerging economies has significantly increased based on huge volatility of their exchange rates. Cheung et. al. (2002) present a survey of the related literature and indicate that despite the great need, the task of forecasting exchange rate has been very difficult because of high volatility for the developing markets especially. They also indicated that exchange rate uncertainty leading to significant risk premium has important effect on interest rates.

Concerning with this process, our paper aims to indicate the effects of exchange rate uncertainty on interest rate in Turkey. Turkey mostly completed financial integration process by liberalizing the capital accounts in 1989 and has experienced huge capital inflows since then. The presence of currency substitution is also a significant property of the economy while there are no foreign exchange derivatives markets. All of these imply that exchange rate volatility might be a significant factor affecting the risk premium or interest rate level of Turkish economy like in other developing countries. Thus, Turkey can be considered as an interesting laboratory for monitoring how exchange rate volatility and interest rate are linked.

Furthermore, from the standpoint of Inflation Targeting commitment of Central Bank of Turkey after 2001, quantifying the effect of risk-premium arising from the exchange rate uncertainty on interest rate is very crucial. Under the freely floating exchange rate regime, it is possible that exchange rate uncertainty leads to additional risk premium culminating an increase in the level of interest rate. Thus, in the framework of Inflation Targeting commitment while exchange rate freely floating, interest rate as a basic tool of central bank for controlling on aggregate demand might lose ground. Therefore, testing this possibility in our study is naturally very crucial for implications about performance of Inflation Targeting Monetary Policy.

The layout of the paper is the following order. Section 2 reviews the studies examining the relationship between exchange rate uncertainty and interest rate in the literature. Section 3 contains the data, methodology and empirical evidence. Final section offers some concluding remarks and policy implications.

Literature Review

Even economic units do not know the future real rate of return; they should form their expectations for the next periods in order to make their portfolio choices in financial markets. From this point of view, information including all aspects of market transaction is significant for the decision making process of investors. Thus, if there is an uncertainty involved in the any financial indicators, this uncertainty also affects the forecast of agents badly. In doubt whether the return from financial investment will realize or not, economic agents tend to either postpone their decision to invest or demand additional risk premium to invest.

In the second case, investors naturally demand a higher return including additional risk premium arising from the uncertainty. Thus, allowing a higher return specification for financial investment including risk premium becomes an optimal manner. As a result, higher uncertainty concerning the indicators results in higher returns in financial markets. The volatility of financial indicators causing uncertainty required additional risk premium or much more return for financial assets. Accordingly, most return or price variation in financial markets comes from variation in risk premia arising from uncertainty. Indeed, it has been widely documented that variation in risk over time is essential for understanding movements in interest rate. The observed variation in the interest rate is, thus, mainly accounted for by movement in the risk premium (Cochrane, 2001: 451). Risk premium affecting the interest rate level is a function of a set of variables like inflation and exchange rate uncertainty. Especially, exchange rate uncertainty has become more important over time as a result of the advent of flexible exchange rates and the much higher degree of integration of financial markets.

Concerning the exchange rate volatility, increasing uncertainty means decreasing unit profit per risk that is achieved by possession of foreign exchange. Thus, in the case of risk avoider investor, increase in uncertainty by holding exchange rate requires an increase of risk premium for financial assets (Domowitz and Hakkio, 1985). Risk aversion agents demand compensation for holding a risky asset in the form of additional returns. Therefore, the exchange rate uncertainty (volatility) means a proxy for additional risk premium required much more return for deposit, that is higher interest rate. Components of deposit interest rate can be indicated as the real rate return, expected inflation and risk premium. Exchange rate uncertainty affects the risk premium component of interest rate and then naturally interest rate level. Thus, possible effect of exchange rate uncertainty on interest rate operates by the risk premium component. In other words, the higher exchange rate volatility, the greater risk premia required for investing on deposit. From the theoretical point of view, Alverez et al. (2006) indicate that time-varying risk is the prime mover of a complete model of interest rates. They also set up a general equilibrium monetary model on endogenous source of risk variation, which can produce key features of actual interest rate.

There are a lot of empirical studies aiming to link exchange rate uncertainty or volatility with time varying risk premium. By a comprehensive survey, Sarno and Tayloy (2002) indicate that significant part of the literature has recently pursued a pure time-series approach although alternative econometric approaches have been applied in the literature for studying foreign exchange risks. These studies have indicated that volatility of exchange rate has a clustering tendency. Thus, once volatility increases, there is high possibility of increasing on the next again. Also, once it is stabilized, there is a possibility of persistency. If the volatility of time series shows clusters, then GARCH model is advised to use. This kind of clustering phenomenon of variability can be modeled with ARCH and GARCH by Engle (1982) and Bollerslev (1986), respectively. Following these studies, the use of ARCH/GARCH type models to account for time variation in the conditional variance has become common.

