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Impact of Short-term Interest Rate on Exchange Rate: The Case of Turkey

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Abstract

After the crises in 2001 inflation targeting regime has been adopted and short-term interest rates have been used as the main monetary policy tool in Turkey. In addition, Central Bank of the Republic of Turkey (CBRT) utilizes short-term interest rates against the sudden rises in dollar rate. In this context, we aim to determine the efficient level of short-term interest rates on dollar rate. Accordingly, using monthly data for the period of 2003:02 – 2015:08, we find no evidence that higher interest rates cause to a weakening of exchange rate, by the frequency domain Granger causality test.

Keywords: Foreign exchange rate, short-term interest rate, frequency domain Granger causality test.

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1. Introduction

Exchange rates fluctuations is one of the main obstacles that developing economies confront in the macroeconomic management. Especially during the economic crisis periods this subject gains more importance in terms of cost and duration of the recovery process. Interest rate is, among other monetary policy instruments, constitutes an important part of policy variables in coping with unintended exchange rate fluctuations. In this regard, despite to the conflicting empirical findings, there is a common belief as that tight monetary policy and higher interest rate do help in stabilizing exchange rates.

Goldfajn & Baig (1998) distinguish four building blocks for the analysis of the appropriate monetary policy to be adopted in the aftermath of a currency crisis. The first block is to search if the real exchange rate has become depreciated and should be brought back to equilibrium level. The second block is to identify the relevant

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mechanisms through which the real exchange rate could be corrected in case it is depreciated. The third block is related to identify the appropriate policies and circumstances that help the reversal through nominal appreciation. In this regard, it should be evaluated whether nominal appreciations occur when interest rates are kept high. Finally, the fourth block is to evaluate the probable consequences of raising interest rates. Expected gains from the effect of raising interest rates on the exchange rate can be canceled out by the costs that arising from raising interest rates such as output loss, increased unemployment rate and financial system fragility.

Central bankers of developing countries face further challenges than developed countries across exogenous monetary shocks. Two of these challenges are closely related: the problem of currency substitution and central bank's motive for monitoring foreign exchange reserves. First, as regards currency substitution, the public may prefer using foreign currency rather than to use domestic currency so that to guard themselves against the eroding effect of inflation. If domestic interest rates go at lower pace or if the domestic currency depreciates considerably, agents like to hold more of their wealth in foreign currency than in domestic currency. Second, in order to reduce the risk of speculative attacks or a probable balance of payment crisis, central banks closely monitor foreign exchange reserves. Central bank will increase its exchange reserves as domestic interest rates increase and decrease as the return on foreign exchanges increases. Thus, central banks may use both the interest rate and exchange rate policies to achieve their goals (Berument, 2007: 412).

In Turkey, some economists argued that exchange rate depreciation observed over the 2003 – 2013 was due to high interest rates and the Central Bank should have reduced the short-term interest rates more quickly and larger extend. In contrast, the Central Bank put forward that the relationship between short-term interest rates and exchange rates has a multi-dimensional and complex nature, and it was not guaranteed to appreciation in exchange rates by reducing the interest rates (Karaca, 2005).

Rest of the paper is organized as follows. In the next section, the theoretical and empirical aspects of the relationship between interest rates and exchange rate are reviewed. In the third section, details of the methodological procedure are explained. Result of the causality analysis is given in the fourth section. The paper concludes in the fifth section.

2. Theoretical Background and Related Literature

The relation between interest rates and exchange rate has been subject to intense debate among economists both theoretically and empirically. As Furman & Stiglitz (1998) pointed out there has been no shortage of opinions about the role of interest rates policies in stabilizing exchange rates, but in general they do not rest on a well-supported body of theory or evidence.

Generally, a contemporaneous relationship is assumed between interest rates and exchange rate. This belief is only warranted under certain circumstances. Using the uncovered interest parity framework,

$$i_t - i_t^* = E(e_{t+1}) - e_t + RP_t$$

where i_t is the domestic interest rate at time *t*, i_t^* is the foreign interest rate at time *t*, e_t is the domestic exchange rate at time *t*, $E(e_{t+1})$ is the expected exchange rate at time $t + 1$, and RP_t is the country risk premium which incorporates both the exchange risk premium and the default risk premium on domestic bonds. According to this framework, an increase in the domestic interest rates will reduce e_t, i.e. appreciate current exchange rate if i_t^* and $E(e_{t+1})$ are kept constant. This is explanation is proposed by the traditional view.