Accordingly, there are significant studies on European countries using time-series approach. Nieuwland et al. (1998) analyze the currency markets of European Monetary System in order to examine risk premia over the 1986-1991 periods. They cover five European currencies (Belgian franc; French franc; Italian lira; Spain peseta; Dutch; guilder) relative to the Deutschmark. They also use survey data concerning the expectations of exchange rate to avoid relying on expectation rationality on the part of market participants. Their GARCH-in-mean specification supported to existence of time-varying risk premia arising from exchange rate volatility in all currencies. Orlowski (2004) indicates that exchange rate uncertainty constitutes one of the most important sources of risk in Hungary, Poland and Czech Republic. He defines the exchange rate risk as the excess exchange rate volatility above the level associated with unbiased uncovered interest and purchasing power parity conditions. Such defined exchange rate risk calculated by variance analysis employing the TARCH-M model. He finds that the log of the conditional variance in the mean equation, as a proxy of the exchange rate risk, appears to be quite pronounced in all countries.

In literature there are also studies focusing on individual countries to model exchange rate uncertainty as a risk premium. Ryan and

Worthington (2002) employ a GARCH-M model to consider the time-series sensitivity of Australian bank stock returns to market interest rate and foreign exchange rate risks. They have found that market risk is an important determinant of bank stock returns along with short and medium term interest rate levels. However, long-term interest rates and the foreign exchange rate do not appear to be significant to the Australian bank return.

Soto and Valdes (1999), using Capital Asset Pricing Model (CAPM) and ARCH-M models, empirically evaluate the importance of exchange rate volatility on interest rate, with special reference to Chile. They use CAPM and find that a systematic but small relation between exchange rate volatility and risk-premium. However, when they consider the overall effect of volatility on risk-premium and estimate an ARCH-M model, they find a large effect of volatility on risk-premium in Chile. Poghosyan and Kocenda (2006), analyze the effect of foreign and domestic currency on denominated yields in Armenia by using weekly data. The risk associated with domestic currency denominated deposit yields is priced relatively higher than the risk associated with the foreign currency denominated deposit yields. The difference in market prices of risk between domestic and foreign currency denominated deposit is possibly derived by the exchange risk premium. The pattern of time-varying risk premium is modeled using GARCH-in-Mean specification. Results of the study indicated that there is a positive correspondence between exchange rate depreciation and interest rate differential as a difference between domestic and foreign currency denominated deposit yield.

Concerning the empirical studies focusing on Turkey, interest rates increase with the higher level of exchange rate uncertainty was also indicated. Berument and Günay (2001) examine the effect of exchange rate risk on interest rates in Turkey with the monthly data from 1986 to 2001. Interest rate is measured with the Treasury auction interest rate. They found that there is a positive relation between the exchange rate risk and interest rate. Şengöl and Aytemiz (2007) also examined the determinants of the exchange rate for the period 1990:01-2006:04 in Turkey. They used a non-parametric Regression Trees Technique taking into account the multiple interactions of explanatory variables on the exchange rate. One of the most important outcomes indicated in this study is that only exchange risk premium has a primary role on exchange rate during all period.

Data, Methodology and Empirical Results

In our complete econometric analysis, we try to test whether the risk premium arises from exchange rate uncertainty and leads to an increase in interest rate. Thus, this paper examines the effect of exchange rate uncertainty on interest rate in Turkey. Firstly, exchange rate uncertainty as a time-varying risk premium is produced by GARCH specification on primarily exchange rate time series. Secondly, we analyze the relationship between exchange rate uncertainty series generated by GARCH specification and interest rate by using Granger Causality Test and Impulse-Response Function Analysis.

The data set employed in this study covers the monthly exchange rate (ER)and deposit interest rate (INTER) for the period 2002M01-2012M12. All primarily data set is obtained from Central Bank of Turkey database. The interest rate is measured with the monthly deposit interest rate while the exchange rate uncertainty or risk is measured with the conditional variance of the monthly exchange rate. Exchange rate uncertainty as a time-varying risk premium produced by GARCH specification on primarily exchange rate time series.

Before running an econometric analysis, we should test whether time series of interest rate and exchange rate are stationary or not. Table 1 presents the unit root test results in terms of Augmented Dickey-Fuller (ADF) and shows that both variable are stationary in level. According to the ADF test results of interest rate (INTER) and exchange rates (ER) are all stationary at the % 1 and % 5 significant levels, respectively.