On the other hand, it is hard to remain as constant of $E(e_{t+1})$ and RP_t along the crisis period. Increases in the interest rates may cause to increase in the borrowing costs, induce bankruptcies, weakening the banking system, worsening the financial situation and leading to capital flight. Therefore, a rise in the risk premium can lead to a rise in interest rates. According to the uncovered interest parity equation given below, RP_t increases as i_t increases and if this increase reach to a threshold level, it can be resulted in an increase in e_t. This mechanism is called as the perverse effect which is advocated by the revisionist view (Gümüş, 2002). The debate between these two approaches emerges apparently in theories of flexible-price and sticky-price monetary model, where the relationship between interest rates and exchange rate differentiates (Seleem, 2013: 4).

In the related literature the subject has been searched in the context of currency crises and East Asian currency crisis in 1997 has given momentum to studies on this issue. As the exchange rate began to depreciate at the early stages of the crisis, traditional monetary policy measures were employed. But continued depreciation of the exchange rates made it doubtful to utilize the interest rates across depreciation of the currency (Basurto & Ghosh, 2001: 99).

Furman & Stiglitz (1998) discuss the contemporaneous relationship between interest rate and exchange rate, and identify 13 episodes in nine emerging markets, characterized by “temporarily high” interest rates. They conducted a simple regression analysis and found that both the magnitude and duration of such interest rate rises are coincided with exchange rate depreciation. With some precautionary reservations, they interpret this result that it at least makes questionable the usefulness of raising interest rates to defend the exchange rate. On the other hand, Goldfajn & Baig (1998) analyzed the relationship between nominal interest rates and nominal exchange rates in the aftermath of currency crises, with a special emphasis on the Asian crisis, found no evidence for the weakening impact of higher interest rates on exchange rates. Using a large panel data set, Kraay (1999) examined the usefulness of higher interest rates across speculative attacks. He failed to find very strong positive or negative association between raising interest rates and the outcome of the speculative attack. Cho & West (2003) empirically tested the said relationship for the exchange rate crises in Korea, the Philippines and Thailand during the 1997–98, by proposing a model that identifies a monetary policy rule and found that an exogenous increase in interest rates caused exchange rate appreciation in Korea and the Philippines, depreciation in Thailand, however, they obtained mixed results. For same countries, using simple linear expectation model Kim & Ratti (2006) provided evidence that sharp increase in the interest rate result in business failures that further deepen exchange rate crisis. More technically, one standard deviation shocks in the interest rate is associated with statistically significant response (depreciation) in the exchange rate in Thailand, Korea and the Philippines.

Focusing on exchange rate volatility rather than exchange rate itself, using a Markov regime switching approach, Chen (2006) tried to shed light on the relationship between interest rates and exchange rates in the case of six developing countries. Obtained empirical evidence shows that nominal interest rates increase leads to a higher probability of switching to a regime with more volatile exchange rate.

In all these studies it is assumed that the relationship between interest rates and exchange rates to be time-invariant during the sample periods. In order to have idea as to the dynamics of the relationship Huang et al. (2010) used time-varying parameter model with GARCH errors. They found evidence that the direct effect of the interest rate on the exchange rate in Korea and the indirect effect in Indonesia and Thailand have time-varying behavior. The empirical results they got reveal that, for all three countries, there is no direct channel through which a higher interest rate causes the currency and there is no significant evidence which supports the traditional view.

Studies for Turkey also give mixed results. In an earlier study, using a VAR model, Agenor et. al. (1997) found that the temporary component of the real exchange rate responds significantly and positively to shocks to the interest rate differential. Interpreting the finding as resulting from a tightening of monetary policy, the result found in line with the Turkish experience. Gümüş (2002) using higher frequency (weekly) data set and applying a VECM, found that raising interest rates had the significant long-term effect of depreciating the nominal exchange rate in contrast with the conventional wisdom. Aysoy & Kıpıcı (2005) investigated the impact of interest rates on the exchange rate within a context of quarterly macroeconometric model of Turkey, and concluded that interest rates has depreciating but transitory impact on the exchange rate in the sample period. Berument (2007), using monthly data from 1986:05 to 2000:10 and VAR framework showed that tight monetary policy, which is indicated as spread between the interbank interest rate and the depreciation rate, is associated with the decrease in income and prices and the appreciation of the local currency. When these components entered into VAR separately, an increase in the interbank rate depreciates the local currency permanently, a case called as the exchange rate puzzle.

Akçağlayan (2008) examined the effects of interest rate policy on the exchange rate during the 2001 crisis. Using error correction model and Toda-Yamamoto method, she concluded that an increase in the interest rate leads to a depreciation in domestic currency. Erdoğan et al. (2013) though did not examine the relationship between interest rates and exchange rates directly, found that there is a one way causality relationship between them. They showed that interest rates affect the real and financial sector through exchange rates.