Table 1: Unit Root Test

Augmented Dickey-Fuller Test			**Test critical values**	
Variable	t-Statistic	Prob.	1% level	-3.477487
INTER	-4.197244	0.0009*	5% level	-2.882127
ER	-3.288676	0.0173**	10% level	-2.577827

, ** indicate significance at %1 and %5 levels, respectively

GARCH (1,1) Specification

In this part, we address the issue of the foreign exchange uncertainty or risk premium by employing GARCH specification on primarily monthly exchange rate. GARCH model is especially well suited for this purpose because it allows us to directly estimate the risk premium as a function of volatility. Firstly, we should estimate the exchange rate equation as an ARMA model. In our study, we indicated that MA (2) fits well for the time series of exchange rate. As can be seen from the Table-2, MA (2) model of exchange rate meets the criterions like significance of the parameters, high determination coefficient, maximum Log-likelihood ratio and significance of F-test statistics.

Table 2: MA Model of Exchange Rate Series

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	0.283821	0.023509	12.07287	0.0000*
MA(1)	1.296746	0.048733	26.60947	0.0000*
MA(2)	0.651092	0.048948	13.30176	0.0000*
R-squared	**Adj.R-squ**	**Mean dep. var**	**S.D. dep. var**	**S.E. of reg.**
0.871598	0.869777	0.280360	0.265051	0.095648*
Sum squ Res.	**Log like.**	**D-W stat**	**F-statistic**	**Prob(F-sta.)**
1.289933	135.1689	0.668194	478.5569	0.000000*

**** indicates significance at %1 level***

After determining the MA (2) Model for exchange rate, we performed Lagrange Multiplier (LM) Test whether ARCH effect exits or not. Table-3 presents ARCH effect test results for MA (2) model. Test statistics is calculated by $LM_{ARCH} = TR^2$. If TR^2 is greater than the Chi-square table value, $(\mathcal{X}^2_{tab})$, we reject the null hypothesis that there is no an ARCH effect in the MA (2) model. According to the Table, we reject the null hypothesis that there is no ARCH effect since TR^2 is greater than the Chi-square table value. Thus we conclude that there is an ARCH effect in the MA (2) model of exchange rate.

Table 3: ARCH Test

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	0.005991	0.002182	2.745520 *	0.0068
RESID^2(-1)	0.341763	0.079228	4.313673*	0.0000
R-squared	**S.E. of reg.**	**$T.R^2$**	**F-statistic**	**D-W stat.**
0.116584	0.024712	16.67157 *	18.60777 *	1.482157

**** indicate significance at %1 level.***

GARCH specification on time series model of exchange rate can be realized after detecting the ARCH effects such as indicated Table-3. Following the studies of Engle (1982) and Bollerslev (1986) respectively, the use of ARCH/GARCH type models to account for time variation in the conditional variance has become common. GARCH time series estimation provides a more sophisticated method of estimating time-varying uncertainty or modeling changes in variance. Accordingly GARCH techniques are popular in empirical investigations of the exchange rate uncertainty since the estimated conditional volatility can serve as a proxy for uncertainty. Moreover, since GARCH models provide a parametric measure of exchange rate uncertainty, an explicit test can be conducted to determine whether the conditional variance is statistically significant. Generally GARCH Model is presented like below:

$$h_t = \omega_0 + \sum_{i=1}^{p} \alpha_i \, \varepsilon_{t-1}^2 + \sum_{i=1}^{q} \beta_i \, h_{t-1}$$

This model can be expressed such as GARCH (*p*, *q*) model in which there are *p* lagged terms of the squared error term and *q* terms of the lagged conditional variances. The moving average component (ARCH term) is ε^2_{t-1} and represents exchange rate volatility from the previous period. The autoregressive component (GARCH term) is h_{t-1} and represents the forecast variance of exchange rate from previous period. The sum of the coefficients (α + β) in the conditional variance equation determines volatility persistence (uncertainty) due to exchange rate shocks. The case of (α + β < 1) symbolize the stationary variance requirement. This means that the GARCH Model is mean reverting and conditionally heteroskedastic, but has a constant unconditional variance.

Estimated GARCH (1, 1) results are presented in Table-4. As we see from the Table, test results of GARCH (1, 1) specification meets the criterions like significance of the parameters, high determination coefficient, maximum Log-likelihood ratio and significance of F-test statistics. Thus, it can be argued that risks associated with uncertainty about the future level of exchange rate were always present during the period under consideration from 2002M01 to 2011M12. The sum of the coefficients of ARCH (α) and GARCH (β) in variance equation equals nearly 0.87. This indicates the volatility persistence due to exchange rate shocks. However, the speed of convergence of the forecast of the conditional volatility to a steady state is low.