On the other hand, Gül *et al.* (2007), Tarı & Abasız (2009) and Kayhan *et. al.* (2013) implemented the subject solely in terms of causal relationship between interest rates and exchange rate, and found no evidence for causal relationship that run from interest rates to exchange rate.

3. Frequency-domain Causality Test Procedure

After detecting the stationarity features of the series, short and long-term dynamics of the Granger causality relationships would be determined by employing VECM (Vector Error Correction Model) and ECM (Error Correction Model) methods. However, short-term relationships could be ignored while testing the restrictions upon the coefficients put by these methods via Wald and F tests. Because, causality relationship may differ with respect to change in the analysis period or stationarity feature as well as depending on the sign and magnitude of dynamic adaptation lag that obtained from the long term relationship. That is, the short term relationships which probably present in the long term, could not be detected (Tarı *et al.*, 2012: 7)

Statistically, the term frequency domain refers to domain for analysis of mathematical functions or signals with respect to frequencies, rather than time. Accordingly, a stationary process can be expressed as a weighted sum of sinusoidal components with a certain frequency (ω). Graphically, in time-domain signal changes over time, whereas in frequency-domain graph shows how much of the signals lies within each given frequency band over a range of frequencies (Tiwari *et al.*, 2015: 227). Based on Geweke (1982) and Hosoya (1991), Breitung & Candelon (2006) proposed a procedure for frequency-domain causality test[1]. First, they created a two-dimensional vector of time series, $z_t = [x_t, y_t]'$, which has a finite order VAR representation of the form

$$\Theta(L)z_t = \varepsilon_t \tag{1}$$

where $\Theta(L) = I - \Theta_1 L - \cdots - \Theta_p L^p$ is a 2×2 lag polynomial with $L^k z_t = z_{t-k}$. Here, it is assumed that the error term ε_t is white noise, i.e. $\varepsilon_t \sim (0, \Sigma)$. For the sake of simplicity no deterministic terms were contained in Eq. (1).

Let G be the lower triangular matrix of the Cholesky decomposition $G'G = \Sigma^{-1}$ where $\eta_t = G\varepsilon_t$ and $E(\eta_t \eta_t') = I$. Under the assumption of stationary system, the MA representation of the system can be expressed as

$$z_t = \Phi(L)\varepsilon_t = \begin{bmatrix} \Phi_{11}(L) & \Phi_{12}(L) \\ \Phi_{21}(L) & \Phi_{22}(L) \end{bmatrix} \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix} = \Psi(L)\eta_t = \begin{bmatrix} \Psi_{11}(L) & \Psi_{12}(L) \\ \Psi_{21}(L) & \Psi_{22}(L) \end{bmatrix} \begin{bmatrix} \eta_{1t} \\ \eta_{2t} \end{bmatrix} \tag{2}$$

where $\Phi(L) = \Theta(L)^{-1}$ and $\Psi(L) = \Phi(L)G^{-1}$. Accordingly, the spectral density of x_t can be written as

$$f_x(\omega) = \frac{1}{2\pi}\{|\Psi_{11}(e^{-i\omega})|^2 + |\Psi_{12}(e^{-i\omega})|^2\} \tag{3}$$

Using this density, Geweke (1982) and Hosoya (1991) suggested following measure of causality

$$M_{y \to x}(\omega) = log\left[\frac{2\pi f_x(\omega)}{|\Psi_{11}(e^{-i\omega})|^2}\right] = log\left[1 + \frac{|\Psi_{12}(e^{-i\omega})|^2}{|\Psi_{11}(e^{-i\omega})|^2}\right] \tag{4}$$

The measure is zero when $|\Psi_{12}(e^{-i\omega})| = 0$, which means *y* does not cause to *x* at frequency ω.

If the elements of z_t are *I*(1) and cointegrated, then the autoregressive polynomial $\Theta(L)$ has a unit root while the remaining roots are outside the unit circle. Subtracting z_{t-1} from both side of Eq. (1) gives

$$\Delta z_t = (\Theta_1 - I)z_{t-1} + \Theta_2 z_{t-2} + \cdots + \Theta_p z_{t-p} + \varepsilon_t = \tilde{\Theta}(L)z_{t-1} + \varepsilon_t \tag{5}$$

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[1] This section draws heavily on Breitung & Candelon (2006).

where $\tilde{\Theta}(L) = \Theta_1 - I + \Theta_2 L + \cdots + \Theta_p L^p$. If y is not a Granger cause of x, then the (1,2)-element of $\Theta(L)$ (or $\tilde{\Theta}(L)$) is zero. Using the orthogonalized MA respresentation the measure of causality can be expressed as

$$\Delta z_t = \tilde{\Phi}(L)\varepsilon_t = \tilde{\Psi}(L)\eta_t \tag{6}$$

where $\tilde{\Psi}(L) = \tilde{\Phi}(L)G^{-1}$, G is a lower triangular matrix and again $\eta_t = G\varepsilon_t$ and $E(\eta_t\eta_t') = I$. As in the stationary case, in a cointegrated system the resulting causality measure is

$$M_{y\rightarrow x}(\omega) = log\left[1 + \frac{\left|\tilde{\Psi}_{12}(e^{-i\omega})\right|^2}{\left|\tilde{\Psi}_{11}(e^{-i\omega})\right|^2}\right] \tag{7}$$

Within a bivariate framework, the hypothesis that *y* does not cause *x* at frequency *ω* can be expressed notationally as

$$M_{y\rightarrow x}(\omega) = 0 \tag{8}$$

Yao & Hosoya (2000) suggest to estimate $M_{y\rightarrow x}(\omega)$by replacing $|\Psi_{11}(e^{-i\omega})|$ and $|\Psi_{12}(e^{-i\omega})|$ in Eq. (4) with estimates obtained from the fitted VAR. Since the expression $|\Psi_{12}(e^{-i\omega})|$ is a complicated nonlinear function of the VAR parameters and difficult to evaluate its derivative, Breitung & Candelon (2006) propose a much simpler approach to test the null hypothesis in Eq. (8).

From Eq. (4) it follows that $M_{y\rightarrow x}(\omega) = 0$ if $|\Psi_{12}(e^{-i\omega})| = 0$. Using $\Psi(L) = \Theta(L)^{-1}G^{-1}$ and

$$\Psi_{12}(L) = -\frac{g^{22}\Theta_{12}(L)}{|\Theta(L)|}$$

where g^{22} is the lower diagonal element of G^{-1} and $|\Theta(L)|$ is the determinant of $\Theta(L)$. It follows that *y* does not cause *x* at frequency *ω* if

$$|\Theta_{12}(e^{-i\omega})| = \left|\sum_{k=1}^{p} \theta_{12,k}\cos(k\omega) - \sum_{k=1}^{p} \theta_{12,k}\sin(k\omega)\, i\right| = 0$$

where $\theta_{12,k}$ is the (1,2)-element of Θ_k. Thus, a necessary and sufficient set of conditions for $|\Theta_{12}(e^{-i\omega})| = 0$ is

$$\sum_{k=1}^{p} \theta_{12,k}\cos(k\omega) = 0 \tag{9}$$

$$\sum_{k=1}^{p} \theta_{12,k}\sin(k\omega) = 0 \tag{10}$$

The approach of Breitung & Candelon (2006) is based on the linear restrictions in Eq. (9) and (10). Letting that $\alpha_j = \theta_{11,j}$ and $\beta_j = \theta_{12,j}$ the VAR equation for x_t is written as

$$x_t = \alpha_1 x_{t-1} + \cdots + \alpha_p x_{t-p} + \beta_1 y_{t-1} + \cdots + \beta_p y_{t-p} + \varepsilon_{1t} \tag{11}$$

The hypothesis $M_{y\rightarrow x}(\omega) = 0$ is equivalent to the linear restriction

$$H_0: R(\omega)\beta = 0 \tag{12}$$

where $\beta = [\beta_1, \dots, \beta_p]'$ and

$$R(\omega) = \begin{bmatrix} \cos(\omega) & \cos(2\omega) & \dots & \cos(p\omega) \\ \sin(\omega) & \sin(2\omega) & \dots & \sin(p\omega) \end{bmatrix}$$

The ordinary F statistic for this test is approximately distributed as $F\,(2,\ T-2p)$ for $\omega \in (0,\ \pi)$. By replacing x_t in Eq. (11) by Δx_t, with the r.h.s. of the equation remaining the same, the frequency domain causality test within conintegrating framework can be implemented. Furthermore, this approach can be generalized to test for causality in higher-dimensional systems. Details have been given in Breitung & Candelon (2006).