Finally, we could properly generate the time series of exchange rate uncertainty using GARCH specification on primarily exchange rate series from 2002M01 to 2011M12. In the next sections, we will analyze the relationship between the series of exchange rate uncertainty and deposit interest rate by using Granger causality Test and Impulse Response Function Analysis.

Table 4: GARCH (1, 1) Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.363786	0.011839	30.72816	0.0000*
MA(1)	1.298691	0.080744	16.08397	0.0000*
MA(2)	0.607429	0.084576	7.182036	0.0000*
Variance Equation				
C	0.000268	0.000164	1.629934	0.0131**
ARCH(1)	0.236226	0.141867	1.665125	0.0451**
GARCH(1)	0.635944	0.134891	4.714501	0.0000*
R-squared	**Adj.R-squ**	**Mean dep. var**	**S.D. dep. var**	**S.E. of reg.**
0.860183	0.855117	0.280360	0.265051	0.100888
Sum squ Res.	**Log like.**	**D-W stat**	**F-statistic**	**Prob(F-sta.)**
1.404610	219.2473	0.615916	169.8007	0.000000*

, ** indicate significance at %1 and %5 levels, respectively

Granger Causality Test

Granger causality test may be illustrated by considering the following equations for the exchange rate uncertainty (ERUNC) and the interest rate (INTER) in a VAR model like bellow:

$$INTER_t = \sum_{j=1}^{m} a_j INTER_{t-j} + \sum_{j=1}^{m} b_j ERUNC_{t-j} + \varepsilon_t$$

$$ERUNC_t = \sum_{j=1}^{m} c_j INTER_{t-j} + \sum_{j=1}^{m} d_j ERUNC_{t-j} + \eta_t$$

Thus most of the part of the change in interest rate would be explained by foreign exchange risk premium. In other words, important component of the interest rate would reflect the exchange rate uncertainty. We seek to evaluate whether an increase in exchange rate volatility produces a larger risk premium on interest rate and higher interest rate. Study also tries to indicate whether exchange rate uncertainty as a proxy of risk primia has significant effect on interest rate.

The test results of Granger causality analysis are presented in Table-5. According to this results, we reject the null hypothesis that inflation uncertainty (ERUNC) does not Granger cause deposit interest rate (INTER). Thus, we found a significant positive effect of exchange rate uncertainty on interest rate. This finding suggests that positive risk premium arising from exchange rate uncertainty required higher interest rate by the agents in order to invest in currency denominated deposits in Turkey.

Table 5: Granger Causality Test Results

Null Hypothesis:	F-Statistic	Probability
INTER does not Granger Cause ERUNC	1.89742	0.17057
ERUNC does not Granger Cause INTER	8.43539	0.00428*

**** indicate significance at %1 level***

Impulse Response Function Analysis

The Impulse Response Function Analysis depends on VAR Model specification. Developed by Sims (1980), VAR Model is a dynamic system by which correlating each variable with its own value and lagged values of other variables. In the VAR model there is a multi-equation system where all the variables are treated as endogenous. In the case of two variables; interest rate (INTER) and exchange rate uncertainty (ERUNC), the time path of $INTER_t$ is affected by current and past realizations of the $ERUNC_t$ sequence while the time path of the $ERUNC_t$ sequence is affected by current and past realizations of the $INTER_t$. Thus, bivariate system is realized like below;

$$INTER_t = \beta_{10} + \beta_{11}ERUNC_t + \beta_{11}INTER_{t-1} + \beta_{12}ERUNC_{t-1} + \varepsilon_{INTERt}$$

$$ERUNC_t = \beta_{20} + \beta_{21}INTER_t + \beta_{22}INTER_{t-1} + \beta_{22}ERUNC_{t-1} + \varepsilon_{ERUNCt}$$

It is assumed that both variables are stationary while residuals are white noise disturbances with standard deviations of their variances. Residuals in both equations are also uncorrelated white-noise disturbances. The Impulse Response Function Analysis has been used to produce the time path of the variables in the VAR Model indicated above. This method shows the response of variables against to shocks from themselves. If the system of equations is stable, any shock should decline to zero while unstable system would produce an explosive time path. More generally, the impulse-response function describes the reaction of the system as a function of time or possibly as a function of some other independent variable that parameterizes the dynamic behavior of the system.

Impulse response graphs of variables concerning with exchange rate uncertainty (ERUNC) and interest rate (INTER) are shown in Graph 1. Vertical axis of each graph represents the direction of the response and magnitude in percentage term to the relevant variable which has a rising shock by 1% standard deviation while horizontal axis represents the number of period (quarters). On the other hand, dashed red lines represent the confidence interval by (+/- 2) standard deviations and have an important role in determining the significance of the results statistically.