4. Empirical Analysis

In this section, we apply causality test in the frequency domain to assess the predictive content of the short-term interest rate for future exchange rate. To this end we used monthly data of short-term interest rate (SIR) and USD / TRL exchange rate (EXR). The former is expressed as mean of the overnight interest rates that valid in the interbank market. Necessary data were derived from the Electronic Data Delivery System – EDDS, the database of Central Bank of Republic of Turkey – CBRT. The sample covers the period 2003m1 – 2015m8. Before analyses, both series were transformed into their first differences of logarithmic values.

Table 1. Results of ADF, PP and KPSS unit root tests

Variable	*c*	*c + t*	*c*	*c + t*	*c*	*c + t*
INR	-8,6900* (0)	-8,7838* (0)	-8,6699* (1)	-8,7838* (0)	0,1837* (5)	0,0479* (4)
EXR	-9,1288* (1)	-9,6097* (1)	-8,6083* (7)	-8,7550* (10)	0,4725 (1)	0,0283 (6)

Notes: i. Figures in parentheses denote lag length for ADF test and band width for PP and KPSS tests. 2) In determining the proper lag length for ADF test SIC was used, in determining the proper bandwidth for PP and KPSS tests Newey-West Bandwidth criterion was employed. 3) *c* and *c+t* stand for constant and deterministic trend terms respectively whereas * denotes rejection of unit root hypothesis at 5% significance level.

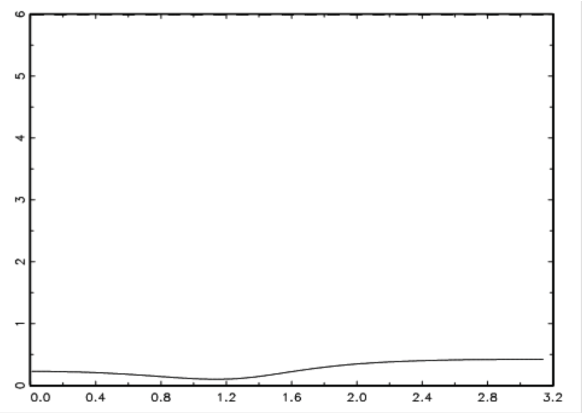

Fig. 1. Causal relationship from *INR* to *EXR*.

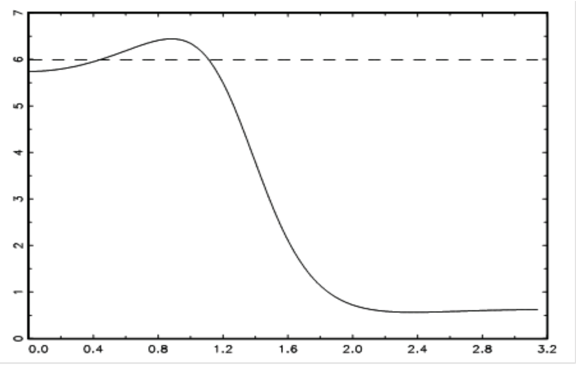

Fig. 2. Causal relationship from *EXR* to *INR*.

Applying the methodology above we have obtained the views given in Fig. 1 and Fig. 2. Scrutinizing the Fig. 1 it is evident that there is no causal relationship from INR to EXR while EXR is cause to INR between $\omega \chi$ (0.4,1.2) frequencies or the period of (2004:09 – 2007:02) according to Fig. 2. These findings were further supported by usual Granger non-causality test (see Tab. 2). These findings are in line with Gül et al. (2007), Tarı & Abasız (2009) and partially with Kayhan et. al. (2013).

Table 2. Results of Granger causality test

Null Hypotheses	*F* statistic	*p* – value
INR does not Granger cause *EXR*	0.12714	0.8807
EXR does not Granger cause *INR*	3.14090	0.0461

Note: According to AIC proper lag length is 2.

Conclusion

The relationship between interest rates and the exchange rate has been subject to hot debate for a long time. While the rationale for using the interest rates to defend the exchange rates stability is well defined in economic theory, the empirical validation of its effectiveness remains mostly inconclusive. Many empirical studies have been performed to examine the interest rates – exchange rate nexus, especially for the East Asian countries.

In this paper we tried to shed some light on this subject, in the case of Turkey, by using frequency domain causality test developed by Breitung & Candelon (2006). Using monthly data for the period of 2003 – 2015, we find no evidence that higher interest rates cause to a weakening of exchange rate. As with Furman & Stiglitz (1998), we recognize that this result is not definitive evidence of the effect of high interest rates on the ability to defend the exchange rate, but at the very least, it questions the presumption that increasing interest rates is an effective mechanism for defending the exchange rate, and as Basurto & Ghosh (2001) we conclude that the perverse effect of higher interest rates on the exchange rate remains a theoretical matter.

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