The response of the INTER to shocks from LERUNC follows an increasing pattern for the first three quarters and later a decreasing pattern. Thus LERUNC has a significant positive effect on INTER. The response of LERUNC to INTER has a negative trend but very small. Then we can ignore the effect of INTER on LERUNC. Thus, exchange rate uncertainty or risk has a significant effect on its connection with interest rate as an independent variable. Deposit interest rate sensitivity to exchange rate uncertainty can be strongly justified in terms of impulse-response function analysis.

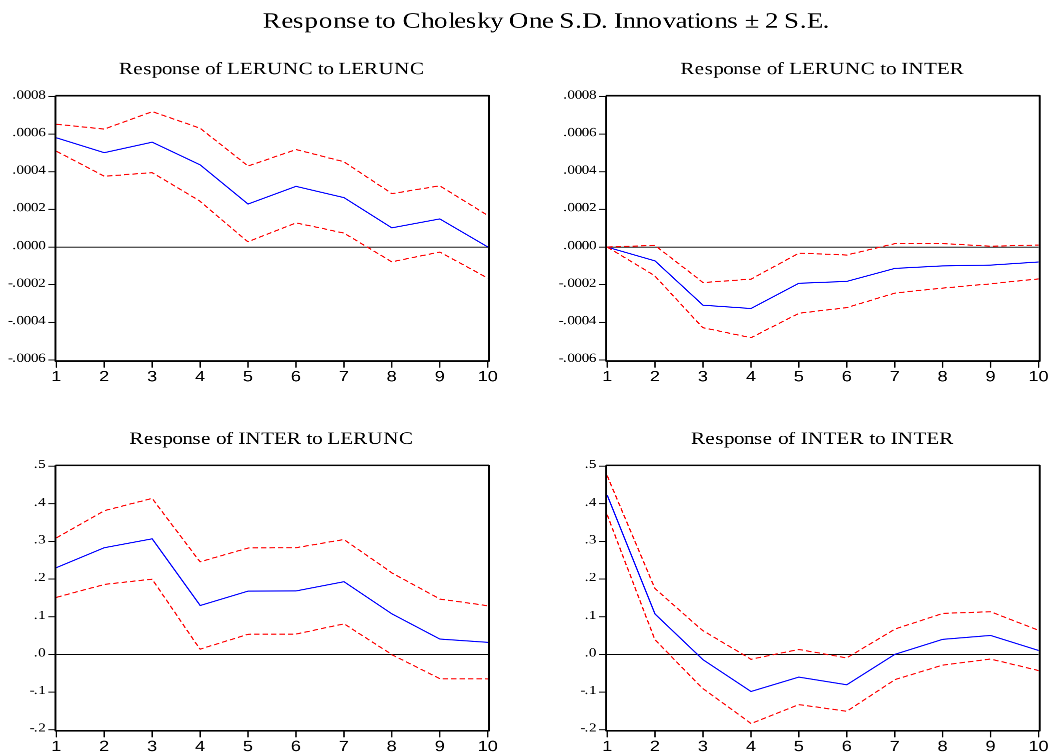

Figure 2: Impulse – Response Function

Conclusion

After an accelerated financial liberalization process, the movements of exchange rate have become a significant factor affecting the level of interest rate in developing economies. From this starting point of view, the main aim of this paper is to explain the behavior of the monthly deposit interest rate as a function of uncertainty associated with exchange rate for Turkey during the period from 2002M01 to

2011M12. Empirical findings indicate that the exchange rate uncertainty or risk premium is substantial and time-varying. The study also indicated that exchange rate volatility and interest rate are positively linked. Thus, exchange rate uncertainty leads to additional risk premium culminating an increase in the level of deposit interest rate. To put in differently, our econometric analysis show that the risk premium arises from exchange rate uncertainty and leads to an increase in interest rate.

Empirical findings have important implications for Inflation Targeting Monetary Policy adopted by Central Bank of Turkey. In the framework of Inflation Targeting commitment, interest rate is used by Central Bank as a significant tool in order to control on aggregate demand while exchange rate freely floats. However, according to results of our study it seems that time-varying risk premiums arising from the volatility of freely floating exchange rates result in higher level of interest rate. Thus, it can be argued that, in the framework of Inflation Targeting Policy adopted by Central Bank of Turkey, interest rate as a basic tool for controlling of aggregate demand loses ground since time-varying exchange risk premiums have a significant effect on interest rates.

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